NARCO
NAV 110/111/112/114 NAV COMS
GENERAL INDEX

	ATP GRID
TABLE OF BLOW-UPS	1B03
RECORD OF REVISIONS	1B04
MAINTENANCE MANUAL	1B02
SECTION I - INTRODUCTION	1C02
SECTION II - INSTALLATION	1C16
SECTION III - NAV 110/COM 110 TSO	1G02
SECTION IV - COM III TSO	1M02
SECTION V - NAV 111/112 TSO	2C02
SECTION VI - NAV 114 TSO	2G02
SECTION VII - TSO'D MP 10	2K02

TABLE OF BLOW-UPS

FIGURE		PAGE	ATP GRID	BLOW-UP FICHE
	Interconnect Board	2-5	1C22	NC F903
2-2	Com 110 TSO Installation Drawing	2-7	1C24	
2-3	COM 110 TSO/NAV 110 TSO Interconnection Diagram	2-9	1D02	
2-4	Nav 110 TSO Installation Drawing	2-11	1D04	
2-6	Basic Com 111 TSO Helicopter Intercom Wiring	2-18	1D11	
2-7	Com 111 TSO Interconnection Diagram	2-20	1D13	
2-8	Com 111 TSO Installation Drawing	2-21	1D14	
2-9	Nav 111 TSO Wiring	2-25	1D18	
2-11	Nav 111 TSO Installation Drawing	2-29	1D22	
2-12	Nav 112 TSO Wiring	2-33	1E02	
2-14	Nav 112 TSO Installation Drawing	2-37	1E06	
2-19	28V Interconnect Wiring Diagram for NAV 114 TSO DME-UGR 2A-DGO-102	2-43	1E12	
2-20	Typical Nav 114 TSO Bench Test Wiring	2-44	1E13	
2-21	Nav 114 TSO Control Head Selector Switch and Stand by Wiring	2-46	1E15	
2-22	Nav 114 TSO Installation Drawing	2-49	1E18	
2-25	VCNA-1 or VCNA-2 Antennas	2-53	1E22	
2-28	MP 10 Installation and Recommended Wiring Diagram	2-57	1F02	
3.3-3	Omni/Loc Switching	3-5	1G08	
3.5-4	Localizer Board	3-40	1H21	
3.5-5	Omni Board	3-42	1H23	
3.5-8	Synthesizer Board, Com 110 TSO	3-48	1J05	
3.5-9	Interconnect Board, Com 110 TSO	3-53	1J10	
3.5-11	Transmitter PC Board, Com 110 TSO	3-55	1J12	
3.5-12	Modulator PC Board, Com 110 TSO	3-57	1J14	
3.5-13	Receiver Board, Com 110 TSO	3-60	1J17	NC F904
3.6-1	Nav 110 TSO Omni Maintenance Information	3-63	1J20	
3.6-2	Nav 110 Tso Localizer Maintenance Information	3-65	1J22	
3.6-3	Nav 110 Tso Internal Interconnection Diagram	3-67	1J23	
3.6-4	Nav 110 TSO Omni Schematic	3-69	1K02	
3.6-5	Nav 110 TSO Localizer Schematic	3-71	1K06	
3.6-7	Com 110 TSO Receiver Schematic	3-75	1K14	
3.6-8	Com 110 TSO Synthesizer Schematic	3-77	1K18	
3.6-9	Com 110 TSO Transmitter/Modulator Schematic	3-79	1K22	
3.6-10	Com 110 TSO Interconnect PC Board Schematic	3-81	1L04	

TABLE OF BLOW-UPS

FIGURE		PAGE	ATP GRID	BLOW-UP FICHE
4.5-3	Synthesizer Board Com 111 TSO	4-26	2A07	NC F904
4.5-4	Interconnect Board Com 111 TSO	4-31	2A12	
4.5-6	Transmitter PC Board, Com 111 TSO	4-33	2A14	
4.5-7	Modulator PC Board, Com 111 TSO	4-35	2A16	
4.5-8	Receiver Board Assy, Com 111 TSO	4-37	2A18	
4.6-1	Internal Interconnect Diagram Com 111 TSO	4-41	2A21	
4.6-2	Receiver Schematic Com 111 TSO	4-43	2B02	
4.6-3	Synthesizer Schematic, Com 111 TSO	4-45	2D06	NC F905
4.6-4	Transmitter Schematic, Com 111 TSO	4-47	2B10	
4.6-5	Interconnect PC Board Schematic	4-49	2B14	
5.3-3	Omni/Loc Switching	5-5	2C10	
5.3-4	Bridge T Filter	5-6	2C11	
5.4-1	Nav 111 TSO/Nav 112 TSO Internal Interconnect	5-16	2C23	
5.5-5	Localizer Board, Nav 111 TSO/Nav-112 TSO	5-28	2D17	
5.5-6	Omni Board, Nav 111 TSO/Nav 112 TSO	5-32	2D21	
5.5-7	Synthesizer HFO Assy	5-35	2D24	
5.5-8	Synthesizer LFO Assy	5-35	2D24	
5.5-9	Synthesizer Filter Assy	5-36	2E01	
5.5-10	Receiver Board Assy	5-38	2E03	
5.5-10A	Receiver (Chassis CN D217C/CNE217C)	5-40A	2E06	
5.6-1	Omni Maintenance Information, Nav 111 TSO/Nav 112 TSO	5-41	2E10	
5.6-2	Localizer Maintenance Information, Nav 111 TSO/ Nav 112 TSO	5-43	2E12	
5.6-3	Internal Interconnection Diagram with Glide slope Connections	5-45	2E13	
5.6-3A	Internal Interconnection Diagram with Glide slope and DME Connections	5-46A	2E15	
5.6-4	Omni Schematic, Nav 111 TSO/Nav 112 TSO	5-47	2E18	
5.6-5	Localizer Schematic, Nav 11 TSO/Nav 112 TSO	5-49	2E22	
5.6-6	Receiver	5-51	2F02	NC F906
5.6-6A	Receiver Schematic (Chassis CND219C/CNE219C	5-52A	2F06	
5.6-7	Synthesizer Schematic, Nav 111 TSO/Nav 112 TSO	5-53	2F11	
6.5-2	Connector Board	6-21	2H10	
6.5-3	Synthesizer Board Assy, Nav 114 TSO	6-23	2H12	
6.5-4	Receiver Board Assy	6-26	2H15	
6.5-4A	Receiver PC Board-Nav 114	6-28A	2H18	

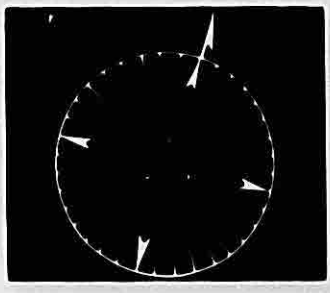
TABLE OF BLOW-UPS

FIGURE		PAGE	ATP GRID	BLOW-UP FICHE
6.6-1	Internal Interconnect Diagram, Nav 114 TSO	6-29	2H21	NC F906
6.6-2	Receiver Schematic	6-31	2J02	
6.6-2A	Receiver Schematic (Chassis CNF219C)	6-32A	2J06	
6.6-3	Synthesizer Schematic	6-33	2J11	
6.6-4	Connector Board Schematic	6-35	2J14	
	Schematic	7-2	2K05	

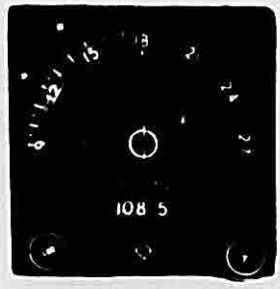
NARCO AVIONICS

TSO'd SPECTRUM LINE

Nav-Coms



NAV 110 TSO



NAV 111 TSO

NAV 112 TSO

MAINTENANCE MANUAL

NARCO AVIONICS
DIVISION OF NARCO SCIENTIFIC INDUSTRIES
FORT WASHINGTON, PENNSYLVANIA, 19034 U.S.A.

January, 1973
Reprinted 2/75

03092-0600

Printed in U.S.A.

ATP
RECORD OF REVISIONS

REV. NO.	SECTIONS COVERED IN REVISION	REV. DATE	INSERTION DATE	BY	NOTES

LIST OF EFFECTIVE PAGES

This List of Effective Pages lists all pages contained in this manual including those pages which were intentionally left blank. The date, where omitted, implies that the page is an original page of this manual.

PAGE	DATE
Cover	2/75
A	2/75
B	
1-1	2/75
1-2 Blank	
2-1	2/75
2-2	2/75
2-3	
2-4	
2-5	2/75
2-6	2/75
2-7	
2-8 Blank	
2-9	
2-10	4/1/73
2-11	
2-12 Blank	
2-13	
2-14	
2-15	
2-16	
2-17	
2-18	2/75
2-19	2/75
2-20	
2-21	2/75
2-22 Blank	
2-23	4/1/73
2-24	2/75
2-25	2/75
2-26	2/75
2-27	
2-28 Blank	
2-29	
2-30 Blank	
2-31	
2-32	2/75
2-33	2/75
2-34	2/75
2-35	
2-36	
2-37	
2-38 Blank	
2-39	
2-40	2/75
2-41	
2-42	
2-43	
2-44	
2-45	
2-46	
2-47	
2-48 Blank	
2-49	
2-50 Blank	
2-51	
2-52	
2-53	
2-54 Blank	
2-55	
2-56 Blank	
2-57	2/75
2-58 Blank	
3-1	
3-2	
3-3	
3-4	
3-5	
3-6	
3-7	2/75
3-8	2/75
3-9	
3-10	
3-11	2/75
3-12	
3-13	
3-14	
3-15	
3-16	
3-17	
3-18	
3-19	2/75
3-20	
3-21	4/1/73
3-22	
3-23	
3-24	
3-25	2/75
3-26	
3-27	
3-28	
3-29	
3-30	
3-31	
3-32	
3-33	
3-34	
3-35	
3-36	
3-37	
3-38	
3-39	
3-40	
3-41	
3-42	
3-43	
3-44	
3-45	
3-46	
3-47	
3-48	
3-49	
3-50	
3-51	
3-52	
3-53	
3-54	
3-55	
3-56	
3-57	
3-58	
3-59	
3-60	
3-61	
3-62 Blank	
3-63	
3-64 Blank	
3-65	4/1/73
3-66 Blank	
3-67	2/75
3-68 Blank	
3-69	2/75
3-70 Blank	
3-71	2/75
3-72 Blank	
3-73	
3-74 Blank	
3-75	4/1/73
3-76 Blank	
3-77	2/75
3-78 Blank	
3-79	4/1/73
3-80 Blank	
3-81	
3-82 Blank	
4-1	
4-2	
4-3	2/75
4-4	
4-5	2/75
4-6	
4-7	
4-8	
4-9	
4-10	
4-11	2/75
4-12	
4-13	2/75
4-14	
4-15	
4-16	
4-17	
4-18	
4-19	
4-20	4/1/73
4-21	
4-22	
4-23	
4-24	
4-25	
4-26	
4-27	
4-28	
4-29	
4-30	
4-31	
4-32	
4-33	
4-34	
4-35	
4-36	
4-37	
4-38	
4-39	
4-40 Blank	
4-41	2/75
4-42 Blank	
4-43	4/1/73
4-44 Blank	
4-45	2/75
4-46 Blank	
4-47	4/1/73
4-48 Blank	
4-49	2/75
5-1	
5-2	
5-3	
5-4	
5-5	
5-6	
5-7	
5-8	
5-9	
5-10	
5-11	2/75
5-12	
5-13	4/1/73
5-14	
5-15	
5-16	
5-17	
5-18	
5-19	
5-20	
5-21	
5-22	
5-23	
5-24	
5-25	
5-26	
5-27	
5-28	
5-29	
5-30	
5-31	
5-32	
5-33	
5-34	
5-35	2/75
5-36	
5-37	
5-38	
5-39	
5-40 Blank	
5-41	
5-42 Blank	
5-43	4/1/73
5-44 Blank	
5-45	2/75
5-46 Blank	
5-46A	2/75
5-46B Blank	
5-47	2/75
5-48 Blank	
5-49	2/75
5-50 Blank	
5-51	
5-52 Blank	
5-53	4/1/73
5-54 Blank	
61-	
62-	
6-3	2/75
6-4	
6-5	2/75
6-6	
6-7	2/75
6-8	
6-9	
6-10 Blank	
6-11	2/75
6-12	
6-13	2/75
6-14	
6-15	
6-16	
6-17	4/1/73
6-18	2/75
6-19	
6-20	
6-21	
6-22	
6-23	
6-24	
6-25	
6-26	
6-27	
6-28	
6-29	2/75
6-30 Blank	
6-31	4/1/73
6-32 Blank	
6-33	2/75
6-34 Blank	
6-35	
6-36 Blank	
7-1	
7-2	

1.1 GENERAL

This manual supports the following NAV/COM equipments of NARCO's TSO'd Spectrum Line:

Section 2, Installation

Section 3, COM 110 TSO /NAV 110 TSO System

Section 4, COM 111 TSO

Section 5, NAV 111 TSO and NAV 112 TSO (including DME channeling)

Section 6, NAV 114 TSO (with DME channeling)

Section 7, MP 10 (TSO'd)

1.1.1 Organization

With the exception of the first two sections, Introduction and Installation, each subsequent section supports specific units.

Within each of these sections the primary topics have been standardized in sequence. Subordinate sections detail the circuitry, maintenance procedures, parts lists, and schematics.

EXAMPLE
6.4.3.2

The 6 identifies Section 6, NAV 114 TSO
The 4 identifies the primary topic in the section as Maintenance.
The 3 identifies a particular area (or assembly).
The 2 identifies details pertinent to the repair or replacement of a part or assembly.

Primary topics are, for example:

6.1 General Information
6.2 Installation Data
6.3 Circuit Description
6.4 Maintenance
6.5 Replacement Parts List
6.6 Schematics

Assemblies common to more than one section are repeated in each section that the assembly is common to.

1.2 NAV 110 TSO/COM 110 TSO SYSTEM

This System contains a NAV 110 TSO and a COM 110 TSO. These units are panel mounted: the NAV unit fits a standard 3 inch diameter opening, the COM unit is installed in the standard width stack area.

The NAV 110 TSO is a separate VOR/LOC Converter/Indicator. This unit has its own frequency selector and when the COM 110 TSO mode switch is in the NAV position, the receiver will operate on the full 200 navigation channels with 50 KHz spacing (108.00 to 117.95).

The COM unit is of solid state design which transmits and receives on 360 channels (118.00 to 135.95 MHz). A digital synthesizer eliminates 80% of the mechanical switching, assuring precise frequency lockon. FET, receiver RF and mixer stages are utilized for interference free low level and high level performance. IC's and subassemblies minimize service time. An Ident filter switch is built-in with the squelch control. The COM's receiver is used by both the COM and the NAV units. Both units cannot use the receiver at the same time. However, no matter which position the NAV/COM mode switch is in, when the transmitter is keyed, the radio will transmit on the frequency that is set in the COM unit. The COM's panel contains a two position slide switch that indicates NAV or COM, thus identifying which unit is utilizing the shared receiver.

1.3 COM 111 TSO

The COM 111 TSO is designed to be used exclusively as a 360 channel transceiver. When used with a NAV 111 TSO or a NAV 112 TSO, the units comprise a one and one-half system.

The COM 111 TSO is essentially the same as the COM 110 TSO except for the NAV/COM mode switch and the Ident Filter.

1.4 NAV 111 TSO and NAV 112 TSO

These solid state un are independent navigation receivers that present OMNI/LOC information, the NAV 112 TSO also contains a glideslope display. Both units have the capability of receiving on all 200 (50 KHz spacing) channels. These units fit a standard 3 inch diameter opening.
Both these units are available prewired for DME channeling.

1.5 NAV 114 TSO

The NAV 114 TSO is a solid state, fully independent NAV receiver that can be placed in the "stack." The NAV 114 TSO has no navigation display as it was designed to drive displays such as NARCO's DGO 10, an HSI, VOR Converters: VOA 100/110, VOA 40/50, VOA 8/9, or the CLC 60.
All NAV 114 units are wired for DME channeling.

1.6 MP 10 (TSO'd)

The TSO'd MP 10 is a standard series pass type of voltage regulator. The input voltage may vary from 20 to 32 volts and the output voltage will remain between 13.8 and 15.0 volts with a 1 amp load.

TABLE OF CONTENTS

SECTION	TOPIC	PAGE	ATP GRID
2	INSTALLATION	2-1	1C18
	TSO EXPLANATION	2-1	
2.1	GENERAL	2-2	1C19
2.2	LICENSE REQUIREMENTS	2-2	
2.3	COM 110 TSO	2-3	1C20
2.3.1	Specifications	2-3	
2.3.2	Units and Accessories Supplied	2-3	
2.3.2.1	COM 110 TSO/NAV 110 TSO Accessories Required, but NOT Supplied	2-3	
2.3.2.2	Optional Accessories	2-4	1C21
2.3.3	Mechanical Installation	2-4	
2.3.3.1	COM 110 TSO	2-4	
2.3.3.2	COM Tray Mounting	2-4	
2.3.4	Electrical Connections	2-4	
2.3.4.1	COM 110 TSO/NAV 110 TSO Interconnection	2-4	
2.3.4.2	Modifications Required for 28V Operation	2-5	1C22
2.3.4.2.1	Procedure	2-5	
2.3.4.3	COM 110 TSO Audio Input Connections	2-6	1C23
2.3.4.4	COM 110 TSO Cabin Speaker Amplifier	2-6	
2.4	NAV 110 TSO	2-10	1D03
2.4.1	Specifications	2-10	
2.4.2	Units and Accessories Supplied	2-10	
2.4.3	Mechanical Installation	2-10	
2.4.3.1	NAV 110 TSO	2-10	
2.4.4	Electrical Connections	2-10	
2.5	COM 110 TSO/NAV 110 TSO SYSTEM PRE-INSTALLATION BENCH TEST	2-13	1D06
2.5.1	Test Set-up and Test of the System	2-13	
2.5.2	Mike Gain Adjust	2-13	
2.5.3	Post Installation	2-13	
2.6	COM 110 TSO/NAV 110 TSO SYSTEM OPERATION	2-14	1D07
2.7	COM 111 TSO	2-15	1D08
2.7.1	Specifications	2-15	
2.7.2	Units and Accessories Supplied	2-15	
2.7.2.1	COM 111 TSO Accessories Required, but NOT Supplied	2-15	
2.7.2.2	Optional Accessories	2-16	1D09
2.7.3	Mechanical Installation	2-16	
2.7.3.1	COM 111 TSO (Including helicopter units)	2-16	
2.7.3.2	COM Tray Mounting	2-16	
2.7.4	Electrical Connections	2-16	
2.7.4.1	COM 111 TSO	2-17	1D10
2.7.4.2	Helicopter COM 111 TSO External Wiring	2-17	
2.7.4.3	COM 111 TSO Audio Input Connecting	2-18	1D11
2.7.4.4	COM 111 TSO Cabin Speaker Amplifier	2-19	1D12
2.7.4.5	Modifications Required for 28V Operation	2-19	
2.7.4.5.1	Procedure	2-19	
2.7.5	COM 111 TSO Pre-Installation Bench Test	2-19	
2.7.5.1	Test Set-up and Test of the COM 111 TSO	2-19	
2.7.5.2	Mike Gain Adjustment	2-19	
2.7.5.3	Post Installation	2-19	
2.7.6	COM 111 TSO Operation	2-20	1D13
2.8	NAV 111 TSO	2-23	1D16
2.8.1	Specifications	2-23	
2.8.2	Units and Accessories Supplied	2-23	
2.8.2.1	NAV 111 TSO Accessories Required, but NOT Supplied	2-23	
2.8.3	Mechanical Installation	2-23	
2.8.3.1	NAV 111 TSO	2-23	
2.8.4	Electrical Connections	2-24	1D17
2.8.4.1	NAV 111 TSO	2-24	
2.8.4.2	Audio Input Connections	2-24	
2.8.4.3	NAV 111 TSO Autopilot Outputs	2-24	
2.8.5	Pre-Installation Bench Test	2-25	1D18
2.8.5.1	Test Set-up and Test for NAV 111 TSO	2-25	
2.8.5.2	Post Installation	2-25	
2.8.6	NAV 111 TSO Operation	2-27	1D20
2.9	NAV 112 TSO	2-31	1D24
2.9.1	Specifications	2-31	
2.9.2	Units and Accessories Supplied	2-31	
2.9.2.1	NAV 112 TSO Accessories Required, but NOT Supplied	2-31	
2.9.2.2	Optional Accessories	2-31	
2.9.3	Mechanical Installation	2-32	NIC
2.9.3.1	NAV 112 TSO	2-32	
2.9.4	Electrical Connections	2-32	
2.9.4.1	NAV 112 TSO	2-32	
2.9.4.2	NAV 112 TSO Audio Input Connections	2-32	
2.9.4.3	Autopilot Output	2-32	
2.9.5	Pre-Installation Bench Test	2-35	1E04
2.9.5.1	Test Set-up and Test for NAV 112 TSO	2-35	
2.9.5	Installation	2-35	

TABLE OF CONTENTS (Continued)

SECTION	TOPIC	PAGE	ATP GRID	BLOW-UP FICHE
2.10	NAV 114 TSO	2-39	1E08	
2.10.1	Specifications	2-39		
2.10.2	Units and Accessories Supplied	2-39		
2.10.2.1	Companion Units	2-39		
2.10.2.2	Accessories Required, but NOT Supplied	2-39		
2.10.2.3	Optional Accessories	2-39		
2.10.3	Mechanical Installation	2-40	1E09	
2.10.3.1	NAV Tray Mounting	2-40		
2.10.4	Electrical Connections	2-40		
2.10.5	Pre-Installation Bench Test	2-45	1E14	
2.10.5.1	Procedure	2-45		
2.10.5.2	Post Installation	2-45		
2.10.6	NAV 114 TSO Operation	2-47	1E16	
2.11	SPECIAL TOOLS FOR CABLE CONNECTOR FABRICATION	2-51	1E20	
2.12	ANTENNAS	2-52	1E24	
2.12.1	VCA-10	2-52		
2.12.2	VRP-37	2-52		
2.12.3	VNA-10	2-52		
2.12.4	VCNA-1 or VCNA-2	2-52		
2.13	VOLTAGE CONVERTER, MP 10	2-57	1F02	
2.13.1	Specifications	2-57		

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE		BLOW-UP FICHE
2-1	Coax Cable Assy	2-4	1C21	
2-2	COM 110 TSO Installation Drawing	2-7	1C24	NC F903
2-3	COM 110 TSO/NAV 110 TSO Interconnection Diagram	2-9	1D02	NC F903
2-4	NAV 110 TSO Installation Drawing	2-11	1D04	NC F903
2-5	Coax Cable Assy	2-16	1D09	
2-6	Basic COM 111 TSO Helicopter Intercom Wiring	2-18	1D11	NC F903
2-7	COM 111 TSO Interconnection Diagram	2-20	1D13	NC F903
2-8	COM 111 TSO Installation Drawing	2-21	1D14	NC F903
2-9	NAV 111 TSO Wiring	2-25	1D18	NC F903
2-10	NAV 111 TSO DME Pigtail Connector	2-26	1D19	
2-11	NAV 111 TSO Installation Drawing	2-29	1D22	NC F903
2-12	NAV 112 TSO Wiring	2-33	1E02	NC F903
2-13	NAV 112 TSO DME Pigtail Connector	2-34	1E03	
2-14	NAV 112 TSO Installation Drawing	2-37	1E06	NC F903
2-15	14V General NAV 114 TSO With DME Interconnect Wiring Diagram	2-41	1E10	
2-16	28V General NAV 114 TSO With Interconnect Wiring Diagram With the MP 10 Input Controlled By The NAV 114 DME's ON-OFF Switch	2-42	1E11	
2-17	Alternate 28V NAV 114 TSO DME Interconnect Wiring Diagram Sharing The MP 10 With Other Units and Supplying Switched 28V to Accessory Units	2-42		
2-18	14V Interconnect Wiring Diagram For NAV 114 TSO DME-UGR2A-DGO 10	2-43	1E12	NC F903
2-19	28V Interconnect Wiring Diagram For NAV 114 TSO DME-UGR2A-DGO 10	2-43		
2-20	Typical NAV 114 TSO Bench Test Wiring	2-44	1E13	NC F903
2-21	NAV 114 TSO Control Head Selector Switch and Standby Wiring	2-46	1E15	NC F903
2-22	NAV 114 TSO Installation Drawing	2-49	1E18	NC F903
2-23	Crimping Tool	2-51	1E20	
2-24	VNA-10 Antenna	2-53	1E22	NC F903
2-25	VCNA-1 or VCNA-2 Antennas	2-53		
2-26	VCA-10 Antenna	2-55	1E24	
2-27	VRP-37 Antenna	2-55		
2-28	MP 10 Installation and Recommended Wiring Diagram	2-57	1F02	NC F903

LIST OF TABLES

SECTION	TITLE	PAGE	
2-1	NAV 111 TSO DME Channel Programming	2-26	1D19
2.2	NAV 112 TSO Glideslope Programming	2-33	1E02
2.3	NAV 112 TSO DME Channel Programming	2-34	1E03
2.4	NAV 114 TSO Glideslope Programming	2-45	1E14
2.5	NAV 114 TSO DME Channel Programming	2-46	1E15

TSO EXPLANATION

The TSO Spectrum Line is approved to be instrument panel mounted within the cabin environment of fixed and rotary wing aircraft using piston or turbine single and multi engines. It is designed for non-pressurized aircraft operating up to 30,000 feet as well as for pressurized aircraft. This equipment requires direct current power but is approved to be installed in aircraft that have additional on board alternating current power sources.

The TSO'd MP 10 Power Converter is approved identically to the TSO Spectrum Line except it may be fuselage mounted in all but fixed wing turbine aircraft.

There are twelve Environmental Test Procedures established in RTCA Document DO-138. These are identified on the TSO Nameplate. The explanation of Environmental Limits for each of these categories for the TSO Spectrum Radios are as follows:

All TSO Spectrum Radios except MP 10 ..... DAPAAAXXXXXX

TSO'd MP 10 ..... $\frac{B}{G}A\frac{N}{L}$ AAAXXXXXX

Ambient Temperature-Altitude

TSO Spectrum Line ..... (D) APAAAXXXXXX

Temperature Range:

Nonoperating Low -50°C (-58°F)
High +71°C (+160°F)

Up to 30 minutes of operation +65°C (+149°F)

Continuous operation
Low −15°C (+5°F)
High +55°C (+131°F)

Altitude: 30,000 Ft. Nonpressurized
15,000 Ft. Pressurized; is not affected by decompression to 40,000 Ft.

TSO'd MP 10 ..... (B/G) A N/L AAAXXXXXX

Temperature Range:

Nonoperating Low -54°C (-65°F)
High +71°C (+160°F)

Continuous operation
Low -46°C (-51°F)
High +71°C (+160°F)

Altitude: 30,000 Ft. Nonpressurized
15,000 Ft. Pressurized; is not affected by decompression to 40,000 Ft.

Humidity

TSO Spectrum Line D (A) PAAAXXXXXX

TSO'd MP 10 .... $\frac{B}{G}$ (A) $\frac{N}{L}$ AAAXXXXXX

Standard Humidity for equipment intended for installation in Civil Aircraft.

These units have been tested under the following humidity conditions: +50°C (+122°F) at 95% RH, reduced to +38°C (+100°F) with humidity maintained as high as possible.

This cycle was repeated twice for a total of 48 hours of exposure. Within 15 minutes* after exposure the units were operated and met all specifications.

*TSO requires that all specifications be met within 4 hours after exposure.

Vibration

TSO Spectrum Line .... DA (D) AAAXXXXXX

Approved when mounted in the instrument panel of any type of piston or turbine, single engine or multiengine fixed wing or rotary wing aircraft. The maximum vibration limits are 0.10 inch double amplitude from 5 to 17 Hz, 1.5G constant acceleration from 17 to 55 Hz, 0.25G from 55 to 2000 Hz.

TSO'd MP 10 ..... $\frac{B}{G}$A(N/L) AAAXXXXXX

Approved when mounted anywhere in the fuselage of any fixed wing, single or multi engine piston aircraft, or fuselage mounted in either piston or turbine engine rotary wing aircraft. The maximum vibration limits are 0.10 inch double amplitude from 5 to 17 Hz, 1.5G constant acceleration from 17 to 35 Hz, 0.02 inch double amplitude from 38 Hz to 55 Hz, and 1.0G constant acceleration from 55 Hz to 2000 Hz.

Audio Frequency Magnetic Field Susceptibility*

TSO Spectrum Line .... DAP (A) AAXXXXXX

TSO'd MP 10 ..... $\frac{B}{G}A\frac{N}{L}$ (A) AAXXXXXX

This equipment is approved for installation in aircraft which have alternating current power sources, including those rated at more than 250 volt amps.

*It is not susceptable to alternating current power source pick up.

Radio Frequency Susceptibility

TSO Spectrum Line .... DAP A (A) AXXXXXX

TSO'd MP 10 ..... $\frac{B}{G}A\frac{N}{L}$A (A) AXXXXXX

This equipment has been tested and is not affected by interference from other on board electronic equipment which meet Category A, Radio Frequency Spurious Emission requirements of the TSO (RTCA Document DO-138).

Radio Frequency Spurious Emission

TSO Spectrum Line .. DAPAA (A) XXXXXX

TSO'd MP 10 ..... $\frac{B}{G}A\frac{N}{L}$AA (A) XXXXXX

This equipment has been tested and does not emit RF in excess of that which would interfere with other on board electronic equipment which meet the requirements of Category A, Radio Frequency Susceptibility of the TSO (RTCA Document DO-138).

Other Environmental Conditions

TSO Spectrum Line .... DAPAAA XXXXXX

TSO'd MP 10 ..... $\frac{B}{G}A\frac{N}{L}$AAA XXXXXX

The letter "X" denotes that recognized installation practices in Civil Aircraft normally do not encounter these Environmental Conditions and are therefore not tested.

These remaining six categories which are shown X'ed from Left to Right refer to:

Explosion ... Waterproofness Hydraulic Fluid
Sand and Dust Fungus ..... Salt Spray .....

2.1 GENERAL

This Section contains detailed instructions for the installation, bench test, and operation of the following NARCO AVIONICS TSO'd NAV/COM:

*NAV 110 TSO, a NAV converter designed to be mated with a COM 110 TSO for receiver circuitry.

NAV 111 TSO, an independent VHF NAV receiver/converter. This unit can be purchased completely wired for DME channeling.

NAV 112 TSO, an independent VHF NAV receiver/converter with glide slope channeling capability and associated meter presentation. Designed to control a remote glide slope receiver such as NARCO's TSO'd UGR-2 or UGR-2A. This unit can be purchased completely wired for DME channeling.

NAV 114 TSO, an independent VHF NAV receiver designed primarily to drive the Narco Pictorial Navigation Display, the DGO 10. The NAV 114 TSO can also drive an HSI, VOR converters such as the VOA 100/110, the VOA 40/50, the VOA 8/9, or NARCO CLC-60 RNAV System.This unit also has ARINC output to drive most existing HSI/Flight Director OMNI Converters. All NAV 114 TSO units are wired for and have DME channeling capability.

* COM 110 TSO, an independent communications transceiver, but designed for use with the NAV 110 TSO.

The COM 110 TSO has a front panel mode switch that transfers the receiver from the communications frequency band to the NAV frequency band to provide the NAV 110 TSO converter with VOR/LOC information.

COM 111 TSO, an independent communications transceiver.

MP 10, a TSO'd voltage converter, 28 to 14 vdc.

*As the NAV 110 TSO and the COM 110 TSO were designed to function as a System, these units will be supported as a single System in the manual.

INSTALLATION HINTS

Our experience with Spectrum field problems indicates that many of the problems related to noise in the radio, alternator whine, regulator clatter, strobe power supply noise, etc, has been a result of misapplication of ground connections of the various Spectrum equipments.

COM 110 TSO/111 TSO

As illustrated in the Installation Manual, the COM Units have three ground connections; J401A-1 Power ground, J401A-2 Mike ground, and J401A-6 Speaker and Phones ground. The only terminal that should be connected to airframe ground is pin 1 or pin 2 (they are the same point physically in the radio). Pin 6 should not be used as ground return; it is only to be used to carry ground out to a floating Speaker, Phones and Mike circuit for those installations where grounding these jacks induces noise into the transmitter carrier and/or noise in the headphone-speaker system.

NAV 111 TSO/112 TSO

The Navigation receiver/converter unit has a rear support stud (8-32) which is connected internally to Chassis Ground J101, pin 11. This support stud can also be used as DC ground return. When it is used, care should be taken not to run a ground wire from pin 11 to some other ground connection. Dual grounds can produce a "ground loop" effect that can induce unwanted noises (alternator whine, regulator clicking, rotary beacon-strobe noise, etc.) into the converter and interfere with OMNI presentation and/or Ident/ ATIS reception.

NAV 114 TSO

The same situation exists in connecting a NAV 114 TSO into an aircraft system, pin 1 of P501A is the only pin to be used for DC ground. Pins 6 and 15 are connections used to carry signal source ground out to an associated OMNI converter and audio junction box for those situations where grounding of the associated circuits (audio & Omni) may cause noise to be induced into the system.

2.2 LICENSE REQUIREMENTS

NAV 110 TSO, NAV 111 TSO, NAV 112 TSO, and NAV 114 TSO require no licensing. COM 110 TSO and COM 111 TSO require licensing in accordance with the following instructions:

If the aircraft has been previously licensed for a communications transmitter, resubmittal of FCC form 404 is not required.

The Federal Communications Commission requires that the operator of the transmitter in this equipment hold a Restricted Radio Telephone Operator Permit, or higher class license. A permit may be obtained by any U.S. citizen from the nearest field office of the FCC; no examination is required.

The transmitter itself, as installed in the aircraft, requires an Aircraft Radio Station License. This license is obtained by Filing FCC Form 404. The COM units may be operated for up to 30 days without a station license, after filing the FCC Form 404 and while awaiting receipt for the station license, providing a copy of the FCC Form 404 is kept in the aircraft.

CAUTION

The VHF transmitter in this equipment is guaranteed to meet Federal Communications Commission approval only when NARCO Crystals are used.

Use of other than NARCO crystals will void manufacturers warranty.

2.3 COM 110 TSO

2.3.1 Specifications

Mechanical

Size: Panel Unit (See Figure 2-2)

Weight: Panel Unit, 3.0 lb.; tray including Connector Kit, 0.53 lb.

Electrical

Voltage: 13.75 operation only

Current: Receive — .8 amps (not including pilot lights)
Transmit — 2.5 amps
Pilot lights — .16 amps

Environmental:

Meets the following TSO Categories:

TSO	ENV CAT.	
C-36c	DAP AAA XXXXXX	Class C
C-37b	DAP AAA XXXXXX	Class II
C-38b	DAP AAA XXXXXX	
C-40a	DAP AAA XXXXXX	

*See Page 2-1.

Receiver

Frequency Range:
118.00 to 135.95 MHz (360 channels) COM mode
108.00 to 117.95 MHz (200 channels) NAV mode

Sensitivity:
COM Band: 1.5μv Nominal/2.5μv Maximum for 6 db S+N/N ratio.

NAV Band: 1.5μv Nominal/2.0μv Maximum for 6 db S+N/N ratio.
2.5μv maximum for full flag.

Spurious and Image Rejection:
Greater than 60 db.

Selectivity:
6 db (nose) — 34 KHz Minimum
60 db (skirt) — 84 KHz Maximum

AVC Flatness:
1 db Maximum for 10μv to 10Kμv

Tone Filter:
18 db minimum ident signal rejection

Audio Output: (5μv, 30% mod., 1000 Hz)
Speaker: 10w minimum
Headphones: 50 mw into 300 ohms

OMNI Accuracy (with NAV 110):
1½° nominal

Audio AGC:
3 db maximum 30% to 100% modulation
(RF signal input = 50μv)

Transmitter

Power Output: 8 watts minimum
Modulation: 85% minimum

Frequency Stability: Maximum ±.005%

Microphone Input:
Adjusted for 0.2v @ 100 ohms.

Duty Cycle: Typical 20%

2.3.2 Units and Accessories Supplied

COM 110 TSO
Tray Assy. 55980-0101
Installation Kit, 03087-0500
(See Fig. 2-2)

2.3.2.1 COM 110 TSO/NAV 110 TSO Accessories Required, but NOT Supplied

For proper operation of these equipments the following accessories are required: a transmitting antenna and a receiving antenna (or a combination type), loud speaker and/or headphones, microphone.

To ensure complete FAA Part 37 TSO compliance as applied to Air Carrier operation, these equipments must be used with Communication and Navigation antennas meeting TSO's C-36b, C-37b, C-38b, and C-40a requirements.

When TSO compliance is not required, the following antennas are recommended.

A. Transmitting Antenna: NARCO type VCA-10 broad band type with gasket, hardware, and BNC connector, Part No. 05502-0000.

B. Receiving Antenna: NARCO type VRP-37 tail mounting type with 30 feet of RF cable and "Balun." Part No. 05507-0000.

OR

NARCO type VNA-10 tail mounting type, Part No. 71226-0001.

C. VHF COM NAV Antenna. VCNA-1 and -2. The COM 110 TSO may use either of these two antennas, without qualification.

D. Loudspeaker/Headphones:
1. Loudspeaker — voice coil impedance, 4 ohms.
2. Headphones — low impedance type, 300 to 1000 ohms. Both handphones and speaker may be used simultaneoulsy.

E. Microphone: The mike gain was set for the Telex low impedance mike. Any other carbon or dynamic noise cancelling mike may be used, however the mike gain may require resetting.

2.3.2.2 Optional Accessories

A. MP 10 Voltage Converter, 28 to 14 volts. (See Section 2-13 for details.)

2.3.3 Mechanical Installation

2.3.3.1 COM 110 TSO

The COM unit is designed to be installed into a pre-mounted panel tray. The unit contains a locking screw, in the front panel, which should be turned full CCW before sliding the unit into the tray. After the unit is in the tray, the locking screw should be turned full CW, this draws in the radio and as it does the mating connector(s) will engage, providing positive connection and securing the radio in the tray.

DO NOT RAM THE UNIT INTO THE TRAY!

Removal of a unit is the reverse of installation, turn the locking screw CCW until the unit is free of the connector(s).

Figure 2-2 provides a detailed drawing of the tray and the parts of the installation kit. The figure also provides all the necessary dimensions for the panel cutout as well as that for the mounting bracket locations, plus a 1:1 panel cutout template.

2.3.3.2 COM Tray Mounting

The COM unit mounting tray shall be mounted behind the aircraft instrument panel using No. 6 binding head screws at each of the four mounting holes.

Mounting brackets to mate the holes are not supplied due to the wide range in mounting requirements. Suitable mounting brackets may be fabricated from ordinary metal sheet or angle stock.

The tray must be provided with a good electrical ground. A ground strap can be attached to the rear-side mounting screw.

It is recommended that the panel mounted unit be provided with ram air cooling.

NOTE: The COM 110 TSO tray has two 15 pin connectors, plus the Coax Cable Assy which must be installed (as shown) prior to mounting the tray in the aircraft. Dress the leads of the connector(s) thru the cable clamp(s) to avoid undue stresses.

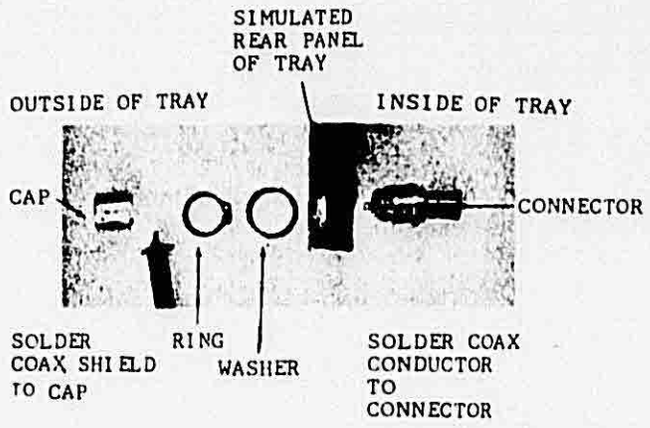


FIGURE 2-1. COAX CABLE ASSY

2.3.4 Electrical Connections

The installing agency is required to make-up the installation cable. Lengths are dependent upon the particular aircraft installation. Refer to the wiring diagrams for all cable connections. Also refer to Section 2.11 for proper lead termination.

It is recommended that circuit protection (COM Units 7.5 amp), be provided between the aircraft buss and the Unit.

All leads should be #22AWG unless otherwise noted.

2.3.4.1 COM 110 TSO/NAV 110 TSO Interconnection

Figure 2-3 shows both installation and interconnection wiring between aircraft and the unit.

The coax cable should be 50 ohm RG-58A/U.

2.3.4.2 Modifications Required for 28V Operation

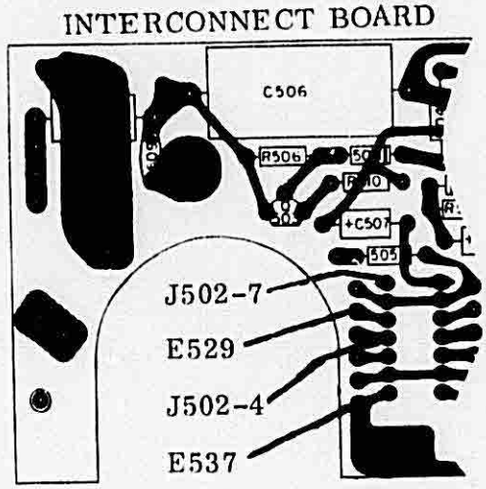
This system is manufactured for 14 volt service, however, with the use of a voltage converter and the addition of a few jumpers, the units can be used in aircraft having 28 volt service.

2.3.4.2.1 Procedure

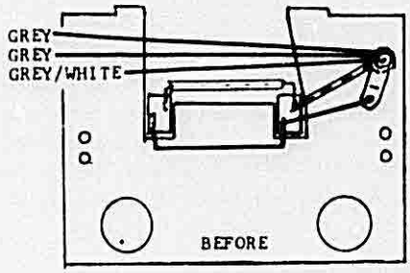
1. Install a 28 to 14v Voltage Converter as outlined in Section 2.13.
2. The COM unit's pilot light power source is via a dimmer switch or directly from the aircraft buss, therefore the pilot light circuit must be modified (a change from parallel to series wiring). Refer to the Interconnect Board, partial drawing.

   A. Remove the wire from pin 4 to P502 which mates J502 and connect it to Pin 5 of P502.
   B. Remove the black wire from E537, on the Interconnect Board, and connect it to E529.

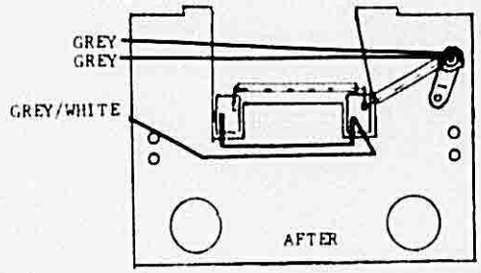
3. The NAV 110 TSO receives it's power source directly from the COM 110 TSO, therefore its A+ is that of the COM 110 TSO. The pilot lights, like the COM units must be modified for proper operation.



A. Remove the wire, in its entirety, which is attached to the ground lug and the bottom terminal of the LOWER pilot light pair.



B. Remove the white/grey wire from the standoff on the Front Panel Assembly and connect it to the bottom terminal of the LOWER pilot light pair.



NOTE: No modification is necessary to pilot lights if the pilot light input is connected to the switched A+ output of the COM 110 TSO.

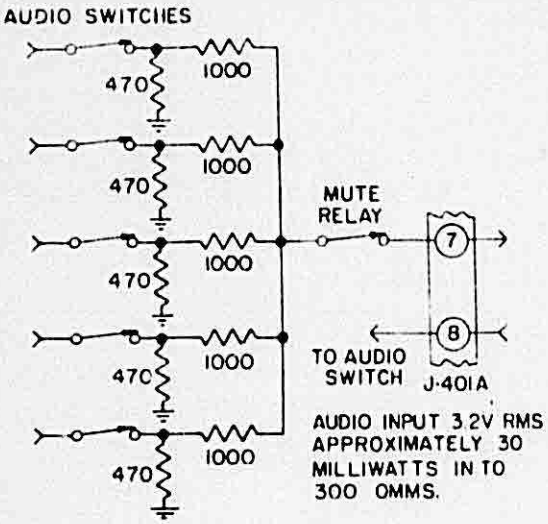
SEE BLOW-UP

2.3.4.3 COM 110 TSO Audio Input Connections

The COM Interconnection diagram show a 1.5K resistor between J401A, pin 7 and pin 8. This resistor is required when an installation does NOT use an audio switching panel containing an isolation amplifier. When an audio switching panel with an isolation amplifier is used (i.e.: Narco's VP22 or CP25), the resistor is removed.

In installations where several switched audio inputs are desired for the COM 110 TSO system and an isolation amplifier is not used, an audio summing network must be utilized for optimum performance. The following diagram show example of such a network. In all installations terminal 3 can be used for headphone connection.

The following example of a summing network can be utilized. Mute relay is controlled by the mike key.



2.3.4.4 COM 110 TSO Cabin Speaker Amplifier

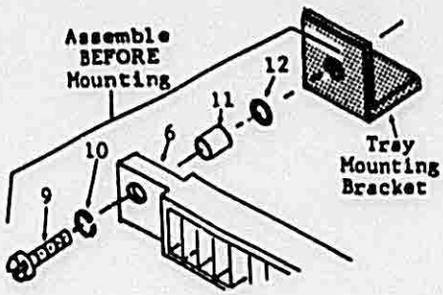
The COM 110 TSO can serve as a cabin speaker amplifier for such Low Level audio equipments as ADF's, MBT's and NAV units as well as its regular communication functions.

To utilize this feature, the following re-routing of the A+ must be made.

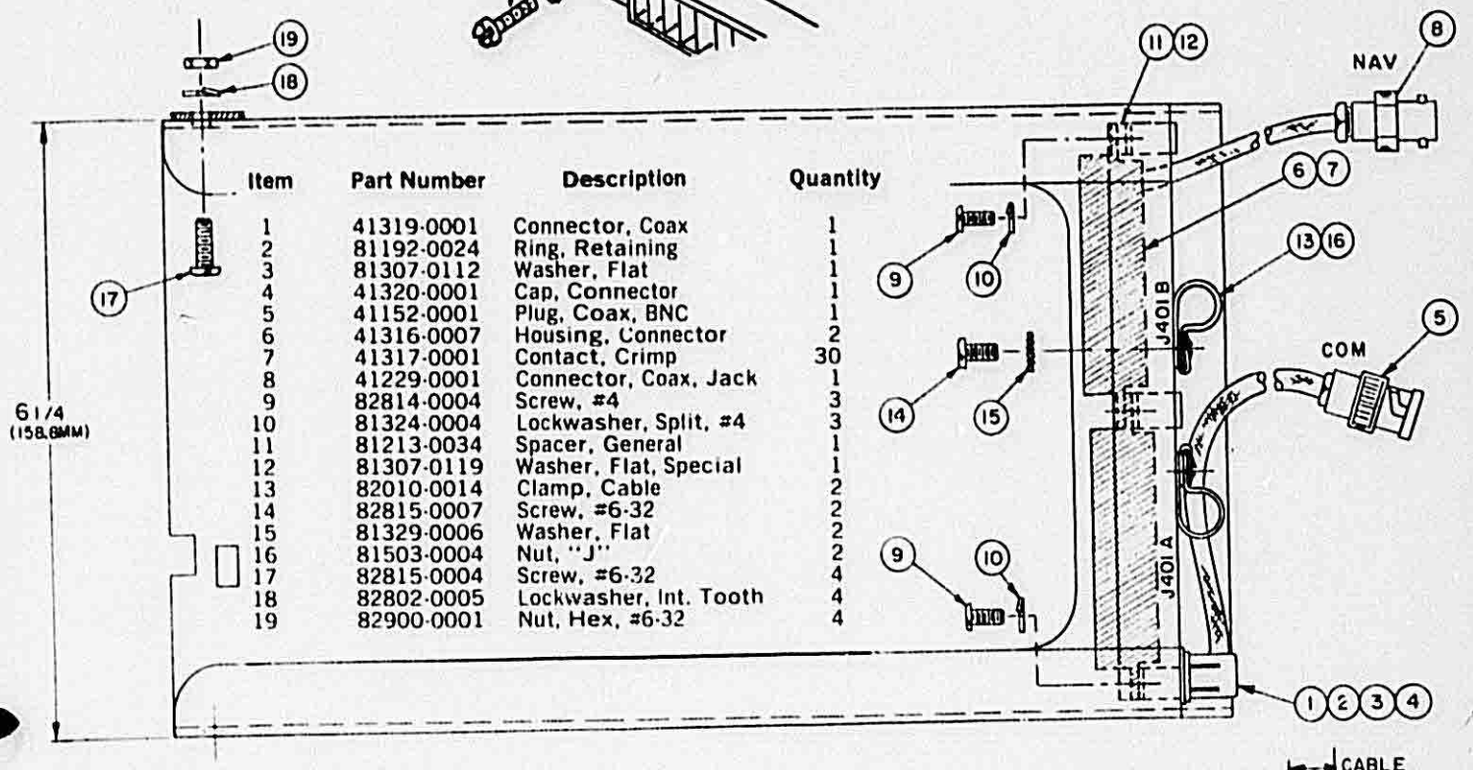
To activate ONLY the COM's audio circuits, the COM's ON-OFF switch must be bypassed and activated via the aircraft's master switch or its circuit breaker in series with the unit.

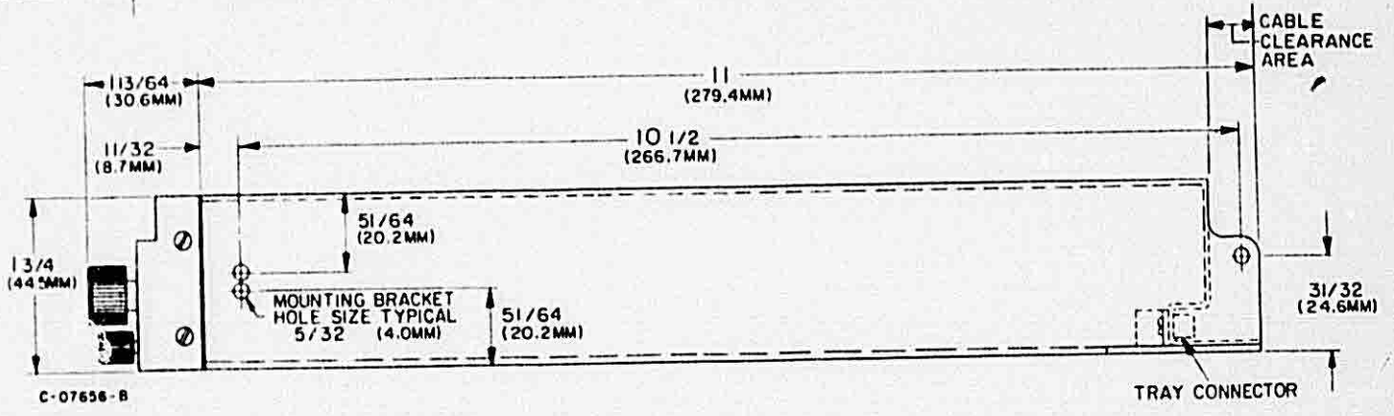
1. Jumper the two blue speaker wires on the ON-OFF switch.
2. Locate and remove the YELLOW #24 wire from the pin at the right rear corner of the Interconnect Board (the pin is on the same pad where one end of R505 is terminated).
3. Attach this YELLOW #24 wire to Pin E532 on the Interconnect Board. (Positive side of 2200 mfd capacitor C501).

This modification will now activate the audio circuits via the master switch or the circuit breaker and when the COM unit is turned ON, the COM unit will be completely activated.



Item	Part Number	Description	Quantity
1	41319-0001	Connector, Coax	1
2	81192-0024	Ring, Retaining	1
3	81307-0112	Washer, Flat	1
4	41320-0001	Cap, Connector	1
5	41152-0001	Plug, Coax, BNC	1
6	41316-0007	Housing, Connector	2
7	41317-0001	Contact, Crimp	30
8	41229-0001	Connector, Coax, Jack	1
9	82814-0004	Screw, #4	3
10	81324-0004	Lockwasher, Split, #4	3
11	81213-0034	Spacer, General	1
12	81307-0119	Washer, Flat, Special	1
13	82010-0014	Clamp, Cable	2
14	82815-0007	Screw, #6-32	2
15	81329-0006	Washer, Flat	2
16	81503-0004	Nut, "J"	2
17	82815-0004	Screw, #6-32	4
18	82802-0005	Lockwasher, Int. Tooth	4
19	82900-0001	Nut, Hex, #6-32	4





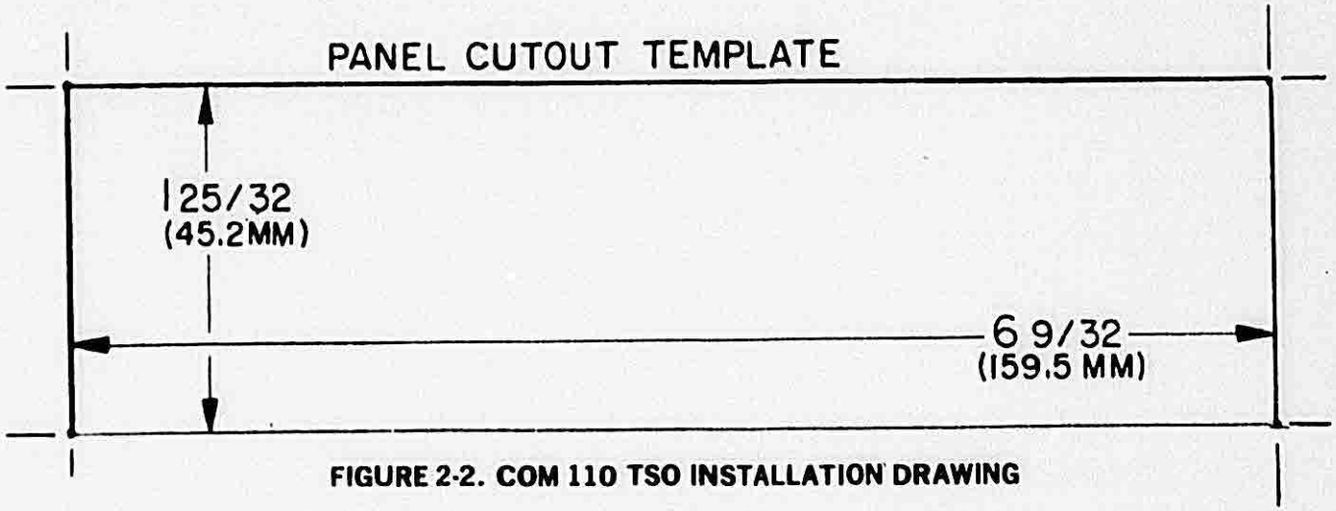
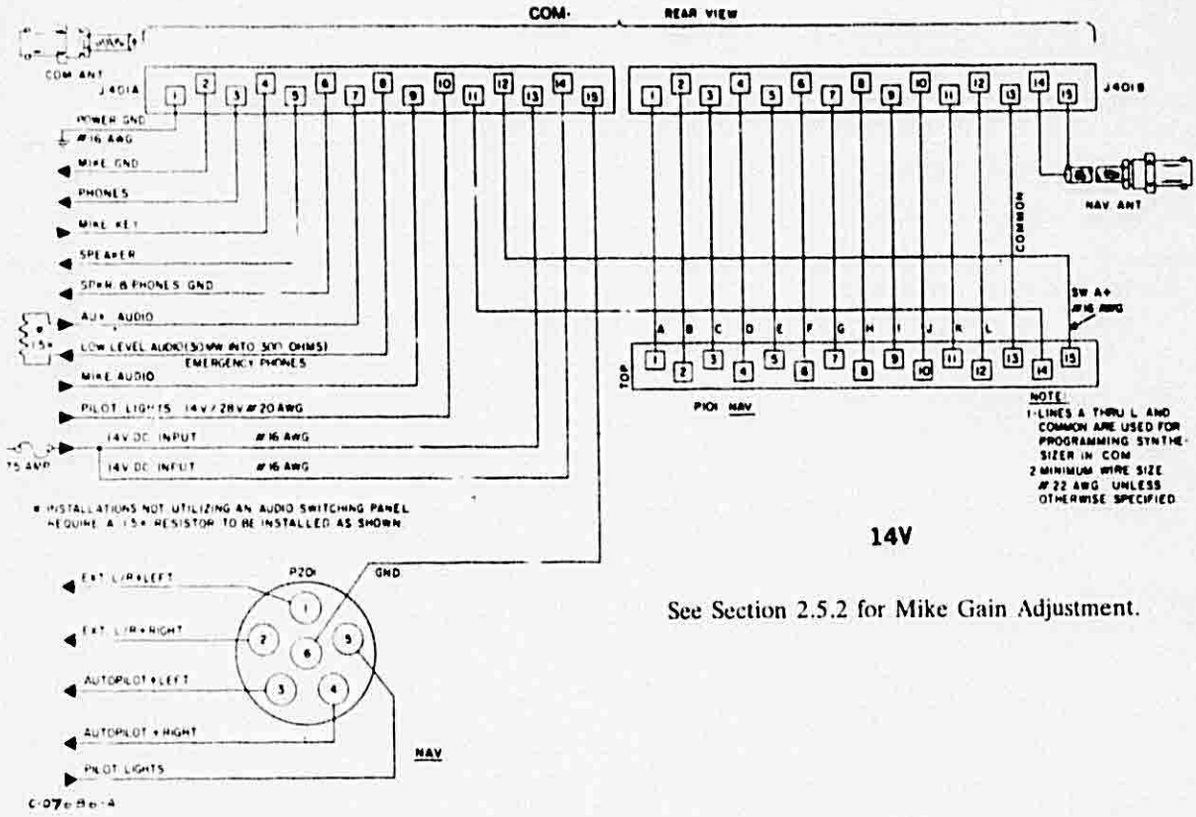


FIGURE 2-2. COM 110 TSO INSTALLATION DRAWING

SEE BLOW-UP



See Section 2.5.2 for Mike Gain Adjustment.

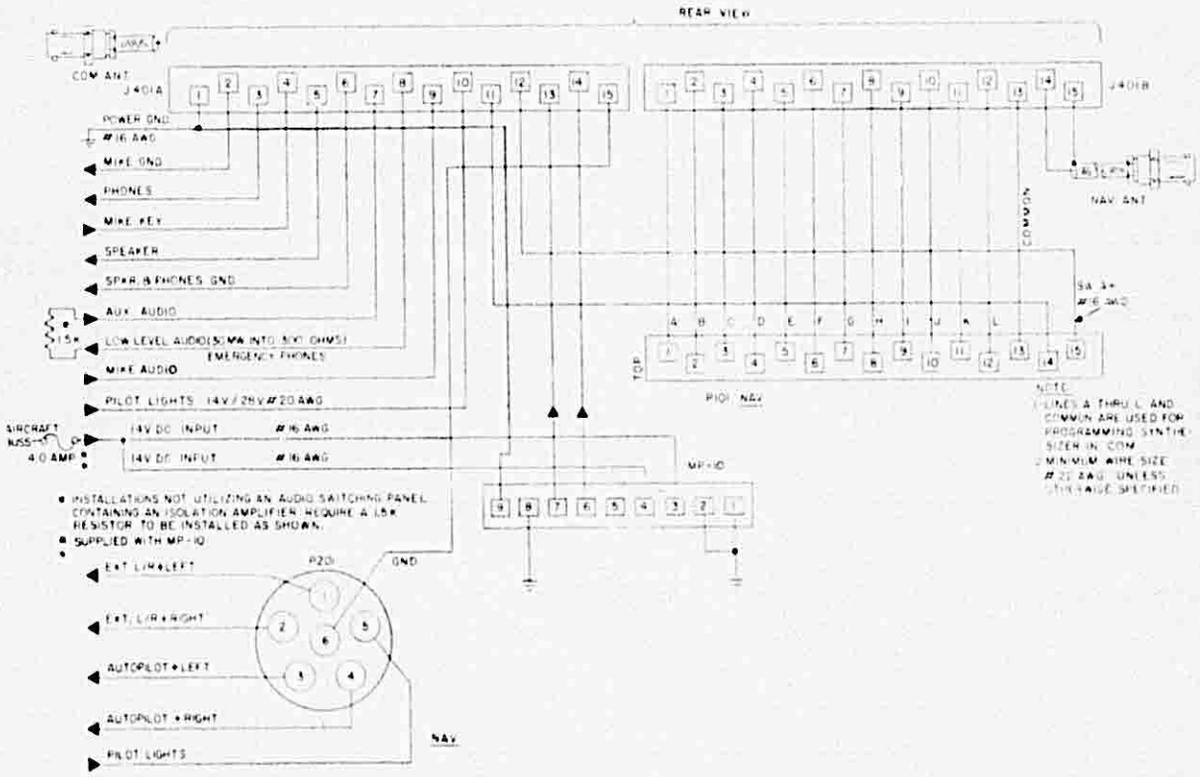


FIGURE 2-3. COM 110 TSO/NAV 110 TSO INTERCONNECTION DIAGRAM

SEE BLOW-UP

2.4 NAV 110 TSO

2.4.1 Specifications

Mechanical
Size: Panel Unit (See Figure 2-4)

Weight: 1 lb. 11 oz.

Electrical
Voltage: 13.75 operation only

Current: Pilot lights — .32 amps

Environmental:
Meets the following TSO categories

TSO	ENV CAT.	
C-36c	DAP AAA XXXXXX	Class C
C-40a	DAP AAA XXXXXX	

*See Page 2-1.

Receiver

Frequency Range:
118.00 to 135.95 MHz (360 channels) COM mode
108.00 to 117.95 MHz (200 channels) NAV mode

Sensitivity:
COM Band: 1.5μv Nominal/2.5μv Maximum for 6 db S+N/N ratio.
NAV Band: 1.5μv Nominal/2.0μv Maximum for 6 db S+N/N ratio.
2.5μv maximum for full flag.

Spurious and Image Rejection:
Greater than 60 db

Selectivity:
6 db (nose) — 34 KHz Minimum
60 db (skirt) — 84 KHz Maximum

AVC Flatness:
1 db Maximum for 10μv to 10Kμv

Tone Filter:
18 db minimum ident signal rejection

Audio Output: (5 μv, 30% mod., 1000 Hz)
Speaker: 10w minimum COM 110 TSO
Headphones: 50 mw into 300 ohms

OMNI Accuracy:
1.5° nominal

Audio AGC:
3 db maximum 30% to 100% modulation
(RF signal input = 50 μv)

2.4.2 Units and Accessories Supplied

NAV 110 TSO

Installation Kit, 03088-0501
(See Fig. 2-4)

2.4.3 Mechanical Installation

For 28v operation, see modifications required, Section 2.3.4.2.

2.4.3.1 NAV 110 TSO

NAV 110 TSO unit is designed to be mounted in a standard 3" aircraft instrument panel opening, with minor modifications. The installation drawing provides all the necessary dimensions including a 1:1 template, should a complete cutout be required.

The NAV 110 TSO is secured to the panel by three #6-32 screws, the length of which must be determined at the time of installation due to various panel thicknesses. Refer to Notes of the NAV 110 TSO installation drawing.

A screw (stud) is provided on the rear of the NAV unit for rear support mounting.

2.4.4 Electrical Connections

The installing agency is required to make-up the installation cable. Lengths are dependent upon the particular aircraft installation. Refer to the wiring diagrams for all cable connections. Also refer to Section 2.11 for proper lead termination.

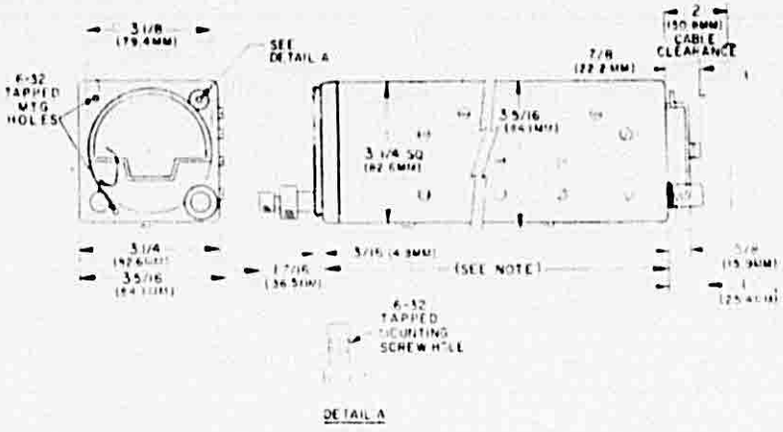
All leads should be #22AWG unless otherwise noted.

Figure 2-3 shows both installation and interconnection wiring between aircraft and the unit.

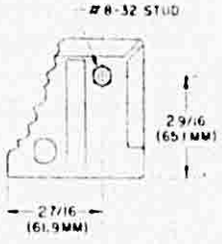
The coax cable should be 50 ohm RG-58A/U.

2.4.4.1 NAV 110 TSO Autopilot Outputs

The NAV 110 TSO can provide OMNI/LOC information to an Autopilot Coupler. Couplers having an input impedance of 5000 ohms or greater may be connected directly across the appropriate pins shown in the Interconnection Diagram. Signal level available is 150 millivolts across a 1K ohm load impedance for a 10 degree course change on OMNI; 90 millivolt for 4 db modulation difference in LOC signal level. Neither AUTOPILOT input lead may be grounded.



	INCHES	MILLIMETERS
A	3 3/16	81.0
B	1/4 DIA	6.4 DIA
C	5/32 DIA	4.0 DIA
D	1/8 R	3.2 R
E	1 3/4 R	44.5 R
F	1 41/64 R	41.7 R
G	13/16	20.6
H	1 59/64 R	40.9 R
J	9/32 R	7.1 R
K	1 5/64	37.7



NOTES:

These equipments are rear panel mounted.
Chassis length 8½" (215.9MM)
Mounting screws to be No. 6-32,
Length to be: 7/16 Min ¾" Max
Plus thickness of panel.

Rear connections:
Has connector and connector assy.

Part Number	Installation Kit	Quantity
41316-0007	CONNECTOR, SHELL, 15 pin	1
41317-0001	CONTACT, CONNECTOR	15
82019-0002	STRAP, CABLE	1
82814-0004	SCREW, 4-40 x 5/16	3
82802-0003	LOCKWASHER, No. 4	3
82900-0004	NUT, HEX, No. 4-40	3
82815-0109	SCREW, 6-32 x ¾	3
55951-0001	HANDLE, CONNECTOR without eyelet	1
81254-0012	EYELET (to be installed in) handle)	1
41116-0002	CONNECTOR, 6 pin	1

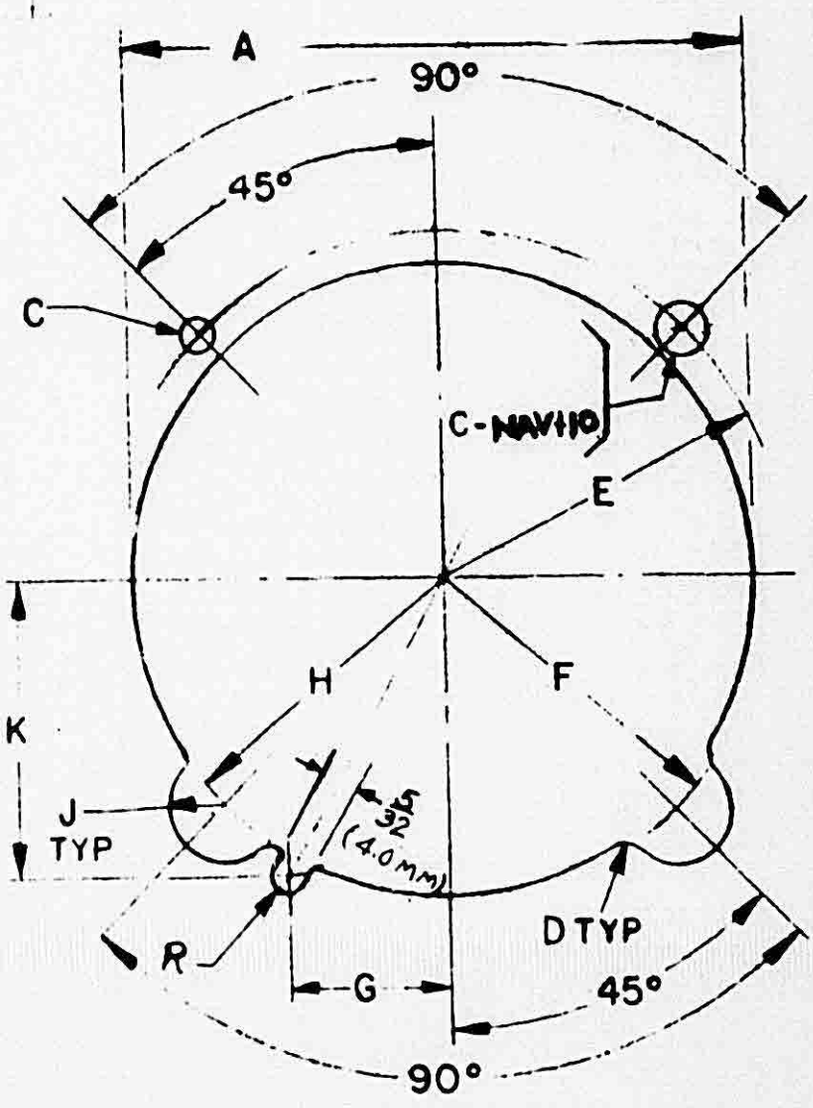


FIGURE 2-4. NAV 110 TSO INSTALLATION DRAWING

SEE BLOW-UP

2.5 COM 110 TSO/NAV 110 TSO SYSTEM PRE-INSTALLATION BENCH TEST

The equipment required to perform this test is listed below:

A low impedance microphone with a push-to-talk switch (preferably the mike to be used in the aircraft).

A speaker load box, 15w capability.

A low voltage dc supply, 12-15 vdc at 10-15 amps such as an Electro Products Laboratories Model NFB or equivalent.

An RF Power Wattmeter: Bird Termaline Model 61 or equivalent.

A VHF Signal Generator, Hewlett Packard Model 608D or equivalent.

An OMNI Signal Generator, Aircraft Radio Corp. Model H-14A or equivalent.

2.5.1 Test Set-Up and Test of the System

Plug the connectors into the COM unit or NAV unit being sure that the contacts mate the contacts of the printed circuit board. (The plug can be put on upside down and no contact will be made.)

Refer to the Interconnection Diagram, Figure 2-3 and connector, J401A.

Connect microphone to the MIKE KEY, pin 4.

Connect speaker load box to the SPEAKER/SPKR & PHONES GND, pins 5 and 6.

Connect a 1.5K resistor between the ANX. AUDIO, pin 7 and the LOW LEVEL AUDIO, pin 8.

Connect a low voltage dc supply to the power input leads, pins 1 (GND), 13 and 14 (A+).

Connect a RF Power Wattmeter or a VHF Signal Generator to the COM RF Output Connector.

Connect an OMNI Signal Generator the NAV antenna connector.

A. Apply power (13.75 VDC).

B. Turn VOL knob full CW, set function switch to COM and position IDENT switch to IDENT. Channel radio to a generator frequency.

C. Check for sensitivity of the COM circuits including audio output. Reading should be 1.5μv for 6 db S+N/N, audio should be 10 watts for the COM unit when RF input is 3.0μv (modulated at 30% - 1000 Hz).

D. Switch to a NAV channel. Switch function switch to NAV, reading should be 1.5μv for 6 db S+N/N, audio output should be 10 watts when RF input is 3.0μv (modulated at 30% - 1000 Hz).

E. Check omni operation using a crystal controlled omni channel at the four cardinal points (0, 90, 180, 270°) readings should ±1.5°.

F. Check Transmitter output by keying transmitter. Readings should be 8 watts minimum for the COM 110 TSO.

G. Modulate the radio, the RF Power output meter should react with a "wiggle."

H. Jumper connector pins 10 to 12 to check internal lighting.

I. To check NAV programming of COM Synthesizer, check 108 MHz on all KHz steps and check all MHz steps on .00 KHz.

J. To check COM programming, check 118 MHz on all KHz steps and check all MHz steps on .00 KHz.

2.5.2 Mike Gain Adjustment

It is recommended that the mike gain adjustment be accomplished on the bench using the aircraft's mike(s). This adjustment can be made in the aircraft, however it would require repeated removal and replacement of the unit as the gain is adjusted to the desired level. Should the aircraft have more than one mike, the unit should be adjusted with each mike and if necessary compromise the setting fror this multi-mike use. Do not key more than one mike at a time.

Adjust the mike gain as follows:

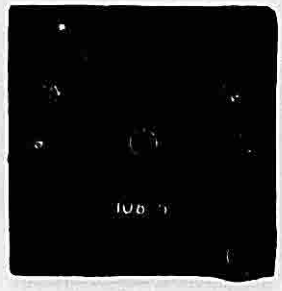
Use the aircraft's mike!

Connect headphones to "phones output" of the Com unit (Pin #3). With mike gain adjust control set fully counterclockwise talk, in a normal speaking voice, into the microphone. Slowly rotate the mike adjust clockwise to the point where the audio in the headphones begins to sound distorted. Rotate the adjustment approximately one-eighth turn counterclockwise from this point for best modulation performance.

2.5.3 Post Installation

After the installation has been completed, the system should be operated on the ground, with all normal power turned ON and the engine running. The receiver should be checked for proper operation by channeling to available signals. The transmitter output and audio quality may be checked by contacting a Control Tower or Unicom.

A FLIGHT TEST IS RECOMMENDED.



2.6 COM 110 TSO/NAV 110 TSO SYSTEM OPERATION

This knob energizes both the COM and the NAV units. Turning the knob CW past the "click" turns the units ON and continued rotation increases volume. Conversely CCW reduces volume and turns the units OFF.

COM Frequency Channeling

The two large knobs have no stops, thus allowing shortest (CW or CCW) rotation to the desired frequency. The left knob selects the MKz (the whole number) the right knob selects the KHz (the fractional number).

SQUELCH

The SQUELCH knob establishes the RF input signal level required to give an audio signal output from the COM receiver. The input signal level is increased by turning the knob CCW. Maximum signal level is with the tick at the 7 o'clock position.

IDENT

Pulling the SQUELCH knob (about ¼") actuates the IDENT switch. The IDENT switch overrides the internal tone filter and when in the IDENT position (out) allows the 1020 Hz station identification code to be heard.

NAV/COM Mode Switch

The mode switch opens up the receiver circuitry of the COM unit for exclusive use by the NAV 110 TSO. Thus it can be seen that you can communicate in the COM mode and navigate in the NAV mode but you can't do both at the same time.

NAV Frequency Channeling

The NAV 110 TSO has dual knobs (large MHz-Small-KHz) to allow channeling NAV frequencies which are seen in the window. The KHz knob is free to allow continuous turning CW or CCW, for it has no stops. The MHz knob rotates CW and CCW between the low end at 108 and the high end stop at 117.

The arrowheads between the "KHz numeral" represent 50 KHz steps. For example a detent stop at "4" represents .40 MHz, a detent stop before the "4" (arrowhead between 3 and 4) represents .35 MHz, a detent stop after the "4" (arrowhead between 4 and 5) represents .45 MHz, etc.

Certain NAV frequencies allow two-way communication, i.e.; Flight Service Stations. You can transmit on any COM channel that is set on the frequency selector and receive on the desired NAV channel WITHOUT switching the NAV-COM code switch.

OBS Knob

The OMNI Bearing Dial is rotated by turning the OBS knob. To set the OBS to a desired OMNI radial, rotate the OBS knob until the desired course bearing number is centered under the white vertical bar on the top of the OBS lens. The large numbers are the course bearings in degrees, the small numbers directly below are the reciprocal course bearing.

Meter Flags

The indicator provides TO-FROM and weak signal indications in the form of a flag in the meter window. If the TO or FROM flag is not completely in view, the signal is weak and the course indication may not be reliable. TO or FROM, will appear completely when the indicator needle is centered regardless of the aircraft heading. This indication is the magnetic bearing TO (or FROM) the selected VOR station. OFF indicates that the unit is not energized or that the selected frequency's signal is too weak for either a TO or FROM flag or due to improper OBS settings.

VOR/ILS Indicator Needle

The indicator needle operates on all NAV channels, VOR, and ILS LOCALIZER (108.00 thru 117.95 MHz).

When a VOR channel is selected, (even tenths: 108.00 thru 111.85 MHz and all channels 112.00 thru 117.95 MHz) the indicator shows left or right deviation from the course chosen on the course selector dial.

When the Channel Selector is set to an ILS LOCALIZER channel (odd tenths: 108.10 thru 111.95 MHz) the indicator shows left or right deviation from the runway center line.

2.7 COM 111 TSO

2.7.1 Specifications

Mechanical
Size: Panel Unit (See Figure 2-8)

Weight: Panel Unit, 3.0 lbs; tray includes Connector Kit 0.62 lbs.

Electrical
Voltage: 13.75 operation only

Current: Receive — .8 amps (not including pilot lights)
Transmit — 2.5 amps
Pilot Lights — .16 amps

Environmental:
Meets the following TSO Categories:

TSO	ENV CAT.	
C-37b	DAP AAA XXXXXX	Class II
C-38b	DAP AAA XXXXXX	

*See Page 2-1.

Receiver

Frequency Range:
118.00 to 135.95 MHz (360 channels)

Sensitivity:
COM Band: 1.5μv Nominal/2.5μv Maximum for 6 db S+N/N ratio

Spurious and Image Rejection:
Greater than 60 db

Selectivity:
6 db (nose) — 34 KHz Minimum
60 db (skirt) — 84 KHz Maximum

AVC Flatness:
1 db Maximum for 10μv to 10Kμv

Audio Output:
Speaker: 10w minimum
Headphones: 50 mw into 300 ohms

Audio AGC:
3 db maximum 30% to 100% modulation
(RF signal input 50μv)

Transmitter

Power Output: 8 watts minimum
Modulation: 85% minimum
Frequency Stability: Maximum ±.005%
Microphone Input:
Adjusted for 0.2v @ 100 ohms
Duty Cycle: Typical 20%

2.7.2 Units and Accessories Supplied

The COM 111 TSO is available for either standard aircraft or helicopter installation. Both trays and Installation Kits are identical.

A. COM 111 TSO

Tray Assy 55980-0101
Installation Kit, 03087-0501
(See Fig. 2-8)

B. Helicopter COM 111 TSO*

Tray Assy 55980-0101
Installation Kit, 03087-0501
(See Fig. 2-8)

*Has higher audio output and intercom capability than the standard COM 111 TSO. Units ordered for helicopter installations are prewired for this application.

2.7.2.1 COM 111 TSO Accessories Required, but NOT Supplied

For proper operation of these equipments the following accessories are required: a transmitting antenna and a receiving antenna (or a combination type), loud speaker and/or headphones, microphone.

To ensure complete FAA Part 37 TSO compliance as applied to Air Carrier operation, these equipments must be used with Communication and Navigation antennas meeting TSO's C-36b, C-37b, C-38b, and C-40a requirements.

When TSO compliance is not required, the following antennas are recommended.

A. Transmitting Antenna: NARCO type VCA-10 broad band type with gasket, hardware and BNC connector, Part No. 05502-0000.

B. Receiving Antenna: NARCO type VRP-37 tail mounting type with 30 feet of RF cable and "Balun." Part No. 05507-0000.

OR

NARCO type VNA-10 tall mounting type, Part No. 71226-0001.

C. VHF COM NAV Antenna, VCNA-1 and -2.

The COM 111 TSO may be desensitized when transmitting with a COM unit. Refer to Paragraph 2.12.4 for details.

D. Loudspeaker/Headphones:
1. Loudspeaker — voice coil impedance, 4 ohms.
2. Headphones — low impedance type, 300 to 1000 ohms. Both headphones and speaker may be used simultaneously.

E. Microphone: The mike gain was set for the Telex low impedance mike. Any other carbon or dynamic noise cancelling mike may be used, however the mike gain may require resetting.

2.7.2.2 Optional Accessories

A. MP 10 Voltage Converter, 28 to 14 volts. (See Section 2.13 for details)

2.7.3 Mechanical Installation

2.7.3.1 COM 111 TSO (Including helicopter units)

The COM units are designed to be installed into their mounting tray. These units contain a locking screw, in their front panel, which should be turned full CCW before sliding the unit into the tray. After the unit is in the tray, the locking screw should be turned full CW, this draws in the radio and as it does the mating connector(s) will engage, providing positive connection and securing the radio in the tray.

DO NOT RAM THE UNIT INTO THE TRAY!

Removal of a unit is the reverse of installation, turn the locking screw CCW until the unit is free of the connector(s).

Figure 2-8 provides a detailed drawing of the tray and the parts of the installation kit. The figure also provides all the necessary dimensions for the panel cutout as well as that for the mounting bracket locations, plus a 1:1 panel cutout template.

2.7.3.2 COM Tray Mounting

The COM unit mounting tray shall be mounted behind the aircraft instrument panel using No. 6 binding head screws at each of the four mounting holes.

Mounting brackets to mate the holes are not supplied due to the wide range in mounting requirements. Suitable mounting brackets may be fabricated from ordinary metal sheet or angle stock.

The tray must be provided with a good electrical ground. A ground strap can be attached to the rear-side mounting screw.

It is recommended that the panel mounted unit be provided with ram air cooling.

NOTE: The COM 111 TSO tray has one 15 pin connector, positioned next to the COM antenna connector, plus the Coax Cable Assy which must be installed (as shown) prior to mounting the tray in the aircraft. Dress the leads of the connector(s) thru the cable clamp(s) to avoid undue stresses.

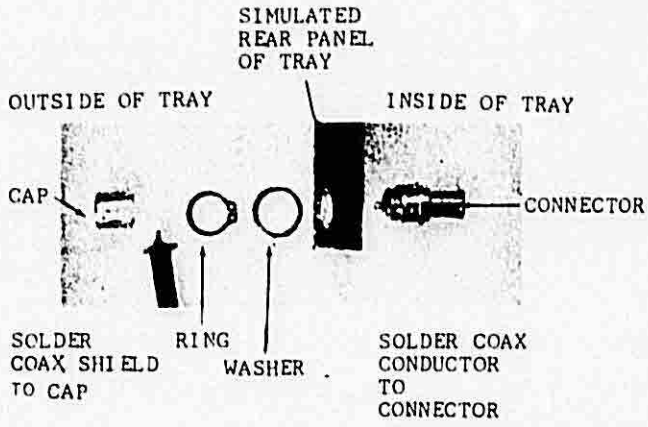


FIGURE 2-5. COAX CABLE ASSY

2.7.4 Electrical Connections

The installing agency is required to make-up the installation cable. Lengths are dependent upon the particular aircraft installation. Refer to the wiring diagrams for all cable connections. Also refer to Section 2.11 for proper lead termination.

It is recommended that circuit protection (COM Unit 7.5 amp) be provided between the aircraft buss and the Unit.

All leads should be #22AWG unless otherwise noted.

2.7.4.1 COM 111

Figure 2-7 shows the installation wiring between the aircraft and the unit.

The coax cable should be 50 ohm RG-58A/U.

ONLY the COM 111 TSO connector (J401A) pins 1 thru 14 are wired for COM 111 TSO operation.

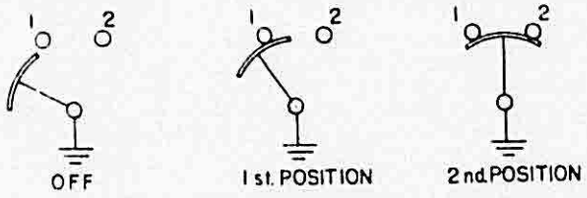
2.7.4.2 Helicopter COM 111 TSO External Wiring

The Helicopter COM 111 TSO has a higher audio output and the capability for an intercom than those units for conventional aircraft. The differences, between the conventional COM unit and the Helicopter COM unit are:

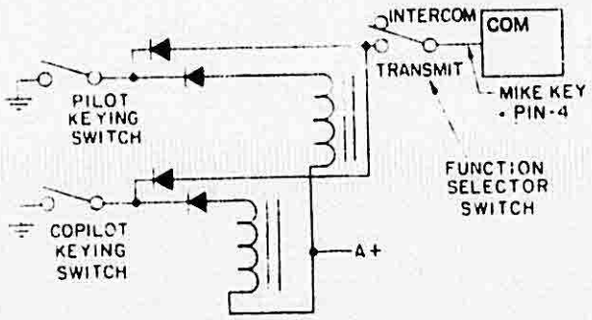
1. Pin 3, headphone output, connects directly to the emitter of Q407 in the Helicopter COM unit, whereas in the conventional COM unit, the headphones are connected to the secondary of T402.

2. Pin 11 connects directly to the junction of C430 and R417 in the Helicopter COM unit, for intercom audio input. In the conventional COM unit, pin 11 is unused.

The switching system shown in the diagram for the intercom system is a two position switch which grounds a wire in the first position and grounds both 1 & 2 in the 2nd position.

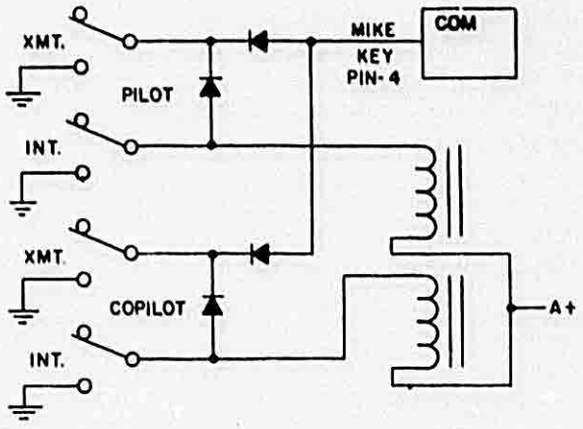


For different control stick switches the wiring would have to be changed accordingly.



Single control stick switch installation. The diodes supply isolation so that the pilot's switch does not pick up copilot's relay, etc., and prevents sneak paths from picking up the transmitter or intercom relay.

Typical separate switch system.



GENERAL RECOMMENDATIONS FOR HELICOPTERS

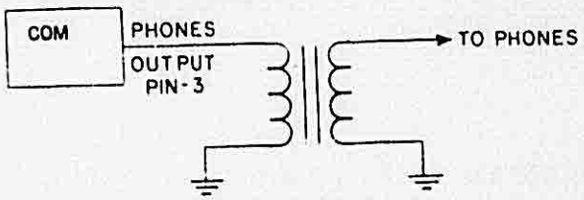
1. *Do not connect microphones in PARALLEL!* The impedance of microphones varies greatly between models and between units of the same type. It is impossible to get a balance between levels of two mikes in parallel and sometimes one mike will completely swamp out the other. In addition one does not want to add the noise that the unused mike will pick up into the audio system.

   Relays should be used so that only the desired mike is feeding the mike input.

2. It is possible with some types of control stick switches to eliminate the intercom relays by having the control stick switch be the ground connection for the microphone. Great care must be taken to avoid sneak paths and prevent noise pickup on the mike lead with this system. For this reason it is NOT RECOMMENDED — Relays should be used.

3. The COM 111 TSO capable of 10 watts of audio. The audio system produces approximately 20 volts P-P a full output at the speaker and the headphone lead from a very low impedance source. Normally the COM 111 TSO is supplied with a voltage divider in the headphone output.

   Because of high noise in most helicopters a higher audio is needed so the helicopter COM 111 TSO is shipped without the audio divider and the full 20 volts P-P is available.



If because of a high noise level environment more headphone audio is desired, one can add a transformer to step-up the audio voltage.

4. Because of the usually long leads and high audio level in the helicopter, it is recommended that shielded wire be used for at least the microphone and aux. audio lead, if it is used.

5. MIKE GAIN ADJUSTMENT — The mike gain pot will affect both transmitter operation and intercom level. The mike gain should be adjusted for full modulation of the transmitter with normal talking into the microphone.

   This will automatically give full audio output into the headphone during intercom operation. If the intercom is too loud a series resistor can be added to the headphone level.

   DO NOT USE THE MIKE GAIN THE ADJUST INTERCOM LEVEL.

6. Sidetone level will be the same as the intercom audio level.

7. If speaker operation is desired, a switch should be provided to turn the speaker off when headphones are used.

   This is necessary with intercoms to prevent audio feedback and is desirable even when one is not using intercom because with the receiver set for a comfortable headphone level, the speaker would be blasting.

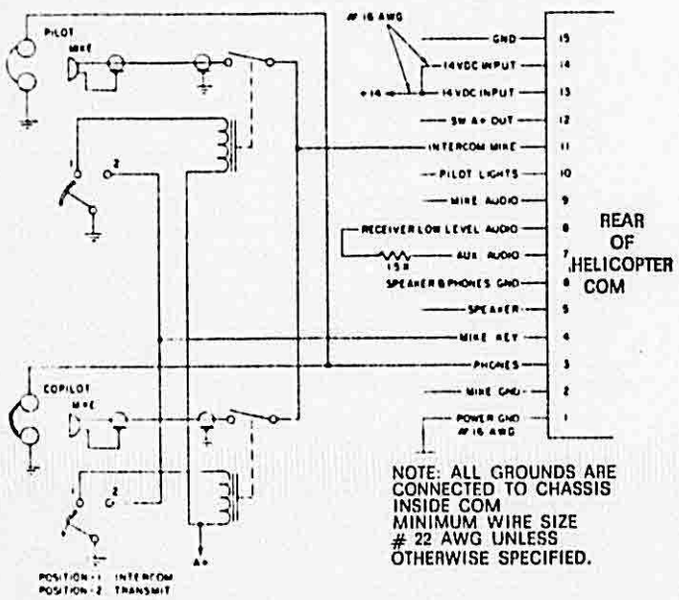


FIGURE 2-6. BASIC COM 111 TSO HELICOPTER INTERCOM WIRING

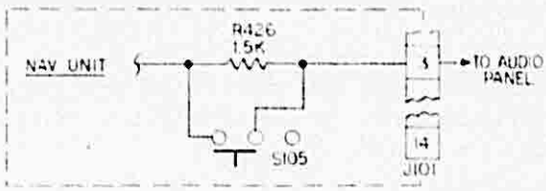
2.7.4.3 COM 111 TSO Audio Input Connections

The COM Interconnection diagram shows a 1.5K resistor between J401A, pin 7 and pin 8. This resistor is required when an installation does NOT use an audio switching panel containing an isolation amplifier. When an audio switching panel with an isolation amplifier is used (i.e.: Narco's VP22 or CP25), the resistor is removed.

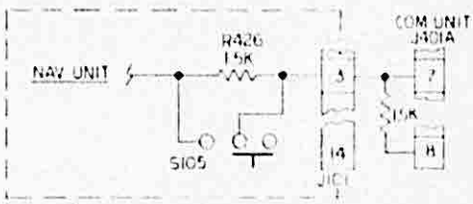
In installations where several switched audio inputs are desired for the COM 111 TSO system and an isolation amplifier is not used, an audio summing network must be utilized for optimum performance. The following diagrams show examples of such a network. In all installations, terminal 3 can be used for headphone connection.

There is an internal 1500 ohm resistor in series with terminal 3.

When used with a CP 25, 125, 126, or 127:

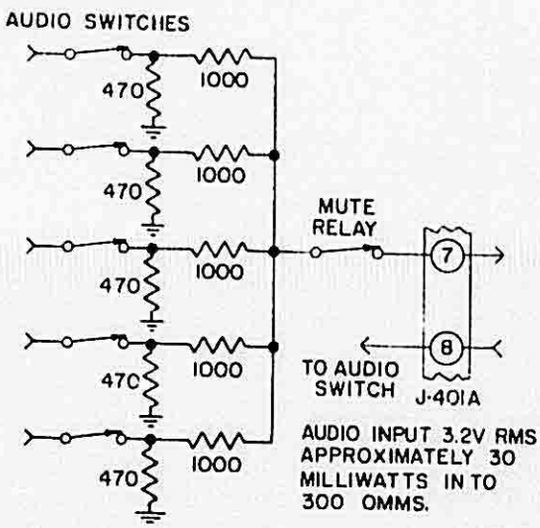


When NO audio panel or isolation is provided and a direct connection is made.



S105 is located on the bottom of the NAV Unit.

The following example of a summing network can be utilized. Mute relay is controlled by the mike key.



SEE BLOW-UP

2.7.4.4 COM 111 TSO Cabin Speaker Amplifier

The COM 111 TSO can serve as a cabin speaker amplifier for such Low Level audio equipments as ADF's, MBT's, and NAV units as well as its regular communication functions.

To utilize this feature, the following re-routing of the A+ must be made.

To activate ONLY the COM's audio circuits, the COM's ON-OFF switch must be bypassed and activated via the aircraft's master switch or its circuit breaker in series with the unit.

1. Jumper the two blue speaker wires on the ON-OFF switch.
2. Locate and remove the YELLOW #24 wire from the pin at the right rear corner of the Interconnect Board (the pin is on the same pad where one end of R505 is terminated).
3. Attach this YELLOW #24 wire to Pin E532 on the Interconnect Board. (Positive side of 2200 mfd capacitor, C501)

This modification will now activate the audio circuits via the master switch or the circuit breaker and when the COM unit is turned ON, the COM unit will be completely activated.

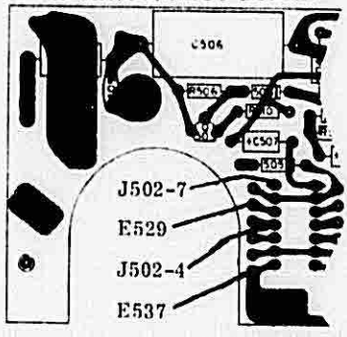
2.7.4.5 Modifications Required for 28V Operation

The COM 111 TSO unit is manufactured for 14 volt service, however, with the use of a voltage converter and the addition of a few jumpers, the unit can be used in aircraft having 28 volt service.

2.7.4.5.1 Procedure

1. Install a 28 to 14v Voltage Converter as outlined in Section 2.13.
2. The COM unit's pilot light power source is via a dimmer switch or directly from the aircraft buss, therefore the pilot light circuit must be modified (a change from parallel to series wiring). Refer to the Interconnect Board, partial drawing.
   A. Remove the wire from pin 4 of P502 which mates J502 and connect it to Pin 5 of P502.
   B. Remove the black wire from E537, on the Interconnect Board, and connect it to E529.

INTERCONNECT BOARD



2.7.5 COM 111 TSO PRE-INSTALLATION BENCH TEST

The equipment required to perform this test is listed below:

A low impedance microphone with a push-to-talk switch (preferably the mike to be used in the aircraft).

A speaker load box, 15w capability.

A low voltage dc supply, 12-15 vdc at 10-15 amps such as an Electro Products Laboratories Model NFB or equivalent.

An RF Power Wattmeter: Bird Termaline Model 61 or equivalent.

A VHF Signal Generator, Hewlett Packard Model 608D or equivalent.

2.7.5.1 Test Set-Up and Test of the COM 111 TSO

Plug the connector into the COM unit being sure that the contacts mate the contacts of the printed circuit board. (The plug can be put on upside down and no contact will be made.)

Refer to the Interconnection Diagram connector, J401A.

Connect microphone to the MIKE KEY, pin 4.

Connect speaker load box to the SPEAKER/SPKR & PHONES GND, pins 5 and 6.

Connect a 1.5K resistor between the ANX. AUDIO, pin 7 and the LOW LEVEL AUDIO, pin 8.

Connect a low voltage dc supply to the power input leads, pins 1 (GND), 13 and 14 (A+).

Connect a RF Power Wattmeter or a VHF Signal Generator to the COM RF Output Connector.

A. Apply power (13.75 VDC).

B. Check for sensitivity of the COM circuits including audio output. Reading should be 1.5uv for 6 db S+N/N, audio should be 10 watts for the COM unit when RF input is 3.0uv (modulated at 30% - 1000 Hz).

C. Check Transmitter output by keying transmitter. Readings should be 8 watts minimum for the COM 111 TSO.

D. Modulate the radio, the RF Power output meter should react with a "wiggle."

E. Jumper connector pins 10 to 12 to check internal lighting.

F. To check COM programming, check 118 MHz on all KHz steps and check all MHz steps on .00 KHz.

2.7.5.2 Mike Gain Adjustment

It is recommended that the mike gain adjustment be accomplished on the bench using the aircraft's mike(s). This adjustment can be made in the aircraft, however it would require repeated removal and replacement of the unit as the gain is adjusted to the desired level. Should the aircraft have more than one mike, the unit should be adjusted with each mike and if necessary compromise the setting for this multi-mike use. Do not key more than one mike at a time.

Adjust the mike gain as follows:

Use the aircraft's mike!

Connect headphones to "phones output" of the Com unit (Pin #3). With mike gain, adjust control set fully counterclockwise, talk in a normal speaking voice into the microphone. Slowly rotate the mike, adjust clockwise to the point where the audio in the headphones begins to sound distorted. Rotate the adjustment approximately one-eighth turn counterclockwise from this point for best modulation performance.

2.7.5.3 Post Installation

After the installation has been completed, the system should be operated on the ground, with all normal power turned on and the engine running. The receiver should be checked for proper operation by channeling to available signals. The transmitter output and audio quality may be checked by contacting a Control Tower or Unicom.

A FLIGHT TEST IS RECOMMENDED.

2.7.6 COM 111 TSO Operation

VOL/ON-OFF Knob

This knob energizes the COM unit. Turning the knob CW past the "click" turns the unit ON and continued rotation increases volume. Conversely CCW reduces volume and turns the unit OFF.

COM Frequency Channeling

The two large knobs have no stops, thus allowing shortest (CW or CCW) rotation to the desired frequency. The left knob selects the MKz (the whole number) the right knob selects the KHz (the fractional number).

SQUELCH

The SQUELCH knob establishes the input signal level required to give an audio signal output from the COM receiver. The input signal level is increased by turning the knob CCW. Maximum signal level is with the tick at the 7 o'clock position.

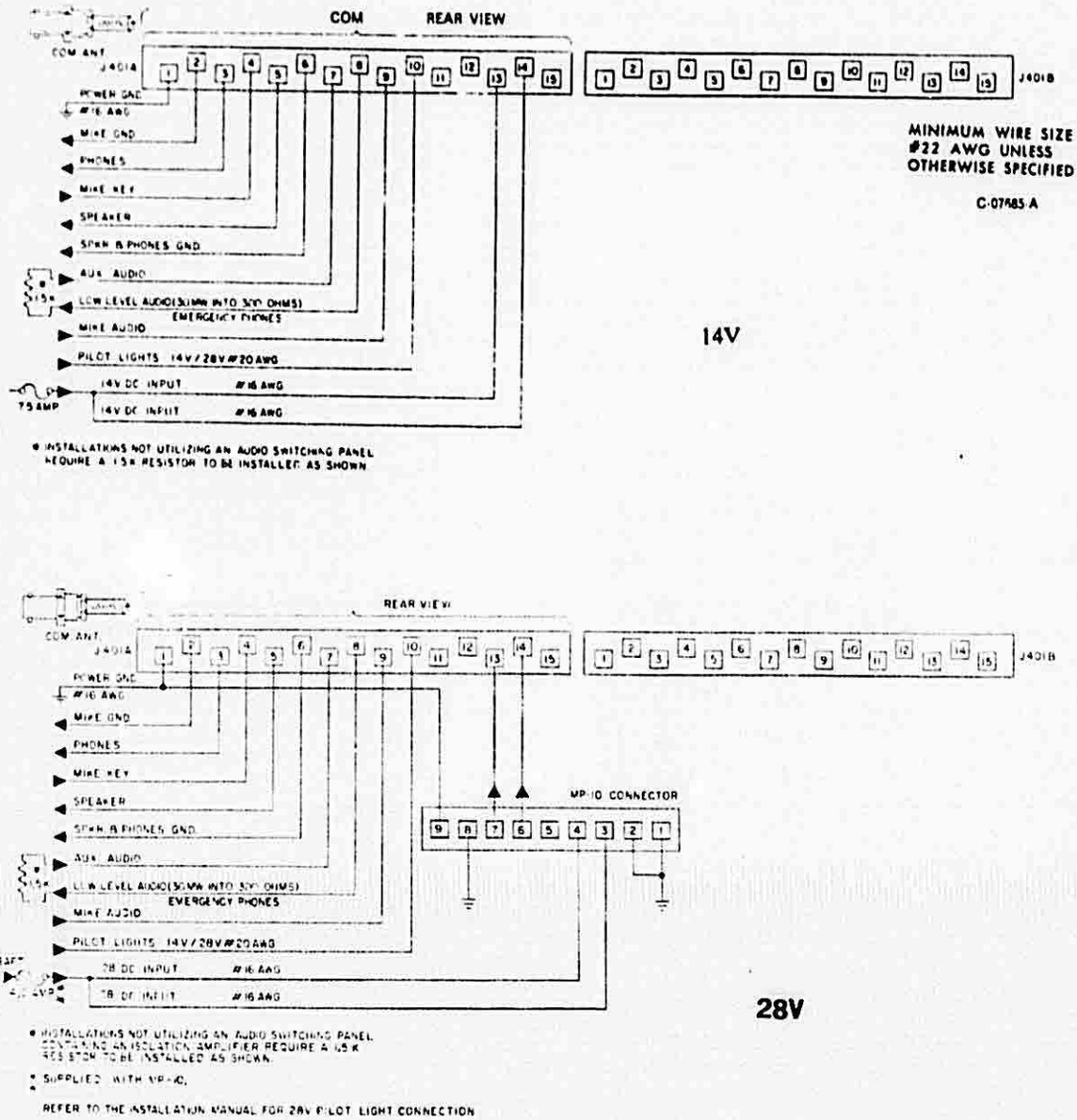
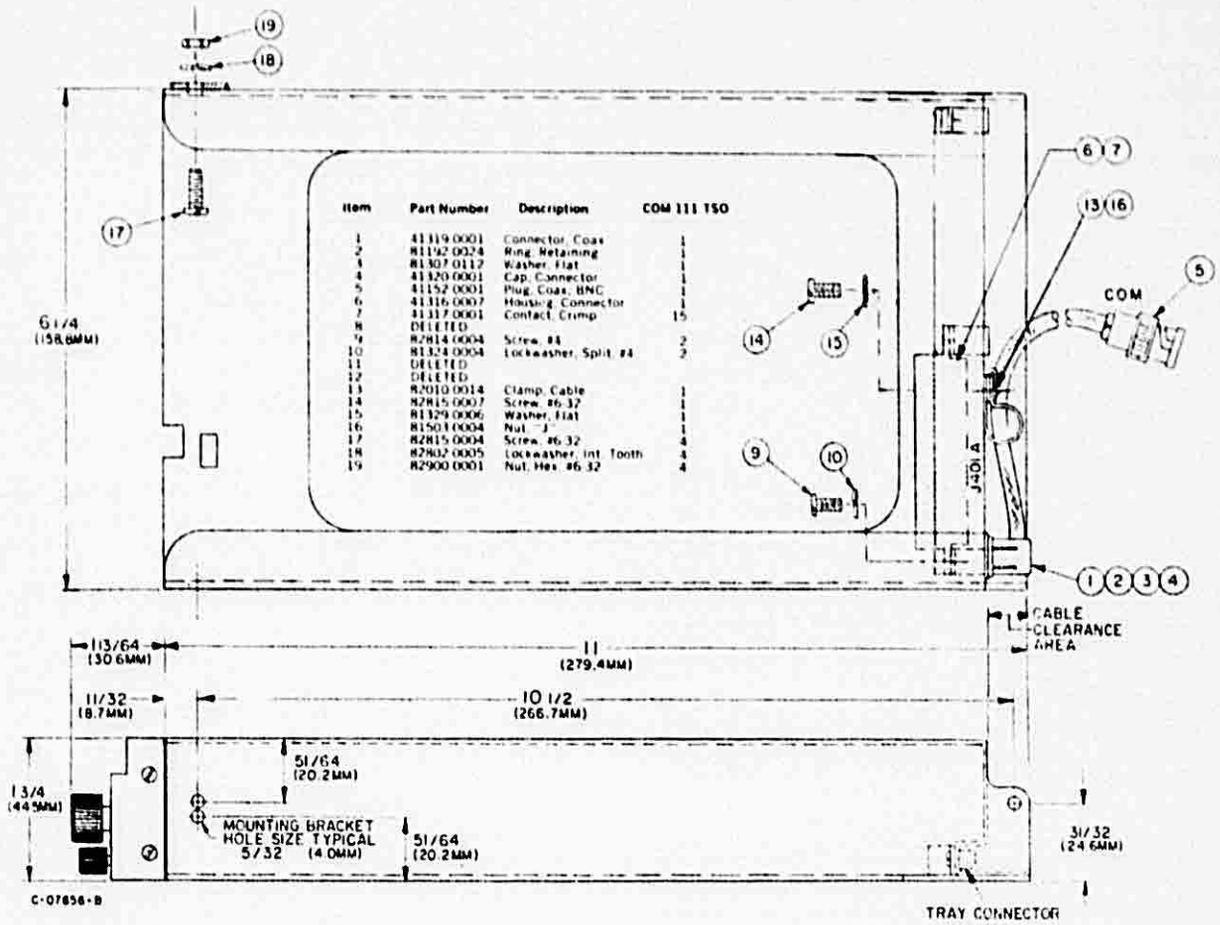


FIGURE 2-7. COM 111 TSO INTERCONNECTION DIAGRAM

SEE BLOW-UP



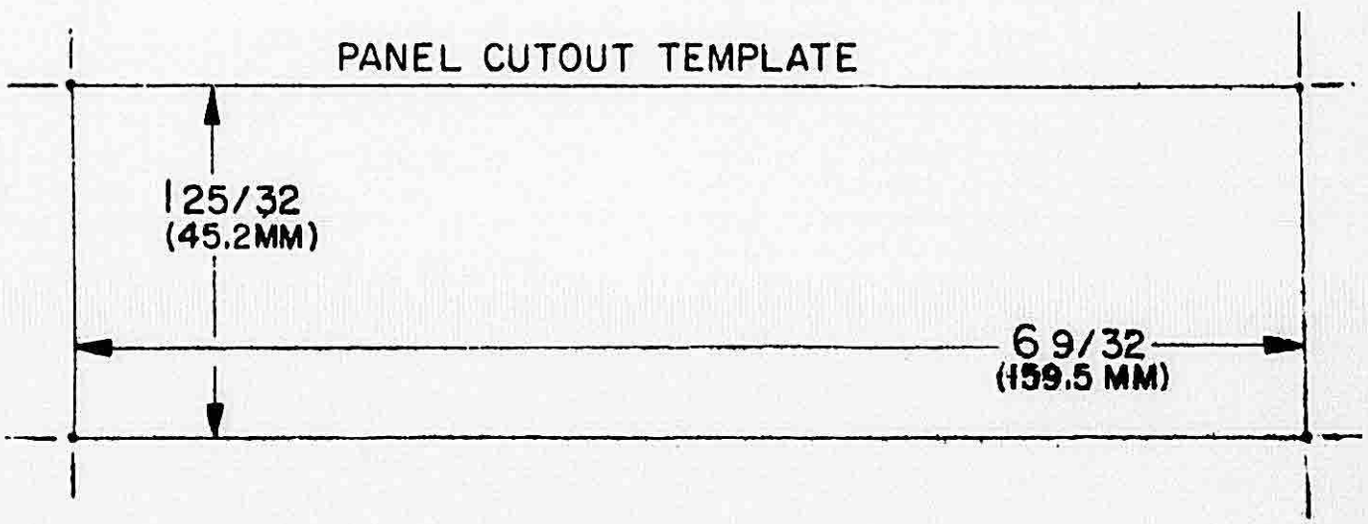


FIGURE 2-8. COM 111 TSO INSTALLATION DRAWING

SEE BLOW-UP

2.8 NAV 111 TSO

2.8.1 Specifications

Mechanical
Size: Panel Unit (See Figure 2-11)
Weight: Panel Unit 2.5 lbs.

Electrical:
Voltage: 13.75 or 27.5v
Current: Receive —.3 amps (not including pilot lights)
Pilot Lights — .32 amps

Environmental:
Meets the following TSO categories:

TSO	ENV CAT.	
C-36c	DAP AAA XXXXXX	Class C
C-40a	DAP AAA XXXXXX	
C-66a	DAP AAA XXXXXX	

*See Page 2-1.

Receiver

Frequency Range:
108.00 to 117.95 MHz (200 channels)

Sensitivity:
NAV Band: 1.5μv Nominal/2.0μv Maximum for 6 db S+N/N ratio
2.5μv maximum for full flag

Spurious and Image Rejection:
Greater than 60 db

Selectivity:
6 db (nose) — 34 KHz Minimum
60 db (skirt) — 84 KHz Maximum

AVC Flatness:
1 db Maximum for 10uv to 10Kuv

Tone Filter:
18 db minimum IDENT Tone rejection

Audio Output: 5uv, 30% Mod., 1000 Hz
Headphones: 30 mw into 300 ohms
OMNI Accuracy: ± 1.5° nominal

2.8.2 Units and Accessories Supplied

NAV 111 TSO (with or without wired-in DME channeling capability)

Installation Kit, 03088-0500
(See Figure 2-11)

2.8.2.1 NAV 111 TSO Accessories Required, but NOT Supplied

For proper operation of these equipments the following accessories are required: receiving antenna (or a combination type).

To ensure complete FAA Part 37 TSO compliance as applied to Air Carrier operation, these equipments must be used with Communication and Navigation antennas meeting TSO's C-36b, C-37b, C-38b, and C-40a requirements.

When TSO compliance is not required, the following antennas are recommended.

A. Receiving Antenna: NARCO type VRP-37 tail mounting type with 30 feet of RF cable and "Balun." Part No. 05507-0000.

OR

NARCO type VNA-10 tall mounting type, Part No. 71226-0001.

B. VHF COM NAV Antenna. VCNA-1 and -2.

The NAV 111 TSO may be desensitized when transmitting with a COM unit. Refer to Paragraph 2.12.4 for details.

C. Headphones — low impedance type, 300 to 1000 ohms. Both headphones and speaker may be used simultaneously.

2.8.3 Mechanical Installation

2.8.3.1 NAV 111 TSO

NAV 111 TSO unit is designed to be mounted in a standard 3" aircraft instrument panel opening, with minor modifications. The installation drawing provides all the necessary dimensions including a 1:1 template, should a complete cutout be required.

The NAV 111 TSO requires but two #6-32 mounting screws as the upper right-hand corner contains a threaded bushing which serves two purposes: the first to secure the unit to the panel, the second to contain the VOL/IDENT switch shaft. Refer to Notes of the NAV 111 TSO installation drawing.

A screw (stud) is provided on the rear of unit for rear support mounting.

2.8.4 Electrical Connections

The installing agency is required to make-up the installation cable. Lengths are dependent upon the particular aircraft installation. Refer to the wiring diagrams for all 14/28v cable connections. Also refer to Section 2.11 for proper lead termination.

It is recommended that circuit protection (circuit breaker or fuse - 2 amp) be provided between the aircraft buss and the Unit.

All leads should be #22AWG unless otherwise noted.

2.8.4.1 NAV 111 TSO

Figures 2-9 and 2-10 shows the installation wiring between the aircraft and the unit.

The NAV 111 TSO requires no modification for 28v operation. The only note of caution is to check that the cable connector is wired properly.

For 28v operation:	For 14v operation:
Pin 1 ..... A+	Pin 1 ..... A+
Pin 12 ..... pilot light input	Jumper between pins 6 and 15
NO jumpers in the connector.	Pin 13 ..... pilot light input
	Jumper between pins 11 and 12

The coax cable should be 50 ohm RG-188A/U so that the entire coax cable may fit thru the opening in the handle for the NAV 111 TSO connector.

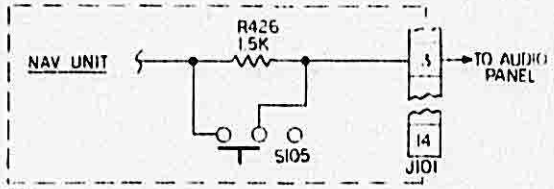
2.8.4.2 Audio Input Connections

The COM Interconnection diagram shows a 1.5K resistor between J401A, pin 7 and pin 8. This resistor is required when an installation does NOT use an audio switching panel containing an isolation amplifier. When an audio switching panel with an isolation amplifier is used (i.e.: Narco's VP22 or CP25), the resistor is removed.

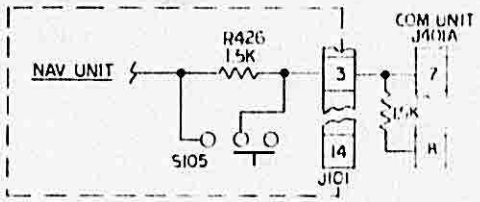
In installations where several switched audio inputs are desired for the COM 110 TSO or COM 111 TSO system and an isolation amplifier is not used, an audio summing network must be utilized for optimum performance. The following diagrams show examples of such a network. In all installations terminal 3 can be used for headphone connection.

There is an internal 1500 ohm resistor in series with terminal 3.

When used with a CP 25, 125, 126, or 127:

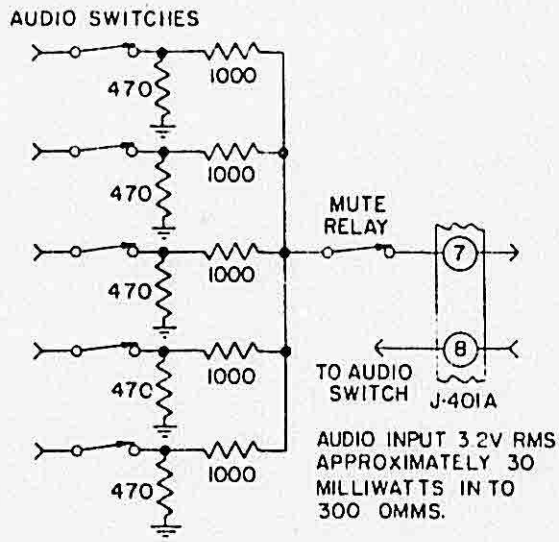


When NO audio panel or isolation is provided and a direct connection is made.



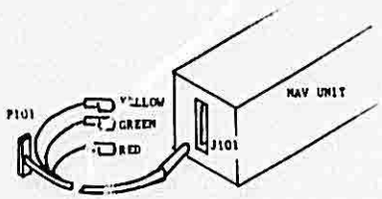
S105 is located on the bottom of the NAV Unit.

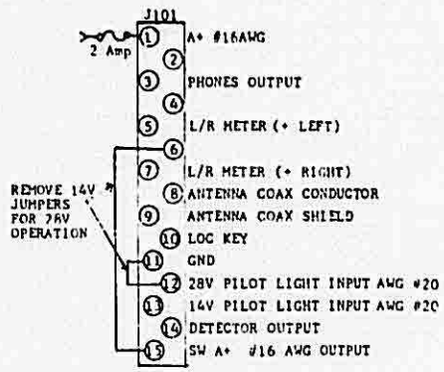
The following example of a summing network can be utilized. Mute relay is controlled by the mike key.



2.8.4.3 NAV 111 TSO

The NAV 111 TSO can provide OMNI/LOC information to an Autopilot Coupler. Couplers having an input impedance of 5000 ohms or greater may be connected directly across the appropriate pins shown in the Interconnection Diagram. Signal level available is 150 millivolts across a 1K ohm load impedance for a 10 degree course change on OMNI; 90 millivolt for 4 db modulation difference in LOC signal level. Neither AUTOPILOT input lead may be grounded. The A/P output is not damped as heavily as the L/R output.





NOTE:

Since the introduction of this Unit, there have been two external outputs provided. One called external L/R at P101, pins 5 & 7 (to drive another meter) and one called undamped output at P101, pins 2 & 4.

Field experience has shown that the external L/R output (pins 5 & 7) is more compatable with autopilots than the undamped output (pins 2 & 4).

Therefore U202, R249, and R264 were removed from the Unit leaving pins 2 & 4 unused. This deletion started with chassis number:

NAV 10 — CNC171B11
NAV 11 — CNA194D3
NAV 12 — CNB194D3
NAV 110 — CNC219A5
NAV 111 — CND 219B3
NAV 112 — CNE 219B3

FIGURE 2-9. NAV 111 TSO WIRING

2.8.5 Pre-Installation Bench Test

The equipment required to perform this test is listed below:

A speaker load box, 15w capability.

A low voltage dc supply, 12-15 vdc at 10-15 amps such as an Electro Products Laboratories Model NFB or equivalent.

A VHF Signal Generator, Hewlett Packard Model 608D or equivalent.

An OMNI Signal Generator, Aircraft Radio Corp. Model H-14A or equivalent.

2.8.5.1 Test Set-Up and Test for NAV 111 TSO

Plug the connector into the NAV 111 TSO being sure that the contacts mate the contacts of the printed circuit board (The plug can be put on upside down and no contact will be made).

Refer to the Interconnection Diagram connector.

Connect a suitable power source to:
Pin 1 for 14 or 28 volt operation

Connect a VHF signal generator to the NAV antenna (pin 8 and pin 9).

Connect, for pilot light operation, a suitable power source to:
Pin 12 for 28 volt
Pin 13 for 14 volt

A. Apply power (13.75 or 27.5 VDC)

B. Turn VOL knob full cw, position IDENT Switch to IDENT, Channel radio to a generator frequency.

C. Switch to a NAV channel. Reading should be 1.5μv for 6 db S+N/N, audio output should be 30 mw when RF input is 3.0μv (modulated at 30% - 1000 Hz).

D. Check omni operation using a crystal controlled omni channel at the Four Cardinal Points (0, 90, 180, 270°) reading should be ±1.5°.

E. Check internal lighting
1. 14v ..... jumper pin 13 to 15.
OR
2. 28v ..... jumper pin 12 to 15.

F. To check NAV programming, check 108 MHz on all KHz steps and check all MHz steps on .00 KHz.

2.8.5.2 Post Installation

After the installation has been completed, the system should be operated on the ground, with all normal power turned on and the engine running. The receiver should be checked for proper operation by channeling to available signals.

A FLIGHT TEST IS RECOMMENDED.

SEE BLOW-UP

TABLE 2.1 NAV 111 TSO DME CHANNEL PROGRAMMING

NARCO	ARINC	NAV P104	MHz CHANNELS 108	109	110	111	112	113	114	115	116	117
B	A	1	X	X		X	X					
C	B	2			X	X		X	X			
D	C	3					X	X		X	X	
E	D	4	X						X	X		X
A	E	5		X	X						X	X

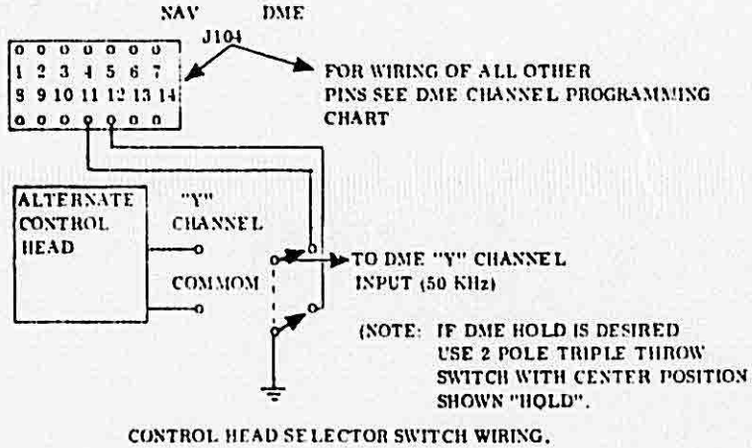
			KHz CHANNELS .00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95
-	-	-																				
F	F	6			X	X	X	X											X	X	X	X
H	G	7	X	X	X	X			X	X	X	X										
J	H	8					X	X	X	X			X	X	X	X						
K	J	9									X	X	X	X			X	X	X	X		
L	K	10	X	X											X	X	X	X			X	X
"Y" CHANNEL ACT.		11		Y		Y		Y		Y		Y		Y		Y		Y		Y		Y
DME COMMON		12																				
SPARE		13																				
GROUND		14																				

NOTES:

1. "X" indicates continuity to the DME common terminal, P104-12
2. "Y" indicates continuity to the ground terminal, P104-14
3. DME common P104-12 must be grounded for DME channeling to operate

A. For DME frequency control by NAV 111 TSO only, P104-12 may be connected to P104-14.

B. When the NAV 111 TSO with DME is used as one of two DME frequency control heads, P104-11 and P104-12 should be wired to one side of a double pole double thrown control head selector switch.



CONTROL HEAD SELECTOR SWITCH WIRING.

FIGURE 2-10. NAV 111 TSO DME PIGTAIL CONNECTOR

2.8.6 NAV 111 TSO Operation

VOL/ON-OFF Knob

This knob energizes the NAV unit. Turning the knob CW past the "click" turns the unit ON and continued rotation increases volume Conversely CCW reduces volume and turns the unit OFF.

IDENT

Pulling the SQUELCH knob (about ¼") actuates the IDENT switch. The IDENT switch overrides the internal tone filter and when in the IDENT position (out) allows the 1020 Hz station identification code to be heard.

NAV Frequency Channeling

The NAV unit has dual knobs (large MHz-Small-KHz) to allow channeling NAV frequencies which are seen in the bottom of the window. The KHz knob is free to allow continuous turning, CW or CCW, for it has no stops. The MHz knob rotates CW and CCW between the low end at 108 and the high end stop at 117.

The arrowheads between the "KHz numerals" represent 50 KHz steps. For example a detent stop at "4" represents .40 MHz, a detent stop before the "4" (arrowhead between 3 and 4; represents .35 MHz, a detent stop after the "4" (arrowhead between 4 and 5) represents .45 MHz, etc.

Certain NAV frequencies allow two-way communication, i.e.: Flight Service Stations.

OBS Knob

The OMNI Bearing Dial is rotated by turning the OBS knob. To set the OBS to a desired OMNI radial, rotate the OBS knob until the desired course bearing number is centered under the white vertical bar on the top of the OBS lens. The large numbers are the course bearings in degrees, the small numbers directly below are the reciprocal course bearings.

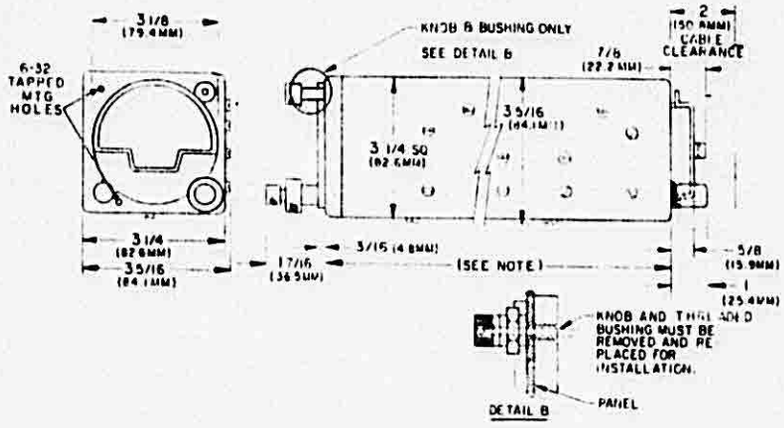
Meter Flags

The indicator provides TO-FROM and weak signal indications in the form of a flag in the meter window. If the TO or FROM flag is not completely in view, the signal is weak and the course indication may not be reliable. TO or FROM, will appear completely when the indicator needle is centered regardless of the aircraft heading. This indication is the magnetic bearing TO (or FROM) the selected VOR station. OFF indicates that the unit is not energized or that the selected frequencies' signal is too weak for either a TO or FROM flag or due to improper OBS settings.

VOR/ILS Indicator Needle

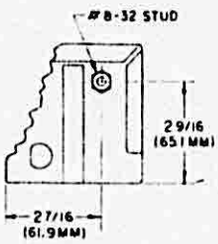
The indicator needle operates on all NAV channels, VOR, and ILS LOCALIZER (108.00 thru 117.95 MHz).

When a VOR channel is selected, (even tenths: 108.00 thru 111.85 MHz and all channels 112.00 thru 117.95 MHz) the indicator shows left or right deviation from the course chosen on the course selector dial.



C-07657-C

	INCHES	MILLIMETERS
A	5-3/16	81.0
B	1/4 DIA	6.4 DIA
C	5/32 DIA	4.0 DIA
D	1/8 R	3.2 R
E	1-3/4 R	44.5 R
F	1-41/64 R	41.7 R
G	13/16	20.6
H	1-39/64 R	40.9 R
J	9/32 R	7.1 R
K	1-31/64	37.7



NOTES:

These equipments are rear panel mounted.

Chassis length 8½" (215.9MM)

Mounting screws to be No. 6-32,
Length to be: 7/16 Min 3/4" Max.
Plus thickness of panel.

Rear connections:

Has one rear connector, units wired for DME channeling also have a connector on a pigtail as well as a G/S pigtail connector

Part Number	Installation Kit	Quantity NAV 111 TSO
41316-0007	CONNECTOR, SHELL 15 pin	1
41317-0001	CONTACT, CONNECTOR	15
82019-0002	STRAP, CABLE	1
82814-0004	SCREW, 4-40 x 5/16	3
82802-0003	LOCKWASHER, No. 4	3
82900-0004	NUT, HEX, No. 4-40	3
82815-0109	SCREW, 6-32 x ¾	2
55951-0001	HANDLE, CONNECTOR without eyelet	
81254-0012	EYELET (to be installed in) handle)	1
84038-0001	ADAPTER, Cable to BNC	1
90058-	CABLE, RG-188A/U, 18"	1
41229-0001	CONNECTOR, BNC	1

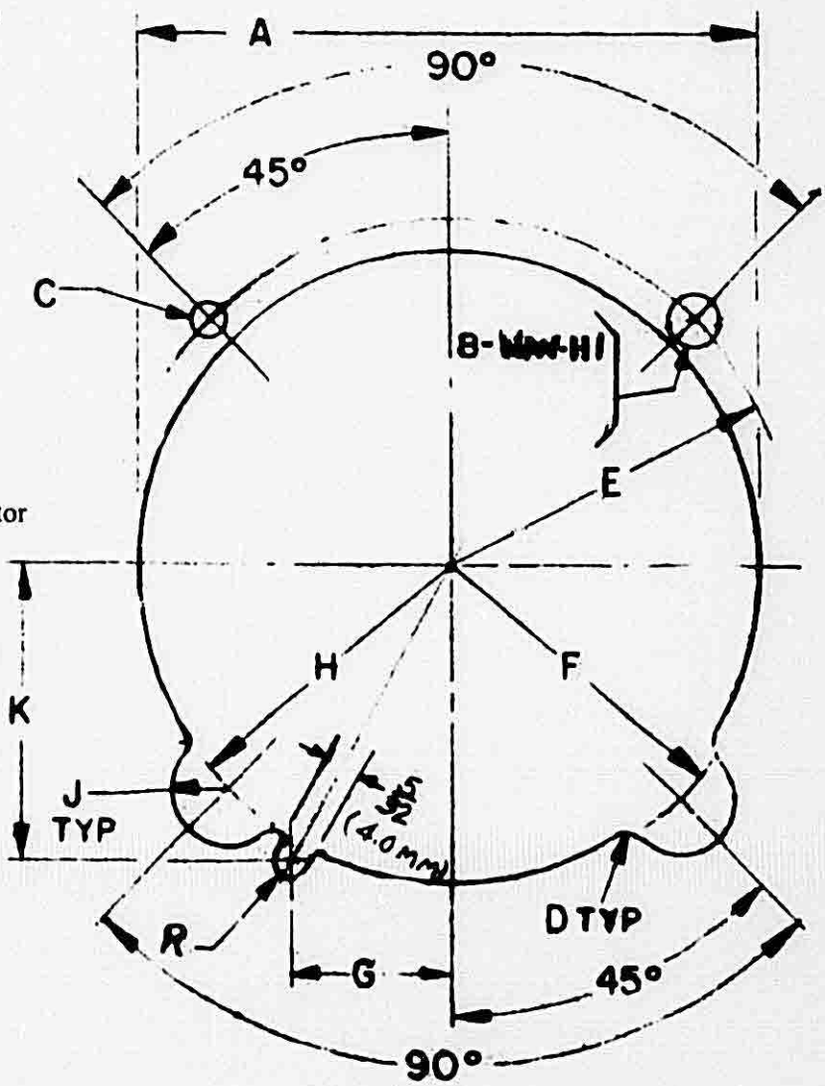


FIGURE 2-11. NAV 111 TSO INSTALLATION DRAWING

SEE BLOW-UP

2.9 NAV 112 TSO

2.9.1 Specifications

Mechanical:

Size: Panel Unit (See Figure 2-14)

Weight: Panel Unit 3.3 lbs (including G/S and symbol DME Pigtails)

Electrical:

Voltage: 13.75 or 27.5v

Current: Receive — .3 amps (not including pilot lights)
Pilot Lights — .32 amps

Environmental:

Meets the following TSO Categories:

TSO	ENV CAT.	
C-34c	DAP AAA XXXXXX	Class C
C-36c	DAP AAA XXXXXX	Class C
C-40a	DAP AAA XXXXXX	
C-66a	DAP AAA XXXXXX	

*See Page 2-1.

Receiver

Frequency Range:
108.00 to 117.95 MHz (200 channels)

Sensitivity:
NAV Band: 1.5μv Nominal/2.0μv Maximum for 6 db S+N/N ratio
2.5μv maximum for full flag

Spurious and Image Rejection:
Greater than 60 db

Selectivity:
6 db (nose) — 34 KHz Minimum
60 db (skirt) — 84 KHz Maximum

AVC Flatness:
1 db Maximum for 10μv to 10Kμv

Tone Filter:
18 db minimum IDENT Tone rejection

Audio Output:
Headphones: 30 mw into 300 ohms
OMNI Accuracy: ± 1.5° nominal

Glide Slope Indicator

A. UP-DOWN Indicator resistance: 1000 ohms.

B. UP-DOWN Indicator sensitivity: 150 microampers for full deflection.

C. ON-OFF Indicator resistance: 1000 ohms.

D. ON-OFF Indicator sensitivity: 250 microampers for full deflection.

2.9.2 Units and Accessories Supplied

NAV 112 TSO (with or without wired-in DME Channeling capability)

Installation Kit, 03088-0502
(See Figure 2-14)

2.9.2.1 NAV 112 TSO Accessories Required, but NOT Supplied

For proper operation of these equipments the following accessories are required:
Receiving antenna (or a combination type), headphones and a glide slope receiver.

To ensure complete FAA Part 37 TSO compliance as applied to Air Carrier operation, these equipments must be used with Communication and Navigation antennas meeting TSO's C-36b, C-37b, C-38b, and C-40a requirements.

When TSO compliance is not required, the following antennas are recommended.

A. Receiving Antenna: NARCO type VRP-37 tail mounting type with 30 feet of RF cable and "Balun." Part No. 05507-0000.

OR

NARCO type VNA-10 tail mounting type, Part No. 71226-0001.

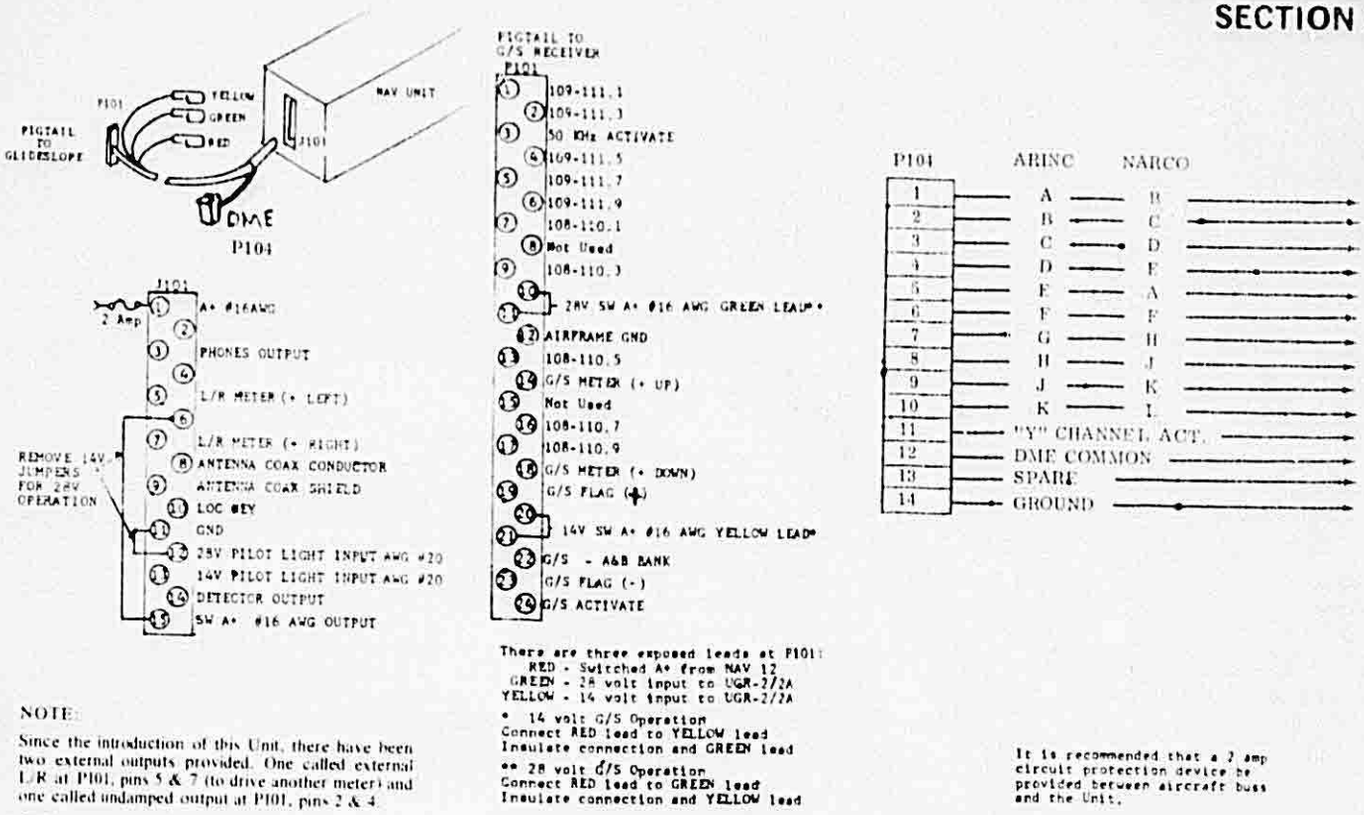
B. VHF COM NAV Antenna: VCNA-1 and -2. NAV 112 TSO may be desensitized when transmitting with a COM unit. Refer to Paragraph 2.12.4 for details.

C. Headphones: low impedance type, 300 to 1000 ohms. Both handphones and speaker may be used simultaneously.

D. Glide Slope Receiver: NARCO UGR-2A which has 50 KHz channeling or a UGR-2 which has 100 KHz channeling. (See Optional Accessories.) In either case, the UGR requires its antenna, a UGA-1 or a UGA-10. Refer to the UGR Maintenance Manual for installation data and check-out procedures.

2.9.2.2 Optional Accessories

UGR-2, 50 KHz Kit (P/N 03502-0501)
Converts the UGR-2 from 20 channels to 40 channels, hence, 50 MHz channel spacing.



There are three exposed leads at P101:
RED - Switched A+ from NAV 12
GREEN - 28 volt input to UGR-2/2A
YELLOW - 14 volt input to UGR-2/2A

* 14 volt G/S Operation
Connect RED lead to YELLOW lead
Insulate connection and GREEN lead

** 28 volt G/S Operation
Connect RED lead to GREEN lead
Insulate connection and YELLOW lead

It is recommended that a 2 amp circuit protection device be provided between aircraft buss and the Unit.

NOTE:

Since the introduction of this Unit, there have been two external outputs provided. One called external L/R at P101, pins 5 & 7 (to drive another meter) and one called undamped output at P101, pins 2 & 4.

Field experience has shown that the external L/R output (pins 5 & 7) is more compatable with autopilots than the undamped output (pins 2 & 4).

Therefore U202, R249, and R264 were removed from the Unit leaving pins 2 & 4 unused. This deletion started with chassis number:

NAV 10 — CNC171B11
NAV 11 — CNA194D3
NAV 12 — CNB194D3
NAV 110 — CNC219A5
NAV 111 — CND 219B3
NAV 112 — CNE 219B3

FIGURE 2-12. NAV 112 TSO WIRING

TABLE 2.2 NAV 112 TSO GLIDESLOPE PROGRAMMING

NAV Connector P101, Pin #		108 MHz										109 MHz										110 MHz										111 MHz									
		10	15	30	35	50	55	70	75	90	95	10	15	30	35	50	55	70	75	90	95	10	15	30	35	50	55	70	75	90	95	10	15	30	35	50	55	70	75	90	95
GS/LOC Act	24	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
GS A/B Act	22	X	X	X	X	X	X	X	X	X	X																					X	X	X	X	X	X	X	X	X	X
(108.1 - 110.1)	7	X	X																			X	X																		
(108.3 - 110.3)	9			X	X																			X	X																
(108.5 - 110.5)	13					X	X																			X	X														
(108.7 - 110.7)	16							X	X																			X	X												
(108.9 - 110.9)	17									X	X																			X	X										
(109.1 - 111.1)	1											X	X																			X	X								
(109.3 - 111.3)	2													X	X																			X	X						
(109.5 - 111.5)	4															X	X																			X	X				
(109.7 - 111.7)	5																	X	X																			X	X		
(109.9 - 111.9)	6																			X	X																			X	X
50 KC Act	3		X		X		X	X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X	

X - Indicates pins that are grounded

SEE BLOW-UP

TABLE 2.3 NAV 112 TSO DME CHANNEL PROGRAMMING

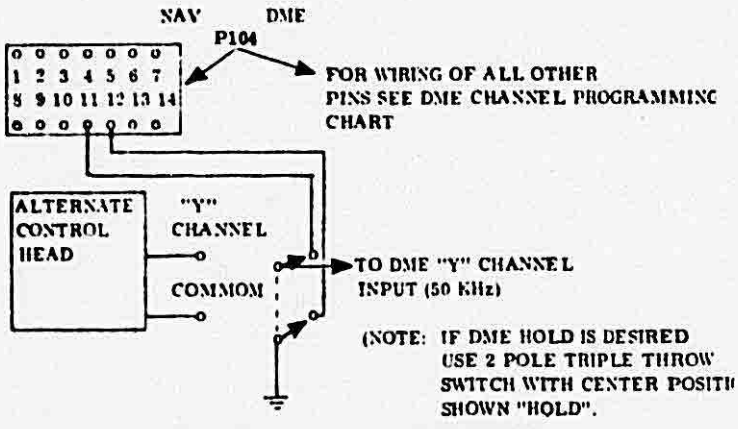
NARCO	ARINC	NAV P104	MHz CHANNELS										
			108	109	110	111	112	113	114	115	116	117	
B	A	1	X	X		X	X						
C	B	2			X	X		X	X				
D	C	3					X	X		X	X		
E	D	4	X						X	X		X	
A	E	5		X	X						X	X	
			KHz CHANNELS										
-	-	-	.00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50
F	F	6			X	X	X	X					
H	G	7	X	X	X	X			X	X	X	X	
J	H	8					X	X	X	X			X
K	J	9									X	X	X
L	K	10	X	X									
"Y" CHANNEL ACT.		11		Y		Y		Y		Y		Y	
DME COMMON		12											
SPARE		13											
GROUND		14											

KHz CHANNELS																				
.55	.60	.65	.70	.75	.80	.85	.90	.95												
					X	X	X	X												
X	X	X	X																	
X			X	X	X	X														
	X	X	X	X			X	X												
				Y		Y		Y												

NOTES:

1. "X" indicates continuity to the DME common terminal P104-12.
2. "Y" indicates continuity to the ground terminal P104-14.
3. DME common (P104-12) must be grounded for DME channeling to operate.
   A. For DME frequency control by NAV 112 DME only. P104-12 may be connected to P104-14.
   B. When the NAV 112 DME is used as one of two DME frequency control heads, P104-11 and P104-12 should be wired to one side of a double pole double throw control head selector switch.

   Diode isolation for control leads contained within NAV 112.



CONTROL HEAD SELECTOR SWITCH WIRING.

FIGURE 2-13. NAV 112 TSO DME PIGTAIL CONNECTOR

2.9.5 Pre-Installation Bench Test

The equipment required to perform this test is listed below:

A speaker load box, 15w capability.

A low voltage dc supply, 12-15 vdc at 10-15 amps such as an Electro Products Laboratories Model NFB or equivalent.

A VHF Signal Generator, Hewlett Packard Model 608D or equivalent.

An OMNI Signal Generator, Aircraft Radio Corp. Model H-14A or equivalent.

2.9.5.1 Test Set-Up and Test for NAV 112 TSO

Plug the connectors into the NAV 112 TSO being sure that the contacts mate the contacts of the printed circuit board (The plug can be put on upside down and no contact will be made.)

Refer to the Interconnection Diagram connector.

Connect a suitable power source to:
Pin 1 for 14 or 28 volt operation

Connect a VHF signal generator to the NAV antenna (pin 8 and pin 9).

Connect, for pilot light operation, a suitable power source to:
Pin 12 for 28 volt
Pin 13 for 14 volt

A. Apply power (13.75 VDC).

B. Turn VOL knob full CW, position IDENT Switch to IDENT, Channel radio to a generator frequency.

C. Switch to a NAV channel. Reading should be 1.5μv for 6 db S+N/N, audio output should be 30 mw when RF input is 3.0μv (modulated at 30% - 100 Hz).

D. Check omni operation using a crystal controlled omni channel at the Four Cardinal Points (0, 90, 180, 270°) reading should be ±1.5°.

E. Check internal lighting
1. 14v ..... jumper pin 13 to 15.
OR
2. 28v ..... jumper pin 12 to 15.

F. To check NAV programming, check 108 MHz on all KHz steps and check all MHz steps on .00 KHz.

G. Glide slope operation should be verified. Refer to the applicable glide slope receiver maintenance manual for details.

2.9.5.2 Post Installation

After the installation has been completed, the system should be operated on the ground, with all normal power turned on and the engine running. The receiver should be checked for proper operation by channeling to available signals.
A FLIGHT TEST IS RECOMMENDED.

2.9.6 NAV 112 TSO

VOL/ON-OFF Knob

This knob energizes the NAV unit. Turning the knob CW past the "click" turns the unit ON and continued rotation increases volume. Conversely CCW reduces volume and turns the unit OFF.

IDENT

Pulling the SQUELCH knob(about ¼") actuates the IDENT switch. The IDENT switch overrides the internal tone filter and when in the IDENT position (out) allows the 1020 Hz station identification code to be heard.

NAV Frequency Channeling

The NAV unit has dual knobs (large MHz-Small-KHz) to allow channeling NAV frequencies which are seen in the bottom of the window. The KHz knob is free to allow continuous turning, CW or CCW, for it has no stops. The MHz knob rotates CW and CCW between the low end at 108 and the high end stop at 117.

The arrowheads between the "KHz numerals" represent 50 KHz steps. For example a detent stop at "4" represents .40 MHz, a detent stop before the "4" (arrowhead between 3 and 4) represents .35 MHz, a detent stop after the "4" (arrowhead between 4 and 5) represents .45 MHz, etc.

Certain NAV frequencies allow two-way communication, i.e: Flight Service Stations.

OBS Knob

The OMNI Bearing Dial is rotated by turning the OBS knob. To set the OBS to a desired OMNI radial, rotate the OBS knob until the desired course bearing number is centered under the white vertical bar on the top of the OBS lens. The large numbers are the course bearings in degrees, the small numbers directly below are the reciprocal course bearings.

Meter Flags

The indicator provides TO-FROM and weak signal indications in the form of a flag in the meter window. If the TO or FROM flag is not completely in view, the signal is weak and the course indication may not be reliable. TO or FROM, will appear completely when the indicator needle is centered regardless of the aircraft heading. This indication is the magnetic bearing TO (or FROM) the selected VOR station. OFF indicates that the unit is not energized or that the selected frequencies' signal is too weak for either a TO or FROM flag or due to improper OBS settings.

The NAV 112's warning flag contains the word "NAV," plus the TO and FROM. When receiving a usable OMNI or LOCALIZER signal the flag turns to TO or FROM.

VOR/ILS Indicator Needle

The indicator needle operates on all NAV channels, VOR, and ILS LOCALIZER (108.00 thru 117.95 MHz).

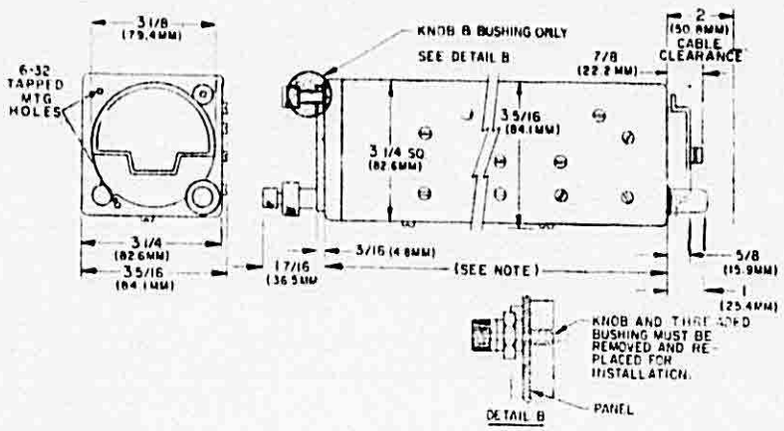
When a VOR channel is selected, (even tenths: 108.00 thru 111.85 MHz and all channels 112.00 thru 117.95 MHz) the indicator shows left or right deviation from the course chosen on the course selector dial.

When the Channel Selector is set to an ILS LOCALIZER channel (odd tenths: 108.10 thru 111.95 MHz) the indicator shows left or right deviation from the runway center line.

G/S Indicator Needle and G/S Flag

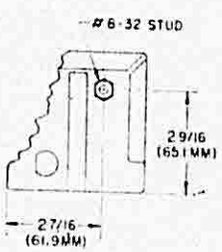
Glide slope transmitters are paired with localizer transmitters in instrument landing systems. Glide slopes operate at ultrahigh frequencies. A glide slope frequency is assigned to each localizer frequency. The frequency selector channels the receiver.

With the UHF glide slope receiver properly tuned and an adequate signal is received, the "GS" warning flag in the NAV disappears. When the "G/S" flag is out of sight the glide slope indicator needle in activated. The position of the G/S needle indicates the location of the aircraft with respect to the location to the center line of the glide slope course.



C-07657-C

	INCHES	MILLIMETERS
A	3- 5/16	81.0
B	1/4 DIA	6.4 DIA
C	5/32 DIA	4.0 DIA
D	1/8 R	3.2 R
E	1-3/4 R	44.5 R
F	1.41/64 R	41.7 R
G	13/16	20.6
H	1.39/64 R	40.9 R
J	9/32 R	7.1 R
K	1.5/64	37.7



NOTES:

These equipments are rear panel mounted.

Chassis length, 8½" (215.9MM)

Mounting screws to be No. 6-32,
Length to be: 7/16 Min/3/4" Max
Plus thickness of panel.

Rear connections:
Has connector and 2
Pigtails with connectors.

	INSTALLATION KIT	Qty
41316-0007	CONNECTOR, SHELL, 15 pin	1
41317-0001	CONTACT, CONNECTOR	15
82019-0002	STRAP, CABLE	1
82814-0004	SCREW, 4-40 x 5/16	3
82802-0003	LOCKWASHER, No. 4	3
82900-0004	NUT, HEX, No. 4-40	3
82815-0109	SCREW, 6-32 x ¾	2
55951-0001	HANDLE, CONNECTOR without eyelet	
81254-0012	EYELET (to be installed in) handle)	1
41116-0002	CONNECTOR, 6 pin	0
84038-0001	ADAPTER, Cable to BNC	1
90058-	CABLE, RG-188A/U, 18"	1
41285-0006	CONNECTOR, 24 pin	1
41229-0001	CONNECTOR, BNC	1

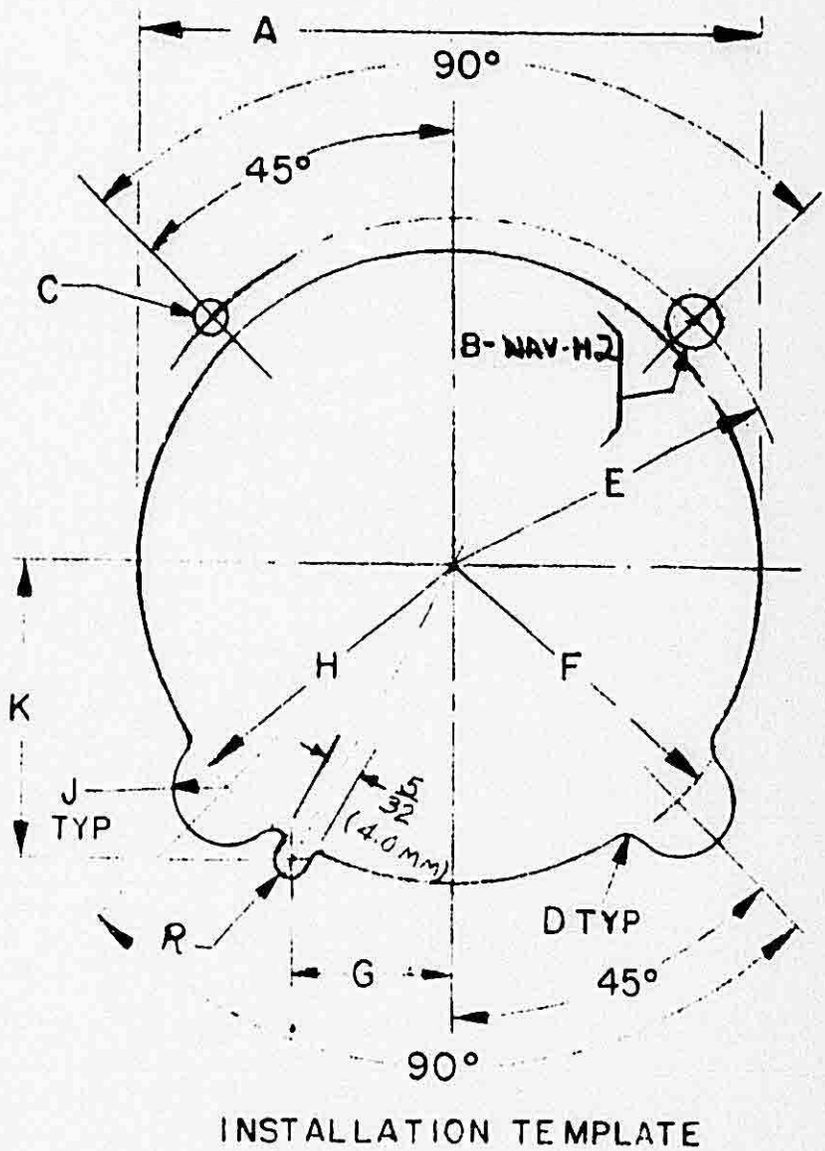


FIGURE 2-14. NAV 112 TSO INSTALLATION DRAWING

SEE BLOW-UP

2.10 NAV 114 TSO

2.10.1 Specifications

Mechanical:

Size: Panel Unit (See Installation Drawing Figure 2-22)

Cabin side of Instrument Panel: knobs and trim panel approx. 6¼ x 1-13/16" deep x 1¾ h.

Behind Instrument Panel: tray and cables approx. 6½W x 11-13/16 deep x 1¾h. See Installation drawing for detail dimensions.

Weight: Panel Unit 2 lb. 8 oz. (1.13 Kilograms)

Electrical:

Voltage: 13.75 operation only

Current: Receive — .6 amps (not including pilot lights)
Pilot Lights — .32 amps

Environmental:

Meets the following TSO Categories:

TSO	ENV CAT.	
C-34c	DAP AAA XXXXXX	Class C
C-36c	DAP AAA XXXXXX	Class C
C-40a	DAP AAA XXXXXX	
C-66a	DAP AAA XXXXXX	

*See page 2-1.

Receiver Frequency Range: (360 channels)
108.00 to 117.95 MHz (200 channels) NAV
118.00 to 125.95 MHz (160 channels) COM

Sensitivity:

NAV Band: 1.5μv Nominal/2.0μv Maximum for 6 db S+N/N ratio

Spurious and Image Rejection:

Greater than 60 db

Selectivity:

6 db (nose) — 34 KHz Minimum
60 db (skirt) — 84 KHz Maximum

AVC Flatness:

1 db Maximum for 10μv to 10Kμv (OMNI Output)

Tone Filter:

18 db minimum IDENT Tone rejection

Audio Output:

Headphones: 30 mw into 300 ohms

VOR/LOC Signal Output

A. Plug J1A-PIN 3 (Narco output) for 500μv OMNI signal 30 Hz - 30% modulation 0.3 vrms.

B. Plug J1A-PIN 11 (ARINC output) for 500μv OMNI signal 30 Hz - 30% modulation 0.5vrms.

NOTE: There is 180° phase difference between NARCO and ARINC outputs.

2.10.2 Units and Accessories Supplied

A. NAV 114 TSO
B. Tray Assy P/N 56230-0106
C. Installation Kit 03091-0500

2.10.2.1 Companion Units

A. DGO 10 Pictorial Navigation Display
B. VOA 100/110 Navigation Converter
C. VOA 40/50 Navigation Converter
D. VOA 8/9 Navigation Converter
E. CLC 60 RNAV System
F. any ARINC Nav Converter
G. All remote DME units with 2 out of 5 channeling system . . . including those designed for 50 KHz "Y" channel implementation.

2.10.2.2 NAV 114 TSO Accessories Required, but NOT Supplied

For proper operation of these equipments the following accessories are required: a receiving antenna (or a combination type), headphones and a glide slope receiver.

To ensure complete FAA Part 37 TSO compliance as applied to Air Carrier operation, these equipments must be used with Communication and Navigation antennas meeting TSO's C-36b, C-37b, C-38b, and C-40a requirements.

When TSO compliance is not required, the following antennas are recommended.

A. Receiving Antenna: NARCO type VRP-37 tail mounting type with 30 feet or RF cable and "Balun." Part No. 05507-0000.

OR

NARCO type VNA-10 tail mounting type, Part No. 71226-0001.

B. VHF COM NAV Antenna. VCNA-1 and -2. NAV 114 TSO may be desensitized when transmitting with a COM unit. Refer to Paragraph 2.12.4 for details.

C. Headphones — low impedance type, 300 to 1000 ohms. Both handphones and speaker may be used simultaneously.

D. Glide Slope Receiver: NARCO UGR-2A which has 50 KHz channeling or a UGR-2 which has 100 KHz channeling. (See Optional Accessories.) In either case, the UGR requires its antenna, a UGA-1 or a UGA-10. Refer to the UGR Maintenance Manual for installation data and check-out procedures.

2.10.2.3 Optional Accessories

A. MP 10 Voltage Converter, 28 to 14 volts. (See Section 2.13)

B. UGR-2, 50 KHz Kit (P/N 03502-0501) Converts the UGR-2 from 20 channels to 40 channels, hence, 50 MHz channel spacing.

2.10.3 Mechanical Installation

The unit is designed to be installed into a mounting tray. The unit contains a locking screw, in the front panel, which should be turned full CCW before sliding the unit into the tray. After the unit is in the tray, the locking screw should be turned full CW, this draws in the radio and as it does the mating connector will engage, providing positive connection and securing the radio in the tray.

DO NOT RAM THE UNIT INTO THE TRAY!

Removal of a unit is the reverse of installation, turn the locking screw CCW until the unit is free of the connector(s).

The installation drawing provides a detailed drawing of the tray and the parts of the installation kit. The figure also provides all the necessary dimensions for the panel cutout as well as that for the mounting bracket locations, plus a 1:1 panel cutout template.

2.10.3.1 NAV Tray Mounting

The NAV 114 TSO mounting tray shall be mounted behind the aircraft instrument panel using No. 6 binding head screws at each of the four mounting holes.

Mounting brackets to mate the holes are not supplied due to the wide range in mounting requirements. Mounting brackets may be fabricated from suitable metal sheet or angle stock.

The tray must be provided with a good electrical ground. A ground strap can be attached to a rear-side mounting screw.

It is recommended that the panel mounted unit be provided with ram air cooling.

NOTE: The NAV 114 TSO has three, 15 pin rear connectors which must be installed (see Fig. 2-22) prior to mounting the tray in the aircraft. Dress the leads of the connector(s) thru the cable clamp(s) to avoid undue stresses. Particular attention should be given to the mounting of connector J1B's outer side. The hardware should be assembled to the connector before mounting is attempted. The fibre washer holds the group together before the screw is secured.

2.10.4 Electrical Connections

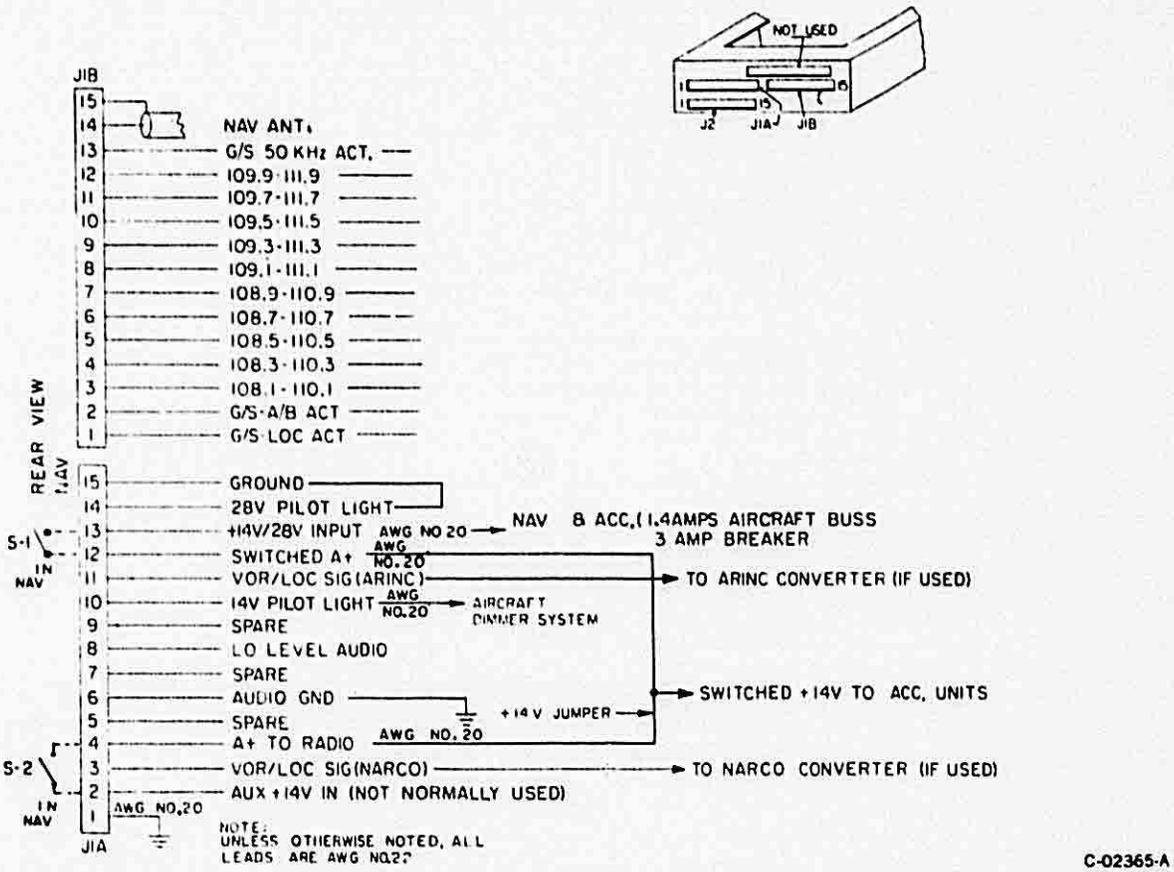
The installing agency is required to make-up the installation cable. Lengths are dependent upon the particular aircraft installation. Refer to the Interconnect Diagrams for all cable connections. (Figure 2-15 thru 2-20)

Also refer to the Section 2-11 for proper lead termination.

The coax cable should be 50 ohm RG-188A/U.

All leads should be #22AWG unless otherwise noted.

A circuit protection device should be provided between the Unit and the aircraft buss:
14 volt installations, 3 amp
28 volt installations, 4 amp



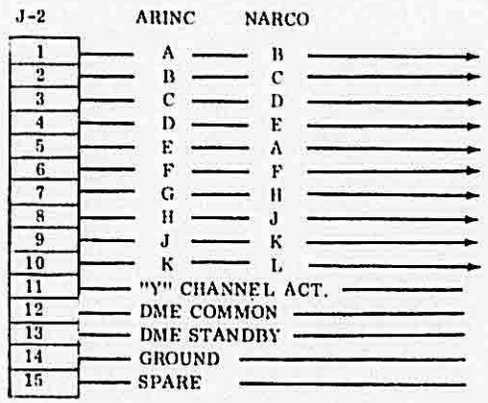


FIGURE 2-15. 14V GENERAL NAV 114 TSO WITH DME INTERCONNECT WIRING DIAGRAM

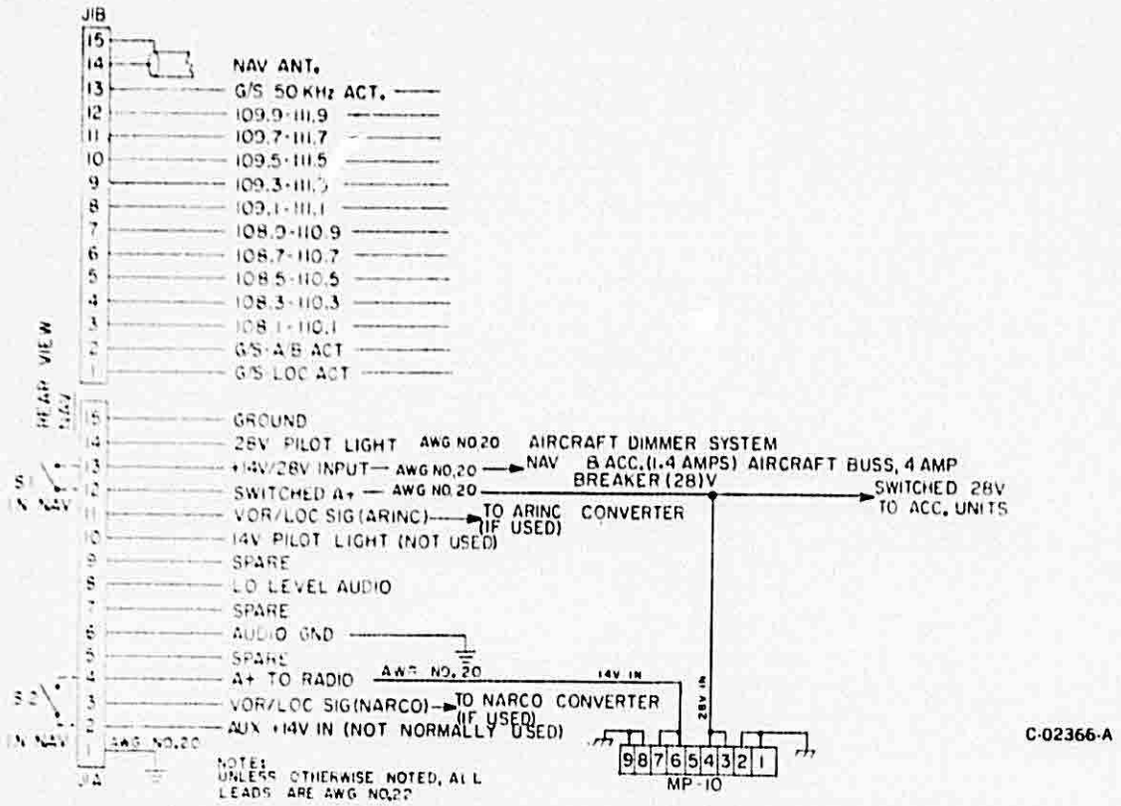


FIGURE 2-16. 28V GENERAL NAV 114 TSO WITH INTERCONNECT WIRING DIAGRAM WITH THE MP 10 INPUT CONTROLLED BY THE NAV 114 DME's ON-OFF SWITCH.

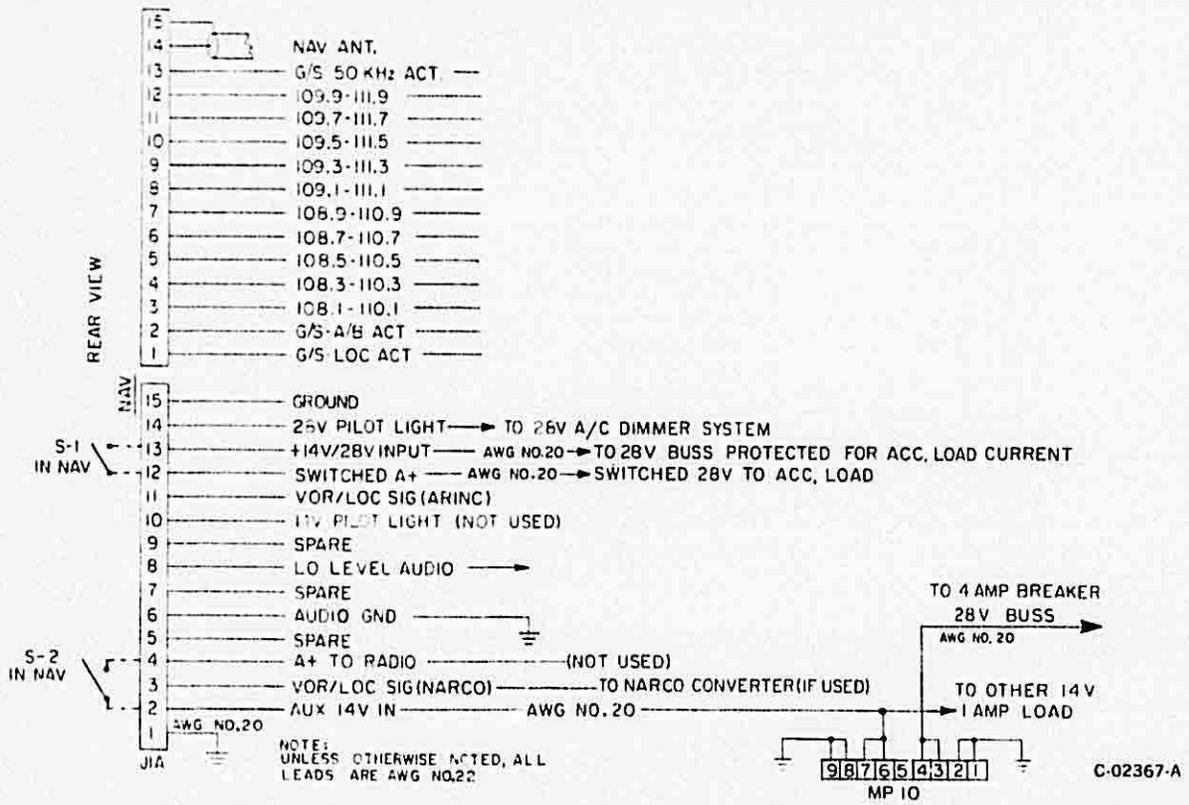


FIGURE 2-17. ALTERNATE 28V NAV 114 TSO DME INTERCONNECT WIRING DIAGRAM SHARING THE MP 10 WITH OTHER UNITS AND SUPPLYING SWITCHED 28V to ACCESSORY UNITS.

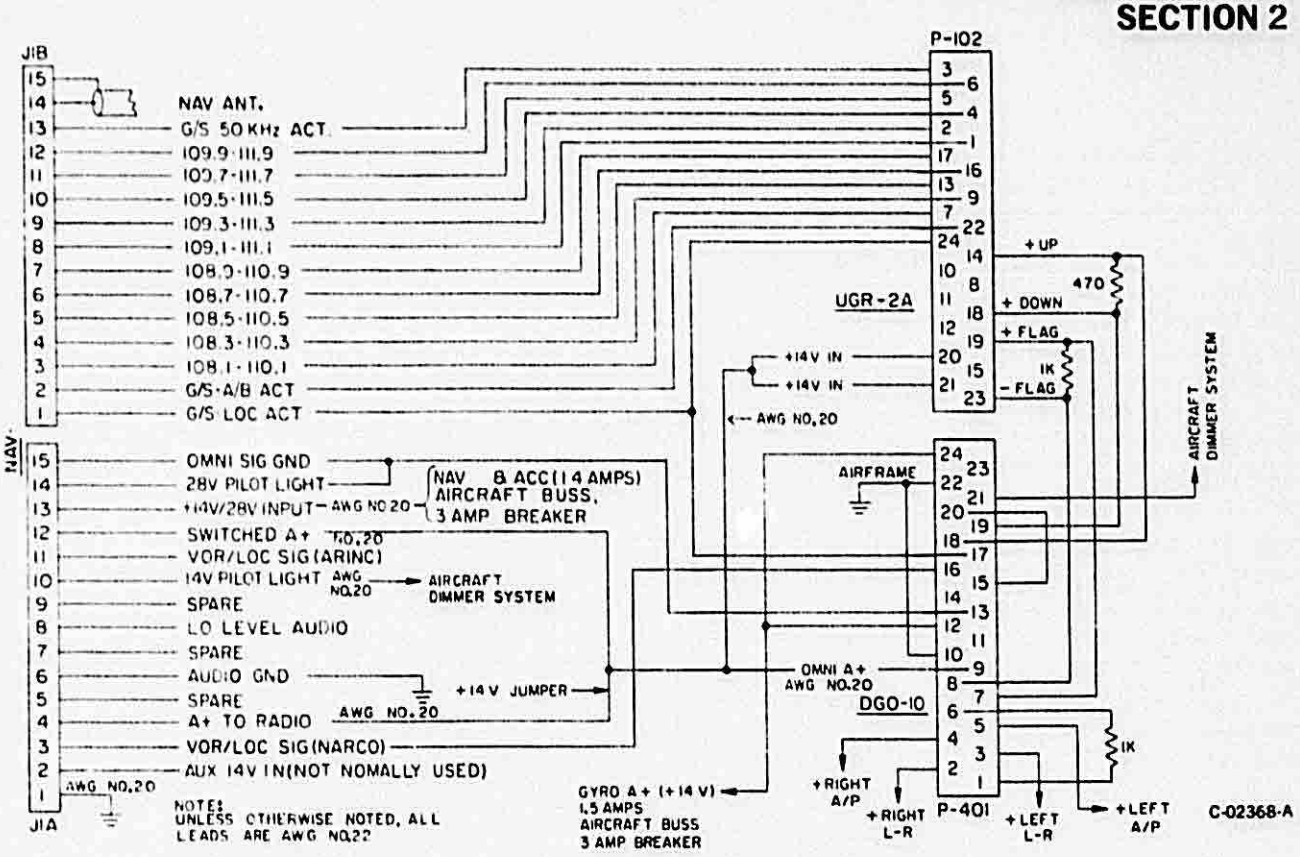


FIGURE 2-18. 14V INTERCONNECT WIRING DIAGRAM FOR NAV 114 TSO DME-UGR2A-DGO 10

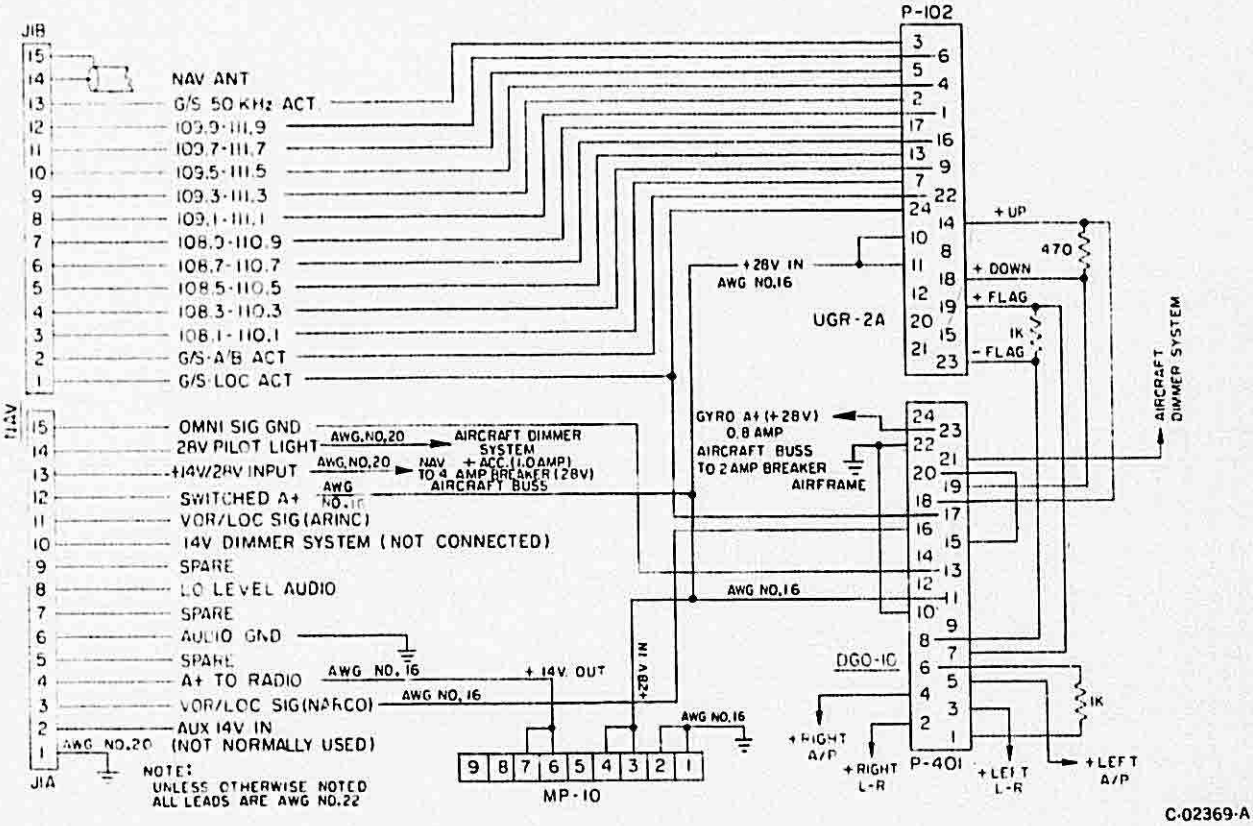
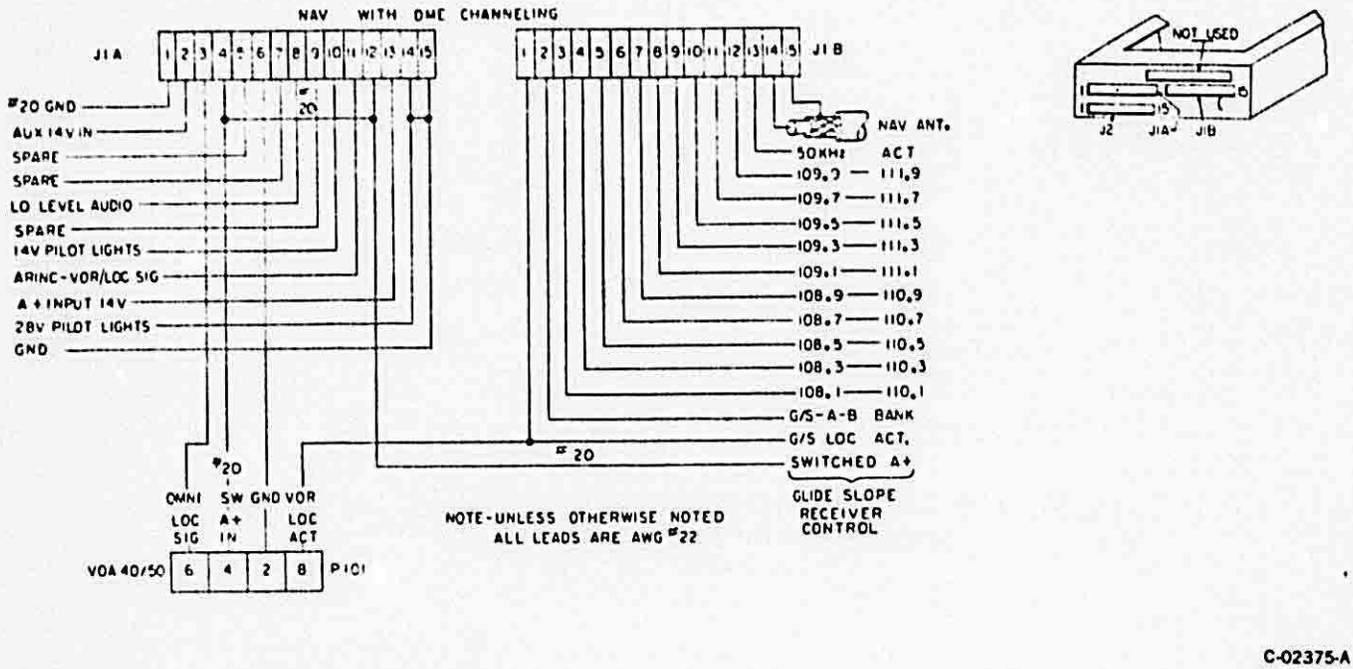


FIGURE 2-19. 28V INTERCONNECT WIRING DIAGRAM FOR NAV 114 TSO DME-UGR2A-DGO 10

SEE BLOW-UP



C-02375-A

FIGURE 2-20. TYPICAL NAV 114 TSO BENCH TEST WIRING

SEE BLOW-UP

2.10.5 Pre-Installation Bench Test

The equipment required to perform this test is listed below:

A low voltage dc supply, 12-15 vdc at 10-15 amps such as an Electro Products Laboratories Model NFB or equivalent.

An OMNI Signal Generator, Aircraft Radio Corp Model H-14A or equivalent.

An AC VTVM.

2.10.5.1 Procedure

A. Apply Power (13.75 VDC)

B. Turn VOL knob full CW, position IDENT Switch to IDENT. Channel radio to a generator frequency.

C. RF input should be 1.5μv for 6 db S+N/N (modulated 30% @ 1K Hertz) at Pin J1A-8, audio output should be 3.0v rms (8.5v P-P) (470 ohm load at Pin 8).

D. Check VOR/LOC output signal by connecting the NAV 114 TSO to a VOR converter such as a VOA 40/50. A 500μv input - 30 Hertz - 30% modulation should give 0.3v ac at J1A-Pin 3. Full TO or FROM flag should occur at 2μv with a normal OMNI signal.

E. Check OMNI operation using a crystal controlled OMNI channel at the Four Cardinal Points (0. 90, 180, 270°) — readings should be ±1.5°.

F. To check Glide Slope programming (plug J1B) a simple procedure using an ohm meter, may be used. No power is needed to the unit. Ground the common lead of the ohm meter to the chassis (Pin J1A-1), place the positive lead of the ohm meter on the proper pin of plug J1B which matches the LOC frequency set-up on the frequency selector. Refer to Table 2.4 which shows which pins should be grounded for the channel selected.

G. DME Channel Programming (Connector J2) may be checked in the same manner as the Glide Slope Programming. In this case, connect J2-12 (Common) to J2-13 (Ground). Tie the negative lead of a VTVM to ground and proceed as in the Glide Slope checkout (F). Refer to the DME Programming, Table 2.5. Diodes are connected in series with the common leads so that VTVM will not read zero resistance.

2.10.5.2 Post Installation

After the installation has been completed, the system should be operated on the ground, with all normal power turned on and the engine running. The receiver should be checked for proper operation by channeling to available signals.

A FLIGHT TEST IS RECOMMENDED.

TABLE 2.4 NAV 114 TSO GLIDE SLOPE PROGRAMMING

NAV Connector J1B, Pin #		108 MHz										109 MHz										110 MHz										111 MHz									
		10	15	30	35	50	55	70	75	90	95	10	15	30	35	50	55	70	75	90	95	10	15	30	35	50	55	70	75	90	95	10	15	30	35	50	55	70	75	90	95
GS/LOC Act	1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
GS A/B Act	2	x	x	x	x	x	x	x	x	x	x																					x	x	x	x	x	x	x	x	x	x
(108.1 - 110.1)	3	x	x																			x	x																		
(108.3 - 110.3)	4			x	x																			x	x																
(108.5 - 110.5)	5					x	x																			x	x														
(108.7 - 110.7)	6							x	x																			x	x												
(108.9 - 110.9)	7									x	x																			x	x										
(109.1 - 111.1)	8											x	x																			x	x								
(109.3 - 111.3)	9													x	x																			x	x						
(109.5 - 111.5)	10															x	x																			x	x				
(109.7 - 111.7)	11																	x	x																			x	x		
(109.9 - 111.9)	12																			x	x																			x	x
50 KC Act	13		x		x		x		x		x		x		x		x		x				x		x		x		x				x		x		x		x	

X - indicates pins that are grounded

TABLE 2.5 NAV 114 TSO DME CHANNEL PROGRAMMING

NARCO	ARINC	NAV J-2	MHz CHANNELS										
			108	109	110	111	112	113	114	115	116	117	
B	A	1	X	X		X	X						
C	B	2			X	X		X	X				
D	C	3					X	X		X	X		
E	D	4	X						X	X		X	
A	E	5		X	X						X	X	
			KHz CHANNELS										
-	-	-	.00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95
F	F	6			X	X	X	X											X	X	X	X
H	G	7	X	X	X	X			X	X	X	X										
J	H	8					X	X	X	X			X	X	X	X						
K	J	9									X	X	X	X			X	X	X	X		
L	K	10	X	X											X	X	X	X			X	X
"Y" CHANNEL ACT.		11		Y		Y		Y		Y		Y		Y		Y		Y		Y		Y
DME COMMON		12																				
DME STANDBY		13																				
GROUND		14																				
SPARE		15																				

NOTES:

1. "X" indicates continuity to the DME common terminal (J2-12)
2. "Y" indicates continuity to the ground terminal (J2-14)
3. DME common (J2-12) must be grounded for DME channeling to operate

3a. For DME frequency control by NAV 114 TSO only, J2-12 may be connected to J2-14

3b. When the NAV 114 TSO is used as one of two DME frequency control heads, J2-11 and J2-12 should be wired to one side of a double throw Control Head Selector Switch. See Control Head Selector Switch Wiring Diagram below.

4. DME standby (J2-13) may be used to deactivate the DME when the NAV 114 TSO is channeled to frequencies above 117.95 MHz. A normally closed 14/28V relay should be wired between J1A-12 (Switched A+) and J2-13 as follows:

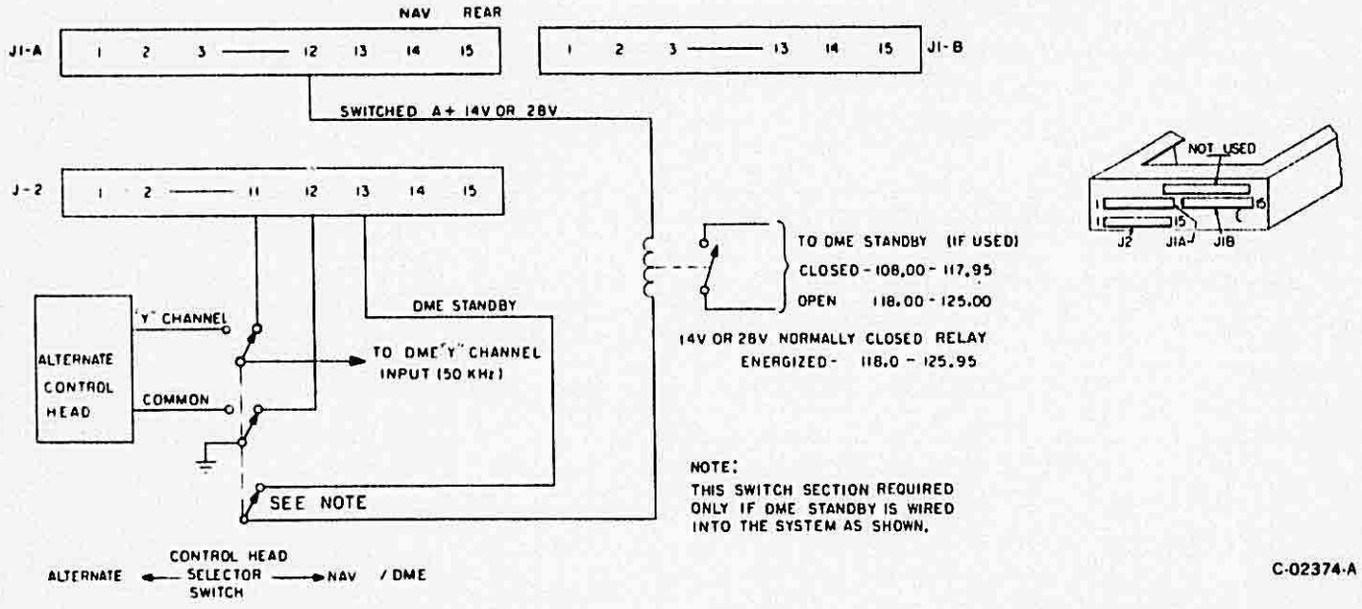


FIGURE 2-21. NAV 114 TSO CONTROL HEAD SELECTOR SWITCH AND STANDBY WIRING

SEE BLOW-UP

2.10.6 NAV 114 TSO Operation

VOL/ON-OFF Knob

This knob energizes the NAV 114 TSO. Turning the knob CW past the "click" turns the unit ON and continued rotation increases volume. Conversely CCW reduces volume and turns the unit off.

Frequency Channeling

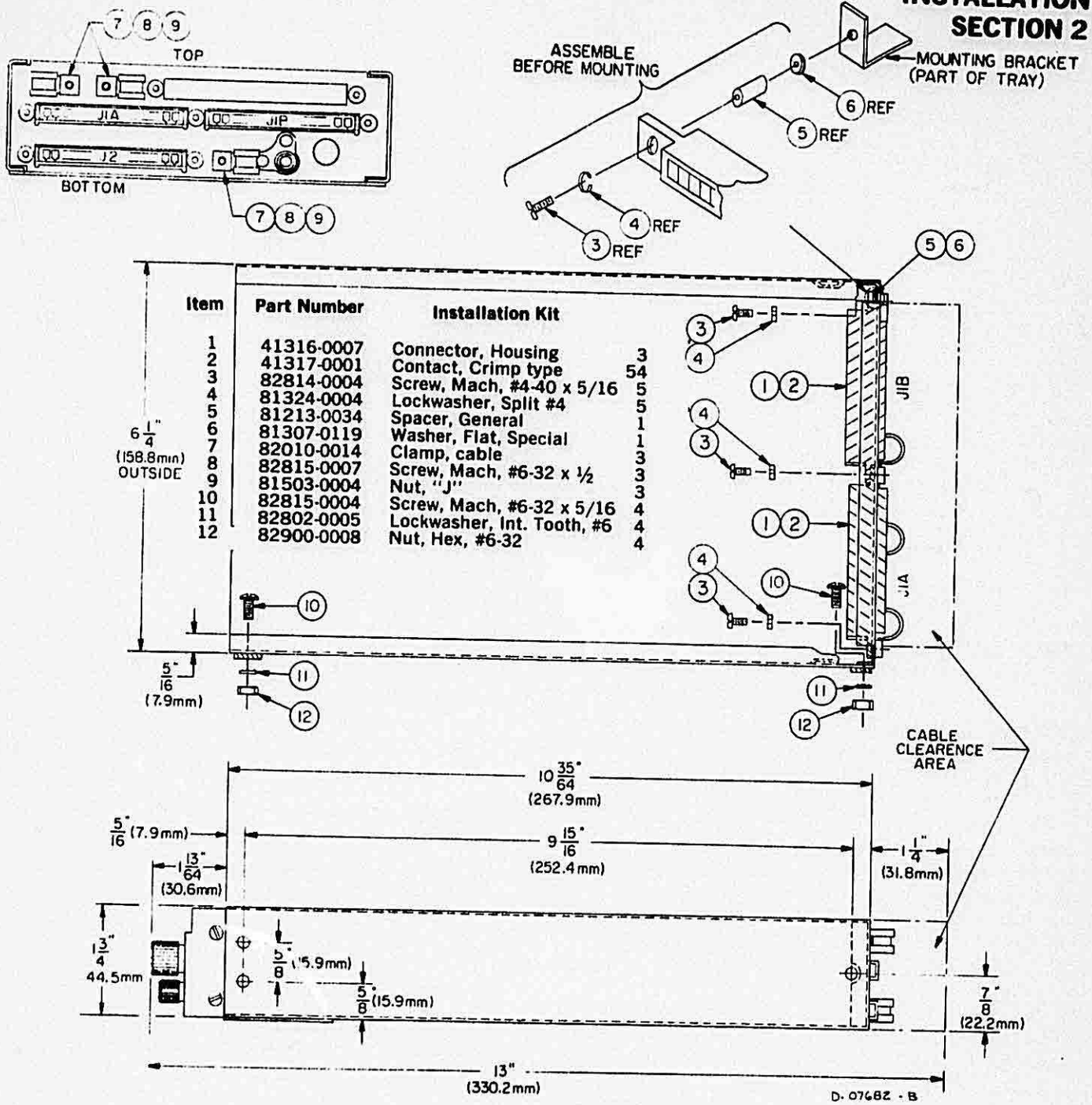
The two large knobs have no stops, thus allowing shortest (CW or CCW) rotation to the desired frequency. The left knob selects the MKz (the whole number) the right knob selects the KHz (the fractional number).

Certain NAV frequencies allow two-way communication, i.e: Flight Service Stations.

Properly paired glide slope and DME frequencies will be selected by the channeling knobs if remote glide slope and DME equipments are part of the NAV 114 TSO System. The glide slope functions only on Localzier channels. The DME functions only on VOR channels provided that the DME standby function is wired into the System.

IDENT

Pulling the IDENT knob (about ¼") actuates the IDENT switch. The IDENT switch overrides the internal tone filter and when in the IDENT position (out) allows the 1020 Hz station identification code to be heard.



Item	Part Number	Installation Kit	
1	41316-0007	Connector, Housing	3
2	41317-0001	Contact, Crimp type	54
3	82814-0004	Screw, Mach, #4-40 x 5/16	5
4	81324-0004	Lockwasher, Split #4	5
5	81213-0034	Spacer, General	1
6	81307-0119	Washer, Flat, Special	1
7	82010-0014	Clamp, cable	3
8	82815-0007	Screw, Mach, #6-32 x ½	3
9	81503-0004	Nut, "J"	3
10	82815-0004	Screw, Mach, #6-32 x 5/16	4
11	82802-0005	Lockwasher, Int. Tooth, #6	4
12	82900-0008	Nut, Hex, #6-32	4

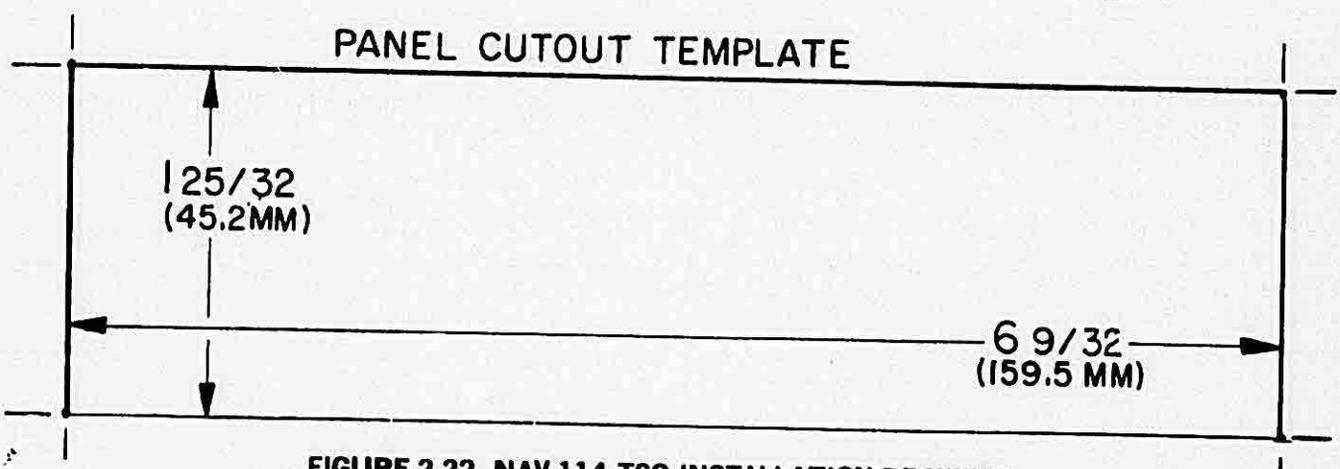


FIGURE 2-22. NAV 114 TSO INSTALLATION DRAWING

SEE BLOW-UP

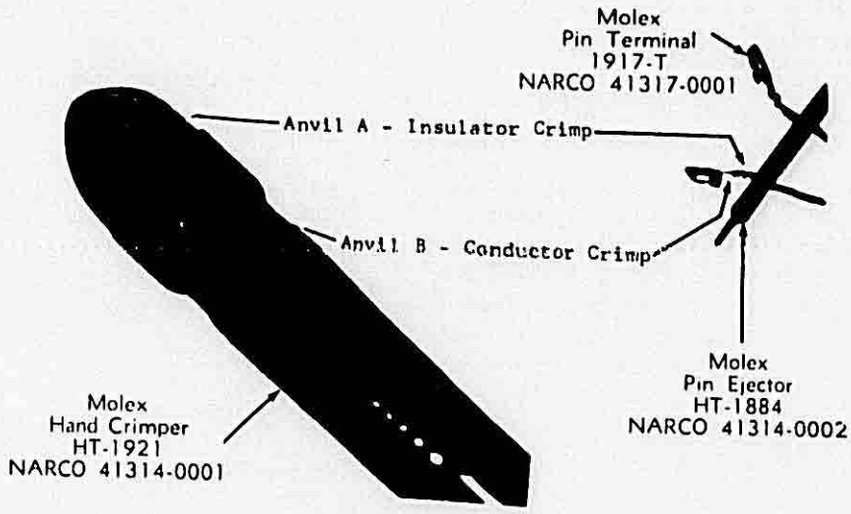


FIGURE 2-23. CRIMPING TOOL

2.11 SPECIAL TOOLS FOR CABLE CONNECTOR FABRICATION

Crimping and ejector tools for the connector connections are available from Narco or Molex.

Molex Products Co.
Downers Grove, Ill. 60515

Hand Crimper HT-1921	(NARCO 41314-0001)
Ejector tool HT-1184	(NARCO 41314-0002)

The connector mounting tabs should be placed on the inside of the tray.

Lead Termination

1. Strip wire 5/32" for PIN Terminal No. 1917-T.
2. Open tool (engraved side toward you), from the opposite side place the conductor tab section of a pin on Anvil B. Close tool slightly (until the tabs touch the female jaw).
3. Insert stripped conductor until insulation is level with outside of jaw. Crimp by squeezing handles together until jaws are fully closed or sufficient crimp is made.
4. Move lead and pin to Anvil A. Rest the insulating tab section on Anvil A. Crimp again until jaw is closed or sufficient crimp is made.
5. If necessary, straighten pin while still being held in the jaw.

Insertion

1. The PIN Terminal may now be inserted into the desired pin location in the translucent connector housing. The pin cannot be inserted up-side-down. Right-side-up it slides in effortlessly. Be sure to push it all the way in, until a "click" can be felt, heard, or even seen (by turning the translucent housing over).
2. There is no necessity to pull back on the lead itself except to test for the "locking feature," and then only with a moderate pull.

Extraction

1. If a pin is erroneously inserted into the wrong housing position, or if at some later time a circuit change is desired, the pin can be removed easily. Slip the flat narrow blade portion of the tool into the mating side of the housing, under the pin. By holding the housing upside-down one can see the blade slide in, up the stop. This action picks up the locking key and allows the lead and pin to slip out of its position using a light pulling action on the lead. Neither pin nor position has been damaged allowing reinsertion in the same or another position.

Crimping with Pliers

The lead PIN Terminal connection using the Molex hand crimper provides a superior connection than with pliers. However, with care a satisfactory connection can be made.

1. Strip lead 5/32" for PIN Terminal 1917-T.
2. Tin exposed conductor.
3. Using needle nose pliers fold over conductor tabs firmly onto the conductor, one side then the other.
4. Repeat step 3 for the insulator tabs.
5. Apply a drop of solder (using minimum heat) to the conductor connection to assure a good electro-mechanical joint.

2.12 ANTENNAS

Antennas VCA-10, VRP-37, VNA-10, and the VCNA-1 and -2 use 50 ohm coaxial transmission line RG-58 A/U unless otherwise noted.

To maintain the 50 ohm match, the exposed center conductor should be as short as possible.

It is possible in some types of airplanes to get satisfactory reception without special precautions. However, it is always advisable and frequently necessary to provide properly fitted ignition shielding. It has been found that such shielding when not in first-class condition as to clean and tight joints, etc., can cause a lot of noise, particularly at VHF. It is, therefore, recommended that any ignition shielding in the airplane in which the equipment is being installed be thoroughly inspected and overhauled if necessary, at the time installation.

To ensure complete FAA Part 37 TSO compliance as applied to Air Carrier operation, these equipments must be used with Communication and Navigation antennas meeting TSO's C-36b, C-37b, C-38b and C-40a requirements.

When TSO compliance is not required, the following antennas are recommended.

2.12.1 VCA-10

The VCA-10 transmitting antenna should be installed on a flat, horizontal part of the fuselage. Mounting it on a curved surface could warp the antenna base and damage the internal structure. The view in every direction from the antenna should be as unobstructed as possible.

The antenna should be installed in the center of the ground plane. Locations near the edge of the ground plane (windshield, windows, doors) may cause dead spots in the radiation and reception patterns.

If this antenna is to be used on a non-metallic aircraft skin, a ground plane at least 1½ feet in diameter must be provided. This could be as simple as aluminum foil cemented inside wood or stiff fiberglass skin, or a doubler plate on a fabric-covered aircraft. Such a ground plane should be either well bonded to the airframe, or well insulated from it, to prevent noise problems or erratic operation.

A doubler plate will be needed for airworthy installation on most aircraft. Check the airworthiness regulations of the country of aircraft registry for acceptable mounting methods. All mounting studs must be used.

The VCA-10 antenna must be properly grounded. Remove all paint or other finish around the grounding stud holes on both sides of the aircraft surface, doubler or ground plane. Use washers supplied (flat washer may be omitted when doubler is used) and tighten locknuts firmly, to insure good contact.

DO NOT PAINT. This antenna may not be coated with any paint or other finish.

The antenna cable should be run as directly as possible to reduce line losses. The radius of any bend should be at least 6". The cable should be secured to the airframe as least every two feet. Be sure cable clamps do not crush the coaxial cable. There must be no possibility of the antenna cable fouling aircraft control cables.

2.12.2 VRP-37

Tail mounting receiving antenna, Narco Type VRP-37 is available for mounting on the upper part of the vertical stabilizer. The VRP-37 is available with an external balun which attaches to the antenna rods. The other end of the balun is factory connected to the coaxial RF cable which connects to the equipment. The balun is made of coaxial RF cable, cut to critical dimensions, which should not be altered. The sheath of the coaxial line to the receiver should be connected to the sheath of the balun cable and grounded directly to the metal surface of the airplane. The VRP-37 Cable Assembly has a grounding lug for making this connection.

2.12.3 VNA-10

The vertical stabilizer mounted receiving antenna VNA-10 will fit a metallic vertical stabilizer whose rake is between 0° and 30°.

The antenna is riveted in place.

Complete detailed installation instructions are found in manual 05531-0620 which is packed with each VNA-10.

2.12.4 VCNA-1 or VCNA-2

The VCNA-1 or -2 VHF NAV/COM antenna should be installed on a flat horizontal part of the fuselage, clear of obstructions. The only precaution of note is that should either of these antennas be tied in to a system consisting of a COM 111 TSO and a NAV 111 TSO or NAV 112 TSO, transmission on frequencies within about one megahertz of a desired OMNI frequency will reduce NAV receiver sensitivity. This reduction in sensitivity becomes less as the transmitter frequency is separated more from the OMNI frequency. With frequency separation greater than about one megahertz, little desensitization will be observed.

Detailed installation data is found in manual Hs-4, packaged with each antenna.

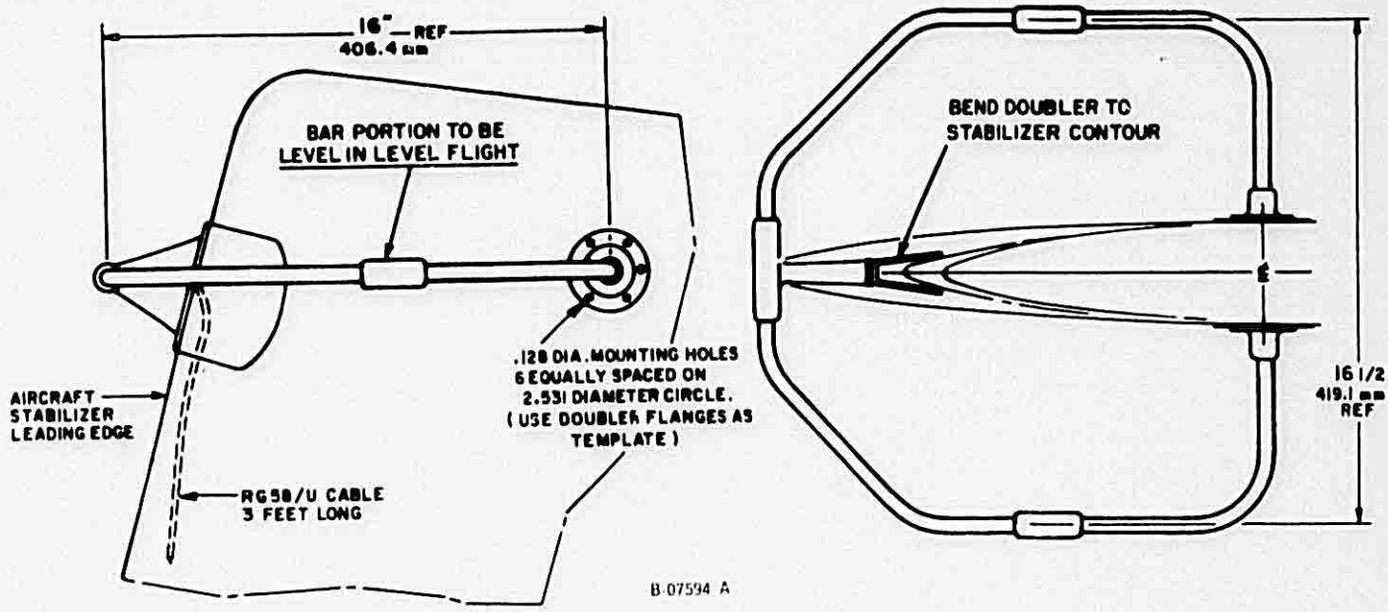
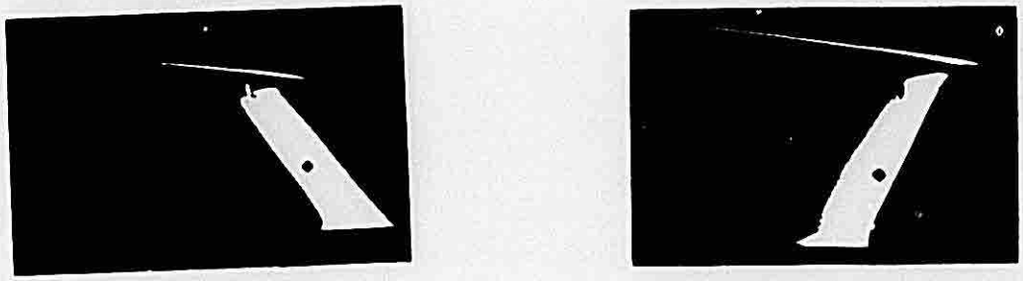


FIGURE 2-24. VNA-10 ANTENNA



VCNA-1

VCNA-2

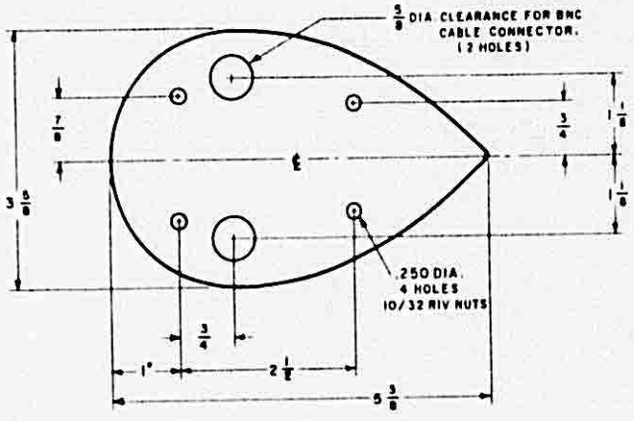
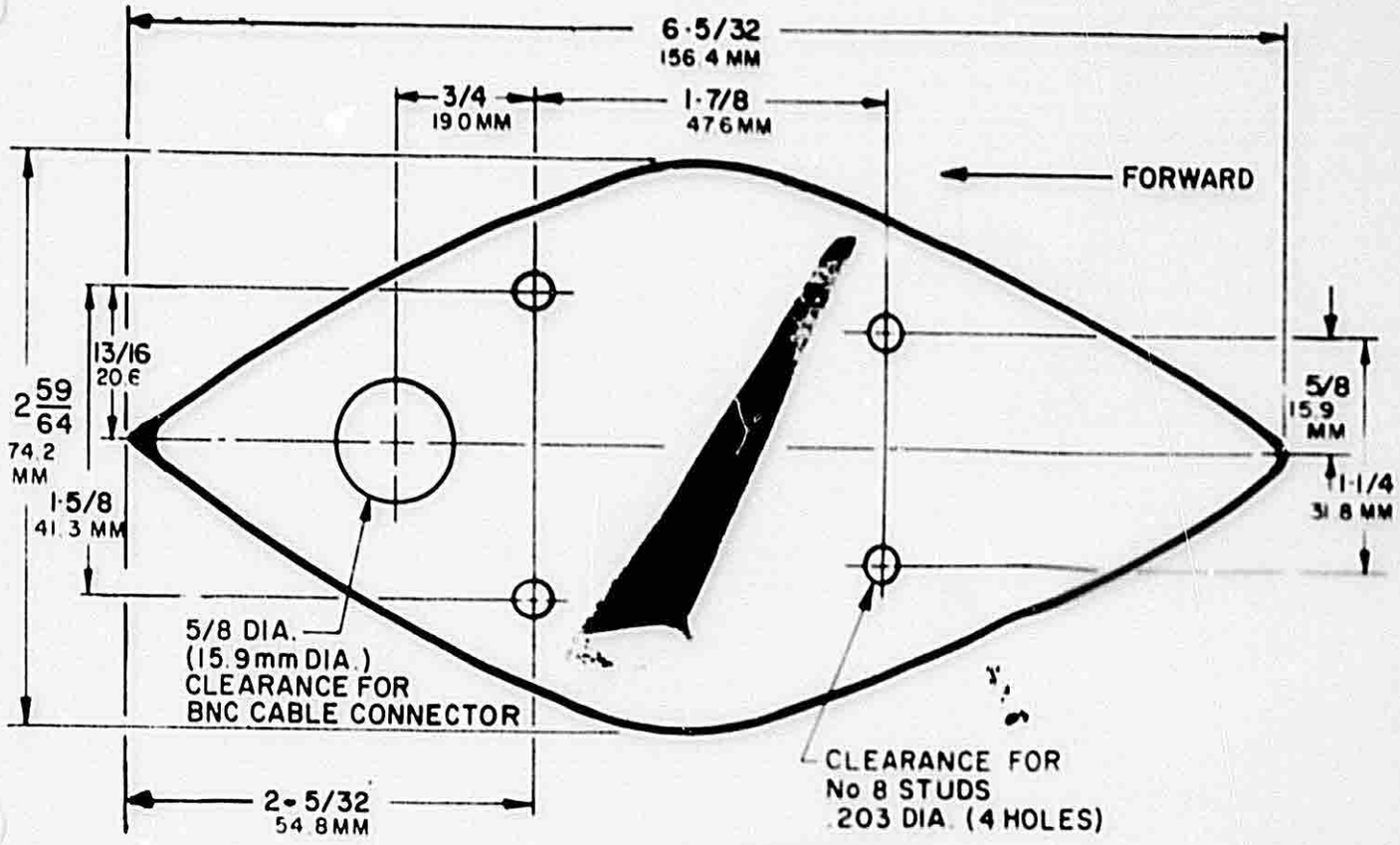


FIGURE 2-25. VCNA-1 or VCNA-2 ANTENNAS

SEE BLOW-UP



FULL SIZE TEMPLATE

A-07631 A

FIGURE 2-26. VCA-10 ANTENNA

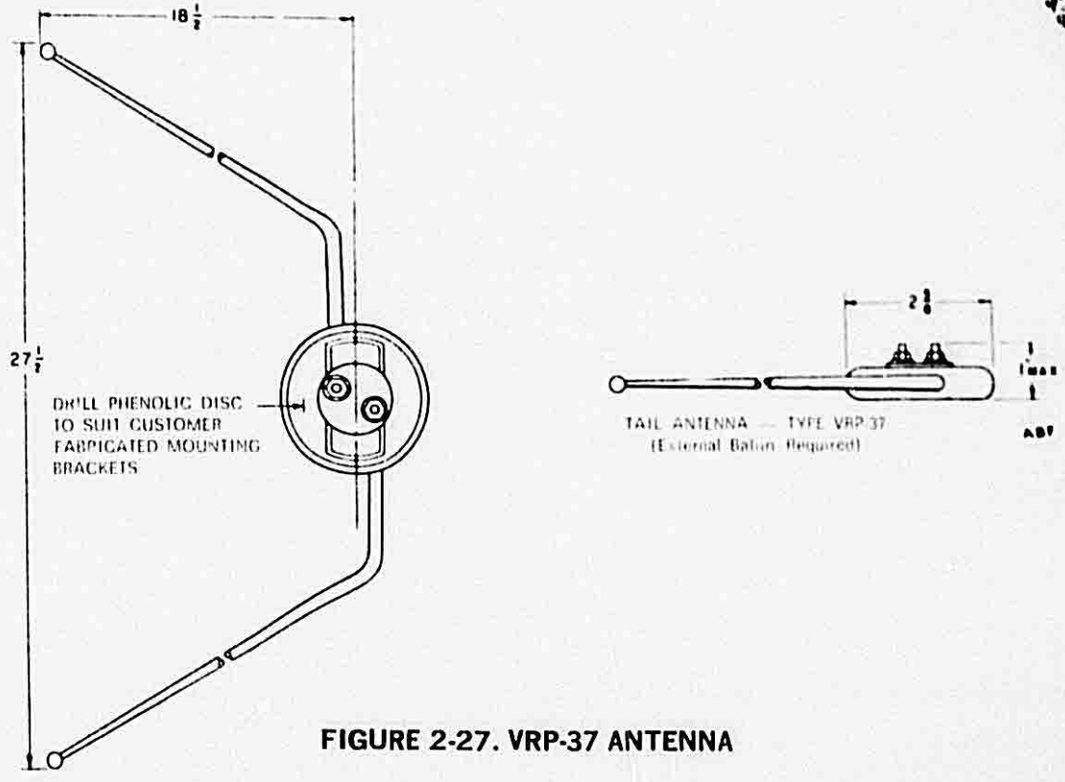


FIGURE 2-27. VRP-37 ANTENNA

2.13 Voltage converter, MP-10

The COM 110 TSO/NAV 110 TSO System, the COM 111 TSO, and the NAV 114 TSO are designed for 14 volt operation. These units may be installed in aircraft having a 28 volt system provided a converter, such as NARCO's MP 10, is used to convert the voltage for the units from 28v to 14v.

No attempt should be made to use one MP 10 to support two or more transceivers. In a multi-transceiver installation, an MP 10 Voltage Converter should be used for each transceiver to assure that should a converter fail, you still have the back-up transceiver. The recommended typical setup is a single COM 110 TSO/ NAV 110 TSO. System or a single COM 111 TSO connected to an MP 10.

The MP 10 can be mounted in any convenient place or position within the aircraft providing that it be mounted on a clean metal surface, to provide good heat transfer. Secure the MP 10 to the aircraft using all four mounting holes and #8-32 hardware (screws, lockwashers, nuts). See Figure 2-28. Secure the cable with a cable clamp approximately 2-3 inches away from the MP 10.

The Installation Kit provides the necessary cable connector and nine crimp type contacts. It is best to install all nine contacts into the connector as this provides firm mating of the connector. A circuit breaker (4 amp) is also provided. It should be installed, as shown, to prevent damage to the converter from a short circuited output.

2.13.1 Specifications

Size and Weight, See Figure 2-28.

Environmental

TSO		ENV CAT.
C71	$\frac{B}{G}A\frac{N}{L}$	AAAXXXXXX

Weight: 1.0 pound

Current Capability:

2.0 amps continuous;
4.0 amps intermittent dut··

INSTALLATION KIT

Part No.	Description	Qty
61565-0001	Circuit Breaker	1
41316-0004	Connector, 9 pin	1
41317-0001	Contact, Crimp	9

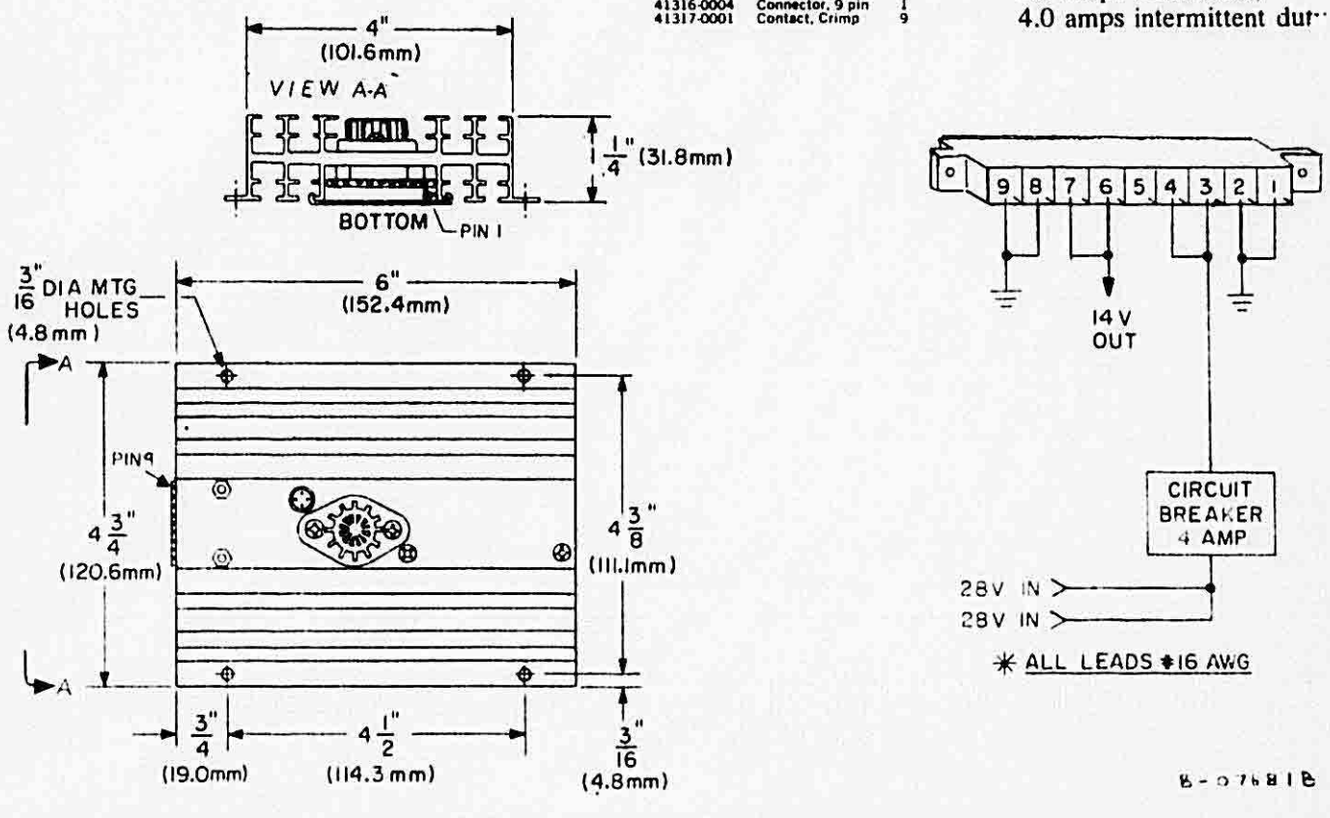


FIGURE 2-28. MP 10 INSTALLATION AND RECOMMENDED WIRING DIAGRAM

SEE BLOW-UP

TABLE OF CONTENTS

SECTION	TOPIC	PAGE	ATP GRID
3	NAV 110 TSO-COM 110 TSO	3-1	1G04
3.1	GENERAL	3-1	
3.2	INSTALLATION	3-1	
3.3	CIRCUIT DESCRIPTION, NAV 110 TSO-COM 110 TSO	3-2	1G05
3.3.1	NAV 110 TSO Circuit Description	3-3	1G06
3.3.1.1	NAV 110 TSO OMNI/LOC Circuits	3-4	1G07
3.3.1.2	NAV 110 TSO Left-Right Phase Detector	3-4	
3.3.1.3	NAV 110 TSO To-From Detector	3-5	1G08
3.3.1.4	NAV 110 TSO OMNI/LOC Switching Circuits	3-5	
3.3.1.5	Localizer Circuitry	3-6	1G09
3.3.1.6	NAV 110 TSO Channel Selection	3-6	
3.3.2	COM 110 TSO Circuit Description	3-7	1G10
3.3.2.1	Receiver	3-8	1G11
3.3.2.2	Interconnect PC Board Circuits	3-10	1G13
3.3.2.3	Synthesizer	3-11	1G14
3.3.2.4	Transmitter Modulator, COM 110 TSO	3-17	1G20
3.4	MAINTENANCE	3-19	1G22
3.4.1	NAV 110 TSO	3-19	
3.4.1.1	Test Equipment Required for NAV 110 TSO	3-19	
3.4.1.2	Test Set-Up	3-19	
3.4.1.3	Alignment Procedures	3-19	
3.4.1.4	NAV 110 TSO Maintenance Procedures and Hints	3-22	1H01
3.4.2	COM 110 TSO	3-23	1H02
3.4.2.1	Test Equipment Required for COM 110 TSO	3-25	1H06
3.4.2.2	Receiver Troubleshooting	3-25	
3.4.2.3	COM 110 TSO Receiver Tuning Procedure	3-28	1H09
3.4.2.4	Synthesizer Troubleshooting	3-29	1H10
3.4.2.5	Troubleshooting Procedure for COM 110 TSO Transmitter/Modulator	3-31	1H12
3.5.1	NAV 110 TSO Replacement Parts List	3-35	1H16
3.5.2	COM 110 TSO Replacement Parts List	3-45	1J02

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE	
3.1-1	NAV 110 TSO/COM 110 TSO SYSTEM	3-1	1G04
3.3-1	NAV 110 TSO/COM 110 TSO Simplified Block Diagram	3-2	1G05
3.3-2	OMNI/LOC Block Diagram	3-3	1G06
3.3-3	OMNI/LOC Switching	3-5	1G08 NC F903
3.3-3A	Bridge T Filter	3-6	1G09
3.3-4	NAV 110 TSO/COM 110 TSO Simplified Block Diagram	3-7	1G10
3.3-5	COM 110 TSO Receiver Block Diagram	3-8	1G11
3.3-6	Synthesizer Block Diagram	3-11	1G14
3.3-7	Transmitter/Modulator Block Diagram	3-16	1G19
3.4-1	COM 110 TSO Interconnections	3-24	1H03
3.4-2	Ramp	3-30	1H11
3.4-3	Test Connections	3-32	1H13
3.4-4	Test Block Diagram	3-32	
3.4-5	COM 110 TSO Power vs Frequency	3-33	1H14
3.4-6	Coil Test Tool	3-33	
3.4-7	COM 110 TSO Modulation Characteristics	3-34	1H15
3.5-1	NAV 110 TSO	3-35	1H16
3.5-2	Front Panel Assy	3-37	1H18
3.5-3	Gear Train Assy	3-38	1H19

LIST OF ILLUSTRATIONS (Continued)

FIGURE	TITLE	PAGE	ATP GRID	BLOW-UP FICH
3.5-4	Localizer Board	3-40	1H21	NC F903
3.5-5	OMNI Board	3-42	1H23	NC F903
3.5-6	COM 110 TSO	3-45	1J02	
3.5-7	Front Panel Assy	3-47	1J04	
3.5-8	Synthesizer Board, COM 110 TSO	3-48	1J05	NC F903
3.5-9	Interconnect Board, COM 110 TSO	3-53	1J10	NC F903
3.5-10	Transmitter, COM 110 TSO	3-54	1J11	
3.5-11	Transmitter PC Board, COM 110 TSO	3-55	1J12	NC F903
3.5-12	Modulator PC Board, COM 110 TSO	3-57	1J14	NC F903
3.5-13	Receiver Board, COM 110 TSO	3-60	1J17	NC F904
3.6-1	NAV 110 TSO OMNI Maintenance Information	3-63	1J20	NC F904
3.6-2	NAV 110 TSO Localizer Maintenance Information	3-65	1J22	NC F904
3.6-3	NAV 110 TSO Internal Interconnect Diagram	3-67	1J23	NC F904
3.6-4	NAV 110 TSO OMNI Schematic	3-69	1K02	NC F904
3.6-5	NAV 110 TSO Localizer Schematic	3-71	1K05	NC F904
3.6-6	COM 110 TSO Internal Interconnect Diagram	3-73	1K11	
3.6-7	COM 110 TSO Receiver Schematic	3-75	1K14	
3.6-8	COM 110 TSO Synthesizer Schematic	3-77	1K18	
3.6-9	COM 110 TSO Transmitter/Modulator Schematic	3-79	1K22	
3.6-10	COM 110 TSO Interconnect PC Board Schematic	3-81	1L08	NC F904

LIST OF TABLES

SECTION	TITLE	PAGE	
3.4.1	Receiver DC Voltage Measurements	3-26	1H07
3.4.2	Synthesizer Programming	3-29	1H10

3.1 GENERAL

This section, Section 3, is devoted to the NAV 110 TSO/COM 110 TSO/System.

These units are treated as a system because the NAV 110 TSO is dependent upon the COM unit for receiver circuitry. The COM units share their receiver circuitry with the NAV units simply by positioning the NAV-COM (mode) switch on the COM panel to NAV.

This switch transfers the receiver circuitry of the COM unit for exclusive use by the NAV 110 TSO. You can communicate in the COM mode and navigate in the NAV mode, but you can't do both at the same time. When the unit is in the NAV mode and the transmitter is keyed, the COM unit will transmit on the frequency selected by the COM channel selector but it will receive on the frequency selected by the NAV 110 TSO.

3.2 INSTALLATION

All pertinent information pertaining to specifications, licensing, and installation are provided, in detail, in Section 2 of this manual.

FIGURE 3.1-1 NAV 110 TSO/COM 110 TSO SYSTEM

3.3 CIRCUIT DESCRIPTION, NAV 110 TSO - COM 110 TSO

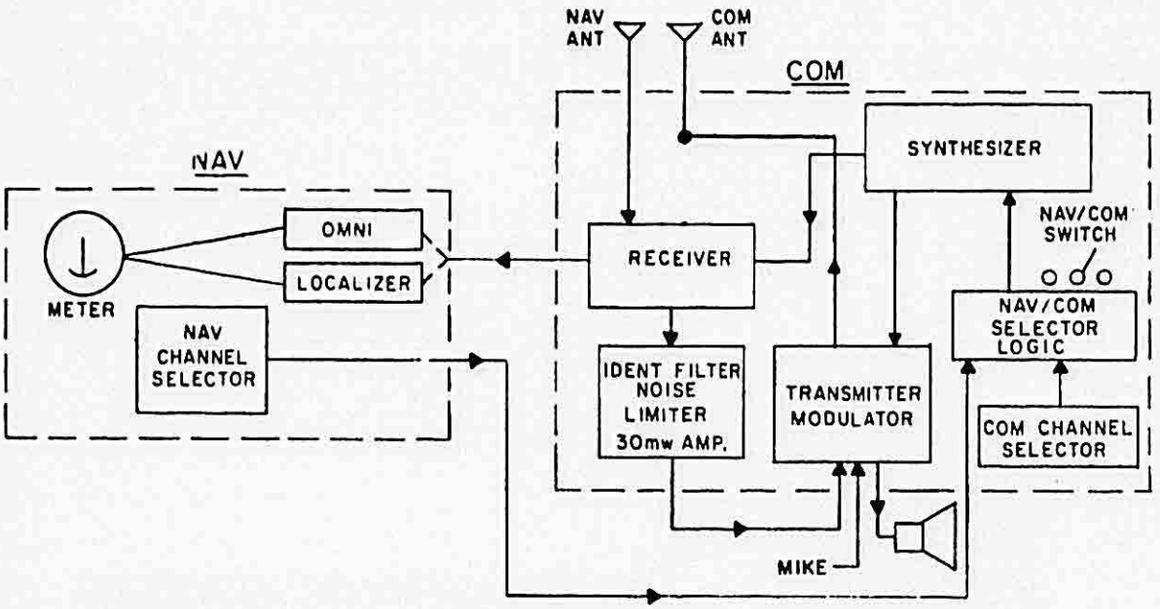


FIGURE 3.3-1 NAV 110 TSO-COM 110 TSO SIMPLIFIED BLOCK DIAGRAM

3.3.1 NAV 110 TSO Circuit Description

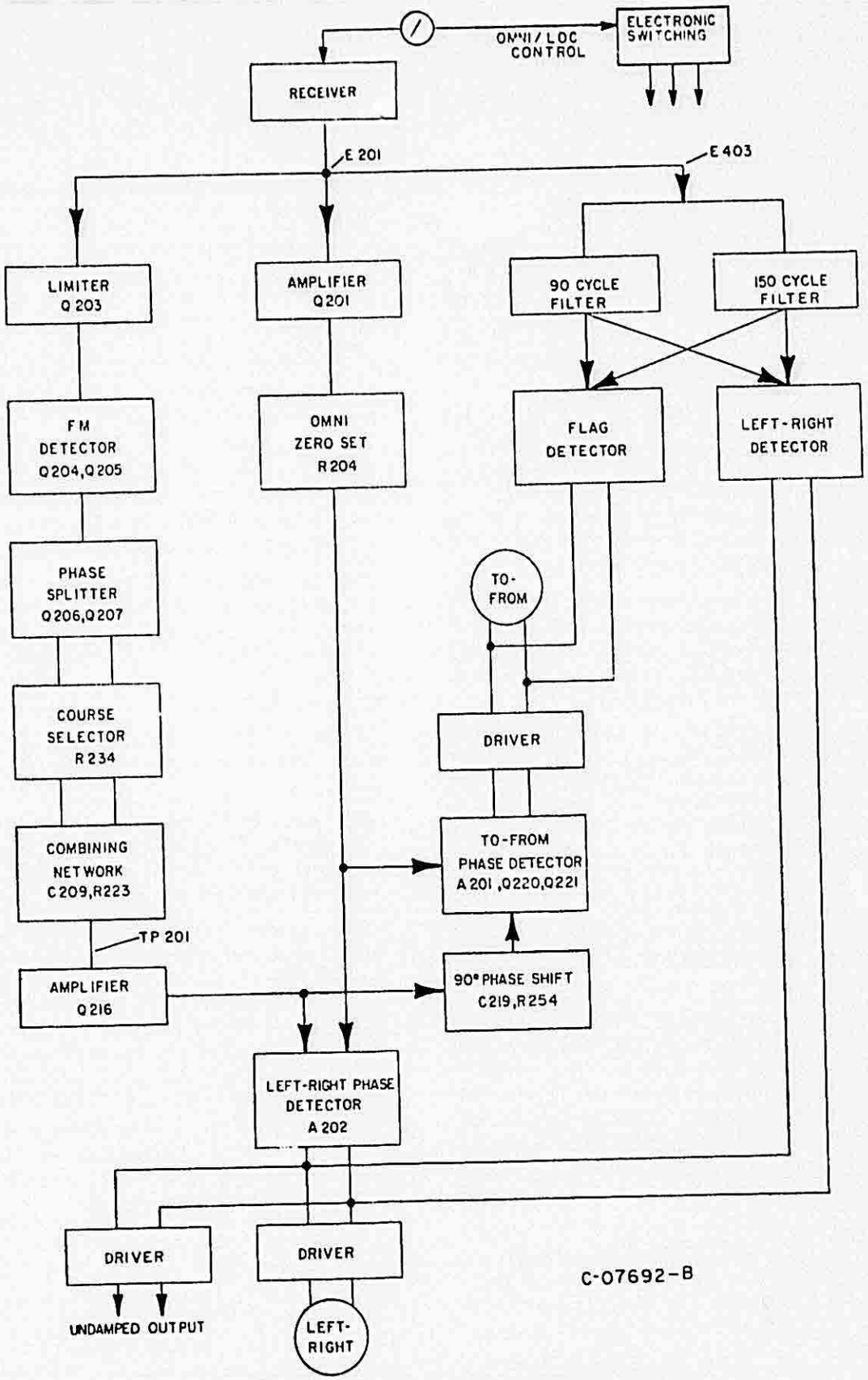


FIGURE 3.3-2 OMNI/LOC BLOCK DIAGRAM

3.3.1.1 NAV 110 TSO OMNI/LOC Circuits

The combined 30/9960 Hertz OMNI signal is applied to the OMNI circuit at terminal E201. The filter section composed of R201 and C202 removes most of the 9960 FM signal in addition to causing some 30 Hertz phase shift. This signal is applied to the base of Q201 as the 30 Hertz reference channel. Q201 amplifies the 30 Hertz signal (gain E201 to collector of Q201 is 2.3).

R204 is the OMNI Zero Set potentiometer. R204 and C203 cause a phase shift in the 30 Hertz signal which is proportional to the resistance of R204. The AC voltage at the base of Q202 is also affected by the resistance of R204. Typical range is .66 - .72v rms. Q202 is an emitter follower stage which drives the Left-Right and To-From Phase Detector.

The combined 30/9960 Hertz is also applied to the Limiter (Q203) thru C204 which removes much of the 30 Hertz signal leaving the 9960 FM signal. Q203 amplifies and limits the signal and applies it to the FM detector circuit. Q204 and Q205 are turned ON and OFF by the signal from Q203. CR201 is a Zener diode voltage regulator for the FM detector circuit.

C205 and L201 form a resonant circuit at approximately 10.7 KHz. The voltage across L201 is proportional to the frequency of the applied voltage. It will be maximum at the resonant frequency and decrease as the frequency is moved from resonance.

C206 and L202 are resonant at approximately 9.3 KHz. R211 makes the Q of the 10.7 and 9.3 KHz circuits approximately equal. The 9960 FM signal varies plus and minus 480 Hertz from 9960 KHz at a 30 Hertz rate. The resonant circuits therefore convert the FM signal to an AM signal.

The AC voltages from L201 and L202 are detected by diodes CR202 and CR203. C207 filters out the remaining 9960 signal and the result is the detected 30 Hertz variable channel signal with an amplitude of approximately .15 volts rms at C208.

The 30 Hertz signal is coupled to phase splitter Q206 and Q207. The combination of Q206 and Q207 act like a single transistor of very high gain. This 30 Hertz signal is then split into two equal but 180 degrees out of phase signals. The high gain transistor configuration and the precision resistors R219 and R220 are used so that the amplitude of the two split signals will be precisely equal.

The split 30 Hertz signals drive the OMNI bearing selector (OBS) potentiometer, R234.

The output from each of the wiper arms of the OBS potentiometer drives an emitter follower, Q209/Q210. The two signals are then combined thru C209/R223 and R226. The result is a signal at TP201 whose phase varies with the OBS dial and whose amplitude is constant.

C210 couples the 30 Hertz signal to amplifiers Q215 and Q216.

CR208 helps maintain the bias point of Q216 over temperature. The output of the collector of Q215 is applied to A202, pins 7/10 in the L-R phase detector. It is also applied to Q214 which inverts its phase. The signal from Q215/Q216 is combined thru C219 and R254 and results as a 90 degree phase shifted signal. This signal is applied to A201, pins 7/10 in the To-From phase detector.

3.3.1.2 NAV 110 TSO Left-Right Phase Detector

CR206 and CR207 are used in the Localizer switching circuitry. In OMNI operation they are closed.

A202 is a multiplier. When the two 30 Hertz signals are 90 degrees out of phase the voltage output across pins 11 and 12 is zero. The voltage across pins 11 and 12 will vary from zero to 150 millivolts for 10 degrees of phase difference as the phase between the two 30 Hertz signals vary.

CR204 and CR205 limit the voltage output of the phase detector to prevent damage to the Left-Rgiht meter.

Q220 and Q221 form a current source to drive the multiplier. R285 adjusts the source current so that the voltage at pins 11 and 12, with on omni signal applied, is approximately 6.5 volts DC.

R240 is a course width adjustment. It loads down the output to give a 5 dot deflection (around 150 millivolts at pins 11/12) for a 10 degree phase shift. The additional resistors, R277, 278, etc., associated with A202 supply proper DC bias to the multiplier. The output of the Left-Right Phase Detector is applied to two isolation amplifiers, U201 and U202, thru isolating resistors R289-R241 and R290-R242.

U201 and U202 are emitter follower drivers for the Left-Right meter and undamped output. R245 and R249 are balance adjustments to make up for slight differences in the transistor pairs.

3.3.1.2 Continued

The output, E204 and E203, from the emitter followers is a voltage of approximately 150 millivolts for a 10 degree phase difference. This voltage will be only slightly effected by the load connected to the output. Therefore if a high impedance autopilot or a 1000 ohm standard meter is connected to the output, the voltage will be the same.

The output of U201 is connected to the Left-Right meter. The Left-Right meter has more damping than the undamped output of U202 because C216 damps the Left-Right needle, however C216 has little effect on the undamped U202 because it is isolated by R241 and R242.

3.3.1.3 NAV 110 TSO To-From Detector

The reference 30 Hertz channel is shifted 90 degrees and applied to the To-From Phase Detector.

Essentially this detector operates the same as the Left-Right Phase Detector. The only appreciable difference is that there is no gain adjustment connected across pins 11 and 12 of A201, A202 has resistor R240.

Flag current is set by R233.

3.3.1.4 NAV 110 TSO OMNI/LOC Switching Circuits

Electronic switching is used for OMNI and Localizer operation. Refer to Figure 3.3-3.

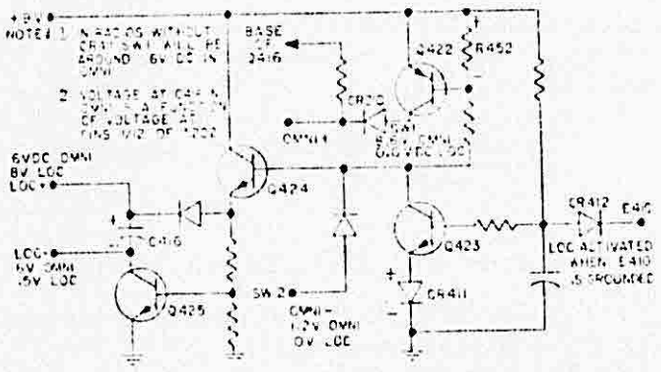


FIGURE 3.3-3 OMNI/LOC SWITCHING

OMNI MODE

In OMNI mode the Localizer activate lead (terminal E410) is open (ungrounded). Q423 is therefore turned ON by current flow thru R454 and R455. This brings SW2 (E409) to approximately ground potential.

With Q423 ON, the current flow causes a voltage drop across R452 turning Q422 ON. With Q422 ON, SW1 (E408) is brought to approximately 9 volts. With Q423 ON, the base of Q424 is connected to ground causing Q424 to be turned OFF. With Q424 OFF, there is no drive to Q425, thus Q425 is OFF.

With Q424 and Q425 OFF, the Localizer + (plus) and - (minus) leads are floating as if they were not connected. The Localizer Left-Right and To-From detectors have no voltage applied to them so that even though they are still connected to the OMNI circuit, they do not effect the OMNI Left-Right or To-From indicators. The voltage measured at each side of C416 during OMNI operation (about 6 volts) is the result of the voltage fed into the Localizer from the L-R and To-From circuits.

In OMNI operation Q424 and Q425 could be removed from the circuit with no change in operation. Also while in OMNI operation, as a result of the voltage (+9v) applied by the switching circuits (SW1), CR210, CR206, and CR207 are closed, and the wiper of R232 is grounded.

LOCALIZER MODE

In Localizer mode E410 is grounded by the channeling switches.

Diode CR412 prevents sneak paths from activating the Localizer when the Localizer activate is used for activating other equipment such as a glide slope receiver or autopilot coupling.

When Q423 is turned OFF, the current thru R452 decreases so the voltage across R452 decreases, and Q422 is turned OFF.

SW2 is no longer at ground potential so the OMNI To-From flag emitter follower drivers, Q212 and Q213, are OFF and the To-From flag is free to follow the Localizer command.

SW1 is no longer connected to +9 volts which turns OFF the OMNI Left-Right and To-From Phase Detectors.

When Q423 is OFF, the collector of Q423 increases in voltage turning Q424 ON. When Q424 is ON it turns Q425 ON. When Q424 is ON it supplies +9 volts to the Localizer circuitry. When Q425 is ON it grounds the negative side of the Localizer circuitry. The Localizer is thus operational.

CR411 gives a small (.5 volt) bias to Q423 to compensate for the .5 volt drop across CR412.

Diodes CR210, CR407, and CR408 prevent current from flowing from the OMNI circuit to the switching circuitry when in Localizer mode and prevents current from flowing from the Localizer circuitry to the switching circuitry when in OMNI mode.

In Localizer mode, Q422 and Q423 could be removed with no change in operation.

SEE BLOW-UP

3.3.1.5 Localizer Circuitry

The signal from the receiver is applied to the Localizer Circuitry at E403.

R465 controls the signal level to the active filters and thus controls the LOC course width.

A. 90 Hz Filter

The 90 and 150 hertz audio signal is fed thru C420 to the electronic filter. R401 and R402 bias the base of Q401 to about 4.6 volts DC.

Q401 and Q402 form a differential amplifier with the output taken from the collector of Q401. This output drives the base of the single stage amplifier, Q405. The output from Q405 is developed across load resistor R414 and drives the To-From and Left-Right Detectors. The output of Q405 also feeds a bridge T audio filter (R410, R411, R407, C402, C403, and R406) that is tuned to 90 Hz. See Fig. 5.3-4 for Bridge T Filter.

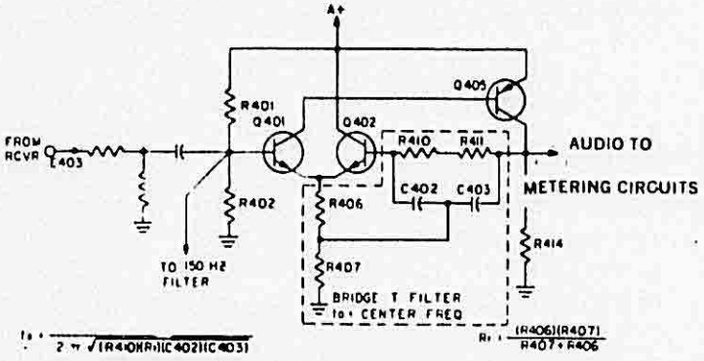


FIGURE 3.3-3A BRIDGE T FILTER

NOTE: For determining the filter frequency the two resistors (R406 and R407 etc.) act as if they are connected in parallel. The bridge T filter has a notch response.

The output of the bridge T filter is applied to the base of Q402 (½ of the differential amplifier). If an audio frequency signal other than the notch frequency is applied to the base of Q401, it is amplified by Q401, applied to the base of Q405, amplified by Q405, and passed back thru the bridge T filter to the base of Q402. This voltage at the base of Q402 is of the proper phase (negative feedback) to oppose the voltage applied to the base of Q401. The net result is that because of the feedback canceling, the voltage output at the collector of Q405 is low.

If a signal is applied at the notch frequency the process is the same, except that the filter passes very little of the signal. There is thus little voltage applied to the base of Q402 and little canceling, and the voltage at the collector of Q405 will be large. Since the feedback network plays a dominant role in determining the gain of the circuit, the gain is quite independent of variations among transistors.

The gain and center frequency of the filter amplifiers is dependent on the exact values of the bridge T filter components. Because of normal component tolerances, R411 is selected during production to tune the filter to 90 Hz.

B. 150 Hz Filter

The 150 hertz filter is the same as the 90 hertz filter except for the values of the components in the bridge T filter that tune it to 150 hertz instead of 90 hertz.

C. Left-Right Detector

The 90 and 150 hertz signal amplitudes are attenuated by R470 and R472 and then applied to the Left-Right Detector, Q409 and Q410. Q407 and Q408 are connected as diodes and along with R466 and R467 form a DC biasing network. Q409 amplifies the 90 hertz signal and Q410 amplifies the 150 hertz signal. If equal 90 and 150 hertz signals are applied, the voltage at E404 will not change. If the 90 and 150 hertz signals are unequal, the voltage at E404 will move and the Left-Right needle will deflect.

D. To-From Detector

R424, R425, R429, R432, and R431 form a DC biasing network for the To-From Detector. The 90 and 150 hertz signals are amplified and applied to Q413 and Q416. If both signals are present, Q413 and Q416 are both turned ON and current will be applied to the flag meter.

3.3.1.6 NAV 110 TSO Channel Selection

The channel selector in the NAV 110 TSO provides the digital code for the Synthesizer in the COM 110 TSO. This code can be checked independently of the COM 110 TSO. Refer to Synthesizer maintenance section.

3.3.2 COM 110 TSO Circuit Description

The COM 110 TSO provides receiver circuitry for a NAV 110 TSO when the mode switch on the COM unit is in the NAV mode position.

NOTE: A COM 110 TSO can be installed in a tray wired for a COM 111 TSO. Of course the COM 110 TSO mode selector switch must be set to COM. Should the unit be set to NAV nothing detremental will happen but extraneous signals may be heard because the synthesizer is not programmed.

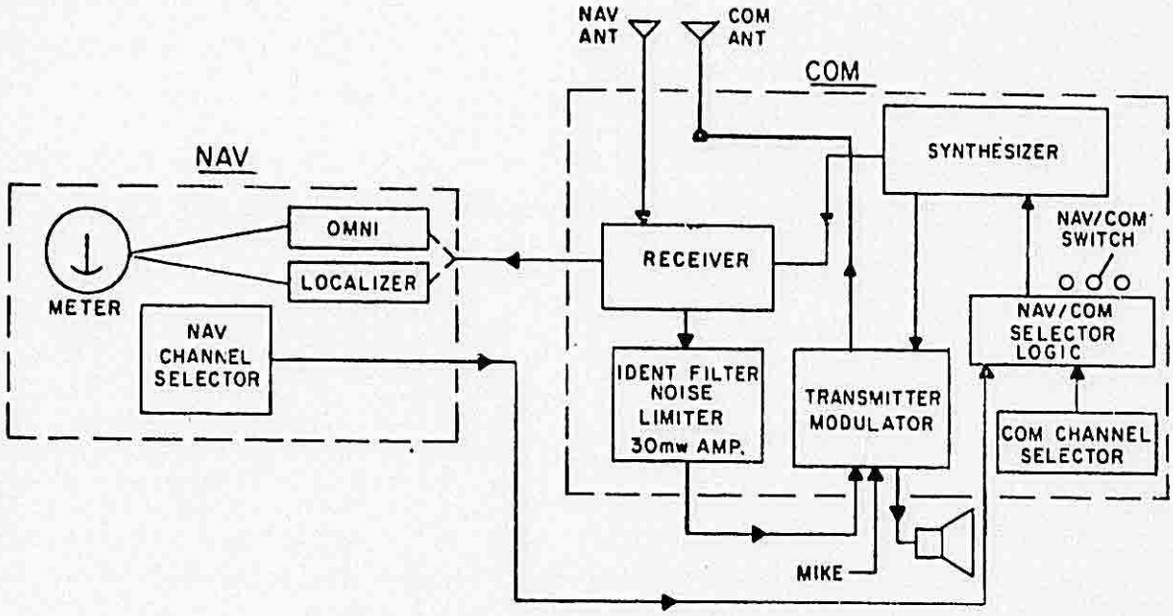


FIGURE 3.3-4 NAV 110 TSO-COM 110 TSO SIMPLIFIED BLOCK DIAGRAM

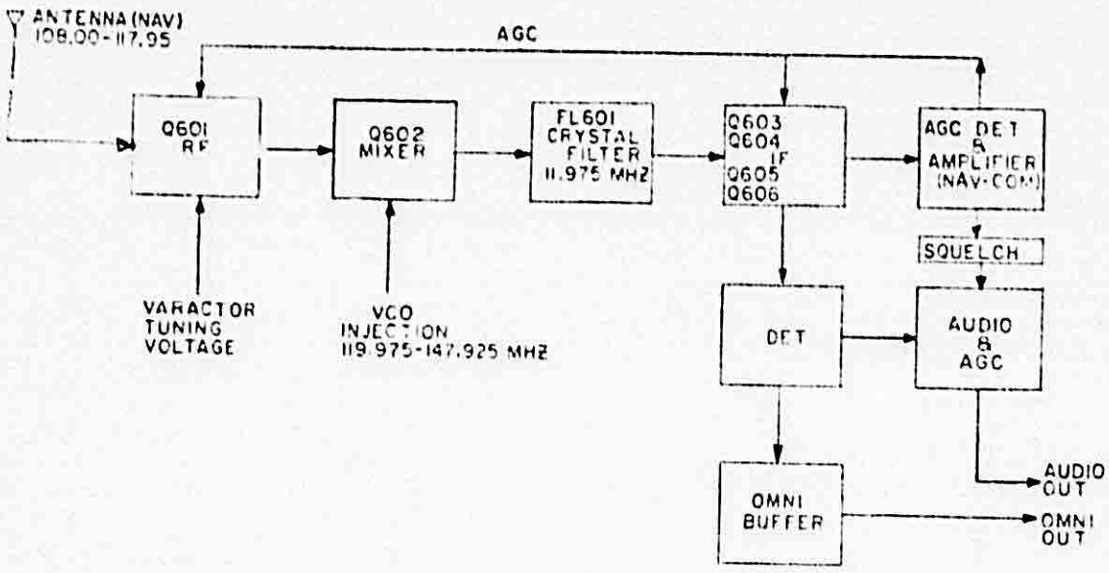


FIGURE 3.3-5 COM 110 TSO RECEIVER BLOCK DIAGRAM

3.3.2.1 Receiver

A. Antenna Input

The NAV antenna is connected to the receiver at all times, the COM antenna is used for transmitter only.

B. RF Amplifier, Q601

The RF Amplifier is a dual gate MOS-FET. Both gates of this device are protected (inside the device) so the device is not as susceptible to damage when soldering or unsoldering. The RF input to Q601 (Gate 1, pin 3) is taken from a tap on the RF input coil, L601. The drain, pin 1, is connected to L602 which is connected to A+ thru R606. Gate 2, pin 2, is connected to the AGC buss thru R603. Q614 functions as a dynamic source resistor. Under no signal conditions the AGC buss is approximately 4.5v. This forward bias on Q614 turns the transistor on hard and it acts as a very low source resistor for the FET. As the AGC buss goes lower (with increasing signal), Q614 starts to turn OFF and its effective resistance goes up. This raises the source voltage. At the same time the Gate 2 voltage is going down. This voltage change (Vg2s) reduces the current in the FET and thus reduces the gain. The input and output tuned circuits are varactor tuned. The control voltage (derived from the Synthesizer VCO) is supplied to the junctions of CR602/CR610, CR603/CR611, and CR604/CR612. At the high end of the band this voltage is high (7.5v) thus causing the capacitance of the diodes to be low. This change in capacity tracks the receiver front end. The tuned circuits are aligned by tuning the capacitors (C603, C606, and C608) at the high end of the band; and the inductors, L601, L602, and L603 at the low end of the band.

C. Mixer, Q602

The Mixer is also a dual gate MOS-FET with both gates protected. The input to the Mixer is taken from the tap on L603 and applied to the input gate (Gate 1, pin 3). VCO injection is applied to Gate 2, pin 2. The VCO injection level is 1.5v p-p. This VCO RF voltage changes the gain of the FET and thus modulates the RF signal input (pin 3). The difference frequency is selected by the crystal filter that is connected to the drain (pin 1) of the Mixer. L604 provides the drain load for the Mixer and C613 is used to tune the input to the crystal filter.

D. IF Filter, FL601

The crystal filter provides the final selectivity of the receiver. The 6 db bandwidth is 34 KHz and the 60 db bandwidth is 84 KHz.

3.3.2.1 Receiver Continued

E. IF Amplifiers, Q603, Q604, Q605, and Q606

The IF Amplifier consists of four R-C coupled stages. The tuned circuit (L606, C618) at the collector of Q603 is intended to reduce noise in the IF Amplifier. R665 provides degeneration in the last stage and its value may vary depending on the overall gain of the amplifier.

F. Detector and OMNI Buffer

CR605 and CR606 detect the positive half of the IF signal present at the collector of Q606. The detected signal is filtered (C632) and coupled to the omni buffer (Q607). The audio signal that is applied to the omni converters is taken from the variable resistor (R659) to allow the proper level to be set.

G. Audio Amplifier and Audio Leveling

The signal from the emitter of Q607 is coupled to the audio amplifier thru R660 after it goes thru the noise limiter circuit. The noise limiter is a peak limiting N/L with the clipping level set by the amount of modulation present. As the audio increases, the clipping level decreases to allow undistorted audio at high signal levels. Q608 is the stage to be gain controlled. The output of Q608 is amplified by Q609 and connected to the emitter follower, Q610. R642 is the volume control for the system and the output is tapped off this resistor. The output of Q610 is also connected to Q611. Q611 is used as a peak detector. As the output of Q610 increases. Q611 is turned ON harder. This causes the DC voltage at R645 to increase. This voltage is applied to the cathode of CR613 and tends to back bias the diode as the output of Q611 increases. CR613 is used as a dynamic degeneration resistor for Q608. As CR613 is back biased, the gain of Q608 decreases and the level of the audio output is controlled. Threshold action occurs due to the initial no signal condition of Q608. When no signal is applied, the emitter voltage of Q608 is pulled down due to the current flowing thru CR613. This causes Q608 to be running at a very low current and on the low end of the gain vs current curve. When an audio signal is applied CR613 starts to be back biased and this allows the voltage at the emitter of Q608 to rise slightly and the current thru Q608 to increase. This increases the gain of the stage. If there were no AC degeneration in the stage, the system would oscillate; but, since CR613 degenerates Q608, the system is stable. Thus, as an audio signal is applied, the output first rises rapidly and then remains constant as the input signal increases. R667 is selected to determine the level where the threshold action occurs.

H. AGC Detector and Amplifier

CR607 and CR615 detect the positive half of the IF signal present at the collector of Q606. The IF signal causes the current flowing thru CR607 to vary as the IF signal varies. The DC return for CR607 is R652 and R666 and the voltage at the base of Q613 will vary as the current thru R652 varies. Thus under no signal conditions the voltage at the base of Q613 allows the transistor to conduct hard and as the IF signal increases this voltage increases and turns the transistor OFF. The voltage at the collector of Q613 is used as the AGC voltage to the RF amplifier and the voltage at the junction of R649 and R650 is used as the AGC voltage to the IF Amplifier.

I. Voltage Regulator

CR608 is an 8.2v Zener diode. The series resistor for the Zener is split and bypassed at the junction of the resistors. This gives added filtering for the regulated voltage.

NOTE: Half of the series resistance and bypassing is located on the Interconnect Board.

J. Squelch Circuit

Q612 is used as a switch which is connected to the AGC line. As R647 is turned CCW, the transistor will turn ON thus shorting the AC and DC as the collector of Q609 to ground. When the AGC line goes low (with increasing signal input) the transistor will shut OFF and allow normal operation.

3.3.2.2 Interconnect PC Board Circuits

The Interconnect PC Board contains three seperate circuits.

A. Ident Filter (C503, L502, R501)

The Ident Filter filters the 1020 hertz ident signal present in the OMNI signal modulation when in the filter position (pushed in). When the Ident knob is in the Ident position (pulled out), the Ident Filter is used as a tuned circuit to enhance the 1020 signal and reduce the high and low frequency response.

B. Noise Limiter

The Noise Limiter is a peak limiting circuit as described in Section 3.3.2.1.G.

C. 30 mw Amplifier

This low level amplifier consists of a voltage amplifier driving a complementary emitter follower (Q501 and Q503). Input is coupled in thru a capacitor (C508) to the base of the voltage amplifier. A feedback voltage divider provides both DC and signal feedback. Two diodes, CR503/CR504 provide foreward bias for the complementary amplifier. The output is capacity coupled thru C507.

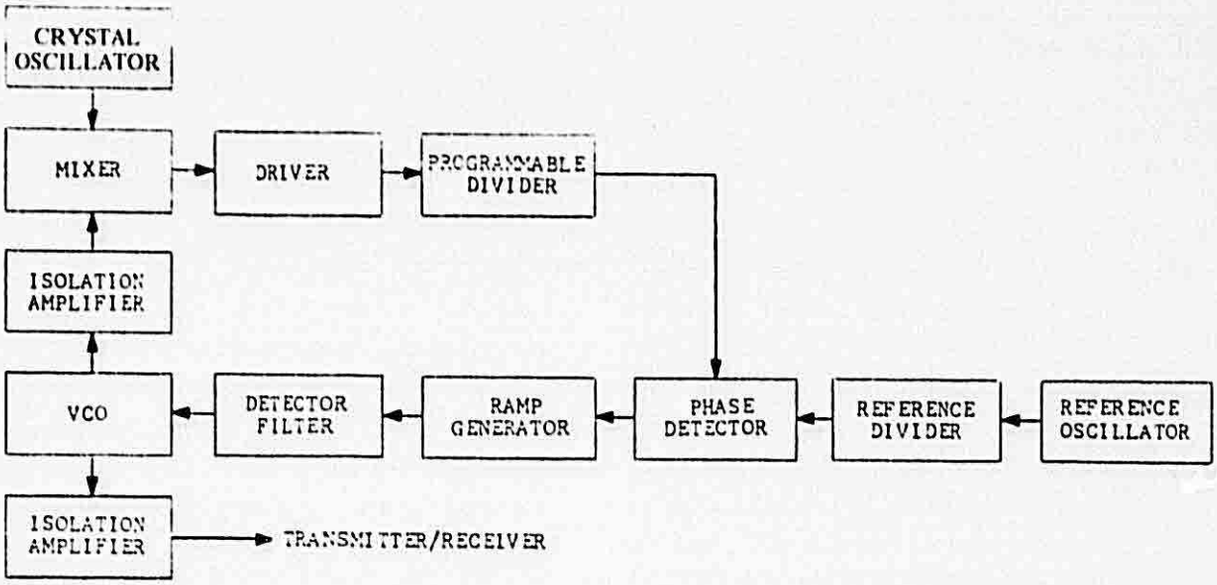


FIGURE 3.3-6 SYNTHESIZER BLOCK DIAGRAM

3.3.2.3 Synthesizer

Prior to the use of digital techniques, transceivers were tuned to channel by combining the outputs of two or more multiple crystal oscillators and using this resulting output to drive a transmitter or tune the receivers. In the digital synthesizer used in the COM 110 TSO only one frequency is generated and that is the frequency needed to tune the transmitter or receiver to the correct channel.

The utmost in simplicity could be achieved in transceiver construction if a simple variable oscillator coupled to the tuning dial and readout could be used to set the transceiver on frequency. Unfortunately no oscillator with the desired stability and accuracy is feasible, so some method must be used to set a variable oscillator on channel and maintain it there.

The digital synthesizer is just such a device. A variable oscillator which is voltage tuned is controlled and monitored by digital counting circuits. Outputs from these circuits guide the voltage controlled oscillator (VCO) to the proper channel and maintain the oscillator on that channel.

In order to obtain the needed accuracy the VCO must be compared with the output of a crystal controlled oscillator. A correction voltage developed to guide and correct the VCO. As a result, the VCO has the accuracy and stability of a crystal controlled oscillator.

Rather than compare the crystal and variable oscillators at the operating frequency, the VCO is divided to a frequency of only 50 KHz where it is compared to a 50 KHz crystal reference signal. The correction voltage is developed to guide the VCO to the correct channel and maintain it there. Therefore, it is apparent that simply changing the divider ratio will move the VCO by some predetermined channel spacing.

The Synthesizer functions in the following manner:

A voltage controlled oscillator output in the 118.00 MHz to 135.95 MHz range (transmit mode) is hetrodyned against a crystal oscillator to the 10 to 30 MHz range. This signal is then amplified and applied as a drive to the digital variable divider circuits.

The purpose of the variable divider is to reduce any of 360 possible frequencies present at the input to a fixed frequency of 50 KHz. The frequency which is selected by the channel selector knobs will be the one reduced to 50 KHz.

Channel selection is accomplished by programming the variable divider to divide by a value from 242 to 601 and then a control loop forces the voltage controlled oscillator to a frequency which will result in 50 KHz at the variable divide output.

Example:

Crystal	148.05	
VCO	118.00	
divider in	30.05	divided by 601 = 50 KHz

3.3.2.3 Continued

In order to produce a control signal to the VCO the variable divider output is compared to a fixed 50 KHz signal by a frequency and phase compariator circuit.

The 50 KHz reference signal is produced by a 3.20 MHz crystal oscillator and a reference divide by 64 chain.

Errors in frequency between the 50 KHz reference and variable divider output are converted to a change in tuning voltage to the VCO.

A "control voltage generator" circuit is utilized to convert the pulse outputs of the "frequency and phase compariator" circuit to a pure DC voltage suitable to tune the VCO.

Voltage regulator circuits convert the unregulated 14 vdc input to the 5.4 volts and 8.6 volts needed for the synthesizer circuits. RF output of the synthesizer is used as transmitter drive and receiver local oscillator injection. DC VCO tuning voltage is also fed to the receiver for tuning the receiver front end stages.

A. Logic Symbols and Truth Tables

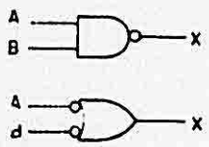
The various types of logic symbols used in the schematics are shown with the associated truth tables.

Two symbols are shown for each gate truth table. The use in the circuit determines which is shown on the schematic.

The small "o" at a terminal indicates a low state at the time of interest.

Two Input NAND Gate

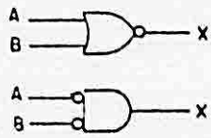
The first symbol illustrates applications where two high inputs are ANDed to produce a low output. The second symbol represents applications where two low inputs are ORed to produce a high output.



A	B	X
0	0	1
1	0	1
0	1	1
1	1	0

Two Input NOR Gate

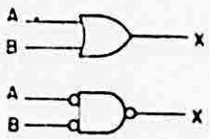
The first symbol illustrates applications where two high inputs are ORed to yield a low output. The second symbol illustrates applications where two low inputs are ANDed to give a high output.



A	B	X
0	0	1
1	0	0
0	1	0
1	1	0

Two Input OR Gate

The first symbol represents applications where two high inputs are ORed to give a high output. The second symbol represents applications where two low inputs are ANDed to give a low output.

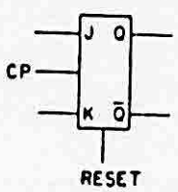


A	B	X
0	0	0
1	0	1
0	1	1
1	1	1

J-K Flip-Flop

The flip-flop triggers on the negative transition of the clock pulse. The time period prior to the negative transistion of the clock pulse is denoted t_n, and the time period subsequent to this transition is denoted t_{n+1}.

When the J and K inputs are high, the flip-flop changes state with each clock pulse. That is, the Q output after the clock pulse will have the same level as the Q output had prior to the clock pulse. If J is low and K is high, the Q output will go low and remain low. If J is high and K is low, the Q output will go high and remain high.



t_n		t_{n+1}
J	K	Q
0	0	Q_n
1	0	1
0	1	0
1	1	$\bar{Q}_n$

3.3.2.3 Continued

A. Voltage Regulators

Unregulated 14 volts is converted to 5.4 volt and 8.6 volt regulated output by voltage regulator circuits.

Each regulator consists of a series pass transistor (Q121 or Q117) a Zener diode reference voltage (CR118 or CR108), and a monitor amplifier (Q120 or Q119). A driver transistor, Q118 is added to the 5 volt circuit.

A voltage rise of the 14 volt input will cause a rise at the center arm of voltage adjust potentiometer (R134 or R139) which will be inverted in the corresponding monitor amplifier causing a correction toward proper (5.4 or 8.6v) voltage output.

B. REFERENCE OSCILLATOR AND DRIVER

The reference oscillator Q112 is an untuned Colpitts type oscillator. The oscillator output is amplified by Q113 to a level sufficient to drive the IC divider chain (3v p-p).

C. CRYSTAL OSCILLATORS

Tuned Colpitts type crystal oscillators, Q101, Q102, and Q103 operate with the 7th overtone crystals. Only one oscillator at a time is turned ON by U117 which feeds approximately 3 volts to the desired oscillator.

Voltages at the base of an oscillator transistor causes emitter current to flow through the corresponding RF switching diode CR101, CR102, or CR103 resulting in only the desired oscillator being connected to Mixer, Q109.

D. VCO

The VCO is a grounded base Colpitts oscillator. The output frequency is determined by L104 in parallel with C124, C125, C126, and tuning diodes CR104 and CR105.

Amplifier, Q106, provides isolation and gain between the VCO and Mixer, Q109. Broadtuned amplifier Q107 is gated by an inhibit circuit which prevents transmitter drive when a malfunction occurs in the Synthesizer and also when the Synthesizer is searching during channeling or from transmit to receive.

E. MODE SELECTOR CIRCUIT

The Mode Selector must respond to command signals from the NAV-COM switch (COM 110 TSO) and the transmit-receive key (transmit relay).

When the COM-NAV switch is in COM, U117 will turn crystal oscillator Q103 ON and will maintain P103-3 near zero. This activates the COM frequency selector. P103-3 is above 2 volts deactivating the NAV frequency selector. Q104 is turned OFF restricting the VCO to its upper range.

When the COM-NAV switch is in NAV mode U117 will turn crystal oscillator Q102 ON and will maintain P103-13 near zero which activates the NAV frequency selector and drives P103-3 above 2 volts deactivating the COM frequency selector. Q104 is turned ON restructing the VCO to its lower range.

When the transmit relay is closed U117 will turn ON crystal oscillator Q101 and will maintain P103-3 near ground which activates the COM frequency selector (no matter what position the COM-NAV switch is in) and P103-13 above 2 volts deactivating the NAV frequency selector. Q104 is turned ON restricting the VCO to its lower range.

The preceding operations are accomplished by four NAND gates in one IC. Three of the gates are wired as simple inverters and the fourth as an inverting AND gate (NAND) requiring a high input at pin 12 and 13 to produce a LOW at pin 11.

F. MIXER AND DRIVER

The Mixer and Driver circuits heterodyne the outputs of the VCO and crystal oscillator to produce the IC drive signal from the difference frequency. Q109 functions as a Mixer and amplifier C170, L105, and C172 form a matching filter which rejects VHF signals and provides a proper match to Q110 in the 10 to 30 MHz range. Q110 provides voltage gain and Q111 provides current gain to drive ICs U111 and U112. The function of Z104 and Z105 (beads) is to reduce VHF radiation.

3.3.2.3 Continued

G. Control Voltage Generator

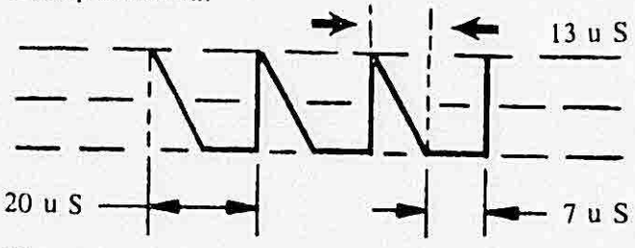
The Control Voltage Generator produces a variable DC control voltage for the VCO from pulse inputs from the Variable Divider and the Reference Divider.

The digital processing section functions on pulses and the VCO is controlled by pure DC. The following method is employed to change pulse information into a pure DC voltage.

To accomplish this transformation an IC gate is wired as a set-reset type flip-flop, U104 which changes alternately as negative going (high toward zero) pulses are fed into pins 9 and 13. The reference channel output will set the flip-flop to high at pin 8 and the variable channel (divide by N) output will reset the output to low at pin 8. A rectangular pulse is thus produced whose length represents the difference in timing between the two channel outputs.

Note that the two channels can take on any given timing difference (or phase difference) yet being identical in PRF (pulse repetition frequency).

One rectangular output of U104 is differentiated and turns Q114 ON causing the voltage at E107 to rise to 8 volts. The other rectangular output of U104 turns Q115 ON and charges C187, thus causing the voltage at E107 to go downward. The voltage will continue downward for the duration of the rectangular pulse. At the end of the pulse the voltage at E107 will level off until Q114 is turned ON again. The end result is a ramp as shown.



The ramp generator consists of Q114, Q115, R175 (adjustable), and charging capacitor C187. Q114 conducts on the leading negative going pulse from pin 11 of U104. Setting the voltage at E107 to maximum (8.6v) turns Q115 ON and C187 begins charging toward the zero, the end of the rectangular output from pin 8 of U104. C187 stabilizes until the next change of U104 when the sawtooth starts again from maximum (8.6v).

Since a DC voltage is required to control the VCO, a lower peak detector is used to convert the ramp to DC. Q116 provides the current amplification necessary and the combination of R179, C190, R182, and C191 provides additional filtering.

H. INHIBIT

When the VCO is not locked on a selected channel, pulses will appear at pin 8 of U110 or pin 8 of U113. These pulses will be passed through CR109 or CR110 and cause C177 to discharge which in turn causes Q122 and Q108 to shut OFF. The VCO buffer stage, Q107, is then non-conducting since its emitter current must flow through Q108.

I. VARIABLE DIVIDER

The Variable Divider can divide an input frequency by an integer from 242 to 601. This is accomplished by three methods: (1) pulse swallowing (2) fixed dividers (3) variable dividers. In this synthesizer the pulse swallowing circuits are part of the fixed dividers. (divide by 2 and divide by 10)

Frequency division is accomplished by feeding an input signal first through a divide by two and pulse swallower then a divide by ten and pulse swallower and finally a divide by 12 to 29 circuit.

The divide by two and pulse swallower consists of U111 (divide by 2) and control flip-flop, U112. If U112 is "cocked" by grounding pin 12, a pulse is "missed" by U111 every 20 microseconds thus requiring the input signal to raise by 50 KHz to make-up for the missing pulse. This results in a final VCO frequency of 50 KHz lower due to the conversion of the VCO to 12 to 30 MHz range.

The divide by ten can swallow up to nine pulses by programming the shift register U106 so that up to nine pulses are needed before the shift register outputs will satisfy "NAND" gate U105 and produce a pulse. U106 will continue to satisfy U105 once for every ten pulses applied to pin 10 of U106. Since the input signal has been divided by two, each "swallowed" pulse results in a raise of 100 KHz at the input frequency or up to .9 MHz. Thus the programming of U106 will set the .1 to .9 MHz channels. Again the VCO will go in the opposite direction due to mixing with a crystal oscillator to obtain the digital drive.

At the end of the divide chain is a programmable divider U107 and U108 which can divide by any integer between 12 and 29. Since the input signal has been divided by 20 prior to reaching this divider circuit, every increase by one results in a 20 channel change at the input or 1 MHz. Thus the programming of U107 and U108 will set the whole MHz channels.

3.3.2.3 Continued

J. REFERENCE DIVIDER

A 3.2 MHz crystal controlled frequency is divided by 64 to produce a 50 KHz reference signal by the reference divider consisting of 3 dual JK flip-flops, U101, U102, U103 and a NAND gate, U113.

Since the clock pulses are connected to both flip-flop stages in an IC (i.e. U101), then both would change states every time a clock pulse was applied except that pin 6 output of one flip-flop is connected to the JK inputs pin 11 and 12 of the other allowing it to respond only to alternate clock pulses.

A narrow pulse output is desired so NAND gate U113 is used to gate through the output of Q113 once every 64 pulses from Q113.

One half of U113 is used to derive a pulse to drive U104 and the other half to inhibit flip-flop, U101 when the system has not yet "locked on."

K. RESTRICTION CIRCUIT

It is necessary to restrict the VCO tuning voltages in the different modes of operation so that the VCO frequency will remain within a range that the digital circuit can correctly respond to and produce proper correction voltages.

In COM receive the circuit will limit the lowest VCO voltage to 4 volts. R128, R129, R130 form a voltage divider and CR107 is a clamping diode. The VCO voltage cannot go lower than 4 volts at the cathode of CR107.

In transmit (or NAV mode) this circuit is disabled by Q104 which grounds the cathode of CR106 reducing the voltage of the anode of CR107 to less than 1 volt and a maximum of only 5 volts can be produced since Q104 is ON and CR117 is conducting causing a reduction in the voltage available at Q116 emitter.

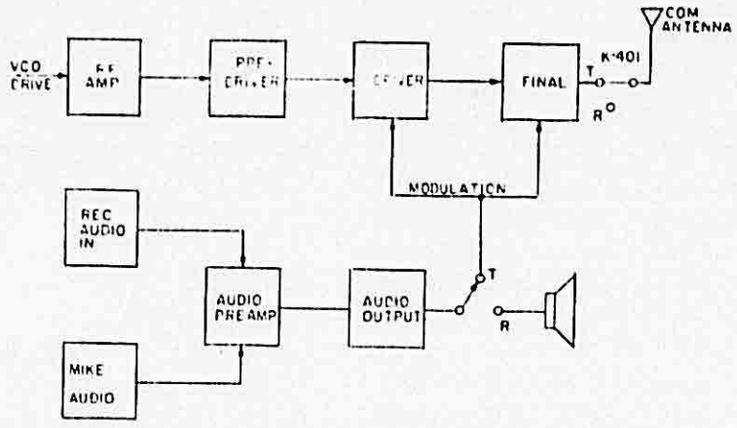


FIGURE 3.3-7 TRANSMITTER/MODULATOR BLOCK DIAGRAM

3.3.2.4 Transmitter/Modulator, COM 110 TSO

The COM 110 TSO transmitter is capable of operating on 360 channels, with 50 KHz spacing within the frequency range of 118.00 and 135.95 MHz.

The Transmitter/Modulator Assembly is self-contained and easily removed. (Remove four mounting screws, unsolder three wire leads and two coax leads, and unplug three connectors.)

The transmitter which is broadband and requires no external tuning, amplifies the RF energy to a final output power level of 8 watts minimum. The last two amplifier stages (Q411/Q412) are collector modulated by the audio modulator to provide a minimum of 85% modulation of the RF carrier.

A. RF Amplifier, Q401

The Synthesizer provides approximately 1 milliwatt of RF energy which is coupled to the base of Q401 thru C401. This Class A operated stage is biased by the resistor network (R402, R403) and the emitter bias resistor (R404). Q401's amplified signal (at the collector) is applied to the broadband interstage network (L401, L413, C405, and C406) This network provides the necessary bandwidth and impedance transformation to drive the predriver amplifier, Q402.

B. Predriver Amplifier, Q402

The Predriver Amplifier, Q402, is partially biased by virtue of the resistor network (R405, R406) and the emitter resistor (R407). However, this quiescent bias is altered when driven by Q401. The amplified signal from this stage is applied to the broadband, impedance transforming, network which consists of R408, L403, L404, C410, and C412.

C. Driver Amplifier, Q411

As in the Predriver Amplifier, the Driver Amplifier, Q411, is partially biased by the resistor network (R410 and R437). R437 is a selected resistor whose value is determined by the DC Beta of Q411. The value of this resistor should be such that the emitter current of Q411 does not exceed a quiescent value of more than 600 milliamperes. Temperature stability of Q411 is accomplished by virtue of the internal emitter bias resistors. The operating bias of this stage is determined by the DC bias as well as that due to RF drive. The collector is coupled to the base of the Final Amplifier by means of C463, C416, and L406.

Audio modulation of this stage is accomplished by the action of CR401, CR402, R428, and R429. These diodes and resistors provide full "upward" modulation and partial "downward" modulation of the collector of Q411. This partial modulation of Q411 provides the proper modulated base drive to be applied to the Final Amplifier.

D. Final Amplifier, Q412

Q412 is an RF power amplifier capable of being high level collector modulated, and delivering a minimum of 8 watts of carrier power. This stage obtains its operating bias by virtue of the RF base drive from Q411. This causes base current to flow thru R413 which biases Q412 into the "Class C" region. The RF energy at the collector is coupled to the harmonic filter by the impedance transforming network (L412 and C462). The harmonic filter consists of L409, L410, C422, C423, C424. C425, and C426.

Modulation of this stage is accomplished by applying the audio voltage to the collector of Q412. Overmodulation is prevented by virtue of the design of the modulator which limits the peak audio voltage to a value which is less than the DC collector voltage on Q412.

E. Modulator

The Modulator consists of a voltage amplifier Q405, and a pair of push-pull Darlington output amplifiers, Q406/Q407 and Q408/Q409. Q410 serves as a wide range temperature regulator to control the bias applied to the audio output stages. The Modulator is capable of delivering a power output of 11 watts into a 6 ohm load.

The Modulator also serves as the receiver audio amplifier in the receive mode. In this mode it is capable of 14 watts into a 4 ohm load.

3.4.1 NAV 110 TSO

3.4.1.1 Test Equipment Required for NAV 110 TSO

a) OMNI Signal Generator, TIC's T-12A or equivalent
b) 14v Power Supply, Electro Products Lab, Model NFB, or equivalent
c) VTVM, RCA Senior Voltohmyst or equivalent
d) Audio Oscillator, Hewlett-Packard 200CD or equivalent
e) Oscilloscope, Tektronix 515A or equivalent
f) Resistor Substitution Box (2)
g) a 1000 ohm, 150 ua meter.

3.4.1.2 Test Set-up

The NAV 110 TSO omni can be aligned and maintained with or without a receiver. If receiver problems are suspected (such as a bad crystal filter which can cause omni errors) a demodulated omni signal can be connected to the omni circuitry without going thru the receiver. Other than OMNI zero set, the OMNI should not be compensated with the idea of removing receiver induced errors. (Typical ±1° of error can be expected from the receiver.)

Most of the measurements are made with a standard omni signal applied to the receiver at 500 microvolts. At this RF level the receiver is well into AGC action and the detected voltage at the input to the omni localizer converter (E201) is set (at manufacture) for .3 vac rms measured with the 30 Hertz signal only present, and with the 9960 signal only present, there will be .15 to .3 vac rms depending on the receiver. The amplitude of the 9960 signal does not have as much effect on the equipment operation as the 30 Hertz signal, as the 9960 signal goes to a limiter.

When a direct omni connection is made without a receiver, the demodulated signal is applied to pin 14 of J101. A+ and Ground must also be applied. The NAV 110 TSO channel selector must be switched to an omni or localizer channel to have the NAV 110 TSO operate in the desired mode.

The generator demodulated amplitude should be adjusted so that at E201, with the system connected, there is .3 vac rms of 30 Hertz measured with the 9960 signal deleted. This will result in .3 vac rms of 9960 with most generators.

NOTE: Measure with one signal present at a time because different voltmeters will read differently with both signals present at the same time.

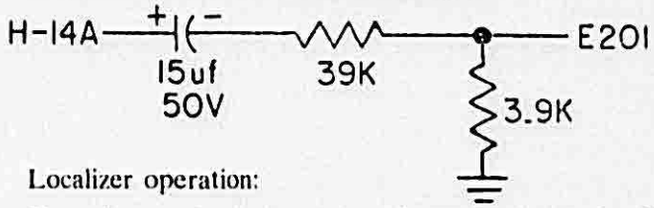
CAUTION:

Some signal generators, such as the H-14A, have large DC and AC voltage output at the demodulation output. Applying a large DC voltage to E201 can damage the radio. (C201 is a 15 volt capacitor.)

CAUTION:

Many pots are protected from undesired changes, such as vibrations, by having a glob (dab) of silicon rubber applied to the pot at the factory. This material has a certain amount of "memory". Therefore if a pot requires readjustment, cut away the silicon rubber completely, adjust the pot, and resecure the pot on the back with a glob of silicon rubber.

The following attenuator/DC blocking circuit is recommended for use with the H-14A.



Localizer operation:

Since the standard omni signal is 30% modulation for both the 30 and 9960 Hertz signal and the localizer signal is 20% modulated for both 90 and 150 Hertz signals there should be .3 vac in the omni mode and .2 vac in the Localizer mode.

3.4.1.3 Alignment Procedures

NOTE:
Early units may utilize the undamped output. Later units have only the external L/R output. See Fig. 3.6-4.

Connect a 1000 ohm, 150 ua meter to the output J201, pins 5 and 7.

A. Power Supply Adjust

(1) Set the power supply to 13.75 volts and connect the VTVM to the emitter of Q420.
(2) Adjust R450 for 9.0 vdc on the VTVM.
(3) Check high and low line (11.0 vdc-15.0 vdc). The 9 volt line shall not vary by more than 0.4v.
(4) Set the power supply back to 13.75v.

B. DC Balance Adjust (OMNI)

(1) Remove input signal to OMNI.
(2) Channel to an OMNI frequency.
(3) Place a jumper (short) from CR206's cathode to CR207's cathode.
(4) Adjust R245 for zero deflection of the Left-Right meter.
NOTE: Because of the longer time constant on the Left-Right needle, wait for the pointer to come to rest before completing this adjustment.
(5) Adjust R249 for zero deflection of the external meter. (Steps 4 and 5 should be set very accurately.)
(6) Redo step 4 and 5 as often as necessary until both meters are centered.
(7) Remove the jumper (short) between CR206 and CR207. Connect the VTVM to CR206 or CR207's cathode. If the voltage reads between 6.0 and 6.8 volts proceed to step 10.
(8) Remove R285 and using the resistor substitution box, select a value which will give 6.5 plus or minus 0.3 vdc at CR206's or CR207's cathode.
(9) Turn the power OFF and install the selected value resistor. Turn power ON and verify step 7.

3.4.1.3 Continued

(10) Connect the VTVM to either side of C211. If the voltage reads between 6.0 and 6.8 volts proceed to step 13.

(11) Remove R272 and using the resistor substitution box, select a value which will give 6.5 plus or minus 0.3 vdc at C211.

(12) Turn power OFF and install the selected value resistor. Turn power ON and verify step 10.

(13) Connect a standard omni signal.
At this time check that the internal Left-Right and the external undamped output meters track closely. 5 dots on the internal meter equals 150 ua on external meter. Check both Left and Right deflection . . . if they do not track, stop and repair before proceeding further.

C. Discriminator Tuning

(1) Connect an audio oscillator, set to around 10 KHz, to the omni generator external modulation input.
NOTE: If the omni is being driven direct, without a receiver, connect the audio oscillator in place of the omni signal, directly to the omni converter.

(2) Connect a scope to the junction of L201 and C205. Keep the percent of modulation (or audio oscillator level) low so that the waveform at L201 is not distorted (the percent modulation will be very low). Tune the audio oscillator frequency for maximum voltage. The peak should occur at 10.7 KHz, if not, select or pad C205 to peak at 10.7 KHz.

(3) Move the scope to junction L202 and C206. Repeat step 2, only at this time peak C206 at 9.3 KHz.

(4) Reconnect the test set-up for normal omni test.

D. Phase Comparator Null

(1) Connect a 50 uf electrolytic or larger capacitor from the junction of C217 and R247 to ground (negative side grounded).

(2) Set the omni generator so only the 9960 FM signal is produced and adjust R237 for zero deflection on the Left-Right meter.

(3) Disconnect the omni signal from the omni and adjust R277 for zero deflection on the Left-Right meter.

(4) Repeat steps 2 and 3 till both conditions are met

(5) Remove the capacitor.

NOTE: Steps 2 and 3 should be set very accurately. It will usually take a few repeats to get proper balance.

NOTE: U203-1 and U203-2 are selected by NARCO from standard RCA CA3026 devices for proper balance.
If a CA3026 is used which has not been selected it may balance correctly but then show large reciprocal or course errors or it may not be possible to balance it at all.
The To-From detector, U203-1, is not as critical as the Left-Right detector, U203-2. The U203-2 part can be used for To-From but the U203-1 can not be used for the Left-Right.
Be sure to order and use the proper part from NARCO. (U203-1 P/N 74012-0003 or U203-2 P/N 74012-0002)

CAUTION: When using a soldering iron in this area it is possible to heat up a diode or other component so that the balance will be affected. Use minimum heat and keep iron away from other components. Use clip leads to connect resistor boxes to circuit.

E. Course Width

(1) Place signal generator at any bearing and turn OBS till Left-Right needle is centered.

(2) Change the omni generator or the OBS dial 10 degrees. Select R240 for 5 dot deflection on the Left-Right meter. (The edge of the circle is considered the first dot.)

F. Course Selector Alignment

(1) Set the omni zero potentiometer to the center of its range. Set the signal generator to 0 degrees "To" and adjust the OBS for a 0°.

CAUTION: If the omni/loc converter is driven directly, without a receiver, and with the generator set for 0 degrees TO, the omni will be 0 degrees FROM because there is normally a 180 degree phase shift in the receiver.

(2) Loosen the setscrews on the collar that damps the OBS card drive gear to the OBS knob shaft. Rotate the OBS knob (being sure the OBS card doesn't turn till the L/R needle is centered and the flag shows "TO".

NOTE: The potentiometer setting should not need adjustment unless the potentiometer is replaced or mechanical slippage occurs. If the zero set potentiometer does not have enough range by a large amount it may be that something is wrong in the unit causing a phase shift.

3.4.1.3 Continued

As a further check on the potentiometer, pins 3 and 1 should have the minimum resistance when the OBS reads approximately 240 degrees, plus or minus approximately 10 degrees and potentiometer pins 4 and 6 will also have a minimum resistance at 240 degrees, plus or minus approximately 10 degrees. (Note: some pots do not have pins 5 and 6 available.)

The minimum resistance will not be zero and will not be the same for each tap point or the same for every potentiometer.

G. OBS Phase Adjustment

(1) Set the signal generator and the OBS dial to 105 degrees. Adjust omni zero set (R204) for zero deflection on the Left Right meter.
(2) Set the signal generator and the OBS dial to 285 degrees. Use omni zero (R204) to split the error.
(3) Repeat steps 1 and 2 to verify error split.
(4) Place signal generator and OBS dial to 195 degrees.
(5) Adjust R225 for zero deflection on the Left-Right meter.
(6) Place generator and OBS dial to 15 degrees. Check that the zero on the meter is less than plus or minus 1 degree. (If error exceeds plus or minus 1 degree use R225 to split the error.)

NOTE: If the course selector is properly aligned mechanically, R225 will have no effect on the Left-Right indicator when the OBS is set to approximately 105 degrees or 285 degrees.
If changing R225 effects the course setting by more than about 1 degree when the OBS is set at 105 or 285 degrees, something is wrong and compensation is not possible.

H. To-From Crossover Adjustment

(1) Place signal generator to 15 degrees. Remove the omni signal.
(2) Adjust R232 for zero deflection of the To-From meter. Reconnect the omni signal.
(3) Rotate the OBS dial to 105 degrees and select R253 for zero deflection on the To-From meter.
(4) Rotate the dial to 285 degrees and observe the To-From meter. Use R253 to split the error.
(5) Repeat steps 3 and 4 to verify the error split.

I. Flag Sensitivity Adjustment (Omni)

(1) Place the signal generator to 500 uv and OBS dial for 5 dot deflection.
(2) Reduce generator RF level till you have 2.5 dots deflection. Set R233 so that the flag is showing a little red.

J. Detector Balance (Localizer)

(1) Channel to a localizer frequency and set generator for localizer.
(2) DC Balance (centering)

Remove all modulation from a 1 Kuv carrier: indicator should center within one pointer width. R416 may be selected to center the pointer. Selected value should be in excess of 1 mego. Do not install this selected resistor at this time.

(3) AC Balance (deflection)

Set signal generator modulation for 90 Hz ONLY. From the generator demodulated output apply, thru a 0.47 mfd coupling capacitor, the 90 Hz tone to TP404. Adjust the 90 Hz amplitude to produce 3 dots left deflection. In many generators this may be accomplished by varying the percent modulation setting.

Set signal generator modulation for 150 Hz ONLY. From the generators demodulated output apply, thru a 0.47 mfd coupling capacitor, the 150 Hz tone to TP405. Deflection should be 3 dots right, ±1 pointer width. R473 may be adjusted to balance the deflection.

(4) Repeat steps 2 and 3 until their individual requirements are met. This is necessary due to interaction between the DC and AC balance adjustments.
(5) Turn power OFF and install the selected value for the DC Balance, step 2.

K. 90 Hz Filter

(1) Apply to the converter a 90 Hz ONLY tone of 0.2 v rms measured at E403. Adjust R465 for 0.06 v rms at TP401.
(2) Connect a scope or AC voltmeter to **TP402**. Select R411 for maximum AC voltage. Nominal value is 18 K ohms.
(3) Turn power OFF and install the selected value resistor.

L. 150 Hz Filter

(1) Apply to the converter a 150 Hz ONLY tone of 0.06 v rms measured at TP401.
(2) Connect scope or AC voltmeter to **TP403**. Select R413 for maximum AC voltage. Nominal value is 18 K ohms.
(3) Turn power OFF and install the selected value resistor.

M. Localizer Deflection and Centering

(1) Apply to the converter a standard centering signal (ie: at E403, 0.2 v rms of 90 Hz and 0.2 v rms of 150 Hz) and adjust R472 for a centered pointer.
(2) Set the tone localizer switch to - 4 db, 90 Hz for right deflection. Adjust R470 for 3 dots deflection.
(3) Repeat steps 1 and 2 until their individual requirements are met.
(4) Set the tone localizer switch to - 4 db, 150 Hz for left deflection. Deflection should be 3 dots.

N. Flag

(1) Apply to the converter a standard centering signal. The flag shall indicate "TO".
(2) Set the tone localizer switch to - 4 db, 150 Hz and note deflection.
    (a) decrease the signal input level until deflection is approximately 2.5 dots. Flag must indicate "TO".
    (b) further decrease the signal input level until the deflection is 1.5 dots. The alarm portion of the flag must at least begin to show.

If these requirements are not met R465 may be adjusted, however, it will then be necessary to repeat the Localizer Deflection and Centering procedure (step M). When adjusting R465 it will be found that if the AC voltage at TP401 exceeds approximately 0.1 v rms the localizer deflection may decrease. If this occurs, the deflection will not be proportional to the difference in depth of modulation.

(3) Set the tone localizer to 4 db, 150 Hz for a Left deflection. Reduce the input voltage to produce approximately ½ flag.
(4) Set the tone localizer to 4 db, 90 Hz for Right deflection. Note amount of flag showing. R411 may be varied ±20% from its selected value for the purpose of equalizing flag response.

3.4.1.4 NAV 110 TSO Maintenance Procedures and Hints

1. Check that B+ is 9 volts.
   CAUTION: The 9 volts is also used to tune the receiver varacters. If the voltage has changed, check the receiver tracking circuits.
2. Check that the signal to E201 is of the proper amplitude. See Section 3.4.1.2.
3. Check that the internal Left-Right meter and an external meter (150 ua, 1000 ohms is connected to J201, pins 3 and 4) track. Check both Left and Right deflection. If they do not track, repair before proceeding further.
4. With no signal applied and the receiver channeled to an omni frequency, measure the DC voltage at pins 11 and 12 of both A201 (To-From Phase Detector) and A202 (Left-Right Phase Detector). This voltage should be between 6 and 7.2 vdc. If incorrect, find the trouble and then adjust the voltage as explained in the alignment procedure 3.4.1.3B. The measured DC voltage found at A201, pin 11 should be also at A201, pin 12. The voltages of A202 are check-out in the same manner.

   NOTE: The localizer and omni circuitry are connected together all the time. For the electrical switching to work properly the phase detector (A201 and A202) voltages must be in the proper ranges. If they are out of range, interaction of omni and localizer circuits is possible. This may show up as weak needle swing or uneven Left and Right swing.
5. Incorrect Voltage at Pin 11 and 12 of A201 or A202.
   If the voltage is high, the current source (Q220/Q221 or Q218/Q219) may be bad.

   If, for example, Q220 opens, there would be no current flow in the device and no voltage drop across the resistors connected to pins 11/12. The voltage at pins 11/12 would then tend to rise towards the supply voltage.
   The device U203 could also be bad.
   If the voltage is high (8 to 9 volts) connect a jumper from the collector of Q218 or Q220 to ground. If the voltage should come down to around 1 volt or less, the current source is probably bad. If the voltage is low, it means the current is high. Q218 (or Q220) could be shorted out, thereby causing the high current.

   R272 (and R285) control the current sources. The higher the resistance, the lower the current.
6. LOC/OMNI Switching and Interaction troubles.

   Interaction on switching troubles will usually show up as the LOC loading the omni. The unit may or may not perform properly in localizer mode.

   Measure the DC voltage across C416. In Localizer mode the minus side of C416 will be .5 vdc and the plus side will be around 8 vdc. In Omni mode there will be around 6 volts on both sides of C416.

   If, in OMNI mode, the voltage on both sides of C416 are not equal, it is an indication that Q424 and Q416 are not switching properly. If the voltage is much different from 6 volts it may be a shorted transistor in the Left-Right or To-From localizer detector circuits.

   The Left-Right or To-From interconnections between the omni and localizer boards (E404/E407 — E401/E402) may be disconnected and the OMNI checked. In OMNI mode E408 will have around 8.8 vdc and E409 around 1.2 vdc. In LOC mode E408 will be zero volts and E409 will also be zero volts.
7. The AC voltages shown on the maintenance diagrams can be used to signal trace the equipment. The actual voltages are not critical in most cases and will vary because of component tolerances from unit to unit.
   The phase detector circuits are driven hard and thus operate into limiting. This means that the course width will not change much with a change in the 30 Hertz drive voltages until they change by a large amount.
   The point at which full flag is reached will vary with the 30 Hertz drive since this occurs with low drive voltage.
8. Localizer

   The localizer input at E403 is .2v rms, 90 Hertz signal and a .2v rms, 150 Hertz signal.

   Check E403 for proper voltage.

   TP402 is the output of the 90 Hertz filter. This voltage will be approximately 1.2v rms for .2v rms of 90 Hertz at E403.
   When an off course signal is applied to the Localizer, the amplitude of one channel will increase and the other decrease. Therefore the filter amplifier must be able to produce an output of around 2.4v rms.
   Observe TP402 and increase the voltage to E403 with 90 Hertz only applied. See that you get 2.4v rms with approximately .4v rms at E403. The waveform should look like a nice sinewave.
   Repeat the above at TP403 with 150 Hertz applied.

   NOTE: Localizer course width is a function of input (E403) amplitude in contrast to omni course width.

3.4.2 COM 110 TSO

The following procedure may be used to determine which sub-assembly is malfunctioning:

Check each sub-assembly for the proper inputs. If all inputs are present but the proper output is not obtained, then the sub-assembly is defective. If an input is not present, refer to the sub-assembly that generates this input and check it for proper operation.

RECEIVER BOARD

With an RF input from a signal generator modulated at 30% with 1 KHz the following outputs should be noted:

.10V rms at E-623 with 3 uv input
.30V rms at E-623 with 500 uv input
.7V rms at E-621 with 5 uv input

If these outputs are not present or if any other receiver associated problems are noted (AGC, SQUELCH, WEAK AUDIO, WEAK FLAG, etc.) check all receiver inputs.

INPUT	Test Point	From	Level
A+	E-601	INTERCONNECT BOARD	10.5 VDC
DC TO VARACTORS	E-605	SYNTHESIZER	4 VDC (118) 7.5 VDC (135)
INJECTION	E-612	SYNTHESIZER	.5-1.0V RMS RF
SQUELCH	E-620	FRONT PANEL POT	ON-.7 VDC, OFF-GND
RF INPUT	E-604	TRANS/MOD ASS'Y.	(Noted above)

To remove the receiver board, unsolder all connections to pins and remove the four screws.

TRANSMITTER AND MODULATOR ASSEMBLY

The modulator amplifies the low level audio from the receiver and provides speaker and headphone outputs. The transmitter amplifies the drive from the Synthesizer and provides RF power to the antenna. antenna.

OUTPUT	COM 110	TEST POINTS
Speaker	10 watts	J401A-5
Headphones	50 milliwatts	J401A-3
Transmitter	8 watts min.	P402

If these outputs are not present or if any other transmitter/modulator problems are noted, check all inputs.

INPUT	Test Point	From	Level
Receive Audio	J-401A #7	Interconnect Board	.5V rms
Mike Audio	J-401A #9	Microphone	.2 VRMS
Transmitter Drive	J-403	Synthesizer	1 mw (RF)
A+	E-532	Interconnect Board	13.75 VDC

SYNTHESIZER BOARD

The Synthesizer provides the local oscillator injection to the receiver and the transmitter drive. The synthesizer also generates the DC control voltage for the receiver front end. To check synthesizer operation, connect the output to a counter and check the frequency in receive. The frequency should read 11.975 MHz above the desired channel and in transmit the frequency should be that of the desired channel.

Local oscillator injection level - .5 to 1.0V rms (RF)
Transmitter Drive - 1 mw minimum
DC Control Voltage - 4 VDC (118 MHz) to 7.5 VDC 135 MHz)

If these output are not present or if any other synthesizer problems are noted, check all inputs.

Input	Test Point	From	Level
Programming (Channeling)	A thru L (Refer to Programming Code)	Front Panel Switches	High (1) = 4 VDC + Low (0) = .7 VDC –
NAV-COM Select	P-103 (5, 10, 1)	Front Panel Switch	High (1) = 4 VDC + Low (0) = .7 VDC –
Transmit-Receive	P-103(12)	Transmit-Receive Relay	High (1) = 4 VDC + Low (0) = .7 VDC –
A+	P-103(8)	Interconnect Board	13.75 VDC

To remove Synthesizer Board disconnect J-103, J-104, J-106, P-101, and P-102. (To remove J-103 - first remove screw from Receiver Board). Remove five screws from Synthesizer Board.

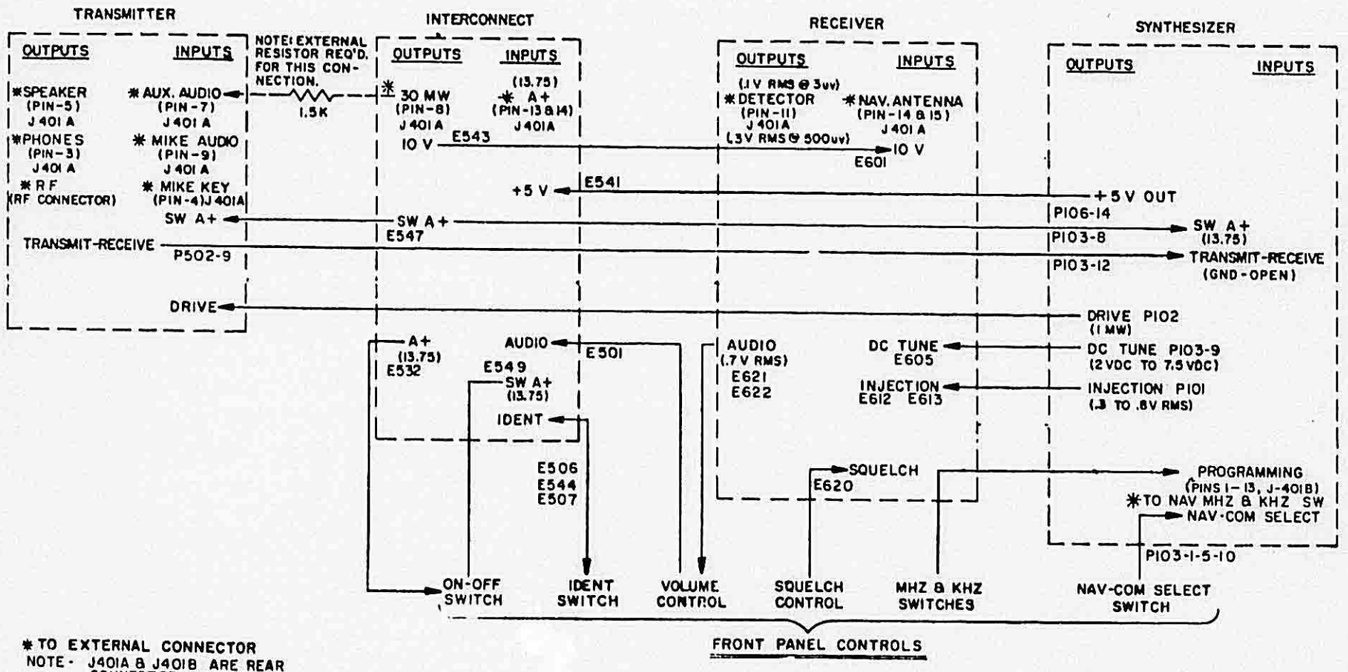


FIGURE 3.4-1 COM 110 TSO INTERCONNECTIONS

3.4.2.1 Test Equipment Required for COM 110 TSO

(1) DC Power Supply - 15v at 5 amps. (for entire unit)
(2) VTVM - RCA Voltohmyst or equivalent.
(3) AC Voltmeter - Ballentine 300D or equivalent.
(4) Hewlett-Packard, HP608 Signal Generator or equivalent.
(5) Resistance Substitution Box
(6) A Counter

3.4.2.2 Receiver Troubleshooting

If all inputs to the receiver are present but one or both outputs are defective, follow the guide to determine which section of the Receiver Board is malfunctioning. After determining which section is at fault, refer to the schematic and text for that section.

PROBLEM	SECTION
Audio Problems Det. OK	Audio Section (Q608 thru Q612)
Detector Problems No signal - No Noise	IF, Detector Section AGC Section Voltage Regulator Section
Detector Problems No signal - Noise present	RF Section Crystal filter
Detector problems AGC	AGC Section
Selectivity Problems	Crystal Filter RF Section (Varactors)

A. Voltage Regulator

The regulated voltage for the receiver board is supplied by the Zener diode CR608. The series resistance for the Zener is split with a filter capacitor in the center to provide better filtering on the 8.2v Zener. The two series resistors are each 27 ohms. Half of the filter is located on the Interconnect Board.

Always check the 8.2v line before attempting to troubleshoot any section of the Receiver Board.

B. RF Section

Active Devices:

The RF Amplifier and Mixer are described in the Circuit Description Section. To determine if the active devices (Q601 and Q602) are defective, the current thru each device must be measured. To measure the current, place the negative lead of a VTVM on the 8.2 line (the feedthru near the 82mf capacitor) and the positive lead on the drain of each FET (no signal input). Multiply the voltage reading by ten to determine the current in milliamps. This current should be approximately 4-5 milliamps for the RF stage and 2-4 milliamps for the Mixer. Gate 2 can also be checked on each device by monitoring the voltage present at this gate. Any voltage greater than that listed indicates a defective gate. See Table 3.4.1. Gate 1 cannot be checked easily since it is at DC ground potential, but if all other checks indicate the device is good and no signal can be driven thru the device, Gate 1 is probably defective. Both Gate 1 and Gate 2 are protected so there is little probability that they would be defective except under extreme conditions.

B. (1) Varactors

The Varactors can be checked by measuring the DC voltage at the junctions (at the cathode of the varactors). There should be no voltage drop across the 100K ohm resistors feeding the varactors. A voltage drop indicates a defective varactor. If any tuned circuit does not peak, especially if the inductance goes to minimum, an open varactor may be indicated.

B. (2) AGC

The AGC operation of the RF amplifier is described in the Circuit Description Section. The AGC can be checked by measuring the current of the RF amplifier as the input signal is increased. Current readings should start at approximately 4-5 milliamps with no signal and go to approximately zero with a large signal input. If this does not occur, check for a defective Gate 2 or defective Q614. Q614 can be checked by measuring its collector voltage. This voltage should start at approximately .5vdc with no signal and rise to approximately 1.0 with a large signal input.

3.4.2.2 Continued

C. IF Section
C. (1) Crystal Filter

The Crystal Filter provides the final selectivity for the receiver, the 6 db bandwidth is 34 KHz and the 60 db bandwidth is 84 KHz. The ultimate attenuation of the Crystal Filter is 80 db, minimum. This means that as the frequency moves further away from center frequency the rejection will get no better than 80 db. To determine if a filter is defective, check the insertion loss thru it by first driving an 11.975 signal into the IF Amplifier (at the filter output) and monitor the detector output. After a reference level is obtained drive the 11.975 MHz signal in the injection port (remove the VCO drive) and ground the source of the mixer. This allows the mixer to function as an amplifier and the filter can be checked without loading it. The approximate level for .10v rms detector output is 5 uv. The filter can be checked for selectivity by measuring adjacent channel rejection. This should be 60 db minimum.

C. (2) Amplifier

The IF Section is described in the Circuit Description Section. If the IF Section is functioning properly there should be some noise at the detector. If there is no noise at the detector, one stage of the IF or the detector is probably defective. The IF stages may be checked by measuring the voltages as listed in Table 3.4.1 The detector and OMNI buffer may be checked in the same manner. If all these voltage checks prove to be right, a faulty bypass might be suspect. This can be checked by monitoring the detector output and bypassing each emitter of all the IF Amplifiers with a .05 mf capacitor. If the noise level comes up significantly when this done, a defective bypass is indicated. Another means of checking the IF stages is by monitoring the detector and driving an 11.975 MHz signal (modulated at 1 KHz) in the base of the last IF stage. With a 10 mv rms signal applied, a .10v rms signal should be seen at the detector. If none is present, this stage would be suspect. If a signal is present, the injected signal can be moved back to the next base and so on, with a gain of approximately 25 db per stage noted. In this manner a defective component may be found.

D. AGC Section

The AGC Detector and Amplifier is described in the Circuit Description Section. If the AGC operation is not functioning, check the DC voltages listed in Table 3.4.1. Check both tantalum capacitors (C639 and C640) for short circuits. Check CR607 and CR615 (by voltage measurements) and check C641 for an open circuit. Refer to the RF section (AGC) if all measurements are proper.

TABLE 3.4.1
RECEIVER DC VOLTAGE MEASUREMENTS

Transistor	Pin 1	Pin 2	Pin 3	Pin 4
Q-601(A)	7.5	4.0	0	.6
Q-601(B)	8.0	2.2	0	1.1
Q-602	7.5	.8	0	1.5
	E	B	C	
Q-603(A)	1.0	1.7	3.7	
Q-603(B)	.3	1.0	6.0	
Q-604(A)	1.0	1.7	3.7	
Q-604(B)	.3	1.0	6.0	
Q-605	.8	1.5	4.5	
Q-606	1.6	2.0	4.0	
Q-607	.8	1.4	5.6	
Q-608(A)	6.6	6.0	.3	
Q-608(B)	6.6	6.0	1.0	
Q-609	.1	.6	4.0	
Q-610	3.5	4.0	8.0	
Q-611	8.0	8.0	6.0	
Q-612	0	.6	0	SQUELCHED
Q-612	0	0	4.0	NO SQUELCH
Q-613(A)	7.2	6.5	4.0	
Q-613(B)	7.6	7.0	2.2	
Q-614(A)	0	.7	.6	
Q-614(B)	0	.65	1.1	

(A) No signal input
(B) 500 microvolts RF signal input 30% mod @ 1000 Hz

3.4.2.2 Continued

e. Audio Section

The Audio Amplifier and Audio AGC circuits are described in the Circuit Description Section. To check the audio circuit, first measure all DC voltages listed on the chart. Be sure to remove the squelch when making the DC measurements. When the problem in the audio section is that of no output, the DC measurements should indicate the defective component. When the problem is weak output or no audio leveling, the DC measurements may not suffice. A defective diode (CR613) may cause weak output. This can be checked by shorting the diode and noting the output. If the output increases to the point of clipping, the diode would be suspect. If C636 were defective, the output would also be weak but the short across CR613 would not cause an increase in output. The audio leveling would malfunction if Q611 and/or CR613 were defective. R667 controls the threshold point of the AGC (that point where maximum gain occurs). If this value is set too low the maximum gain point could occur on noise only. This would cause a poor signal to noise ratio. The squelch circuit is described in the Circuit Description Section. If Q612 were shorted, the audio output would be dead at all times and, if it were open, the audio output could never be squelched. The selected resistor across the squelch pot determines how deeply the receiver may be squelched. Raising this resistor value would require more input signal level to break the squelch, lowering this value would require less signal.

The following chart may be used to determine if each section is functioning properly. These levels are nominal values and they may vary slightly from radio to radio. Any major differences (25%) in these levels would indicate a defective section.

SECTION	INPUT	AT	OUTPUT	AT
Audio Section	.15v rms of 1000 Hz	Emitter of Q607	.7v rms	E621
IF Amplifier	5-10 uv at 11.975 MHz with 30% Mod. @ 1000 Hz (Filter disconnected)	E625	.10v rms	E623
Crystal Filter	20 uv @ 11.975 MHz with 30% Mod. @ 1000 Hz	E624	.10v rms	E623
Mixer (as Amplifier) (Source Shorted to GND)	5 uv @ 11.975 MHz with 30% Mod. @ 1000 Hz (injection disconnected)	E612	.10v rms	E623
Mixer (as Mixer)	7 uv @ RF freq. with 30% Mod. @ 1000 Hz	Gate 1 (pin 3 of Q602)	.10v rms	E623
RF	3 uv @ RF freq. with 30% Mod. @ 1000 Hz	E604	.10v rms	E623

3.4.2.3 COM 110 TSO Receiver Tuning Procedure

1. Turn DC power supply ON, (A+ 13.75 vdc) and check Zener voltage (8.2v±5%)
2. Connect AC VTVM to OMNI output (E623)
3. Set channel selector to 135.00 ("COM-NAV" switch to "COM")
4. Set signal generator to 135.00 (zero-beat generator)
5. Set signal generator output level to give a useable indication on AC VTVM.
6. Tune C613 and L606 for maximum response (reduce generator level if necessary)
7. Tune C603, C606, and C608 for maximum output on AC VTVM
8. Set channel selector to 108.50 ("COM-NAV" switch to "NAV")
9. Set signal generator to 108.50 and tune L601, L602, and L603 for maximum output
10. Set channel selector to 135.50 ("COM-NAV" switch to "COM")
11. Set signal generator to 135.50 and tune C603, C606, and C608 for maximum output
12. Repeat steps 8-11 until no further increase in output is noted
13. Set channel selector and signal generator to 135.50 "COM-NAV" switch to "COM")
14. Note change in output (in db) as RF input is varied from 10 to 10K microvolts
15. If output varies by more than 1 db change R666 to bring variation within 1 db (lower value of R666)
    (When adjusting R666 monitor the voltage at the collector of Q604. This voltage should not be lower than 3.5v with no signal input, If this voltage is lower than 3.5v raise R666)
16. Set RF input to 500 microvolts @ 30% modulation 1000 Hz
17. Set output to .30v rms by adjusting R659 (.30 ±.02v rms)
18. Check output @2.0 uv (.10v rms minimum) if level is less than the minimum allowed, lower the value of the AGC selected "R" (R666) until the minimum is achieved
19. Repeat steps 16-18 until both requirements are met (500 μv level an l 2μv level)
20. Monitor audio output with AC VTVM
21 Set the signal generator to 50μv @ 20% modulation 1000 Hz
22. Check AGC by varying modulation from 20% to 100%, maximum increase in output = 2 db
23. If output exceeds 2 db increase, lower value of selected "R" (R667)
24. Check AGC action from 2 μv to 10K μv @ 30% modulation 1000 Hz (maximum allowed ± 3 db). If output exceeds 3 db increase, lower value of selected "R"
25. Check sensitivity @ 135.50 (2 μv maximum for 6 db S+N/N)
26. Check sensitivity @ 108.50 (2 μv maximum for 6 db S+N/N)
27. Check adjacent channel rejection using AGC voltage as a reference (minimum =60 db) @ 135.00
28. Check image using AGC as a reference (minimum=60 db).

3.4.2.4 Synthesizer Troubleshooting

COM 110 TSO SYNTHESIZER SUB-ASSEMBLY TEST

A. COM - RECEIVE MODE

1. Connect unit under test to system harness and set controls for COM-Receive Mode
2. Check J103-8 for A+ (approximately 12 volts)
3. Check J103-16 for 5 VDC
4. Check J103-12 for 2.5 volts (approximately)
5. Check J103-3 for .5 volts (approximately)
6. See Table 3.4.2 and check U114, U115, and U116 for proper coding.
7. Rotate MHz channel selector and note stepping voltage of approximately .2v per MHz at J103-9 (4 to 7.5v)
8. Connect a counter to P107 and check frequency. Dial + 11.975±.005% (Note output, approximately 3-10 milliwatts)

B. COM-TRANSMIT MODE

1. Apply a ground to J103-12 or key transmitter.
2. Check voltage at J103-9 voltage should step as MHz channel selector is rotated (2-3 volts to approximately 4 volts)
3. Counter connected to P101 should read dial frequency ±.005%

C. NAV MODE TEST

1. Set NAV-COM switch to NAV
2. Check J103-13 for approximately .5 volts
3. Rotate MHz dial on NAV 110 TSO and observe stepping voltage at J103-9 (2.5 - 4 volts approximately)
4. Counter connected to P101 should read NAV dial frequency +11.975±.005%

Regulator Alignment

Set R134 for 5.4 volts at emitter of Q117
Set R139 for 8.6 volts at emitter of Q121

Test - vary input voltage from 11 to 16 volts.

5.4 volts: should not vary more than .3 volts.
8.6 volts: should not vary more than .6 volts.

NOTES:

Accidental shorts will usually damage Q120, Q118, Q119 and not the pass transistor (Q121 or Q117).

The heat sink becomes hot when synthesizer is tested unmounted.

The load on the 5.4v regulator is 510 ma.
The load on the 8.6v regulator is 90 ma.

Reference Oscillator Alignment

Select C186 to produce a frequency of 3200.590 KHz at the collector of Q113. This alignment is necessary if the crystal is replaced.

Test

4 v p-p at collector of Q113 at 3200.590 KHz±20 Hertz.

Crystal Oscillator Alignment

Monitor E106 with a high frequency scope or VTVM with an RF probe. Set coil slug to middle on "ON" range for troubleshooting. When synthesizer is in full operation check output frequencies and reset if necessary for:

Synthesizer Output	Mode	Frequency Selected
126.00 ± 3 KHz	Transmit	126.00 MHz
137.975 ± 3 KHz	Receive	126.00 MHz
123.975 ± 3 KHz	NAV	112.00 MHz

NOTES: Use only NARCO crystals.
Slugs are cemented to prevent detuning by vibration.

Oscillator output can be monitored with a scope or VTVM equipped with an RF probe at E106. This is a result of the mixing of the crystal and the VCO.

TABLE 3.4.2 SYNTHESIZER PROGRAMMING

MHz NAV	MHz COM	U115 8	U115 11	U115 3	U115 6	U116 11	U116 3	U116 6	Fractional MHz	U114 8	U114 11	U114 3	U114 6	U116 5
	118	1	1	0	0	1	0	1	.00	1	0	1	1	1
	119	1	1	1	0	0	1	0	.05	0	0	1	1	1
	120	0	1	1	1	0	0	1	.10	1	0	0	1	1
	121	0	0	1	1	1	0	0	.15	0	0	0	1	1
	122	1	0	0	1	1	1	0	.20	1	0	0	0	1
	123	0	1	0	0	1	1	1	.25	0	0	0	0	1
	124	0	0	1	0	0	1	1	.30	1	0	0	0	0
	125	0	0	0	1	0	0	1	.35	0	0	0	0	0
108	126	0	0	0	0	1	0	0	.40	1	1	0	0	0
109	127	1	0	0	0	0	1	0	.45	0	1	0	0	0
110	128	0	1	0	0	0	0	1	.50	1	1	1	0	0
111	129	0	0	1	0	0	0	0	.55	0	1	1	0	0
112	130	1	0	0	1	0	0	0	.60	1	0	1	1	0
113	131	0	1	0	0	1	0	0	.65	0	0	1	1	0
114	132	1	0	1	0	0	1	0	.70	1	1	0	1	1
115	133	0	1	0	1	0	0	1	.75	0	1	0	1	1
116	134	0	0	1	0	1	0	0	.80	1	1	1	0	1
117	135	1	0	0	1	0	1	0	.85	0	1	1	0	1
									.90	1	1	1	1	0
									.95	0	1	1	1	0

NOTE: "1" represents above 2 volts
"0" represents below 1 volt
Values in table are inverted from switch inputs.

3.4.2.4 Continued

VCO Alignment

Proper alignment of the VCO can best be accomplished in a radio with the Synthesizer operational.

(a) Channel radio to 118.95 MHz transmit mode, voltage on feedthru capacitor C136 should be adjusted to 2.5v ±.05v with L104.

(b) Channel radio to 135.95 receive mode, (VCO out at 147.925 MHz) adjust C126 for 7.6 ±.1 volts.

(c) Repeat steps (a) and (b) until both meet proper levels.

Test

Short collector of inhibit switch Q108 to ground to prevent inhibit circuit from turning Q107 OFF. An output of 3 milliwatts (minimum) should appear at P101 in receive mode. Voltage at C136 should vary from approximately 4 volts at 118.95 to 7.6 volts at 135.95 in approximately .2 volt steps as the MHz dial is channeled clockwise between the two frequencies.

NOTES:

Due to restriction circuits, VCO cannot be tuned to 118.95 unless transmitter key input is grounded.

If the Synthesizer is not operational the VCO can be aligned by removing the VCO control line from E105 and applying proper tuning voltage to the VCO control line.

Adjust T101 for maximum output at 126.00 transmit mode. This is a very broad tuned circuit and usually does not require adjustment.

Mode Selector

The Mode Selector can be best tested by replacing U117 with a known good IC.

Mixer and Drive Test

Test

(a) During normal operation, a 4v p-p signal will be present at E106.
(b) Set channel selector to 118.00, frequency reading should be 30.05 MHz.
(c) Set channel selector to 135.95, frequency reading should be 12.10 MHz.

It is important that the peaks go below .8 volts as measured on a high frequency scope.

NOTE:

If either the VCO or the Crystal Oscillator is not functioning no output will be present at E106.

Control Voltage Generator Alignment

The Synthesizer must be aligned in a working radio or suitable test fixture. Set COM frequency to 118.00, transmit mode, adjust R131 for the following waveshape:

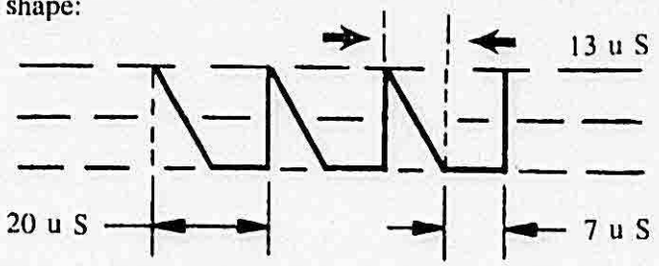


FIGURE 3.4-2 RAMP

NOTE:

Setting of R131 is not critical for troubleshooting, that is, an improperly set R131 will not stop the operation of the unit, however, it must be set properly to ensure reliable operation of the radio.

Inhibit

Test
Ground the VCO control line at E105. The output at P101 should drop approximately 20 db.

Variable Divider

Check pin 14 on the 14 pin IC and pin 16 on the 16 pin IC for 5 vdc.
Test
Check for 3v minimum p-p at E106.
Check pin 5 of U111 for a square wave (approximately 3 v p-p) output.
Check pin 6 of U105 for negative going pulses.
Check pin 9 of U106 for negative going pulses approximately .1 microsec wide at 20 microsec spacing (during lock).

Reference Divider

Test
Check pin 1 of U101 for 4v p-p at 3.2 MHz.
Check pin 8 of U101 for approximately 3v p-p at .8 MHz.
Check pin 8 of U102 for approximately 3v p-p at .2 MHz.
Check pin 8 of U103 for approximately 3v p-p at .05 MHz.

NOTE - If system is not locked, remove U113 to perform the test.

Restriction Circuit

Adjustment: Set R130 for 4.2 volts at the plus side of C199.
Test
Check the collector of Q104 for near zero volts in NAV and Transmit modes, and approximately 4.8 volts in COM Receive.

3.4.2.5 Troubleshooting Procedure for COM 110 TSO Transmitter/Modulator

In the event that difficulty should arise in the operation of the Transmitter/Modulator, the following information can be used as a guide in localizing and diagnosing the problem.

A. Remove the top dust cover from the unit. This is retained by 6 sheet metal screws.

B. Connect the RF Power Meter, connectors, microphone, etc. to the unit. A 10 amp regulated power supply should be used to supply the 13.75 vdc (A+).

C. Determine that the Transmitter/Modulator, hereafter called module, has A+ applied when the mike key is depressed. This voltage can be measured on the Interconnect Board at the junction of R505 and the Yellow #18 wire.

D. With A+ applied, a normally operating module should deliver a minimum RF power output of 8 watts, and should be capable of a minimum of 85% modulation. If either of these two conditions cannot be met, proceed as follows.

(1) No RF or low RF power output.

(a) Remove phone plug which supplies RF drive power from synthesizer. Connect a suitable signal generator, tuned to 125 MHz, to the mating plug and key the unit. Set RF drive level to one milliwatt, minimum.

(b) If 8 watt (minimum) output is not obtained, the module should be removed from the unit before continuing the troubleshooting. Proceed to step E.

(2) No modulation or inadequate modulation.

(a) Connect an audio wattmeter, or a 6 ohm, 25 watt resistor between pin 5 of the modulator PC board, P401A, and ground. Pin 5 of P401A is the speaker output connection. With A+ turned ON, apply a 1.5v rms, 1 KHz signal to pin 7 of P401A. (Do not key the transmitter under these conditions since this will disconnect both the audio signal and the 6 ohm load.) The modulator should now be delivering approximtely 11 watts of undistorted audio power. This is equivalent to 8.1v rms across the 6 ohm resistor. If this condition cannot be met, proceed to step E.

3.4.2.5 Continued

E. Removal of Module.

In the event that the difficulty with the module cannot be diagnosed, localized, and corrected by referring to steps D1 and D2, it will be necessary to remove the module from the unit. Unsolder wires (two Yellow* and one Red) and two coax cables coming from the module to the unit. Also disconnect the phono-plug and the two IC connectors from their respective mates.

Removing four screws holding the module to the side rail will permit the removal of the module from the unit. Once the module is out of the unit, remove the three screws (on the printed circuit board side of the module) holding the audio PC board to the transmitter heat sink. The module will now open 180 degrees in a clam shell fashion, permitting access to the Transmitter/Modulator section. If the problem appears to be in the Transmitter, unsolder and remove the two shields covering the RF section and the harmonic filter.

(1) RF Section and Harmonic Filter
Connect the module as shown in Figure 3.4-4

NOTE:

As can be seen in Figs. 3.4-4, the RF drive power can be obtained from either a signal generator or a sweeper. The preferred method is to sweep the module from 100 to 150 MHz, using a Texcan VS-50, Texcan VS-80, Wavetech 1001, or any equivalent swept source having built-in markers. This will permit a display of power output vs frequency, which greatly facilitates the troubleshooting procedure. If a sweeper is not available, a signal generator such as a HP 608D or equivalent can be used. In this case, specific frequencies will have to be preset manually.

(a) Drive the module with 1 mw at approximately 125 MHz, turn on A+ and using a high impedance VTVM, measure the DC voltages at the collector, emitter, and base of the RF transistors. Typical voltages are, (±20%).

Transistor	With RF Drive	Without RF Drive
Q401 C	+11.5 vdc	+12.0
Q401 E	+ 0.45	+ 0.47
Q401 B	+ 1.0	+ 1.1
Q402 C	+12.5	+13.0
Q402 E	+ 1.5	+ 0.42
Q402 B	+ 1.0	+ 1.1
Q411 C	+12.0	+12.5
Q411 B	0	0
Q411 E	+ 1.0	+ 1.1
Q412 C	+13.0	+13.3
Q412 E	0	0
Q412 B	- 1.5	0

Large voltage variations from these typical values require a component check of the particular stage.

(b) The total current drain under CW conditions be approximately 2 amps. The current drain without RF drive is approximately 500 ma.

(c) Apply swept drive to the module, and observe the detected waveform on the scope. Figure 3.4-5 represents a typical waveform of a normally operating transmitter

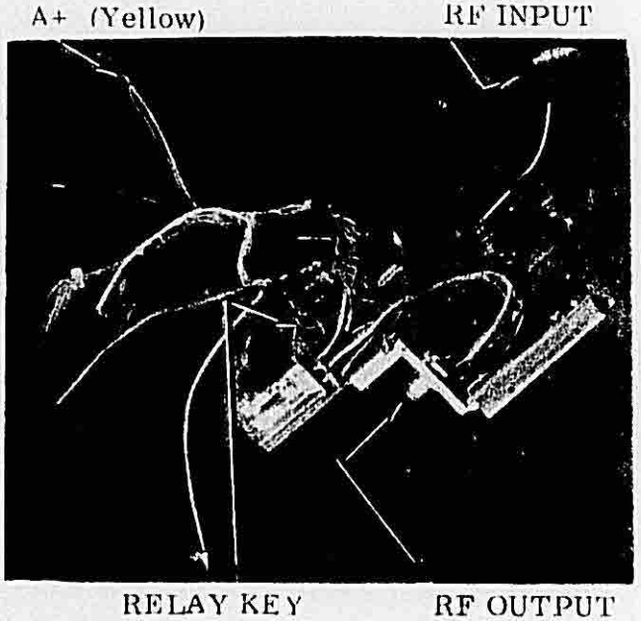


FIGURE 3.4-3 TEST CONNECTIONS

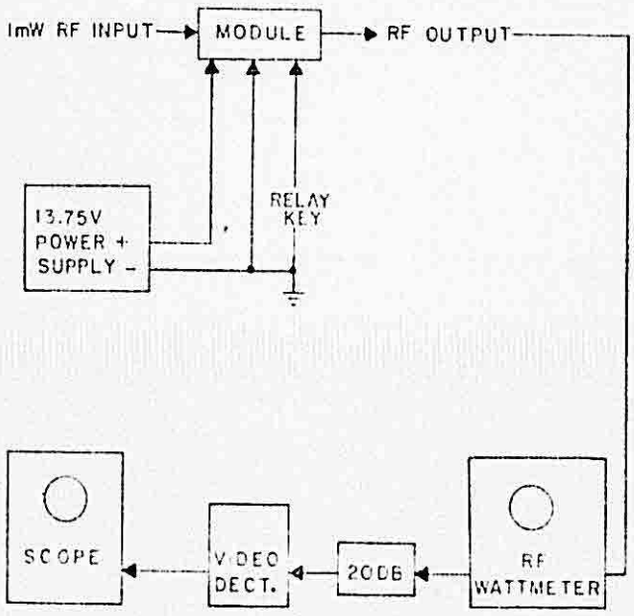


FIGURE 3.4-4 TEST BLOCK DIAGRAM

3.4.2.5 Continued

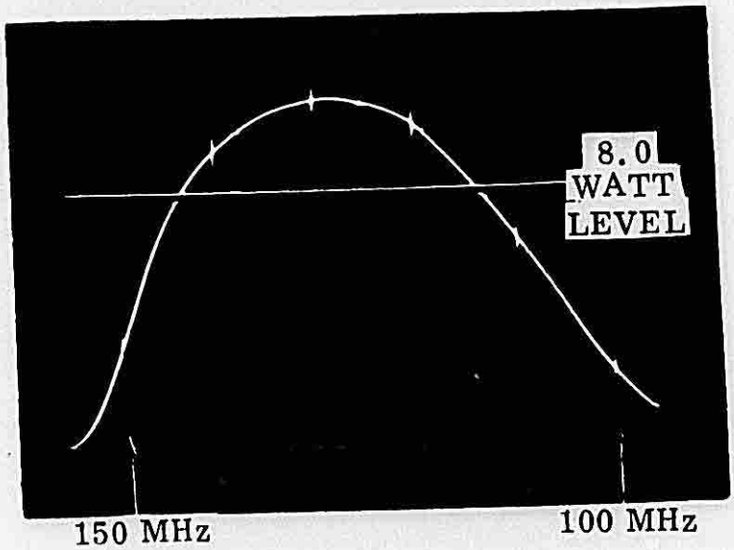


FIGURE 3.4-5 COM 110 TSO POWER VS FREQUENCY

If the minimum power output cannot be obtained between 118 and 136 MHz, slight adjustment of the air wound coils in the RF section can be made. The necessity for adjusting a particular coil can be determined by inserting a small piece of brass or powdered iron into the coil while observing the effect on the scope. A small phenolic rod with a brass insert on one end and a powdered iron insert in the other will prove to be a useful tool for this test.

Inserting the brass will decrease the inductance, while iron will increase the inductance. The final adjustment can be made by knifing the end turns on the coil. Large industance compensation should be avoided since this is an indication of other circuit problems. In general,tuning of the coils is not necessary unless they have been disturbed due to a component replacement.

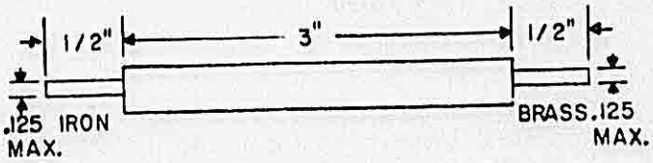


FIGURE 3.4-6 COIL TEST TOOL

(d) Adjustment of the harmonic filter is not recommended unless an RF voltmeter with a large dynamic range is available. The HP 3406A Broadband Sampling Voltmeter or the Boonton 91-CA RF Voltmeter are recommended for this adjustment. Unsolder L412 from C462 and drive this point with a milliwatt signal from a HP 608D (or equivalent) RF generator between the frequencies of 118 and 136 MHz. Measure the output of the filter (which should be terminated with 50 ohms) with the RF Voltmeter. The variation signal level should not be more than 0.2 db across the band. Care should be taken to maintain a constant input level while this test is being made.

In order to adjust the frequencies of maximum attenuation, set the generator to 335 MHz and adjust L409 for minimum output voltage. Set signal generator to 223 MHz and adjust L410 for minimum output.

When the harmonic filter is being tested, it is necessary to apply A+ in order to key the relay so that the output signal from the filter is available at the output terminal, P402. However, it is necessary to deenergize the transmitter during this procedure by unsoldering the two wires (Red and Blue) that apply the DC voltage to the RF transistors.

Should the harmonic filter fail to respond to these adjustments, it is suggested that the unit be returned to the factory for further repairs.

3.4.2.5 Continued

(2) Modulator

Connect the module as shown in Figs. 3.4-4. Sweep transmitter between the frequencies of 100 and 150 MHz. Observe the detected waveform on the oscilloscope. The trace should appear as shown in Fig. 3.4-5. Apply a 50 millivolt. 1 KHz signal to pin 9 of P401A. The transmitter should modulate normally between 118 and 136 MHz as shown in Fig. 3.4-7.

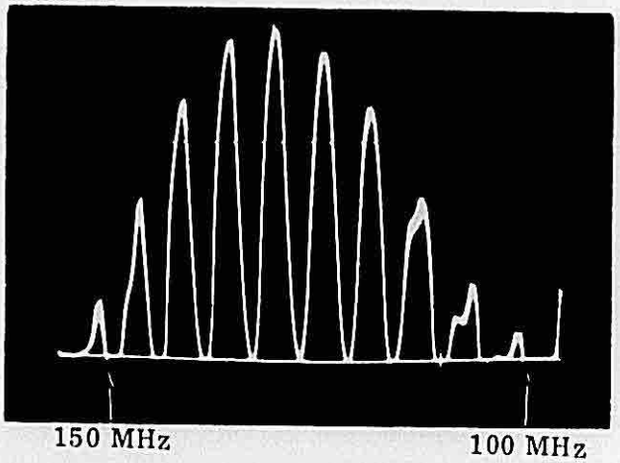


FIGURE 3.4-7 COM 110 TSO MODULATION CHARACTERISTICS

The microphone gain control, R416, might need adjustment in order to obtain full modulation.

NOTE: This control should be reset for different installations, depending upon the particular microphone used in the aircraft. Speaking normally into the mike, adjust R416 until the positive and negative audio peaks show signs of clipping. This adjustment is best performed on a single frequency than with a swept RF signal.

If the modulator fails to modulate as described, the following information should prove useful in localizing the problem area.

(a) Audio Preamplifier, Q405
With 50 millivolts at 1 KHz applied to pin 9 of P401A, the following AC and DC voltages should appear at the terminals of Q401 (plus or minus 20%).

Terminal	AC	DC
Base	—	0.8 vdc
Emitter	—	0.18 vdc
Collector	12v p-p	12.5 vdc

This stage can be further isolated by disconnecting the driver transformer (T401) secondary terminals, soldering a 500 ohm, ½ watt resistor across the primary terminals and checking the stage performance. Alternatively a 10K ohm, ½ watt resistor could be soldered across the full secondary of T401, or an audio wattmeter could be substituted in either of these two locations. The audio power output of this stage is approximately 35 milliwatts.

(b) Push-Pull Darlingtons, Q406, Q407, Q408, and Q409
With a 50 millivolt, 1 KHz signal applied to pin 9 of P401A, the following AC and DC voltages should appear at the following terminals:

Transistor	Terminal	AC	DC
Q406 & Q408	Base	27v p-p	1.0 vdc
	Emitter	26v p-p	0.7 vdc
	Collector	—	13.6 vdc
Q407 & Q409	Base	26v p-p	0.7 vdc
	Emitter	25v p-p	0.3 vdc
	Collector	—	13.6 vdc

The DC voltage readings on the base and emitter terminals of the above transistors can vary considerably depending upon the Beta match of the particular transistor pair. Severly mismatched transistors can cause excessive audio distortion.

The Darlington stages can be further isolated by disconnecting the primary of the driver transformer, T401, and applying a 12 v p-p audio signal from a 500 to 600 ohm, 1 KHz source. The secondary of the modulation transformer, T403, can be unsoldered and connected to an audio wattmeter, or a 6 ohm, 25 watt resistor. Under these conditions, the modulator should deliver 11 watts into a 6 ohm load.

(c) Bias Transistor, Q410

Under normal conditions, the following voltages can be measured on the terminals of Q410.

Terminal	Voltage
Base	0.7 vdc
Emitter	0
Collector	2.0 vdc

At room temperatures, this stage will restrict the idling current of the modulator (no signal) to to approximately 50 to 75 milliamperes.

3.5.1 NAV 110 REPLACEMENT PARTS LIST

To provide a cross-reference relationship of subassemblies to their Next Higher Assembly, the notation "See Fig. . . . . for Breakdown" follows the entry of a subassembly that is too large to be included within this list and that a separate list is provided. The subsequent list which breaks down the subassembly will refer back with the notation, "See Fig. . . . for NHA," to that list which first noted the subassembly.

The word "No Number" in the Part Number column indicates that the part or subassembly is not a true subassembly. It is however a group of components which function together and by setting them aside in a separate list, greater detail of the components can be shown. Since the subassembly has no number, only piece parts of the "group" can be ordered or the complete Next Higher Assembly.

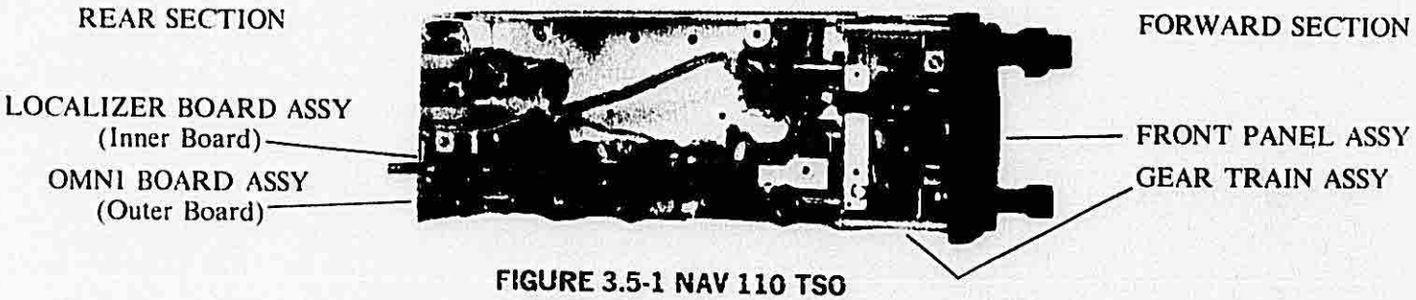


FIGURE 3.5-1 NAV 110 TSO

Fig. & Index No.	Part Number	Description
3.5.1	01178-0101	NAV 110 TSO
3.5.1	01162-0101	FRONT PANEL ASSY (See Fig. 3.5-2 for breakdown)
	01161-0103	GEAR TRAIN ASSY (See Fig. 3.5-3 for breakdown)
	01156-0106	LOCALIZER BOARD ASSY (See Fig. 3.5-4 for breakdown)
	01157-0102	OMNI BOARD ASSY (See Fig. 3.5-5 for breakdown)
	55890-0001	CHASSIS
	55891-0001	COVER
	55894-0001	BRACKET, BOARD MTG
	55895-0001	BRACKET, REAR
	55856-0001	LAMPHOLDER, LEFT
	55857-0001	LAMPHOLDER, RIGHT
	55859-0101	CONNECTOR, PRINTED BOARD ASSY
	55984-0001	GEAR (96 T)
	55968-0001	PINION (16 T)
	55914-0001	GEAR, SPUR, KHz (24 T)
	55991-0001	HINGE, BOARD & STOP
	55990-0001	HINGE, BOARD
	81213-0057	SPACER, (.140 LG. CONNECTOR BD.)
	81213-0107	SPACER, (.146 LG. POT MTG.)
	81207-0035	SPACER, (.390 LG. LOC. BD. REAR MTG.)
	81213-0034	SPACER, (.062 LG. WAFER SW.)
	81213-0103	SPACER, (.430 LG. FT. PANEL TO FT. PLT.)
	81213-0097	SPACER, (.687 LG. SWITCH)
	81214-0010	SPACER, (.140 LG. SWITCH)
	81214-0017	SPACER, PHENOLIC, BLACK
	55946-0001	CLAMP, SHAFT (MHz)
	55974-0001	CLAMP, SHAFT (OBS & KHz GEAR)

	Part Number	Description
	55883-0001	SHIM, KHz & MHz SHAFT
	55924-0004	SHAFT, OBS. (3-5/32 LG.)
	55955-0002	SHAFT, MHz
	55912-0001	SHAFT, KHz
	88203-0001	KNOB, OBS. KHz
	88204-0001	KNOB, MHz
	81212-0008	SPACER, 5/16 HEX, 1/4-32 THREAD
	04380-0002	INSERT, KNOB (OBS)
	04380-0007	INSERT, KNOB (FREQ.)
	04479-0001	LABEL, LOGO
	04481-0001	LABEL, NAMEPLATE, NAV 110 TSO
	82826-0003	SCREW, MACH. #3-48 x 1/4
	82803-0023	SCREW, MACH. #4-40 x 1 7/8, RD. HD. SL.
	82879-0403	SCREW, MACH. #4-40 x 1/4, 100° FT. HD. PHILLIPS
	82965-0009	SCREW, MACH. #4-40 x 3/4 FILISTER HD. PHILLIPS
	82965-0005	SCREW, MACH. #4-40 x 3/8 FILISTER HD. PHILLIPS
	82814-0003	SCREW, MACH. #4-40 x 1/4 BIND. HD. SL.
	82814-0005	SCREW, MACH. #4-40 x 3/8 BIND. HD. SL.
	82814-0007	SCREW, MACH. #4-40 x 1/2 BIND. HD. SL.
	82814-0008	SCREW, MACH. #4-40 x 5/8 BIND. HD. SL.
	82889-0004	SCREW, SOCKET SET #4-40 x 3/16
	82889-0002	SCREW SOCKET, SET #4-40 x 1/8
	82904-0102	NUT, SELF CLINCHING #4-40
	82900-0003	NUT, HEX #4-40 x 3/16
	81290-0003	NUT, "U" #4-40
	81275-0001	NUT, LOCK, #4-40 (ESNA.) FILTER & HINGE
	82922-0001	NUT, HEX, KEPS #4-40
	82900-0011	NUT, HEX #8-32 x 5/16
	82801-0005	LOCKWASHER, EXTERNAL TEETH #8
	81312-0018	WASHER, SPRING
	82802-0003	LOCKWASHER, INTERNAL TEETH #4
	81324-0003	LOCKWASHER, SPLIT #3
	81329-0214	WASHER, FLAT #3
	81336-0011	WASHER, FLAT, (PLASTIC, HINGE TO CHASSIS)
	81324-0004	LOCKWASHER, SPLIT #4
	81160-0003	GROMMET, RUBBER
	81355-0001	RIVET, PLASTIC
	84158-0003	INSERT, TAP-LOK, #6-32
	82864-0004	SCREW, MACH. #4-40 x 5/16 RD. HD. SL. (NYLON)
J201	41204-0003	CONNECTOR, SOCKET MINATURE 6 PIN
	76116-0001	METER
R234	32068-0001	POTENTIOMETER, COURSE SELECTOR
R204	32064-0004	RESISTOR, VARIABLE, 5K ±30%
R472	32064-0005	RESISTOR, VARIABLE, 500 ±30%
	12000-0009	LAMP #330
	81747-0012	FILTER, LAMP
	82816-0009	SCREW, MACH. #8-32 x 3/4, BIND. HD. SLOTTED
S103	61554-0001	SWITCH SECTION, NAV MHz
S101	61553-0001	SWITCH SECTION, NAV KHz
S102	61548-0001	SWITCH SECTION, LOC KHz
	55740-0003	BEARING PLATE
R263	31192-0102	RESISTOR, CARBON 1K ±10%, 1/4W
R264	31192-0681	RESISTOR, CARBON 680 ±10%, 1/4W
	81431-0011	STRIP, TIE, 7 LUG
	81307-0100	WASHER, FLAT (OBS SHAFT)
C223	21554-0050	CAPACITOR, ELECTROLYTIC +150% -10%, 3 V.N.P.
	57628-0001	PLATE, COVER
	82814-0002	SCREW, MACH. #4-40 x 3/16 BIND. HD. SL.
	81307-0076	WASHER FLAT, 030 THICK
C224	21291-0025	CAPACITOR CERAMIC 430 pf ±10%, 500V
C225	21291-0025	CAPACITOR CERAMIC 430 pf ±10%, 500V

Fig. & Index No.	Part Number	Description
3.5-2	01162-0101	NAV 110 TSO FRONT PANEL ASSY (See Fig. 3.5-1 for NHA)
1	55928-0001	FRONT PANEL
2	55935-0001	LENS
4	55936-0001	AZIMUTH CARD
5	55989-0001	RETAINER, CARD
6	55830-0001	GEAR, OBS.
7	55855-0001	LOCK (NYLON)
8	55953-0001	BRACKET
9	55925-0001	SPRING, DIAL
10	82826-0002	SCREW, MACH, #3-48 x 3/16. RD. HD. SL
11	82965-0006	SCREW, MACH, #4-40 x 7/16 PHILLIPS
12	81324-0003	LOCKWASHER, SPLIT, #3
13	81329-0214	WASHER, FLAT, #3
14	81329-0004	WASHER, FLAT, #4
15	82922-0001	NUT, HEX, KEPS, #4-40
16	55974-0001	CLAMP, SHAFT - (Part of 01151(Fig. 3.5-1)

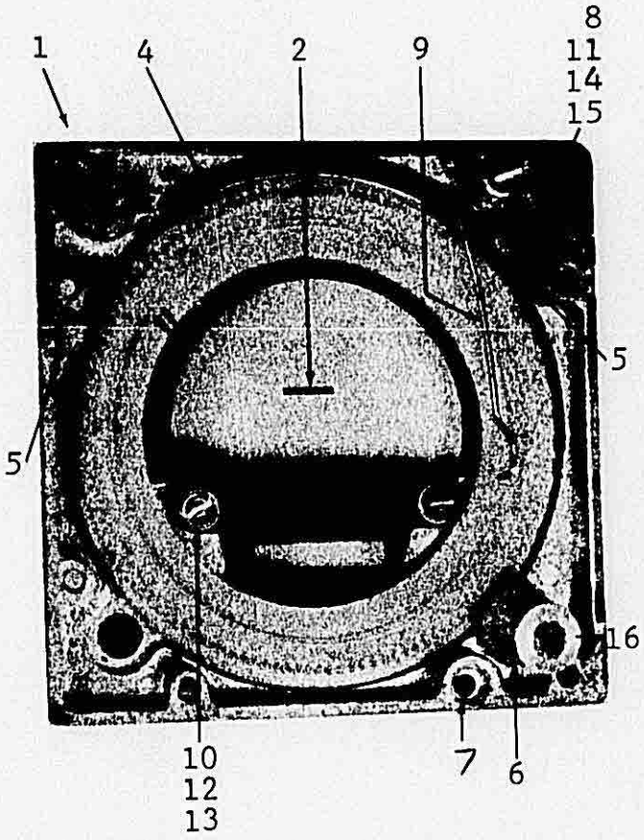
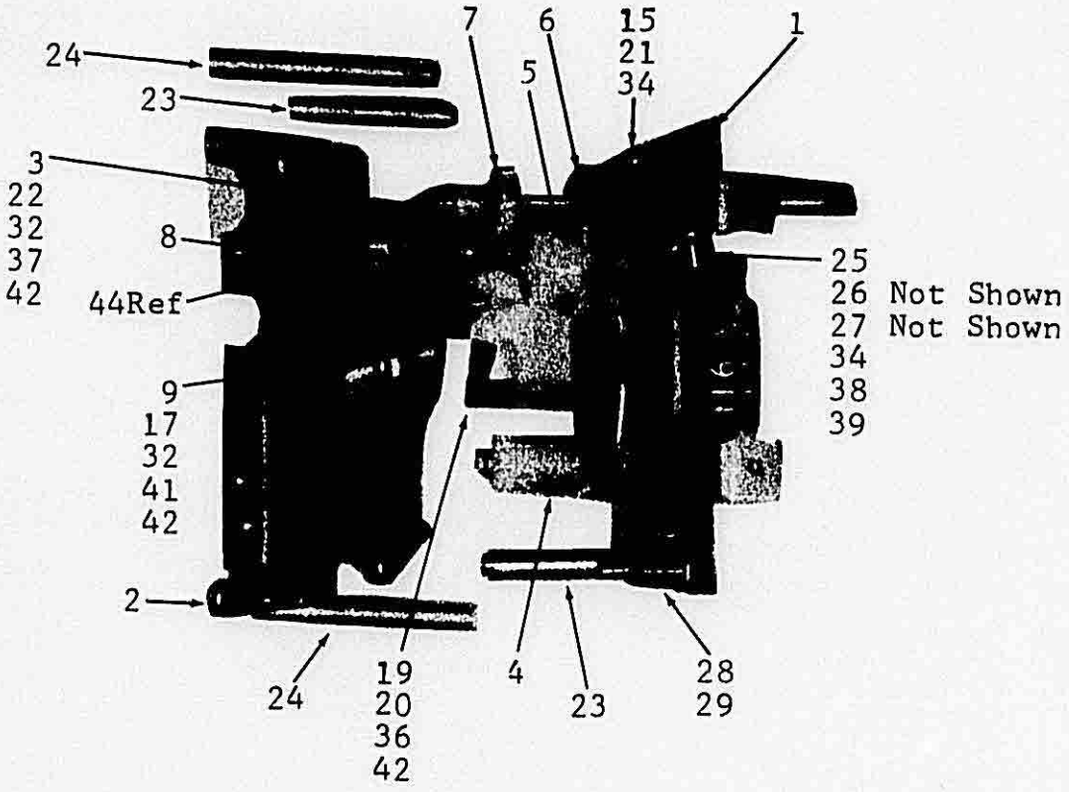


FIGURE 3.5-2 FRONT PANEL ASSY



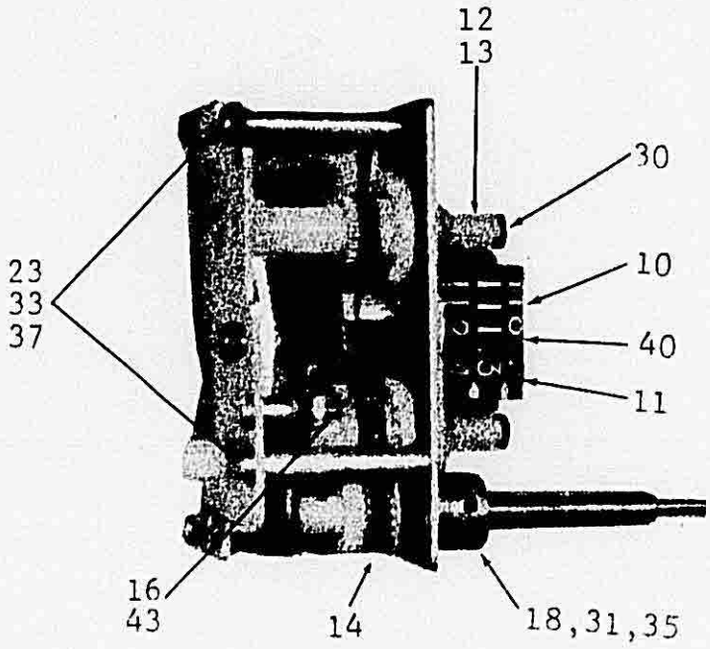
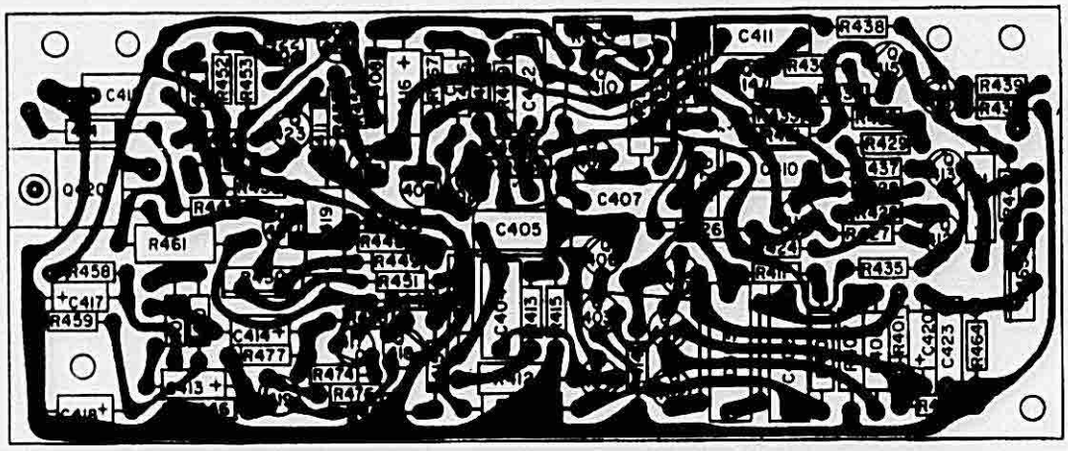


FIGURE 3.5-3 GEAR TRAIN ASSY

Fig. & Index No.	Part Number	Description
3.5-3	01161-0103	GEAR TRAIN ASSY (See Fig. 3.5-1 for NHA)
1	55932-0001	PLATE, FRONT
2	55931-0003	PLATE, REAR
	57636-0001	KEEPER, SPRING (NOT SHOWN)
	55836-0002	SPACER, HEX (Belt Tension) (Not Shown)
	82826-0007	SCREW, MACH. #3-48 x ½ RD. HD. SL (Not Shown)
	82819-0003	SCREW, MACH. #4-40 x ¼ FH, SL (Not Shown)
	81307-0060	WASHER, FLAT
3	55930-0001	PLATE, BEARING
4	55987-0001	DETENT & GEAR, MHZ
5	55866-0101	DETENT AND CLUSTER ASSY
6	55916-0001	PULLEY & SHAFT
7	55913-0001	GEAR & SHAFT
8	55915-0001	GEAR, (34T) MHZ SV
9	55986-0001	GEAR, IDLER (52T)
10	55922-0001	DRUM & GEAR MHZ
11	55923-0001	DRUM & GEAR KHZ
12	55933-0001	BEARING BLOCK
13	55924-0001	SHAFT, DRUMS
14	54960-0004	BELT, GEAR (64T)
15	57605-0001	SPRING, DETENT
16	55992-0001	STOP, MHZ
17	55983-0001	BUSHING, IDLER
18	55939-0001	SLEEVE, STOP
19	55875-0001	BRACKET, BELT TENSION
20	57636-0001	KEEPER, SPRING
21	57606-0001	SPACER (DETENT SPRING)
22	81208-0013	SPACER (BRG. PLATE)
23	81208-0015	SPACER (F. TO R. PLATE)
24	81207-0037	SPACER (R. PLATE TO F. P.)
24A	57684-0001	SPRING, EQUALIZER
24B	55836-0002	SPACER, HEX (Belt Tension)
24C	81208-0016	SPACER, (F. TO R. PLATE)
25	41321-0001	SOCKET, LAMP
26	12000-0009	LAMP, #330
27	81747-0012	FILTER, LAMP
28	81423-0002	TERMINAL, STANDOFF
29	81702-0004	LUG, SOLDER
30	81192-0014	GRIP RING (⅛ SHAFT)
31	84116-0011	PIN, SPIROL (3/64 DIA. x 3 [16)
32	82814-0007	SCREW, MACH, #4-40 x ½, BIND. HD, SL.
33	82814-0003	SCREW, MACH, #4-40 x ¼, BIND. HD, SL.
34	82826-0003	SCREW, MACH, #3-48 x ¼, RD. HD, SL.
35	82889-0002	SETSCREW, SOCKET, #4-40 x ⅛
36	82814-0008	SCREW, MACH, #4-40 x ⅝, BIND, HD, SL.
36A	82826-0007	SCREW, MACH, #3-48 x ½ RD. HD. SL
36B	82819-0003	SCREW, MACH, #4-40 x ¼, FH, SL
37	82802-0003	LOCKWASHER, INTERNAL TOOTH, #4
38	81324-0003	LOCKWASHER, SPLIT, #3
39	81329-0214	WASHER, FLAT, #3
40	81312-0008	WASHER, SPRING (DRUMS)
41	81312-0011	WASHER, SPRING (IDLER)
41A	82801-0001	LOCKWASHER, EXTERNAL TOOTH, #4
42	82900-0004	NUT, HEX, #4-40, ¼
42A	81307-0060	WASHER, FLAT
43	84082-0001	RIVET, SEMI-TUBULAR
44	REF	COLLAR



B-57686-A

FIGURE 3.5-4 LOCALIZER BOARD

Fig. & Index No.	Part Number	Description
3.5-4	01156-0106	LOCALIZER BOARD ASSY NAV 110 TSO (See Fig. 3.5-1 for NHA)
	82814-0003	SCREW, MACH, #4-40 x 1/4, BND. HD, SL.
	82922-0001	NUT, HEX
C402	23094-0177	CAPACITOR, MYLAR, METALIZED, .15 mf ±10%, 200V
C403	23094-0177	CAPACITOR, MYLAR, METALIZED, .15 mf ±10%, 200V
C404	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C405	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C406	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C407	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C409	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C410	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C411	23094-0171	CAPACITOR, MYLAR, METALIZED, .047 mf ±10%, 200V
C412	21555-0028	CAPACITOR, TANTALUM, 15 mf ±10%, 20V
C415	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C416	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C419	21555-0018	CAPACITOR, TANTALUM, 22 ±10%, 15V
C420	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C422	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C423	23094-0163	CAPACITOR, MYLAR, METALIZED, 0.01 mf ±10%, 200V
CR406	75027-0004	DIODE, ZENER, 5.6V
CR407	75028-0001	DIODE, SILICON
CR408	75028-0001	DIODE, SILICON
CR411	75028-0001	DIODE, SILICON
CR412	75204-0045	RECTIFIER, SILICON, LEAD MTG
CR414	75204-0045	RECTIFIER, SILICON, LEAD MTG
Q401	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q402	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q403	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q404	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q405	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q406	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q407	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q408	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q409	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q410	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q411	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q412	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q413	75565-0006	TRANSISTOR, SILICON, PNP, 2N5356
Q414	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q415	75565-0006	TRANSISTOR, SILICON, PNP, 2N5356
Q416	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q420	75576-0001	TRANSISTOR, SILICON, NPN
Q421	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q422	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q423	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q424	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q425	75595-0003	TRANSISTOR, SILICON, NPN 2N5172

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
3.5-4	Continued	
R401	31192-0473	RESISTOR, CARBON COMP., 47K ±10%, ¼W
R402	31192-0473	RESISTOR, CARBON COMP., 47K ±10%, ¼W
R406	31199-0278	RESISTOR, METAL FILM, 6.34K ±1%, ¼W
R407	31199-0230	RESISTOR, METAL FILM, 2.0K ±1%, ¼W
R408	31199-0226	RESISTOR, METAL FILM, 1.82K ±1%, ¼W
R409	31199-0278	RESISTOR, METAL FILM, 6.34K ±1%, ¼W
R410	31199-0385	RESISTOR, METAL FILM, 75K ±1%, ¼W
R411	31192-SEL	RESISTOR, CARBON SEL., ±10%, ¼W
R412	31199-0381	RESISTOR, METAL FILM, 68.1K ±1%, ¼W
R413	31192-SEL	RESISTOR, CARBON SEL., ±10%, ¼W
R414	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R415	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R416	31192-SEL	RESISTOR, CARBON SEL., ±10%, ¼W
R421	31199-0226	RESISTOR, METAL FILM, 1.82K ±1%, ¼W
R421	31199-0221	RESISTOR, METAL FILM, 1.62K ±1%, ¼W
R422	31199-0221	RESISTOR, METAL FILM, 1.62K ±1%, ¼W
R423	SEE LIST 3.5-1	
R424	31192-0182	RESISTOR, CARBON, 1.8K ±10%, ¼W
R425	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R426	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R427	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R428	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R429	31192-0181	RESISTOR, CARBON, 180 ±10%, ¼W
R430	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R431	31192-0182	RESISTOR, CARBON, 1.8K ±10%, ¼W
R432	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R433	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R434	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R435	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R436	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R437	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R438	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R438	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R439	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R442	31192-0153	RESISTOR, CARBON, 15K ±10%, ¼W
R447	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R448	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R449	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R450	32054-0001	RESISTOR, VARIABLE, 470
R451	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R452	31192-0682	RESISTOR, CARBON, 6.8K ±10%, ¼W
R453	31192-0562	RESISTOR, CARBON, 5.6K ±10%, ¼W
R454	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R455	31192-0473	RESISTOR, CARBON, 47K ±10%, ¼W
R456	31192-0333	RESISTOR, CARBON, 33K ±10%, ¼W
R457	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R461	31196-0003	RESISTOR, WIREWOUND, 27 2W
R462	SEE LIST 3.5-1	
R463	SEE LIST 3.5-1	
R464	31192-0683	RESISTOR, CARBON, 68K ±10%, ¼W
R465	32054-0011	RESISTOR, VARIABLE, 100K
R466	31195-0332	RESISTOR, CARBON, 3.3K ±5%, ¼W
R467	31195-0332	RESISTOR, CARBON, 3.3K ±5%, ¼W
R468	31195-0153	RESISTOR, CARBON, 15K ±5%, ¼W
R469	31195-0153	RESISTOR, CARBON, 15K ±5%, ¼W
R470	32054-0021	RESISTOR, VARIABLE, 22K
R472	SEE LIST 3.5-1	
R473	32054-0001	RESISTOR, VARIABLE, 470

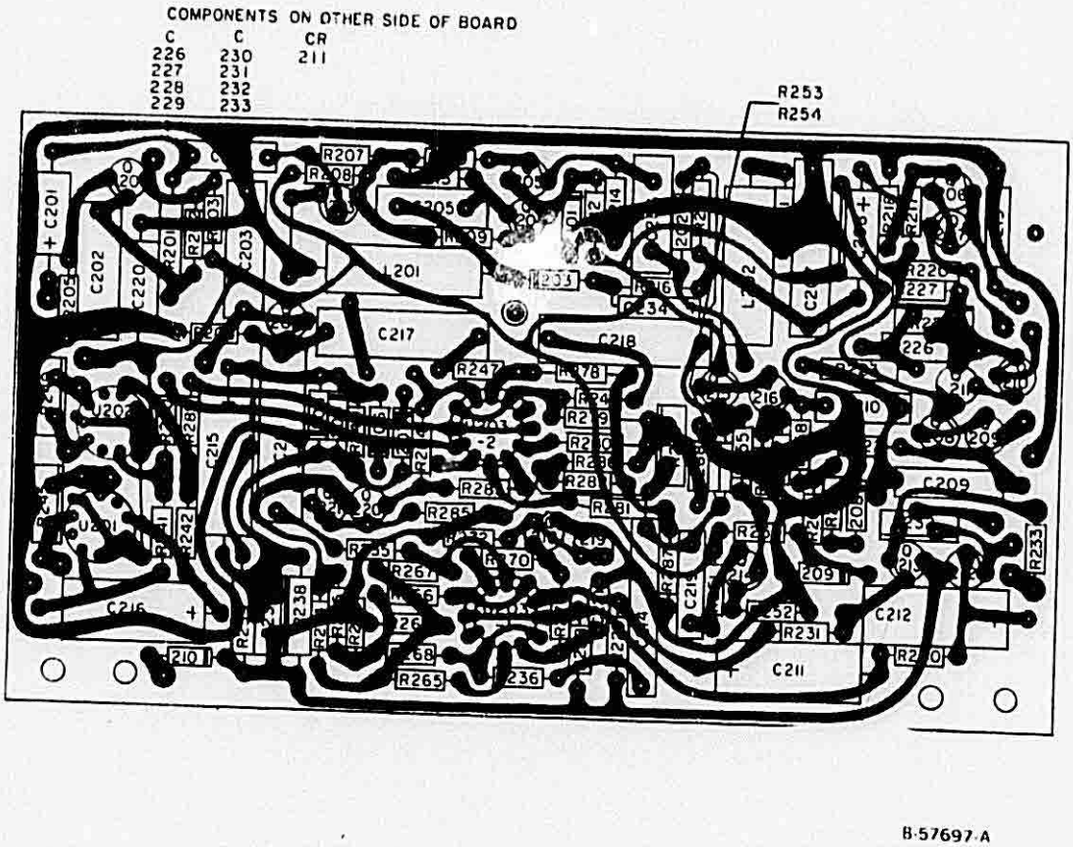


FIGURE 3.5-5 OMNI BOARD

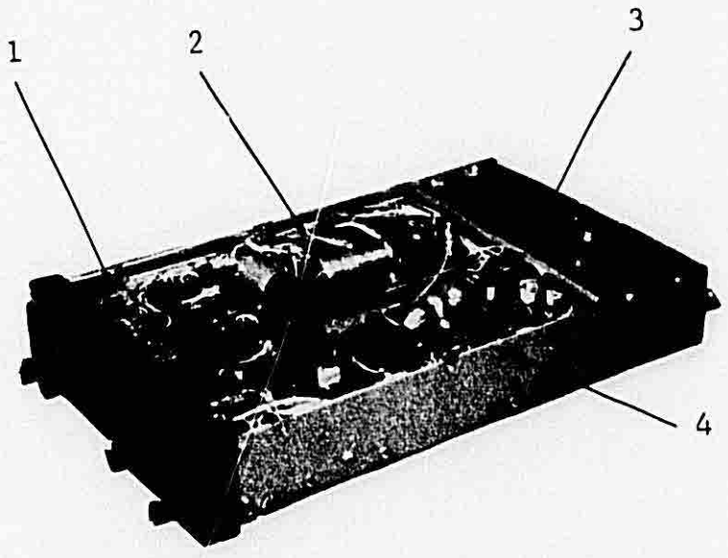
SEE BLOW-UP

Fig. & Index No.	Part Number	Description
3.5-5	01157-0102	OMNI BOARD ASSEMBLY (See Fig. 3.5-1 for NHA)
C-201	21555-0018	CAPACITOR, TANTALUM, 22mf ±10%, 15V
C-202	23094-0179	CAPACITOR, MYLAR, METALIZED, .22mf ±10%, 200V
C-203	23094-0179	CAPACITOR, MYLAR, METALIZED, .22mf ±10%, 200V
C-204	23094-0155	CAPACITOR, MYLAR, METALIZED, .0022mf ±10%, 200V
C-205	24045-SEL	CAPACITOR, DIPPED MICA, SEL. ±5%, 300V
C-206	24045-SEL	CAPACITOR, DIPPED MICA, SEL, ±5%, 300V
C-207	23094-0179	CAPACITOR, MYLAR, METALIZED, .22 mf ±10%, 200V
C-208	21555-0018	CAPACITOR, TANTALUM, 22mf ±10%, 15V
C-209	23100-0007	CAPACITOR, POLYCARBONATE, METALIZED, .1 ±10%, 100V
C-210	23094-0169	CAPACITOR, MYLAR, METALIZED, .033mf ±10%, 200V
C-211	21554-0048	CAPACITOR, ELECTROLYTIC, 3.0 mf, 3V N.P.
C-212	21554-0049	CAPACITOR, ELECTROLYTIC, 5.0 mf, 3V N.P.
C-213	23094-0181	CAPACITOR, MYLAR, METALIZED, .33mf ±10%, 200V
C-214	23094-0181	CAPACITOR, MYLAR, METALIZED, .33mf ±10%, 200V
C-215	21554-0048	CAPACITOR, ELECTROLYTIC, 3.0 mf, 3V N.P.
C-216	21554-0050	CAPACITOR, ELECTROLYTIC, 20 mf, 3V N.P.
C-217	23094-0083	CAPACITOR, MYLAR, METALIZED, .47mf ±10%, 200V
C-218	23094-0083	CAPACITOR, MYLAR, METALIZED, .47mf ±10%, 200V
C-219	23094-0175	CAPACITOR, MYLAR, METALIZED, .1mf ±10%, 200V
C-220	21555-0018	CAPACITOR, TANTALUM, 22mf ±10%, 15V
C-221	21291-0025	CAPACITOR, CERAMIC, 430pf ±10%, 500V
C-223	See List 3.5-1	
C-224	See List 3.5-1	
C-225	See List 3.5-1	
C-226	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V
C-227	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V
C-228	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V
C-229	21291-0025	CAPACITOR, CERAMIC, 430pf ±10%, 500V
C-230	21291-0025	CAPACITOR, CERAMIC, 430pf ±10%, 500V
C-231	21291-0025	CAPACITOR, CERAMIC, 430pf ±10%, 500V
C-232	21291-0025	CAPACITOR, CERAMIC, 430pf ±10%, 500V
C-233	21291-0025	CAPACITOR, CERAMIC, 430pf ±10%, 500V
C-234	21555-0058	CAPACITOR, TANTALUM, 6.8mf ±10%, 35V
CR-201	75027-0009	DIODE, ZENER, 6.8V
CR-202	75028-0001	DIODE, SILICON
CR-203	75028-0001	DIODE, SILICON
CR-204	75028-0001	DIODE, SILICON
CR-205	75028-0001	DIODE, SILICON
CR-206	75028-0003	DIODE, SILICON
CR-207	75028-0003	DIODE, SILICON
CR-208	75028-0001	DIODE, SILICON
CR-209	75027-0004	DIODE, ZENER, 5.6V
CR-210	75028-0001	DIODE, SILICON
CR-211	75027-0004	DIODE, ZENER, 5.6V
L-201	11360-0016	CHOKE, 150mh ±10%
L-202	11360-0016	CHOKE, 150mh ±10%
Q-201	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-202	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-203	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-204	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-205	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-206	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-207	75565-0006	TRANSISTOR, SILICON, PNP, 2N5350
Q-208	75565-0006	TRANSISTOR, SILICON, PNP, 2N5356
Q-209	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-210	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-211	75565-0006	TRANSISTOR, SILICON, PNP, 2N5356
Q-212	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-213	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-214	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-215	75565-0006	TRANSISTOR, SILICON, PNP, 2N5356
Q-216	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-218	75557-0003	TRANSISTOR, SILICON, NPN, 2N706
Q-219	75557-0003	TRANSISTOR, SILICON, NPN, 2N706
Q-220	75557-0003	TRANSISTOR, SILICON, NPN, 2N706
Q-221	75557-0003	TRANSISTOR, SILICON, NPN, 2N706
R-201	31199-0278	RESISTOR, METAL FILM, 6.34K ±1%, ¼W
R-202	31192-0684	RESISTOR, CARBON COMP., 680K ±10%, ¼W
R-203	31192-0682	RESISTOR, CARBON COMP., 6.8K ±10%, ¼W
R-204	See List 3.5-1	
R-205	31192-0152	RESISTOR, CARBON COMP., 1.5K ±10%, ¼W
R-206	31192-0472	RESISTOR, CARBON COMP., 4.7K ±10%, ¼W
R-207	31192-0684	RESISTOR, CARBON COMP., 680K ±10%, ¼W
R-208	31192-0682	RESISTOR, CARBON COMP., 6.8K ±10%, ¼W
R-209	31192-0123	RESISTOR, CARBON COMP., 12K ±10%, ¼W
R-210	31192-0123	RESISTOR, CARBON COMP., 12K ±10%, ¼W

Fig. & Index No.	Part Number	Description
R-211	31192-0561	RESISTOR, CARBON COMP., 560 ±10%, ¼W
R-212	31192-0151	RESISTOR, CARBON COMP., 150 ±10%, ¼W
R-213	31192-0821	RESISTOR, CARBON COMP., 820 ±10%, ¼W
R214	31192-0821	RESISTOR, CARBON COMP., 820 ±10%, ¼W
R-215	31192-0563	RESISTOR, CARBON COMP., 56K ±10%, ¼W
R-216	31192-0563	RESISTOR, CARBON COMP., 56K ±10%, ¼W
R-217	31192-0683	RESISTOR, CARBON COMP., 68K ±10%, ¼W
R-218	31192-0393	RESISTOR, CARBON COMP., 39K ±10%, ¼W
R-219	31199-0221	RESISTOR, METAL FILM, 1.62K ±1%, ¼W
R-220	31199-0221	RESISTOR, METAL FILM, 1.62K ±1%, ¼W
R-222	31192-0222	RESISTOR, CARBON COMP., 2.2K ±10%, ¼W
R-223	31199-0366	RESISTOR, METAL FILM, 47.5K ±1%, ¼W
R-225	32054-0021	RESISTOR, CARBON, VARIABLE, 22K ±20%
R-226	31199-0301	RESISTOR, METAL FILM, 10K ±1%, ¼W
R-227	31192-0222	RESISTOR, CARBON COMP., 2.2K ±10%, ¼W
R-228	31199-0259	RESISTOR, METAL FILM, 4.02K ±1%, ¼W
R-229	31199-0259	RESISTOR, METAL FILM, 4.02K ±1%, ¼W
R-230	31192-0473	RESISTOR, CARBON COMP., 47K ±10%, ¼W
R-231	31192-0473	RESISTOR, CARBON COMP., 47K ±10%, ¼W
R-232	32054-0007	RESISTOR, VARIABLE, 10K ±10%
R-233	31192-SEL	RESISTOR, CARBON COMP., SEL. ±10%, ¼W
R-234	SEE LIST 3.5-1	
R-235	31192-0103	RESISTOR, CARBON COMP., 10K ±10%, ¼W
R-236	31192-0103	RESISTOR, CARBON COMP., 10K ±10%, ¼W
R-237	32054-0011	RESISTOR, CARBON, VARIABLE, 100K ±20%
R-238	31199-0261	RESISTOR, METAL FILM, 4.22K ±1%, ¼W
R-239	31199-0259	RESISTOR, METAL FILM, 4.02K ±1%, ¼W
R-240	31192-SEL	RESISTOR, CARBON COMP. SEL. ±10%, ¼W
R-241	31192-0153	RESISTOR, CARBON COMP., 15K ±10%, ¼W
R-242	31192-0153	RESISTOR, CARBON COMP., 15K ±10%, ¼W
R-245	32054-0003	RESISTOR, VARIABLE, 4.7K ±10%
R-247	31192-0822	RESISTOR, CARBON COMP., 8.2K ±10%, ¼W
R-248	31192-0103	RESISTOR, CARBON COMP., 10K ±10%, ¼W
R-249	32054-0003	RESISTOR, VARIABLE, 4.7K ±10%
R-251	31192-0822	RESISTOR, CARBON COMP., 8.2K ±10%, ¼W
R-252	31192-0392	RESISTOR, CARBON COMP., 3.9K ±10%, ¼W
R-253	31192-SEL	RESISTOR, CARBON COMP., SEL. ±10%, ¼W
R-254	31192-0683	RESISTOR, CARBON COMP., 68K ±10%, ¼W
R-255	31192-0332	RESISTOR, CARBON COMP., 3.3K ±10%, ¼W
R-256	31192-0332	RESISTOR, CARBON COMP., 3.3K ±10%, ¼W
R-257	31192-0222	RESISTOR, CARBON COMP., 2.2K ±10%, ¼W
R-258	31192-0684	RESISTOR, CARBON COMP., 680 ±10%, ¼W
R-259	31192-0332	RESISTOR, CARBON COMP., 3.3K ±10%, ¼W
R-260	31192-0472	RESISTOR, CARBON COMP., 4.7K ±10%, ¼W
R-261	31192-0102	RESISTOR, CARBON COMP., 1K ±10%, ¼W
R-263	See List 3.5-1	
R-264	See List 3.5-1	
R-265	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-266	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-267	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-268	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-269	31192-0103	RESISTOR, CARBON COMP., 10K ±10%, ¼W
R-270	31192-0680	RESISTOR, CARBON COMP., 68 ±10%, ¼W
R-271	31192-0680	RESISTOR, CARBON COMP., 68 ±10%, ¼W
R-272	31192-0103	RESISTOR, CARBON COMP., 10K ±10%, ¼W
R-273	31192-0472	RESISTOR, CARBON COMP., 4.7K ±10%, ¼W
R-274	31192-0392	RESISTOR, CARBON COMP., 3.9K ±10%, ¼W
R-275	31192-0472	RESISTOR, CARBON COMP., 4.7K ±10%, ¼W
R-277	32054-0007	RESISTOR, CARBON, VARIABLE, 10K ±20%
R-278	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-279	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-280	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-281	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-282	31192-0103	RESISTOR, CARBON COMP., 10K ±10%, ¼W
R-283	31192-0680	RESISTOR, CARBON COMP., 68 ±10%, ¼W
R-284	31192-0680	RESISTOR, CARBON COMP., 68 ±10%, ¼W
R-285	31192-SEL	RESISTOR, CARBON COMP., SEL ±10%, ¼W
R-286	31192-0472	RESISTOR, CARBON COMP., 4.7K ±10%, ¼W
R-287	31192-0392	RESISTOR, CARBON COMP., 3.9K ±10%, ¼W
R-288	31192-0472	RESISTOR, CARBON COMP., 4.7K ±10%, ¼W
R-289	31192-0102	RESISTOR, CARBON COMP., 1K ±10%, ¼W
R-290	31192-0102	RESISTOR, CARBON COMP., 1K ±10%, ¼W
U-201	74013-0001	INTEGRATED CIRCUIT, CA3036
U-202	74013-0001	INTEGRATED CIRCUIT, CA3036
U-203-1	74012-0003	INTEGRATED CIRCUIT CA3026
U-203-2	74012-0002	INTEGRATED CIRCUIT CA3026

3.5.2 COM 110 REPLACEMENT PARTS LIST

To provide a cross-reference relationship of subassemblies to their Next Higher Assembly, the notation "See Fig. . . . . for Breakdown" follows the entry of a subassembly that is too large to be included within this list and that a separate list is provided. The subsequent list which breaks down the subassembly will refer back with the notation. "See Fig. . . . . for NHA," to that list which first noted the subassembly.



1 FRONT PANEL ASSY
2 INTERCONNECT PC BOARD
3 TRANSMITTER / MODULATOR
4 RECEIVER PC BOARD
5 RECEIVER FILTER
Part of Item 4
6 VOLTAGE CONTROLLED OSC. & ISO AMP
Part of Item 7
7 FREQUENCY SYNTHEIZER
8 TRAY MOUNTING LOCK
Part of Item 1

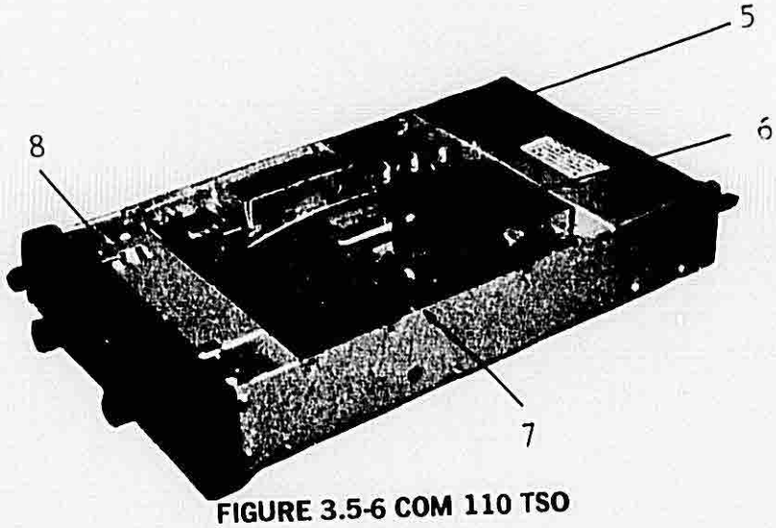


FIGURE 3.5-6 COM 110 TSO

Fig. & Index No.	Part Number	Description
3.5-6	01180-0101	COM 110 TSO
	55941-0001	PANEL, TRIM
	55942-0001	LENS
	88209-0001	KNOB, MHz-KHz
	88208-0001	KNOB, ON-OFF, SQUELCH - IDENT.
	55967-0001	SLIDER
	04486-0001	LABEL, TRIM PANEL
	04488-0001	INSERT, KNOB
	04488-0002	INSERT, KNOB
	04487-0001	INSERT, TRIM PANEL
	61528-0003	SWITCH SLIDER (DP DT) S-101
	55833-0102	CHASSIS MAIN SPOTWELD ASSEMBLY
	55947-0001	COVER, TOP
	55948-0001	COVER, BOTTOM
	01154-0101	FRONT PANEL ASSEMBLY, COM 110 TSO (See Fig. 3.5-7 for breakdown)
	01146-0101	SYNTHESIZER BOARD, COM 110 TSO (See Fig. 3.5-8 for breakdown)
	01148-0103	INTERCONNECTING BOARD, COM 110 TSO (See Fig. 3.5-9 for breakdown)
	01149-0103	TRANSMITTER, COM 110 TSO (See Fig. 3.5-10 for breakdown)
	01147-0101	RECEIVER BOARD (See Fig. 3.5-11 for breakdown)
	41130-0004	PLUG, PHONO (MALE)
	04284-0001	LABEL, MIKE ADJUST
	04069-0001	LABEL, FCC CERTIFICATION
	91016-0050	TUBING, FIBERGLASS BASE, COATED
	82819-0103	SCREW MACH., #4-40 x 1/4 LG. FLAT HD. SLOTTED
	82958-0002	SCREW MACH., #4-40 x 3/16 LG. PAN HD. SL., TAPTITE
	82962-0002	SCREW MACH., #4-40 x 3/16 LG. PAN HD. SL.
	82960-0003	THD. CUTTING #4-40 x 1/4 LG. PAN HD. SL. (SEMS)
	82960-0002	THD. CUTTING #4-40 x 3/16 LG. PAN HD. SL. (SEMS)
	82963-0001	SCREW MACH., #2-56 x 1/8 LG. PAN HD. SL. (SEMS)
	82889-0002	SETSCREW, HEX SOCKET, #4-40 x 1/8 LG.
	81290-0003	NUT, "U"
	81747-0012	FILTER, COLORED, (LIGHT BLUE)
	12000-0015	LAMP, INCANDESCENT, #336
	82814-0003	SCREW MACHINE, #4-40 x 1/4 LG. BND. HD. SL
	81701-0004	LUG SOLDER
	91018-0055	TUBING, PLASTIC EXTRUDED
	81709-0001	LUG, SOLDER
	11454-0005	FERRITE BEAD
	04396-0001	NAMEPLATE, PATENT NOTICE
	99057-0002	GASKET, FOAM
	83017-0003	INSULATOR
	04432-0001	LABEL WARNING
	82922-0001	NUT, HEX, #4-40
	55980-0101	TRAY ASSY
	81702-0004	LUG, SOLDER
	81423-0002	STANDOFF
C640	21555-0026	CAPACITOR, TANTALUM, 10 mf ±10%, 20V
C501	21554-0054	CAPACITOR, ELECTROLYTIC, 2200mf, 15V
L501	11527-0002	CHOKE, HASH
	81312-0019	WASHER, SPRING
	82888-0009	SCREW, MACH, #4-40 x 3/4, RH HD, SL (NYLON)
	04485-0001	LABEL, NAMEPLATE

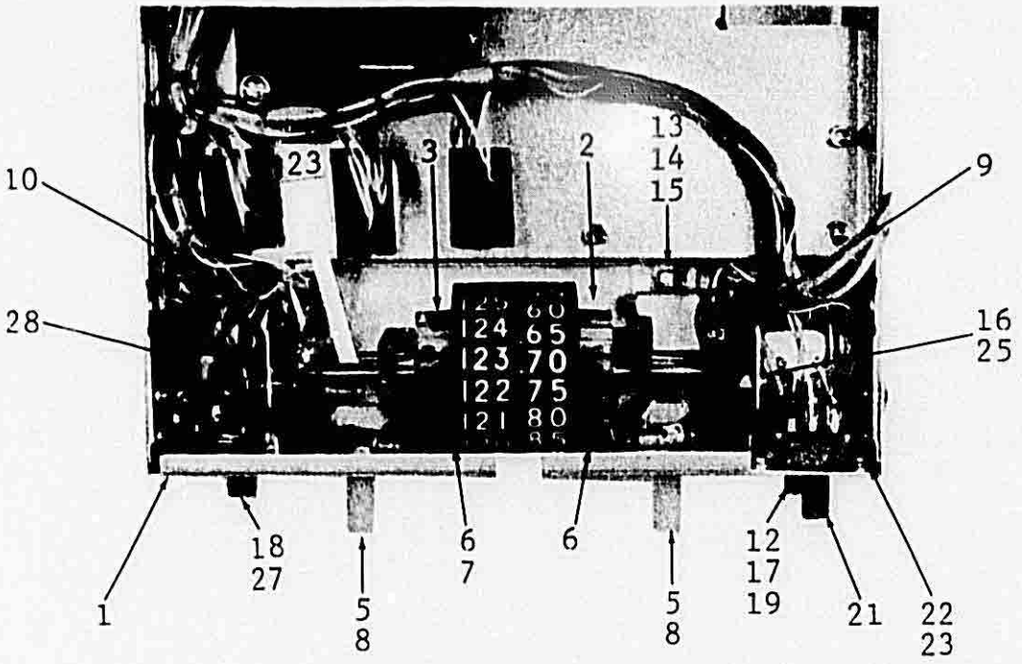
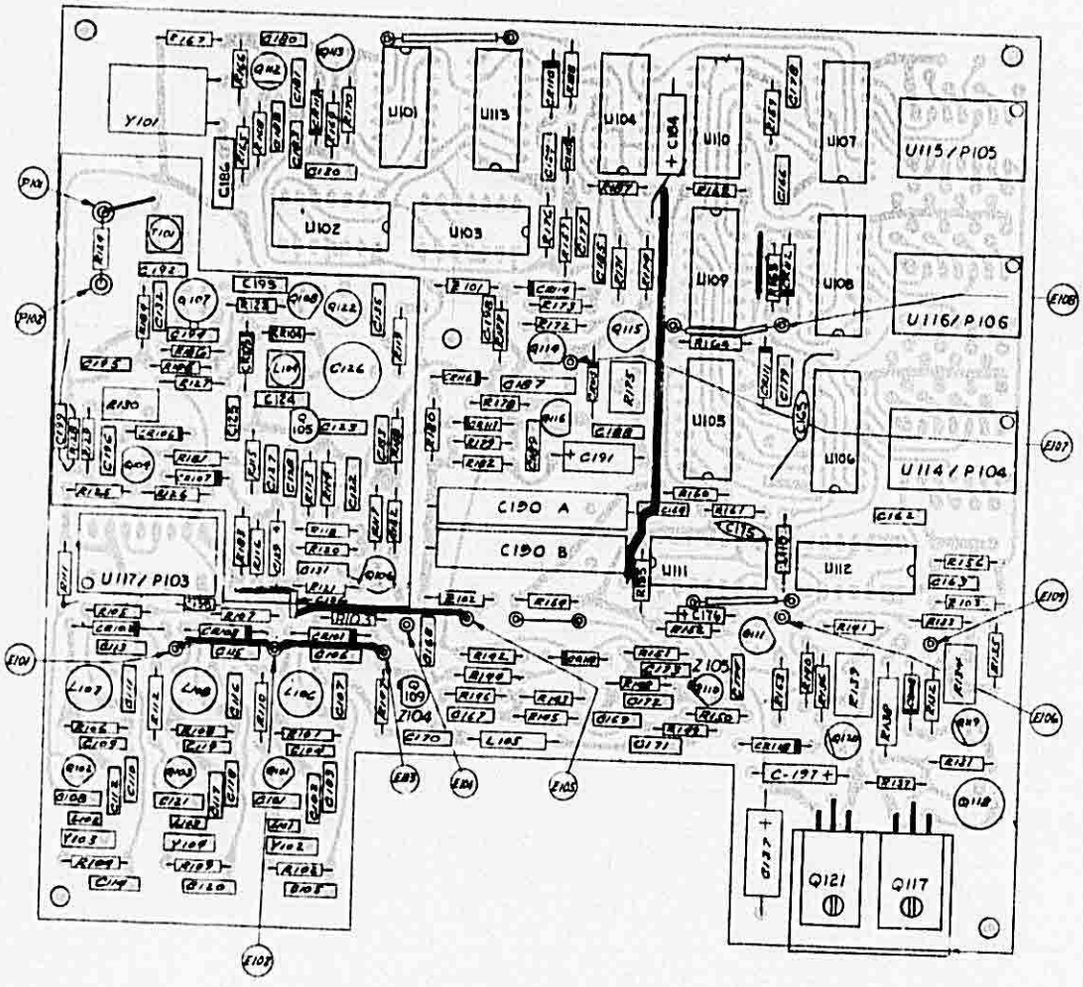


FIGURE 3.5-7 FRONT PANEL ASSY

Fig. & Index No.		Part Number	Description
3.5-7		01154-0101	FRONT PANEL ASSY (See Fig. 3.5-6 for NHA)
1		55998-0101	CHASSIS FRONT SPOTWELD ASSEMBLY
2		55957-0001	DRUM, KHz, 20 POS
3		55958-0001	DRUM, MHz, 18 POS
4		55959-0001	SHAFT, DRUM
5		55940-0001	SHAFT & GEAR DRIVE
6		55945-0001	SPRING DETENT
7		55982-0001	BAR, LOCK DETENTS
8		55926-0001	BEARING, SWAGED
9	S-102	61537-0001	SWITCH COM. KHZ
10	S-103	61538-0001	SWITCH COM. MH7
11		NOT USED	
12		55871-0001	SHAFT, IDENT. SQUELCH
13		54978-0004	SCREW, LOCKING HEX
14		54949-0001	CAM, LOCK
15		82920-0013	NUT, LOCKING REDUCED HEX
16		55836-0001	SPACER, HEX THREADED
17		84116-0003	PIN, SPIROL, MINIATURE
18	R642	32059-0003	RESISTOR VARIABLE, 1K (W/DPST SWITCH)
19	R647	32055-0008	RESISTOR VARIABLE, 5K
20		NOT USED	
21		61528-0003	SWITCH SLIDER, (SPDT)
22		81352-0001	NUT, FLUSH, SELF-CLINCHING, #2-56
23		82867-0001	SCREW, MACH, #2-56 x 1/8, HEX HD
24		82963-0002	SCREW, MACH, #2-56 x 3/16, PAN HD, SL (NOT SHOWN)
25		82962-0001	SCREW, MACH, #4-40 x 1/8, PAN HD, SL.
26		82904-0001	NUT, SELF-CLINCHING, #2-56 (NOT SHOWN)
27		82802-0057	LOCKWASHER, INT. TOOTH
28	C651	21291-0005	CAPACITOR, CER DISC, .10 uf 50V
29		NOT USED	
		81312-0019	WASHER, SPRING (Not shown)
		81307-0060	WASHER, FLAT, SPECIAL (Not shown)

Note: Cable switches, lamps and IC Sockets part of cabling assy.



D-55949-Rev. K
D-55963-F

FIGURE 3.5-8 SYNTHESIZER BOARD, COM 110 TSO

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
3.5-8	01146-0101	SYNTHESIZER BOARD, COM 110 TSO (See Fig. 3.5-6 for NHA)
	55950-0001	HEATSINK
	55956-0001	SHIELD, VCO
	55961-0001	COVER, VCO
	55874-0001	SPRING, FINGER
	74903-0001	I. C. SOCKET LOCATER, 14 PIN
	74903-0002	I. C. SOCKET LOCATER, 16 PIN
	82814-0004	SCREW, MACH, #4-40 x 5/16, BND. HD, SLOTTED
	82922-0001	NUT, HEX, #4-40
	81335-0015	INSULATOR, SHOULDER
	55850-0001	CAN, SHIELD
	55864-0001	CAN, SHIELD
	52726-0001	TRANSPAD
	99065-0004	TAPE, DOUBLE SIDED
C-101	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-102	24516-0569	CAPACITOR, CERAMIC DISC, 5.6 pf, 500V, NPO
C-103	24516-0180	CAPACITOR, CERAMIC DISC, 18 pf ±10%, 500V, NPO
C-104	24516-0569	CAPACITOR, CERAMIC DISC, 5.6 pf, 500V, NPO
C-105	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-106	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-107	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-108	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-109	24516-0569	CAPACITOR, CERAMIC DISC, 5.6 pf, 500V, NPO
C-110	24516-0180	CAPACITOR, CERAMIC DISC, 18 pf ±10%, 500V, NPO
C-111	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-112	24516-0569	CAPACITOR, CERAMIC DISC, 5.6 pf, 500V, NPO
C-113	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-114	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-115	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-116	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-117	24516-0479	CAPACITOR, CERAMIC DISC, 4.7 pf, 500V, NPO
C-118	24516-0180	CAPACITOR, CERAMIC DISC, 18 pf ±10%, 500V, NPO
C-119	24516-0229	CAPACITOR, CERAMIC DISC, 2.2 pf, 500V, NPO
C-120	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-121	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-122	21291-0005	CAPACITOR, CERAMIC DISC, .01 mf ±20%, 50V
C-123	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-124	24516-0479	CAPACITOR, CERAMIC DISC, 4.7 pf, 500V, NPO
C-125	24052-0150	CAPACITOR, DIPPED MICA, 15 pf ±10%, 500V, NPO
C-126	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-127	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-128	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-129	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C-130	24052-SEL.	CAPACITOR, DIPPED MICA, SEL.
C-131	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-132	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-133	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-134	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-135	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-136	21296-0003	CAPACITOR, CERAMIC FEED-THRU, .001 mf, 500V
C-137	21555-0012	CAPACITOR, TANTALUM, 82 mf ±10%, 10V
C-138	21291-0025	CAPACITOR, CERAMIC DISC, 430pf ±10%, 500V
C-162	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-163	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-164	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-165	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-166	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-167	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-168	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-169	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-170	24516-0180	CAPACITOR, CERAMIC DISC, 18 pf ±10%, 500V
C-171	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-172	24516-0100	CAPACITOR, CERAMIC DISC, 10 pf ±10%, 500V
C-173	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V

Fig. & Index No.	Part Number	Description
C-174	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-175	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-176	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C-177	21291-0005	CAPACITOR, CERAMIC DISC, .01 mf ±20%, 50V
C-178	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-179	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-180	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-181	24049-0471	CAPACITOR, DIPPED MICA, 470 pf ±5%, 500V
C-182	24049-0251	CAPACITOR, DIPPED MICA, 250 pf ±5%, 500V
C-183	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-184	21555-0003	CAPACITOR, TANTALUM, 47 mf ±10%, 6V
C-185	24049-0331	CAPACITOR, DIPPED MICA, 330 pf ±5%, 500V
C-186	24052-SEL	CAPACITOR, DIPPED MICA, SEL ±5%, 500V
C-187	23094-0155	CAPACITOR, MYLAR, .0022 mf ±10%, 200V
C-188	23094-0155	CAPACITOR, MYLAR, .0022 mf ±10%, 200V
C-189	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-190	23094-0187	CAPACITOR, CERAMIC DISC, 1.0 mf ±20%, 10V, Qty 2
C-191	21555-0026	CAPACITOR, TANTALUM, 10 mf ±10%, 20V
C-192	24516-0100	CAPACITOR, CERAMIC DISC, 10 pf ±10%, 500V
C-193	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-194	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-195	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-196	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-197	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C-198	24515-0005	CAPACITOR, CERAMIC DISC, .05 ±20%, 10V
C-199	21555-0003	CAPACITOR, TANTALUM, 47 mf ±10%, 6V
CR-101	75038-0002	DIODE, RF SWITCH
CR-102	75038-0002	DIODE, RF SWITCH
CR-103	75038-0002	DIODE, RF SWITCH
CR-104	75037-0002	DIODE, VARACTOR
CR-105	75037-0002	DIODE, VARACTOR
CR-106	75019-0004	DIODE, SILICON
CR-107	75019-0004	DIODE, SILICON
CR-108	75027-0010	DIODE, ZENER, ±5%, 2.6V, 1N702A
CR-109	75019-0004	DIODE, SILICON
CR-110	75019-0004	DIODE, SILICON
CR-111	75019-0004	DIODE, SILICON
CR-112	75019-0004	DIODE, SILICON
CR-113	75019-0004	DIODE, SILICON
CR-114	75019-0004	DIODE, SILICON
CR-115	75019-0004	DIODE, SILICON
CR-116	75019-0004	DIODE, SILICON
CR-117	75019-0004	DIODE, SILICON
CR-118	75027-0004	DIODE, ZENER, ±5%, 5.6V, 1N75[illegible]
CR-119	75036-0001	DIODE, SILICON
L-101	11713-0013	COIL, P.S., BLACK
L-102	11713-0013	COIL, P.S., BLACK
L-103	11713-0013	COIL, P.S., BLACK
L-104	11756-0001	COIL, VCO
L-105	11451-0011	CHOKE, RF, 2.2 uh
L-106	11752-0001	COIL, CRYSTAL OSCILLATOR
L-107	11752-0001	COIL, CRYSTAL OSCILLATOR
L-108	11752-0001	COIL, CRYSTAL OSCILLATOR
L-110	11485-0020	COIL, R.F., 3.9 uh
Q-101	75802-0001	TRANSISTOR, NPN
Q-102	75802-0001	TRANSISTOR, NPN
Q-103	75802-0001	TRANSISTOR, NPN
Q-104	75802-0002	TRANSISTOR, NPN
Q-105	75802-0003	TRANSISTOR, PNP
Q-106	75802-0004	TRANSISTOR, NPN
Q-107	75802-0005	TRANSISTOR, NPN
Q-108	75802-0006	TRANSISTOR, NPN
Q-109	75802-0007	TRANSISTOR, NPN
Q-110	75802-0008	TRANSISTOR, NPN
Q-111	75802-0009	TRANSISTOR, PNP
Q-112	75802-0010	TRANSISTOR, NPN
Q-113	75802-0011	TRANSISTOR, NPN
Q-114	75802-0012	TRANSISTOR, PNP
Q-115	75802-0013	TRANSISTOR, NPN
Q-116	75802-0014	TRANSISTOR, PNP
Q-117	75802-0015	TRANSISTOR, NPN
Q-118	75802-0016	TRANSISTOR, NPN
Q-119	75802-0017	TRANSISTOR, NPN
Q-120	75802-0018	TRANSISTOR, NPN
Q-121	75802-0019	TRANSISTOR, NPN
Q-122	75802-0020	TRANSISTOR, NPN

Fig. & Index No.	Part Number	Description
R-101	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
R-102	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W
R-103	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-104	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W
R-105	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-106	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
R-107	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-108	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
R-109	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W
R-110	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-111	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-112	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-113	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-114	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-115	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-116	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-117	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-118	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-119	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-120	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-121	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-122	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-123	31192-0470	RESISTOR, CARBON, 47 ±10%, ¼W
R-124	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-125	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-126	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-127	31192-0473	RESISTOR, CARBON, 47K ±10%, ¼W
R-128	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-129	31192-0821	RESISTOR, CARBON, 820 ±10%, ¼W
R-130	32054-0001	RESISTOR, VARIABLE, 470
R-131	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-132	31192-0820	RESISTOR, CARBON, 82 ±10%, ¼W
R-133	31192-0181	RESISTOR, CARBON, 180 ±10%, ¼W
R-134	32054-0013	RESISTOR, VARIABLE, 220
R-135	31192-0821	RESISTOR, CARBON, 820 ±10%, ¼W
R-136	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R-137	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
R-138	31141-0109	RESISTOR, CARBON, 1.0 ±10%, ½W
R-139	32054-0001	RESISTOR, VARIABLE, 470
R-140	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W
R-141	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-142	31192-0680	RESISTOR, CARBON, 68 ±10%, ¼W
R-143	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-144	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-145	31192-0680	RESISTOR, CARBON, 68 ±10%, ¼W
R-146	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W
R-147	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-148	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-149	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-150	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-151	31192-0221	RESISTOR, CARBON, 220 ±10%, ¼W
R-152	31192-0822	RESISTOR, CARBON, 8.2K ±10%, ¼W
R-153	31192-0122	RESISTOR, CARBON, 1.2K ±10%, ¼W
R-154	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-155	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-156	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-157	31192-0333	RESISTOR, CARBON, 33K ±10%, ¼W
R-158	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-159	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-160	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-161	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-162	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-163	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-164	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-165	31192-0223	RESISTOR, CARBON, 22K ±10%, ¼W
R-166	31192-0223	RESISTOR, CARBON, 22K ±10%, ¼W
R-167	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-168	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-169	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W

Fig. & Index No.	Part Number	Description
R-170	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-171	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-172	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-173	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-174	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-175	32054-0009	RESISTOR, CARBON, VARIABLE, 1K
R-176	21192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-177	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-178	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R-179	31192-0332	RESISTOR, CARBON, 3.3K ±10%, ¼W
R-180	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-181	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-182	31192-0680	RESISTOR, CARBON, 68 ±10%, ¼W
R-183	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-184	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-185	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-186	31192-0331	RESISTOR, CARBON, 330 ±10%, ¼W
R-187	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-188	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
T-101	11757-0001	TRANSFORMER, VCO OUTPUT
U-101	75802-0021	INTEGRATED CIRCUIT, DTL, 9097
U-102	75802-0022	INTEGRATED CIRCUIT, DTL, 9097
U-103	75802-0023	INTEGRATED CIRCUIT, DTL, 9097
U-104	75802-0024	INTEGRATED CIRCUIT, TTL, 9002
U-105	75802-0025	INTEGRATED CIRCUIT, TTL, 9004
U-106	75802-0026	INTEGRATED CIRCUIT, MSI, 9300
U-107	75802-0027	INTEGRATED CIRCUIT, MSI, 9300
U-108	75802-0028	INTEGRATED CIRCUIT, MSI, 9300
U-109	75802-0029	INTEGRATED CIRCUIT, TTL, 9007
U-110	75802-0030	INTEGRATED CIRCUIT, TTL, 9007
U-111	75802-0031	INTEGRATED CIRCUIT, TTL, 9001
U-112	75802-0032	INTEGRATED CIRCUIT, TTL, 9001
U-113	75802-0033	INTEGRATED CIRCUIT, TTL, 9004
U-114	75802-0034	INTEGRATED CIRCUIT, DTL, 946
U-115	75802-0035	INTEGRATED CIRCUIT, DTL, 946
U-116	75802-0036	INTEGRATED CIRCUIT, DTL, 946
U-117	75802-0037	INTEGRATED CIRCUIT, TTL, 9002
Y-101	72032-0001	CRYSTAL, 3.20066 MHz FUND.
Y-102	72031-0002	CRYSTAL, 148.054 MHz 7th O. T.
Y-103	72031-0003	CRYSTAL, 142.027 MHz 7th O. T.
Y-104	72031-0001	CRYSTAL, 160.029 MHz 7th O. T.
P-101	41292-0001	JACK, PHONO
P-102	41292-0001	JACK, PHONO
P-103	41313-0004	SOCKET, I. C. WIRE WRAP 16 PIN
P-104	41313-0003	SOCKET, I. C. WIRE WRAP 14 PIN
P-105	41313-0003	SOCKET, I. C. WIRE WRAP 14 PIN
P-106	41313-0003	SOCKET, I. C. WIRE WRAP 14 PIN
Z-101	11454-0001	BEAD (Qty 2)
Z-102	11454-0001	BEAD (Qty 2)
Z-103	11454-0001	BEAD (Qty 2)
Z-104	11454-0001	BEAD
Z-105	11454-0001	BEAD

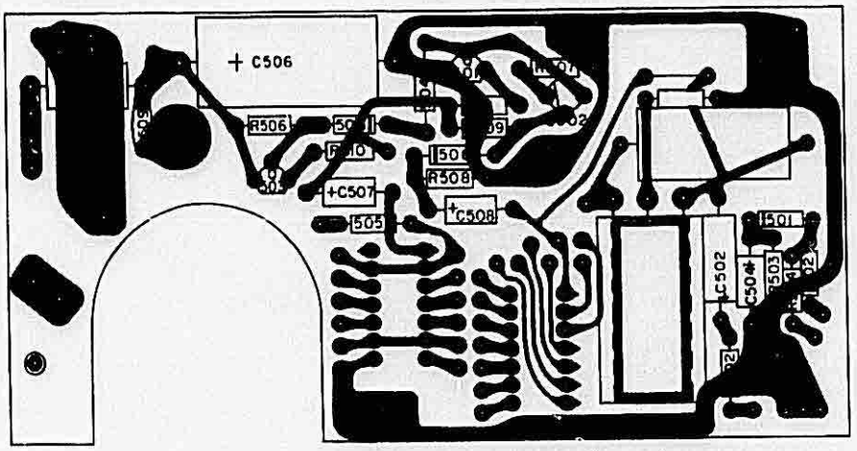


FIGURE 3.5-9 INTERCONNECT BOARD, COM 110 TSO

Fig. & Index No.	Part Number	Description
3.5-9	01148-0103	INTERCONNECT BOARD, COM 110 TSO (See Fig. 3.5-6 for NHA)
C-502	21555-0026	CAPACITOR, TANTALUM, 10 mf, 20V
C-503	23100-0013	CAPACITOR, POLY CARB., 1.0 mf
C-504	21555-0016	CAPACITOR, TANTALUM, 3.3 mf, 15V
C-505	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-506	21554-0051	CAPACITOR, ELECTROLYTIC, 250 mf, 20V
C-507	21555-0016	CAPACITOR, TANTALUM, 3.3 mf, 15V
C-508	21555-0016	CAPACITOR, TANTALUM, 3.3 uf, 15V
C-509	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
CR-501	75028-0001	DIODE, SILICON
CR-502	75028-0001	DIODE, SILICON
CR-503	75028-0001	DIODE, SILICON
CR-504	75028-0001	DIODE, SILICON
CR-505	75028-0001	DIODE, SILICON
CR-506	75028-0001	DIODE, SILICON
L-502	11488-0001	IDENT FILTER
Q-501	75558-0006	TRANSISTOR, 2N5811
Q-502	75550-0002	TRANSISTOR, 2N3391
Q-503	75558-0005	TRANSISTOR, 2N5810
R-501	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R-502	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-503	31192-0154	RESISTOR, CARBON, 150K ±10%, ¼W
R-504	31192-0333	RESISTOR, CARBON, 33K ±10%, ¼W
R-505	31196-0003	RESISTOR, WIREWOUND, 27 ±5%, 2W
R-506	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-507	31192-0470	RESISTOR, CARBON, 47 ±10%, ¼W
R-508	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R-509	31192-0822	RESISTOR, CARBON, 8.2K ±1%, ¼W
R-510	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-511	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
J-103	41322-0002	SOCKET I. C. SOLDER TAIL
J-104	41322-0001	SOCKET I. C. SOLDER TAIL
J-105	41322-0001	SOCKET I. C. SOLDER TAIL
J-106	41322-0001	SOCKET I. C. SOLDER TAIL
	41278-0008	LAMPHOLDER, SUBMINIATURE

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
3.5-10	01149-0103	TRANSMITTER, COM 110 TSO (See Fig. 3.5-6 for NHA)
	56276-0001	INSULATOR, MICA
	82803-0003	SCREW, MACH., RH, SL, #4-40 x ¼
	81324-0004	LOCKWASHER, SPLIT, #4
	81797-0001	TERMINAL, FEEDTHRU, TURRET
	81336-0002	WASHER, NYLON
	55970-0001	HEATSINK TRANSMITTER
	55973-0001	HINGE, LEFT
	55973-0002	HINGE, RIGHT
	55975-0001	INSULATOR, TRANSMITTER BOARD
	55976-0001	SHIELD, TRANSMITTER
	55977-0001	SHIELD, FILTER
	55978-0001	COVER, TRANSMITTER
	55839-0001	COVER, FILTER
	55979-0001	PIN, GUIDE
	81679-0010	PIN, ROLL
	81207-0025	SPACER
	81217-0002	SPACER (PHENOLIC)
	41318-0001	CONNECTOR, RF, FEMALE
	81737-0002	LUG, SOLDER & LOCKWASHER
	81254-0001	EYELET (SE-34)
	81254-0033	EYELET (SE-33)
	81335-0013	INSULATOR, SHOULDER
	52726-0001	TRANSPAD
	82963-0003	SCREW, MACH, #2-56 x ¼ LG. PAN HD, SL.
	82961-0003	SCREW, THREAD CUTTING, #2-56 x ¼ LG., PAN HD., SL
	82962-0003	SCREW, MACH, #4-40 x ¼ LG, PAN HD, SL
	82814-0005	SCREW, MACH, #4-40 x ⅜ LG. BND. HD, SL
	82922-0001	NUT, HEX, #4-40
	82900-0211	NUT, HEX, #8-32
	83011-0011	INSULATOR
	99065-0002	TAPE, DOUBLE SIDED
	41330-0004	PLUG, PHONO (MALE)
	41322-0001	SOCKET, I.C. SOLDER TAIL
	99065-0004	TAPE, DOUBLE SIDED
	82017-0001	CLAMP, CABLE
	No Number	TRANSMITTER PC BOARD ASSY (See Fig. 3.5-11 for breakdown)
	No Number	MODULATOR PC BOARD ASSY (See Fig. 3.5-12 for breakdown)

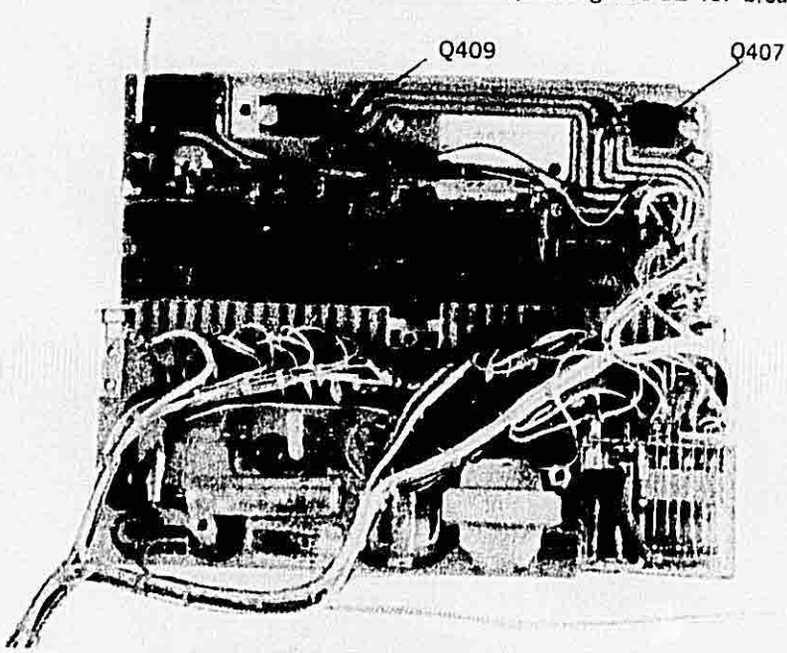
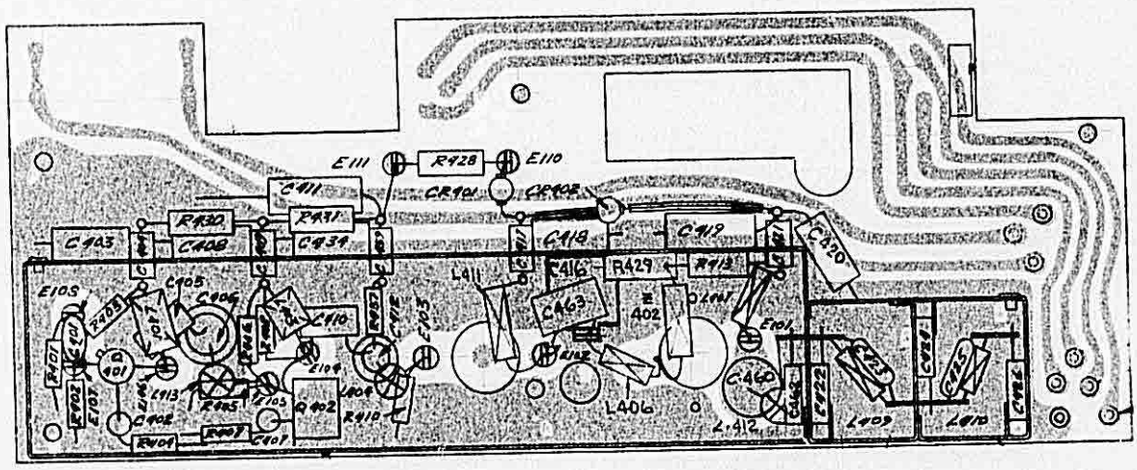


FIGURE 3.5-10 TRANSMITTER, COM 110 TSO

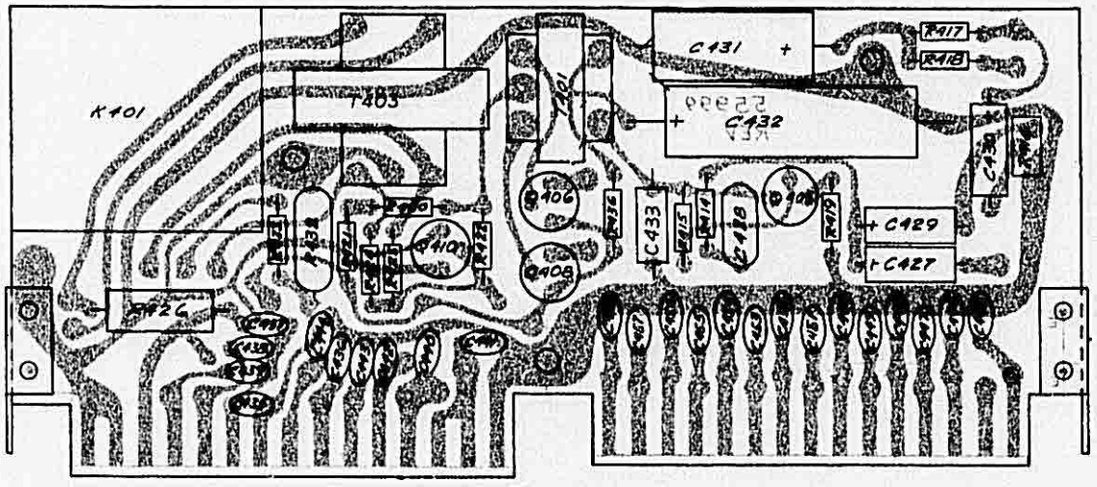


C-55158
C-55943

FIGURE 3.5-11 TRANSMITTER PC BOARD, COM 110 TSO

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
3.5-11	No Number	TRANSMITTER PC BOARD, COM 110 TSO (See Fig. 3.5-10 for NHA)
C-401	21291-0021	CAPACITOR, CERAMIC DISC, .011 uf, ±20%
C-402	21290-0008	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-403	23089-0063	CAPACITOR, MYLAR, .01 uf ±10%, 80V
C-404	21290-0007	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-405	24054-0100	CAPACITOR, DIPPED MICA, 10 pf ±.5 pf
C-406	24543-0390	CAPACITOR, LEADLESS DISC, 39 pf ±10%, N470
C-407	21290-0008	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-408	23089-0063	CAPACITOR, MYLAR, .01 uf ±10%, 80V
C-409	21290-0007	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-410	24052-0180	CAPACITOR, DIPPED MICA, 18 pf ±1 pf
C-411	21554-0039	CAPACITOR, TANTALUM, 12 uf ±10%, 30V
C-412	24542-0001	CAPACITOR, LEADLESS DISC, 75 pf ±10%, X5F
C-416	24037-0118	CAPACITOR, MICA, 250 pf ±10%
C-417	21290-0007	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-418	23089-0063	CAPACITOR, MYLAR, .01 uf ±10%, 80V
C-419	21554-0039	CAPACITOR, ALUMINUM, 12 uf, 30VSP
C-420	23089-0063	CAPACITOR, MYLAR, .01 uf ±10%, 80V
C-421	21290-0007	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-422	24037-0109	CAPACITOR, MICA, 50 pf ±5%
C-423	24054-0309	CAPACITOR, DIPPED MICA, 3 pf ±0.5 pf
C-424	24037-0121	CAPACITOR, MICA, 36 pf ±5%
C-425	24054-0100	CAPACITOR, DIPPED MICA, 10 pf ±0.5 pf
C-426	24037-0117	CAPACITOR, MICA, 18 pf ±5%
C-434	23089-0063	CAPACITOR, MYLAR, .01 uf ±10%, 80V
C-459	21290-0007	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-460	24542-0002	CAPACITOR, LEADLESS DISC, .001 uf ±20%, X5F
C-461	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-462	24037-SEL.	CAPACITOR, MICA, SEL.
C-463	24049-0251	CAPACITOR, DIPPED MICA, 250 pf ±5%, 500V
CR-401	75214-0001	DIODE, SILICON-RECTIFIER, 1N5061
CR-402	75214-0001	DIODE, SILICON-RECTIFIER, 1N5061
L-401	11713-0012	COIL, 10 ½T, BLACK, 0.125 I. D.
L-403	11713-0011	COIL, 6½T, BLUE, 0.125 I. D.
L-404	11713-0009	COIL, 2½T RED, .125 I. D.
L-406	90039-0004	COIL, ⅝ inch, SILVER STRAP - if required
L-407	11713-0007	COIL, 12½T, RED, 0.080 I. D.
L-409	11713-0006	COIL, 10½T, BLACK, 0.080 I. D.
L-410	11713-0005	COIL, 7½T, VIOLET, ;.080 I. D.
L-411	11713-0007	COIL, 12½T, RED, .080 I. D.
L-412	11713-0010	COIL, 3½T, ORANGE, .125 I. D.
L-413	11713-0016	COIL, 4½T, YELLOW, .125 I. D.
Q-401	75802-0038	TRANSISTOR, NPN, SILICON
Q-402	75802-0039	TRANSISTOR, NPN, SILICON
Q-407	75802-0044	TRANSISTOR, NPN, SILICON
Q-409	75802-0046	TRANSISTOR, NPN SILICON
Q-411	75802-0040	TRANSISTOR, NPN, SILICON
Q-412	75802-0041	TRANSISTOR, NPN, SILICON
R-401	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-402	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-403	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-404	31192-0470	RESISTOR, CARBON, 47 ±10%, ¼W
R-405	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-406	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-407	31192-0220	RESISTOR, CARBON, 22 ±10%, ¼W
R-408	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-410	31195-0111	RESISTOR, CARBON, 110 ±10%, ¼W
R-413	31141-0100	RESISTOR, CARBON, 10 ±10%, ½W
R-428	31200-0008	RESISTOR, WIREWOUND, 10 ±5%, 2W
R-429	31141-0150	RESISTOR, CARBON, 15 ±10%, ½W
R-430	31141-0101	RESISTOR, CARBON, 100 ±10%, ½W
R-431	31141-0100	RESISTOR, CARBON, 10 ±10%, ½W
R-437	31192-SEL	RESISTOR, CARBON, SEL. ¼W
Z-401	11454-0005	BEAD - FERRITE (Qty 2)
Z-402	11137-0005	CHOKE .47 uh/100 ½W CARBON RESISTOR COMB.



C-55159
C-55999

FIGURE 3.5-12 MODULATOR PC BOARD, COM 110 TSO

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
3.5-12	No Number	MODULATOR PC BOARD COM 110 TSO (See Fig. 3.5-10 for NHA)
C-427	21555-0026	CAPACITOR, TANTALUM, 10 uf ±10%, 20V
C-429	21555-0052	CAPACITOR, TANTALUM, 2.2 uf, 35V (CNB171A4 and later)
C-430	21555-0026	CAPACITOR, TANTALUM, 10 uf, 20V (CNB171A4 and later)
C-431	21554-0019	CAPACITOR, ELECTROLYTIC, 100 uf, 18V
C-432	21554-0003	CAPACITOR, ELECTROLYTIC, 200 uf, 15V
C-435	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-436	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-437	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-438	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-439	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-440	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-441	21291-0005	CAPACITOR, CERAMIC DISC, .01 mf ±10%, 50V
C-442	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-443	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-444	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-445	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-446	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-447	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-448	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-449	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-450	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-451	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-452	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-453	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-454	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-455	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-456	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-457	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-458	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
K-401	65138-0001	RELAY, 6 POLE
Q405	75802-0042	TRANSISTOR, NPN, SILICON
Q-406	75802-0043	TRANSISTOR, NPN SILICON
Q-408	75802-0045	TRANSISTOR, NPN SILICON
Q-410	75802-0047	TRANSISTOR, NPN SILICON
R-415	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-416	32054-0013	RESISTOR, VARIABLE, 220, POT
R-417	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-418	31192-0221	RESISTOR, CARBON, 220 ±10%, ¼W
R-419	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-420	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-421	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
R-422	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-424	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-425	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-426	31135-0271	RESISTOR, CARBON, 270 ±10%, 1W
R-432	31161-0029	RESISTOR, WIREWOUND, 600 ±5%, 3W
R-433	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-436	31192-0150	RESISTOR, CARBON, 15 ±10%, ¼W
R-438	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
T-401	11745-0001	TRANSFORMER, DRIVER
T-403	11795-0001	TRANSFORMER, MODULATOR

Fig. & Index No.	Part Number	Description
3.5-13	01147-0101	RECEIVER BOARD, COM 110 TSO (See Fig. 3.5-6 for NHA)
	55969-0001	SHIELD
	81214-0010	SPACER, PHENOLIC 7/32 O. D. x .140 LG.
	82922-0001	NUT. HEX. #4-40
	56485-0001	CLIP, Grounding
C-602	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-603	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-604	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-605	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-606	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-607	24509-0228	CAPACITOR, CERAMIC, .22 pf ±5%, 500V
C-608	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-609	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-610	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-611	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-612	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-613	22041-0002	CAPACITOR, VARIABLE 9 to 35 pf
C-614	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-615	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-616	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-617	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-618	24049-0511	CAPACITOR, DIPPED MICA, 510 pf ±5%, 500V
C-619	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-620	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-621	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-622	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-623	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-624	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-625	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-626	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-627	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-628	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-629	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf, ±5%, 10V
C-630	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-631	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-632	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-633	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C-634	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-635	23094-0171	CAPACITOR, MET. MYLAR, .047 mf ±10%, 200V
C-636	21555-0011	CAPACITOR, TANTALUM, 39 mf ±10%, 10V
C-637	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-638	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-639	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C-641	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-642	21555-0012	CAPACITOR, TANTALUM, 82 mf ±10%, 10V
C-643	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-644	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-645	21296-0003	CAPACITOR, FEED THRU CERAMIC .001 mf GMV, 500V
C-646	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-647	21296-0003	CAPACITOR, FEED THRU CERAMIC .001 mf GMV, 500V
C-648	21291-0025	CAPACITOR, CERAMIC DISC, 930 pf ±10%, 500V
C-649	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-650	21555-0011	CAPACITOR, TANTALUM, 39 mf ±10%, 10V
C-651	21515-0010	CAPACITOR, CERMIC DISC, .02 mf, 50V
CR-602	75037-0001	DIODE, TUNING
CR-603	75037-0001	DIODE, TUNING,
CR-604	75037-0001	DIODE, TUNING,
CR-605	75028-0001	DIODE, SILICON
CR-606	75028-0001	DIODE, SILICON
CR-607	75028-0001	DIODE, SILICON
CR-608	75025-0002	DIODE, ZENER, 8.2V ±5%, 1W
CR-610	75037-0001	DIODE, TUNING
CR-611	75037-0001	DIODE, TUNING
CR-612	75037-0001	DIODE, TUNING
CR-613	75028-0001	DIODE, SILICON
CR-614	75028-0001	DIODE, SILICON
FL-601	11751-0002	FILTER, CRYSTAL, 11.975 MHz

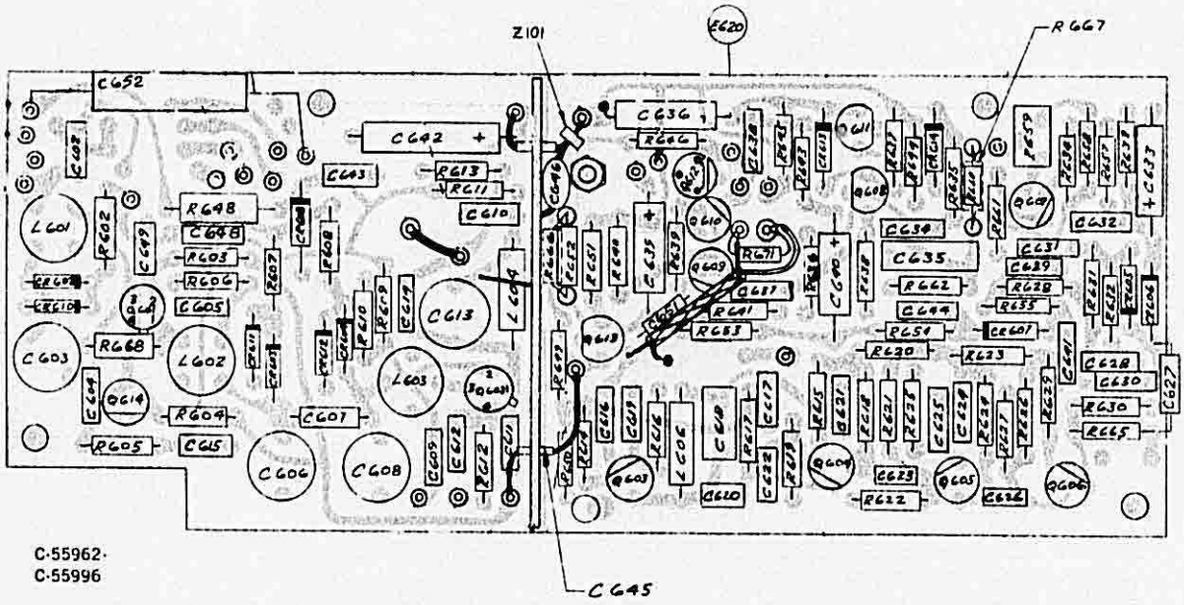


FIGURE 3.5-13 RECEIVER BOARD, COM 110 TSO

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
L-601	11753-0002	COIL, TUNED SLUG, (RF INPUT)
L-602	11754-0001	COIL, TUNED SLUB, (RF OUTPUT)
L-603	11755-0001	COIL, TUNED SLUB, (MIXER INPUT)
L-604	11138-0015	CHOKE, RF, 6.8 ±10%
L-606	11834-0001	COIL, TUNEABLE
Q-601	75611-0002	TRANSISTOR, FET, N CHANNEL
Q-602	75611-0002	TRANSISTOR, FET, N CHANNEL
Q-603	75588-0003	TRANSISTOR, NPN, 2N3662
Q-604	75588-0003	TRANSISTOR, PNP, 2N3662
Q-605	75588-0003	TRANSISTOR, NPN, 2N3662
Q-606	75588-0003	TRANSISTOR, NPN, 2N3662
Q-607	75595-0003	TRANSISTOR, NPN, 2N5172
Q-608	75565-0006	TRANSISTOR, PNP, 2N5356
Q-609	75595-0003	TRANSISTOR, NPN, 2N5172
Q-610	75595-0003	TRANSISTOR, NPN, 2N5172
Q-611	75565-0006	TRANSISTOR, PNP, 2N5356
Q-612	75595-0003	TRANSISTOR, NPN, 2N5172
Q-613	75565-0006	TRANSISTOR, PNP, 2N5356
Q-614	75595-0003	TRANSISTOR, NPN, 2N5172
R-602	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-603	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-604	31192-0273	RESISTOR, CARBON, 27K ±10%, ¼W
R-605	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-606	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-607	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-608	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-609	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-610	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-611	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-612	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-613	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-614	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-615	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-616	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-617	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-618	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-619	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-620	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-621	31192-0822	RESISTOR, CARBON, 8.2K ±10%, ¼W
R-622	31192-0332	RESISTOR, CARBON, 3.3K ±10%, ¼W
R-623	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-624	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-625	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-626	31192-0562	RESISTOR, CARBON, 5.6K ±10%, ¼W
R-627	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-628	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-629	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-630	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-631	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-632	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-633	31192-0273	RESISTOR, CARBON, 27K ±10%, ¼W
R-634	31192-0473	RESISTOR, CARBON, 47K ±10%, ¼W
R-635	31192-0154	RESISTOR, CARBON, 150K ±10%, ¼W
R-636	31192-0564	RESISTOR, CARBON, 560K ±10%, ¼W
R-637	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-638	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-639	31192-0155	RESISTOR, CARBON, 1.5M ±10%, ¼W
R-640	31192-0123	RESISTOR, CARBON, 12K ±10%, ¼W
R-641	31192-0331	RESISTOR, CARBON, 330 ±10%, ¼W
R-643	31192-0682	RESISTOR, CARBON, 6.8K ±10%, ¼W
R-644	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-645	31192-0683	RESISTOR, CARBON, 68K ±10%, ¼W
R-646	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-648	31196-0003	RESISTOR, CARBON, 27 ±5%, 2W
R-649	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-650	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-651	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-652	31192-0474	RESISTOR, CARBON, 470K ±10%, ¼W
R-653	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-654	31192-0153	RESISTOR, CARBON, 15K ±10%, ¼W
R-657	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-658	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-659	32054-0009	RESISTOR, CARBON, VARIABLE, 1K
R-660	31192-0683	RESISTOR, CARBON, 68K ±10%, ¼W
R-661	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-662	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-665	31192-0330	RESISTOR, CARBON, 33 ±10%, ¼W
R-666	31192-SEL.	RESISTOR, CARBON, SEL. ±10%, ¼W
R-667	31192-SEL.	RESISTOR, CARBON, SEL. ±10%, ¼W
R-668	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-669	31192-SEL.	RESISTOR, CARBON, SEL. ±10%, ¼W
R-671	31192-0391	RESISTOR, CARBON, 390 ±10%, ¼W
Z-101	11454-0001	FERRITE BEAD

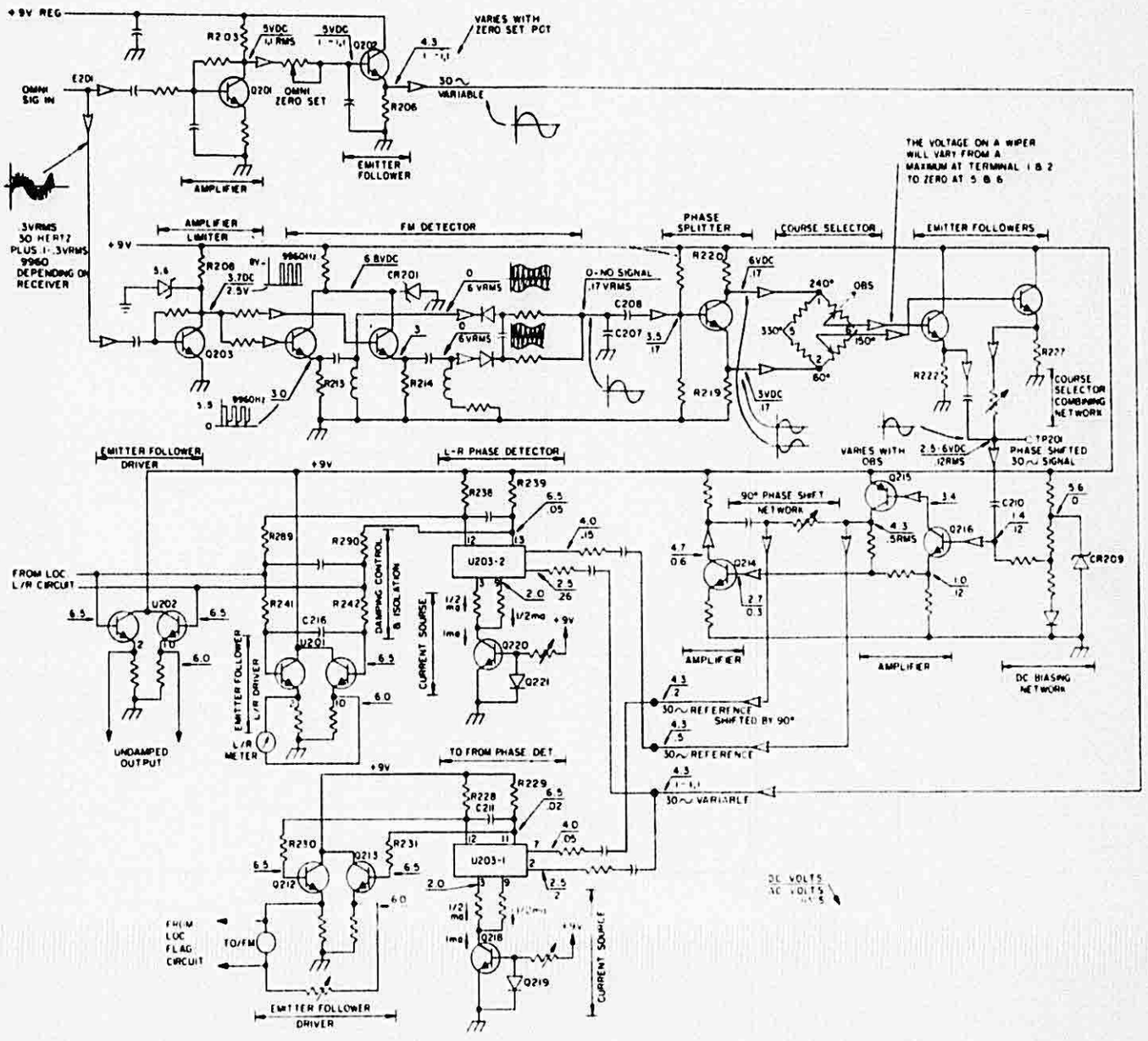


FIGURE 3.6-1 NAV 110 TSO OMNI MAINTENANCE INFORMATION

SEE BLOW-UP

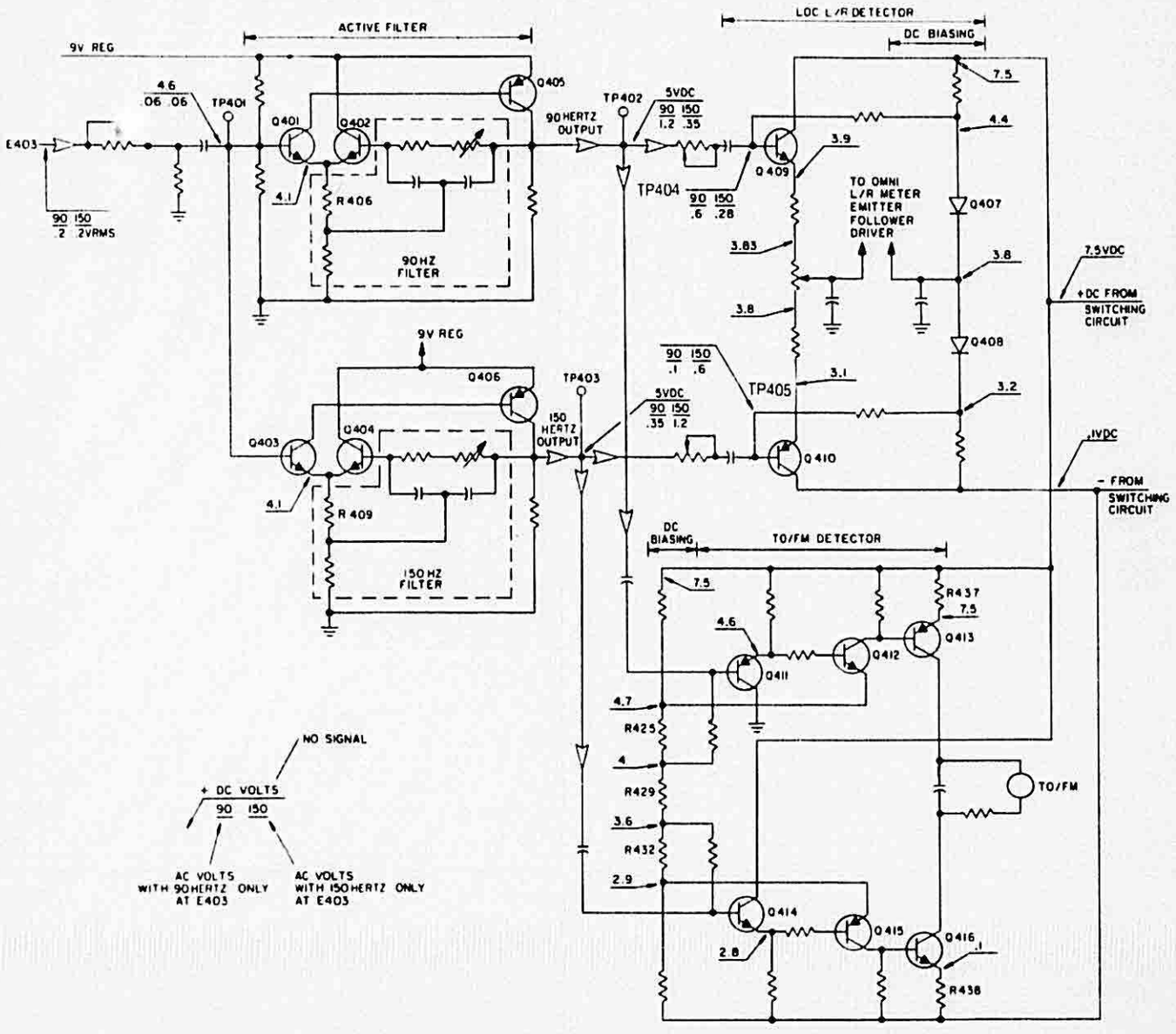


FIGURE 3.6-2 NAV 110 TSO LOCALIZER MAINTENANCE INFORMATION

SEE BLOW-UP

NAV 110 TSO DME CHANNEL PROGRAMMING

NARCO	ARINC	NAV J104	MHz CHANNELS 108	109	110	111	112	113	114	115	116	117
B	A	1	X	X		X	X					
C	B	2			X	X		X	X			
D	C	3					X	X		X	X	
E	D	4	X						X	X		X
A	E	5		X	X						X	X

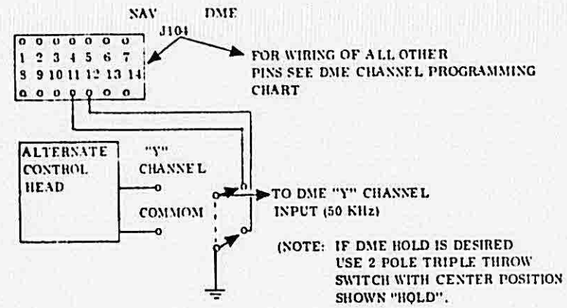
			KHz CHANNELS .00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95
-	-	-																				
F	F	6			X	X	X	X											X	X	X	X
H	G	7	X	X	X	X			X	X	X	X										
J	H	8					X	X	X	X			X	X	X	X						
K	J	9									X	X	X	X			X	X	X	X		
L	K	10	X	X											X	X	X	X			X	X
"Y" CHANNEL ACT.		11		Y		Y		Y		Y		Y		Y		Y		Y		Y		Y
DME COMMON		12																				
SPARE		13																				
GROUND		14																				

NOTES:

1. "X" indicates continuity to the DME common terminal, P104-12
2. "Y" indicates continuity to the ground terminal, P104-14
3. DME common P104-12 must be grounded for DME channeling to operate

A. For DME frequency control by NAV 110 TSO only, P104-12 may be connected to P104-14.

B. When the NAV 110 TSO with DME is used as one of two DME frequency control heads, P104-11 and P104-12 should be wired to one side of a double pole double thrown control head selector switch.



CONTROL HEAD SELECTOR SWITCH WIRING.

NAV 110 TSO DME PIGTAIL CONNECTOR

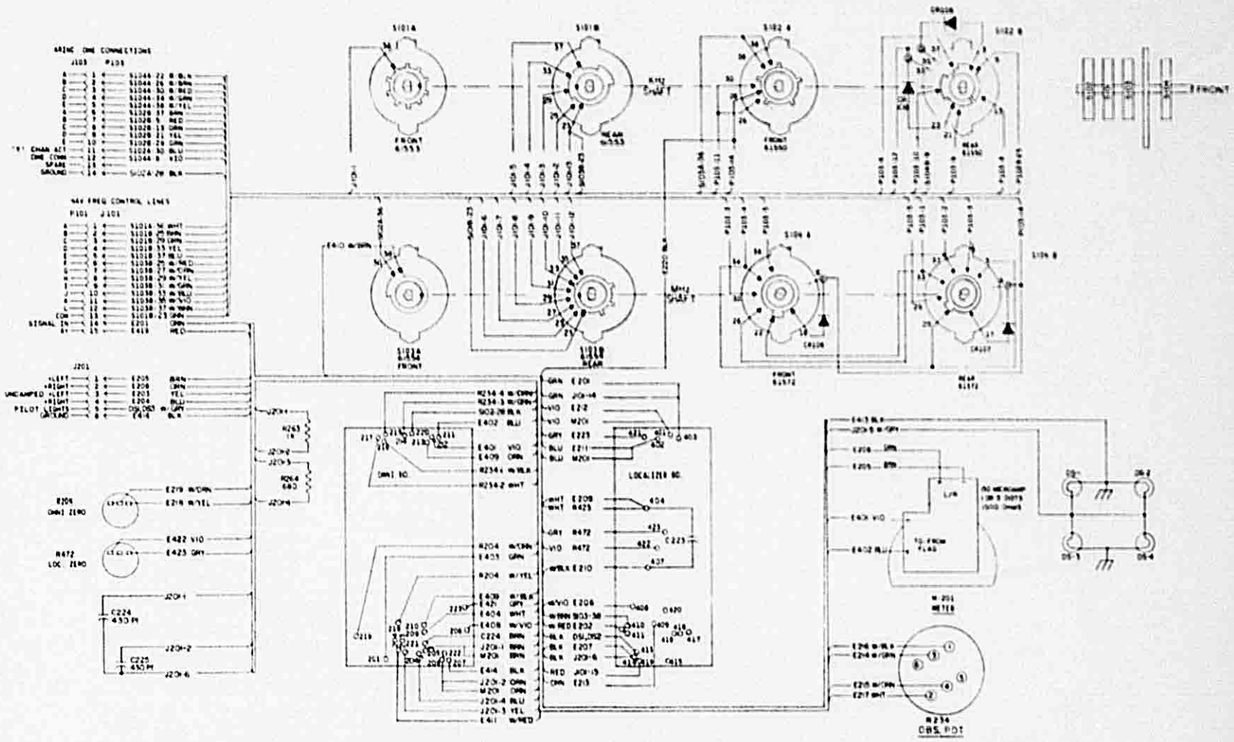


FIGURE 3.6-3 NAV 110 TSO INTERNAL INTERCONNECT DIAGRAM

NOTE:

Since the introduction of this Unit, there have been two external outputs provided. One called external L/R at P101, pins 5 & 7 (to drive another meter) and one called undamped output at P101, pins 2 & 4.

Field experience has shown that the external L/R output (pins 5 & 7) is more compatable with autopilots than the undamped output (pins 2 & 4).

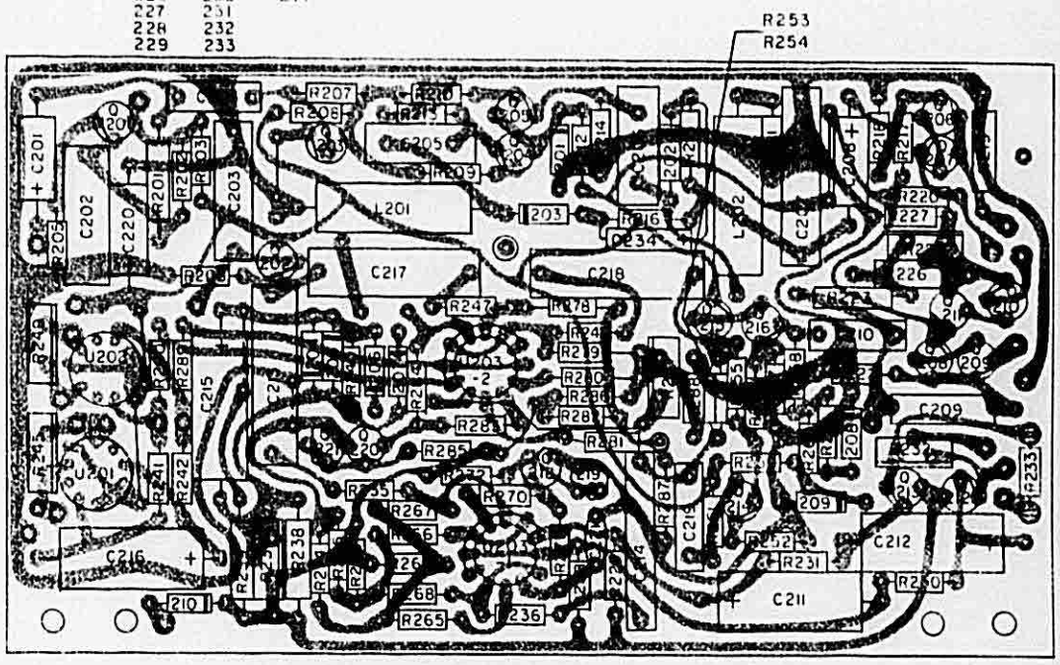
Therefore U202, R249, and R264 were removed from the Unit leaving pins 2 & 4 unused. This deletion started with chassis number:

NAV 10 — CNC171B11
NAV 11 — CNA194D3
NAV 12 — CNB194D3
NAV 110 — CNC219A5
NAV 111 — CND 219B3
NAV 112 — CNE 219B3

SEE BLOW-UP

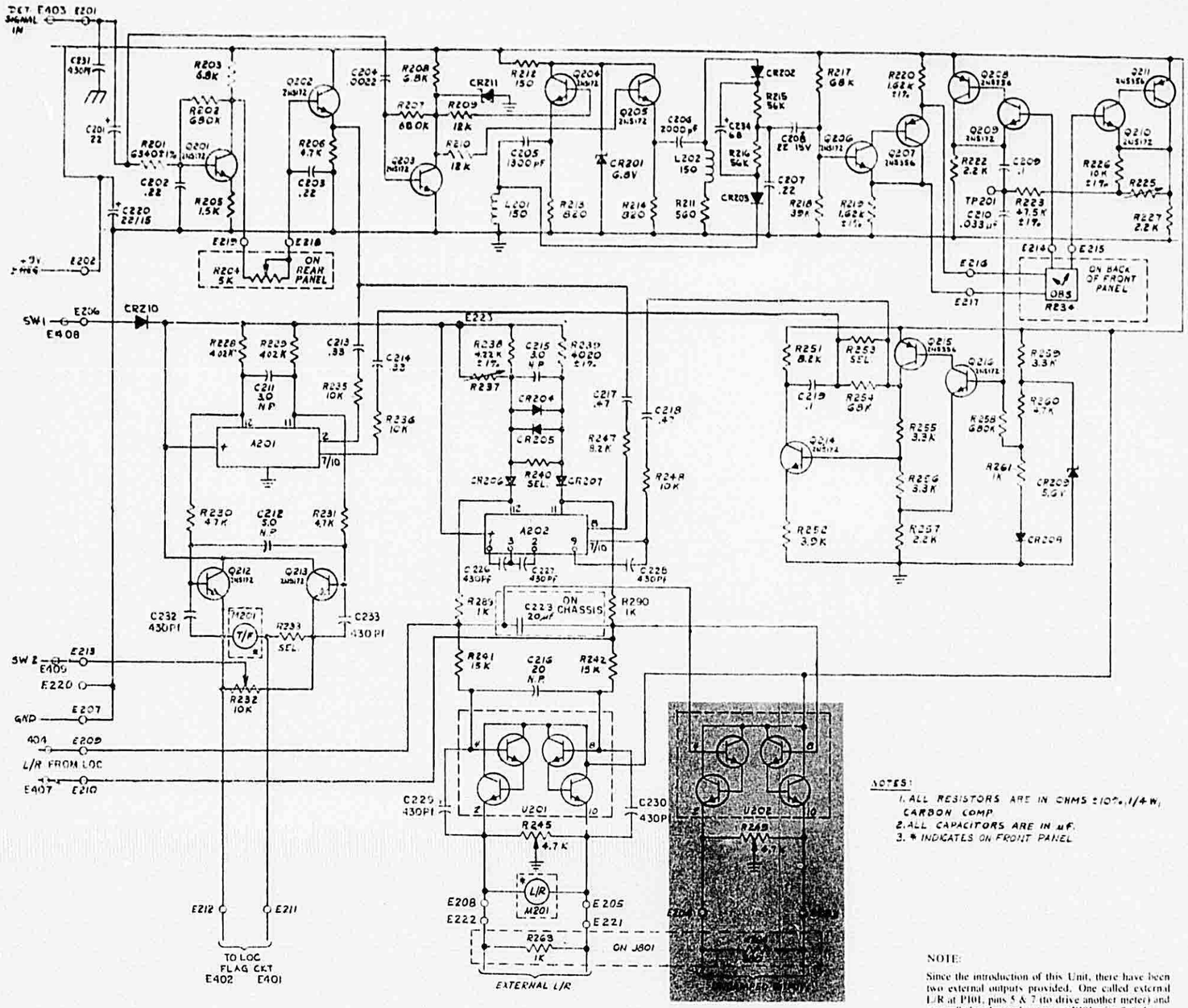
COMPONENTS ON OTHER SIDE OF BOARD

C	C	CR
226	230	211
227	231	
228	232	
229	233	



B-5*697-A

SEE BLOW-UP



NOTES:
1. ALL RESISTORS ARE IN OHMS ±10%, 1/4 W, CARBON COMP.
2. ALL CAPACITORS ARE IN µF.
3. * INDICATES ON FRONT PANEL

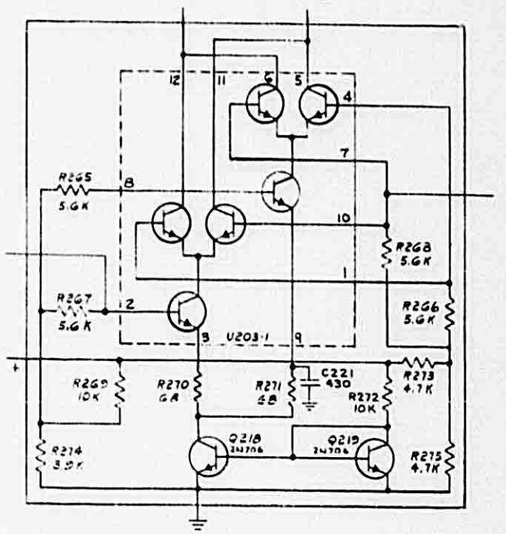
NOTE:

Since the introduction of this Unit, there have been two external outputs provided. One called external L/R at P101, pins 5 & 7 (to drive another meter) and one called undamped output at P101, pins 2 & 4.

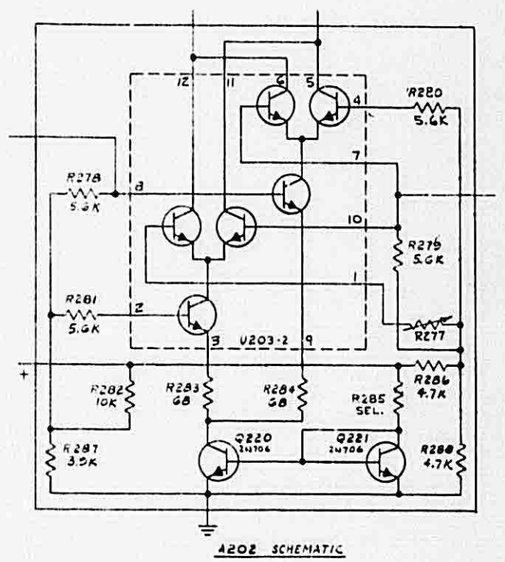
Field experience has shown that the external L/R output (pins 5 & 7) is more compatable with autopilots than the undamped output (pins 2 & 4).

Therefore U202, R249, and R264 were removed from the Unit leaving pins 2 & 4 unused. This deletion started with chassis number:

NAV 10 — CNC171B11
NAV 11 — CNA193D3
NAV 12 — CNB193D3
NAV 110 — CNC219A5
NAV 111 — CND 219B3
NAV 112 — CNE 219B3



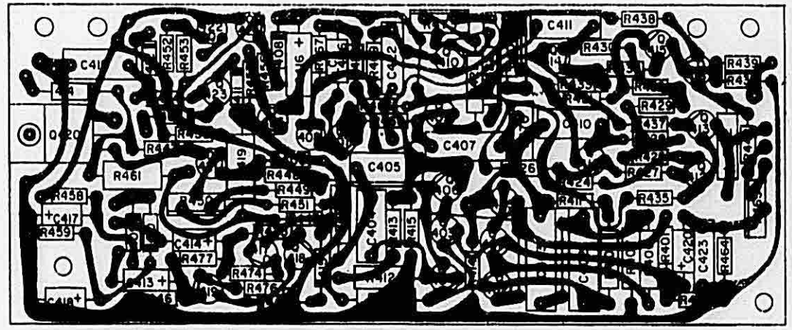
A201 SCHEMATIC



A202 SCHEMATIC

FIGURE 3.6-4 NAV 110 TSO OMNI SCHEMATIC

SEE BLOW-UP



B-57686-A

SEE BLOW-UP

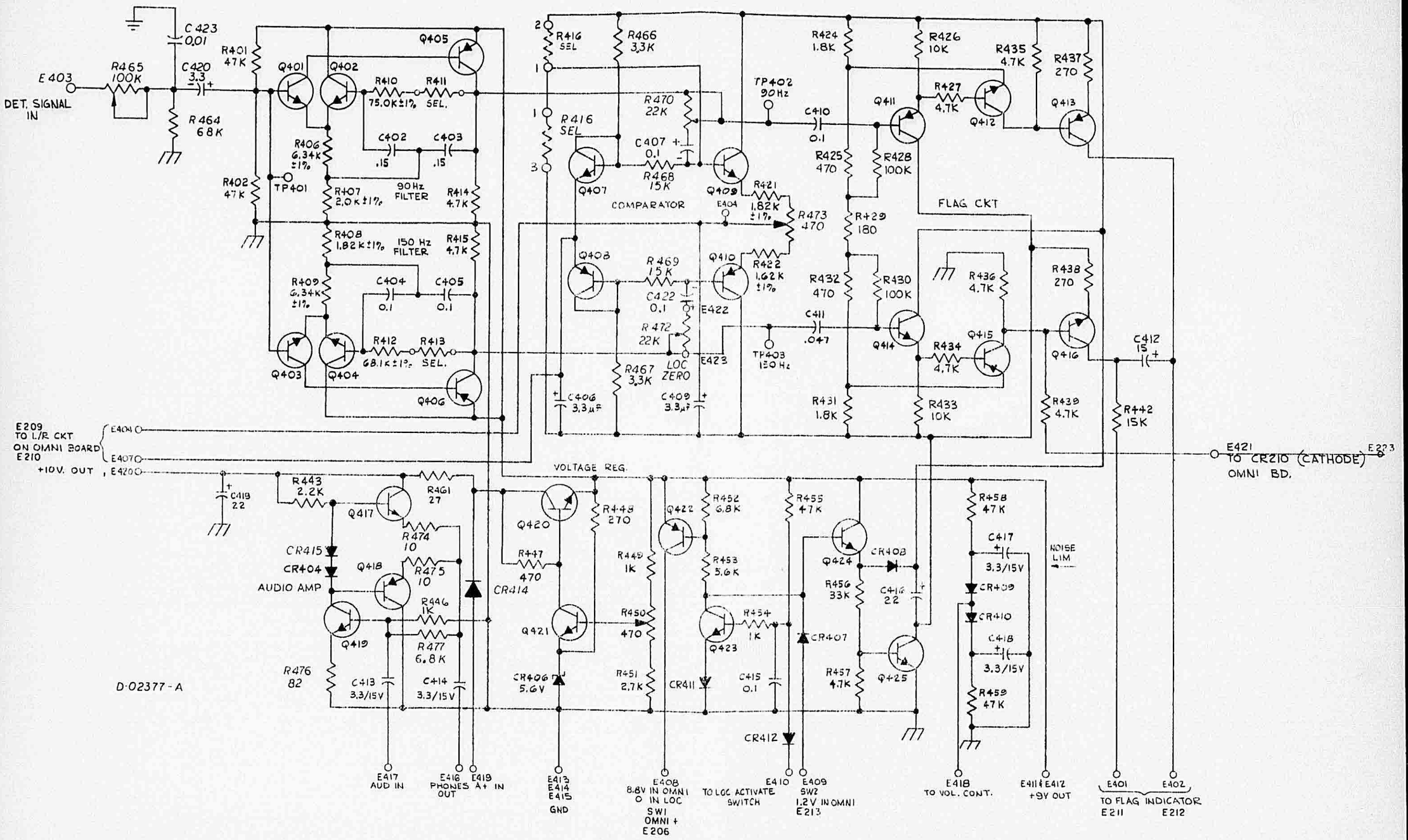


FIGURE 3.6-5 NAV 110 TSO LOCALIZER SCHEMATIC

SEE BLOW-UP

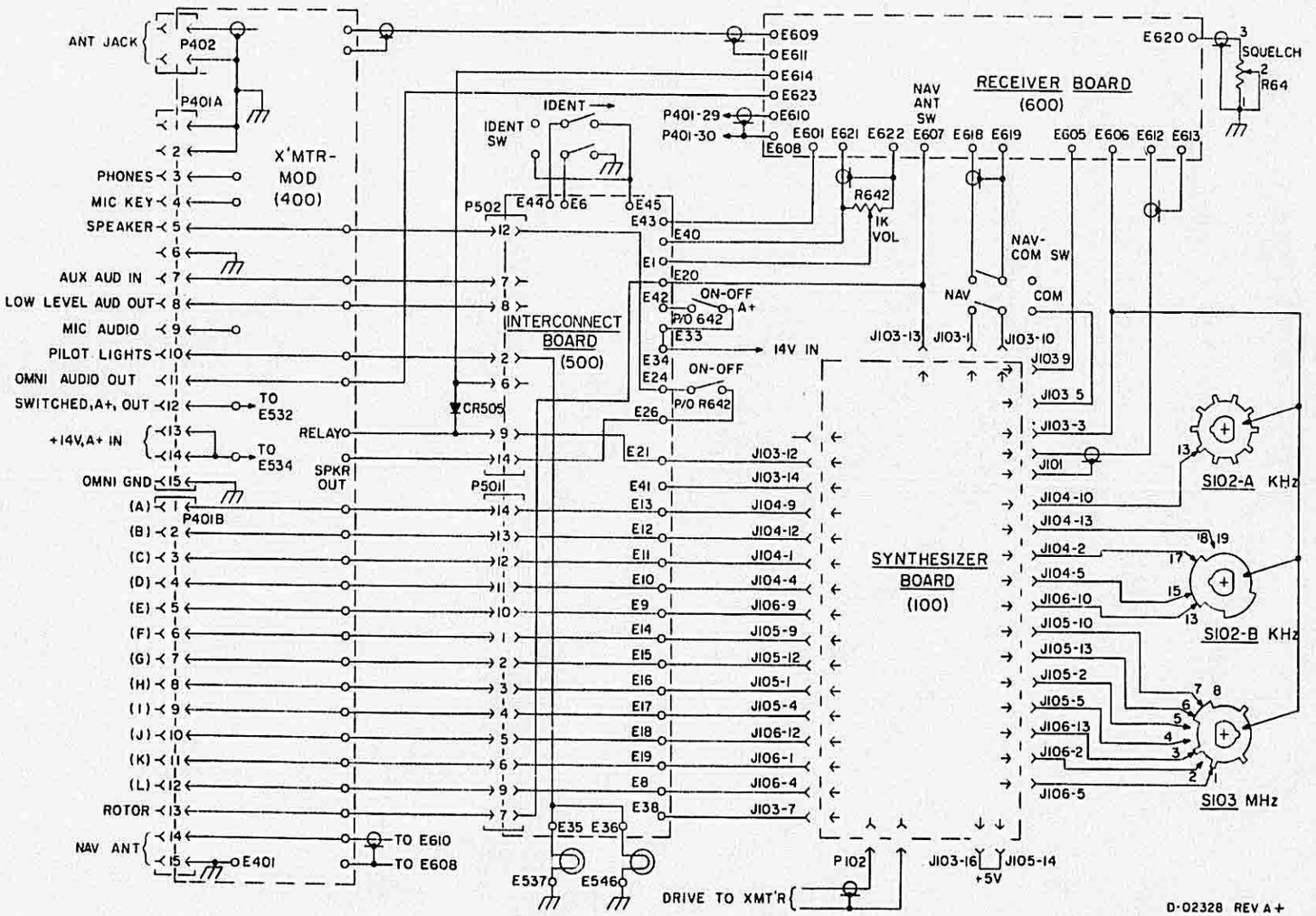
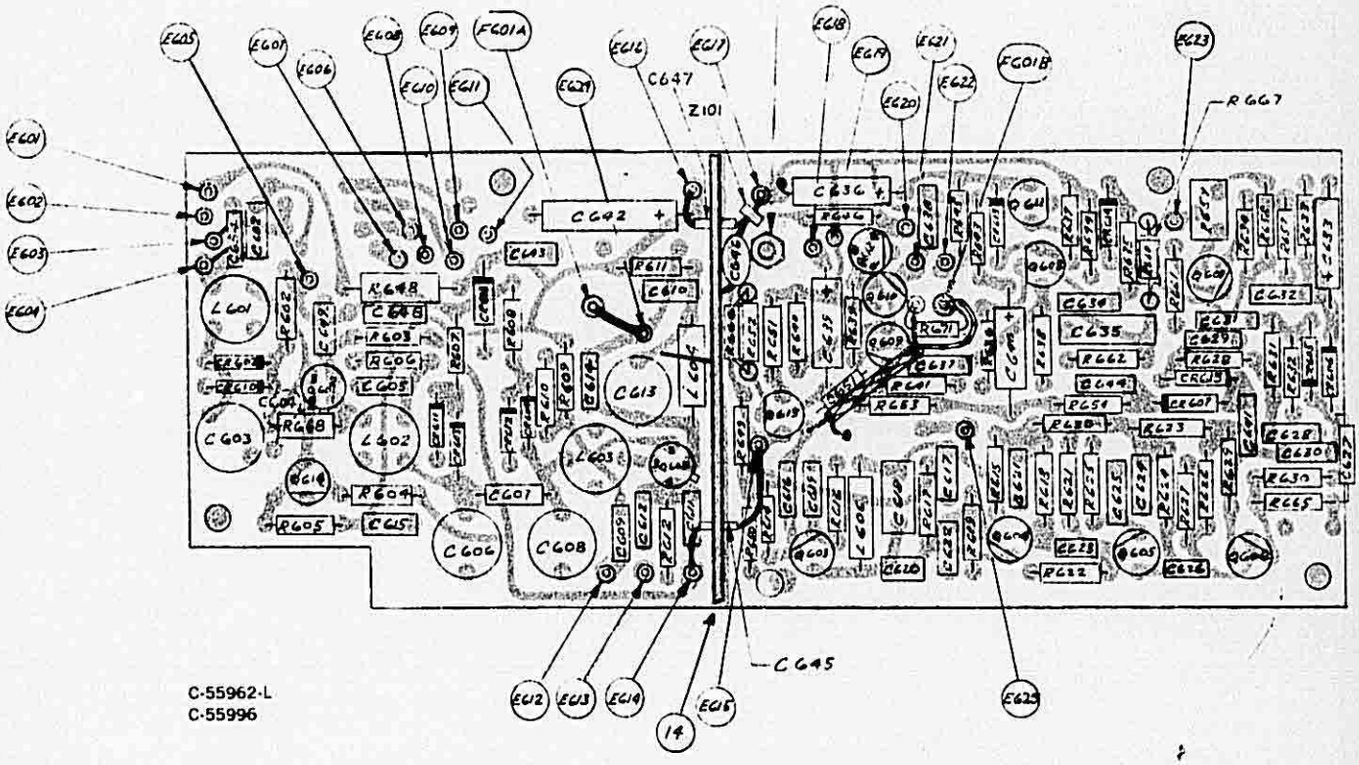
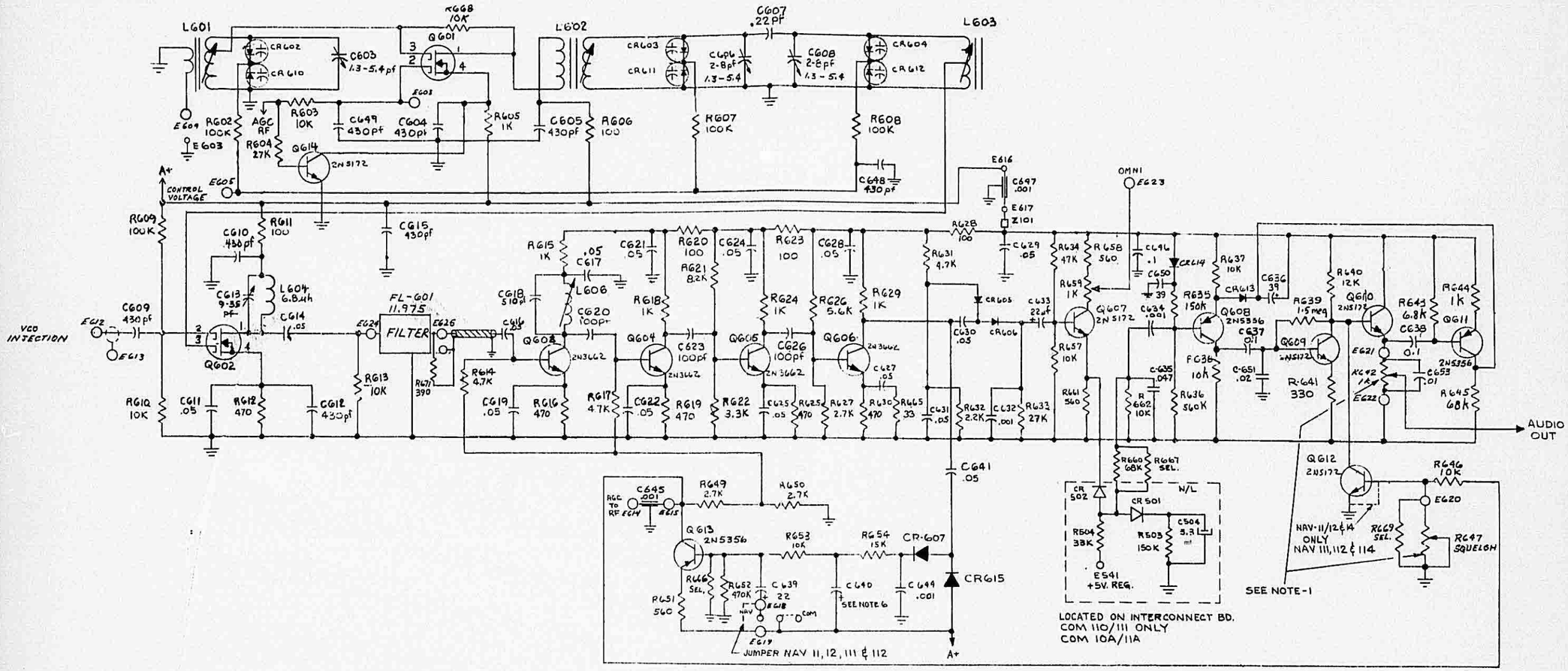


FIGURE 3.6-6 COM 110 TSO INTERNAL INTERCONNECT DIAGRAM


EG01
EG02
EG03
EG04
EG05
EG07
EG06
EG08
EG09
EG01A
EG10
EG11
EG12
EG13
EG14
EG15
EG16
EG17
EG18
EG19
EG21
EG22
EG20
EG01B
EG23
C647
Z101
RG67
CG42
CG36
L601
L602
L603
C603
C606
C608
C613
CG45
C-55962-L
C-55996
14

SEE BLOW-UP



NOTES:

1- R642 & R647 ARE PART OF FRONT PANEL B 01154 PARTS LIST.
2- COM 10/10A & COM 11/11A B-01147-101 PARTS LIST AS SHOWN. (ALSO COM 110/111)
3- NAV 11, 12 & 14, B-01147-2 OMIT SYMBOLS, R656, CR 609, R663, C602, R601, CR-601, C601, R664, Q612, R647, R646. (ALSO NAV 111, 112 & 114)
4- ALL RESISTORS ARE IN OHMS ± 10%, ¼ W., CARBON COMP. EXCEPT AS NOTED.
5- ALL CAPACITORS ARE IN μF EXCEPT AS NOTED.
6- C640 (10MMF COM 10A, NAV 11, NAV 12 & NAV 14, COM 110, NAV 111, NAV 112 & NAV 114.
(3.3MF COM 11A, COM 111.

D-02299 REV-P

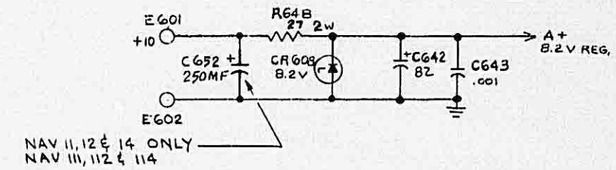
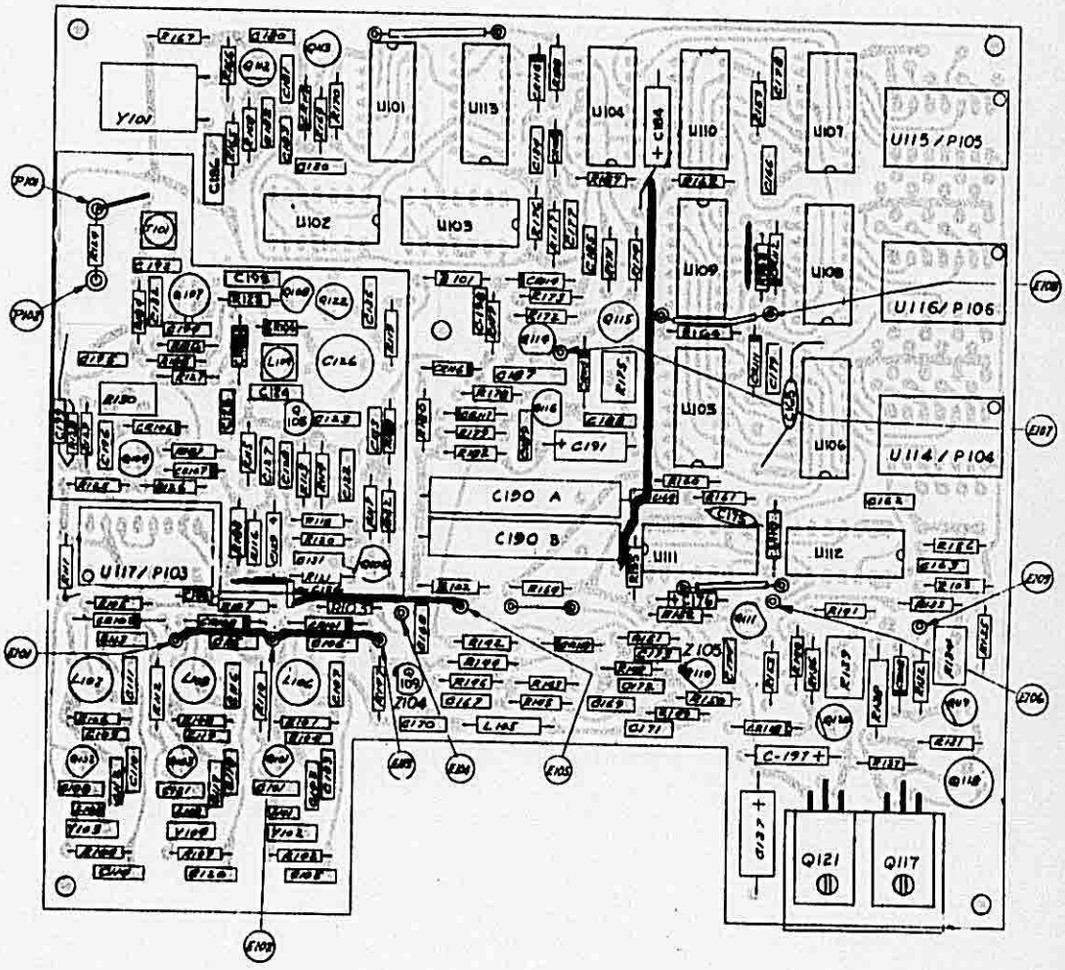


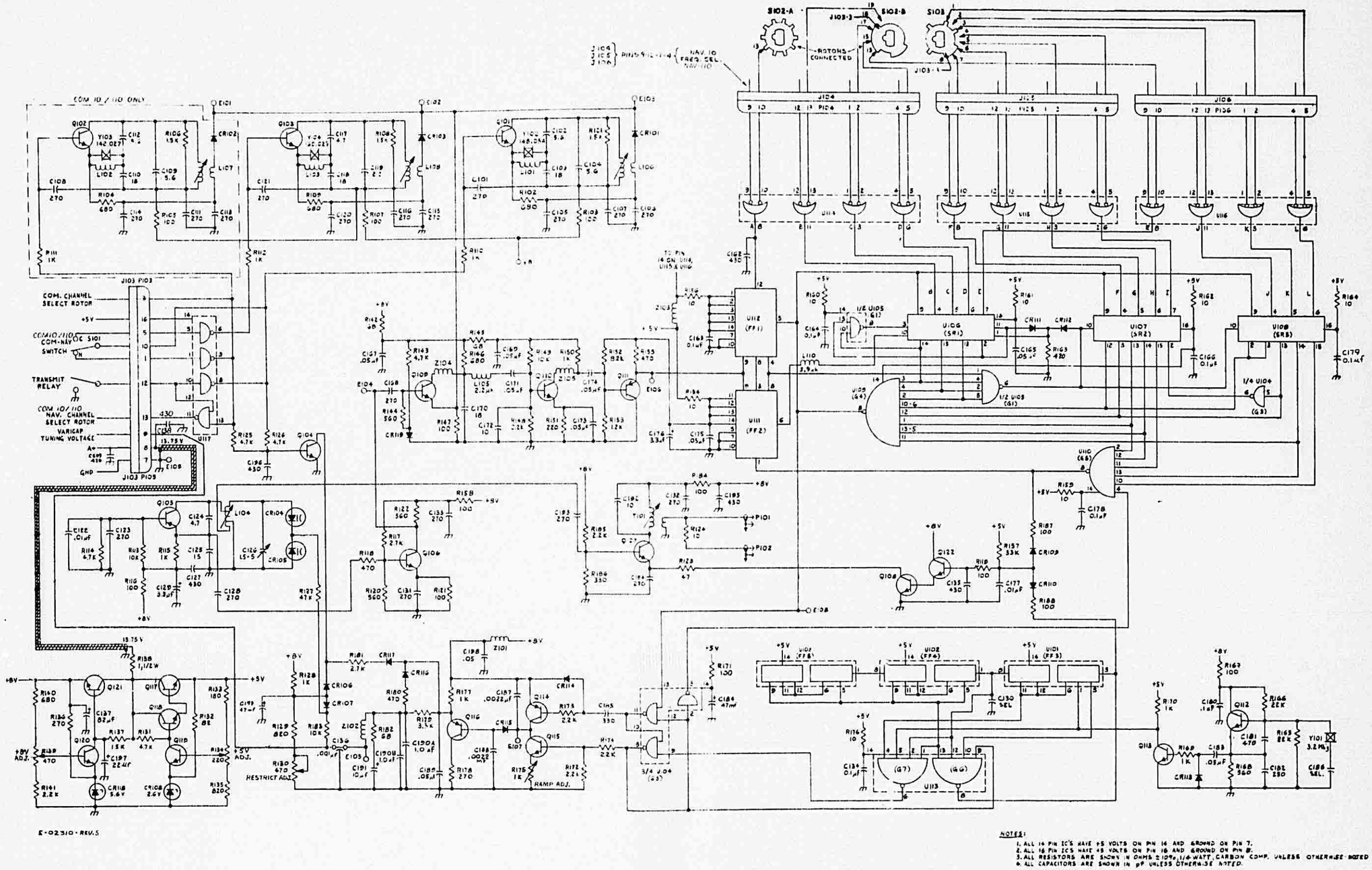
FIGURE 3.6-7 COM 110 TSO RECEIVER SCHEMATIC

SEE BLOW-UP



D-55949-Rev. K
D-55963-F

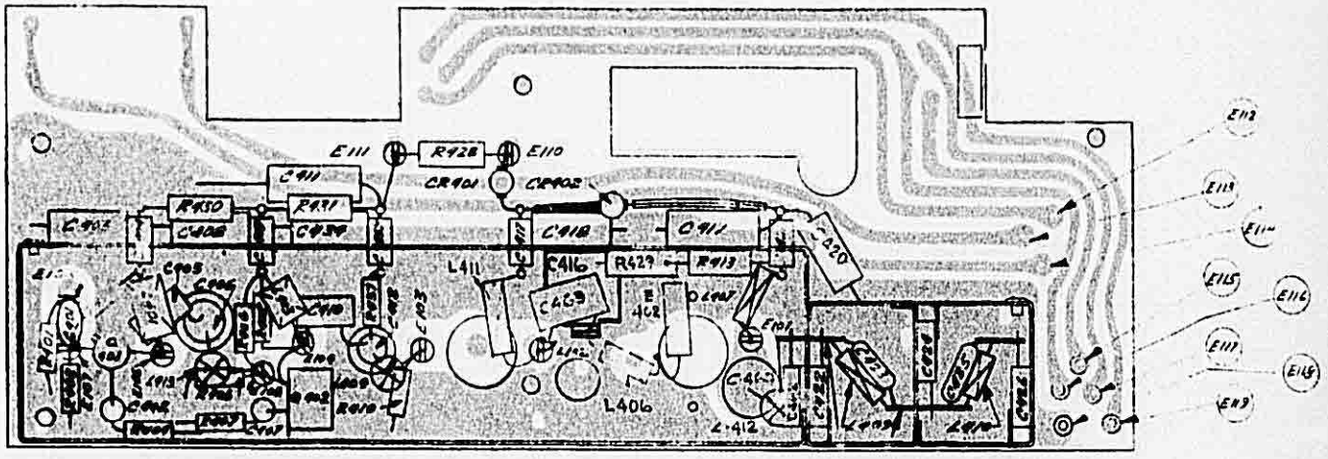
SEE BLOW-UP



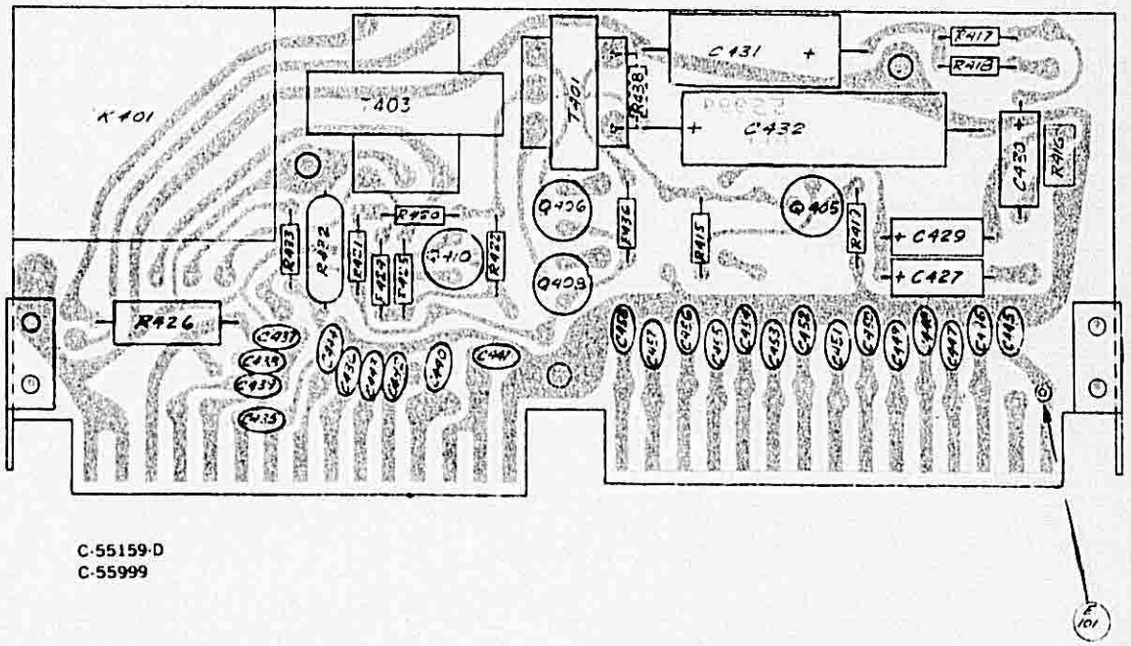
NOTES:
1. ALL 16 PIN IC'S HAVE +5 VOLTS ON PIN 14 AND GROUND ON PIN 7.
2. ALL 16 PIN ICS HAVE +5 VOLTS ON PIN 16 AND GROUND ON PIN 8.
3. ALL RESISTORS ARE SHOWN IN OHMS ±10%, 1/4-WATT, CARBON COMP. UNLESS OTHERWISE NOTED
4. ALL CAPACITORS ARE SHOWN IN pF UNLESS OTHERWISE NOTED.

FIGURE 3.6-8 COM 110 TSO SYNTHESIZER SCHEMATIC

SEE BLOW-UP

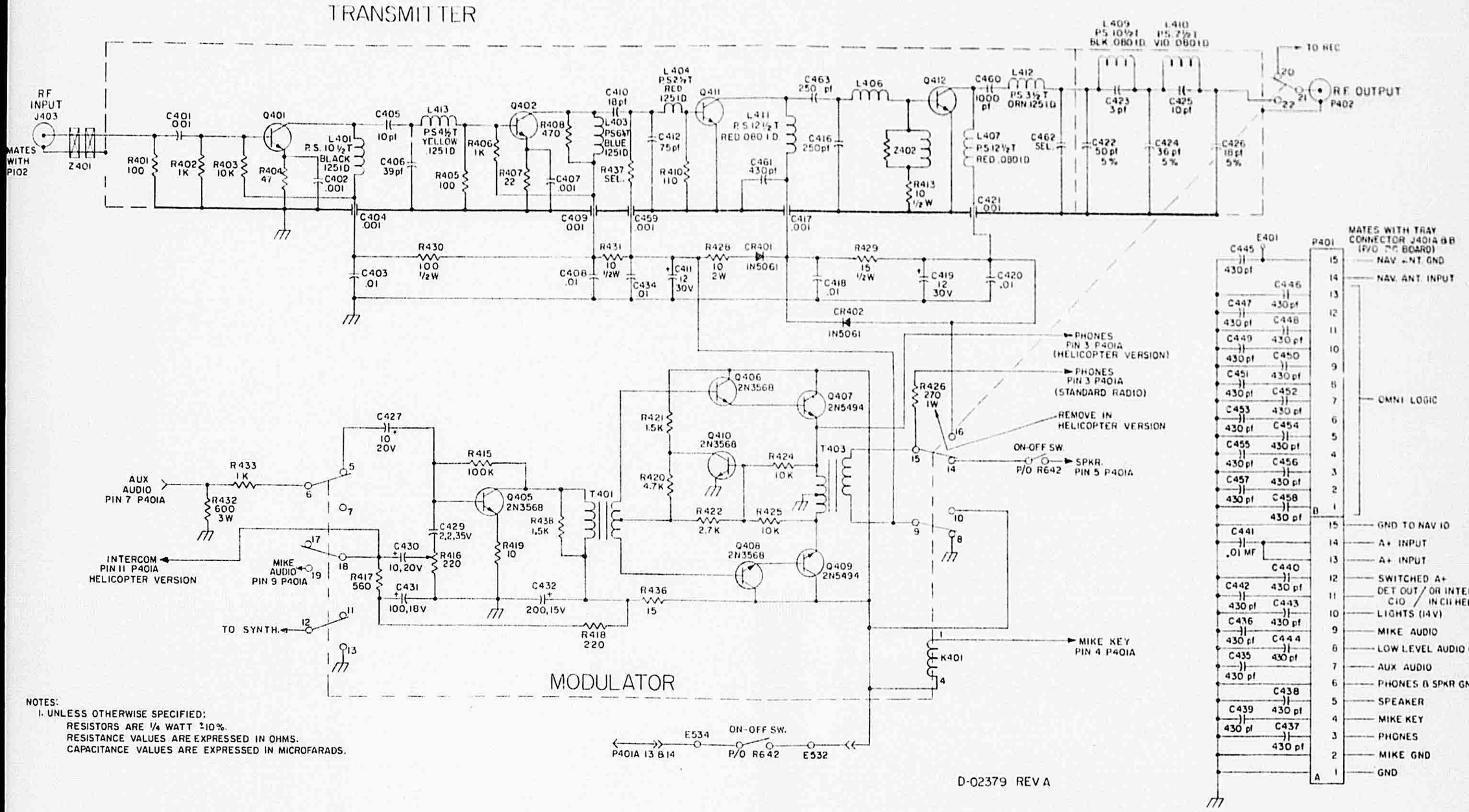


C-55158-C
C-55943



C-55159-D
C-55999

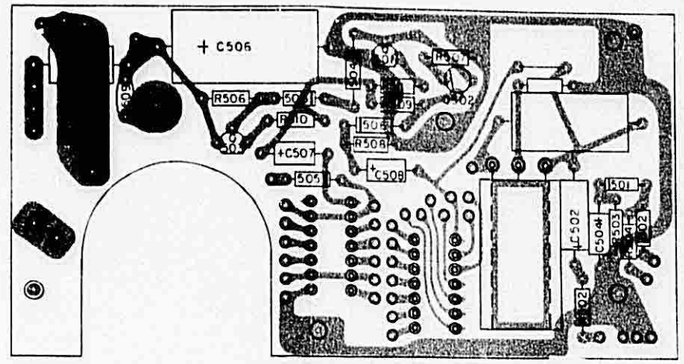
SEE BLOW-UP



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   RESISTORS ARE 1/4 WATT ±10%.
   RESISTANCE VALUES ARE EXPRESSED IN OHMS.
   CAPACITANCE VALUES ARE EXPRESSED IN MICROFARADS.

FIGURE 3.6-9 COM 110 TSO TRANSMITTER/MODULATOR SCHEMATIC

SEE BLOW-UP



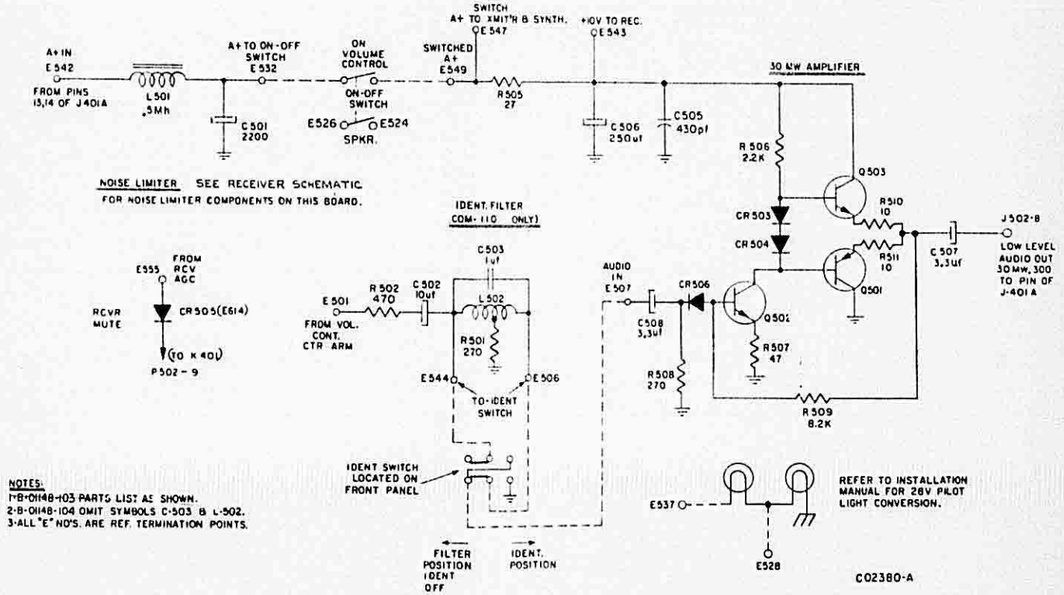


FIGURE 3.6-10 COM 110 TSO INTERCONNECT PC BOARD SCHEMATIC

SEE BLOW-UP

TABLE OF CONTENTS

SECTION	TOPIC	PAGE	ATP GRID
4	COM 111 TSO		
4.1	GENERAL	4-1	1M04
4.2	INSTALLATION	4-1	
4.3	CIRCUIT DESCRIPTION, COM 111 TSO	4-2	1M05
4.3.1	Receiver	4-3	1M06
4.3.2	Interconnect PC Board Circuits	4-4	1M07
4.3.3	Synthesizer	4-5	1M08
4.3.4	Transmitter/Modulator, COM 111 TSO	4-10	1M13
4.4	COM 111 TSO MAINTENANCE	4-11	1M14
4.4.1	Test Equipment Required for COM 111 TSO	4-13	1M18
4.4.1.1	Receiver Troubleshooting	4-13	
4.4.2	COM 111 TSO Receiver Tuning Procedure	4-16	1M21
4.4.3	Synthesizer Troubleshooting	4-17	1M22
4.4.4	Troubleshooting Procedure for COM 111 TSO Transmitter/Modulator	4-19	1M24
4.5	REPLACEMENT PARTS LIST, COM 111 TSO	4-23	2A04

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE		BLOW-UP FICHE
4.1-1	COM 111 TSO	4-1	1M04	
4.3-1	COM 111 TSO Simplified Block Diagram	4-2	1M05	
4.3-2	COM 111 TSO Receiver Block Diagram	4-2		
4.3-3	Synthesizer Block Diagram	4-5	1M08	
4.3-4	Transmitter Modulator Block Diagram	4-9	1M12	
4.4-1	COM 111 TSO Interconnections	4-12	1M15	
4.4-2	Ramp	4-18	1M23	
4.4-3	Test Connections	4-20	2A01	
4.4-4	Test Block Diagram	4-20		
4.4-5	COM 111 TSO Power vs Frequency	4-21	2A02	
4.4-6	Coil Test Tool	4-21		
4.4-7	COM 111 TSO Modulation Characteristics	4-22	2A03	
4.5-1	COM 111 TSO	4-23	2A04	
4.5-2	Front Panel Assy	4-25	2A06	
4.5-3	Synthesizer Board, COM 111 TSO	4-26	2A07	NC F904
4.5-4	Interconnect Board, COM 111 TSO	4-31	2A12	NC F904
4.5-5	Transmitter, COM 111 TSO	4-32	2A13	
4.5-6	Transmitter PC Board, COM 111 TSO	4-33	2A14	NC F904
4.5-7	Modulator PC Board, COM 111 TSO	4-35	2A16	NC F904
4.5-8	Receiver Board Assy, COM 111 TSO	4-37	2A18	NC F904
4.6-1	Internal Interconnect Diagram, COM 111 TSO	4-41	2A21	NC F904
4.6-2	Receiver Schematic, COM 111 TSO	4-43	2B02	NC F904
4.6-3	Synthesizer Schematic, COM 111 TSO	4-45	2B06	NC F905
4.6-4	Transmitter/Modulator Schematic, COM 111 TSO	4-47	2B10	NC F905
4.6-5	Interconnect PC Board Schematic, COM 111 TSO	4-49	2B14	NC F905

LIST OF TABLES

SECTION	TITLE	PAGE	
4.4.1	Receiver DC Voltage Measurements	4-14	1M19
4.4.2	Synthesizer Programming	4-17	1M22

4.1 GENERAL

This section, Section 4, is devoted to the COM 111 TSO. The COM 111 TSO is essentially the same as the COM 110 TSO less the NAV/COM mode switch and the Ident Filter. This unit is designed to be used exclusively as 360 channel transceiver., when a COM 111 TSO is used with the NAV 111 TSO or NAV 112 TSO, the pair would comprise a one and a one-half system.

4.2 INSTALLATION

All pertinent information pertaining to specifications, licensing, and installation are provided, in detail, in Section 2 of this manual.

FIGURE 4.1-1 COM 111 TSO

4.3 CIRCUIT DESCRIPTION, COM 111 TSO

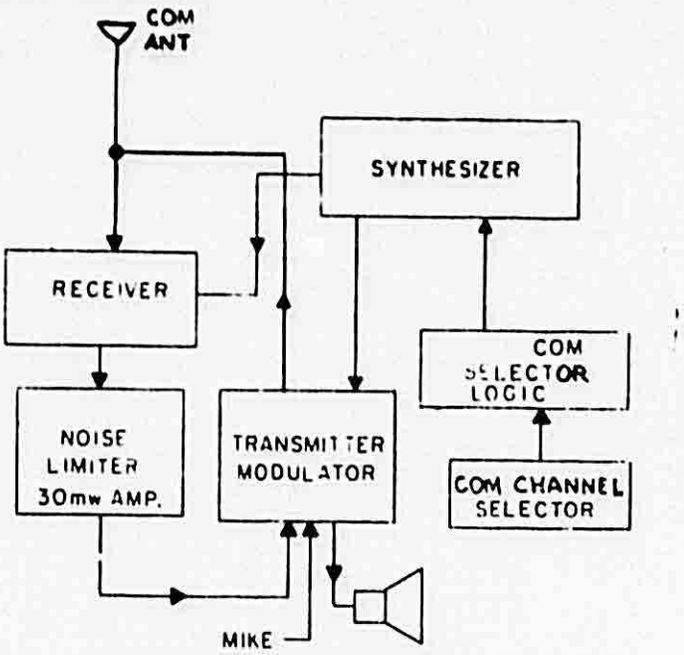


FIGURE 4.3-1 COM 111 TSO SIMPLIFIED BLOCK DIAGRAM

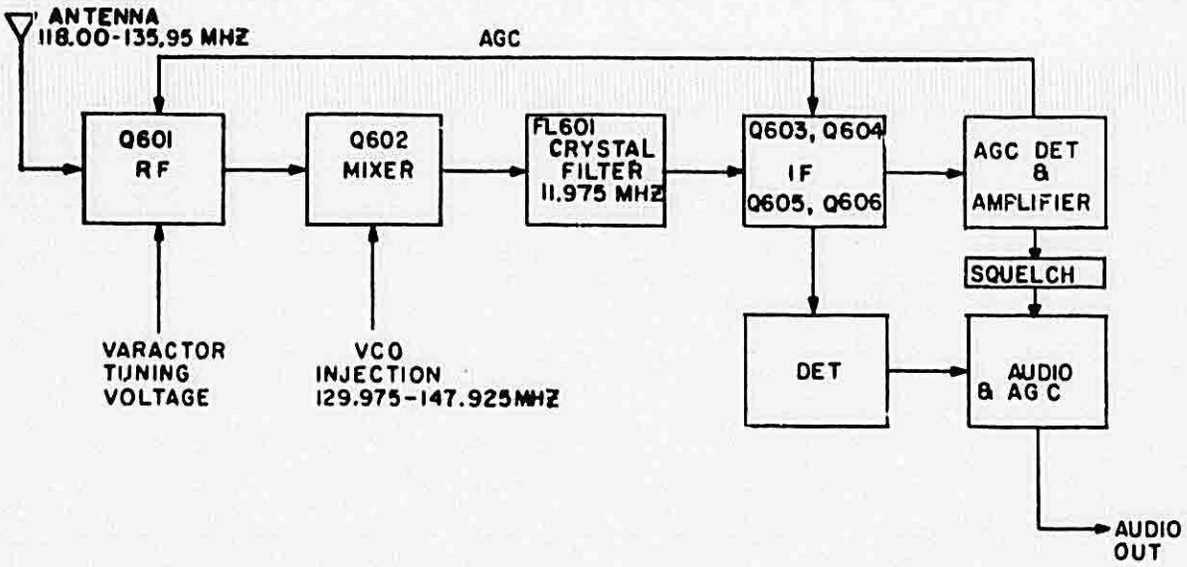


FIGURE 4.3-2 COM 111 TSO RECEIVER BLOCK DIAGRAM

4.3.1 Receiver

A. RF Amplifier, Q601

The RF Amplifier is a dual gate MOS-FET. Both gates of this device are protected (inside the device) so the device is not as susceptible to damage when soldering or unsoldering. The RF input to Q601 (Gate 1, pin 3) is taken from a tap on the RF input coil, L601. The drain, pin 1, is connected to L602 which is connected to A+ thru R606. Gate 2, pin 2, is connected to the AGC buss thru R603. Q614 functions as a dynamic source resistor. Under no signal conditions the AGC buss is approximately 4.5v. This forward bias on Q614 turns the transistor ON hard and it acts as a very low source resistor for the FET. As the AGC buss goes lower (with increasing signal), Q614 starts to turn OFF and its effective resistance goes up. This raises the source voltage. At the same time the Gate 2 voltage is going down. This voltage change (Vg2s) reduces the current in the FET and thus reduces the gain. The input and output tuned circuits are varactor tuned. The control voltage (derived from the Synthesizer VCO) is supplied to the junctions of CR602/CR610, CR603/CR611, and CR604/CR612. At the high end of the band this voltage is high (7.5v) thus causing the capacitance of the diodes to be low. This change in capacity tracks the receiver front end. The tuned circuits are aligned by tuning the capacitors (C603, C606, and C608) at the high end of the band; and the inductors, L601, L602, and L603 at the low end of the band.

B. Mixer, Q602

The Mixer is also a dual gate MOS-FET with both gates protected. The input to the Mixer is taken from the tap on L603 and applied to the input gate (Gate 1, pin 3). VCO injection is applied to Gate 2, pin 2. The VCO injection level is 1.5 v p-p. This VCO RF voltage changes the gain of the FET and thus modulates the RF signal input (pin 3). The difference frequency is selected by the crystal filter that is connected to the drain (pin 1) of the Mixer. L604 provides the drain load for the Mixer and C613 is used to tune the input to the crystal filter.

C. IF Filter, FL601

The crystal filter provides the final selectivity of the receiver. The 6 db bandwidth is 34 KHz and the 60 db bandwidth is 84 KHz. L605 provides additional filtering of VCO injection.

D. IF Amplifiers, Q603, Q604, Q605, and Q606

The IF Amplifier consists of four R-C coupled states. The tuned circuit (L606, C618) at the collector of Q603 is intended to reduce noise in the IF Amplifier. R665 provides degeneration in the last stage and its value may vary depending on the overall gain of the amplifier.

E. Detector

CR605 and CR606 detect the positive half of the IF signal present at the collector of Q606.

F. Audio Amplifier and Audio Leveling

The signal from the emitter of Q607 is coupled to the audio amplifier thru R660 after it goes thru the noise limiter circuit. The noise limiter is a peak limiting N/L with the clipping level set by the amount of modulation present. As the audio increases, the clipping level decreases to allow undistorted audio at high signal levels. Q608 is the stage to be gain controlled. The output of Q608 is amplified by Q609 and connected to the emitter follower, Q610. R642 is the volume control for the system and the output is tapped off this resistor. The output of Q610 is also connected to Q611. Q611 is used as a peak detector. As the output of Q610 increases, Q611 is turned ON harder. This causes the DC voltage at R645 to increase. This voltage is applied to the cathode of CR613 and tends to back bias the diode as the output of Q611 increases. CR613 is used as a dynamic degeneration resistor for Q608. As CR613 is back biased, the gain of Q608 decreases and the level of the audio output is controlled. Threshold action occurs due to the initial no signal condition of Q608. When no signal is applied, the emitter voltage of Q608 is pulled down due to the current flowing thru CR613. This causes Q608 to be running at a very low current and on the low end of the gain vs current curve. When an audio signal is applied CR613 starts to be back biased and this allows the voltage at the emitter of Q608 to rise slightly and the current thru Q608 to increase. This increases the gain of the stage. If there were no AC degeneration in the stage, the system would oscillate; but, since CR613 degenerates Q608, the system is stable. Thus, as an audio signal is applied, the output first rises rapidly and then remains constant as the input signal increases. R667 is selected to determine the level where the threshold action occurs.

G. AGC Detector and Amplifier

CR607 and CR615 detect the positive half of the IF signal present at the collector of Q606. The IF signal causes the current flowing thru CR607 to vary as the IF signal varies. The DC return for CR607 is R652 and R666 and the voltage at the base of Q613 will vary as the current thru R652 varies. Thus under no signal conditions the voltage at the base of Q613 allows the transistor to conduct hard and as the IF signal increases this voltage increases and turns the transistor OFF. The voltage at the collector of Q613 is used as the AGC voltage to the RF amplifier and the voltage at the junction of R649 and R650 is used as the AGC voltage to the IF Amplifier.

4.3.1 Receiver, Continued

H. Voltage Regulator

CR608 is an 8.2v Zener diode. The series resistor for the Zener is split and bypassed at the junction of the resistors. This gives added filtering for the regulated voltage.

NOTE:
Half of the series resistance and bypassing is located on the Interconnect Board.

I. Squelch Circuit

Q612 is used as a switch which is connected to the AGC line. As R647 is turned CCW, the transistor will turn ON thus shorting the AC and DC at the collector of Q609 to ground. When the AGC line goes low (with increasing signal input) the transistor will shut OFF and allow normal operation.

4.3.2 Interconnect PC Board Circuits

The Interconnect PC Board contains two seperate circuits.

A. Noise Limiter

The Noise Limiter is a peak limiting circuit as described in Section 4.3.1.F.

B. 30 mw Amplifier

This low level amplifier consists of a voltage amplifier driving a complimentary emitter follower (Q501 and Q503). Input is coupled in thru a capacitor (C508) to the base of the voltage amplifier. A feedback voltage divider provides both DC and signal feedback. Two diodes, CR503/CR504 provide foreward bias for the complimentary amplifier. The output is capacity coupled thru C507.

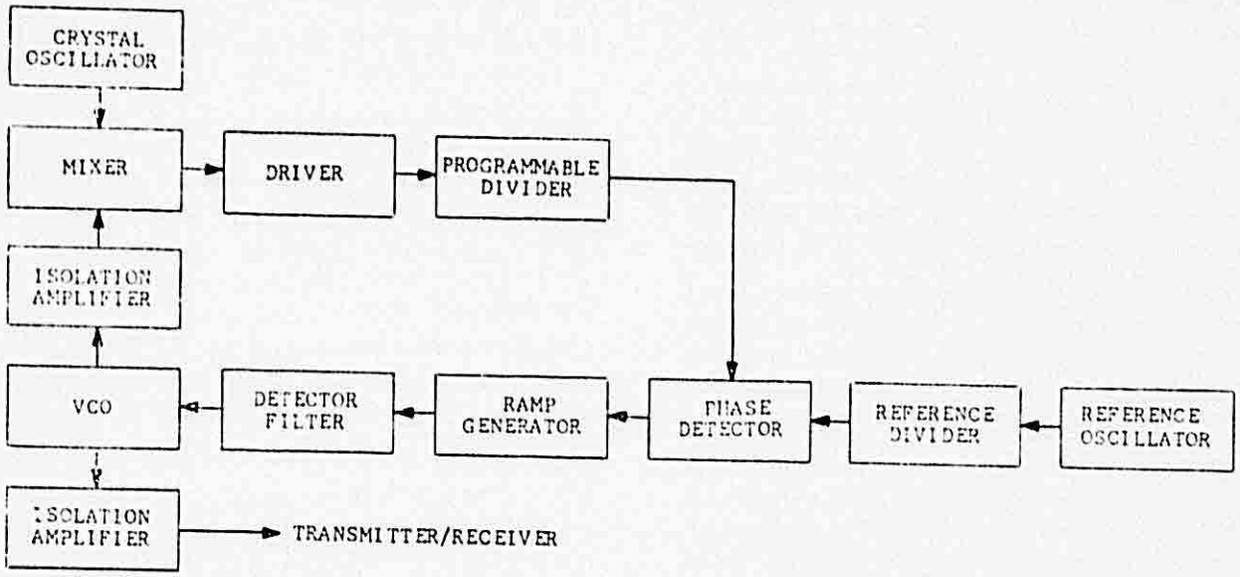


FIGURE 4.3-3 SYNTHESIZER BLOCK DIAGRAM

4.3.3 Synthesizer

Prior to the use of digital techniques, transceivers were tuned to channel by combining the outputs of two or more multiple crystal oscillators and using this resulting output to drive a transmitter or tune the receivers. In the digital synthesizer used in the COM 111 TSO only one frequency is generated and that is the frequency needed to tune the transmitter or receiver to the correct channel.

The utmost in simplicity could be achieved in transceiver construction if a simple variable oscillator coupled to the tuning dial and readout could be used to set the transceiver on frequency. Unfortunately no oscillator with the desired stability and accuracy is feasible, so some method must be used to set a variable oscillator on channel and maintain it there.

The digital synthesizer is just such a device. A variable oscillator which is voltage tuned is controlled and monitored by digital counting circuits. Outputs from these circuit guide the voltage controlled oscillator (VCO) to the proper channel and maintain the oscillator on that channel.

In order to obtain the needed accuracy the VCO must be compared with the output of a crystal controlled oscillator. A correction voltage developed to guide and correct the VCO. As a result, the VCO has the accuracy and stability of a crystal controlled oscillator.

Rather than compare the crystal and variable oscillators at the operating frequency, the VCO is divided to a frequency of only 50 KHz where it is compared to a 50 KHz crystal reference signal. The correction voltages developed to guide the VCO to the correct channel and maintain it there. Therefore, it is apparent that simply changing the divider ratio will move the VCO by some predetermined channel spacing.

The Synthesizer functions in the following manner:

A voltage controlled oscillator output in the 118.00 MHz to 135.95 MHz range (transmit mode) is heterodyned against a crystal oscillator to the 10 to 30 MHz range. This signal is then amplified and applied as a drive to the digital variable divider circuits.

The purpose of the variable divider is to reduce any of 360 possible frequencies present at the input to a fixed frequency of 50 KHz. The frequency which is selected by the channel selector knobs will be the one reduced to 50 KHz.

Channel selection is accomplished by programming the variable divider to divide by a value from 242 to 601 and then a control loop forces the voltage controlled oscillator to a frequency which will result in 50 KHz at the variable divide output.

Example:

Crystal 148.05
VCO 118.00
divider in 30.05 divided by 601 = 50KHz

4.3.3 Continued

In order to produce a control signal to the VCO the variable divider output is compared to a fixed 50 KHz signal by a frequency and phase comparitor circuit.

The 50 KHz reference signal is produced by a 3.20 MHz crystal oscillator and a reference divide by 64 chain.

Errors in frequency between the 50 KHz reference and variable divider output are converted to a change in tuning voltage to the VCO.

A "control voltage generator" circuit is utilized to convert the pulse outputs of the "frequency and phase compariator" circuit to a pure DC voltage suitable to tune the VCO.

Voltage regulator circuits convert the unregulated 14 vdc input to the 5.4 volts and 8.6 volts needed for the synthesizer circuits. RF output of the synthesizer is used as transmitter drive and receiver local oscillator injection. DC VCO tuning voltage is also fed to the receiver for tuning the receiver front end stages.

A. Logic Symbols and Truth Tables

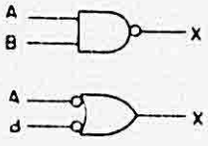
The various types of logic symbols used in the schematics are shown with the associated truth tables.

Two symbols are shown for each gate truth table. The use in the circuit determines which is shown on the schematic.

The small "o" at a terminal indicates a low state at the time of interest.

Two Input NAND Gate

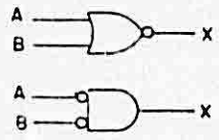
The first symbol illustrates applications where two high inputs are ANDed to produce a low output. The second symbol represents applications where two low inputs are ORed to produce a high output.



A	B	X
0	0	1
1	0	1
0	1	1
1	1	0

Two Input NOR Gate

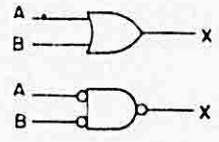
The first symbol illustrates applications where two high inputs are ORed to yield a low output. The second symbol illustrates applications where two low inputs are ANDed to give a high output.



A	B	X
0	0	1
1	0	0
0	1	0
1	1	0

Two Input OR Gate

The first symbol represents applications where two high inputs are ORed to give a high output. The second symbol represents applications where two low inputs are ANDed to give a low output.

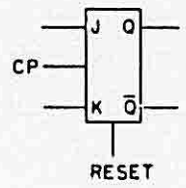


A	B	X
0	0	0
1	0	1
0	1	1
1	1	1

J-K Flip-Flop

The flip-flop triggers on the negative transition of the clock pulse. The time period prior to the negative transistion of the clock pulse is denoted t_n, and the time period subsequent to this transition is denoted t_n+1.

When the J and K inputs are high, the flip-flop changes state with each clock pulse. That is, the Q output after the clock pulse will have the same level as the Q output had prior to the clock pulse. If J is low and K is high, the Q output will go low and remain low. If J is high and K is low, the Q output will go high and remain high.



t_n		t_{n+1}
J	K	Q
0	0	Q_n
1	0	1
0	1	0
1	1	$\overline{Q_n}$

4.3.3 Continued

A. Voltage Regulators

Unregulated 14 volts is converted to 5.4 volt and 8.6 volt regulated output by voltage regulator circuits.

Each regulator consists of a series pass transistor (Q121 or Q117) a Zener diode reference voltage (CR118 or CR108), and a monitor amplifier (Q120 or Q119). A driver transistor, Q118 is added to the 5 volt circuit.

A voltage rise of the 14 volt input will cause a rise at a the center arm of voltage adjust potentiometer (R134 or R139) which will be inverted in the corresponding monitor amplifier causing a correction toward proper (5.4 or 8.6v) voltage output.

B. REFERENCE OSCILLATOR AND DRIVER

The reference oscillator Q112 is an untuned Colpitts type oscillator. The oscillator output is amplified by Q113 to a level sufficient to drive the IC divider chain (3v p-p).

C. CRYSTAL OSCILLATORS

Tuned Colpitts type crystal oscillators, Q101, and Q103 operate with the 7th overtone crystals. Only one oscillator at a time is turned ON by U117 which feeds approximately 3 volts to the desired oscillator.

Voltages at the base of an oscillator transistor causes emitter current to flow through the corresponding RF switching diode CR101, or CR103 resulting in only the desired oscillator being connected to Mixer, Q109.

D. VCO

The VCO is a grounded base Colpitts oscillator. The output frequency is determined by L104 in parallel with C124, C125, C126, and tuning diodes CR104 and CR105.

Amplifier, Q106, provides isolation and gain between the VCO and Mixer, Q109. Broadtuned amplifier Q107 is gated by an inhibit circuit which prevents transmitter drive when a malfunction occurs in the Synthesizer and also when the Synthesizer is searching during channeling or from transmit to receive.

E. MODE SELECTOR CIRCUIT

The Mode Selector must respond to command signals from transmit-receive key (transmit relay).

When the transmit relay is closed U117 will turn ON crystal oscillator Q101 and will maintain P103-3 near ground which activates the COM frequency selector. Q104 is turned ON restricting the VCO to its lower range.

The preceding operations are accomplished by four NAND gates in one IC. Three of the gates are wired as simple inverters and the fourth as an inverting AND gate (NAND) requiring a high input at pin 12 and 13 to produce a LOW at pin 11.

F. MIXER AND DRIVER

The Mixer and Driver circuits heterodyne the outputs of the VCO and crystal oscillator to produce the IC drive signal from the difference frequency. Q109 functions as a Mixer, and amplifier C170, L105, and C172 form a matching filter which rejects VHF signals and provides a proper match to Q110 in the 10 to 30 MHz range. Q110 provides voltage gain and Q111 provides current gain to drive ICs U111 and U112. The function of Z104 and Z105 (beads) is to reduce VHF radiation.

4.3.3 Continued

G. Control Voltage Generator

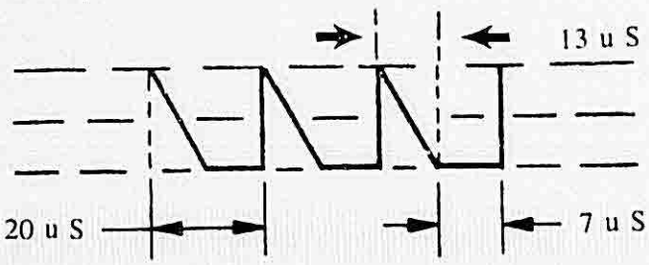
The Control Voltage Generator produces a variable DC control voltage for the VCO from pulse inputs from the Variable Divider and the Reference Divider.

The digital processing section functions on pulses and the VCO is controlled by pure DC. The following method is employed to change pulse information into a pure DC voltage.

To accomplish this transformation an IC gate is wired as a set-reset type flip-flop, U104 which changes alternately as negative going (high toward zero) pulses are fed into pins 9 and 13. The reference channel output will set the flip-flop to high at pin 8 and the variable channel (divide by N) output will reset the output to low at pin 8. A rectangular pulse is thus produced whose length represents the difference in timing between the two channel outputs.

Note that the two channels can take on any given timing difference (or phase difference) yet being identical in PRF (pulse repetition frequency).

One rectangular output of U104 is differentiated and turns Q114 ON causing the voltage at E107 to rise to 8 volts. The other rectangular output of U104 turns Q115 ON and charges C187 thus causing the voltage at E107 to go downward. The voltage will continue downward for the duration of the rectangular pulse. At the end of the pulse the voltage at E107 will level off until Q114 is turned ON again. The end result is a ramp as show.



The ramp generator consists of Q114, Q115, R175 (adjustable), and charging capacitor C187. Q114 conducts on the leading negative going pulse from pin 11 of U104. Setting the voltage at E107 to maximum (8.6v) turns Q115 ON and C187 beings charging toward zero, the end of the rectangular output from pin 8 of U104. C187 stabilizes until the next change of U104 when the sawtooth starts again from maximum (8.6v).

Since a DC voltage is required to control to VCO, a lower peak detector is used to convert the ramp to DC. Q116 provides the current amplification necessary and the combination of R179, C190, R182, and C191 provides additional filtering.

H. INHIBIT

When the VCO is not locked on a selected channel, pulses will appear at pin 8 of U110 or pin 8 of U113. These pulses will be passed through CR109 or CR110 and cause C177 to discharge which in turn causes Q122 and Q108 to shut OFF. The VCO buffer stage, Q107, is then non-conducting since its emitter current must flow through Q108.

I. VARIABLE DIVIDER

The Variable Divider can divide an input frequency by an integer from 242 to 601. This is accomplished by three methods: (1) pulse swallowing (2) fixed dividers (3) variable dividers. In this synthesizer the pulse swallowing circuits are part of the fixed dividers (divide by 2 and by 10).

Frequency division is accomplished by feeding an input signal first through a divide by two and pulse swallower then a divide by ten and pulse swallower and finally a divide by 12 to 29 circuit.

The divide by two and pulse swallower consists of U111 (divide by 2) and control flip-flop U112. If U112 is "cocked" by grounding pin 12, a pulse is "missed" by U111 every 20 microseconds thus requiring the input signal to raise by 50 KHz to make-up for the missing pulse. This results in a final VCO frequency of 50 KHz lower due to the conversion of the VCO to 12 to 30 MHz range.

The divide by ten can swallow up to nine pulses by programming the shift register U106 so that up to nine pulses are needed before the shift register outputs will satisfy "NAND" gate U105 and produce a pulse. U106 will continue to satisfy U105 once for every ten pulses applied to pin 10 of U106. Since the input signal has been divided by two, each "swallowed" pulse results in a raise of 100 KHz at the input frequency or up to .9 MHz. Thus the programming of U106 will set the .1 to .9 MHz channels. Again the VCO will go in the opposite direction due to mixing with a crystal oscillator to obtain the digital drive.

At the end of the divide chain is a programmable divider U107 and U108 which can divide by any integer between 12 and 29. Since the input signal has been divided by 20 prior to reaching this divider circuit, every increase by one results in a 20 channel change at the input or 1 MHz. Thus the programming of U107 and U108 will set the whole MHz channels.

4.3.3 Continued

J. REFERENCE DIVIDER

A 3.2 MHz crystal controlled frequency is divided by 64 to produce a 50 KHz reference signal by the reference divider consisting of 3 dual JK flip-flops, Q101, U102, U103 and a NAND gate, U113.

Since the clock pulses are connected to both flip-flop stages in an IC (i.e. U101), then both would change state every time a clock pulse was applied except that pin 6 output of one flip-flop is connected to the JK inputs pin 11 and 12 of the other allowing it to respond only to alternate clock pulses.

A narrow pulse output is desired so NAND gate U113 is used to gate through the output of Q113 once every 64 pulses from Q113.

One half of U113 is used to derive a pulse to drive U104 and the other half to inhibit flip-flop, U101 when the system has not yet "locked on."

K. RESTRICTION CIRCUIT

It is necessary to restrict the VCO tuning voltages in the different modes of operation so that the VCO frequency will remain within a range that the digital circuit can correctly respond to and produce proper correction voltages.

In COM receive the circuit will limit the lowest VCO voltage to 4 volts. R128, R129, R130 form a voltage divider and CR107 is a clamping diode. The VCO voltage cannot go lower than 4 volts at the cathode of CR107.

In transmit this circuit is disabled by Q104 which grounds the cathode of CR106 reducing the voltage of the anode of CR107 to less than 1 volt and a maximum of only 5 volts can be produced since Q104 is ON and CR117 is conducting causing a reduction in the voltage available at Q116 emitter.

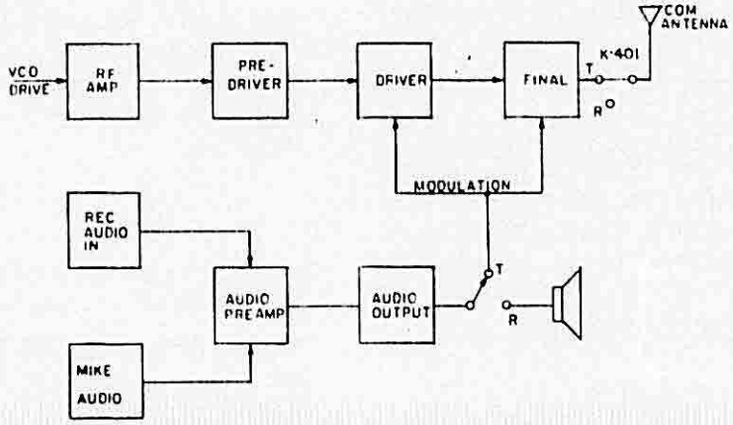


FIGURE 4.3-4 TRANSMITTER/MODULATOR BLOCK DIAGRAM

4.3.5 Transmitter/Modulator, COM 111 TSO

The COM 111 TSO transmitter is capable of operating on 360 channels, with 50 KHz spacing within the frequency range of 118.00 and 135.95 MHz.

The Transmitter/Modulator Assembly is self-contained and easily removed. (Remove four mounting screws, unsolder three wire leads and two coax leads, and unplug three connectors.)

The transmitter which is broadband and requires no external tuning, amplifies the RF energy to a final output power level of 8 watts minimum. The last two amplifier stages (Q411/Q412) are collector modulated by the audio modulator to provide a minimum of 85% modulation of the RF carrier.

A. RF Amplifier, Q401

The Synthesizer provides approximately 1 milliwatt of RF energy which is coupled to the base of Q401 thru C401. This Class A operated stage is biased by the resistor network (R402, R403) and the emitter bias resistor (R404). Q401's amplified signal (at the collector) is applied to the broadband interstage network (L401, L413, C405, and C406) This network provides the necessary bandwidth and impedance transformation to drive the predriver amplifier, Q402.

B. Predriver Amplifier, Q402

The Predriver Amplifier, Q402, is partially biased by virtue of the resistor network (R405/R406) and the emitter resistor (R407). However, this quiescent bias is altered when driven by Q401. The amplified signal from this stage is applied to the broadband, impedance transforming, network which consists of R408, L403, L404, C410, and C412.

C. Driver Amplifier, Q411

As in the Predriver Amplifier, the Driver Amplifier, Q411, is partially biased by the resistor network (R410 and R437). R437 is a selected resistor whose value is determined by the DC Beta of Q411. The value of this resistor should be such that the emitter current of Q411 does not exceed a quiescent value of more than 600 milliamperes. Temperature stability of Q411 is accomplished by virtue of the internal emitter bias resistors. The operating bias of this stage is determined by the DC bias as well as that due to RF drive. The collector is coupled to the base of the Final Amplifier by means of C463, C416, and L406.

Audio modulation of this stage is accomplished by the action of CR401, CR402, R428, and R429. These diodes and resistors provide full "upward" modulation and partial "downward" modulation of the collector of Q411. This partial modulation of Q411 provides the proper modulated base drive to be applied to the Final Amplifier.

D. Final Amplifier, Q412

Q412 is an RF power amplifier capable of being high level collector modulated, and delivering a minimum of 8 watts of carrier power. This stage obtains its operating bias by virtue of the RF base drive from Q411. This causes base current to flow thru R413 which biases Q412 into the "Class C" region. The RF energy at the collector is coupled to the harmonic filter by the impedance transforming network (L412 and C462). The harmonic filter consists of L409, L410, C422, C423, C424, C425, and C426.

Modulation of this stage is accomplished by applying the audio voltage to the collector of Q412. Overmodulation is prevented by virtue of the design of the modulator which limits the peak audio voltage to a value which is less than the DC collector voltage on Q412.

E. Modulator

The Modulator consists of a voltage amplifier Q405, and a pair of push-pull Darlington output amplifiers, Q406/Q407 and Q408/Q409. Q410 serves as a wide range temperature regulator to control the bias applied to the audio output stages. The Modulator is capable of delivering a power output of 11 watts into a 6 ohm load.

The Modulator also serves as the receiver audio amplifier in the receive mode. In this mode it is capable of 14 watts into a 4 ohm load.

4.4 COM 111 TSO MAINTENANCE

The following procedure may be used to determine which sub-assmebly is malfunctioning:

Check each sub-assembly for the proper inputs. If all inputs are present but the proper output is not obtained, then the sub-assembly is defective. If an input is not present, refer to the sub-assembly that generates this input and check it for proper operation.

RECEIVER BOARD

With an RF input from a signal generator modulated at 30% with 1 KHz, the following outputs should be noted:

.10V rms at E-623 with 3 uv input
.30V rms at E-623 with 500 uv input
.7V rms at E-621 with 5 uv input

If these outputs are not present or if any other receiver associated problems are noted (AGC SQUELCH, WEAK AUDIO, WEAK FLAG, etc.) check all receiver inputs.

INPUT	Test Point	From	Level
A+	E-601	INTERCONNECT BOARD	10.5 VDC
DC TO VARACTORS	E-605	SYNTHESIZER	4 VDC (118) 7.5 VDC (135)
INJECTION	E-612	SYNTHESIZER	.5-1.0V RMS RF
SQUELCH	E-620	FRONT PANEL POT	ON-.7 VDC, OFF-GND
RF INPUT	E-604	TRANS./MOD. ASS'Y.	(Noted above)

To remove the receiver board, unsolder all connections to pins and remove the four screws.

TRANSMITTER AND MODULATOR ASSEMBLY

The modulator amplifies the low level audio from the receiver and provides speaker and headphone outputs. The transmitter amplifies the drive from the Synthesizer and provides RF power to the antenna.

OUTPUT	COM 111 TSO	TEST POINTS
Speaker	10 watts	J401A-5
Headphones	50 milliwatts	J401A-3
Transmitter	8 watts min.	P402

If these outputs are not present or if any other transmitter/modulator problems are noted, check all inputs.

Input	Test Point	From	Level
Receive Audio	J-401A #7	Interconnect Board	.5V rms
Mike Audio	J-401A #9	Microphone	.2V rms
Transmitter Drive	J-403	Synthesizer	1 mw (RF)
A+	E-532	Interconnect Board	13.75 VDC

SYNTHESIZER BOARD

The Synthesizer provides the local oscillator injection to the receiver and the transmitter drive. The synthesizer also generates the DC contol voltage for the receiver front end. To check synthesizer operation, connect the output to a counter and check the frequency in receive. The frequency should read 11.975 MHz above the desired channel and in transmit the frequency should be that of the desired channel.

Local oscillator injection level - .5 to 1.0V rms (RF)
Transmitter Drive - 1 mw minimum
DC Control Voltage -4 VDC (118 MHz) to 7.5 VDC (135 MHz)

If these output are not present or if any other synthesizer problems are noted, check all inputs.

Input	Test Point	From	Level
Programming (Channeling)	A thru L	Front Panel Switches	High (1) = 4 VDC + Low (0) = .7 VDC −
(Refer to Programming Code)			
Transmit-Receive	P-103(12)	Transmit-Receive Relay	High (1) = 4 VDC + Low (0) = .7 VDC −
A+	P-103(8)	Interconnect Board	13.75 VDC

To remove Synthesizer Board disconnect J-103, J-104, J-106, P-101, and P-102. (To remove J-103 - first remove screw from Receiver Board.) Remove five screws from Synthesizer Board.

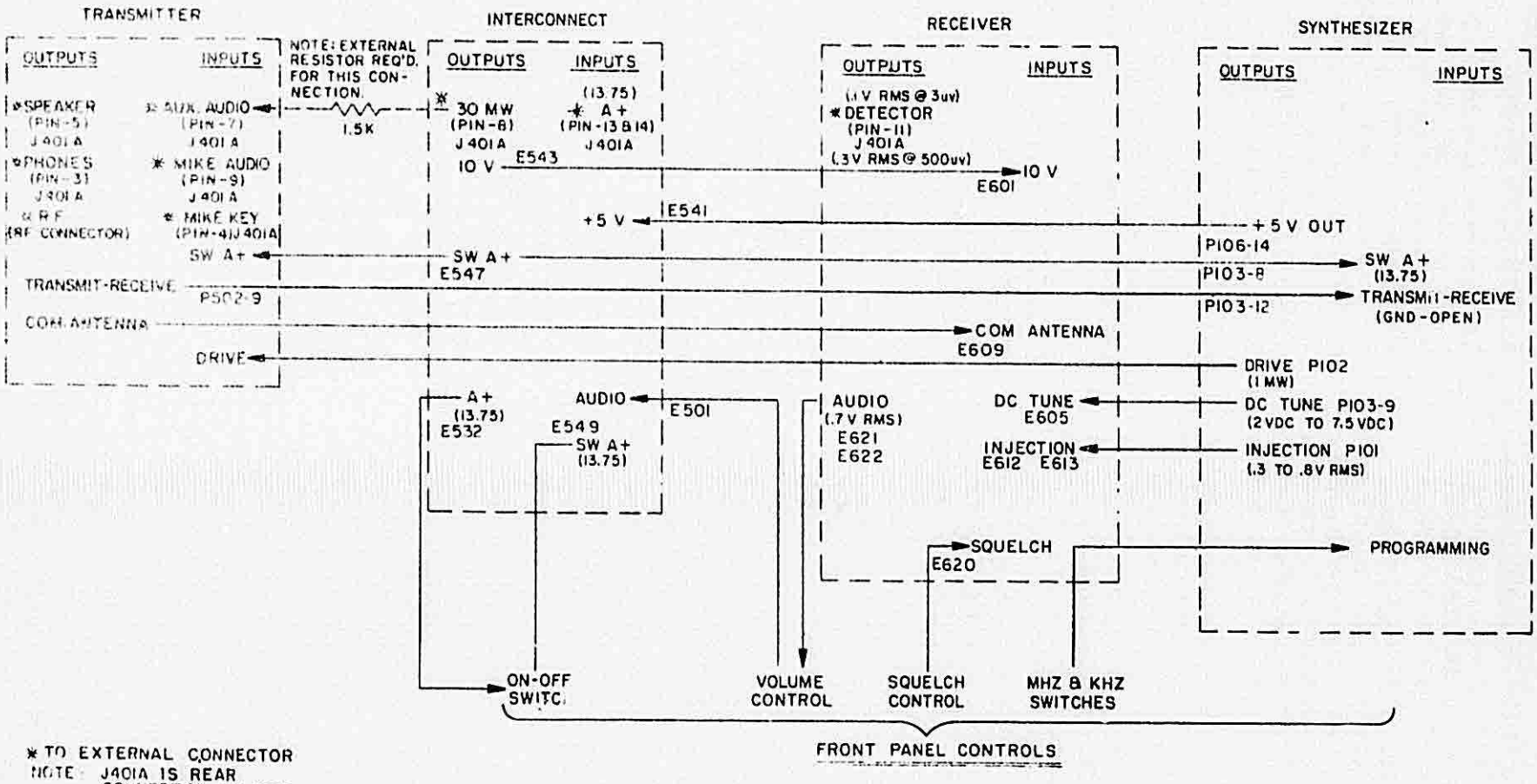


FIGURE 4.4-1 COM 111 TSO INTERCONNECTIONS

4.4.1 Test Equipment Required For COM 111 TSO

(1) DC Power Supply - 15v at 5 amps. (for entire unit)
(2) VTVM - RCA Voltohmyst or equivalent.
(3) AC Voltmeter - Ballentine 300D or equivalent.
(4) Hewlett-Packard, HP608 Signal Generator or equivalent.
(5) Resistance Substitution Box
(6) A Counter

4.4.1.1 Receiver Troubleshooting

If all inputs to the receiver are present but one or both outputs are defective, follow the guide to determine which section of the Receiver Board is malfunctioning. After determining which section is at fault, refer to the schematic and text for that section.

PROBLEM	SECTION
Audio Problems Det. OK	Audio Section (Q608 thru Q612)
Detector Problems No signal - No Noise	IF, Detector Section AGC Section Voltage Regulator Section
Detector Problems No signal - Noise present	RF Section Crystal filter
Detector problems AGC	AGC Section
Selectivity Problems	Crystal Filter RF Section (Varactors)

A. Voltage Regulator

The regulated voltage for the receiver board is supplied by the Zener diode CR608. The series resistance for the Zener is split with a filter capacitor in the center to provide better filtering on the 8.2v Zener. The two series resistors are each 27 ohms. Half of the filter is located on the Interconnect Board.

Always check the 8.2v line before attempting to troubleshoot any section of the Receiver Board.

B. RF Section

Active Devices:

The RF Amplifier and Mixer are described in the Circuit Description Section. To determine if the active devices (Q601 and Q602) are defective, the current thru each device must be measured. To measure the current, place the negative lead of a VTVM on the 8.2 line (the feed-thru near the 82mf capacitor) and the positive lead on the drain of each FET (no signal input). Multiply the voltage reading by ten to determine the current in milliamps. This current should be approximately 4-5 milliamps for the RF stage and 2-4 milliamps for the Mixer. Gate 1 cannot be checked easily since it is at DC ground potential, but if all other checks indicate the device is good and no signal can be driven thru the device, Gate 1 is probably defective. Both Gate 1 and Gate 2 are protected so there is little probability that they would be defective except under extreme conditions.

B. (1) Varactors

The Varactors can be checked by measuring the DC voltage at the junctions (at the cathode of the varactors). There should be no voltage drop across the 100K ohm resistors feeding the varactors. A voltage drop indicates a defective varactor. If any tuned circuit does not peak, especially if the inductance goes to minimum, an open varactor may be indicated.

B. (2) AGC

The AGC operation of the RF amplifier is described in the Circuit Description Section. The AGC can be checked by measuring the current of the RF amplifier as the input signal is increased. Current readings should start at approximately 4-5 milliamps with no signal and go to approximately zero with a large signal input. If this does not occur, check for a defective Gate 2 or defective Q614. Q614 can be checked by measuring its collector voltage. This voltage should start at approximately .5vdc with no signal and rise to approximately 1.0 with a large signal input.

4.4.1.1 Continued

C. IF Section
C. (1) Crystal Filter

The Crystal Filter provides the final selectivity for the receiver, the 6 db bandwidth is 34 KHz and the 60 db bandwidth is 84 KHz. The ultimate attenuation of the Crystal Filter is 80 db, minimum. This means that as the frequency moves further away from center frequency the rejection will get no better than 80 db. To determine if a filter is defective, check the insertion loss thru it by first driving an 11.975 signal into the IF Amplifier (at the filter output) and monitor the detector output. After a reference level is obtained, drive the 11.975 MHz signal in the injection port (remove the VCO drive) and ground the source of the mixer. This allows the mixer to function as an amplifier and the filter can be checked without loading it. The approximate level for.10v rms detector output is 5 uv. The filter can be checked for selectivity by measuring adjacent channel rejection. This should be 60 db minimum.

C. (2) Amplifier

The IF Section is described in the Circuit Description Section. If the IF Section is functioning properly there should be some noise at the detector. If there is no noise at the detector, one stage of the IF or the detector is probably defective. The IF stages may be checked by measuring the voltages as listed in Table 4.4.1. The detector and OMNI buffer may be checked in the same manner. If all these voltage checks prove to be right, a faulty bypass might be suspect. This can be checked by monitoring the detector output and bypassing each emitter of all the IF Amplifiers with a .05 mf capacitor. If the noise level comes up significantly when this done, a defective bypass is indicated. Another means of checking the IF stages is by monitoring the detector and driving an 11.975 MHz signal (modulated at 1 KHz) in the base of the last IF stage. With a 10mv rms signal applied, a .10v rms signal should be seen at the detector. If none is present, this stage would be suspect. If a signal is present, the injected signal can be moved back to the next base and so on, with a gain of approximately 25 db per stage noted. In this manner a defective component may be found.

D. AGC Section

The AGC Detector and Amplifier is described in the Circuit Description Section. If the AGC operation is not functioning, check the DC voltages listed in Table 4.4.1 Check tantalum capacitor (C639) for short circuit. Check CR607 and CR615 (by voltage measurements) and check C641 for an open circuit. Refer to the RF Section (AGC) if all measurements are proper.

TABLE 4.4.1.
RECEIVER DC VOLTAGE MEASUREMENTS

Transistor	Pin 1	Pin 2	Pin 3	Pin 4
Q-601(A)	7.5	4.0	0	.6
Q-601(B)	8.0	2.2	0	1.1
Q-602	7.5	.8	0	1.5
	E	**B**	**C**	
Q-603(A)	1.0	1.7	3.7	
Q-603(B)	.3	1.0	6.0	
Q-604(A)	1.0	1.7	3.7	
Q-604(B)	.3	1.0	6.0	
Q-605	.8	1.5	4.5	
Q-606	1.6	2.0	4.0	
Q-607	.8	1.4	5.6	
Q-608(A)	6.6	6.0	.3	
Q-608(B)	6.6	6.0	1.0	
Q-609	.1	.6	4.0	
Q-610	3.5	4.0	8.0	
Q-611	8.0	8.0	6.0	
Q-612	0	.6	0	SQUELCHED
Q-612	0	0	4.0	NO SQUELCH
Q-613(A)	7.2	6.5	4.0	
Q-613(B)	7.6	7.0	2.2	
Q-614(A)	0	.7	.6	
Q-614(B)	0	.65	1.1	

(A) No signal input
(B) 500 microvolts RF signal input 30% mod @ 1000 Hz

4.4.1.1 Continued

E. Audio Section

The Audio Amplifier and Audio AGC circuits are described in the Circuit Description Section. To check the audio circuit, first measure all DC voltages listed on the chart. Be sure to remove the squelch when making the DC measurements. When the problem in the audio section is that of no output, the DC measurements should indicate the defective component. When the problem is weak output or no audio leveling, the DC measurements may not suffice. A defective diode (CR613) may cause weak output. This can be checked by shorting the diode and noting the output. If the output increases to the point of clipping, the diode would be suspect. If C636 were defective, the output would also be weak but the short across CR613 would not cause an increase in output. The audio leveling would malfunction if Q611 and/or CR613 were defective. R667 controls the threshold point of the AGC (that point where maximum gain occurs). If this value is set too low the maximum gain point could occur on noise only. This would cause a poor signal to noise ratio. The squelch circuit is described in the Circuit Description Section. If Q612 were shorted, the audio output would be dead at all times and, if it were open, the audio output could never be squelched. The selected resistor across the squelch pot determines how deeply the receiver may be squelched. Raising this resistor value would require more input signal level to break the squelch, lowering this value would require less signal.

The following chart may be used to determine if each section is functioning properly. These levels are nominal values and they may vary slightly from radio to radio. Any major differences (25%) in these levels would indicate a defective section.

SECTION	INPUT	AT	OUTPUT	AT
Audio Section	.15v rms of 1000 Hz	Emitter of Q607	.7v rms	E621
IF Amplifier	5-10 uv at 11.975 MHz with 30% Mod. @ 1000 Hz (Filter disconnected)	E625	.10v rms	E623
Crystal Filter	20 uv @ 11.975 MHz with 30% Mod. @ 1000 Hz	E624	.10v rms	E623
Mixer (as Amplifier) (Source Shorted to GND)	5 uv @ 11.975 MHz with 30% Mod. @ 1000 Hz (injection disconnected)	E612	.10v rms	E623
Mixer (as Mixer)	7 uv @ RF freq. with 30% Mod. @ 1000 Hz	Gate 1 (pin 3 of Q602)	.10v rms	E623
RF	3 uv @ RF freq. with 30% Mod. @ 1000 Hz	E604	.10v rms	E623

4.4.2 COM 111 TSO Receiver Tuning Procedure

1. Turn DC power supply ON, (A+ 13.75 vdc) and check Zener voltage (8.2v ±5%)
2. Connect AC VTVM to omni output (E623)
3. Set channel selector to 135.00
4. Set signal generator to 135.00 (zero-beat generator)
5. Set signal generator output level to give a useable indication on AC VTVM.
6. Tune C613 and L606 for maximum response (reduce generator level if necessary)
7. Tune C603, C606, and C608 for maximum output on AC VTVM
8. Set channel selector to 118.50
9. Set signal generator to 118.50 and tune L601, L602, and L603 for maximum output
10. Set channel selector to 135.50
11. Set signal generator to 135.50 and tune C603, C606, and C608 for maximum output
12. Repeat steps 8-11 until no further increase in output is noted
13. Set channel selector and signal generator to 135.50
14. Note change in output (in db) as RF input is varied from 10 to 10K microvolts
15. If output varies by more than 1 db change R666 to bring variation within 1 db (lower value of R666).
    (When adjusting R666 monitor the voltage at the collector of Q604. This voltage should not be lower than 3.5v with no signal input, If this voltage is lower than 3.5v raise R666)
16. Set RF input to 500 microvolts @ 30% modulation 1000 Hz
17. Set output to .30v rms by adjusting R659 (.30 ±.02v rms)
18. Check output @2.0 uv (.10v rms minimum) if level is less than the minimum allowed, lower the value of the AGC selected "R" (R666) until the minimum is achieved
19. Repeat steps 16-18 until both requirements are met (500 μv level and 2μv level)
20. Monitor audio output with AC VTVM
21. Set the signal generator to 50μv @ 20% modulation 1000 Hz
22. Check AGC by varying modulation from 20% to 100%, maximum increase in output = 2 db
23. If output exceeds 2 db increase, lower value of selected "R" (R667)
24. Check AGC action from 2 μv to 10K μv @ 30% modulation 1000 Hz (maximum allowed ±3 db). If output exceeds 3 db increase, lower value of selected "R"
25. Check sensitivity @ 135.50 (2 μv maximum for 6 db S+N/N)
26. Check sensitivity @ 118.50 (2 μv maximum for 6 db S+N/N)
27. Check adjacent channel rejection using AGC voltage as a reference (minimum = 60 db) @ 135.00
28. Check image using AGC as a reference (minimum=60 db).

4.4.3 Synthesizer Troubleshooting

COM SYNTHESIZER SUB-ASSEMBLY TEST

A. COM - RECEIVE MODE

1. Connect unit under test to system harness and set controls for COM-Receive Mode
2. Check J103-8 for A+ (approximately 12 volts)
3. Check J103-16 for 5 VDC
4. Check J103-12 for 2.5 volts (approximately)
5. Check J103-3 for .5 volts (approximately)
6. See Table 4.4.2 and check U114, U115, and U116 for proper coding.
7. Rotate MHz channel selector and note stepping voltage of approximately .2v per MHz at J103-9 (4 to 7.5v)
8. Connect a counter to P107 and check frequency. Dial +11.975 .005% (Note output, approximately 3-10 milliwatts)

B. COM-TRANSMIT MODE

1. Apply a ground to J103-12 or key transmitter.
2. Check voltage at J103-9 voltage should step as MHz channel selector is rotated (2-3 volts to approximately 4 volts)
3. Counter connected to P101 should read dial frequency ± .005%

Regulator Alignment

Set R134 for 5.4 volts at emitter of Q117
Set R139 for 8.6 volts at emitter of Q121

Test - vary input voltage from 11 to 16 volts.

5.4 volts: should not vary more than .3 volts.
8.6 volts: should not vary more than .6 volts.

NOTES:

Accidental shorts will usually damage Q120, Q118, Q119 and not the pass transistor (Q121 or Q117).

The heat sink becomes hot when synthesizer is tested unmounted.

The load on the 5.4v regulator is 510 ma.
The load on the 8.6v regulator is 90 ma.

Reference Oscillator Alignment

Select C186 to produce a frequency of 3200.590 KHz at the collector of Q113. This alignment is necessary if the crystal is replaced.

Test

4 v p-p at collector of Q113 at 3200.590 KHz ± 20 Hertz.

Crystal Oscillator Alignment

Monitor E106 with a high frequency scope or VTVM with an RF probe. Set coil slug to middle on "ON" range for troubleshooting. When synthesizer is in full operation check output frequencies and reset if necessary for:

Synthesizer Output		Mode	Frequency Selected
126.00	± 3 KHz	Transmit	126.00 MHz
137.975	± 3 KHz	Receive	126.00 MHz

NOTES: Use only NARCO crystals.
Slugs are cemented to prevent detuning by vibration.

Oscillator output can be monitored with a scope or VTVM equipped with an RF probe at E106. This is a result of the mixing of the crystal and the VCO.

TABLE 4.4.2 Synthesizer Programming

MHz NAV	MHz COM	U115 8	U115 11	U115 3	U115 6	U116 11	U116 3	U116 6	Fractional MHz	U114 8	U114 11	U114 3	U114 6	U116 8
	118	1	1	0	0	1	0	1	.00	1	0	1	1	1
	119	1	1	1	0	0	1	0	.05	0	0	1	1	1
	120	0	1	1	1	0	0	1	.10	1	0	0	1	1
	121	0	0	1	1	1	0	0	.15	0	0	0	1	1
	122	1	0	0	1	1	1	0	.20	1	0	0	0	1
	123	0	1	0	0	1	1	1	.25	0	0	0	0	1
	124	0	0	1	0	0	1	1	.30	1	0	0	0	0
	125	0	0	0	1	0	0	1	.35	0	0	0	0	0
108	126	0	0	0	0	1	0	0	.40	1	1	0	0	0
109	127	1	0	0	0	0	1	0	.45	0	1	0	0	0
110	128	0	1	0	0	0	0	1	.50	1	1	1	0	0
111	129	0	0	1	0	0	0	0	.55	0	1	1	0	0
112	130	1	0	0	1	0	0	0	.60	1	0	1	1	0
113	131	0	1	0	0	1	0	0	.65	0	0	1	1	0
114	132	1	0	1	0	0	1	0	.70	1	1	0	1	1
115	133	0	1	0	1	0	0	1	.75	0	1	0	1	1
116	134	0	0	1	0	1	0	0	.80	1	1	1	0	1
117	135	1	0	0	1	0	1	0	.85	0	1	1	0	1
									.90	1	1	1	1	0
									.95	0	1	1	1	0

NOTE: "1" represents above 2 volts
"0" represents below 1 volt
Values in table are inverted from switch inputs.

4.4.3 Continued

VCO Alignment

Proper alignment of the VCO can best be accomplished in a radio with the Synthesizer operational.

(a) Channel radio to 118.95 MHz transmit mode, voltage on feedthru capacitor C136 should be adjusted to 2.5v ±.05v with L104.

(b) Channel radio to 135.95 receive mode, (VCO out at 147.925 MHz) adjust C126 for 7.6 ±.1 volts.

(c) Repeat steps (a) and (b) until both meet proper levels.

Test

Short collector of inhibit switch Q108 to ground to prevent inhibit circuit from turning Q107 OFF. An output of 3 milliwatts (minimum) should appear at P101 in receive mode. Voltage at C136 should vary from approximately 4 volts at 118.95 to 7.6 volts at 135.95 in approximately .2 volt steps as the MHz dial is channeled clockwise between the two frequencies.

NOTES:

Due to restriction circuits, VCO cannot be tuned to 118.95 unless transmitter key input is grounded.

If the Synthesizer is not operational the VCO can be aligned by removing the VCO control line from E105 and applying proper tuning voltage to the VCO control line.

Adjust T101 for maximum output at 126.00 transmit mode. This is a very broad tuned circuit and usually does not require adjustment.

Mode Selector

The Mode Selector can be best tested by replacing U117 with a known good IC.

Mixer and Drive Test

(a) During normal operation, a 4v p-p signal will be present at E106.
(b) Set channel selector to 118.00, frequency reading should be 30.05 MHz.
(c) Set channel selector to 135.95, frequency reading should be 12.10 MHz.

It is important that the peaks go below .8 volts as measured on a high frequency scope.

NOTE:

If either the VCO or the Crystal Oscillator is not functioning no output will be present at E106.

Control Voltage Generator Alignment

The Synthesizer must be aligned in a working radio or suitable test fixture. Set COM frequency to 118.00, transmit mode, adjust R131 for the following waveshape:

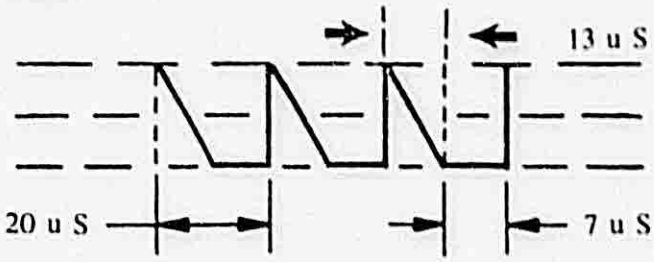


FIGURE 4.4-2. RAMP

NOTE:

Setting of R131 is not critical for troubleshooting, that is, an improperly set R131 will not stop the operation of the unit, however, it must be set properly to ensure reliable operation of the radio.

Inhibit

Test

Ground the VCO control line at E105. The output at P101 should drop approximately 20 db.

Variable Divider

Check pin 14 on the 14 pin IC and pin 16 on the 16 pin IC for 5vdc.

Test

Check for 3v minimum p-p at E106.
Check pin 5 of U111 for a square wave (approximately 3 v p-p) output.
Check pin 6 of U105 for negative going pulses.
Check pin 9 of U106 for negative going pulses approximately .1 microsec wide at 20 microsec spacing (during lock).

Reference Divider

Test

Check pin 1 of U101 for 4v p-p at 3.2 MHz.
Check pin 8 of U101 for approximately 3v p-p at .8 MHz.
Check pin 8 of U102 for approximately 3v p-p at .2 MHz.
Check pin 8 of U103 for approximately 3v p-p at .05 MHz.
NOTE - If system is not locked, remove U113 to perform the test.

Restriction Circuit

Adjustment: Set R130 for 4.2 volts at the plus side of C199.

Test

Check the collector of Q104 for near zero volts in NAV and Transmit modes, and approximately 4.8 volts in COM Receive.

4.4.4 Troubleshooting Procedure for COM 111 TSO Transmitter/ Modulator

In the event that difficulty should arise in the operation of the Transmitter/Modulator, the following information can be used as a guide in localizing and diagnosing the problem.

A. Remove the top dust cover from the unit. This is retained by 6 sheet metal screws.

B. Connect the RF Power Meter, connectors, microphone, etc. to the unit. A 10 amp regulated power supply should be used to supply the 13.75 vdc (A+).

C. Determine that the Transmitter/Modulator, hereafter called module, has A+ applied when the mike key is depressed. This voltage can be measured on the Interconnect Board at the junction of R505 and the Yellow #18 wire.

D. With A+ applied, a normally operating module should deliver a minimum RF power output of 8 watts, and should be capable of minimum of 85% modulation. If either of these two conditions cannot be met, proceed as follows.

(1) No RF or low RF power output.

(a) Remove phone plug which supplies RF drive power from synthesizer. Connect a suitable signal generator, tuned to 125 MHz, to the mating plug and key the unit. Set RF drive level to one milliwatt, minimum.

(b) If 8 watt (minimum) output is not obtained, the module should be removed from the unit before continuing the troubleshooting. Proceed to step E.

(2) No modulation or inadequate modulation.

(a) Connect an audio wattmeter, or a 6 ohm, 25 watt resistor between pin 5 of the modulator PC board, P401A, and ground. Pin 5 of P401A is the speaker output connection. With A+ turned ON apply a 1.5v rms, 1 KHz signal to pin 7 of P401A (Do not key the transmitter under these conditions since this will disconnect both the audio signal and the 6 ohm load.) The modulator should now be delivering approximately 11 watts of undistorted audio power. This is equivalent to 8.1 v rms across the 6 ohm resistor. If this condition cannot be met, proceed to step E.

M24

4.4.4. Continued

E. Removal of Module.

In the event that the difficulty with the module cannot be diagnosed, localized, and corrected by referring to steps D1 and D2, it will be necessary to remove the module from the unit. Unsolder three wires (two Yellow and one Red) and two coax cables coming from the module to the unit. Also disconnect the phono-plug and the two IC connectors from their respective mates.

Removing four screws holding the module to the side rail will permit the removal of the module from the unit. Once the module is out of the unit, remove the three screws (on the printed circuit board side of the module) holding the audio PC board to the transmitter heat sink. The module will now open 180 degrees in a clam shell fashion, permitting access to the Transmitter/Modulator section. If the problem appears to be in the Transmitter, unsolder and remove the two shields covering the RF section and the harmonic filter.

(1) RF Section and Harmonic Filter
Connect the module as shown in Figure 4.4-4.

NOTE: As can be seen in Figs. 4.4-4, the RF drive power can be obtained from either a signal generator or a sweeper. The preferred method is to sweep the module from 100 to 150 MHz, using a Texcan VS-50, Texcan VS-80, Wavetech 1001, or any equivalent swept source having built-in markers. This will permit a display of power output vs frequency, which greatly facilitates the troubleshooting procedure. If a sweeper is not available, a signal generator such as a HP 608D or equivalent can be used. In this case, specific frequencies will have to be preset manually.

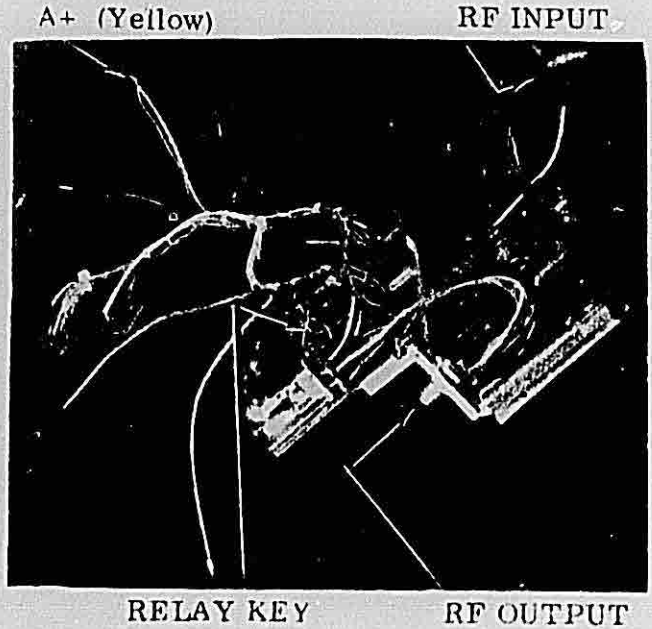


FIGURE 4.4-3 TEST CONNECTIONS

(a) Drive the module with 1 mw at approximately 125 MHz, turn on A+ and using a high impedance VTVM, measure the DC voltages at the collector, emitter, and base of the RF transistors. Typical voltages are. (±20%).

Transistor	With RF Drive	Without RF Drive
Q401 C	+11.7 vdc	+12.0
Q401 E	+ 0.5	+ 0.45
Q401 B	+ 1.1	+ 1.15
Q402 C	+13.0	+13.3
Q402 E	+ 1.1	+ 0.47
Q402 B	+ 1.0	+ 1.1
Q411 C	+12.5	+12.8
Q411 E	+ 1.5	+ 1.4
Q411 B	+ 1.2	+ 2.1
Q412 C	+13.3	+13.6
Q412 E	0	0
Q412 B	− 0.7	0

Large voltage variations from these typical values require a component check of the particular stage.

(b) The total current drain under CW conditions should be approximately 2 amps. The current drain without RF drive is approximately 500 ma.

(c) Apply swept drive to the module, and observe the detected waveform on the scope. Figure 4.4-5 presents a typical waveform of a normally operating transmitter.

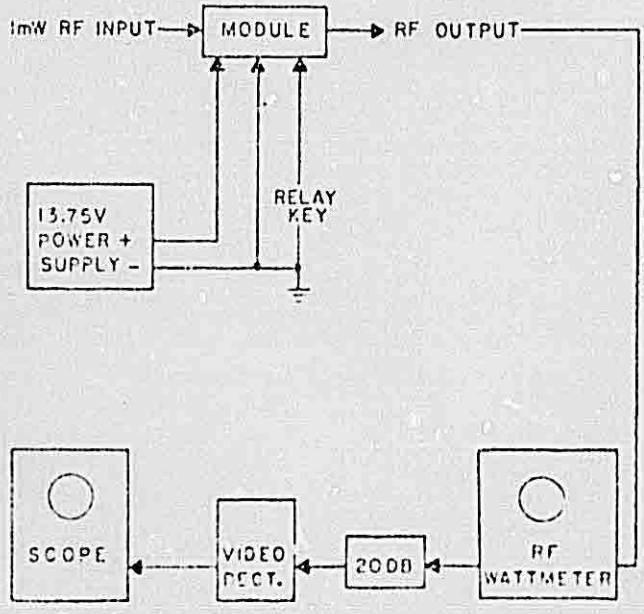


FIGURE 4.4-4 TEST BLOCK DIAGRAM

4.4.4. Continued

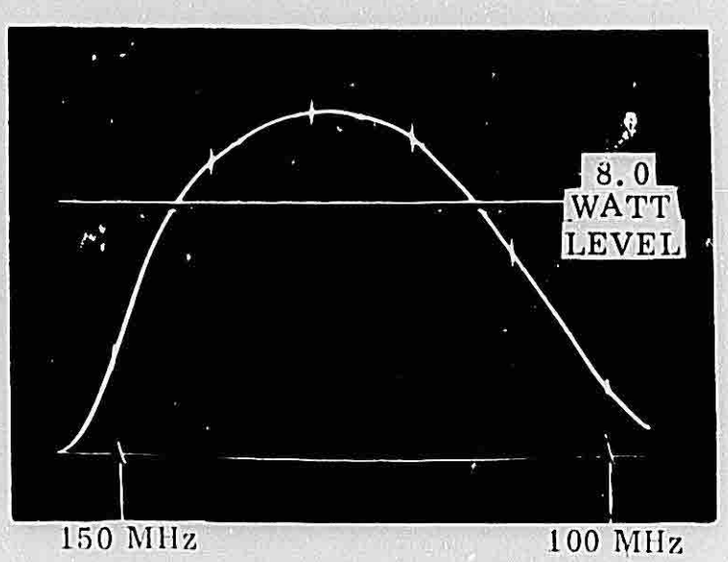


FIGURE 4.4-5 COM 111 TSO POWER VS FREQUENCY

If the minimum power output cannot be obtained between 118 and 136 MHz, slight adjustment of the air wound coils in the RF section can be made. The necessity for adjusting a particular coil can be determined by inserting a small piece of brass or powdered iron into the coil while observing the effect on the scope. A small phenolic rod with a brass insert on one end and a powdered iron insert in the other will prove to be useful tool for this test.

Inserting the brass will decrease the inductance, while iron will increase the inductance. The final adjustment can be made by knifing the end turns on the coil. Large inductance compensation should be avoided since this is an indication of other circuit problems. In general, tuning of the coils is not necessary unless they have been disturbed due to a component replacement.

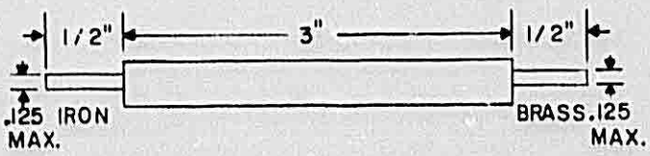


FIGURE 4.4-6 COIL TEST TOOL

(d) Adjustment of the harmonic filter is not recommended unless an RF voltmeter with a large dynamic range is available. The HP 3406A Broadband Sampling Voltmeter or the Boonton 91-CA RF Voltmeter are commended for this adjustment. Unsolder L412 from C462 and drive this point with a milliwatt signal from a HP 608D (or equivalent) RF generator between the frequencies of 118 and 136 MHz. Measure the output of the filter (which should be terminated in 50 ohms) with the RF Voltmeter. The variation signal level should not be more than 0.2 db across the band. Care should be taken to maintain a constant input level while this test is being made.

In order to adjust the frequencies of maximum attenuation, set the generator to 335 MHz and adjust L409 for minimum output voltage. Set signal generator to 223 MHz and adjust L410 for minimum output.

When the harmonic filter is being tested, it is necessary to apply A+ in order to key the relay so that the output signal from the filter is available at the output terminal, P402. However, it is necessary to deenergize ths transmitter during this procedure by unsoldering the two wires (Red and Blue) that apply the DC voltage to the RF transistors.

Should the harmonic filter fail to respond to these adjustments, it is suggested that the unit be returned to the factory for further repairs.

4.4.4 Continued

(2) Modulator

Connect the module as shown in Fig. 4.4-4. Sweep transmitter between the frequencies of 100 and 150 MHz. Observe the detected waveform on the oscilloscope. The trace should appear as shown in Fig. 4.4-5. Apply a 50 millivolt, 1 KHz signal to pin 9 of P401A. The transmitter should modulate normally between 118 and 136 MHz as shown in Fig. 4.4-7.

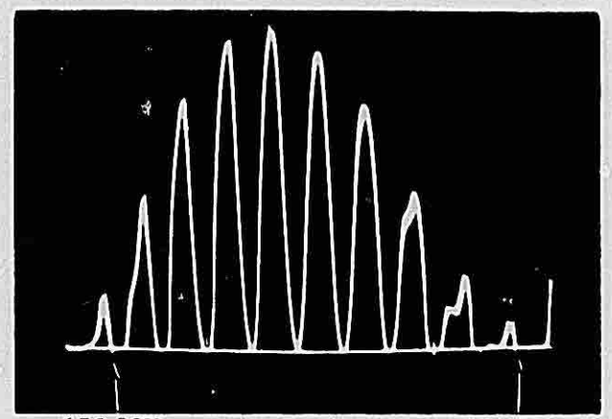


FIGURE 4.4-7 COM 111 TSO MODULATION CHARACTERISTICS

The microphone gain control, R416, might need adjustment in order to obtain full modulation.

NOTE: This control should be reset for different installations, depending upon the particular microphone used in the aircraft. Speaking normally into the mike, adjust R416 until the positive and negative audio peaks show signs of clipping. This adjustment is best performed on a single frequency than with a swept RF signal.

If the modulator fails to modulate as described, the following information should prove useful in localizing the problem area.

(a) Audio Preamplifier, Q405
With 50 millivolts at 1 KHz applied to pin 9 of P401A, the following AC and DC voltages should appear at the terminals of Q401 (plus or minus 20%).

Terminal	AC	DC
Base	——	0.8 v
Emitter	——	0.15 v
Collector	12v p-p	13.1 v

This stage can be further isolated by disconnecting the driver transformer (T401) secondary terminals, soldering a 500 ohm, ½ watt resistor across the primary terminals and checking the stage performance. Alternatively a 10K ohm, ½ watt resistor could be soldered across the full secondary of T401, or an audio wattmeter could be substituted in either of these two locations. The audio power output of this stage is approximately 35 milliwatts.

(b) Push-Pull Darlingtons, Q406, Q407, Q408, and Q409
With a 50 millivolt, 1 KHz signal applied to pin 9 of P401A, the following AC and DC voltages should appear at the following terminals:

Transistor	Terminal	AC	DC
Q406 & Q408	Base	25v p-p	1.0
	Emitter	24v p-p	0.7
	Collector	——	13.6
Q407 & Q409	Base	24v p-p	0.9
	Emitter	23v p-p	0.4
	Collector	——	13.6

The DC voltage readings on the base and emitter terminals of the above transistors can vary consideraly depending upon the Beta match of the particular transistor pair. Severly mismatched transistors can cause excessive audio distortion.

The Darlington stages can be further isolated by disconnecting the primary of the driver transformer, T401, and applying a 12v p-p audio signal from a 500 to 600 ohm, 1 KHz source. The secondary of the modulation transformer, T403, can be unsoldered and connected to an audio wattmeter, or a 6 ohm, 25 watt resistor. Under these conditions, the modulator should deliver 11 watts into a 6 ohm load.

(c) Bias Transistor, Q410
Under normal conditions, the following voltages can be measured on the terminals of Q410.

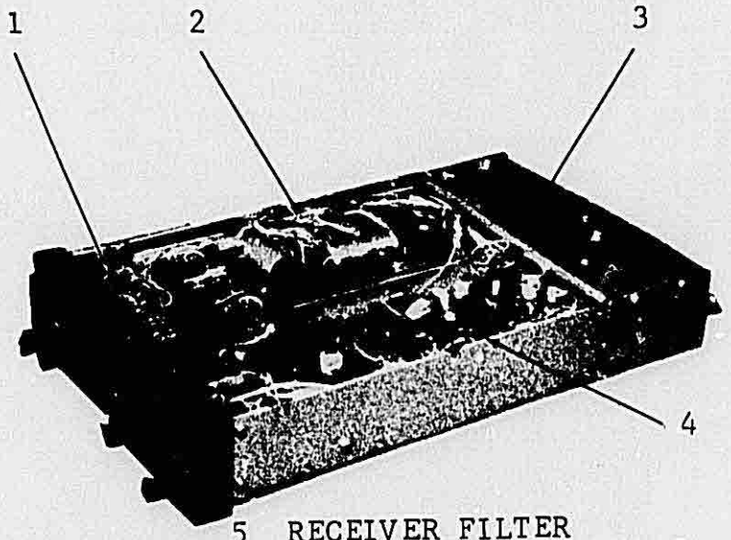
Terminal	Voltage
Base	0.7 v
Emitter	0
Collector	2.0 v

At room temperatures, this stage will restrict the idling current of the modulator (no signal) to approximately 50 to 75 milliamperes.

4.5 REPLACEMENT PARTS LIST COM 111 TSO

To provide a cross-reference relationship of subassemblies to their Next Higher Assembly, the notation "See Fig. .... for Breakdown" follows the entry of a subassembly that is too large to be included within this list and that a separate list is provided. The subsequent list which breaks down the subassembly will refer back with the notation, "See Fig. .... for NHA," to that list which first noted the subassembly.

The words "No Number" in the Part Number column indicates that the part or subassembly is not a true subassembly. It is however a group of components which function together and by setting them aside in a separate list, greater detail of the components can be shown. Since the subassembly has no number, only piece parts of the "group" can be ordered or the complete Next Higher Assembly.



1 FRONT PANEL ASSY
2 INTERCONNECT PC BOARD
3 TRANSMITTER / MODULATOR
4 RECEIVER PC BOARD
5 RECEIVER FILTER
Part of Item 4
6 VOLTAGE CONTROLLED OSC. & ISO AMP
Part of Item 7
7 FREQUENCY SYNTHEIZER
8 TRAY MOUNTING LOCK
Part of Item 1

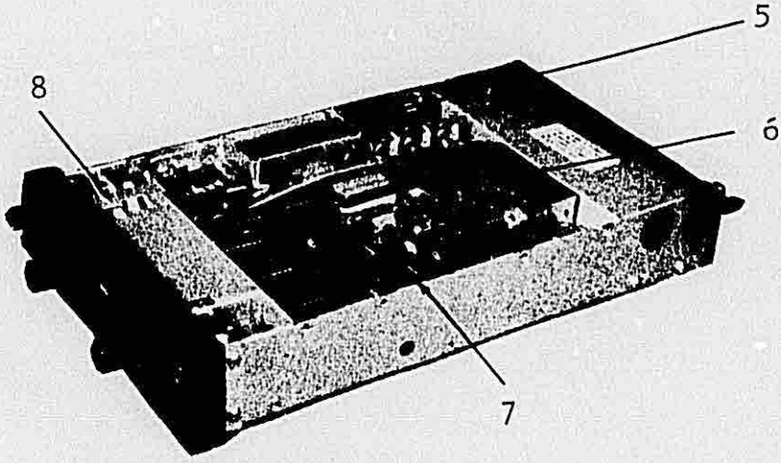


FIGURE 4.5-1 COM 111 TSO

Fig. & Index No.	Part Number	Description
4.5-1	01180-0102	COM 111 TSO
	55941-0001	PANEL, TRIM
	55942-0001	LENS
	88209-0001	KNOB, MHz-KHz
	88208-0001	KNOB, ON-OFF, SQUELCH - IDENT.
	04486-0002	LABEL, TRIM PANEL
	04488-0001	INSERT, KNOB
	04488-0002	INSERT, KNOB
	55833-0102	CHASSIS MAIN SPOTWELD ASSEMBLY
	55947-0001	COVER, TOP
	55948-0001	COVER, BOTTOM
	01154-0102	FRONT PANEL ASSEMBLY, COM 111 TSO (See Fig. 4.5-2 for breakdown)
	01146-0102	SYNTHESIZER BOARD, COM 111 TSO (See Fig. 4.5-3 for breakdown)
	01148-0104	INTERCONNECTING BOARD, COM 111 TSO (See Fig.4.5-4 for breakdown)
	01149-0103	TRANSMITTER, COM 111 TSO (See Fig. 4.5-5 for breakdown)
	01147-0101	RECEIVER BOARD COM 111 TSO (See Fig. 4.5-8 for breakdown)
	41130-0004	PLUG, PHONO (MALE)
	04284-0001	LABEL, MIKE ADJUST
	04069-0001	LABEL, FCC CERTIFICATION
	82819-0103	SCREW MACH., #4-40 x 1/4 LG. FLAT HD. SLOTTED
	82958-0002	SCREW MACH., #4-40 x 3/16 LG. PAN HD. SL., TAPTITE
	82962-0002	SCREW MACH., #4-40 x 3/16 LG. PAN HD. SL
	82960-0003	THD. CUTTING #4-40 x 1/4 LG. PAN HD. SL. (SEMS)
	82960-0002	THD. CUTTING #4-40 x 3/16 LG. PAN HD. SL. (SEMS)
	82963-0001	SCREW MACH., #2-56 x 1/8 LG. PAN HD. SL. (SEMS)
	82889-0002	SETSCREW, HEX SOCKET, #4-40 x 1/8 LG.
	81290-0003	NUT, "U"
	81747-0012	FILTER, COLORED, (LIGHT BLUE)
	12000-0015	LAMP, INCADESCENT, #336
	82814-0003	SCREW MACHINE, #4-40 x 1/4 LG. BND. HD. SL
	81701-0004	LUG SOLDER
	91018-0055	TUBING, PLASTIC EXTRUDED
	81709-0001	LUG, SOLDER
	11454-0005	FERRITE BEAD
	04396-0001	NAMEPLATE, PATENT NOTICE
	83011-0005	INSULATOR, GLASS, SELF-ADHESIVE (COM 11A)
	99057-0002	GASKET, FOAM
	83017-0003	INSULATOR
	04432-0001	LABEL WARNING
	82922-0001	NUT, HEX, #4-40
	04385-0002	LABEL, NAMEPLATE
C-640	21555-0054	CAPACITOR, TANTALUM, 3.3 mf ±10%, 35V
	55980-0101	TRAY ASSY
	81702-0004	LUG, SOLDER
	81423-0002	STANDOFF
C-501	21554-0054	CAPACITOR, ELECTROLYTIC, 2200 mf, 15V
L-50.	11527-0002	CHOKE, HASH
	81312-0019	WASHER, SPRING
	82888-0009	SCREW, MACH, #4-40 x 3/4 RD, HD, SL (NYLON)

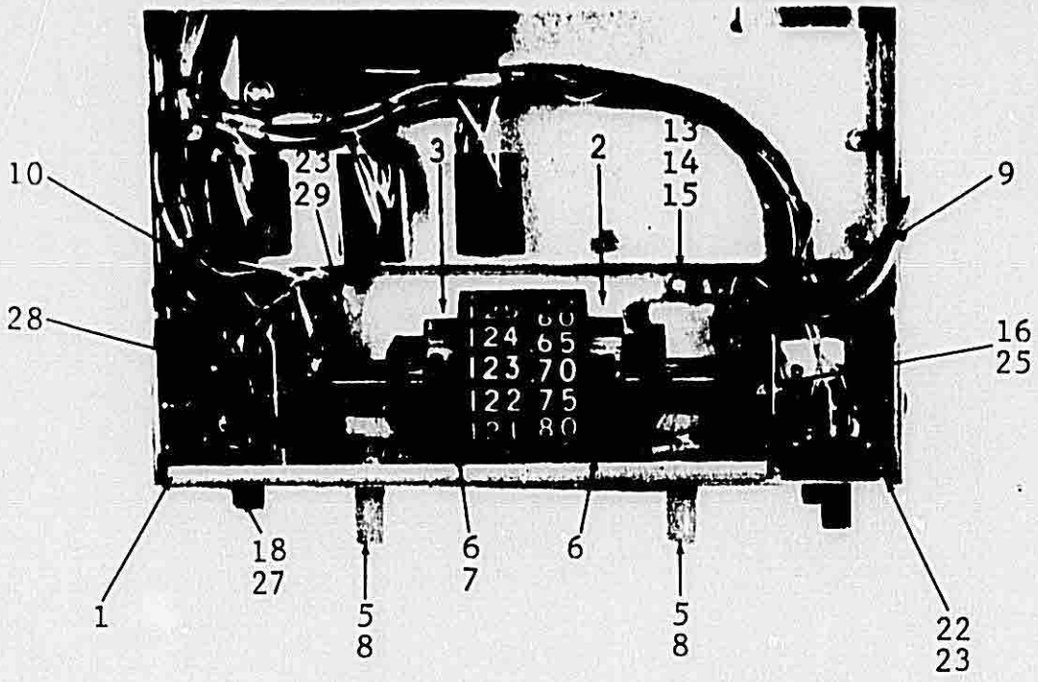
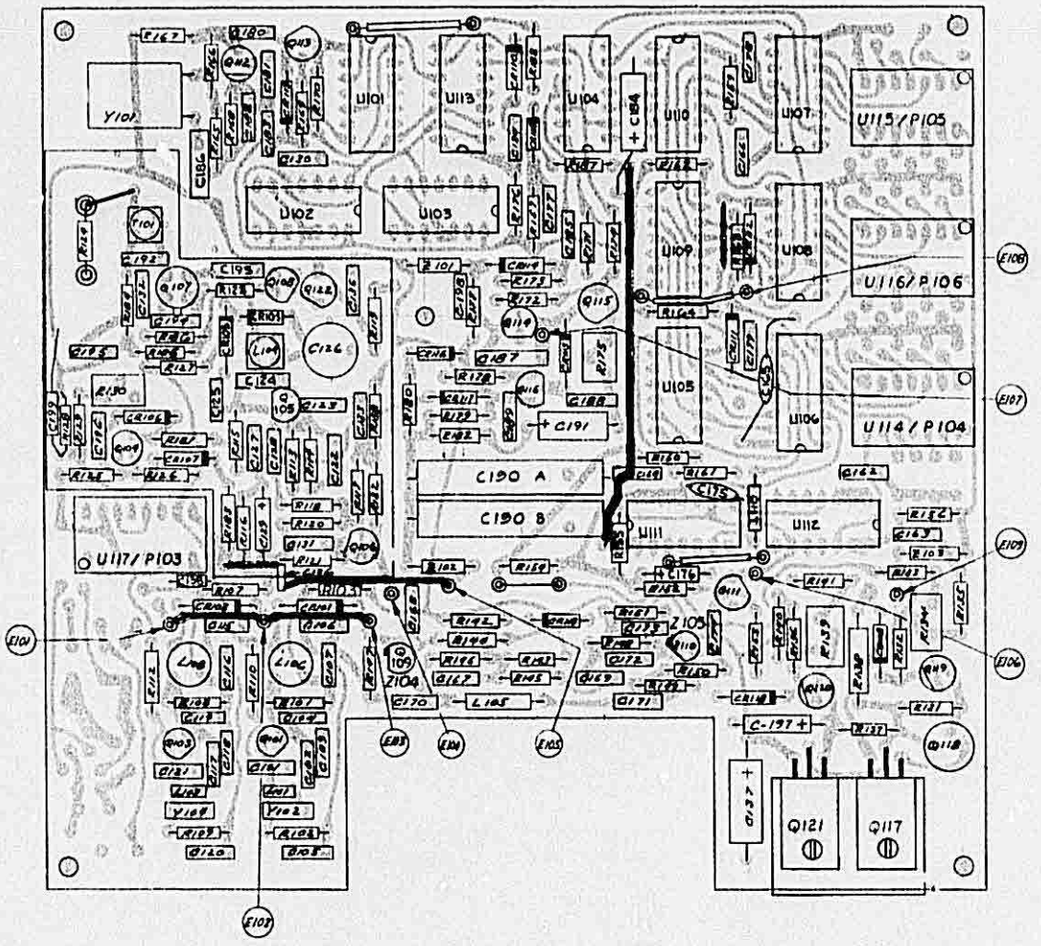


FIGURE 4.5-2 FRONT PANEL ASSY

Fig. & Index No.	Part Number	Description
4.5-2	01154-0102	FRONT PANEL ASSY (See Fig. 4.5-1 for NHA)
1	55998-0101	CHASSIS FRONT SPOTWELD ASSEMBLY
2	55957-0001	DRUM, KHz, 20 POS
3	55958-0001	DRUM, MHz, 18 POS
4	55959-0001	SHAFT, DRUM
5	55940-0001	SHAFT & GEAR DRIVE
6	55945-0001	SPRING DETENT
7	55982-0001	BAR, LOCK DETENTS
8	55926-0001	BEARING, SWAGED
9 S-102	61537-0001	SWITCH COM. KHZ
10 S-103	61538-0001	SWITCH COM. MHZ
11	NOT USED	
12	NOT USED	
13	54978-0004	SCREW, LOCKING HEX
14	54949-0001	CAM, LOCK
15	82920-0013	NUT, LOCKING REDUCED HEX
16	55836-0001	SPACER, HEX THREADED
17	NOT USED	
18 R642	32059-0003	RESISTOR VARIABLE, 1K (W/DPST SWITCH)
19	NOT USED	
20 R647	32055-0009	RESISTOR VARIABLE, 5K
21	NOT USED	
22	81352-0001	NUT, FLUSH, SELF-CLINCHING, #2-56
23	82867-0001	SCREW, MACH, #2-56 x 1/8, HEX HD
24	82963-0002	SCREW, MACH, #2-56 x 3/16, PAN HD, SL(NOT SHOWN)
25	82962-0001	SCREW, MACH, #4-40 x 1/8, PAN HD, SL.
26	82904-0001	NUT, SELF-CLINCHING, #2-56 (NOT SHOWN)
27	82802-0057	LOCKWASHER, INT. TOOTH
28 C651	21291-0005	CAPACITOR, CER DISC, .10 uf 50V
29	NOT USED	
	81312-0019	WASHER, SPRING (Not Shown)
	81307-0060	WASHER, FLAT, SPECIAL (Not Shown)

Note: Cable, switches, lamps, and IC Sockets part of cabling assy.



D-55949-K
D-55963-F

FIGURE 4.5-3 SYNTHESIZER BOARD, COM 111 TSO

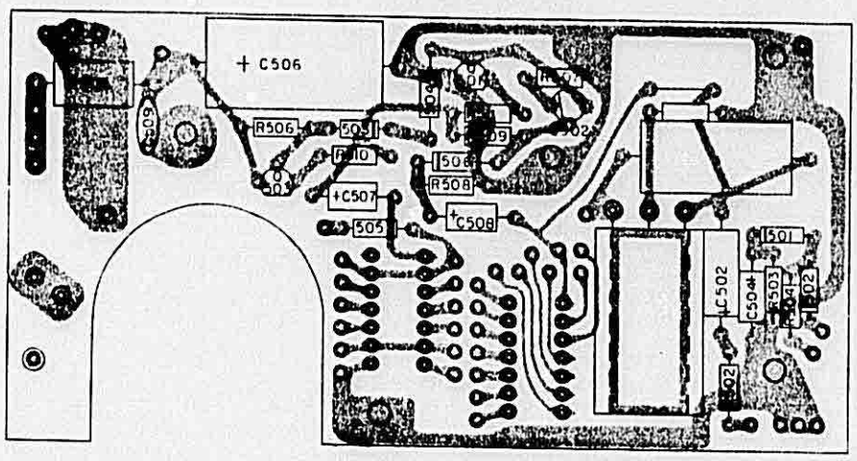
SEE BLOW-UP

Fig. & Index No.	Part Number	Description
4.5-3	01146-0102	SYNTHESIZER BOARD, COM 111 TSO (See Fig. 4.5-1 for NHA)
	55950-0001	HEATSINK
	55956-0001	SHIELD, VCO
	55961-0001	COVER, VCO
	55874-0001	SPRING, FINGER
	74903-0001	I. C. SOCKET LOCATER, 14 PIN
	74903-0002	I. C. SOCKET LOCATER, 16 PIN
	82814-0004	SCREW, MACH, #4-40 x 5/16, BND. HD, SLOTTED
	82922-0001	NUT, HEX, #4-40
	81335-0015	INSULATOR, SHOULDER
	55850-0001	CAN, SHIELD
	55864-0001	CAN, SHIELD
	52726-0001	TRANSPAD
	99065-0004	TAPE, DOUBLE SIDED
C-101	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-102	24516-0569	CAPACITOR, CERAMIC DISC, 5.6 pf, 500V, NPO
C-103	24516-0180	CAPACITOR, CERAMIC DISC, 18 pf ±10%, 500V, NPO
C-104	24516-0569	CAPACITOR, CERAMIC DISC, 5.6 pf, 500V, NPO
C-105	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-106	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10% 500V
C-107	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-115	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-116	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-117	24516-0479	CAPACITOR, CERAMIC DISC, 4.7 pf, 500V, NPO
C-118	24516-0180	CAPACITOR, CERAMIC DISC, 18 pf ±10%, 500V, NPO
C-119	24516-0229	CAPACITOR, CERAMIC DISC, 2.2 pf, 500V, NPO
C-120	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-121	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-122	21291-0005	CAPACITOR, CERAMIC DISC, .01 mf ±20%, 50V
C-123	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-124	24516-0479	CAPACITOR, CERAMIC DISC, 4.7 pf, 500V, NPO
C-125	24052-0150	CAPACITOR, DIPPED MICA, 15 pf ±10%, 500V, NPO
C-126	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-127	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-128	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-129	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C-130	24052-SEL.	CAPACITOR, DIPPED MICA, SEL.
C-131	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-132	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-133	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-134	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-135	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-136	21296-0003	CAPACITOR, CERAMIC FEED-THRU, .001 mf, 500V
C-137	21555-0012	CAPACITOR, TANTALUM, 82 mf ±10%, 10V
C-138	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-162	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-163	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-164	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-165	24515-0005	CAPACITOR, CERAMIC DISC, 05 mf ±20%, 10V
C-166	24515-0001	CAPACITOR, CERAMIC DISC, 1 mf ±20%, 10V
C-167	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-168	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-169	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-170	24516-0180	CAPACITOR, CERAMIC DISC, 18 pf ±10%, 500V
C-171	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-172	24516-0100	CAPACITOR, CERAMIC DISC, 10 pf ±10%, 500V
C-173	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V

Fig. & Index No.	Part Number	Description
C-174	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-175	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf, ±20%, 10V
C-176	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C-177	21291-0005	CAPACITOR, CERAMIC DISC, .01 mf ±20%, 50V
C-178	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-179	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-180	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-181	24049-0471	CAPACITOR, DIPPED MICA, 470 pf ±5%, 500V
C-182	24049-0251	CAPACITOR, DIPPED MICA, 250 pf ±5%, 500V
C-183	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-184	21555-0003	CAPACITOR, TANTALUM, 47 mf ±10%, 6V
C-185	24049-0331	CAPACITOR, DIPPED MICA, 330 pf ±5%, 500V
C-186	24052-SEL	CAPACITOR, DIPPED MICA, SEL ±5%, 500V
C-187	23094-0155	CAPACITOR, MYLAR, .0022 mf ±10%, 200V
C-188	23094-0155	CAPACITOR, MYLAR, .0022 mf ±10%, 200V
C-189	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-190	23094-0187	CAPACITOR, CERAMIC DISC, .05 ±20%, 10V (Qty 2)
C-191	21555-0026	CAPACITOR, TANTALUM, 10 mf ±10%, 20V
C-192	24516-0100	CAPACITOR, CERAMIC DISC, 10 pf ±10%, 500V
C-193	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-194	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-195	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-196	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-197	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C-198	24515-0005	CAPACITOR, CERAMIC DISC, .05 ±20%, 10V
C-199	21555-0003	CAPACITOR, TANTALUM, 47 mf ±10%, 6V
CR-101	75038-0002	DIODE, RF SWITCH
CR-103	75038-0002	DIODE, RF SWITCH
CR-104	75037-0002	DIODE, VARACTOR
CR-105	75037-0002	DIODE, VARACTOR
CR-106	75019-0004	DIODE, SILICON
CR-107	75019-0004	DIODE, SILICON
CR-108	75027-0010	DIODE, ZENER, ±5%, 2.6V, 1N702A
CR-109	75019-0004	DIODE, SILICON
CR-110	75019-0004	DIODE, SILICON
CR-111	75019-0004	DIODE, SILICON
CR-112	75019-0004	DIODE, SILICON
CR-113	75019-0004	DIODE, SILICON
CR-114	75019-0004	DIODE, SILICON
CR-115	75019-0004	DIODE, SILICON
CR-116	75019-0004	DIODE, SILICON
CR-117	75019-0004	DIODE, SILICON
CR-118	75027-0004	DIODE ZENER, ±5%, 5.6V, 1N752A
CR-119	75036-0001	DIODE, SILICON
L-101	11713-0013	COIL, P.S., BLACK
L-103	11713-0013	COIL, P.S., BLACK
L-104	11756-0001	COIL, VCO
L-105	11451-0011	CHOKE, RF, 2.2 uh
L-106	11752-0001	COIL, CRYSTAL OSC.
L-108	11752-0001	COIL, CRYSTAL OSC.
L-110	11485-0020	COIL, R.F., 3.9 uh
Q-101	75802-0001	TRANSISTOR, NPN
Q-103	75802-0001	TRANSISTOR, NPN
Q-104	75802-0002	TRANSISTOR, NPN, 2N5172
Q-105	75802-0003	TRANSISTOR, PNP, 2N4258
Q-106	75802-0004	TRANSISTOR, NPN, SE 3005
Q-107	75802-0005	TRANSISTOR, NPN
Q-108	75802-0006	TRANSISTOR, NPN, 2N5172
Q-109	75802-0007	TRANSISTOR, NPN
Q-110	75802-0008	TRANSISTOR, NPN
Q-111	75802-0009	TRANSISTOR, PNP, 2N4258
Q-112	75802-0010	TRANSISTOR, NPN, 2N3391
Q-113	75802-0011	TRANSISTOR, NPN, 2N5134
Q-114	75802-0012	TRANSISTOR, PNP, 2N4258
Q-115	75802-0013	TRANSISTOR, NPN, 2N5172
Q-116	75802-0014	TRANSISTOR, PNP, 2N5356
Q-117	75802-0015	TRANSISTOR, NPN, 2N5494
Q-118	75802-0016	TRANSISTOR, NPN, 2N3568
Q-119	75802-0017	TRANSISTOR, NPN, 2N3391
Q-120	75802-0018	TRANSISTOR, NPN, 2N3391
Q-121	75802-0019	TRANSISTOR, NPN, 2N5494
Q-122	75802-0020	TRANSISTOR, NPN, 2N5172

Fig. & Index No.	Part Number	Description
R-101	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
R-102	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W
R-103	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-107	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-108	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
R-109	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W
R-110	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-112	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-113	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-114	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-115	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-116	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-117	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-118	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-119	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-120	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-121	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-122	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-123	31192-0470	RESISTOR, CARBON, 47 ±10%, ¼W
R-124	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-125	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-126	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-127	31192-0473	RESISTOR, CARBON, 47K ±10%, ¼W
R-128	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-129	31192-0821	RESISTOR, CARBON, 820 ±10%, ¼W
R-130	32054-0001	RESISTOR, VARIABLE, 470
R-131	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-132	31192-0820	RESISTOR, CARBON, 82 ±10%, ¼W
R-133	31192-0181	RESISTOR, CARBON, 180 ±10%, ¼W
R-134	32054-0013	RESISTOR, VARIABLE, 220
R-135	31192-0821	RESISTOR, CARBON, 820 ±10%, ¼W
R-136	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R-137	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
R-138	31141-0109	RESISTOR, CARBON, 1.0 ±10%, ½W
R-139	32054-0001	RESISTOR, VARIABLE, 470
R-140	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W
R-141	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-142	31192-0680	RESISTOR, CARBON, 68 ±10%, ¼W
R-143	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-144	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-145	31192-0680	RESISTOR, CARBON, 68 ±10%, ¼W
R-146	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W
R-147	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-148	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-149	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-150	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-151	31192-0221	RESISTOR, CARBON, 220 ±10%, ¼W
R-152	31192-0822	RESISTOR, CARBON, 8.2K ±10%, ¼W
R-153	31192-0122	RESISTOR, CARBON, 1.2K ±10%, ¼W
R-154	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-155	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-156	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-157	31192-0333	RESISTOR, CARBON, 33K ±10%, ¼W
R-158	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-159	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-160	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-161	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-162	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-163	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-164	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-165	31192-0223	RESISTOR, CARBON, 22K ±10%, ¼W
R-166	31192-0223	RESISTOR, CARBON, 22K ±10%, ¼W
R-167	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-168	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-169	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W

Fig. & Index No.	Part Number	Description
R-170	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-171	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-172	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-173	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-174	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-175	32054-0009	RESISTOR, CARBON, VARIABLE, 1K
R-176	21192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-177	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-178	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R-179	31192-0332	RESISTOR, CARBON, 3.3K ±10%, ¼W
R-180	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-181	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-182	31192-0680	RESISTOR, CARBON, 68 ±10%, ¼W
R-183	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-184	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-185	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-186	31192-0331	RESISTOR, CARBON, 330 ±10%, ¼W
R-187	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-188	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
T-101	11757-0001	TRANSFORMER, VCO OUTPUT
U-101	75802-0021	INTEGRATED CIRCUIT, DTL, 9097
U-102	75802-0022	INTEGRATED CIRCUIT, DTL, 9097
U-103	75802-0023	INTEGRATED CIRCUIT, DTL, 9097
U-104	75802-0024	INTEGRATED CIRCUIT, TTL, 9002
U-105	75802-0025	INTEGRATED CIRCUIT, TTL, 9004
U-106	75802-0026	INTEGRATED CIRCUIT, MSI, 9300
U-107	75802-0027	INTEGRATED CIRCUIT, MSI, 9300
U-108	75802-0028	INTEGRATED CIRCUIT, MSI, 9300
U-109	75802-0029	INTEGRATED CIRCUIT, TTL, 9007
U-110	75802-0030	INTEGRATED CIRCUIT, TTL, 9007
U-111	75802-0031	INTEGRATED CIRCUIT, TTL, 9001
U-112	75802-0032	INTEGRATED CIRCUIT, TTL, 9001
U-113	75802-0033	INTEGRATED CIRCUIT, TTL, 9004
U-114	75802-0034	INTEGRATED CIRCUIT, DTL, 946
U-115	75802-0035	INTEGRATED CIRCUIT, DTL, 946
U-116	75802-0036	INTEGRATED CIRCUIT, DTL, 946
U-117	75802-0037	INTEGRATED CIRCUIT, TTL, 9002
Y-101	72032-0001	CRYSTAL, 3.20066 MHZ FUND.
Y-102	72031-0002	CRYSTAL, 148.054 MHZ 7th O. T.
Y-104	72031-0001	CRYSTAL, 160.029 MHZ 7th O. T.
P-101	41292-0001	JACK, PHONO
P-102	41292-0001	JACK, PHONO
P-103	41313-0004	SOCKET, I. C. WIRE WRAP 16 PIN
P-104	41313-0003	SOCKET, I. C. WIRE WRAP 14 PIN
P-105	41313-0003	SOCKET, I. C. WIRE WRAP 14 PIN
P-106	41313-0003	SOCKET, I. C. WIRE WRAP 14 PIN
Z-101	11454-0001	BEAD (Qty 2)
Z-102	11454-0001	BEAD (Qty 2)
Z-103	11454-0001	BEAD (Qty 2)
Z-104	11454-0001	BEAD
Z-105	11454-0001	BEAD



B-57698-A

FIGURE 4.5-4 INTERCONNECT BOARD, COM 111 TSO

Fig. & Index No.	Part Number	Description
4.5-4	01148-0104	INTERCONNECT BOARD, COM 111 TSO (See Fig. 4.5-1 for NHA)
C-502	21555-0026	CAPACITOR, TANTALUM, 10 mf, 20V
C-504	21555-0016	CAPACITOR, TANTALUM, 3.3 mf, 15V
C-505	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf, ±10%,500V
C-506	21554-0051	CAPACITOR, ELECTROLYTIC, 250 mf, 20V
C-507	21555-0016	CAPACITOR, TANTALUM, 3.3 mf, 15V
C-508	21555-0016	CAPACITOR, TANTALUM, 3.3 uf, 15V
C-509	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-510	21554-0019	CAPACITOR, 100 mf, 18V (CNB171A2 and later)
CR-501	75028-0001	DIODE, SILICON
CR-502	75028-0001	DIODE, SILICON
CR-503	75028-0001	DIODE, SILICON
CR-504	75028-0001	DIODE, SILICON
CR-505	75028-0001	DIODE, SILICON
CR-506	75028-0001	DIODE, SILICON
Q-501	75558-0006	TRANSISTOR, 2N5811
Q-502	75550-0002	TRANSISTOR, 2N3391
Q-503	75558-0005	TRANSISTOR, 2N5810
R-502	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-503	31192-0154	RESISTOR, CARBON, 150K ±10%, ¼W
R-504	31192-0333	RESISTOR, CARBON, 33K ±10%, ¼W
R-505	31196-0003	RESISTOR, WIREWOUND, 27 ±5%, 2W
R-506	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-507	31192-0470	RESISTOR, CARBON, 47 ±10%, ¼W
R-508	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R-509	31192-0822	RESISTOR, CARBON, 8.2K ±10%, ¼W
R-510	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-511	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
J-104	41322-0001	SOCKET I. C. SOLDER TAIL
J-105	41322-0001	SOCKET I. C. SOLDER TAIL
J-106	41322-0001	SOCKET I. C. SOLDER TAIL
J-103	41322-0002	SOCKET I. C. SOLDER TAIL
	41278-0008	LAMPHOLDER, SUBMINIATURE

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
	01149-0103	TRANSMITTER, COM 111 TSO (See Fig. 4.5-1 for NHA)
	56276-0001	INSULATOR, MICA
	82803-0003	SCREW, MACH., RH, SL, #4-40 x —
	81324-0004	LOCKWASHER, SPLIT, #4
	81797-0001	TERMINAL, FEEDTHRU, TURRET
	81336-0002	WASHER, NYLON
	55970-0001	HEATSINK TRANSMITTER
	55973-0001	HINGE, LEFT
	55973-0002	HINGE, RIGHT
	55975-0001	INSULATOR, TRANSMITTER BOARD
	55976-0001	SHIELD, TRANSMITTER
	55977-0001	SHIELD, FILTER
	55978-0001	COVER, TRANSMITTER
	55839-0001	COVER, FILTER
	55979-0001	PIN, GUIDE
	81679-0010	PIN, ROLL
	81207-0025	SPACER
	81217-0002	SPACER (PHENOLIC)
	41318-0001	CONNECTOR, RF, FEMALE
	81737-0002	LUG, SOLDER & LOCKWASHER
	81254-0001	EYELET (SE-34)
	81254-0033	EYELET (SE-33)
	81335-0013	INSULATOR, SHOULDER
	82963-0003	SCREW, MACH, #4-40 x 1/4 LG., PAN HD, SL
	52726-0001	TRANSPAD
	82961-0003	SCREW, THREAD CUTTING, #2-56 x 1/4 LG., PAN HD., SL.
	82962-0003	SCREW, MACH, #4-40 x 1/4 LG, PAN HD, SL
	82814-0005	SCREW, MACH, #4-40 x 3/8 LG, BND. HD, SL
	82922-0001	NUT, HEX, #4-40
	82900-0211	NUT, HEX, #8-32
	83011-0011	INSULATOR
	99065-0002	TAPE, DOUBLE SIDED
	41130-0004	PLUG, PHONO (MALE)
	41322-0001	SOCKET, I. C. SOLDER TAIL
	99065-0004	TAPE, DOUBLE SIDED
	82017-0001	CLAMP, CABLE
	No Number	TRANSMITTER PC BOARD ASSY (See Fig. 4.5-6 for breakdown)
	No Number	MODULATOR PC BOARD ASSY (See Fig. 4.5-7 for breakdown)

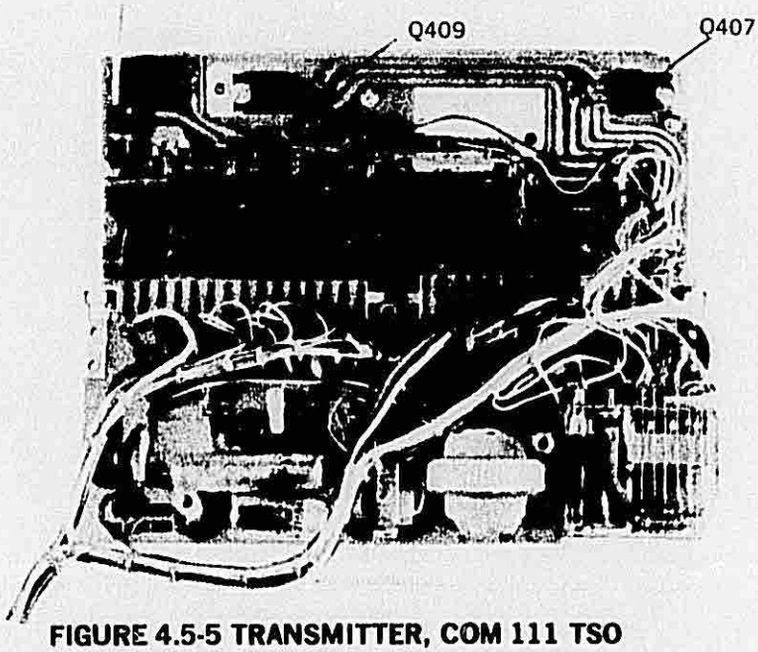
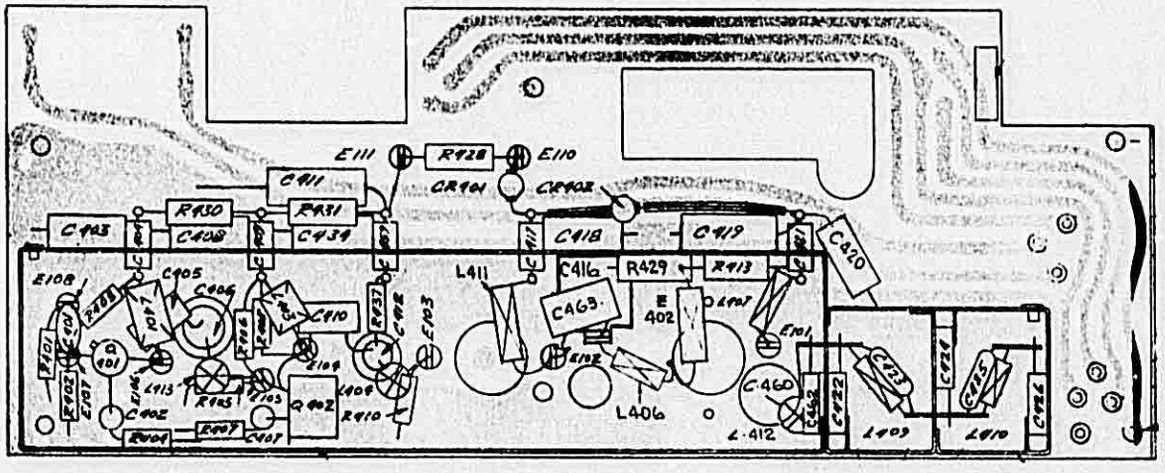


FIGURE 4.5-5 TRANSMITTER, COM 111 TSO

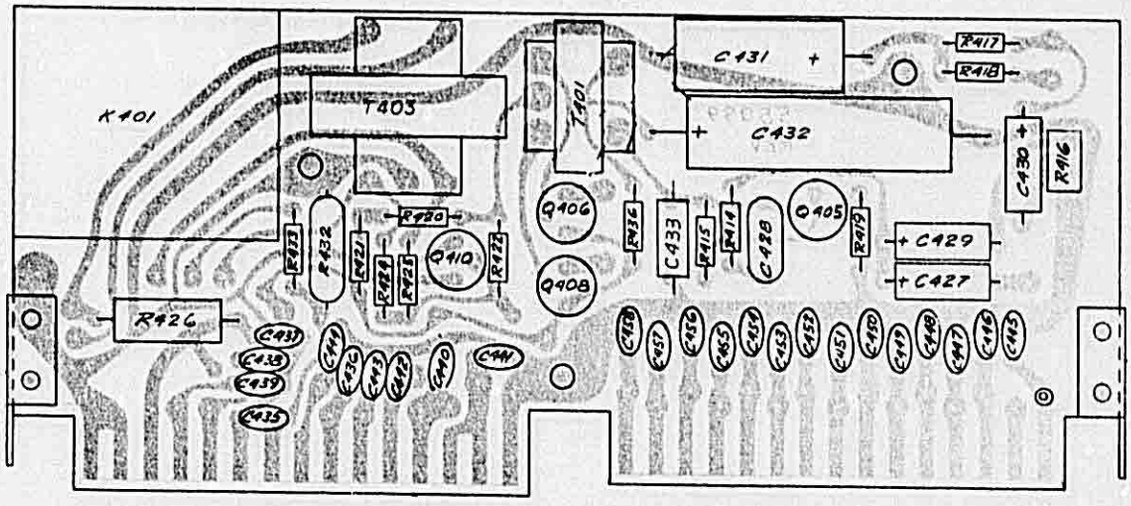


C-55158
C-55943

FIGURE 4.5-6 TRANSMITTER PC BOARD, COM 111 TSO

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
4.5-6	No Number	TRANSMITTER PC BOARD , COM 111 TSO (See Fig. 4.5-5 for NHA)
C-401	21291-0021	CAPACITOR, CERAMIC DISC, .011 uf, ±20%
C-402	21290-0008	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-403	23089-0063	CAPACITOR, MYLAR, .01 uf ±10%, 80V
C-404	21290-0007	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-405	24054-0100	CAPACITOR, DIPPED MICA, 10 pf ±.5 pf (CNB171A1 and later)
C-406	24543-0390	CAPACITOR, LEADLESS DISC, 39 pf ±10%, N470
C-407	21290-0008	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-408	23089-0063	CAPACITOR, MYLAR, .01 uf ±10%, 80V
C-409	21290-0007	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-410	24052-0180	CAPACITOR, DIPPED MICA, 18 pf ±1 pf
C-411	21554-0039	CAPACITOR, TANTALUM, 12 uf ±10%, 30V
C-412	24542-0001	CAPACITOR, LEADLESS DISC, 75 pf ±10%, X5F
C-416	24037-0118	CAPACITOR, MICA, 250 pf ±10%
C-417	21290-0007	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-418	23089-0063	CAPACITOR, MYLAR, .01 uf ±10%, 80V
C-419	21554-0039	CAPACITOR, ALUMINUM, 12 uf, 30VSP
C-420	23089-0063	CAPACITOR, MYLAR, .01 uf ±10%, 80V
C-421	21290-0007	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-422	24037-0109	CAPACITOR, MICA, 50 pf ±5%
C-423	24054-0309	CAPACITOR, DIPPED MICA, 3 pf ±0.5 pf
C-424	24037-0121	CAPACITOR, MICA, 36 pf ±5%
C-425	24054-0100	CAPACITOR, DIPPED MICA, 10 pf ±0.5 pf
C-426	24037-0117	CAPACITOR, MICA, 18 pf ±5%
C-434	23089-0063	CAPACITOR, MYLAR, .01 uf ±10%, 80V
C-459	21290-0007	CAPACITOR, FEEDTHRU, CERAMIC, .001 uf ±20%, X5U
C-460	24542-0002	CAPACITOR, LEADLESS DISC, .001 uf ±20%, X5F
C-461	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-462	24037-SEL.	CAPACITOR, MICA, SEL.
C-463	24049-0251	CAPACITOR, DIPPED MICA, 250 pf ±5%, 500V
C-464	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
CR-401	75214-0001	DIODE, SILICON-RECTIFIER, 1N5061
CR-402	75214-0001	DIODE, SILICON-RECTIFIER, 1N5061
L-401	11713-0012	COIL, 10 ½T, BLACK, 0.125 I. D.
L-403	11713-0011	COIL, 6½T, BLUE, 0.125 I. D.
L-404	11713-0009	COIL, 2½T, RED, .125 I. D.
L-406	90039-0004	COIL, ⅝ inch SILVER STRAP (if required)
L-407	11713-0007	COIL, 12½T, RED, 0.080 I. D.
L-409	11713-0006	COIL, 10½T, BLACK, 0.080 I. D.
L-410	11713-0005	COIL, 7½T, VIOLET, 0.080 I. D.
L-411	11713-0007	COIL, 12½T, RED, .080 I. D.
L-412	11713-0010	COIL, 3½T, ORANGE, .125 I. D.
L-413	11713-0016	COIL, 4½T, YELLOW, .125 I. D.
Q-401	75802-0038	TRANSISTOR, NPN SILICON
Q-402	75802-0039	TRANSISTOR, NPN SILICON
Q-407	75802-0044	TRANSISTOR NPN SILICON
Q-409	75802-0046	TRANSISTOR, NPN SILICON
Q-411	75802-0040	TRANSISTOR, NPN, SILICON
Q-412	75802-0041	TRANSISTOR, NPN, SILICON
R-401	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-402	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-403	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-404	31192-0470	RESISTOR, CARBON, 47 ±10%, ¼W
R-405	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-406	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-407	31192-0220	RESISTOR, CARBON, 22 ±10%, ¼W
R-408	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-410	31195-0111	RESISTOR, CARBON, 110 ±10%, ¼W
R-413	31141-0100	RESISTOR, CARBON, 10 ±10%, ½W
R-428	31200-0008	RESISTOR, WIREWOUND, 10 ±5%, 2W
R-429	31141-0150	RESISTOR, CARBON, 15 ±10%, ½W
R-430	31141-0101	RESISTOR, CARBON, 100 ±10%, ½W
R-431	31141-0100	RESISTOR, CARBON, 10 ±10%, ½W
R-437	31192-SEL	RESISTOR, CARBON, SEL, ¼W
R-438	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
Z-401	11454-0005	BEAD - FERRITE (Qty 2)
Z-402	11137-0005	CHOKE. .47 uh/100 ½W CARBON RESISTOR COMB.

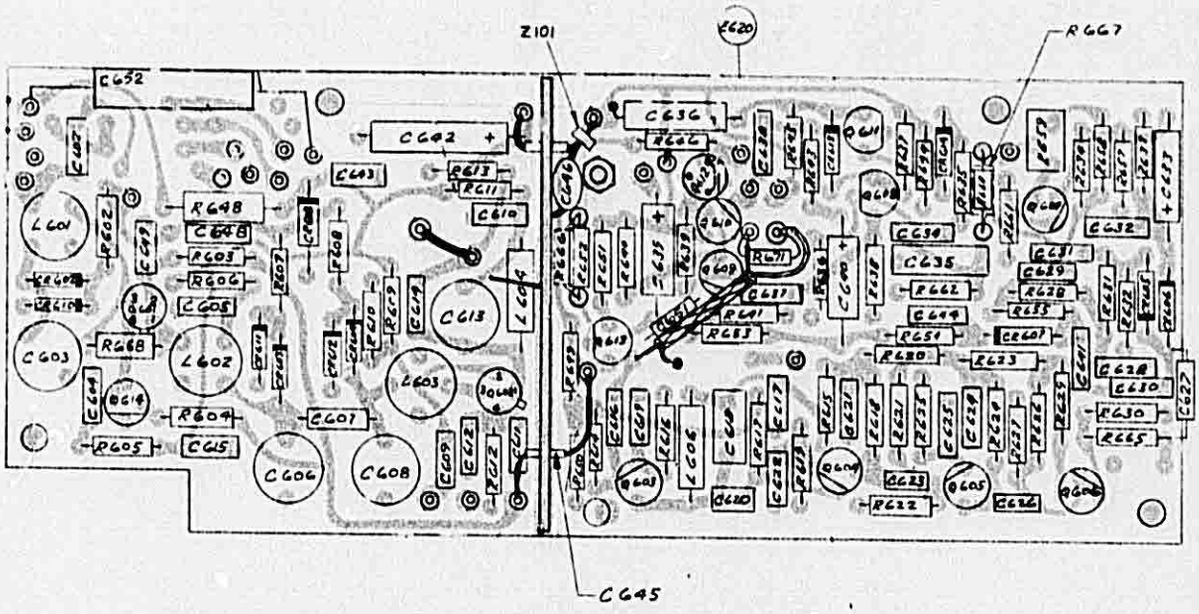


C-55159
C-55999

FIGURE 4.5-7 MODULATOR PC BOARD, COM 111 TSO

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
4.5-7	No Number	MODULATOR PC BOARD, COM 111 TSO (See Fig. 4.5-5 for NHA)
C-427	21555-0026	CAPACITOR, TANTALUM, 10 uf ±10%, 20V
C-429	21555-0052	CAPACITOR, TANTALUM, 2.2 uf .35V
C-430	21555-0026	CAPACITOR, TANTALUM, 10 uf, 20V
C-431	21554-0019	CAPACITOR, ELECTROLYTIC, 100 uf, 18V
C-432	21554-0003	CAPACITOR, ELECTROLYTIC, 200 uf, 15V
C-435	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-436	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-437	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-438	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-439	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-440	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-441	21291-0005	CAPACITOR, CERAMIC DISC, .01 mf ±10%, 50V
C-442	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-443	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-444	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-445	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-446	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-447	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-448	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-449	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-450	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-451	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-452	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-453	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-454	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-455	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-456	21291-0025	CAPACITOR, CERMAIC DISC, 430 pf ±10%, 500V
C-457	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-458	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
K-401	65138-0001	RELAY, 6 POLE
Q-405	75802-0042	TRANSISTOR, NPN SILICON
Q-406	75802-0043	TRANSISTOR, NPN SILICON
Q-410	75802-0047	TRANSISOTOR, NPN SILICON
R-415	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-416	32054-0013	RESISTOR, VARIABLE, 220, POT
R-417	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-418	31192-0221	RESISTOR, CARBON, 220 ±10%, ¼W
R-419	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-420	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-421	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
R-422	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-424	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-425	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-426	31135-0271	RESISTOR, CARBON, 270 ±10%, 1W
R-432	31161-0029	RESISTOR, WIREWOUND, 600 ±5%, 3W
R-433	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-436	31192-0150	RESISTOR, CARBON, 15 ±10%, ¼W
T-401	11745-0001	TRANSFORMER, DRIVER
T-403	11795-0001	TRANSFORMER, MODULATOR



C-55962
C-55996

FIGURE 4.5-8 RECEIVER BOARD ASSY, COM 111 TSO

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
4.5-8	01147-0101	RECEIVER BOARD ASSY, COM 111 TSO (See Fig. 4.5-1 for NHA)
	55969-0001	SHIELD
	81214-0010	SPACER, PHENOLIC 7/32 O. D. x .140 LG.
	82922-0001	NUT, HEX, #4-40
	56485-0001	GROUNDING, CLIP
C-602	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-603	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-604	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-605	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-606	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-607	24509-0228	CAPACITOR, CERAMIC, .22 pf ±5%, 500V
C-608	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-609	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-610	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-611	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-612	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-613	22041-0002	CAPACITOR, VARIABLE, 9 to 35 pf
C-614	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-615	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-616	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-617	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-618	24049-0511	CAPACITOR, DIPPED MICA, 510 pf ±5%, 500V
C-619	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-620	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-621	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-622	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-623	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-624	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-625	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-626	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-627	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-628	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-629	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf, ±5%, 10V
C-630	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-631	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-632	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-633	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C-634	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-635	23094-0171	CAPACITOR, MET. MYLAR, .047 mf ±10%, 200V
C-636	21555-0011	CAPACITOR, TANTALUM, 39 mf ±10%, 10V
C-637	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-638	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-639	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C-641	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-642	21555-0012	CAPACITOR, TANTALUM, 82 mf ±10%, 10V
C-643	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-644	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-645	21296-0003	CAPACITOR, FEED THRU CERAMIC .001 mf GMV, 500V
C-646	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-647	21296-0003	CAPACITOR, FEED THRU CERAMIC .001 mf GMV, 500V
C-648	21291-0025	CAPACITOR, CERAMIC DISC, 930 pf ±10%, 500V
C-649	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-650	21555-0011	CAPACITOR, TANTALUM, 39 mf ±10%, 10V
C-651	21515-0010	CAPACITOR, CERAMIC DISC, .02 mf, 50V
CR-602	75037-0001	DIODE, TUNING
CR-603	75037-0001	DIODE, TUNING
CR-604	75037-0001	DIODE, TUNING
CR-605	75028-0001	DIODE, SILICON
CR-606	75028-0001	DIODE, SILICON
CR-607	75028-0001	DIODE, SILICON
CR-608	75025-0002	DIODE, ZENER, 8.2V ±5%, 1W
CR-610	75037-0001	DIODE, TUNING
CR-611	75037-0001	DIODE, TUNING
CR-612	75037-0001	DIODE, TUNING
CR-613	75028-0001	DIODE, SILICON
CR-614	75028-0001	DIODE, SILICON
FL-601	11751-0002	FILTER, CRYSTAL, 11.975 MHz

Fig. & Index No.	Part Number	Description
L-601	11753-0002	COIL, TUNED SLUG, (RF INPUT)
L-602	11754-0001	COIL, TUNED SLUB (RF OUTPUT)
L-603	11755-0001	COIL, TUNED SLUB (MIXER INPUT),
L-604	11138-0015	CHOKE, RF, 6.8 ±10%
L-606	11834-0001	COIL TUNEABLE
Q-601	75611-0002	TRANSISTOR, FET, N CHANNEL
Q-602	75611-0002	TRANSISTOR, FET, N CHANNEL
Q-603	75588-0003	TRANSISTOR, NPN, 2N3662
Q-604	75588-0003	TRANSISTOR, PNP, 2N3662
Q-605	75588-0003	TRANSISTOR, NPN, 2N3662
Q-606	75588-0003	TRANSISTOR, NPN, 2N3662
Q-607	75595-0003	TRANSISTOR, NPN, 2N5172
Q-608	75565-0006	TRANSISTOR, PNP, 2N5356
Q-609	75595-0003	TRANSISTOR, NPN, 2N5172
Q-610	75595-0003	TRANSISTOR, NPN, 2N5172
Q-611	75565-0006	TRANSISTOR, PNP, 2N5356
Q-612	75595-0003	TRANSISTOR, NPN, 2N5172
Q-613	75565-0006	TRANSISTOR, PNP, 2N5356
Q-614	75595-0003	TRANSISTOR, NPN, 2N5172
R-602	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-603	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-604	31192-0273	RESISTOR, CARBON, 27K ±10%, ¼W
R-605	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-606	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-607	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-608	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-609	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-610	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-611	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-612	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-613	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-614	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-615	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-616	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-617	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-618	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-619	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-620	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-621	31192-0822	RESISTOR, CARBON, 8.2K ±10%, ¼W
R-622	31192-0332	RESISTOR, CARBON, 3.3K ±10%, ¼W
R-623	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-624	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-625	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-626	31192-0562	RESISTOR, CARBON, 5.6K ±10%, ¼W
R-627	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-628	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-629	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-630	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-631	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-632	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-633	31192-0273	RESISTOR, CARBON, 27K ±10%, ¼W
R-634	31192-0473	RESISTOR, CARBON, 47K ±10%, ¼W
R-635	31192-0154	RESISTOR, CARBON, 150K ±10%, ¼W
R-636	31192-0564	RESISTOR, CARBON, 560K ±10%, ¼W
R-637	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-638	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-639	31192-0155	RESISTOR, CARBON, 1.5M ±10%, ¼W
R-640	31192-0123	RESISTOR, CARBON, 12K ±10%, ¼W
R-641	31192-0331	RESISTOR, CARBON, 330 ±10%, ¼W
R-643	31192-0682	RESISTOR, CARBON, 6.8K ±10%, ¼W
R-644	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-645	31192-0683	RESISTOR, CARBON, 68K ±10%, ¼W
R-646	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-648	31196-0003	RESISTOR, CARBON, 27 ±5%, 2W
R-649	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-650	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-651	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-652	31192-0474	RESISTOR, CARBON, 470K ±10%, ¼W
R-653	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-654	31192-0153	RESISTOR, CARBON, 15K ±10%, ¼W
R-657	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-658	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-659	32054-0009	RESISTOR, CARBON, VARIABLE, 1K
R-660	31192-0683	RESISTOR, CARBON, 68K ±10%, ¼W
R-661	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-662	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-665	31192-0330	RESISTOR, CARBON, 33 ±10%, ¼W
R-666	31192-SEL.	RESISTOR, CARBON, SEL. ±10%, ¼W
R-667	31192-SEL.	RESISTOR, CARBON, SEL. ±10%, ¼W
R-668	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-669	31192-SEL.	RESISTOR, CARBON, SEL. ±10%, ¼W
R-671	31192-0391	RESISTOR, CARBON, 390 ±10%, ¼W
Z-101	11454-0001	FERRITE BEAD

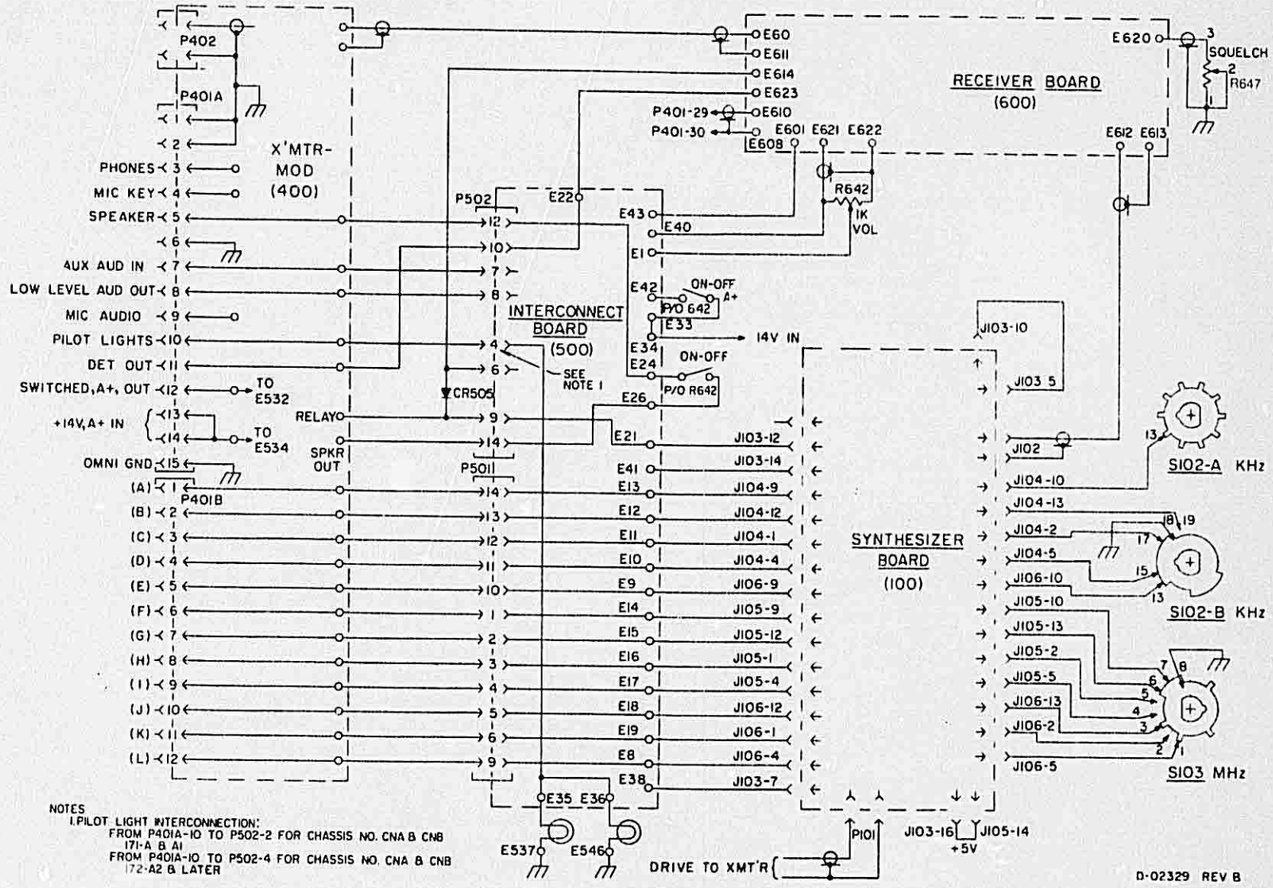
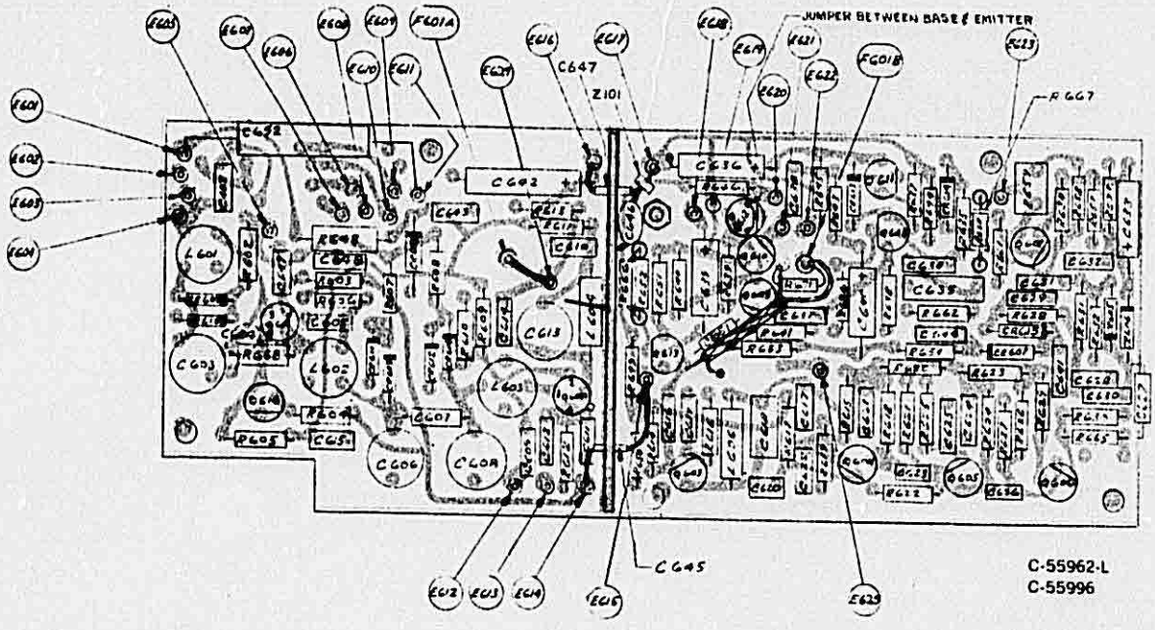
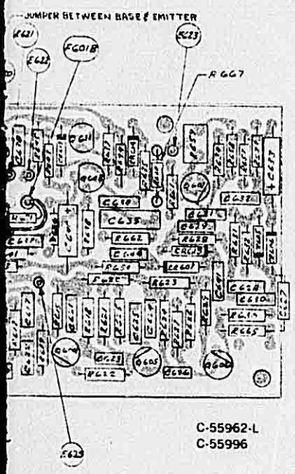


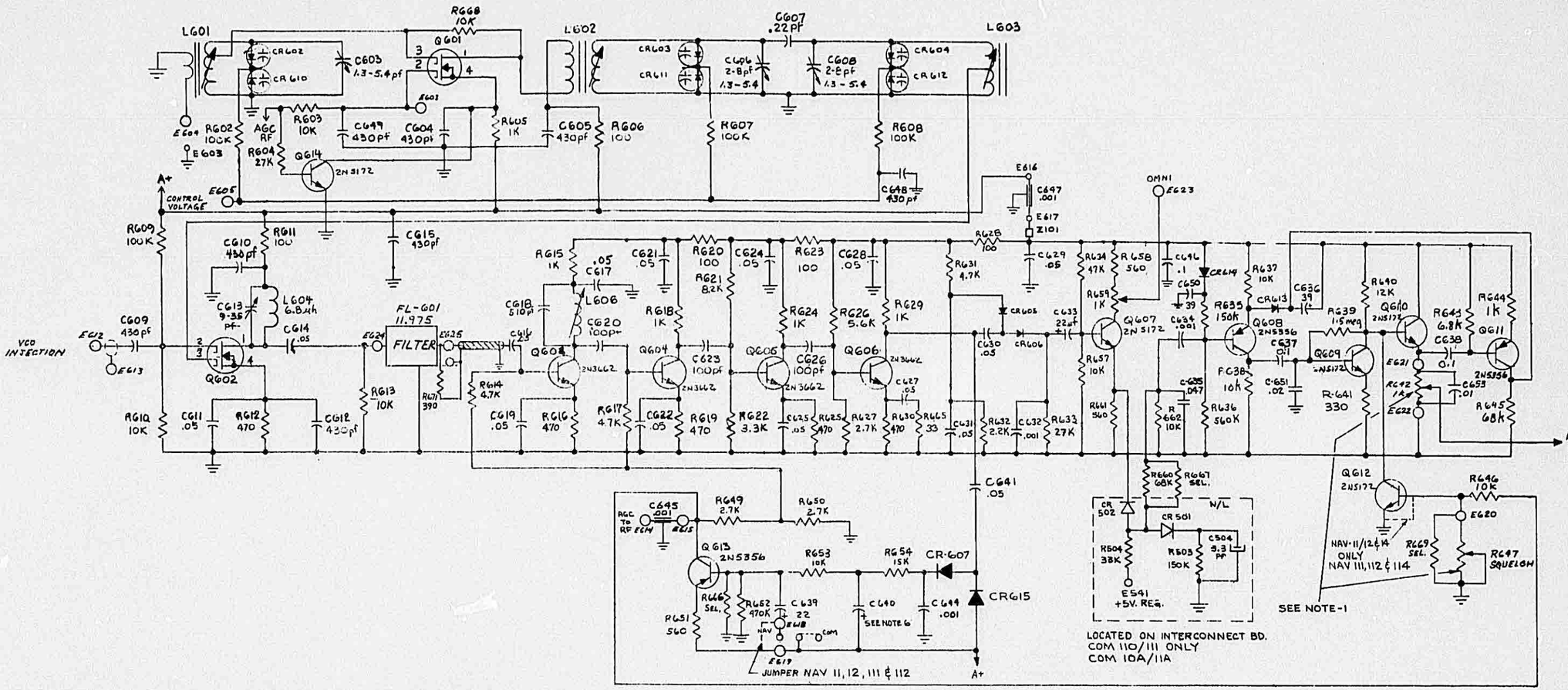
FIGURE 4.6-1 INTERNAL INTERCONNECT DIAGRAM, COM 111 TSO

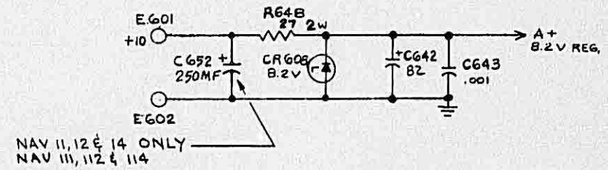
SEE BLOW-UP



SEE BLOW-UP







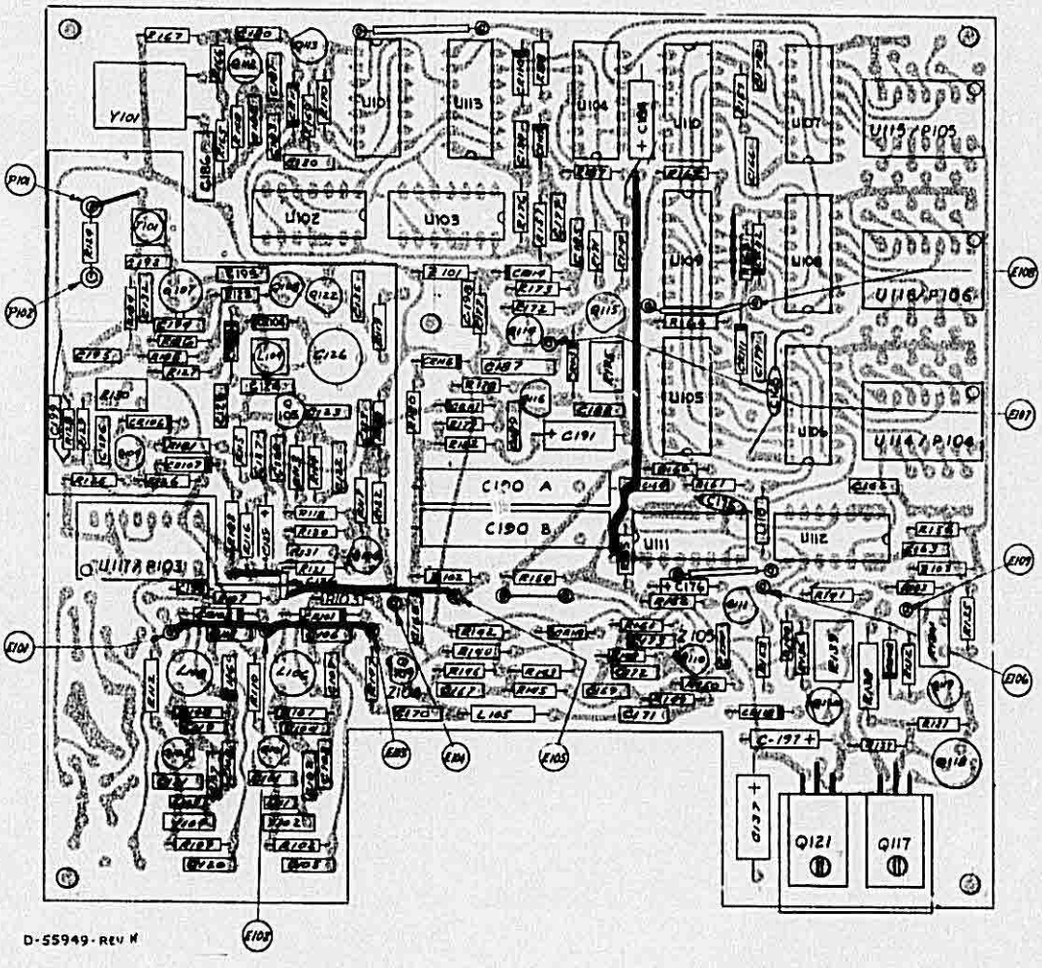
NOTES:

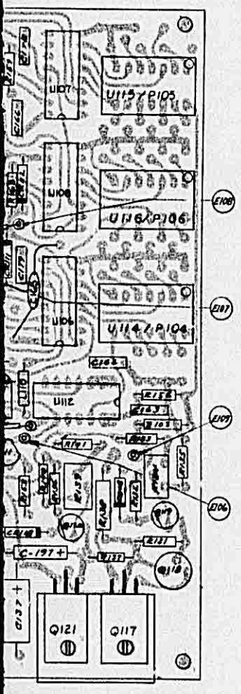
1- R642 & R647 ARE PART OF FRONT PANEL B 01154 PARTS LIST.
2- COM 10/10A & COM 11/11A B-01147-101 PARTS LIST AS SHOWN. (ALSO COM 110/111)
3- NAV 11, 12 & 14, B-01147-2 OMIT SYMBOLS, R656, CR 609, R663, C602, R601, CR-601, C601, R669, Q612, R647, R696. (ALSO NAV 111, 112 & 114)
4- ALL RESISTORS ARE IN OHMS ± 10%, ¼ W., CARBON COMP. EXCEPT AS NOTED.
5- ALL CAPACITORS ARE IN µF EXCEPT AS NOTED.
6- C640 (10MMF COM 10A, NAV 11, NAV 12 & NAV 14, COM 110, NAV 111, NAV 112 & NAV 114.
(3.3MF COM 11A, COM 111.

D-02299 REV-P

FIGURE 4.6-2 RECEIVER SCHEMATIC, COM 111 TSO

SEE BLOW-UP


D-55949-REV H
SEE BLOW-UP



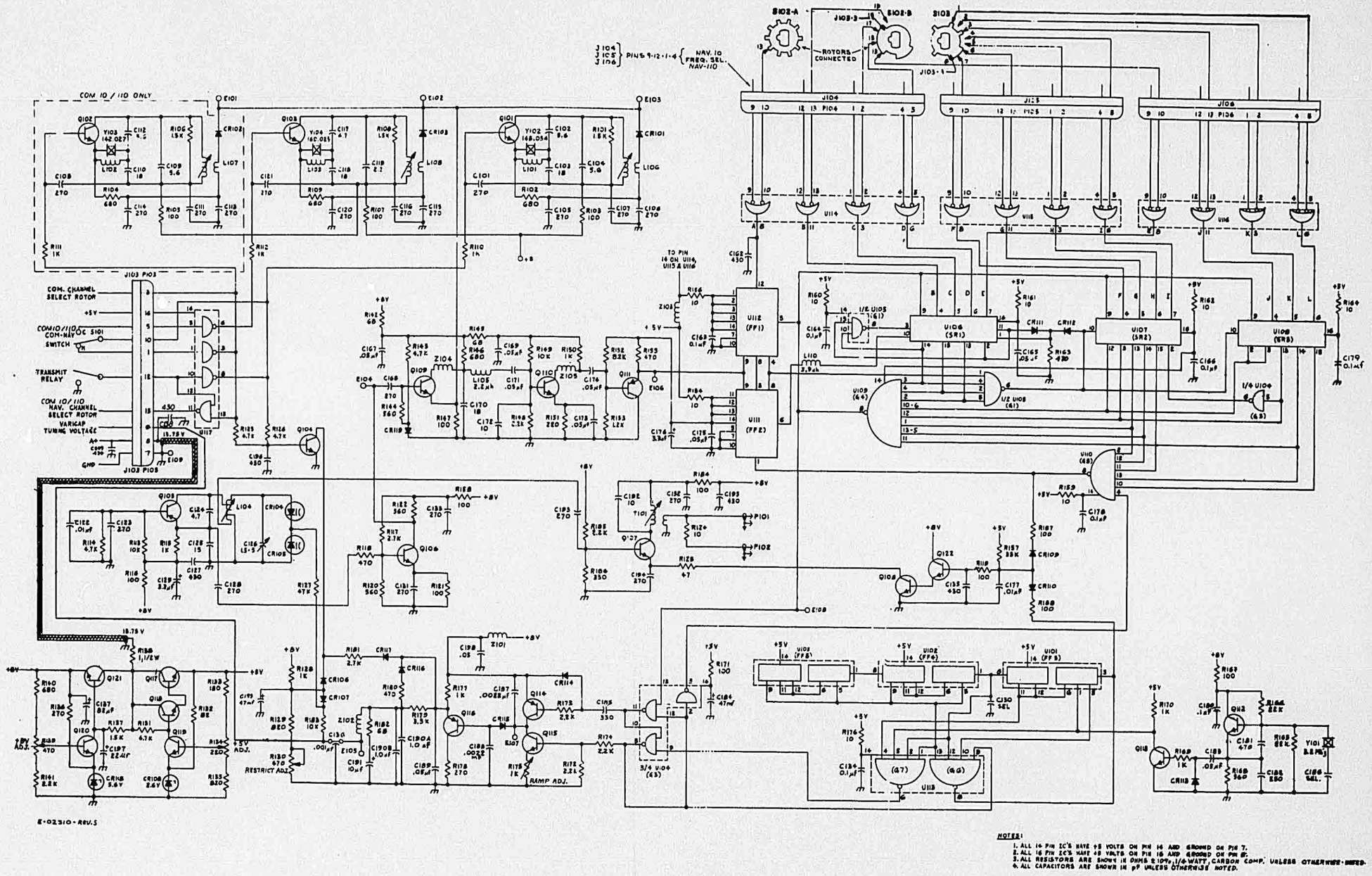
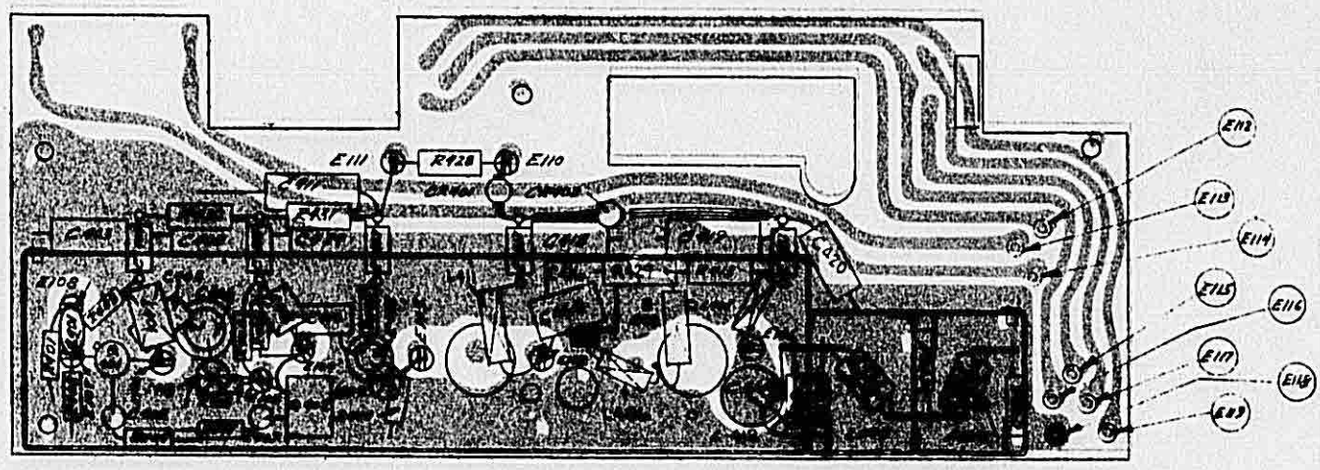
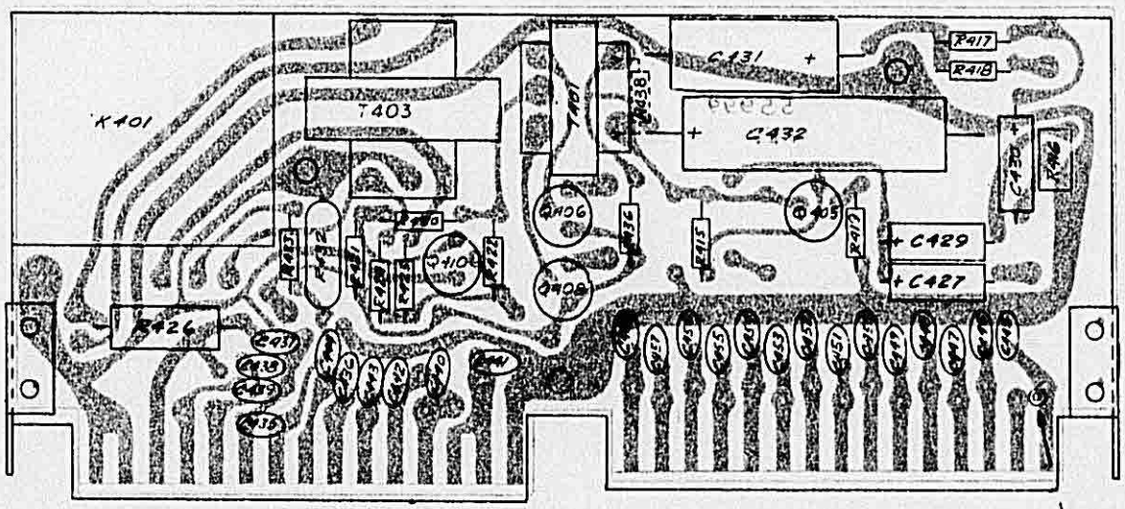


FIGURE 4.6-3 SYNTHESIZER SCHEMATIC, COM 111 TSO

SEE BLOW-UP



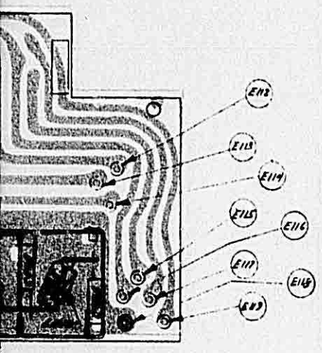
C-55158-C
C-55943

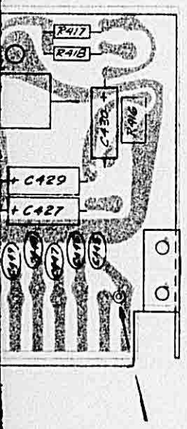


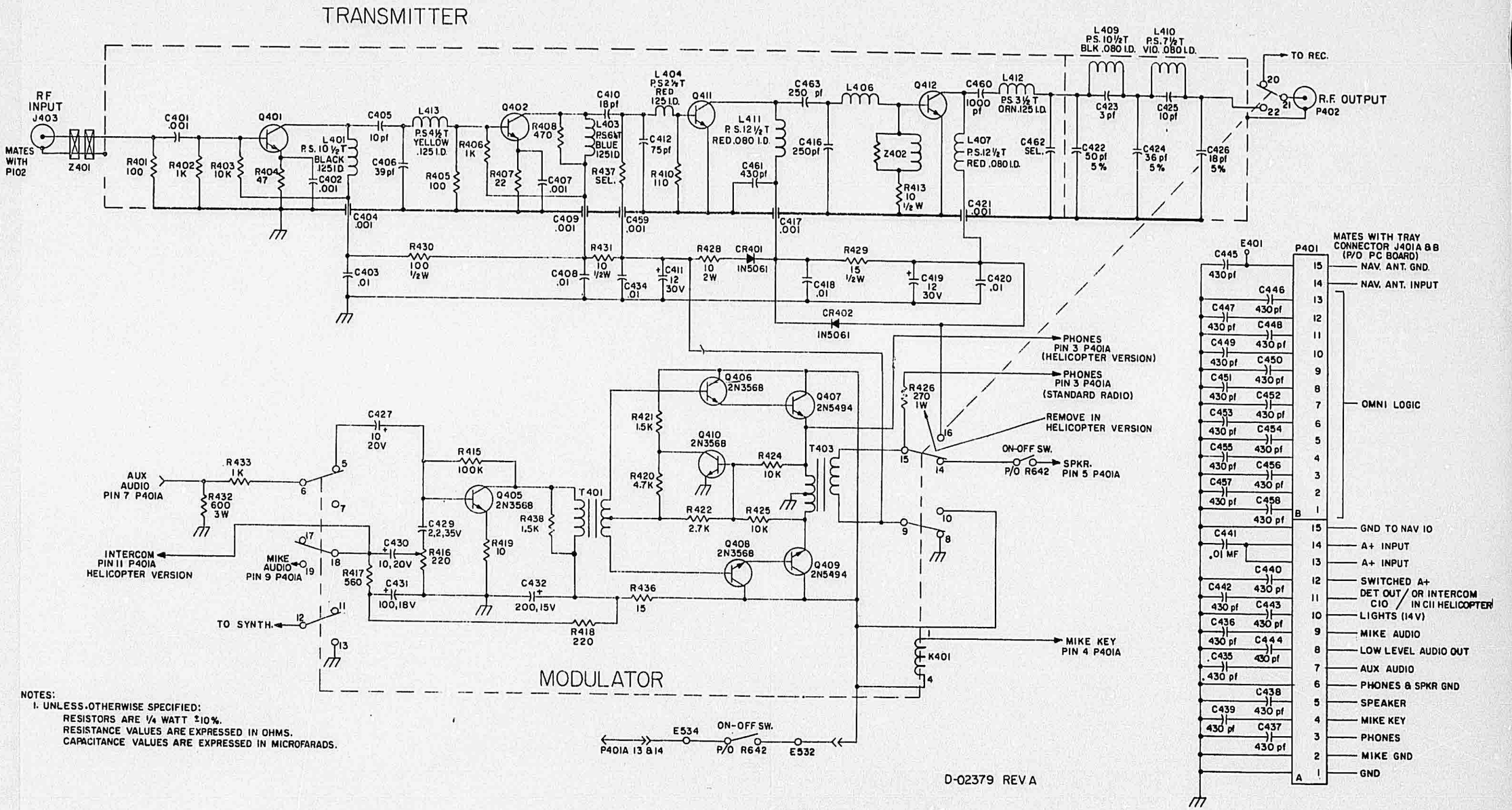
C-55159-D
C-55999

NOTES:
1. UNLE

SEE BLOW-UP



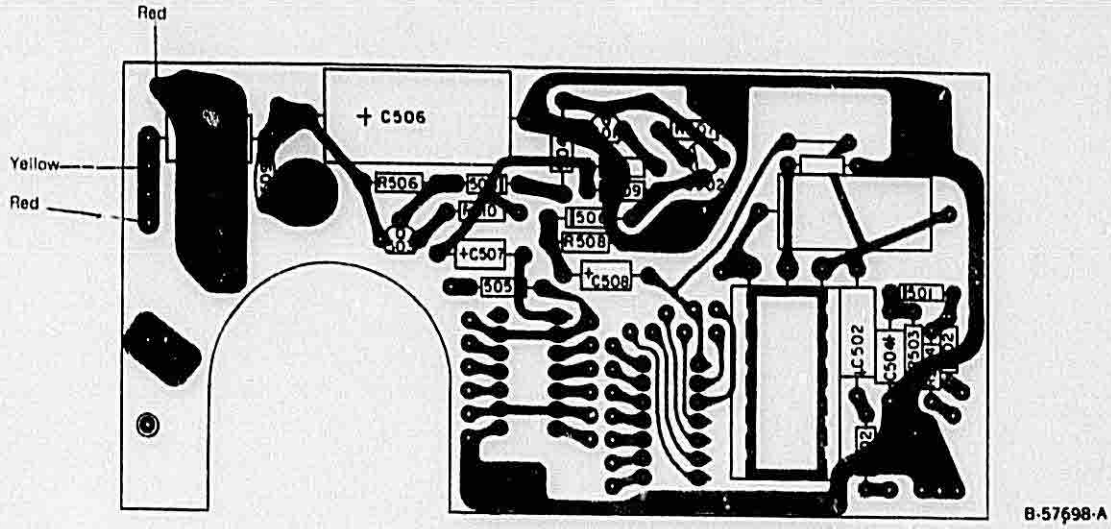




NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   RESISTORS ARE ¼ WATT ±10%.
   RESISTANCE VALUES ARE EXPRESSED IN OHMS.
   CAPACITANCE VALUES ARE EXPRESSED IN MICROFARADS.

FIGURE 4.6-4 TRANSMITTER/MODULATOR SCHEMATIC, COM 111 TSO

SEE BLOW-UP



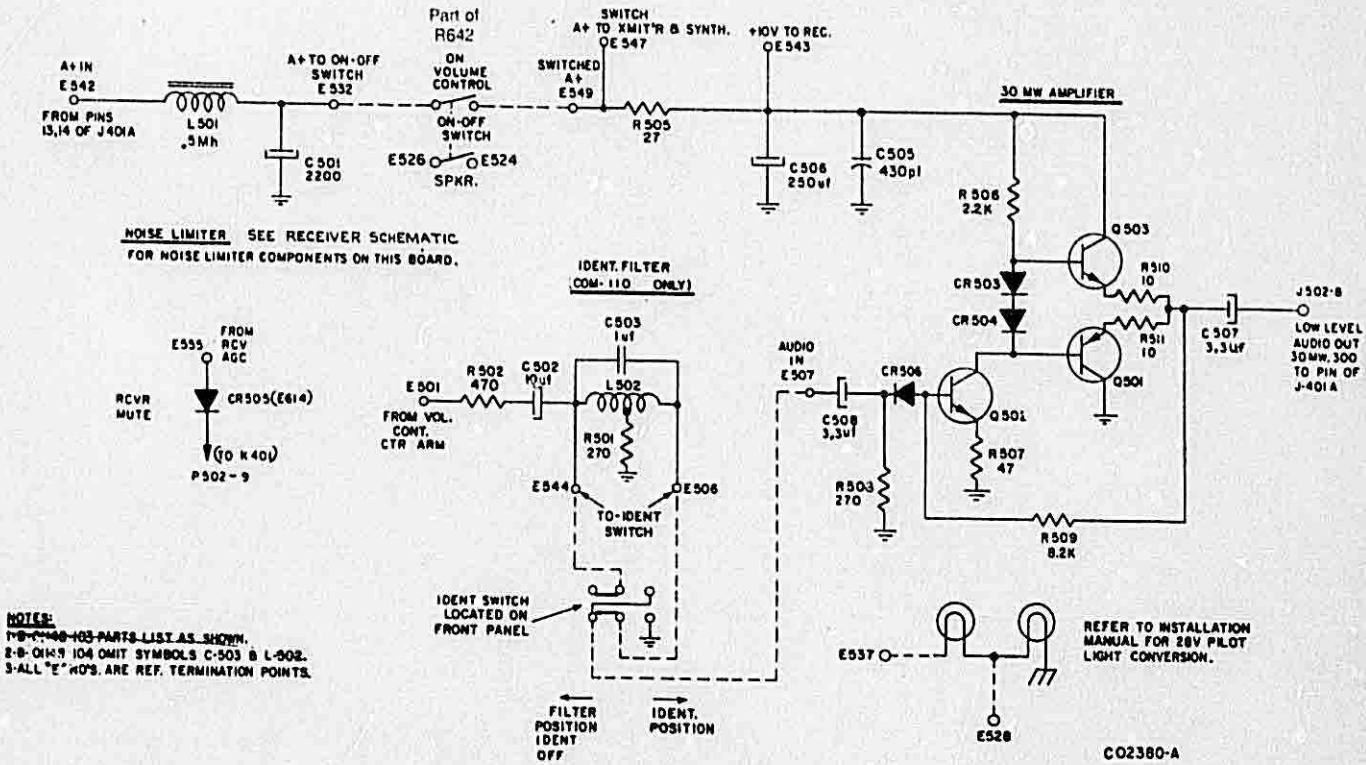


FIGURE 4.6-5 INTERCONNECT PC BOARD SCHEMATIC

SEE BLOW-UP

TABLE OF CONTENTS

SECTION	TOPIC	PAGE	ATP GRID
5	NAV 111 TSO/NAV 112 TSO	5-1	2C06
5.1	GENERAL	5-1	
5.2	INSTALLATION	5-1	
5.3	NAV 111 TSO and NAV 112 TSO CIRCUIT DESCRIPTION	5-2	2C07
5.3.1	NAV 111 TSO/NAV 112 TSO OMNI/LOC Circuits	5-4	2C09
5.3.2	NAV 111 TSO/NAV 112 TSO Left-Right Phase Detector	5-4	
5.3.3	NAV 111 TSO/NAV 112 TSO To-From Detector	5-5	2C10
5.3.4	NAV 111 TSO/NAV 112 TSO, OMNI/LOC Switching Circuits	5-5	
5.3.5	Localizer Circuitry	5-6	2C11
5.3.6	Receiver	5-7	2C12
5.3.7	Ident Filter, Noise Limiter, and 30 mw Amplifier	5-8	2C13
5.3.8	Synthesizer	5-9	2C16
5.4	MAINTENANCE	5-11	2C18
5.4.1	NAV 111 TSO/NAV 112 TSO	5-11	
5.4.1.1	Test Equipment Required for NAV 111 TSO/NAV 112 TSO	5-11	
5.4.1.2	Test Set-up	5-11	
5.4.1.3	Alignment, Procedures	5-11	
5.4.1.4	NAV 111 TSO/NAV 112 TSO Maintenance Procedures and Hints	5-14	2C21
5.4.2	NAV 111 TSO/NAV 112 TSO Receiver	5-15	2C22
5.4.2.1	Test Equipment Required for NAV 111 TSO/NAV 112 TSO	5-17	2D01
5.4.2.2	Receiver Troubleshooting	5-17	
5.4.2.3	NAV 111 TSO/NAV 112 TSO Receiver Tuning Procedure	5-20	2D07
5.4.2.4	NAV 111 TSO/NAV 112 TSO Synthesizer Troubleshooting	5-20	
5.5	NAV 111 TSO/NAV 112 TSO REPLACEMENT PARTS LIST	5-21	2D10

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE	ATP GRID	BLOW-UP FICHE
5.1-1	NAV 111 TSO and NAV 112 TSO	5-1	2C06	
5.3-1	NAV 111 TSO/NAV 112 TSO Simplified Block Diagram	5-2	2C07	
5.3-2	OMNI/LOC Block Diagram	5-3	2C08	
5.3-3	OMNI/LOC Switching	5-5	2C10	NC F905
5.3-4	Bridge T Filter	5-6	2C11	NC F905
5.3-5	NAV 111 TSO/NAV 112 TSO Receiver Block Diagram	5-7	2C12	
5.3-6	Synthesizer Block Diagram	5-9	2C16	
5.4-1	NAV 111 TSO/NAV 112 TSO Internal Interconnect	5-16	2C23	NC F905
5.5-1	NAV 111 TSO/NAV 112 TSO	5-21	2D10	
5.5-2	Front Panel Assy	5-24	2D13	
5.5-3	Filter Assy	5-25	2D14	
5.5-4	Gear Train Assy	5-26	2D16	
5.5-5	Localizer Board, NAV 111 TSO/NAV 112 TSO	5-28	2D17	NC F905
5.5-6	OMNI Board, NAV 111 TSO/NAV 112 TSO	5-32	2D21	NC F905
5.5-7	Synthesizer HFO Assy NAV 111 TSO/NAV 112 TSO	5-34	2D23	
5.5-8	Synthesizer LFO Assy, NAV 111 TSO/NAV 112 TSO	5-35	2D24	NC F905
5.5-9	Synthesizer Filter Assy, NAV 111 TSO/NAV 112 TSO	5-36	2E01	NC F905
5.5-10	Receiver Board Assy	5-38	2E03	NC F905
5.6-1	OMNI Maintenance Information, NAV 111 TSO/NAV 112 TSO	5-41	2E10	
5.6-2	Localizer Maintenance Information, NAV 111 TSO/NAV 112 TSO	5-43	2E12	
5.6-3	Internal Interconnection Diagram with Glide Slope Connections	5-45	2E13	NC F905
5.6-4	OMNI Schematic, NAV 111 TSO/NAV 112 TSO	5-47	2F18	NC F905
5.6-5	Localizer Schematic, NAV 111 TSO/NAV 112 TSO	5-49	2E22	NC F905
5.6-6	Receiver	5-51	2F02	NC F905
5.6-7	Synthesizer Schematic, NAV 111 TSO/NAV 112 TSO	5-53	2F11	NC F906

LIST OF TABLES

SECTION	TITLE	PAGE	ATP GRID
5.4.1	Receiver DC Voltage Measurements	5-18	2D03
5.6-3A	Internal Interconnection Diagram with Glide Slope and DME Connections	5-46A	2E15

The NAV 111 and NAV 112 utilize a newly designed Receiver Board Assembly.

This Assembly is also used in the NAV 11 and NAV 12. A similar Receiver Board Assembly is used in the NAV 14 and NAV 114, the difference being, no LO Filter circuit components.

To determine if this new assembly is in a Unit check the Chassis Number and the number (in solder) on the board.

Unit	First Used in Units With Chassis No.	Check Component Orientation with Figure No.	Part No. on Solder Side of the Board
NAV 111	CND219C	5.5-10A	59083
NAV 112	CNE219C	5.5-10A	59083
Replacement Module Part Number (complete and tested)			
NAV 111 01221-1210			
NAV 112 01221-1210			
For Information Only:			
NAV11	CNA194E		59083
NAV 12	CNB194E		59083
NAV 14	CNC194E	(no LO Filter Assy)	59083
NAV 114	CNF219C	(no LO Filter Assy)	59083

As noted, the NAV 11,12, 111, 112 all use the same New Receiver Board Assembly, thus they are interchangeable. This Assembly, if necessary, could be used in a NAV 14 or NAV 114, however, the LO Filter would not be connected.

The NAV 14 and NAV 114 use identical Receiver Board Assemblies, thus they are interchangeable unto themselves.

Care must be taken in any interchange as there ARE a few differences in the interconnect wiring. Should a board be removed and replaced, the interconnect wiring should be that equivalent to the Schematic (Figure 5.6-6A).

The basic differences in the new board and the orignal are in the following areas:

1) additional stage of RF selectivity.
2) an integrated circuit replacing four discrete stages in the IF Amplifier.
3) a different crystal filter.
4) an integrated circuit in the Detector, AGC Amplifier, Audio Amplifier, and OMNI Buffer Stages.
5) it will be seen that the LO Injection Filter, which was previously mounted to the bottom of the Receiver Board, is now incorporated within the circuitry on the Receiver Board (NAV 114 Receiver Board does not have these components).

For technical support for the NAV 111/112, refer to:

Circuit Description, Section 5.3.6A Receiver (Chassis CND219C/CNE219C) page 5-8A and 5-8B.

Maintenance, Section 5.4.2.1A Test Equipment Required (Chassis CND219C/CNE219C) page 5-19A.

Section 5.4.2.2A Receiver Troubleshooting (Chassis CND219C/CNE219C) page 5-19B

Section 5.4.2.3A Tuning Procedure for NAV (Chassis CND219C/CNE219C) page 5-20A.

Replacement Parts List, Figure 5.5-10A. Receiver (Chassis CND219C/CNE219C) and its list, page 5-40A.

Schematic, Figure 5.6-6A. Receiver Schematic (Chassis CND219C'CNE219C) page 5-52A.

5.1 GENERAL

This section, Section 5, is devoted to the NAV 111 TSO and the NAV 112 TSO.

These NAV units are designed to be mounted in a standard 3" aircraft instrument panel opening, with minor modifications. The NAV units are independent navigation receivers that present standard OMNI/LOC information (the NAV 112 TSO also provides glide-slope information and can be obtained with or without wired-in DME channeling capability).

5.2 INSTALLATION

All pertinent information pertaining to specifications, licensing, and installation are provided, in detail, in Section 2 of this manual.

NAV 111 TSO

NAV 112 TSO

FIGURE 5.1-1 NAV 111 TSO and NAV 112 TSO

5.3 NAV 111 TSO and NAV 112 TSO CIRCUIT DESCRIPTION

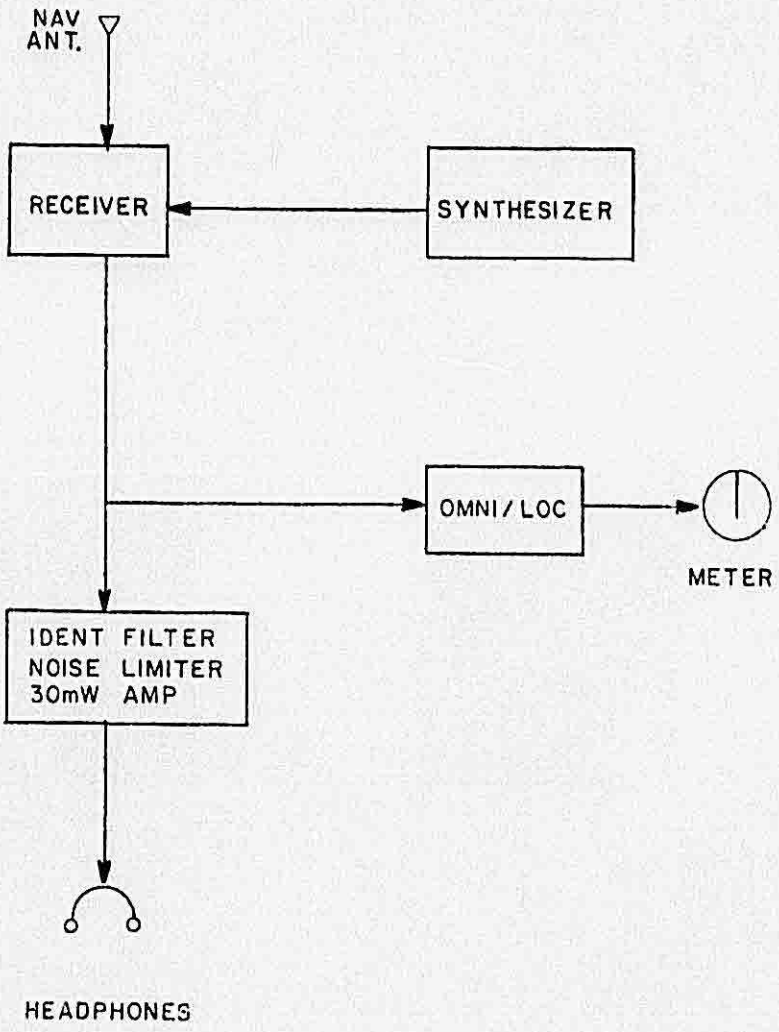


FIGURE 5.3-1 NAV 111 TSO/NAV 112 TSO SIMPLIFIED BLOCK DIAGRAM

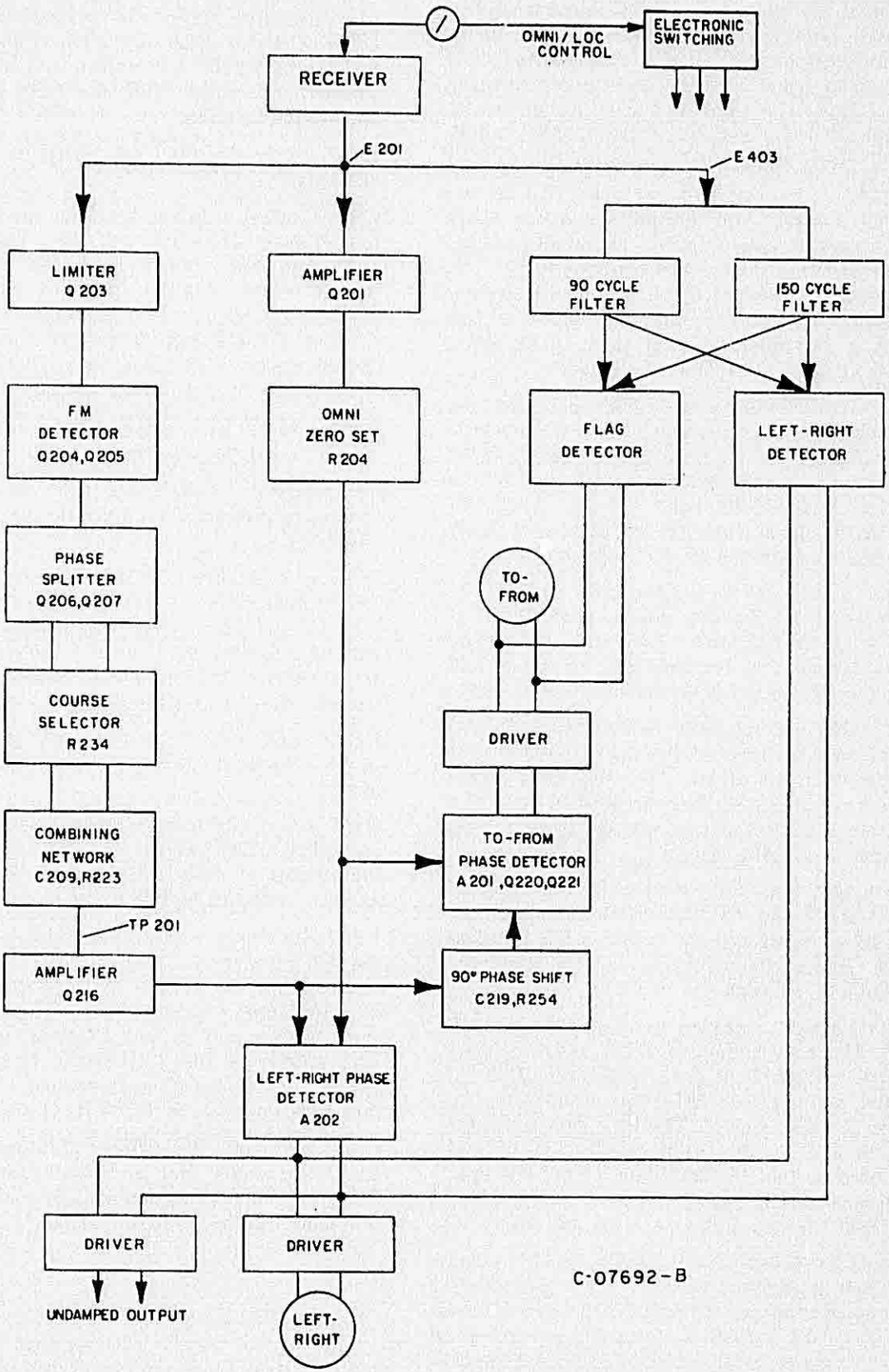


FIGURE 5.3-2. OMNI/LOC BLOCK DIAGRAM

5.3.1 NAV 111 TSO/NAV 112 TSO OMNI/LOC Circuits

The combined 30/9960 Hertz OMNI signal is applied to the omni circuit at terminal E201. The filter section composed of R201 and C202 removes most of the 9960 FM signal in addition to causing some 30 Hertz phase shift. This signal is applied to the base of Q201 as the 30 Hertz variable channel. Q201 amplifies the 30 Hertz signal (gain E201 to collector of Q201 is 2.3).

R204 is the OMNI Zero Set potentiometer. R204 and C203 cause a phase shift in the 30 Hertz signal which is proportional to the resistance of R204. The AC voltage at the base of Q202 is also affected by the resistance of R204. Typical range is .66 - .72v rms. Q202 is an emitter follower stage which drives the Left-Right and TO-From Phase Detector.

The combined 30/9960 Hertz is also applied to the Limiter (Q203) thru C204 which removes much of the 30 Hertz signal leaving the 9960 FM signal. Q203 amplifies and limits the signal and applies it to the FM detector circuit. Q204 and Q205 are turned ON and OFF by the signal from Q203. CR201 is a Zener diode voltage regulator for the FM detector circuit.

C205 and L201 form a resonant circuit at approximately 10.7 KHz. The voltage across L201 is proportional to the frequency of the applied voltage. It will be maximum at the resonant frequency and decrease as the frequency is moved from resonance.

C206 and L202 are resonant at approximately 9.3 KHz. R211 makes the Q of the 10.7 and 9.3 KHz circuits approximately equal. The 9960 FM signal varies plus and minus 480 Hertz from 9960 KHz at a 30 Hertz rate. The resonant circuits therefore convert the FM signal to an AM signal.

The AC voltages from L201 and L202 are detected by diodes CR202 and CR203. C207 filters out the remaining 9960 signal and the result is the detected 30 Hertz reference channel signal with an amplitude of approximately .15 volts rms at C208.

The 30 Hertz signal is coupled to phase splitter Q206 and Q207. The combination of Q206 and Q207 act like a single transistor of very high gain. This 30 Hertz signal is then split into two equal but 180 degrees out of phase signals. The high gain transistor configuration and the precision resistors R219 and R220 are used so that the amplitude of the two split signals will be precisely equal.

The split 30 Hertz signals drive the OMNI bearing selector (OBS) potentiometer, R234.

The output from each of the wiper arms of the OBS potentiometer drives an emitter follower, Q209/Q210. The two signals are then combined thru C209/R223 and R226. The result is a signal at TP201 whose phase varies with the OBS dial and whose amplitude is constant.

C210 couples the 30 Hertz signal to amplifiers Q215 and Q216.

CR208 helps maintain the bias point of Q216 over temperature. The output of the collector of Q215 is applied to A202, pins 7/10 in the L-R phase detector. It is also applied to Q214 which inverts its phase. The signal from Q215/Q216 is combined thru C219 and R254 and results as a 90 degree phase shifted signal. This signal is applied to A201, pins 7/10 in the To-From phase detector.

5.3.2 NAV 111 TSO/NAV 112 TSO Left-Right Phase Detector

CR206 and CR207 are used in the Localizer switching circuitry. In OMNI operation they are closed.

A202 is a multiplier. When the two 30 Hertz signals are 90 degrees out of phase the voltage output across pins 11 and 12 is zero. The voltage across pins 11 and 12 will vary from zero to around 150 millivolts for 10 degrees of phase difference as the phase between the two 30 Hertz signals vary.

CR204 and CR205 limit the voltage output of the phase detector to prevent damage to the Left-Right meter.

Q220 and Q221 form a current source to drive the multiplier. R285 adjusts the source current so that the voltage at pins 11 and 12, with an omni signal applied, is approximately 6.5 volts DC.

R240 is a course width adjustment. It loads down the output to give a 5 dot deflection (around 150 millivolts at pins 11/12) for a 10 degree phase shift. The additional resistors, R277, R278, etc., associated with A202 supply proper DC bias to the multiplier. The output of the Left-Right Phase Detector is applied to two isolation amplifiers, U201 and U202, thru isolating resistors R289-R241 and R290-R242.

U201 and U202 are emitter follower drivers for the Left-Right meter and undamped output. R245 and R249 are balance adjustments to make up for slight differences in the transistor pairs.

5.3.2 Continued

The output, E204 and E203, from the emitter followers is a voltage of approximately 150 millivolts for a 10 degree phase difference. This voltage will be only slightly effected by the load connected to the output. Therefore if a high impedance autopilot or a 1000 ohm standard meter is connected to the output, the voltage output will be the same.

The output of U201 is connected to the Left-Right meter. The Left-Right meter has more damping than the undamped output of U202 because C216 damps the Left-Right needle, however C216 has little effect on the undamped U202 because it is isolated by R241 and R242.

5.3.3 NAV 111 TSO/NAV 112 TSO To-From Detector

The reference 30 Hertz channel is shifted 90 degrees and applied to the To-From Phase Detector.

Essentially this detector operates the same as the Left-Right Phase Detector. The only appreciable difference is that there is no gain adjustment resistor connected across pins 11 and 12 of A201. (A202 has resistor R240) Flag current is set by R233.

5.3.4 NAV 111 TSO/NAV 112 TSO OMNI/LOC Switching Circuits

Electronic switching is used for OMNI and Localizer operation. Refer to Figure 5.3-3.

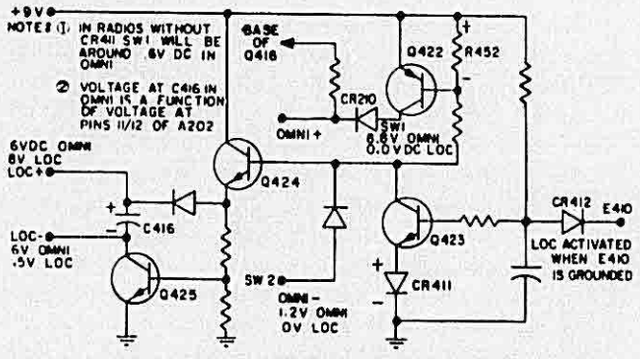


FIGURE 5.3-3. OMNI/LOC SWITCHING

OMNI MODE

In OMNI mode the Localizer activate lead (terminal E410) is open (ungrounded). Q423 is therefore turned ON by current flow thru R454 and R455. This brings SW2 (E409) to approximately ground potential.

With Q423 ON, the current flow causes a voltage drop across R452 turning Q422 ON. With Q422 ON, SW1 (E408) is brought to approximately 9 volts. With Q423 ON, the base of Q424 is connected to ground causing Q424 to be turned OFF. With Q424 OFF, there is no drive to Q425, thus Q425 is OFF.

With Q424 and Q425 OFF, the Localizer + (plus) and - (minus) leads are floating as if they were not connected. The Localizer Left-Right and To-From detectors have no voltage applied to them so that even thought they are still connected to the OMNI circuit, they do not effect the OMNI Left-Right or To-From indicators. The voltage measured at each side of C416 during OMNI operation (about 6 volts) is the result of the voltage fed into the Localizer from the L-R and To-From circuits.

In OMNI operation Q424 and Q425 could be removed from the circuit with no change in operation. Also while in OMNI operation, as a result of the voltage (+9v) applied by the switching circuits (SW1), CR210, CR206, and CR207 are closed, and the wiper of R232 is grounded.

LOCALIZER MODE

In Localizer mode E410 is grounded by the channeling switches.

Diode CR412 prevents sneak paths from activating the Localizer when the Localizer activate is used for activating other equipment such as a glide slope receiver or autopilot coupling.

When Q423 is turned OFF, the current thru R452 decreases so the voltage across R452 decreases and Q422 is turned OFF.

SW2 is no longer at ground potential so the OMNI To-From flag emitter follower drivers, Q212 and Q213, are OFF and the To-From flag is free to follow the Localizer command.

SW1 is no longer connected to +9 volts which turns OFF the OMNI Left-Right and To-From Phase Detectors.

When Q423 is OFF, the collector of Q423 increases in voltage turning Q424 ON. When Q424 is ON it turns Q425 ON. When Q424 is ON it supplies +9 volts to the Localizer circuitry. When Q425 is ON it grounds the negative side of the Localizer circuitry. The Localizer is thus operational.

CR411 gives a small (.5 volt) bias to Q423 to compensate for the .5 volt drop across CR412.

Diodes CR210, CR407, and CR408 prevent current from flowing from the OMNI circuit to the switching circuitry when in Localizer mode and prevents current from flowing from the Localizer circuitry to the switching circuitry when in OMNI mode.

In Localizer mode, Q422 and Q423 could be removed with no change in operation.

SEE BLOW-UP

5.3.5 Localizer Circuitry

The signal from the receiver is applied to the Localizer Circuitry at E403.

R465 controls the signal level to the active filters and thus controls the LOC course width.

A. 90 Hz Filter

The 90 and 150 Hertz audio signal is fed thru C420 to the electronic filter. R401 and R402 bias the base of Q401 to about 4.6 volts DC.

Q401 and Q402 form a differential amplifier with the output taken from the collector of Q401. This output drives the base of the single stage amplifier, Q405. The output from Q405 is developed across load resistor R414 and drives the To-From and Left-Right Detectors. The output from Q405 also feeds a bridge T audio filter (R410, R411, R407, C402, C403, and R406) that is tuned to 90 Hz.

NOTE: For determining the filter frequency the two resistors (R406 and R407 etc.) act as if they are connected in parallel. The bridge T filter has a notch response.

The output of the bridge T filter is applied to the base of Q402 (½ of the differential amplifier). If an audio frequency signal other than the notch frequency is applied to the base of Q401, it is amplified by Q401, applied to the base of Q405, amplified by Q405, and passed back thru the bridge T filter to the base of Q402. This voltage at the base of Q402 is of the proper phase (negative feedback) to oppose the voltage applied to the base of Q401. The net result is that because of the feedback canceling, the voltage output at the collector of Q405 is low.

If a signal is applied at the notch frequency the process is the same, except that the filter passes very little of the signal. There is thus little voltage applied to the base of Q402 and little canceling, and the voltage at the collector of Q405 will be large. Since the feedback network plays a dominant role in determining the gain of the circuit, the gain is quite independent of variations among transistors.

The gain and center frequency of the filter amplifiers is dependent on the exact values of the bridge T filter components. Because of normal component tolerances, R411 is selected during production to tune the filter to 90 Hz.

B. 150 Hz Filter

The 150 Hertz filter is the same as the 90 Hertz filter except for the values of the components in the bridge T filter that tune it to 150 Hertz instead of 90 Hertz.

C. Left-Right Detector

The 90 and 150 Hertz signal amplitudes are attenuated by R-470 and R-472 and then applied to the Left-Right Detector, Q409 and Q410. Q407 and Q408 are connected as diodes and along with R466 and R467 form a DC biasing network. Q409 amplifies the 90 Hertz signal and Q410 amplifies the 150 Hertz signal. If equal 90 and 150 Hertz signals are applied, the voltage at E404 will not change. If the 90 and 150 Hertz signals are unequal, the voltage at E404 will move and the Left-Right needle will deflect.

D. To-From Detector

R424, R425, R429, R432, and R431 form a DC biasing network for the To-From Detector, the 90 and 150 Hertz signals are amplified and applied to Q413 and Q416. If both signals are present, Q413 and Q416 are both turned ON and current will be applied to the flag meter.

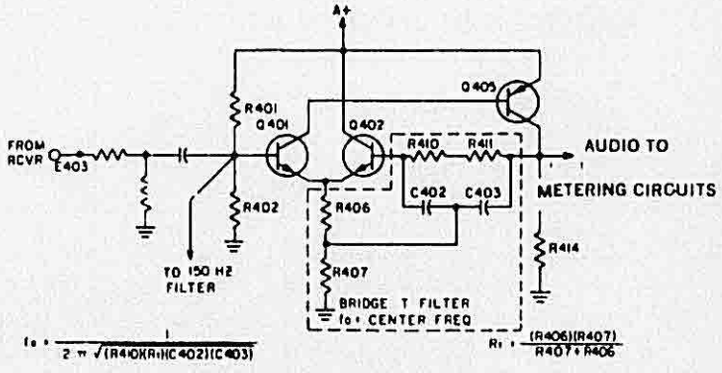


FIGURE 5.3-4 BRIDGE T FILTER

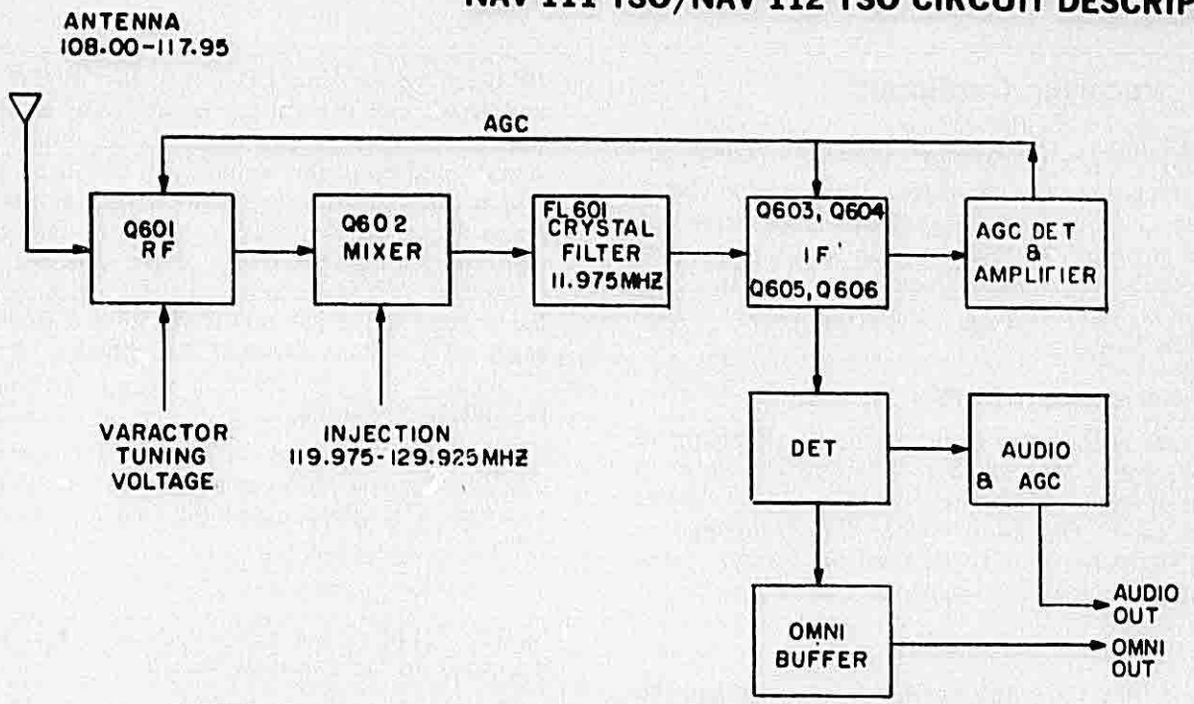


FIGURE 5.3-5 NAV 111 TSO/112 TSO RECEIVER BLOCK DIAGRAM

5.3.6 Receiver

A. RF Amplifier, Q601

The RF Amplifier is a dual gate MOS-FET. Both gates of this device are protected (inside the device) so the device is not as susceptible to damage when soldering or unsoldering. The RF input to Q601 (Gate 1, pin 3) is taken from a tap on the RF input coil, L601. The drain, pin 1, is connected to L602 which is connected to A+ thru R606. Gate 2, pin 2, is connected to the AGC buss thru R603. Q614 functions as a dynamic source resistor. Under no signal conditions the AGC buss is approximately 4.5v. This forward bias on Q614 turns the transistor ON hard and it acts as a very low source resistor for the FET. As the AGC buss goes lower (with increasing signal), Q614 starts to turn OFF and its effective resistance goes up. This raises the source voltage. At the same time the Gate 2 voltage is going down. This voltage change (Vg2s) reduces the current in the FET and thus reduces the gain. The input and output tuned circuits are varactor tuned. The control voltage (derived from the Synthesizer VCO) is supplied to the junctions of CR602/CR610, CR603/CR611, and CR604/CR612. At the high end of the band this voltage is high (7.5v) thus causing the capacitance of the diodes to be low. This change in capacity tracks the receiver front end. The tuned circuits are tracked by tuning the capacitors (C603, C606, and C608) at the high end of the band; and the inductors, L601, L602, and L603 at the low end of the band.

B. Mixer, Q602

The Mixer is also a dual gate MOS-FET with both gates protected. The input to the Mixer is taken from the tap on L603 and applied to the input gate (Gate 1, pin 3). VCO injection is applied to Gate 2, pin 2. The VCO injection level is 1.5v p-p. This VCO RF voltage changes the gain of the FET and thus modulates the RF signal input (pin 3). The difference frequency is selected by the crystal filter that is connected to the drain (pin 1) of the Mixer. L604 provides the drain load for the Mixer and C613 is used to tune the input to the crystal filter.

C. IF Filter, FL601

The crystal filter provides the final selectivity of the receiver. The 6 db bandwidth is 34 KHz and the 60 db bandwidth is 84 KHz.

5.3.6 Receiver, Continued

D. IF Amplifiers, Q603, Q604, Q605, and Q606

The IF Amplifier consists of four R-C coupled stages. The tuned circuit (L606, C618) at the collector of Q603 is intended to reduce noise in the IF Amplifier. R665 provides degeneration in the last stage and its value may vary depending on the overall gain of the amplifier.

E. Detector and OMNI Buffer

CR605 and CR606 detect the positive half of the IF signal present at the collector of Q606. The detected signal is filtered (C632) and coupled to the OMNI buffer (Q607). The audio signal that is applied to the OMNI converters is taken from the variable resistor (R659) to allow the proper level to be set.

F. Audio Amplifier and AGC Circuit

The signal from the emitter of Q607 is coupled to the audio amplifier thru R660. Q608 is the stage to be gain controlled. The output of Q608 is amplified by Q609 and connected to the emitter follower, Q610. R642 is the volume control for the system and the output is tapped off this resistor. The output of Q610 is also connected to Q611. Q611 is used as a peak detector. As the output of Q610 increases, Q611 is turned ON harder. This causes the DC voltage at R645 to increase. This voltage is applied to the cathode of CR613 and tends to back bias the diode as the output of Q611 increases. CR613 is used as a dynamic degeneration resistor for Q608. As CR613 is back biased, the gain of Q608 decreases and the level of the audio output is controlled. Threshold action occurs due to the initial no signal condition of Q608. When no signal is applied, the emitter voltage of Q608 is pulled down due to the current flowing thru CR613. This causes Q608 to be running at a very low current and on the low end of the gain vs current curve. When an audio signal is applied CR613 starts to be back biased and this allows the voltage at the emitter of Q608 to rise slightly and the current thru Q608 to increase. This increases the gain of the stage. If there were no AC degeneration in the stage, the system would oscillate; but, since CR613 degenerates Q608, the system is stable. Thus, as an audio signal is applied, the output first rises rapidly and then remains constant as the input signal increases. R667 is selected to determine the level where the threshold action occurs.

G. AGC Detector and Amplifier

CR607 and CR615 detect the positive half of the IF signal present at the collector of Q606. The IF signal causes the current flowing thru CR607 to vary as the IF signal varies. The DC return for CR607 is R652 and R666 and the voltage at the base of Q613 will vary as the current thru R652 varies. Thus under no signal conditions the voltage at the base of Q613 allows the transistor to conduct hard and as the IF signal increases this voltage increases and turns the transistor OFF. The voltage at the collector of Q613 is used as the AGC voltage to the RF amplifier and the voltage at the junction of R649 and R650 is used as the AGC voltage to the IF Amplifier.

H. Voltage Regulator

CR608 is an 8.2v Zener diode. The series resistor for the Zener is split and bypassed at the junction of the resistors. This gives added filtering for the regulated voltage.

NOTE: Half of the series resistance and bypassing is located on the Localizer Board.

5.3.7 Ident Filter, Noise Limiter, and 30 mw Amplifier

A. Ident Filter (C-801, L-801, R-801)

The Ident Filter filters the 1020 Hertz Ident signal present in the OMNI signal modulation when in the filter position (pushed in). When the Ident knob is in the Ident position (pulled out), the Ident Filter is used as a tuned circuit to enhance the 1020 signal and reduce the high and low frequency response

B. Noise Limiter (on Localizer PC Board)

The Noise Limiter is a peak limiting circuit connected to the high side of the volume control.

As the audio level increases, capacitors C-417 and C-418 charge-up to back bias diodes CR-409 and CR-410 thus allowing the audio to pass undistorted. With no signal (noise only) the Noise Limiter clips more heavily.

C. 30 mw Amplifier (on Localizer PC Board)

This low level amplifier consists of a voltage amplifier driving a complementary emitter follower (Q-417 and Q-418). Input is coupled in thru a capacitor (C-413) to the base of the voltage amplifier. A feedback voltage divider provides both DC and signal feedback. Two diodes, CR-403/CR-404 provide forward bias for the complementary amplifier. The output is capacity coupled thru C-414.

5.3.6.A Receiver (Chassis CND219C/ CNE219C)

A. RF Amplifier (Q602)

The RF Amplifier is a dual gate MOS-FET. Both gates of this device are protected (inside the device so the device is not as susceptible to damage when soldering or unsoldering.

The RF input to Q602 (Gate 1, pin 3) is taken from a tap on the RF input coil, L603. The drain, pin 1, is connected to L602 which is connected to A+ thru R613. Gate 2, pin 2, is connected to the AGC bus thru R622. Gate 1, pin 3, is biased approximately .7 volts less than the source, pin 4. The source is biased to approximately 2 volts. This fixed bias is applied to the source to allow the voltage on gate 2 to swing below the source voltage and cut-off the RF Amplifier during AGC. The input and output tuned circuits are varactor tuned. The control voltage is supplied to the junction of CR609/610, CR607/608, CR604/605, and CR602/603 thru 100K resistors. At the high end of the band this voltage is high thus causing the capacitance of diodes to be low. This change in capacity tracks the front end. The tuned circuits are tracked by tuning the capacitors (C643, C641, C616, and C615) at the high end of the band and tuning the inductors (L604, L603, L602, and L601) at the low end of the band.

B. Mixer (Q601)

The Mixer is a dual gate MOS-FET with both gates protected. The input to the Mixer is taken from the tap on L601 and applied to the input gate, pin 3. LO injection is applied to gate 2, pin 2. The level of the LO injection is 1.5 volts p-p. This LO RF voltage changes the gain of the FET and thus modulates the RF signal input. The difference frequency is selected by the Crystal Filter that is connected to the drain, pin 1, of the Mixer. T602 provides the drain load for the Mixer.

C. IF Filter Assy (XT601, XT603, and XT603).

The Crystal Filter Assy provides the final selectivity of the Receiver. The 6 db bandwidth is 34 KHz and the 60 db bandwidth is 84 KHz. The tuned circuits on the input (T602, C637) and output (T601, C601) provide the reactive load necessary to minimize the ripple of the Filter.

D. IF Amplifier (U601)

Integrated Circuit U601, the IF Amplifier, takes its input from the secondary of T601 and its output is coupled to the primary of T604. The output supply voltage (DC) is applied to the center tap of T604 and the low level stages of U601 are supplied thru pin 2. Pin 5 is the AGC input. Positive going voltage reduces the gain of the Amplifier.

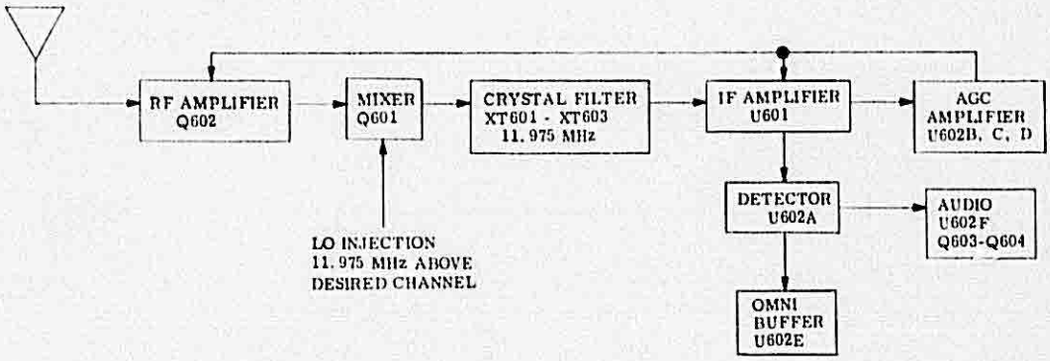


FIGURE 5-3.5A RECEIVER BLOCK DIAGRAM

5.3.6A Continued

E. Detector, OMNI Output (U602* A and E

The input to the Detector is taken from the secondary of T604. CR606 protects the Detector from overload during transients. The Detector inputs are pins 7 and 8. Pin 9 is the Detector output. The audio at pin 9 is DC coupled to pin 14, the OMNI buffer input. Pin 15 is the OMNI buffer output. R634 is the load for the buffer and the wiper of R634 is the output that goes to the OMNI/LOC circuitry.

F. Audio Amplifier and Noise Limiter (U602* F)

The Audio at pin 15 of U602 is coupled to the Noise Limiter thru emitter follower Q603. The Noise Limiter diode (CR611) is biased to permit the equivalent of 30% modulation to pass undistorted. Any noise impulse exceeding this level will be clipped by the Noise Limiter. The cathode of CR611 is biased thru R631 and R628. C645 filters the audio from the bias network. The anode of CR611 is biased thru R633 and R630. As the current changes thru Q603 (due to RF signal level) the relative bias across CR611 changes to allow less clipping with high RF signals and more clipping with only noise present. The output of the NOISE Limiter is coupled to the Audio Amplifier (pin 2 of U602) thru R626 and C628. Pin 1 is the emitter of the Amplifier and pin 3 is the collector. Q604 is the emitter follower output that drives the volume control.

G. AGC Amplifier (U602* B, C, and D)

Three sections of U602 comprise the AGC Amplifier. The DC at pin 9 of U602 changes with RF input level. This DC goes positive with increasing signal level. Pin 9 is internally coupled to pin 11, the input to the first DC amplifier. The output of the first DC amplifier is internally connected to the second DC amplifier. Pin 6 is the output of the second DC amplifier. The output of pin 6 goes positive with increasing signal level. This positive going AGC voltage is applied to pin 5 of U601 thru R614. C631 and C636 provide AC filtering of the AGC line. Pin 11 is also internally coupled to a third DC amplifier. Pin 13 is the output of this amplifier. This output goes negative with increasing signal and it is applied to the AGC gate of the RF Amplifier thru R622. C640 provides the filtering for this AGC line.

H. LO Filter (U603)

The function of the LO Filter Assembly is to select the HFO plus LFO output from the double balanced mixer in the HFO Assembly and reject the HFO and HFO minus LFO components. The resulting output is amplified by U603 to the level required for proper injection as the Receiver LO.

* U602's multi-functions (Detector, AGC, Audio) for the Receiver are broken-out and identified as symbol numbers U602 A, B, C, D, E, and F. The Block Diagram, Text, and Schematic show these suffixes.

5.3.8 Synthesizer

The synthesizer generates the 200 channel LO injection signal needed to tune the single conversion receiver. A tuning voltage is also supplied by a switched tap on a resistor network to tune the receiver front end voltage variable capacitor diodes (Varicaps).

To generate 200 channels a Low Frequency Crystal Oscillator (LFO) with 20 crystals in the 23 MHz range and a High Frequency Crystal Oscillator (HFO) in the 100 MHz range are mixed in a double balanced mixer in the HFO Assembly and then amplified and filtered in a Filter Assembly attached to the receiver.

The LFO is an untuned Colpitts oscillator and the HFO is a tracked tuned Colpitts oscillator. An IC Amplifier is used in the filter and a varicap tracked tuned circuit in the output stage.

A. LFO

The LFO is a Colpitts type untuned crystal oscillator. C103, C104, and C105 form a feedback tap with C103 providing a low voltage output.

B. HFO

The HFO is a tuned grounded base Colpitts type oscillator. Tuning is accomplished by varying the inductance of L101 while tracking is performed by adding segments of PC board inductor on every other step in frequency.

Outputs from the HFO and LFO are fed to the double balanced mixer consisting of the secondary of L101 and CR101, CR102, CR104, CR104, and L102.

C. FILTER

The function of the Filter-Amplifier Assembly is to select the HFO plus LFO output from the double balanced mixer in the HFO Assembly and reject the HFO and HFO minus LFO components. The resulting output is amplified by an IC Amplifier to the level required for proper injection as the Receiver LO.

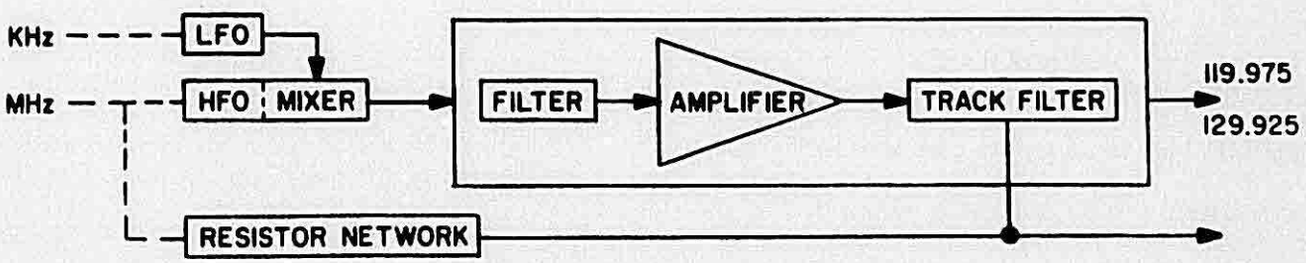


FIGURE 5.3-6 SYNTHESIZER BLOCK DIAGRAM

5.4.1 NAV 111 TSO/NAV 112 TSO

5.4.1.1 Test Equipment Required for NAV 111 TSO/NAV 112 TSO

a) OMNI Signal Generator, TIC'S T-12A or equivalent
b) 14v Power Supply, Electro Products Lab, Model NFB or equivalent
c) VTVM, RCA Senior Voltohmyst or equivalent
d) Audio Oscillator, Hewlett-Packard 200CD or equivalent
e) Oscilloscope, Tektronix 515A or equivalent
f) Resistor Substitution Box (2)
g) a 1000 ohm, 150 ua meter.

5.4.1.2 Test Set-up

The NAV 111/112 TSO omni can be aligned and maintained with or without a receiver. If receiver problems are suspected (such as a bad crystal filter which can cause omni errors) a demodulated omni signal can be connected to the omni circuitry without going thru the receiver. Other than omni zero set, the omni should not be compensated with the idea of removing receiver induced errors. (Typical, ±1%of error can be expected from the receiver.)

Most of the measurements are made with a standard omni signal applied to the receiver at 500 microvolts. At this RF level the receiver is well into AGC action and the detected voltage at the input to the omni localizer converter (E201) is set (at manufacture) for .3 vac rms measured with the 30 Hertz signal only present, and with the 9960 signal only present, there will be .15 to .3 vac rms depending on the receiver. The amplitude of the 9960 signal does not have as much effect on the equipment operation as the 30 Hertz signal, as the 9960 signal goes to a limiter.

When a direct omni connection is made without a receiver, the demodulated signal is applied to pin 14 of J101. A+ and Ground must also be applied. The NAV channel selector must be switched to an OMNI or localizer channel to have the NAV operate in the desired mode.

The generator demodulated amplitude should be adjusted so that at E201, with the system connected, there is .3 vac rms of 30 Hertz measured with the 9960 signal deleted. This will result in .3 vac rms of 9960 with most generators.

NOTE: Measure with one signal present at a time because different voltmeters will read differently with both signals present at the same time.

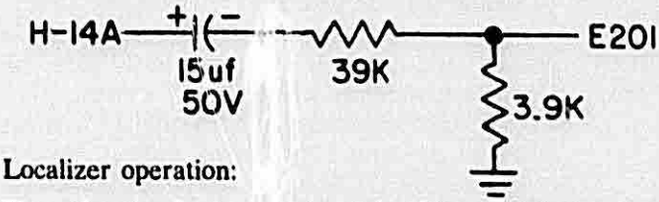
CAUTION:

Some signal generators, such as the H-14A, have large DC and AC voltage output at the demodulation output. Applying a large DC voltage to E201 can damage the radio. (C201 is a 15 volt capacitor.)

CAUTION:

Many pots are protected from undesired changes, such as vibrations, by having a glob (dab) of silicon rubber applied to the pot at the factory. This material has a certain amount of "memory". Therefore if a pot requires readjustment, cut away the silicon rubber completely, adjust the pot, and resecure the pot on the back with a glob of silicon rubber.

The following attenuator/DC blocking circuit is recommended for use with the H-14A.



Localizer operation:

Since the standard omni signal is 30% modulation for both the 30 and 9960 Hertz signal and the localizer signal is 20% modulated for both 90 and 150 Hertz signals there should be .3 vac in the OMNI mode and .2 vac in the Localizer mode.

5.4.1.3 Alignment Procedures

NOTE:
Early units may utilize the undamped output. Later units units have only the External L/R output. See Fig. 5.6-4.

Connect a 1000 ohm, 150 ua meter to the output J201, pins 3 and 4.

A. Power Supply Adjust

(1) Set the power supply to 13.75 volts and connect the VTVM to the emitter of Q420.
(2) Adjust R450 for 9.0 vdc on the VTVM.
(3) Check high and low line (11.0 vdc-15.0 vdc). The 9 volt line shall not vary by more than 0.4v.
(4) Set the power supply back to 13.75v.

B. DC Balance Adjust (OMNI)

(1) Remove input signal to OMNI.
(2) Channel to an OMNI frequency.
(3) Place a jumper (short) from CR206's cathode to CR207's cathode.
(4) Adjust R245 for zero deflection of the Left-Right meter.
NOTE: Because of the longer time constant on the Left-Right needle, wait for the pointer to come to rest before completing this adjustment.
(5) Adjust R249 for zero deflection of the external meter. (Steps 4 and 5 should be set very accurately.)
(6) Redo steps 4 and 5 as often as necessary until both meters are centered.
(7) Remove the jumper (short) between CR206 and CR207. Connect the VTVM to CR206 or CR207's cathode. If the voltage reads between 6.0 and 6.8 volts proceed to step 10.
(8) Remove R285 and using the resistor substitution box, select a value which will give 6.5 plus or minus 0.3 vdc at CR206's or CR207's cathode.
(9) Turn the power OFF and install the selected value resistor. Turn power ON and verify step 7.

5.4.1.3 Continued

(10) Connect the VTVM to either side of C211. If the voltage reads between 6.0 and 6.8 volts proceed to step 13.

(11) Remove R272 and using the resistor substitution box, select a value which will give 6.5 plus or minus 0.3 vdc at C211.

(12) Turn power OFF and install the selected value resistor. Turn power ON and verify step 10.

(13) Connect a standard omni signal.
At this time check that the internal Left-Right and the external undamped output meters track closely. 5 dots on the internal meter equals ±50 ua on external meter. Check both Left and Right deflection . . . if they do not track, stop and repair before proceeding further.

C. Discriminator Tuning

(1) Connect an audio oscillator, set to around 10 KHz, to the omni generator external modulation input.
NOTE: If the omni is being driven direct, without a receiver, connect the audio oscillator in place of the omni signal, directly to the omni converter.

(2) Connect a scope to the junction of L201 and C205. Keep the percent of modulation (or audio oscillator level)low so that the waveform at L201 is not distorted (the percent modulation will be very low). Tune the audio oscillator frequency for maximum voltage. The peak should occur at 10.7 KHz, if not, select or pad C205 to peak at 10.7 KHz.

(3) Move the scope to junction L202 and C206. Repeat step 2, only at this time peak C206 at 9.3 KHz.

(4) Reconnect the test set-up for normal OMNI test.

D. Phase Comparator Null

(1) Connect a 50 uf, 10v electrolytic or larger capacitor from the junction of C217 and R247 to ground (negative side grounded).

(2) Set the OMNI generator so only the 9960 FM signal is produced and adjust R237 for zero deflection on the Left-Right meter.

(3) Disconnect the OMNI signal from the OMNI and adjust R277 for zero deflection on the Left-Right meter.

(4) Repeat steps 2 and 3 till both conditions are met.

(5) Remove the capacitor.

NOTE: Steps 2 and 3 should be set very accurately. It will usually take a few repeats to get proper balance.

NOTE: U203-1 and U203-2 are selected by NARCO from standard RCA CA3026 devices for proper balance.

If a CA3026 is used which has not been selected it may balance correctly but then show large reciprocal or course errors or it may not be possible to balance it at all.
The To-From detector, U203-1, is not as critical as the Left-Right detector, U203-2. The U203-2 part can be used for To-From but the U203-1 can not be used for the Left-Right.

Be sure to order and use the proper part from NARCO. (U203-1 P/N 74012-0003 or U203-2 P/N 74012-0002)

CAUTION: When using a soldering iron in this area it is possible to heat up a diode or other component so that the balance will be affected. Use minimum heat and keep iron away from other components. Use clip leads to connect resistor boxes to circuit.

E. Course Width

(1) Place signal generator at any bearing and turn OBS till Left-Right needle is centered.

(2) Change the omni generator or the OBS dial 10 degrees. Select R240 for 5 dot deflection on the Left-Right meter. (The edge of the circle is considered the first dot.)

F. Course Selector Alignment

(1) Set the omni zero potentiometer to the center of its range. Set the signal generator to 0 degrees "To" and adjust the OBS for 0°.

CAUTION: If the omni/loc converter is driven directly, without a receiver, and with the generator set for 0 degrees TO, the omni will be 0 degrees FROM because there is normally a 180 degree phase shift in the receiver.

(2) Loosen the setscrews on the collar that damps the OBS card drive gear to the OBS knob shaft. Rotate the OBS knob being sure the OBS card doesn't turn till the L/R needle is centered and the flag shows "TO".

NOTE: The potentiometer setting should not need adjustment unless the potentiometer is replaced or mechanical slippage occurs. If the zero set potentiometer does not have enough range by a large amount it may be that something is wrong in the unit causing a phase shift.

5.4.1.3 Continued

As a further check on the potentiometer, pins 3 and 1 should have the minimum resistance when the OBS reads approximately 240 degrees, plus or minus approximately 10 degrees and potentiometer pins 4 and 6 will also have a minimum resistance at 240 degrees, plus or minus approximately 10 degrees. (Note: some pots do not have pins 5 and 6 available.)
The minimum resistance will not be zero and will not be the same for each tap point or the same for every potentiometer.

G. OBS Phase Adjustment

(1) Set the signal generator and the OBS dial to 105 degrees. Adjust omni zero set (R204) for zero deflection on the Left-Right meter.
(2) Set the signal generator and the OBS dial to 285 degrees. Use omni zero (R204) to split the error.
(3) Repeat steps 1 and 2 to verify error split.
(4) Place signal generator and OBS dial to 195 degrees.
(5) Adjust R225 for zero deflection on the Left-Right meter.
(6) Place generator and OBS dial to 15 degrees. Check that the zero on the meter is less than plus or minus 1 degree. (If error exceeds plus or minus 1 degree use R225 to split the error.)

NOTE: If the course selector is properly aligned mechanically, R225 will have no effect on the Left-Right indicator when the OBS is set to approximately 105 degrees or 285 degrees.
If changing R225 effects the course setting by more than about 1 degree when the OBS is set at 105 or 285 degrees, something is wrong and compensation is not possible.

H. To-From Crossover Adjustment

(1) Place signal generator to 15 degrees. Remove the omni signal.
(2) Adjust R232 for zero deflection of the To-From meter. Reconnect the omni signal.
(3) Rotate the OBS dial to 105 degrees and select R253 for zero deflection on the To-From meter.
(4) Rotate the dial to 285 degrees and observe the To-From meter. Use R253 to split the error.
(5) Repeat steps 3 and 4 to verify the error split.

I. Flag Sensitivity Adjustment (Omni)

(1) Place the signal generator to 500 μv and OBS dial for 5 dot deflection.
(2) Reduce generator RF level till you have 2.5 dots deflection. Set R233 so that the flag is showing a little red.

J. Detector Balance (Localizer)

(1) Channel to a localizer frequency and set generator for localizer.
(2) DC Balance (centering)

Remove all modulation from a 1 Kuv carrier: indicator should center within one pointer width. R416 may be selected to center the pointer. Selected value should be in excess of 1 mego. Do not install this selected resistor at this time.

(3) AC Balance (deflection)

Set signal generator modulation for 90 Hz ONLY. From the generator demodulated output apply, thru a 0.47mfd coupling capacitor, the 90 Hz tone to TP404. Adjust the 90 Hz amplitude to produce 3 dots left deflection. In many generators this may be accomplished by varying the percent modulation setting.

Set signal generator modulation for 150 Hz ONLY. From the generators demodulated output apply, thru a 0.47 mfd coupling capacitor, the 150 Hz tone to TP405: Deflection should be 3 dots right, ±1 pointer width. R473 may be adjusted to balance the deflection.

(4) Repeat steps 2 and 3 until their individual requirements are met. This is necessary due to interaction between the DC and AC balance adjustments.
(5) Turn power OFF and install the selected value for the DC balance, step 2.

K. 90 Hz Filter

(1) Apply to the converter a 90 Hz ONLY tone of 0.2v rms measured at E403. Adjust R465 for 0.06v rms at TP401.
(2) Connect a scope or AC voltmeter to TP402. Select R411 for maximum AC voltage. Nominal value is 18K ohms.
(3) Turn power OFF and install the selected value resistor.

L. 150 Hz Filter

(1) Apply to the converter a 150 Hz ONLY tone of 0.06v rms measured TP401.
(2) Connect scope or AC voltmeter to TP403. Select R413 for maximum AC voltage. Nominal value is 18K ohms.
(3) Turn power OFF and install the selected value. resistor.

M. Localizer Deflection and Centering

(1) Apply to the converter a standard centering signal (i.e.: at E403, 0.2v rms of 90 Hz and 0.2v rms of 150 Hz) and adjust R472 for a centered pointer.
(2) Set the tone localizer switch to - 4 db, 90 Hz for right deflection. Adjust R470 for 3 dots deflection.
(3) Repeat steps 1 and 2 until their individual requirements are met.
(4) Set the tone localizer switch to - 4 db, 150 Hz for left deflection. Deflection should be 3 dots.

N. Flag

(1) Apply to the converter a standard centering signal. The flag shall indicate "TO".
(2) Set the tone localizer switch to - 4 db, 150 Hz and note deflection.
    (a) decrease the signal input level until deflection is approximately 2.5 dots. Flag must indicate "TO".
    (b) further decrease the signal input level until the deflection is 1.5 dots. The alarm portion of the flag must at least begin to show.

If these requirements are not met R465 may be adjusted, however, it will then be necessary to repeat the Localizer Deflection and Centering procedure (step M). When adjusting R465 it will be found that if the AC voltage at TP401 exceeds approximately 0.1v rms the localizer deflection may decrease. If this occurs, the deflection will not be proportional to the difference in depth of modulation.

(3) Set the tone localizer to 4 db, 150 Hz for a Left deflection. Reduce the input voltage to produce approximately ½ flag.
(4) Set the tone localizer to 4 db, 90 Hz for Right deflection. Note amount of flag showing R411 may be varied ±20% from its selected value for the purpose of equalizing flag response.

5.4.1.4 NAV 111 TSO/NAV 112 TSO Maintenance Procedures and Hints Hints

1. Check that B+ is 9 volts.
   CAUTION: The 9 volts is also used to tune the receiver varacters. If the voltage has changed, check the receiver tracking circuits.

2. Check that the signal to E201 is of the proper amplitude. See Section 5.4.1.2.

3. Check that the internal Left-Right meter and an external meter (150 ua, 1000 ohms is connected to J201, pins 3 and 4) track. Check both Left and Right deflection. If they do not track, repair before proceeding further.

4. With no signal applied and the receiver channeled to an omni frequency, measure the DC voltage at pins 11 and 12 of both A201 (To-From Phase Dectector) and A202 (Left-Right Phase Detector). This voltage should be between 6 and 7.2 vdc. If incorrect, find the trouble and then adjust the voltage as explained in the alignment procedure 5.4.1.3B. The measured DC voltage found at A201, pin 11 should be also at A201, pin 12. The voltages of A202 are check-out in the same manner.

   NOTE: The localizer and omni circuitry are connected together all the time. For the electrical switching to work properly the phase detector (A201 and A202) voltages must be in the proper ranges. If they are out of range, interaction of omni and localizer circuits is possible. This may show up as weak needle swing or uneven Left and Right swing.

5. Incorrect Voltage at Pin 11 and 12 of A201 or A202.
   If the voltage is high, the current source(Q220/Q221 or Q218/Q219) may be bad.

   If, for example, Q220 opens, there would be no current flow in the device and no voltage drop across the resistors connected to pins 11/12. The voltage at pins 11/12 would then tend to rise towards the supply voltage.
   The device U203 could also be bad.
   If the voltage is high (8 to 9 volts) connect a jumper from the collector of Q218 or Q220 to ground. If the voltage should come down to around 1 volt or less, the current source is probably bad. If the voltage is low, it means the current is high. Q218 (or Q220) could be shorted out, thereby causing the high current.

   R272 (and R285) control the current sources. The higher the resistance, the lower the current.

6. LOC/OMNI Switching and Interaction troubles.

   Interaction on switching troubles will usually show up as the LOC loading the omni. The unit may or may not perform properly in localizer mode. Measure the DC voltage across C416. In Localizer mode the minus side of C416 will be .5 vdc and the plus side will be around 8 vdc. In Omni mode there will be around 6 volts on both sides of C416.

   If, in OMNI mode, the voltage on both sides of C416 are not equal, it is an indication that Q424 and Q416 are not switching properly. If the voltage is much different from 6 volts it may be a shorted transistor in the Left-Right or To-From localizer detector circuits.

   The Left-Right or To-From interconnections between the omni and localizer boards (E404/E407 — E401/E402) may be disconnected and the omni checked. In OMNI mode E408 will have around 8.8 vdc and E409 around 1.2 vdc. In Loc mode E408 will be zero volts and E409 will also be zero volts.

7. The AC voltages shown on the maintenance diagrams can be used to signal trace the equipment. The actual voltages are not critical in most cases and will vary because of component tolerances from unit to unit.
   The phase detector circuits are driven hard and thus operate into limiting. This means that the course width will not change much with a change in the 30 Hertz drive voltages until they change by a large amount.
   The point at which full flag is reached will vary with the 30 Hertz drive since this occurs with low drive voltage.

8. Localizer
   The localizer input at E403 is .2v rms, 90 Hertz signal and a .2v rms, 150 Hertz signal.

   Check E403 for proper voltage.

   TP402 is the output of the 90 Hertz filter. This voltage will be approximately 1.2v rms for .2v rms of 90 Hertz at E403.
   When an off course signal is applied to the Localizer, the amplitude of one channel will increase and the other decrease. Therefore the filter amplifier must be able to produce an output of around 2.4v rms.
   Observe TP402 and increase the voltage to E403 with 90 Hertz only applied. See that you get 2.4v rms with approximately .4 v rms at E403. The waveform should look like a nice sinewave.
   Repeat the above at TP403 with 150 Hertz applied.

   NOTE: Localizer course width is a function of input (E403) amplitude in contrast to omni course width.

5.4.2 NAV 111 TSO/NAV 112 TSO Receiver

The following procedure may be used to determine which subassembly is malfunctioning. Check each subassembly for the proper inputs. If all inputs are present, but the proper output is not obtained, then the subassembly is defective. If an input is not present, refer to the subassembly that generates this input and check it for proper operation.

RECEIVER BOARD

With an RF input from a signal generator, modulated 30% with 1 KHz, the following outputs should be noted:

.10v rms at E623 with 3 uv input
.30v rms at E623 with 500 uv input
. 7v rms at E621 with 5 uv input

If these inputs are not present or if any other receiver associated problems are noted (weak flag, AGC, squelch, weak audio, etc.) check all receiver inputs.

Input	Test Point	From	Level
A+	E601	Localizer Board	10.5 vdc
DC to Varactors	E605	S101A	4 vdc (117)
Injection	E612	Filter Assy	2.5 vdc (108) .3-.5v rms RF
RF input	E604	Filter Assy J101	(noted above)

To remove the Receiver Board unsolder all connections to the pins and remove the four screws.

LFO

1. Check for 9 vdc at feedthru capacitor on the LFO box.
2. Locate the center conductor of the coax leading from the LFO to the terminal strip on the HFO. Disconnect the center coax from the terminal strip and check for .25v rms (approximately) with a RF voltmeter or VTVM equipped with a RF probe.
3. Rotate the KHz knob on the Front Panel and observe for output. Output should appear on all channels but briefly go to zero between channels.
4. If output does not appear "on channel" but appears as the knob is slowly rotated, then realign the KHz shaft using the following procedure.
   a. Remove the Receiver Board far enough to gain access to the retaining ring and setscrew on the KHz shaft.
   b. Loosen the setscrew in the retaining ring and adjust the shaft as necessary.
      NOTE! The shaft should be vertical, with the keying slot pointing right as viewed from the **rear** of the unit when the KHz is set to .00
   c. Check output of LFO on all channels. A counter can be used to determine correct frequency. Frequency should read 22.525 at .00 KHz and 23.475 MHz at .95 KHz. Frequency advances 50 KHz for each CW detent of the KHz dial.
5. If it is determined that the LFO is faulty the following procedure may be used to remove the LFO Assembly.
   a. Set the KHz dial to .00 KHz.
   b. Loosen the setscrew on the KHz shaft retaining ring and remove the shaft out the rear of the unit.
   c. Remove the screws holding the LFO Assy to the main frame.
   d. Disconnect wires to the LFO Assy, including the switches.
   e. Replace the LFO Assy including the switches.
   f. Replace the shaft thru the rear of the unit, keying slot should point to the right as viewed from the rear of the unit on all switches.
   g. Reconnect wires and replace mounting hardware.
   h. The flat of the shaft should be vertical at .00 KHz. Tighten setscrew on retaining ring and check output of LFO. Also check for proper channeling. Realign as necessary.
      NOTE: The LFO should drop out at approximately the same knob rotation out of detent in the CW and CCW directions. NAV 112 TSO glideslope coding should also be checked, see Table 2.2.

HFO

1. Check for 9 vdc at the feedthru capacitor on the rear of the HFO box.
2. Disconnect the center conductor of the coax on the HFO terminal which leads to the input of the Filter Assy mounted on the Receiver Board.
3. Connect the coax to the output of a signal generator set to 125 MHz with an output of 20 millivolts.
4. Measure the output of the Filter Assy at the terminals where the output coax is connected to the Receiver Board. Approximately .25v rms should be indicated by a RF voltmeter or a VTVM with an RF probe.
5. If output is present, then a faulty HFO is indicated. If output is not present, a faulty Filter Assy is indicated.
6. A HFO Assy can be replaced by the following procedure.
   a. Remove the Receiver Board far enough to obtain access to the setscrew on the KHz shaft retaining ring. Remove the screw holding the OMNI and LOC Boards and hinge the boards down.
   b. Set the KHz dial to .00 and note the shaft position. Loosen the setscrew which holds the insulated KHz shaft in place and move the shaft toward the rear of the unit until it is flush with the LFO box.
   c. Remove the wires connected to the HFO Assy including the switches. Remove the screws which hold the HFO box to the frame.
   d. Remove the HFO by moving the assembly toward the LFO until clear of its shaft.
7. A HFO Assy can be installed using the following procedure.
   a. Set the MHz dial to 108.
   b. Set switches in HFO Assy so that keying slots point to the left as viewed from the front (switch side).
   c. Install assembly on MHz shaft.
   d. Rewire and replace KHz shaft (See LFO step 5h).

Filter Assy

Use HFO Assy steps 1 thru 5 to determine if the Filter Assy is faulty.

To remove the Filter Assy, first remove the Receiver Board, then remove the hardware holding the Filter Assy to the Receiver Board.

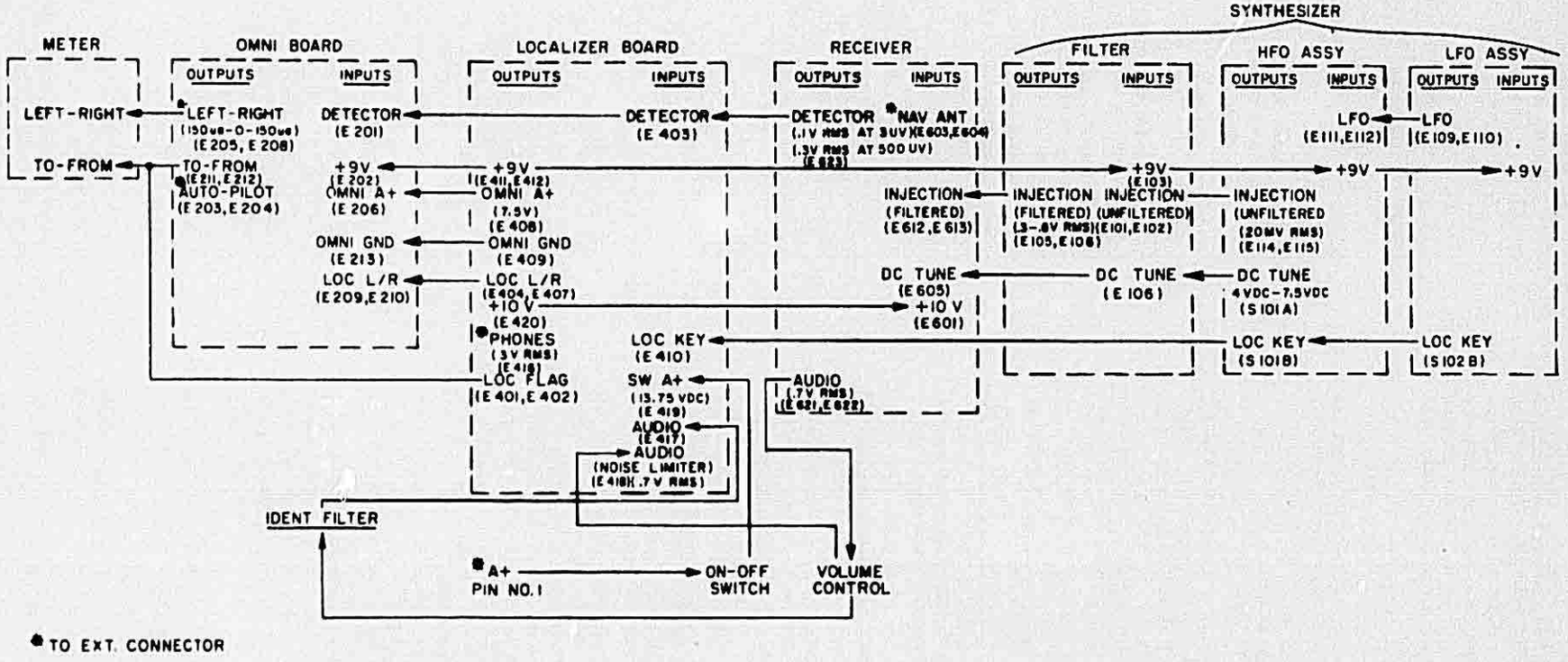


FIGURE 5.4-1. NAV 111 TSO/NAV 112 TSO INTERNAL INTERCONNECT

SEE BLOW-UP

5.4.2.1 Test Equipment Required for NAV 111 TSO/NAV 112 TSO

(1) DC Power Supply - 15v at 1.5 amps. (for entire unit)

(2) VTVM - RCA Voltohmyst or equivalent.

(3) AC Voltmeter - Ballentine 300D or equivalent.

(4) Hewlett-Packard, HP608 Signal Generator or equivalent.

(5) Resistance Substitution Box.

5.4.2.2 Receiver Troubleshooting

If all inputs to the receiver are present but one or both outputs are defective, follow the guide to determine which section of the Receiver Board is malfunctioning. After determining which section is at fault, refer to the schematic and text for that section.

PROBLEM	SECTION
Audio Problems Det. OK	Audio Section (Q608 thru Q612)
Detector Problems No signal - No Noise	IF, Detector Section AGC Section Voltage Regulator Section
Detector Problems No signal - Noise present	RF Section Crystal filter
Detector problems AGC	AGC Section
Selectivity Problems	Crystal Filter RF Section (Varactors)

A. Voltage Regulator

The regulated voltage for the receiver board is supplied by the Zener diode CR608. The series resistance for the Zener is split with a filter capacitor in the center to provide better filtering on the 8.2v Zener. The two series resistors are each 27 ohms. Half of the filter is located on the Interconnect Board.

Always check the 8.2v line before attempting to troubleshoot any section of the Receiver Board.

B. RF Section

Active Devices:

The RF Amplifier and Mixer are described in the Circuit Description Section. To determine if the active devices (Q601 and Q602) are defective, the current thru each device must be measured. To measure the current, place the negative lead of a VTVM on the 8.2 line (the feedthru near the 82mf capacitor) and the positive lead on the drain of each FET (no signal input). Multiply the voltage reading by ten to determine the current in milliamps. This current should be approximately 4-5 milliamps for the RF stage and 2-4 milliamps for the Mixer. Gate 2 can also be checked on each device by monitoring the voltage present at this gate. Any voltage greater than that listed indicates a defective gate. See Table 5.4.1. Gate 1 cannot be checked easily since it is at DC ground potential, but if all other checks indicate the device is good and no signal can be driven thru the device, Gate 1 is probably defective. Both Gate 1 and Gate 2 are protected so there is little probability they they would be defective except under extreme conditions.

B. (1) Varactors

The Varactors can be checked by measuring the DC voltage at the junctions (at the cathode of the varactors). There should be no voltage drop across the 100K ohm resistors feeding the varactors. A voltage drop indicates a defective varactor. If any tuned circuit does not peak, especially if the inductance goes to minimum, an open varactor may be indicated.

B. (2) AGC

The AGC operation of the RF amplifier is described in the Circuit Description Section. The AGC can be checked by measuring the current of the RF amplifier as the input signal is increased. Current readings should start at approximately 4-5 milliamps with no signal and go to approximately zero with a large signal input. If this does no occur, check for a defective Gate 2 or defective Q614. Q614 can be checked by measuring its collector voltage. This voltage should start at approximately .5vdc with no signal and rise to approximately 1.0 with a large signal input.

5.4.2.2 Continued

C. IF Section
C. (1) Crystal Filter

The Crystal Filter provides the final selectivity for the receiver, the 6 db bandwidth is 34 KHz and the 60 db bandwidth is 84 KHz. The ultimate attenuation of the Crystal Filter is 80 db. This means that as the frequency moves further away from center frequency the rejection will get no better than 80 db. To determine if a filter is defective, check the insertion loss thru it by first driving an 11.975 signal into the IF Amplifier (at the filter output) and monitor the detector output. After a reference level is obtained, drive the 11.975 MHz signal in the injection port (remove the VCO drive) and ground the source of the mixer. This allows the mixer to function as an amplifier and the filter can be checked without loading it. The approximate level for .10v rms detector output is 5 uv. The filter can be checked for selectivity by measuring adjacent channel rejection. This should be 60 db minimum.

C. (2) Amplifier

The IF Section is described in the Circuit Description Section. If the IF Section is functioning properly there should be some noise at the detector. If there is no noise at the detector, one stage of the IF or the detector is probably defective. The IF stages may be checked by measuring the voltages as listed in Table 5.4.1. The detector and OMNI buffer may be checked in the same manner. If all these voltage checks prove to be right, a faulty bypass might be suspect. This can be checked by monitoring the detector output and bypassing each emitter of all the IF Amplifiers with a .05 mf capacitor. If the noise level comes up significantly when this is done, a defective bypass is indicated. Another means of checking the IF stages is by monitoring the detector and driving an 11.975 MHz signal (modulated at 1 KHz) in the base of the last IF stage. With a 10 mv rms signal applied, a .10v rms signal should be seen at the detector. If none is present, this stage would be suspect. If a signal is present, the injected signal can be moved back to the next base and so on, with a gain of approximately 25 db per stage noted. In this manner a defective component may be found.

D. AGC Section

The AGC Detector and Amplifier is described in the Circuit Description Section. If the AGC operation is not functioning, check the DC voltages listed in Table 5.4.1 Check tantalum capacitor (C639) for short circuit. Check CR607 and CR615 (by voltage measurements) and check C641 for an open circuit. Refer to the RF Section (AGC) if all measurements are proper.

TABLE 5.4.1
RECEIVER DC VOLTAGE MEASUREMENTS

Transistor	Pin 1	Pin 2	Pin 3	Pin 4
Q-601Ⓐ	7.5	4.0	0	.6
Q-601Ⓑ	8.0	2.2	0	1.1
Q-602	7.5	.8	0	1.5
	E	**B**	**C**	
Q-603Ⓐ	1.0	1.7	3.7	
Q-603Ⓑ	.3	1.0	6.0	
Q-604Ⓐ	1.0	1.7	3.7	
Q-604Ⓑ	.3	1.0	6.0	
Q-605	.8	1.5	4.5	
Q-606	1.6	2.0	4.0	
Q-607	.8	1.4	5.6	
Q-608Ⓐ	6.6	6.0	.3	
Q-608Ⓑ	6.6	6.0	1.0	
Q-609	.1	.6	4.0	
Q-610	3.5	4.0	8.0	
Q-611	8.0	8.0	6.0	
Q-613Ⓐ	7.2	6.5	4.0	
Q-613Ⓑ	7.6	7.0	2.2	
Q-614Ⓐ	0	.7	.6	
Q-614Ⓑ	0	.65	1.1	

Ⓐ No signal input
Ⓑ 500 microvolts RF signal input 30% mod @ 1000 Hz

5.4.2.1A Test Equipment Required for NAV Receiver (Chassis CND219C/CNE219C)

(1) DC Power Supply - 15v at 1.5 amps. (for entire unit).

(2) VTVM - RCA Voltohmyst or equivalent.

(3) AC Voltmeter - Ballentine 300D or equivalent.

(4) Hewlett-Packard, HP608 Signal Generator or equivalent.

(5) Resistance Substitution Box.

(6) Sweep Generator, Texscan VS80 or equivalent.

(7) Oscilloscope, Tektronix 533A or equivalent.

5.4.2.2A Receiver Troubleshooting

If all inputs to the receiver are present but one or both outputs are defective, follow the guide to determine which section of the Receiver Board is malfunctioning. After determining which section is at fault, refer to the schematic and text for that section.

PROBLEM	SECTION
Audio Problems Det. OK	Audio Section Q603, Q604, U602
Detector Problems No signal - No Noise	IF, Detector Section AGC Section Voltage Regulator
Detector Problems No signal -	RF Section Crystal filter
Detector Problems AGC	AGC Section
Selectivity Problems	Crystal Filter RF Section (Varactors)

A. Voltage Regulator

The regulated voltage for the receiver board is supplied by the Zener diode CR608. The series resistance for the Zener is split with a filter capacitor in the center to provide better filtering on the 8.2v Zener. The two series resistors are each 27 ohms. Half of the filter is located on the Localizer Board.

Always check the 8.2v line before attempting to troubleshoot any section of the Receiver Board.

B. RF Section

Active Devices:

The RF Amplifier and Mixer are described in the Circuit Description Section. To determine if the active devices (Q601 and Q602) are defective, the current thru each device must be measured. To measure the current, place the negative lead of a VTVM on the 8.2v line and the positive lead on the drain of each FET (no signal input). Multiply the voltage reading by ten to determine the current in milliamps. This current should be approximately 4-5 milliamps for the RF stage and 2-4 milliamps for the Mixer. Gate 2 can also be checked on each device by monitoring the voltage present at this gate. Any voltage greater than that listed indicates a defective gate. Refer to the Receiver Schematic. If all other checks indicate the device is good and no signal can be driven thru the device, Gate 1 is probably defective. Both Gate 1 and Gate 2 are protected so there is little probability they would be defective except under extreme conditions.

B. (1) Varactors

The Varactors can be checked by measuring the DC voltage at the junctions (at the cathode of the varactors). There should be no voltage drop across the 100K ohm resistors feeding the varactors. A voltage drop indicates a defective varactor. If any tuned circuit does not peak, especially if the inductance goes to minimum, an open varactor may be indicated.

B. (2) AGC

The AGC can be checked by measuring the current of the RF amplifier as the input signal is increased. Current readings should start at approximately 4-5 milliamps with no signal and go to approximately zero with a large signal input. If this does not occur, check for a defective Gate 2.

5.4.2.2A Continued

C. IF Section

C. (1) Crystal Filter

The Crystal Filter provides the final selectivity for the receiver, the 6 db bandwidth is 34 KHz and the 60 db bandwidth is 84 KHz. The ultimate attenuation of the Crystal Filter is 80 db. This means that as the frequency moves further away from center frequency the rejection will get no better than 80 db. To determine if a filter is defective, check the insertion loss thru it by first driving an 11.975 signal into the IF Amplifier (at the filter output) and monitor the detector output. After a reference level is obtained, drive the 11.975 MHz signal in the injection port (remove the VCO drive) and ground the source of the mixer. This allows the mixer to function as an amplifier and the filter can be checked without loading it. The approximate level for .10v rms detector output is 5 uv. The filter can be checked for selectivity by measuring adjacent channel rejection. This should be 60 db, minimum.

To check ripple of the crystal filter, sweep the Receiver either at RF or IF frequency. If the Unit is swept at the IF frequency, the input can be thru the Mixer (remove the jumper connecting the LO to the Mixer).

1. Connect the sweep generator (608) output to the RF input or the Mixer LO input.
2. Connect the horizontal output of the generator to the external horizontal input of the scope.
3. Monitor the OMNI buffer output (wiper of R634) with the vertical input to the scope.
4. Sweep the Receiver and tune T601, T602, and T604 for maximum flat response.

   NOTE:
   Additional attenuation may be necessary to prevent the Unit from developing AGC. If the Unit is in AGC, the swept waveform will be squared-off. Level should be set to allow output at the Detector to just rise out of the noise.

C. (2) U601 IF Amplifier

To check the IF Amplifier, monitor the voltage at the center tap of T604 and pin 2 of U601. Compare these readings to the red voltage readings on the Schematic, Fig. 5.6-6A.

If the device is drawing the proper current, T604 may be defective. The voltage at pin 5 should be less than 3 volts with no signal. If this voltage is much higher than 3 volts, the device will be cut off.

D. Detector, AGC, Audio

U602 may best be checked by measuring the voltage at its terminals. Any problems in the audio **only** may be caused byQ604. Again, voltage measurements should detect a problem in this area.

5.4.2.2 Continued

E. Audio Section

The Audio Amplifier and Audio AGC circuits are described in the Circuit Description Section. To check the audio circuit, first measure all DC voltages listed on the chart. Be sure to remove the squelch when making the DC measurements. When the problem in the audio section is that of no output, the DC measurements should indicate the defective component. When the problem is weak output or no audio leveling, the DC measurements may not suffice. A defective diode (CR613) may cause weak output. This can be checked by shorting the diode and noting the output. If the output increases to the point of clipping, the diode would be suspect. If C636 were defective, the output would also be weak but the short across CR613 would not cause an increase in output. The audio leveling would malfunction if Q611 and/or CR613 were defective. R667 controls the threshold point of the AGC (that point where maximum gain occurs). If this value is set too low the maximum gain point could occur on noise only. This would cause a poor signal to noise ratio.

The following chart may be used to determine if each section is functioning properly. These levels are nominal values and they may vary slightly from radio to radio. Any major differences (25%) in these levels would indicate a defective section.

SECTION	INPUT	AT	OUTPUT	AT
Audio Section	.15v rms of 1000 Hz	Emitter of Q607	.7v rms	E621
IF Amplifier	5-10 uv at 11.975 MHz with 30% Mod. @ 1000 Hz (Filter disconnected)	E625	.10v rms	E623
Crystal Filter	20 uv @ 11.975 MHz with 30% Mod. @ 1000 Hz	E624	.10v rms	E623
Mixer (as Amplifier) (Source Shorted to GND)	5 uv @ 11.975 MHz with 30% Mod. @ 1000 Hz (injection disconnected)	E612	.10v rms	E623
Mixer (as Mixer)	7 uv @ RF freq. with 30% Mod. @ 1000 Hz	Gate 1 (pin 3 of Q602)	.10v rms	E623
RF	3 uv @ RF freq. with 30% Mod. @ 1000 Hz	E604	.10v rms	E623

5.4.2.3 NAV 111 TSO/NAV 112 TSO Receiver Tuning Procedure

1. Turn DC power supply ON, (A+ 13.75 vdc) and check Zener voltage (8.2v±5%)
2. Connect AC VTVM to OMNI output (E623)
3. Set channel selector to 117.00
4. Set signal generator to 117.00 (zero-beat generator)
5. Set signal generator output level to give a useable indication on AC VTVM
6. Tune C613 and L606 for maximum response (reduce generator level if necessary)
7. Tune C603, C606, and C608 for maximum output on AC VTVM
8. Set channel selector to 108.50
9. Set signal generator to 108.50 and tune L601, L602, and L603 for maximum output
10. Set channel selector to 117.50
11. Set signal generator to 117.50 and tune C603, C606, and C608 for maximum output
12. Repeat steps 8-11 until no further increase in output is noted
13. Set channel selector and signal generator to 117.50
14. Note change in output (in db) as RF input is varied from 10 to 10K microvolts
15. If output varies by more than 1 db change R666 to bring variation within 1 db (lower value of R666)
    (When adjusting R666 monitor the voltage at the collector of Q604. This voltage should not be lower than 3.5v with no signal input. If this voltage is lower than 3.5v, raise R666)
16. Set RF input to 500 microvolts @ 30% modulation 1000 Hz
17. Set output to .03v rms by adjusting R659 (.30 ±.02v rms)
18. Check output @ 2.0 μv (.10v rms minimum) if level is less than the minimum allowed, lower the value of the AGC selected "R" (R666) until the minimum is achieved
19. Repeat steps 16-18 until both requirements are met (500 μv level and 2 μv level).
20. Monitor audio output with AC VTVM
21. Set the signal generator to 50 μv @ 20% modulation 1000 Hz
22. Check AGC by varying modulation from 20% to 100%, maximum increase in ouput = 2 db
23. If output exceeds 2 db increase, lower value of selected "R" (R667)
24. Check AGC action from 2 μv to 10K μv @ 30% modulation 1000 Hz (maximum allowed ±3 db). If output exceeds 3 db increase, lower value of selected "R"
25. Check sensitivity @ 135.50 (2 μv maximum for 6 db S+N/N)
26. Check sensitivity @ 108.50 (2 μv maximum for 6 db S+N/N)
27. Check adjacent channel rejection using AGC voltage as a reference (minimum = 50 db) @ 117.50
28. Check image using AGC as a reference (minimum = 60 db).

5.4.2.4 NAV 111 TSO/NAV 112 TSO Synthesizer Troubleshooting

A. LFO

Check for .25v rms at E109 at terminal strip on HFO.

B. HFO

Alignment: Adjust L101 for output on all crystal frequencies. Check that oscillator is not marginal on any crystal by turning slug slightly on each frequency and at the same time maintain oscillation.

NOTE:

HFO must be tuned using the LFO as input. Output level can be monitored at input of filter an plifier coax on terminal strip mounted on HFO.

Test: .15v rms as measured on RF voltmeter at terminal strip on HFO.

NOTE:

Both HFO plus LFO and HFO minus LFO results are present.

C. FILTER

Alignment: Align the filter in the NAV unit with a functioning LFO and HFO Assembly. Peak the three tuning slugs for maximum output at 112.00 MHz on the units frequency selector.

Test: Check for an output of .25v (minimum) on all channels.

NOTE:

Input level for test with a signal generator is 20 millivolts at filter input to produce .25 volts output.

To troubleshoot the Synthesizer Chain, a signal substitution method is best.

A. Substitute a 23 MHz signal of 250 millivolts out of a HP608 type signal generator for the LFO.

B. Substitute a 125 MHz signal of 20 millivolts out of a HP608 type signal generator for the HFO.

C. Substitute approximately 125 MHz signal of 200 millivolts out of a HP608 type signal generator for LO injection. Tune for a desired signal response.

5.4.2.3A NAV 111 TSO/NAV 112 TSO Receiver Tuning Procedure, Chassis CND219C/CNE219C

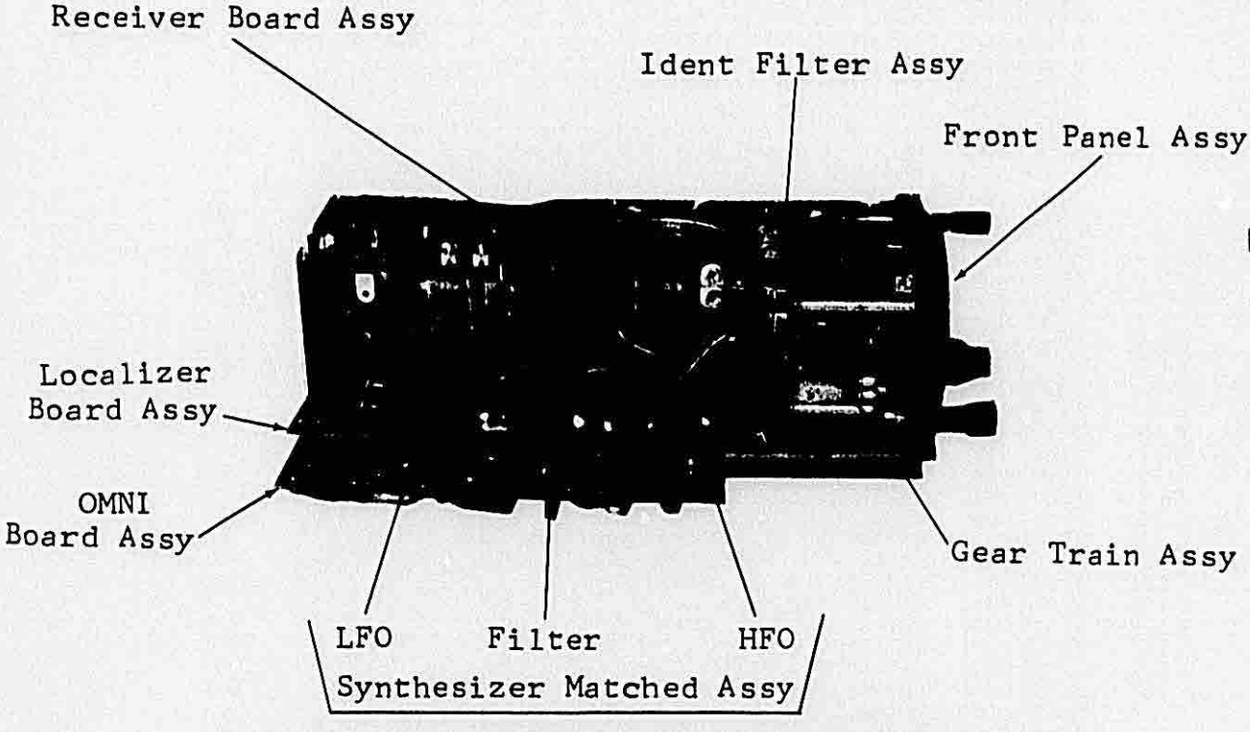
1. With the Unit connected, sweep the Receiver as described in Section 5.4.2.2A, Step C. (1).
2. After IF is aligned, set the Unit and generator (the 608) to the high end of the band (117.5 or 125.5 ...NAV 111/112 respectively).
3. Tune C643, C641, C616, and C615 for maximum output at the Detector (wiper of R634).
4. Set Unit and signal generator to 108.50 MHz.
5. Tune L601, L602, L603, and L604 for maximum output at the Detector.
6. Repeat Steps 2 thru 5 until no further improvement in output is noted.
7. Set the signal generator to 10 uv and note the Detector level output.
8. Set the signal generator to 20K uv and again note the Detector level output.
9. If the output exceeds 3 db increase, select R627 to keep the level from changing more than 3 db.
10. After AGC is set, set the generator to 500 uv and adjust R634 for .3 vrms output with 30% modulation at 1 KHz.

This Subsection contains a series of lists and figures to identify the parts of the equipment(s) covered in this Section.

When two or more similar units or subassemblies are being covered, their component parts may be described in a single list. Such a list is provided with an APPLICATION CODE identifying each assembly that is being broken down within that particular list. This Application Code is listed in the USED ON column opposite parts which are NOT common to all the subassemblies. The word ALL is indicated opposite those parts which are common.

To provide a cross-reference relationship of subassemblies to their Next Higher Assembly, the notation "See Fig. .... for Breakdown" follows the entry of a subassembly that is too large to be included within this list and that a separate list is provided. The subsequent list which breaks down the subassembly will refer back with the notation, "See Fig. .... for NHA," to that list which first noted the subassembly.

The words "No Number" in the Part Number column indicates that the part or subassembly is not a true subassembly. It is however a group of components which function together and by setting them aside in a separate list, greater detail of the components can be shown. Since the subassembly has no number, only piece parts of the "group" can be ordered or the complete Next Higher Assembly.



NAV 112

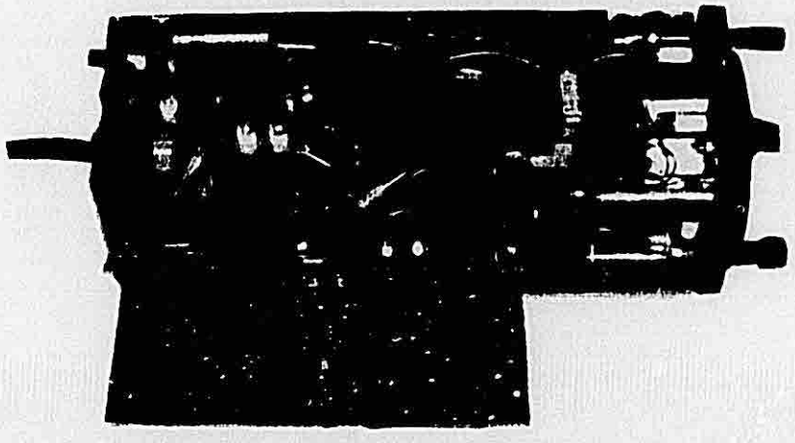


FIGURE 5.5-1 NAV 111/112 TSO

Fig. & Index No.	Part Number	Description	Used On
		APPLICATION CODE	
		A - NAV 111 TSO **B - NAV 111 TSO-DME**	
		C - NAV 112 TSO **D - NAV 112 TSO-DME**	
5.5-1	01178-0102	NARCO AVIONICS NAV 111 TSO	A
5.5-1	01178-0105	NARCO AVIONICS NAV 111 TSO-DME	B
5.5-1	01178-0103	NARCO AVIONICS NAV 112 TSO	C
5.5-1	01178-0104	NARCO AVIONICS NAV 112 TSO-DME	D
	01162-0101	FRONT PANEL ASSY (See Fig. 5.5-2 for breakdown)	A, B
	01162-0102	FRONT PANEL ASSY (See Fig. 5.5-2 for breakdown)	C, D
	01163-0102	IDENT FILTER ASSY (See Fig. 5.5-3 for breakdown)	ALL
	01161-0103	GEAR TRAIN ASSY (See Fig. 5.5-4 for breakdown)	A, B
	01161-0104	GEAR TRAIN ASSY (See Fig. 5.5-4 for breakdown)	C, D
	01156-0105	LOCALIZER BOARD ASSY (See Fig. 5.5-5 for breakdown)	ALL
	01157-0102	OMNI BOARD ASSY (See Fig. 5.5-6 for breakdown)	ALL
	01150-0104	SYNTHESIZER HFO ASSY (See Fig. 5.5-7 for breakdown)	A, C
	01150-0105	SYNTHESIZER, HFO ASSY (See Fig. 5.5-8 for breakdown)	B, D
	01150-0102	SYNTHESIZER LFO ASSY (See Fig. 5.5-7 for breakdown)	A, C
	01150-0106	SYNTHESIZER, LFO ASSY (See Fig. 5.5-8 for breakdown)	B, D
	01150-0103	SYNTHESIZER FILTER ASSY (See Fig. 5.5-9 for breakdown)	ALL
	01147-0102	RECEIVER BOARD ASSY (See Fig. 5.5-10 for breakdown)	ALL
	55890-0001	CHASSIS	ALL
	55891-0001	COVER	ALL
	55894-0001	BRACKET, BOARD MTG	ALL
	55895-0001	BRACKET, REAR	ALL
	55856-0001	LAMPHOLDER, LEFT	A, B
	55857-0001	LAMPHOLDER, RIGHT	A, B
	41278-0009	LAMPHOLDER	C, D
	81795-0001	RECEPTACLE	B, D
R-204	32064-0004	RESISTOR, VARIABLE, 5K ±30%	ALL
R472	32064-0005	RESISTOR, VARIABLE 22K ±30%	ALL
R-234	32068-0001	RESISTOR, POTENTIOMETER, COURSE SEL.	ALL
R-462	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W	ALL
R-463	31134-0022	RESISTOR, WIREWOUND, 50 ±5%, 10W	ALL
R-263	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W	ALL
R-264	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W	ALL
CR-413	75204-0045	RECTIFIER, SILICON, LEAD MTG.	ALL
C-223	21554-0050	CAPACITOR, ELECTROLYTIC +150% -10%, 3V NP	ALL
C-224	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V	ALL
C-225	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V	ALL
P-101	41285-0004	CONNECTOR, 24 contacts	C
P-102	41323-0004	CONNECTOR (for meter)	C
S-103	61549-0001	SWITCH SECTION, GS KHz	C, D
S-104	61572-0001	SWITCH, DME, MHz	B, D
C-501	21291-0005	CAPACITOR, CERAMIC, .01 mf ±10%, 50V	ALL
P-103	41285-0001	CONNECTOR, 14 contacts	B, D
	55859-0101	CONNECTOR, PRINTED BOARD ASS'Y	ALL
	55984-0001	GEAR (96 T)	ALL
	55968-0001	PINION (16 T)	ALL
	55914-0001	GEAR, SPUR, KHz (24 T)	ALL
	55991-0001	HINGE, BOARD & STOP	ALL
	55990-0001	HINGE, BOARD	ALL
	55867-0001	BRACKET, MOUNTING, INDICATOR	C, D
	81213-0057	SPACER, (.140 LG. CONNECTOR BD.)	ALL
	81213-0107	SPACER, (.146 LG. POT MTG.)	ALL
	81207-0035	SPACER, (.390 LG. LOC. BD. REAR MTG.)	ALL
	81206-0156	SPACER, (.125 LG. FILTER)	ALL
	81213-0103	SPACER, (.430 LG. FT. PANEL TO FT. PLT.)	ALL
	82808-0003	SCREW, MACH, #2-56 x ¼, RD HD, PHILLIPS	C, D
	82900-0001	NUT, HEX, #2-56	C, D
	82802-0001	LOCKWASHER, #2-56 INT.	C, D
	81214-0017	SPACER, PHENOLIC, BLACK	ALL

5.5-1 Continued

Fig. & Index No.	Part Number	Description	Used On
	55946-0001	CLAMP, SHAFT (MHz)	ALL
	55974-0001	CLAMP, SHAFT (OBS. & KHz GEAR)	ALL
	55944-0001	CLAMP, KHz	ALL
	55883-0001	SHIM, KHz & MHz SHAFT	ALL
	55955-0003	SHAFT, MHz	ALL
	55934-0002	SHAFT, KHz (1/4 x 3/16 REAR) 3-5/32 LG.	ALL
	55924-0004	SHAFT, OBS. (3-5/32 LG.)	ALL
	04481-0005	LABEL, NAMEPLATE, NAV 111 TSO DME	B
	55924-0002	SHAFT, KHz (1/8 DIA. FRONT)	ALL
	04481-0004	LABEL, NAMEPLATE, NAV 112 TSO DME	D
	91018-0055	TUBING, PLASTIC, EXTRUDED, 15/32 LG.	C, D
	91018-0050	TUBING, PLASTIC, EXTRUDED, 3/8 LG.	C, D
	91016-0007	TUBING COATED, FIBERGLASS, 1/2" LG.	C
	91016-0013	TUBING, COATED, FIBERGLASS, 2" LG.	C
	82017-0001	CABLE, CLAMP, MINIATURE	B, C, D
	55995-0001	BUSHING, VOL. IDENT.	ALL
	88203-0001	KNOB, OBS. KHz	ALL
	88204-0001	KNOB, MHz	ALL
	88207-0001	KNOB, VOL., ON-OFF, IDENT.	ALL
	81702-0008	SOLDER LUG	ALL
	81212-0008	SPACER, 5/16 HEX, 1/4-32 THD	ALL
C-640	21555-0026	CAPACITOR, TANT, 10mf ±10%, 20V	ALL
	04380-0002	INSERT, KNOB (OBS)	ALL
	04380-0008	INSERT, KNOB (VOL., ID.)	ALL
	04380-0007	INSERT, KNOB (FREQ.)	ALL
	04480-0001	LABEL, FCC CERTIFICATION	ALL
	04479-0002	LABEL, LOGO, NAV 111 TSO	A, B
	04479-0003	LABEL, LOGO, NAV 112 TSO	C, D
	04481-0002	LABEL, NAMEPLATE, NAV 111 TSO	A
	04481-0003	LABEL, NAMEPLATE, NAV 112 TSO	C
	82826-0003	SCREW, MACH. #3-48 x 1/4	ALL
	82879-0403	SCREW, MACH. #4-40 x 1/4 100° FT. HD. PHILLIPS	ALL
	82965-0009	SCREW, MACH. #4-40 x 3/4 FILISTER HD. PHILLIPS	ALL
	82965-0005	SCREW, MACH. #4-40 x 3/8 FILISTER HD. PHILLIPS	ALL
	82814-0003	SCREW, MACH. #4-40 x 1/4 BIND. HD. SL.	ALL
	82814-0005	SCREW, MACH. #4-40 x 3/8 BIND. HD. SL.	ALL
	82814-0007	SCREW, MACH. #4-40 x 1/2 BIND. HD. SL.	ALL
	82814-0008	SCREW, MACH. #4-40 x 5/8 BIND. HD. SL.	ALL
	82889-0004	SCREW, SOCKET, SET #4-40 x 3/16	ALL
	82889-0001	SCREW, SOCKET, SET #4-40 x 3/32	ALL
	82889-0002	SCREW, SOCKET, SET #4-40 x 1/8	ALL
	82904-0102	NUT, SELF-CLINCHING #4-40	ALL
	82900-0003	NUT, HEX #4-40 x 3/16	ALL
	81290-0003	NUT, "U" #4-40	ALL
	81275-0001	NUT, LOCK, #4-40 (ESNA,) FILTER & HINGE.	ALL
	82922-0001	NUT, HEX, KEPS #4-40	ALL
	82900-0002	NUT, HEX #3-48 x 3/16	C, D
	82900-0011	NUT, HEX #8-32 x 5/16	ALL
	82801-0005	LOCKWASHER, EXTERNAL TEETH #8	ALL
	81312-0018	WASHER, SPRING	ALL
	82802-0003	LOCKWASHER, INTERNAL TEETH #4	ALL
	81324-0003	LOCKWASHER, SPLIT #3	ALL
	81329-0214	WASHER, FLAT #3	ALL
	81336-0011	WASHER, FLAT, (PLASTIC, HINGE TO CHASSIS)	ALL
	81324-0004	LOCKWASHER, SPLIT #4	ALL
	81254-0033	EYELET #SE-33	C, D
	84047-0002	CRADLE, MOUNTING, LIGHTS	C, D
	82010-0022	CLIP, CABLE	A, B
	81160-0003	GROMMET, RUBBER	ALL
	81355-0001	RIVET, PLASTIC	ALL
	82864-0004	SCREW, MACH. #4-40 x 5/16 RD. HD. SL. (NYLON)	ALL
	81434-0004	STRIP, TIE LUG, 3 LUG	C, D
	76116-0001	METER	A, B
	76124-0101	METER, ASSEMBLY	C, D
	12000-0009	LAMP #330	A, B
	81747-0012	FILTER, LAMP	ALL
	12000-0015	LAMP #336, MIDGET GROOVE	C, D
	82816-0009	SCREW, MACH. #8-32 x 3/4, BIND. HD. SLOTTED	ALL
	81763-0001	CONNECTOR, SOLDERLESS, QUICK-DISCONNECT	C, D
	81431-0011	STRIP, TIE, 7 LUG	ALL
	83019-0001	INSULATOR, PHENOLIC.	ALL
	81307-0100	WASHER, FLAT (OBS SHAFT)	ALL
	57623-0001	PLATE MOUNTING, (CABLE CLAMP)	B, C, D
	82011-0001	CABLE CLAMP (STRAIN RELIEF)	B, C, D
	82965-0003	SCREW, MACH. #4-40 x 1/4 FILISTER HD. PHILLIPS	B, C, D
	57628-0001	PLATE, COVER	ALL
	82814-0002	SCREW, MACH. #4-40 x 3/16 BIND. HD. SL.	ALL
	81307-0076	WASHER FLAT, 030 THICK	ALL
	81702-0004	LUG, SOLDER	ALL

Fig. & Index No.	Part Number	Description	Used On
		APPLICATION CODE	
		A - FRONT PANEL ASSY, NAV 111 **B - FRONT PANEL ASSY, NAV 112**	
5.5-2	01162-0101	NAV 111 FRONT PANEL ASSY (See Fig. 5.5-1 for Next High Assy)	A
5.5-2	01162-0102	NAV 112 FRONT PANEL ASSY ASSY (See Fig. 5.5-1 For Next Higher Assy)	B
1	55928-0001	FRONT PANEL	ALL
2	55935-0001	LENS	A
3	55831-0001	LENS	B
4	55936-0001	AZIMUTH CARD	ALL
5	55989-0001	RETAINER, CARD	ALL
6	55830-0001	GEAR, OBS.	ALL
7	55855-0001	LOCK (NYLON)	ALL
8	55953-0001	BRACKET	ALL
9	55925-0001	SPRING, DIAL	ALL
10	82826-0002	SCREW, MACH, #3-48 x 3/16. RD. HD. SL	ALL
11	82965-0006	SCREW, MACH, #4-40 x 7/16 PHILLIPS	ALL
12	81324-0003	LOCKWASHER, SPLIT, #3	ALL
13	81329-0214	WASHER, FLAT, #3	ALL
14	81329-0004	WASHER, FLAT, #4	ALL
15	82922-0001	NUT, HEX, KEPS, #4-40	ALL
16	55974-0001	CLAMP, SHAFT - (Part of 01151(Fig. 4.5-1)	ALL

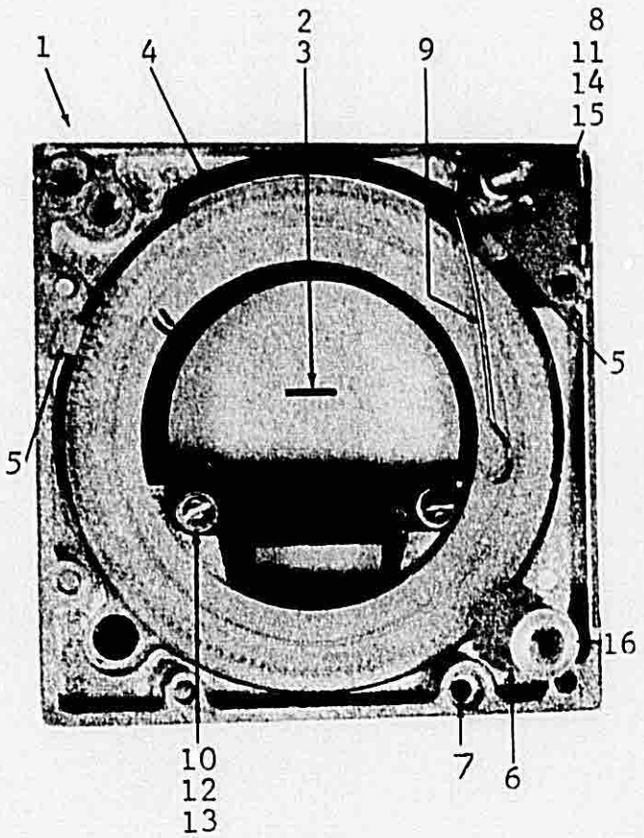


FIGURE 5.5-2 FRONT PANEL ASSY

Fig. & Index No.	Part Number	Description	
5.5-3	01163-0102	IDENT FILTER ASSY (See Fig. 5.5-1 for NHA)	
1	55892-0001	BRACKET, ON-OFF-VOL-IDENT	
2	55893-0001	LEVER, SLIDE SWITCH, IDENT	
3	55843-0001	SHAFT, IDENT. & VOL.	
4	55844-0001	BUSHING, LEVER	
5	84116-0003	PIN, SPIROL (¼ LG. .031 DIA.)	
6	82826-0004	SCREW, MACH, #3-48 x 5/16 RD. HD. SL	
7	81324-0003	LOCKWASHER, SPLIT, #3	
8	82802-0057	LOCKWASHER, & INTERNAL TEETH, ¼	
9	82900-0002	NUT, HEX, #3-48	
10	82900-0228	NUT, HEX, ¼-32	
11	81192-0009	RETAINER, TRUARC	
12	23087-0017	CAPACITOR	C-801
13	21555-0026	CAPACITOR	C-802
14	11488-0001	COIL	L-801
15	31192-0271	RESISTOR	R-801
16	31192-0331	RESISTOR	R-802
17	32059-0004	RESISTOR, VARIABLE WITH SW.	R-642
18	61528-0003	SWITCH, SLIDE	SW-801
19	99065-0004	TAPE DOUBLE SIDED	
	82826-0002	SCREW, MACH, #3-48 x 3/16, RD. HD. SL	

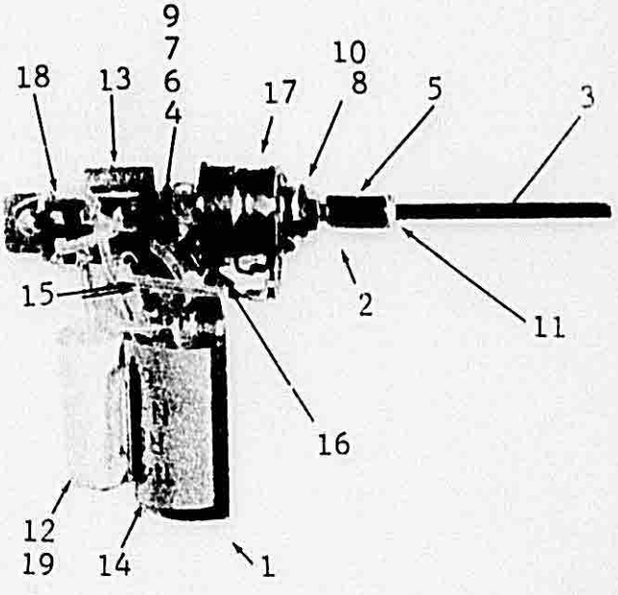


FIGURE 5.5-3 FILTER ASSY

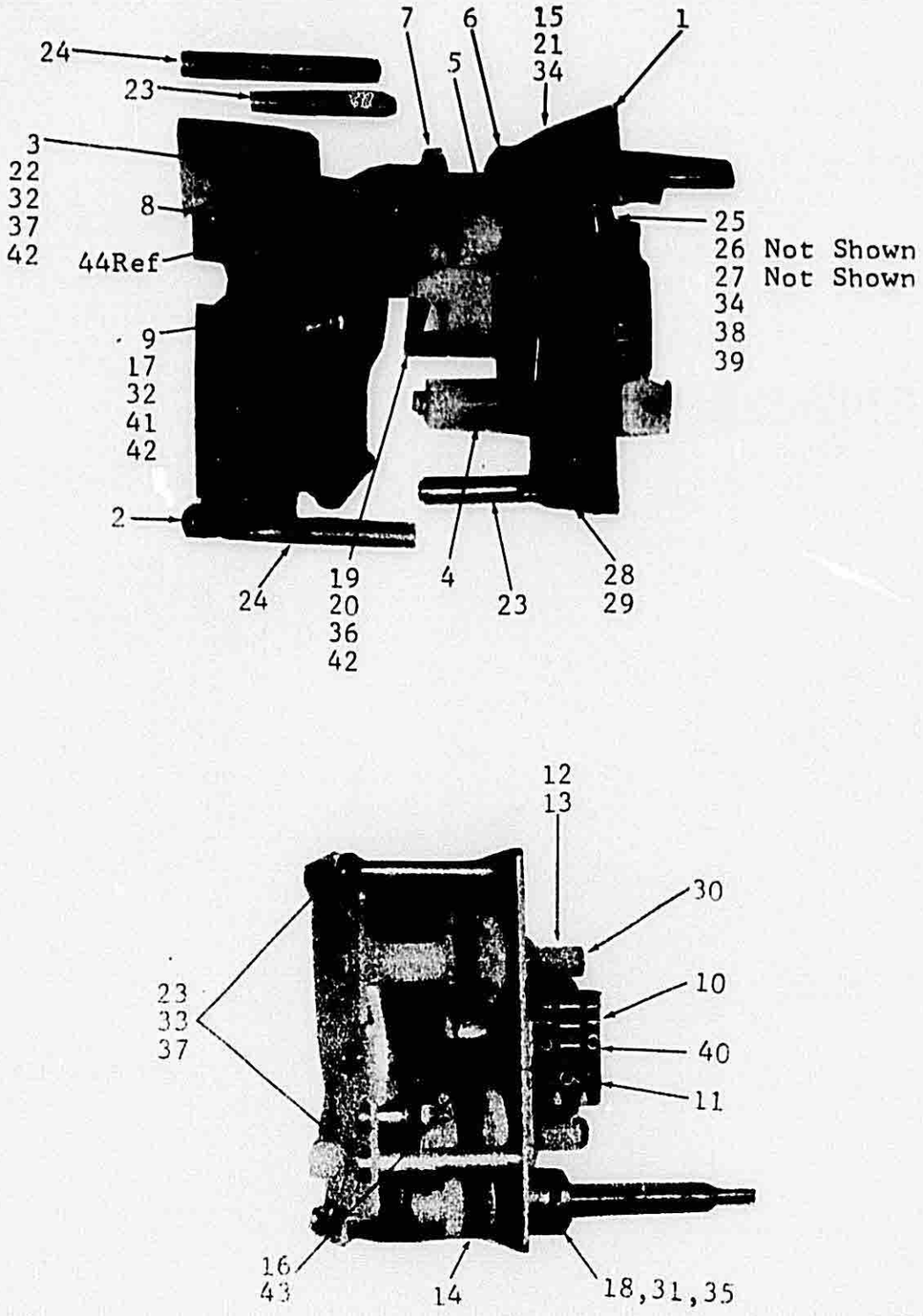


FIGURE 5.5-4 GEAR TRAIN ASSY

Fig.	Part No	Description	Used On
		APPLICATION CODE	
		A - GEAR TRAIN ASSY NAV 111 TSO	
		B - GEAR TRAIN ASSY NAV 112 TSO	
5.5-4	01161-0103	GEAR TRAIN ASSY (See Fig. 5.5-1 for NHA)	A
5.5-4	01161-0104	GEAR TRAIN ASSY (See Fig. 5.5-1 for NHA)	B
1	55932-0001	FRONT PLATE	A
1	55865-0001	FRONT PLATE	B
2	55931-0003	REAR PLATE	ALL
3	55930-0001	BEARING PLATE	ALL
4	55987-0001	DETENT & GEAR, MHz	ALL
5	55866-0101	DETENT & CLUSTER ASSEMBLY	ALL
6	55916-0001	PULLEY & SHAFT	ALL
7	55913-0001	GEAR & SHAFT	ALL
8	55915-0001	GEAR (34T) MHz SW.	ALL
9	55986-0001	GEAR IDLER (52T)	ALL
10	55922-0001	DRUM & GEAR MHz	ALL
11	55923-0001	DRUM & GEAR KHz	ALL
12	55933-0001	BEARING BLOCK	ALL
13	55924-0001	SHAFT DRUMS	ALL
14	54960-0004	BELT, GEAR (64T)	ALL
15	57605-0001	SPRING, DETENT	ALL
16	55992-0001	STOP, MHz	ALL
17	55983-0001	BUSHING, IDLER	ALL
18	55939-0001	SLEEVE, STOP	ALL
19	55875-0001	BRACKET, BELT TENSION	ALL
20	82801-0001	LOCKWASHER, EXTERNAL TOOTH #4	ALL
21	57606-0001	SPACER (DETENT SPRING)	ALL
22	81208-0013	SPACER (BRG. PLATE) .183 LG.	ALL
23	81208-0015	SPACER (F. TO R. PLATE) 1.095 LG.	ALL
24	81207-0037	SPACER (R. PLATE TO F.P.) 1.618 LG.	ALL
24A	57684-0001	SPRING, EQUALIZER	ALL
25	41321-0001	LAMP SOCKET	A
26	12000-0009	LAMP #330	A
27	18747-0012	FILTER, LAMP	A
28	81423-0002	TERMINAL, STANDOFF	A
29	81702-0004	LUG, SOLDER	A
30	81192-0014	GRIP RING (1/8 SHAFT)	ALL
31	84116-0011	SPIROL PIN (3/64 DIA. x 3/16)	ALL
32	82814-0007	SCREW, MACH. #4-40 x 1/2 BIND. HD. SL.	ALL
33	82814-0003	SCREW, MACH. #4-40 x 1/4 BIND. HD. SL.	ALL
34	82826-0003	SCREW, MACH. #3-48 x 1/4 RD. HD. SL.	A
35	82889-0002	SCREW, SOCKET, SET #4-40 x 1/8	ALL
36	82814-0008	SCREW, MACH. #4-40 x 5/8 BIND. HD. SL	ALL
37	82802-0003	LOCKWASHER, INTERNAL TOOTH #4	ALL
38	81324-0003	LOCKWASHER, SPLIT #3	A
39	81329-0214	WASHER, FLAT #3	A
40	81312-0008	WASHER, SPRING (DRUMS)	ALL
41	81312-0011	WASHER, SPRING (IDLER)	ALL
41A	82801-0001	LOCKWASHER, EXTERNAL TOOTH, #4	ALL
42	82900-0004	NUT, #4-40, 1/4 HEX	ALL
43	84082-0001	RIVET, SEMI-TUBULAR	ALL
44	57636-0001	KEEPER, SPRING (NOT SHOWN)	ALL
45	55836-0002	SPACER, HEX (BELT TENSION) (NOT SHOWN)	ALL
46	81208-0016	SPACER, (F. TO R. PLATE) 1.095 LG. (NOT SHOWN)	ALL
47	82826-0007	SCREW, MACH. #3-48 x 1/2 RD. HD. SL. (NOT SHOWN)	ALL
48	82819-0003	SCHREW, MACH. #4-40 x 1/4 FT. HD. SL. (NOT SHOWN)	ALL
49	81307-0060	WASHER, FLAT (NOT SHOWN)	ALL

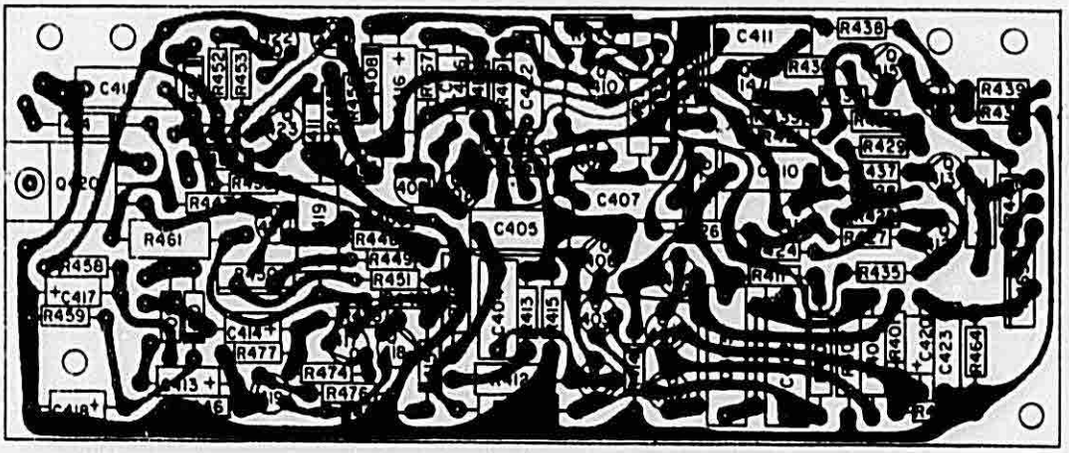


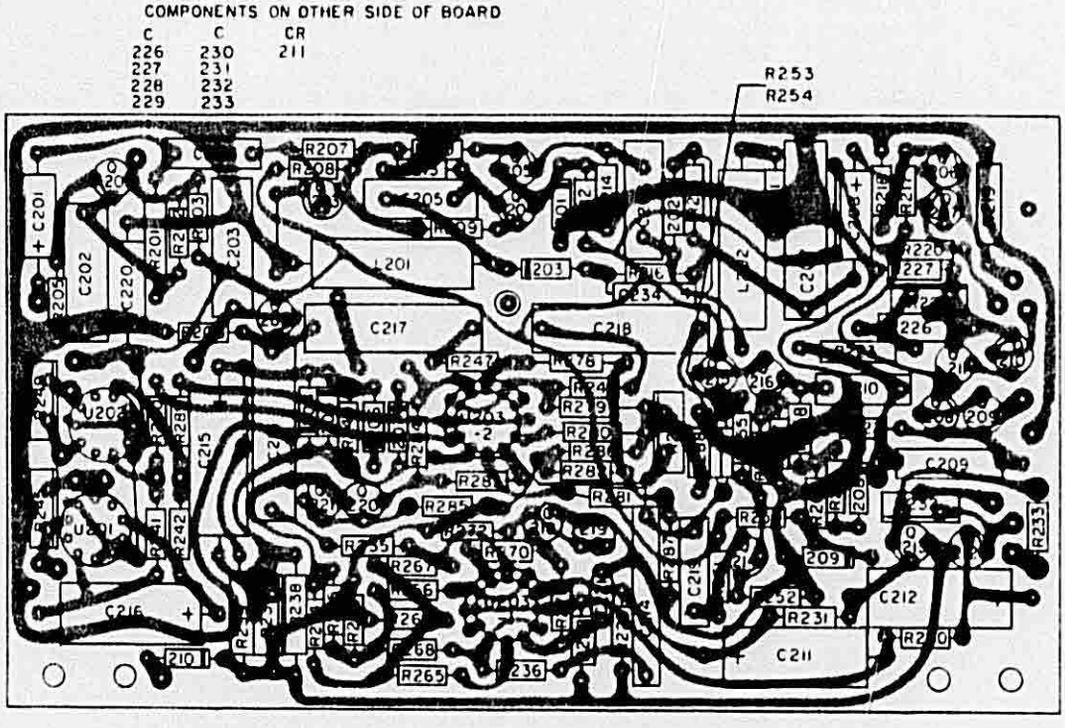
FIGURE 5.5-5 LOCALIZER BOARD, NAV 111 TSO/NAV 112 TSO

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
5.5-5	01156-0105	LOCALIZER BOARD ASSY, (See Fig. 5.5-1 for NHA)
	82814-0003	SCREW, MACH, #4-40 x 1/4, BND. HD, SL.
	82922-0001	NUT, HEX
C402	23094-0177	CAPACITOR, MYLAR, METALIZED, .15 mf ±10%, 200V
C403	23094-0177	CAPACITOR, MYLAR, METALIZED, .15 mf ±10%, 200V
C404	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C405	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C406	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C407	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C409	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C410	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C411	23094-0171	CAPACITOR, MYLAR, METALIZED, .047 mf ±10%, 200V
C412	21555-0028	CAPACITOR, TANTALUM, 15 mf ±10%, 20V
C413	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C414	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C415	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C416	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C417	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C418	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C419	21555-0018	CAPACITOR, TANTALUM, 22 ±10%, 15V
C420	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C422	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C423	23094-0163	CAPACITOR, MYLAR, METALIZED, 0.01 mf ±10%, 200V
CR404	75028-0001	DIODE, SILICON
CR406	75027-0004	DIODE, ZENER, 5.6V
CR407	75028-0001	DIODE, SILICON
CR408	75028-0001	DIODE, SILICON
CR409	75028-0001	DIODE, SILICON
CR410	75028-0001	DIODE, SILICON
CR411	75028-0001	DIODE SILICON
CR412	75204-0045	RECTIFIER, SILICON, LEAD MTG
CR414	75204-0045	RECTIFIER, SILICON, LEAD MTG
CR415	75028-0001	DIODE, SILICON
Q401	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q402	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q403	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q404	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q405	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q406	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q407	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q408	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q409	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q410	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q411	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q412	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q413	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q414	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q415	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q416	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q417	75558-0005	TRANSISTOR, SILICON, NPN 2N5810
Q418	75558-0006	TRANSISTOR, SILICON, PNP 2N5811
Q419	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q420	75576-0001	TRANSISTOR, SILICON, NPN
Q421	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q422	75565-0006	TRANSISTOR, SILICON, PNP 2N5356
Q423	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q424	75595-0003	TRANSISTOR, SILICON, NPN 2N5172
Q425	75595-0003	TRANSISTOR, SILICON, NPN 2N5172

Fig. & Index No.	Part Number	Description
R401	31192-0473	RESISTOR, CARBON, COMP., 47K ±10%, ¼W
R402	31192-0473	RESISTOR, CARBON, COMP., 47K ±10%, ¼W
R406	31199-0278	RESISTOR, METAL FILM, 6.34K ±1%, ¼W
R407	31199-0230	RESISTOR, METAL FILM, 2.0K ±1%, ¼W
R408	31199-0226	RESISTOR, METAL FILM, 1.82K ±1%, ¼W
R409	31199-0278	RESISTOR, METAL FILM, 6.34K ±1%, ¼W
R410	31199-0385	RESISTOR, METAL FILM, 75K ±1%, ¼W
R411	31192-SEL	RESISTOR, CARBON SEL., ±10%, ¼W
R412	31199-0381	RESISTOR, METAL FILM, 68.1K ±1%, ¼W
R413	31192-SEL	RESISTOR, CARBON SEL., ±10%, ¼W
R414	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R415	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R416	31192-SEL	RESISTOR, CARBON, SEL., ±10%, ¼W
R421	31199-0226	RESISTOR, METAL FILM, 1.82K ±1%, ¼W
R422	31199-0221	RESISTOR, METAL FILM, 1.62K ±1%, ¼W
R424	31192-0182	RESISTOR, CARBON 1.8K ±10%, ¼W
R425	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R426	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R427	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R428	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R429	31192-0181	RESISTOR, CARBON, 180 ±10%, ¼W
R430	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R431	31192-0182	RESISTOR, CARBON, 1.8K ±10%, ¼W
R432	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R433	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R434	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R435	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R436	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R437	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R438	31192-0271	RESISTOR, CARBON 270 ±10%, ¼W
R439	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R442	31192-0153	RESISTOR, CARBON, 15K ±10%, ¼W
R443	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R444	31192-0470	RESISTOR, CARBON, 47 ±10%, ¼W
R446	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R447	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R448	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R449	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R450	32054-0001	RESISTOR, VARIABLE, 470
R451	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R452	31192-0682	RESISTOR, CARBON, 6.8K ±10%, ¼W
R453	31192-0562	RESISTOR, CARBON, 5.6K ±10%, ¼W
R454	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R455	31192-0473	RESISTOR, CARBON, 47K ±10%, ¼W
R456	31192-0333	RESISTOR, CARBON, 33K ±10%, ¼W
R457	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R458	31192-0473	RESISTOR, CARBON, 47K ±10%, ¼W
R459	31192-0473	RESISTOR, CARBON, 47K ±10%, ¼W
R461	31196-0003	RESISTOR, WIREWOUND, 27, 2W
R464	31192-0683	RESISTOR, CARBON, 68K ±10%, ¼W
R465	32054-0011	RESISTOR, VARIABLE, 100K
R466	31195-0332	RESISTOR, CARBON, 3.3K ±5%, ¼W
R467	31195-0332	RESISTOR, CARBON, 3.3K ±5%, ¼W
R468	31195-0153	RESISTOR, CARBON, 15K ±5%, ¼W
R469	31195-0153	RESISTOR, CARBON, 15K ±5%, ¼W
R470	32054-0021	RESISTOR, VARIABLE, 22K
R473	32054-0001	RESISTOR, VARIABLE, 470
R474	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R475	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R476	31192-0820	RESISTOR, CARBON, 82 ±10%, ¼W
R477	31192-0682	RESISTOR, CARBON, 6.8K ±10%, ¼W

Fig. & Index No.	Part Number	Description
5.5-6	01157-0102	OMNI BOARD ASSEMBLY (See Fig. 5.5-1 for NHA)
C-201	21555-0018	CAPACITOR, TANTALUM, 22mf ±10%, 15V
C-202	23094-0179	CAPACITOR, MYLAR, METALIZED, 22mf ±10%, 200V
C-203	23094-0179	CAPACITOR, MYLAR, METALIZED, 22mf ±10%, 200V
C-204	23094-0155	CAPACITOR, MYLAR, METALIZED, .0022mf ±10%, 200V
C-205	24045-SEL	CAPACITOR, DIPPED MICA, SEL ±5%, 300V
C-206	24045-SEL	CAPACITOR, DIPPED MICA, SEL ±5%, 300V
C-207	23094-0179	CAPACITOR, MYLAR, METALIZED, .22mf ±10%, 200V
C-208	21555-0018	CAPACITOR, TANTALUM, 22mf ±10%, 15V
C-209	23100-0007	CAPACITOR, POLYCARBONATE, METALIZED, 1 ±10%, 100V
C-210	23094-0169	CAPACITOR, MYLAR, METALIZED, 033mf ±10%, 200V
C-211	21554-0048	CAPACITOR, ELECTROLYTIC, 3.0 mf, 3V N.P.
C-212	21554-0049	CAPACITOR, ELECTROLYTIC, 5.0 mf, 3V N.P.
C-213	23094-0181	CAPACITOR, MYLAR, METALIZED, 33mf ±10%, 200V
C-214	23094-0181	CAPACITOR, MYLAR, METALIZED, 33mf ±10%, 200V
C-215	21554-0048	CAPACITOR, ELECTROLYTIC, 3.0 mf, 3V N.P.
C-216	21554-0050	CAPACITOR, ELECTROLYTIC, 20 mf, 3V N.P.
C-217	23094-0083	CAPACITOR, MYLAR, METALIZED, 47mf ±10%, 200V
C-218	23094-0083	CAPACITOR, MYLAR, METALIZED, 47mf ±10%, 200V
C-219	23094-0175	CAPACITOR, MYLAR, METALIZED, 1mf ±10%, 200V
C-220	21555-0018	CAPACITOR, TANTALUM, 22mf ±10%, 15V
C-221	21291-0025	CAPACITOR, CERAMIC 430 pf ±10%, 500V
C-226	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V
C-227	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V
C-228	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V
C-229	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V
C-230	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V
C-231	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V
C-232	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V
C-233	21291-0025	CAPACITOR, CERAMIC, 430 pf ±10%, 500V
C-234	21555-0058	CAPACITOR, TANTALUM, 6.8 mf ±10%, 35V
CR-201	75027-0009	DIODE, ZENER, 6.8V
CR-202	75028-0001	DIODE, SILICON
CR-203	75028-0001	DIODE, SILICON
CR-204	75028-0001	DIODE, SILICON
CR-205	75028-0001	DIODE, SILICON
CR-206	75028-0003	DIODE, SILICON
CR-207	75028-0003	DIODE, SILICON
CR-208	75028-0001	DIODE, SILICON
CR-209	75027-0004	DIODE, ZENER, 5.6V
CR-210	75028-0001	DIODE, SILICON
CR-211	75027-0004	DIODE, ZENER, 5.6V
L-201	11360-0016	CHOKE, 150mh ±10%
L-202	11360-0016	CHOKE, 150mh ±10%
Q-201	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-202	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-203	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-204	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-205	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-206	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-207	75565-0006	TRANSISTOR, SILICON, PNP, 2N5356
Q-208	75565-0006	TRANSISTOR, SILICON, PNP, 2N5356
Q-209	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-210	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-211	75565-0006	TRANSISTOR, SILICON, PNP, 2N5356
Q-212	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-213	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-214	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-215	75565-0006	TRANSISTOR, SILICON, PNP, 2N5356
Q-216	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q-218	75557-0003	TRANSISTOR, SILICON, NPN, 2N706
Q-219	75557-0003	TRANSISTOR, SILICON, NPN, 2N706
Q-220	75557-0003	TRANSISTOR, SILICON, NPN, 2N706
Q-221	75557-0003	TRANSISTOR, SILICON, NPN, 2N706
R-201	31199-0278	RESISTOR, METAL FILM, 6.34K ±1%, ¼W
R-202	31192-0684	RESISTOR, CARBON COMP., 680K ±10%, ¼W
R-203	31192-0682	RESISTOR, CARBON COMP., 6.8K ±10% ¼W
R-205	31192-0152	RESISTOR, CARBON COMP., 1.5K ±10%, ¼W
R-206	31192-0472	RESISTOR, CARBON COMP., 4.7K ±10%, ¼W
R-207	31192-0684	RESISTOR, CARBON COMP., 680K ±10%, ¼W
R-208	31192-0682	RESISTOR, CARBON COMP., 6.8K ±10%, ¼W
R-209	31192-0123	RESISTOR, CARBON COMP., 12K ±10%, ¼W
R-210	31192-0123	RESISTOR, CARBON COMP., 12K ±10%, ¼W



B-57697-A

FIGURE 5.5-6 OMNI BOARD, NAV 111 TSO/NAV 112 TSO

SEE BLOW-UP

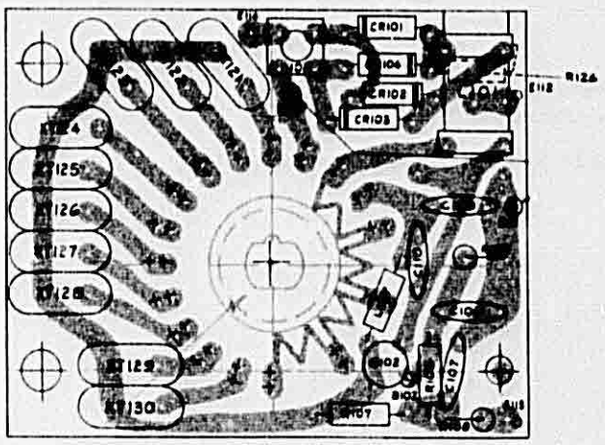
Fig. & Index No.	Part Number	Description
R-211	31192-0561	RESISTOR, CARBON COMP., 560 ±10%, ¼W
R-212	31192-0151	RESISTOR, CARBON COMP., 150 ±10%, ¼W
R-213	31192-0821	RESISTOR, CARBON COMP., 820 ±10%, ¼W
R214	31192-0821	RESISTOR, CARBON COMP., 820 ±10%, ¼W
R-215	31192-0563	RESISTOR, CARBON COMP., 56K ±10%, ¼W
R-216	31192-0563	RESISTOR, CARBON COMP., 56K ±10%, ¼W
R-217	31192-0683	RESISTOR, CARBON COMP., 68K ±10%, ¼W
R-218	31192-0393	RESISTOR, CARBON COMP., 39K ±10%, ¼W
R-219	31199-0221	RESISTOR, METAL FILM, 1.62K ±1%, ¼W
R-220	31199-0221	RESISTOR, METAL FILM, 1.62K ±1%, ¼W
R-222	31192-0222	RESISTOR, CARBON COMP., 2.2K ±10%, ¼W
R-223	31199-0366	RESISTOR, METAL FILM, 47.5K ±1%, ¼W
R-225	32054-0021	RESISTOR, VARIABLE, 22K ±20%
R-226	31199-0301	RESISTOR, METAL FILM, 10K ±1%, ¼W
R-227	31192-0222	RESISTOR, CARBON COMP., 2.2K ±10%, ¼W
R-228	31199-0259	RESISTOR, METAL FILM, 4.02K ±1%, ¼W
R-229	31199-0259	RESISTOR, METAL FILM, 4.02K ±1%, ¼W
R-230	31192-0473	RESISTOR, CARBON COMP., 47K ±10%, ¼W
R-231	31192-0473	RESISTOR, CARBON COMP., 47K ±10%, ¼W
R-232	32054-0007	RESISTOR, VARIABLE, 10K ±10%
R-233	31192-SEL	RESISTOR, CARBON COMP., SEL. ±10%, ¼W
R-235	31192-0103	RESISTOR, CARBON COMP., 10K ±10%, ¼W
R-236	31192-0103	RESISTOR, CARBON COMP., 10K ±10%, ¼W
R-237	32054-0011	RESISTOR, VARIABLE, 100K ±20%
R-238	31199-0261	RESISTOR, METAL FILM, 4.22K ±1%, ¼W
R-239	31199-0259	RESISTOR, METAL FILM, 4.02K ±1%, ¼W
R-240	31192-SEL	RESISTOR, CARBON COMP. SEL. ±10%, ¼W
R-241	31192-0153	RESISTOR, CARBON COMP., 15K ±10%, ¼W
R-242	31192-0153	RESISTOR, CARBON COMP., 15K ±10%, ¼W
R-245	32054-0003	RESISTOR, VARIABLE, 4.7K ±10%
R-247	31192-0822	RESISTOR, CARBON COMP., 8.2K ±10%, ¼W
R-248	31192-0103	RESISTOR, CARBON COMP., 10K ±10%, ¼W
R-249	32054-0003	RESISTOR, VARIABLE, 4.7K ±10%
R-251	31192-0822	RESISTOR, CARBON COMP., 8.2K ±10%, ¼W
R-252	31192-0392	RESISTOR, CARBON COMP., 3.9K ±10%, ¼W
R-253	31192-SEL	RESISTOR, CARBON COMP., SEL. ±10%, ¼W
R-254	31192-0683	RESISTOR, CARBON COMP., 68K ±10%, ¼W
R-255	31192-0332	RESISTOR, CARBON COMP., 3.3K ±10%, ¼W
R-256	31192-0332	RESISTOR, CARBON COMP., 3.3K ±10%, ¼W
R-257	31192-0222	RESISTOR, CARBON COMP., 2.2K ±10%, ¼W
R-258	31192-0684	RESISTOR, CARBON COMP., 680 ±10%, ¼W
R-259	31192-0332	RESISTOR, CARBON COMP., 3.3K ±10%, ¼W
R-260	31192-0472	RESISTOR, CARBON COMP., 4.7K ±10%, ¼W
R-261	31192-0102	RESISTOR, CARBON COMP., 1K ±10%, ¼W
R-263	See List 3.5-1	
R-264	See List 3.5-1	
R-265	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-266	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-267	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-268	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-269	31192-0103	RESISTOR, CARBON COMP., 10K ±10%, ¼W
R-270	31192-0680	RESISTOR, CARBON COMP., 68 ±10%, ¼W
R-271	31192-0680	RESISTOR, CARBON COMP., 68 ±10%, ¼W
R-272	31192-0103	RESISTOR, CARBON COMP., 10K ±10%, ¼W
R-273	31192-0472	RESISTOR, CARBON COMP., 4.7K ±10%, ¼W
R-274	31192-0392	RESITOR, CARBON COMP., 3.9K ±10%, ¼W
R-275	31192-0472	RESISTOR, CARBON COMP., 4.7K ±10%, ¼W
R-277	32054-0007	RESISTOR, VARIABLE, 10K ±20%
R-278	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-279	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-280	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-281	31192-0562	RESISTOR, CARBON COMP., 5.6K ±10%, ¼W
R-282	31192-0103	RESISTOR, CARBON COMP., 10K ±10%, ¼W
R-283	31192-0680	RESISTOR, CARBON COMP., 68 ±10%, ¼W
R-284	31192-0680	RESISTOR, CARBON COMP., 68 ±10%, ¼W
R-285	31192-SEL	RESISTOR, CARBON COMP., SEL ±10%, ¼W
R-286	31192-0472	RESISTOR, CARBON COMP., 4.7K ±10%, ¼W
R-287	31192-0392	RESISTOR, CARBON COMP., 3.9K ±10%, ¼W
R-288	31192-0472	RESISTOR, CARBON COMP., 4.7K ±10%, ¼W
R-289	31192-0102	RESISTOR, CARBON COMP., 1K ±10%, ¼W
R-290	31192-0102	RESISTOR, CARBON COMP., 1K ±10%, ¼W
U-201	74013-0001	INTEGRATED CIRCUIT, CA3036
U-202	74013-0001	INTEGRATED CIRCUIT, CA3036
U-203-1	74012-0003	INTEGRATED CIRCUIT, CA3026
U-203-2	74012-0002	INTEGRATED CIRCUIT, CA3026

APPLICATION CODE

A - SYNTHESIZER HFO ASSY, NAV 111 and NAV 112

B - SYNTHESIZER HFO ASSY, NAV 111 with DME and NAV 112 with DME

Fig. & Index No.	Part Number	Description	Used On
5.5-7	01150-0104	SYNTHESIZER HFO ASSY (without DME) (See Fig. 5.5-1 for NHA)	A
5.5-7	01150-0105	SYNTHESIZER HFO ASSY (with DME) (See Fig. 5.5-1 for NHA)	B
	82901-0101	NUT, SWAGE, #4-40	ALL
	55886-0001	BOX, HFO	ALL
	55887-0001	COVER, HFO	ALL
	82900-0003	NUT, HEX, #4-40	ALL
	81290-0001	NUT, U, #4	ALL
	81213-0034	SPACER, .062 LG	B
	81254-0037	EYELET, SE-43	ALL
	82958-0002	SCREW, TAP-TITE, PAN HD, SLOTTED, #4-40 x 3/16	ALL
	82814-0008	SCREW, MACH. BINDING HD, SLOTTED, #4-40 x 5/8	ALL
	82802-0003	LOCKWASHER, INTERNAL TEETH, #4	ALL
	81307-0099	WASHER, FLAT	ALL
	82814-0007	SCREW, MACH. BINDING HD, SLOTTED, #4-40 x 1/2	ALL
	81433-0004	TIE STRIP, 4 LUG	ALL
	81214-0003	SPACER, .187 Lg. (Phenolic)	ALL
	81206-0061	SPACER, .187 Lg.	ALL
	82801-0001	LOCKWASHER, EXTERNAL, #4	ALL
C-106	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V	ALL
C-107	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V	ALL
C-109	24052-0101	CAPACITOR, DIPPED MICA, 100 pf	ALL
C-110	24049-0220	CAPACITOR, DIPPED MICA, 22 pf	ALL
C-122	21296-0003	CAPACITOR, CERAMIC-FEEDTHRU, .001, 500V	ALL
CR-101	75034-0001	DIODE, HOT CARRIER, FH1100	ALL
CR-102	75034-0001	DIODE, HOT CARRIER, FH1100	ALL
CR-103	75034-0001	DIODE, HOT CARRIER, FH1100	ALL
CR-104	75034-0001	DIODE, HOT CARRIER, FH1100	ALL
L-101	11759-0001	COIL, HFO	ALL
L-102	11747-0001	TRANSFORMER, BAL. MIXER	ALL
L-107	11485-0003	COIL, RF, .15 uh	ALL
Q-102	75561-0031	TRANSISTOR, 2N4258	ALL
R-105	31192-0272	RESISTOR, CARBON, 2.7K ±10%, 1/4W	ALL
R-106	31192-0272	RESISTOR, CARBON, 2.7K ±10%, 1/4W	ALL
R-107	31192-0561	RESISTOR, CARBON, 560 ±10%, 1/4W	ALL
R-108	31192-0101	RESISTOR, CARBON, 100 ±10%, 1/4W	ALL
R-114	31192-0820	RESISTOR, CARBON, 82 ±10%, 1/4W	ALL
R-115	31192-0820	RESISTOR, CARBON, 82 ±10%, 1/4W	ALL
R-116	31192-0820	RESISTOR, CARBON, 82 ±10%, 1/4W	ALL
R-117	31192-0820	RESISTOR, CARBON, 82 ±10%, 1/4W	ALL
R-118	31192-0820	RESISTOR, CARBON, 82 ±10%, 1/4W	ALL
R-119	31192-0820	RESISTOR, CARBON, 82 ±10%, 1/4W	ALL
R-120	31192-0820	RESISTOR, CARBON, 82 ±10%, 1/4W	ALL
R-121	31192-0820	RESISTOR, CARBON, 82 ±10%, 1/4W	ALL
R-122	31192-0390	RESISTOR, CARBON, 39 ±10%, 1/4W	ALL
R-123	31192-0390	RESISTOR, CARBON, 39 ±10%, 1/4W	ALL
R-124	31192-0471	RESISTOR, CARBON, 470 ±10%, 1/4W	ALL
R-125	31192-0271	RESISTOR, CARBON, 270 ±10%, 1/4W	ALL
R-126	31192-0181	RESISTOR, CARBON, 180 ±10%, 1/4W	ALL
S-101	61573-0001	SWITCH, MHz, VARACTOR-LOCALIZER	A
S-101	61578-0001	SWITCH, MHz, VARACTOR-LOCALIZER - G/S	B
XT-121	72033-0021	CRYSTAL, 5th O.T., 97.45 MHz	ALL
XT-122	72033-0022	CRYSTAL, 5th O.T., 98.45 MHz	ALL
XT-123	72033-0023	CRYSTAL, 5th O.T., 99.45 MHz	ALL
XT-124	72033-0024	CRYSTAL, 5th O.T., 100.45 MHz	ALL
XT-125	72033-0025	CRYSTAL, 5th O.T., 101.45 MHz	ALL
XT-126	72033-0026	CRYSTAL, 5th O.T., 102.45 MHz	ALL
XT-127	72033-0027	CRYSTAL, 5th O.T., 103.45 MHz	ALL
XT-128	72033-0028	CRYSTAL, 5th O.T., 104.45 MHz	ALL
XT-129	72033-0029	CRYSTAL, 5th O.T., 105.45 MHz	ALL
XT-130	72033-0030	CRYSTAL, 5th O.T., 106.45 MHz	ALL
Z-102	11454-0001	FERRITE BEAD	ALL



B 55851
C 61547
HFO

FIGURE 5.5-7 SYNTHESIZER HFO ASSY

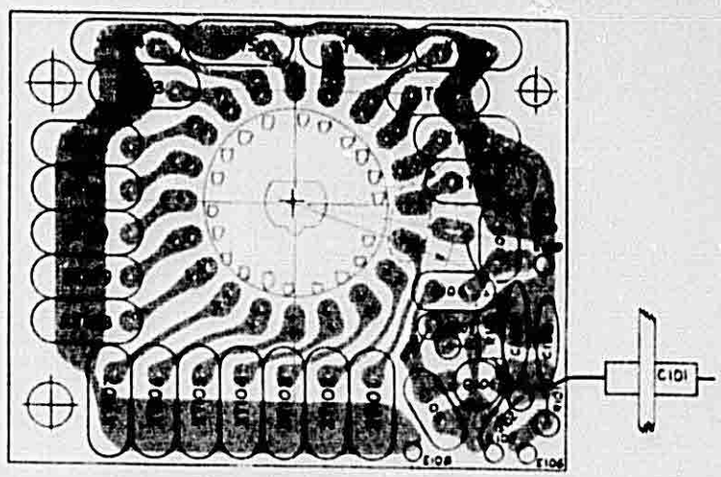


FIGURE 5.5-8 SYNTHESIZER LFO ASSY

B 55852
C 61548
LFO

Fig. & Index No.	Part Number	Description	Used on
		A - SYNTHESIZER LFO ASSY, NAV 111 TSO and NAV 112 TSO	
		B - SYNTHESIZER LFO ASSY, NAV 111 TSO and NAV 112 TSO with DME	
5.5-8	01150-0102	SYNTHESIZER LFO ASSY (without DME) (See Fig. 5.5-1 for Next Higher Assy)	A
5.5-8	01150-0106	SYNTHESIZER LFO ASSY (with DME) (See Fig. 5.5-1 for Next Higher Assy)	B
	82901-0101	NUT, SWAGE, #4-40	ALL
	55888-0001	BOX, LFO	ALL
	55889-0001	COVER, LFO	ALL
	82900-0003	NUT, HEX, #4-40 x 3/16	ALL
	81290-0001	NUT, U, #4	ALL
	82958-0002	SCREW, TAP-TITE, PAN HD, #4-40 x 3/16, SLOTTED	ALL
	81307-0099	WASHER, FLAT	ALL
	82814-0007	SCREW, MACH, 4-40 x ½ BIND HD, SLOTTED	ALL
	55740-0003	BEARING PLATE	ALL
	81206-0061	SPACER .187 LG.	ALL
	82802-0003	LOCKWASHER, INTERNAL TEETH, #4	ALL
	82801-0001	LOCKWASHER, EXTERNAL TEETH, #4	ALL
	81254-0037	EYELET, SE-43	ALL
	82814-0010	SCREW, MACH, #4-40 x 7/8 BINDING HD., SLOTTED	ALL
C-101	21296-0003	CAPACITOR, CERAMIC, FEEDTHRU, .001, 500V	ALL
C-102	21291-0005	CAPACITOR, CERAMIC DISC, .01 ±20%, 50V	ALL
C-103	24052-0361	CAPACITOR, DIPPED MICA, 360 pf	ALL
C-104	24052-0101	CAPACITOR, DIPPED MICA, 100 pf	ALL
C-105	24052-0201	CAPACITOR, DIPPED MICA, 200 pf	ALL
C-123	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V	ALL
Q-101	75588-0003	TRANSISTOR, 2N3662	ALL
R-101	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W	ALL
R-102	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W	ALL
R-103	31192-0153	RESISTOR, CARBON, 15K ±10%, ¼W	ALL
R-104	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W	ALL
R-113	31192-0470	RESISTOR, CARBON, 47 ±10%, ¼W	ALL
R-127	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W	ALL
S-102	61548-0001	SWITCH, KHz, LOCALIZER	B
S-102	61550-0001	SWITCH, KHz, LOCALIZER/DME	A
XT-101	72033-0001	CRYSTAL, FUND. MODE. 22.525 MHZ	B
XT-102	72033-0002	CRYSTAL, FUND. MODE. 22.575 MHZ	ALL
XT-103	72033-0003	CRYSTAL, FUND. MODE. 22.625 MHZ	ALL
XT-104	72033-0004	CRYSTAL, FUND. MODE. 22.675 MHZ	ALL
XT-105	72033-0005	CRYSTAL, FUND. MODE. 22.725 MHZ	ALL
XT-106	72033-0006	CRYSTAL, FUND. MODE. 22.775 MHZ	ALL
XT-107	72033-0007	CRYSTAL, FUND. MODE. 22.825 MHZ	ALL
XT-108	72033-0008	CRYSTAL, FUND. MODE. 22.875 MHZ	ALL
XT-109	72033-0009	CRYSTAL, FUND. MODE. 22.925 MHZ	ALL
XT-110	72033-0010	CRYSTAL, FUND. MODE. 22.975 MHZ	ALL
XT-111	72033-0011	CRYSTAL, FUND. MODE. 23.025 MHZ	ALL
XT-112	72033-0012	CRYSTAL, FUND. MODE. 23.075 MHZ	ALL
XT-113	72033-0013	CRYSTAL, FUND. MODE. 23.125 MHZ	ALL
XT-114	72033-0014	CRYSTAL, FUND. MODE. 23.175 MHZ	ALL
XT-115	72033-0015	CRYSTAL, FUND. MODE. 23.225 MHZ	ALL
XT-116	72033-0016	CRYSTAL, FUND. MODE. 23.275 MHZ	ALL
XT-117	72033-0017	CRYSTAL, FUND. MODE. 23.325 MHZ	ALL
XT-118	72033-0018	CRYSTAL, FUND. MODE. 23.375 MHZ	ALL
XT-119	72033-0019	CRYSTAL, FUND. MODE. 23.425 MHZ	ALL
XT-120	72033-0020	CRYSTAL, FUND. MODE. 23.475 MHZ	ALL

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
5.5-9	01150-0103	SYNTHESIZER FILTER ASSY (See Fig. 5.5-1 for Next Higher Assy)
	55964-0001	COVER, FILTER
	55960-0002	BRACKET, FILTER
	81254-0037	EYELET, SE-43
	55850-0002	CAN, SHIELD
	81795-0001	RECEPTACLE
C-111	24516-0180	CAPACITOR, DIPPED MICA, 18 pf
C-113	24509-0109	CAPACITOR, CERAMIC, 1.0 pf ±5%, 500V
C-114	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-115	24516-0150	CAPACITOR, CERAMIC DISC, 15 pf
C-117	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-119	24052-0750	CAPACITOR, DIPPED MICA, 75 pf
C-120	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
CR-105	75037-0001	DIODE, VAR. CAP
L-103	11783-0001	COIL, FILTER
L-104	11783-0001	COIL, FILTER
L-105	11783-0002	COIL, FILTER
R-110	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-111	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-112	31192-0562	RESISTOR, CARBON, 5.6K ±10%, ¼W
U-101	74018-0001	INTEGRATED CIRCUIT, LINEAR

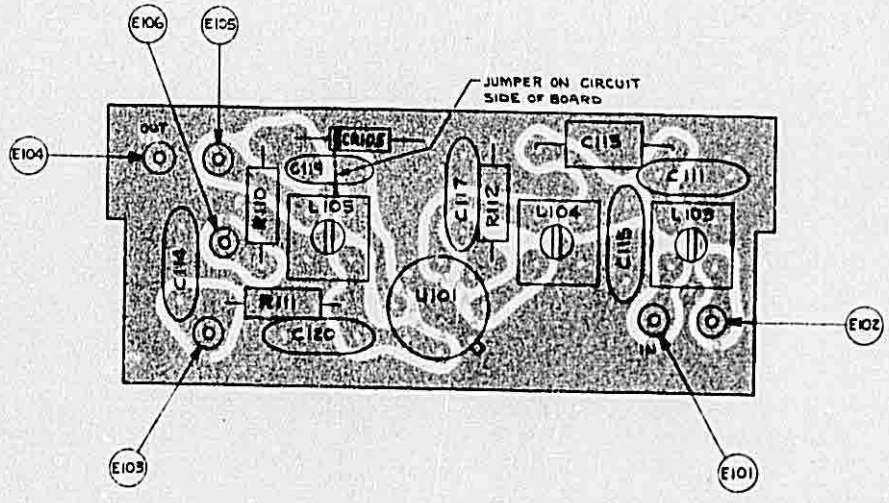


FIGURE 5.5-9 SYNTHESIZER FILTER ASSY

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
5.5.-10	01147-0102	RECEIVER BOARD ASSY, (See Fig. 5.5-1 for NHA)
	55969-0001	SHIELD
	82922-0001	NUT, HEX, #4-40
	81214-0012	SPACER, GENERAL (PHENOLIC)
	55849-0001	SPACER, FILTER
	56485-0001	CLIP, GROUNDING
C-603	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-604	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-605	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-606	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-607	24509-0228	CAPACITOR, CERAMIC, .22 pf ±5%, 500V
C-608	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-609	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-610	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-611	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-612	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-613	22041-0002	CAPACITOR, VARIABLE, 9 to 35 pf
C-614	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-615	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-616	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-617	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-618	24049-0511	CAPACITOR, DIPPED MICA, 510 pf ±5%, 500V
C-619	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-620	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-621	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-622	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-623	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-624	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-625	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-626	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-627	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-628	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-629	24515-0005	CAPACITOR, CERMAIC DISC, .05 mf, ±5%, 10V
C-630	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-631	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-632	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-633	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C-634	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-635	23094-0171	CAPACITOR, MET. MYLAR, .047 mf ±10%, 200V
C-636	21555-0011	CAPACITOR, TANTALUM, 39 mf ±10%, 10V
C-637	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-638	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-639	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C-641	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-642	21555-0012	CAPACITOR, TANTALUM, 82 mf ±10%, 10V
C-643	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-644	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-645	21296-0003	CAPACITOR, FEED THRU CERAMIC .001 mf GMV, 500V
C-646	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-647	21296-0003	CAPACITOR, FEED THRU CERAMIC .001 mf GMV, 500V
C-648	21291-0025	CAPACITOR, CERAMIC DISC, 930 pf ±10%, 500V
C-649	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-650	21555-0011	CAPACITOR, TANTALUM, 39 mf ±10%, 10V
C-651	21515-0010	CAPACITOR, CERAMIC DISC, .02 mf, 50V
C-652	21554-0012	CAPACITOR, ELECTROLYTIC, 250 mf, 15V
CR-602	75037-0001	DIODE, TUNING,
CR-603	75037-0001	DIODE, TUNING,
CR-604	75037-0001	DIODE, TUNING,
CR-605	75028-0001	DIODE, SILICON
CR-606	75028-0001	DIODE, SILICON
CR-607	75028-0001	DIODE, SILICON
CR-608	75025-0002	DIODE, ZENER, 8.2V ±5%, 1W
CR-610	75037-0001	DIODE, TUNING,
CR-611	75037-0001	DIODE, TUNING,
CR-612	75037-0001	DIODE, TUNING,
CR-613	75028-0001	DIODE, SILICON
CR-614	75028-0001	DIODE, SILICON
CR-615	75028-0001	DIODE, SILICON
FL-601	11751-0002	FILTER, CRYSTAL, 11.975 MHZ

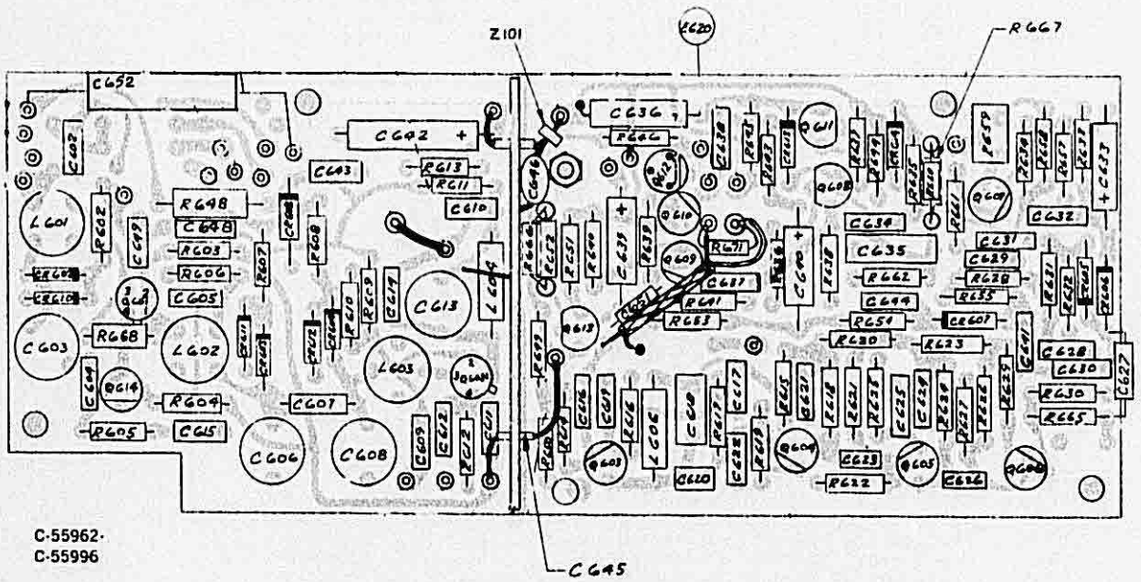


FIGURE 5.5-10 RECEIVER BOARD ASSY

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
L-601	11753-0002	COIL, TUNED SLUG, (RF INPUT)
L-602	11754-0001	COIL, TUNED SLUB, (RF OUTPUT)
L-603	11755-0001	COIL, TUNED SLUB, (MIXER INPUT)
L-604	11138-0015	CHOKE, RF, 6.8 uh ±10%
L-606	11834-0001	CHOKE, TUNEABLE
Q-601	75611-0002	TRANSISTOR, FET, N CHANNEL (MOTOROLA SL119)
Q-602	75611-0002	TRANSISTOR, FET, N CHANNEL (MOTOROLA SL119)
Q-603	75588-0003	TRANSISTOR, NPN, 2N3662
Q-604	75588-0003	TRANSISTOR, PNP, 2N3662
Q-605	75588-0003	TRANSISTOR, NPN, 2N3662
Q-606	75588-0003	TRANSISTOR, NPN, 2N3662
Q-607	75595-0003	TRANSISTOR, NPN, 2N5172
Q-608	75565-0006	TRANSISTOR, PNP, 2N5356
Q-609	75595-0003	TRANSISTOR, NPN, 2N5172
Q-610	75595-0003	TRANSISTOR, NPN, 2N5172
Q-611	75565-0006	TRANSISTOR, PNP, 2N5356
Q-612	75595-0003	TRANSISTOR, NPN, 2N5172
Q-613	75565-0006	TRANSISTOR, PNP, 2N5356
Q-614	75595-0003	TRANSISTOR, NPN, 2N5172
R-602	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-603	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-604	31192-0273	RESISTOR, CARBON, 27K ±10%, ¼W
R-605	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-606	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-607	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-608	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-609	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-610	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-611	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-612	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-613	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-614	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-615	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-616	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-617	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-618	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-619	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-620	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-621	31192-0822	RESISTOR, CARBON, 8.2K ±10%, ¼W
R-622	31192-0332	RESISTOR, CARBON, 3.3K ±10%, ¼W
R-623	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-624	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-625	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-626	31192-0562	RESISTOR, CARBON, 5.6K ±10%, ¼W
R-627	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-628	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-629	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-630	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-631	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-632	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-633	31192-0273	RESISTOR, CARBON, 27K ±10%, ¼W
R-634	31192-0473	RESISTOR, CARBON, 47K ±10%, ¼W
R-635	31192-0154	RESISTOR, CARBON, 150K ±10%, ¼W
R-636	31192-0564	RESISTOR, CARBON, 560K ±10%, ¼W
R-637	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-638	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-639	31192-0155	RESISTOR, CARBON, 1.5M ±10%, ¼W
R-640	31192-0123	RESISTOR, CARBON, 12K ±10%, ¼W
R-641	31192-0331	RESISTOR, CARBON, 330 ±10%, ¼W
R-643	31192-0682	RESISTOR, CARBON, 6.8K ±10%, ¼W
R-644	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-645	31192-0683	RESISTOR, CARBON, 68K ±10%, ¼W
R-646	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-648	31196-0003	RESISTOR, CARBON, 27 ±5%, 2W
R-649	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-650	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-651	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-652	31192-0474	RESISTOR, CARBON, 470K ±10%, ¼W
R-653	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-654	31192-0153	RESISTOR, CARBON, 15K ±10%, ¼W
R-657	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-658	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-659	32054-0009	RESISTOR, CARBON, VARIABLE, 1K
R-660	31192-0683	RESISTOR, CARBON, 68K ±10%, ¼W
R-661	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-662	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-665	31192-0330	RESISTOR, CARBON 33 ±10%, ¼W
R-666	31192-SEL.	RESISTOR, CARBON, SEL. ±10%, ¼W
R-667	31192-SEL.	RESISTOR, CARBON, SEL. ±10%, ¼W
R-668	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-671	31192-0391	RESISTOR, CARBON, SEL ±10%, ¼W
Z-101	11454-0001	FERRITE BEAD

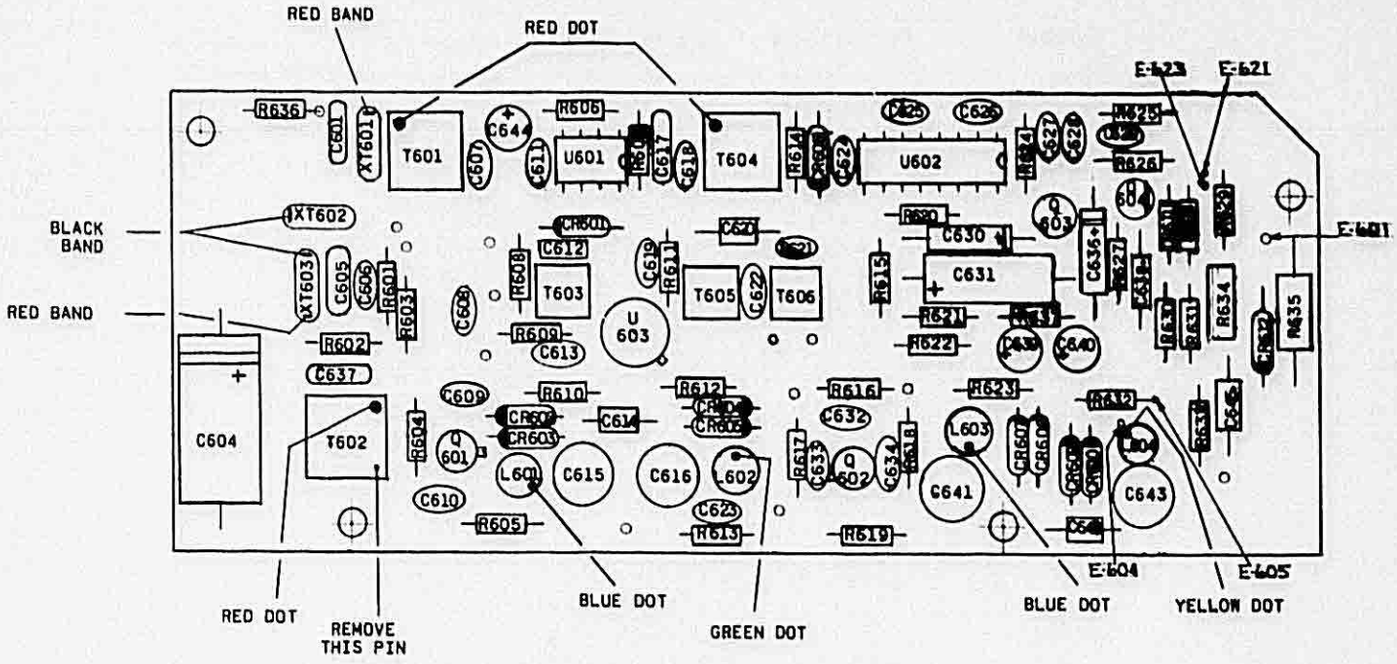


FIGURE 5.5-10A. RECEIVER (CHASSIS CND217C/CNE217C)

Symbol	Part Number	Description
	55850-2	CAN, SHIELD
C601	24052-100	CAPACITOR, Dipped Mica, 10pf ±1pf, 500V
C604	21554-51	CAPACITOR, Electrolytic, 250mf,20V
C605	24052-330	CAPACITOR, Dipped Mica, 33pf ±5%, 500V
C606	24515-5	CAPACITOR, Ceramic Disc, .05mf ±20%, 10V
C607	2415-5	CAPACITOR, Ceramic Disc, .05mf ±20%, 10V
C608	21291-25	CAPACITOR, Ceramic Disc, 430pf ±10%, 500V
C609	21291-31	CAPACITOR, Ceramic Disc, 390pf ±10%, 500V
C610	24515-5	CAPACITOR, Ceramic Disc, .05mf ±20%, 10V
C611	24515-5	CAPACITOR, Ceramic Disc, .05mf ±20%, 10V
C612	24052-470	CAPACITOR, Dipped Mica, 47pf ±5%, 300V
C613	21291-25	CAPACITOR, Ceramic Disc, 430pf ±10%, 500V
C614	24509-688	CAPACITOR, Ceramic Tub., 68pf ±5%, 500V
C615	22051-2	CAPACITOR, Variable, 1.3-5.4pf
C616	22051-2	CAPACITOR, Variable, 1.3-5.4pf
C617	24052-150	CAPACITOR, Dipped Mica, 15pf ±1pf, 500V
C618	2415-5	CAPACITOR, Ceramic Disc, .05mf ±20%, 10V
C619	21291-25	CAPACITOR, Ceramic Disc, 430pf ±10%, 500V
C620	24509-109	CAPACITOR, Ceramic Tub., 1.0pf ±5%, 500V
C621	24516-180	CAPACITOR, Ceramic Disc, 18pf ±10%, 500V
C622	24516-150	CAPACITOR, Ceramic Disc, 15pf ±10%, 500V
C623	21291-31	CAPACITOR, Ceramic Disc, 390pf ±10%, 500V
C624	21291-30	CAPACITOR, Ceramic Disc, .01mf ±20%, 50V
C625	24515-5	CAPACITOR, Ceramic Disc, .05mf ±5%, 10V
C626	24515-5	CAPACITOR, Ceramic Disc, .05mf ±5%, 10V
C627	21291-30	CAPACITOR, Ceramic Disc, .01mf ±20%, 50V
C628	24515-5	CAPACITOR, Ceramic Disc, .05mf ±5%, 10V
C629	21291-30	CAPACITOR, Ceramic Disc, .01mf ±20%, 50V
C630	21555-58	CAPACITOR, Tantalum, 6.8mf ±10%, 35V

SEE BLOW-UP

Symbol	Part Number	Description
C631	21555-12	CAPACITOR, Tantalum, 82mf ±10%, 10V
C632	23107-125	CAPACITOR, Mylar, .1mf ±10%, 100V
C633	21291-31	CAPACITOR, Ceramic Disc, 390pf ±10%, 500V
C634	21291-31	CAPACITOR, Ceramic Disc, 390pf ±10%, 500V
C636	21555-11	CAPACITOR, Tantalum, 39mf ±10%, 10V
C637	24052-100	CAPACITOR, Dipped Mica, 10pf ±1pf, 500V
C638	21555-2	CAPACITOR, Tantalum, 6.8mf ±10%, 6V
C639	21564-120	CAPACITOR, Tantalum, 22mf ±10%, 10V
C640	21564-117	CAPACITOR, Tantalum, 6.8mf ±10%, 10V
C641	22053-1	CAPACITOR, Variable, 2.5/5pf, 63V
C642	24509-109	CAPACITOR, Ceramic Tub., 1.0pf ±5%, 500V
C643	22053-1	CAPACITOR, Variable, 2.5/5pf, 63V
C644	21564-37	CAPACITOR, Tantalum, 68mf ±10%, 10V
C645	21555-44	CAPACITOR, Tantalum, .47mf ±10%, 35V
CR601	75037-1	DIODE, Varactor
CR602	75037-1	DIODE, Varactor
CR603	75037-1	DIODE, Varactor
CR604	75037-1	DIODE, Varactor
CR605	75037-1	DIODE, Varactor
CR606	75038-2	DIODE, R F Switch
CR607	75037-1	DIODE, Varactor
CR608	75037-1	DIODE, Varactor
CR609	75037-1	DIODE, Varactor
CR610	75037-1	DIODE, Varactor
CR611	75028-1	DIODE, Silicon
CR612	75025-6	DIODE, Zener, 7.5V
L601	11847-1	COIL, (Mixer Input)
L602	11846-1	COIL, (RF Output)
L603	11847-1	COIL, (RF Input)
L604	11845-1	COIL, (Ant Input)
Q601	75611-s	TRANSISTOR, FET
Q602	75611-s	TRANSISTOR, FET
Q603	75565-6	TRANSISTOR, 2N4250
Q604	75550-22	TRANSISTOR, 2N3391
R601	31192-101	RESISTOR, Carbon, 100 ±10%, 1/4W
R602	31192-103	RESISTOR, Carbon, 10K ±10%, 1/4W
R603	31192-104	RESISTOR, Carbon, 100K ±10%, 1/4W
R604	31192-103	RESISTOR, Carbon, 10K ±10%, 1/4W
R605	31192-221	RESISTOR, Carbon, 220 ±10%, 1/4W
R606	31192-101	RESISTOR, Carbon, 100 ±10%, 1/4W
R607	31192-470	RESISTOR, Carbon, 47 ±10%, 1/4W
R608	31192-104	RESISTOR, Carbon, 100K ±10%, 1/4W
R609	31192-101	RESISTOR, Carbon, 100 ±10%, 1/4W
R610	31192-104	RESISTOR, Carbon, 100K ±10%, 1/4W

Symbol	Part Number	Description
R611	31192-562	RESISTOR, Carbon, 5.6K ±10%, 1/4W
R612	31192-104	RESISTOR, Carbon, 100K ±10%, 1/4W
R613	31192-101	RESISTOR, Carbon, 100 ±10%, 1/4W
R614	31192-272	RESISTOR, Carbon, 2.7K ±10%, 1/4W
R615	31192-273	RESISTOR, Carbon, 27K ±10%, 1/4K
R616	31192-681	RESISTOR, Carbon, 680 ±10%, 1/4W
R617	31192-221	RESISTOR, Carbon, 220 ±10%, 1/4W
R618	31192-684	RESISTOR, Carbon, 680K ±10%, 1/4W
R619	31192-224	RESISTOR, Carbon, 220K ±10%, 1/4W
R620	31192-563	RESISTOR, Carbon, 56K ±10%, 1/4W
R621	31192-473	RESISTOR, Carbon, 47K ±10%, 1/4W
R622	31192-473	RESISTOR, Carbon, 47K ±10%, 1/4W
R623	31192-104	RESISTOR, Carbon, 100K ±10%, 1/4W
R624	31192-681	RESISTOR, Carbon, 680 ±10%, 1/4W
R625	31192-101	RESISTOR, Carbon, 100 ±10%, 1/4W
R626	31192-273	RESISTOR, Carbon, 27K ±10%, 1/4W
R627	31192-223	RESISTOR, Carbon, 22K ±10%, 1/4W
R628	31192-103	RESISTOR, Carbon, 10K ±10%, 1/4W
R629	31192-103	RESISTOR, Carbon, 10K ±10%, 1/4W
R630	31192-222	RESISTOR, Carbon, 2.2K ±10%, 1/4W
R631	31192-273	RESISTOR, Carbon, 10K ±10%, 1/4W
R632	31192-104	RESISTOR, Carbon, 100K ±10%, 1/4W
R633	31192-222	RESISTOR, Carbon, 2.2K ±10%, 1/4W
R634	32054-25	RESISTOR, Variable, 2.2K
R635	31196-3	RESISTOR, Wirewound, 27, 3W
R636	31192-103	RESISTOR, Carbon, 10K ±10%, 1/4W
R637	31192-101	RESISTOR, Carbon, 100 ±10%, 1/4W
T601	11868-2	INDUCTOR, IF
T602	11868-2	INDUCTOR, IF
T603	11783-2	INDUCTOR, Filter
T604	11868-2	INDUCTOR, IF
T605	11783-1	INDUCTOR, Filter
T606	11783-1	INDUCTOR, Filter
U601	74028-1	IC, MC135OP
U602	74099-1	IC, CA 3088
U603	74018-1	IC, MC 1590G
XT601 XT602 XT603	43207-1	CRYSTAL, Filter 11.975 MHz, (3 sections XT601, XT602,XT603)

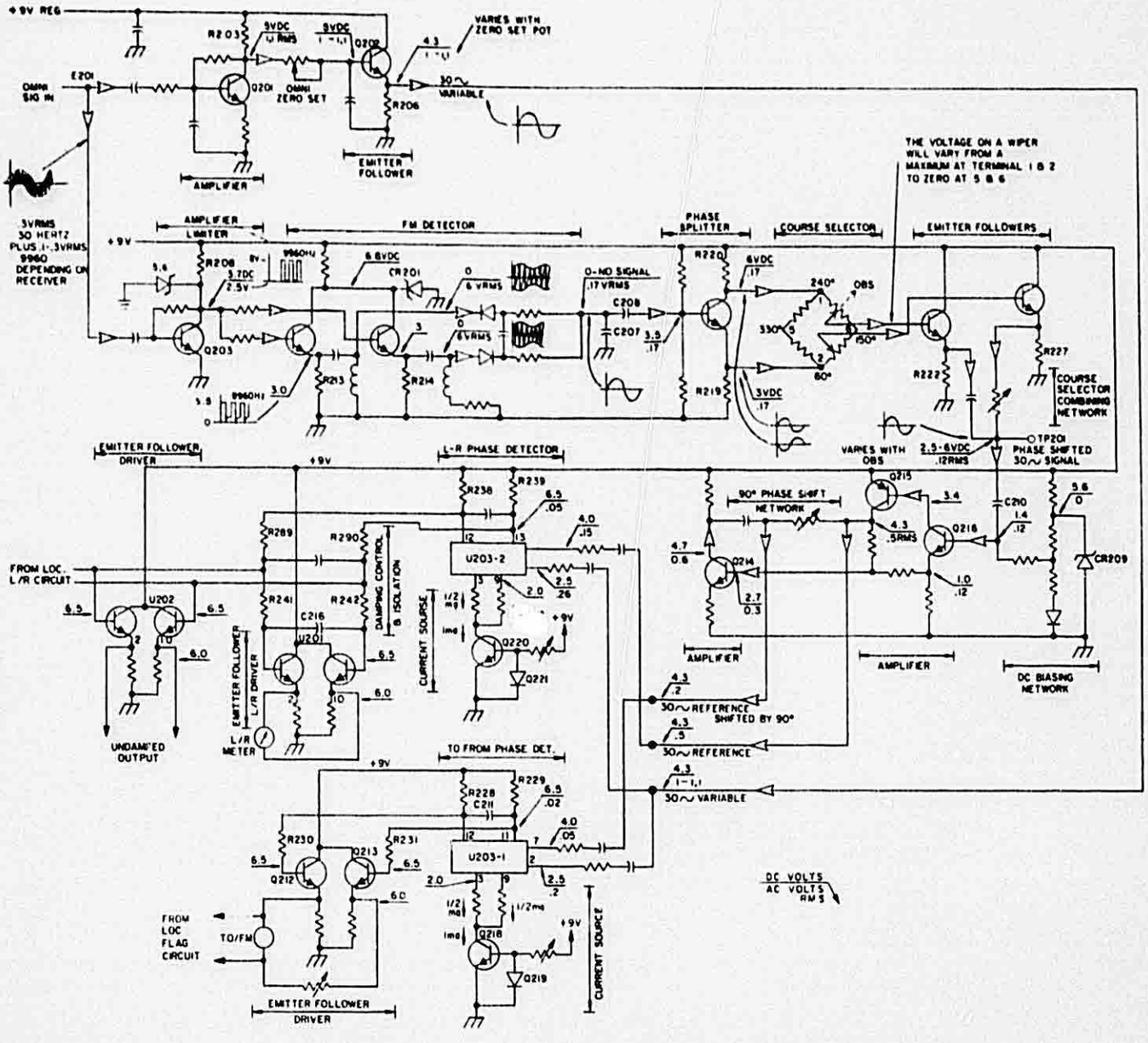


FIGURE 5.6-1 OMNI MAINTENANCE INFORMATION, NAV 111 TSO/NAV 112 TSO

SEE BLOW-UP

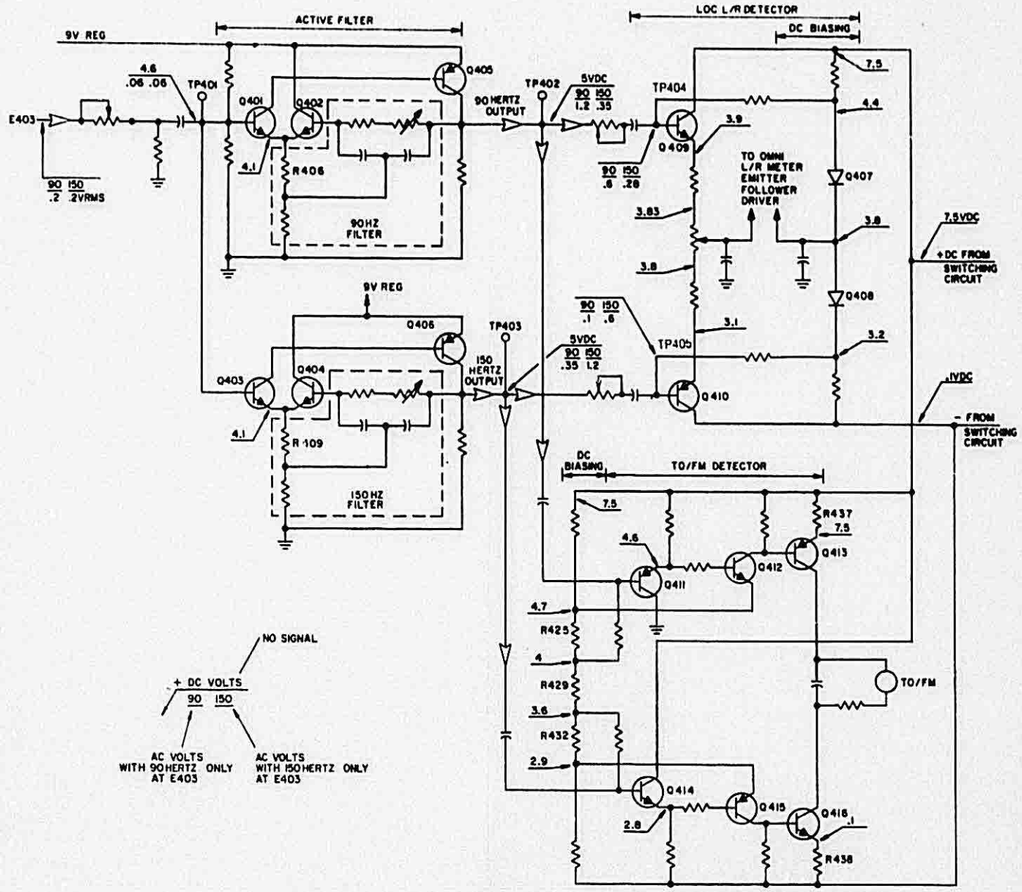
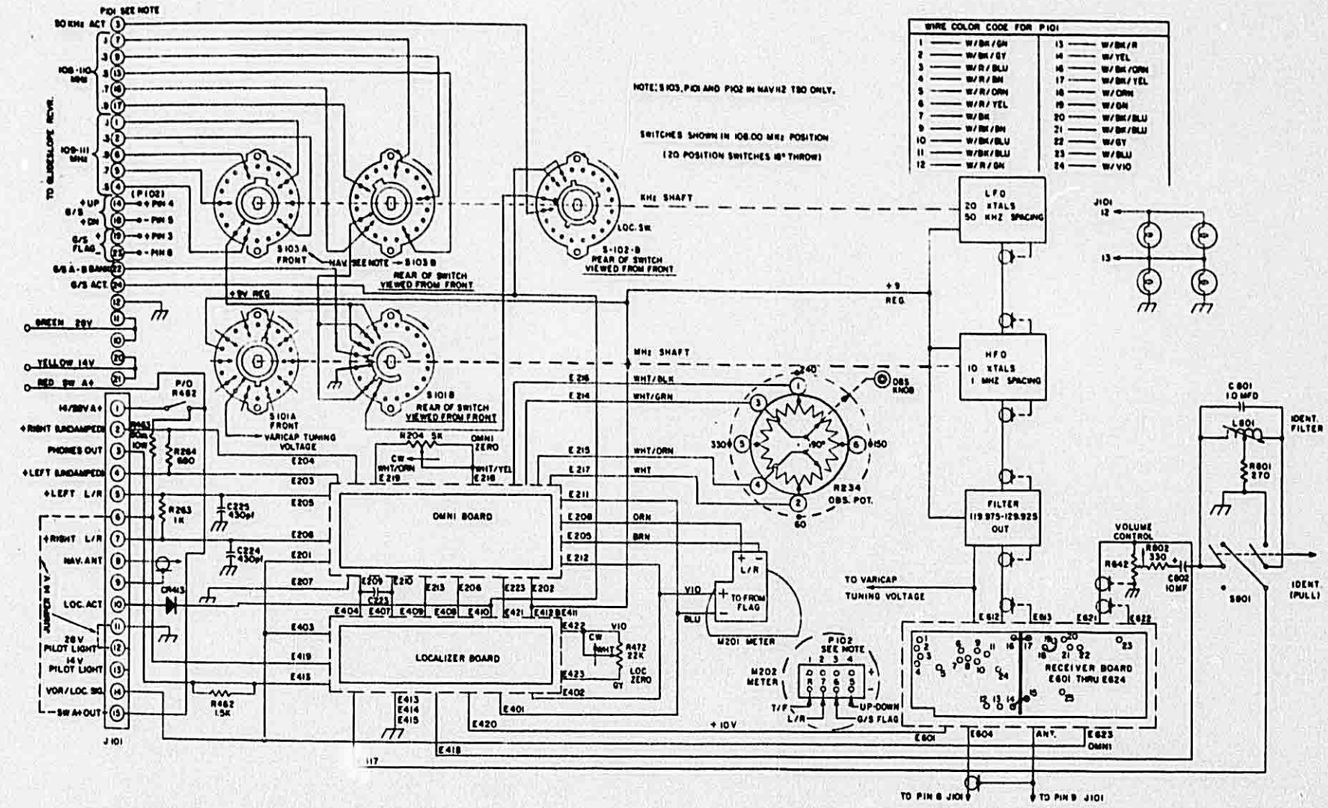


FIGURE 5.6-2 LOCALIZER MAINTENANCE INFORMATION, NAV 111 TSO/NAV 112 TSO

SEE BLOW-UP



D-2384-A

FIGURE 5.6-3 INTERNAL INTERCONNECTION DIAGRAM WITH GLIDE SLOPE CONNECTIONS

NOTE:

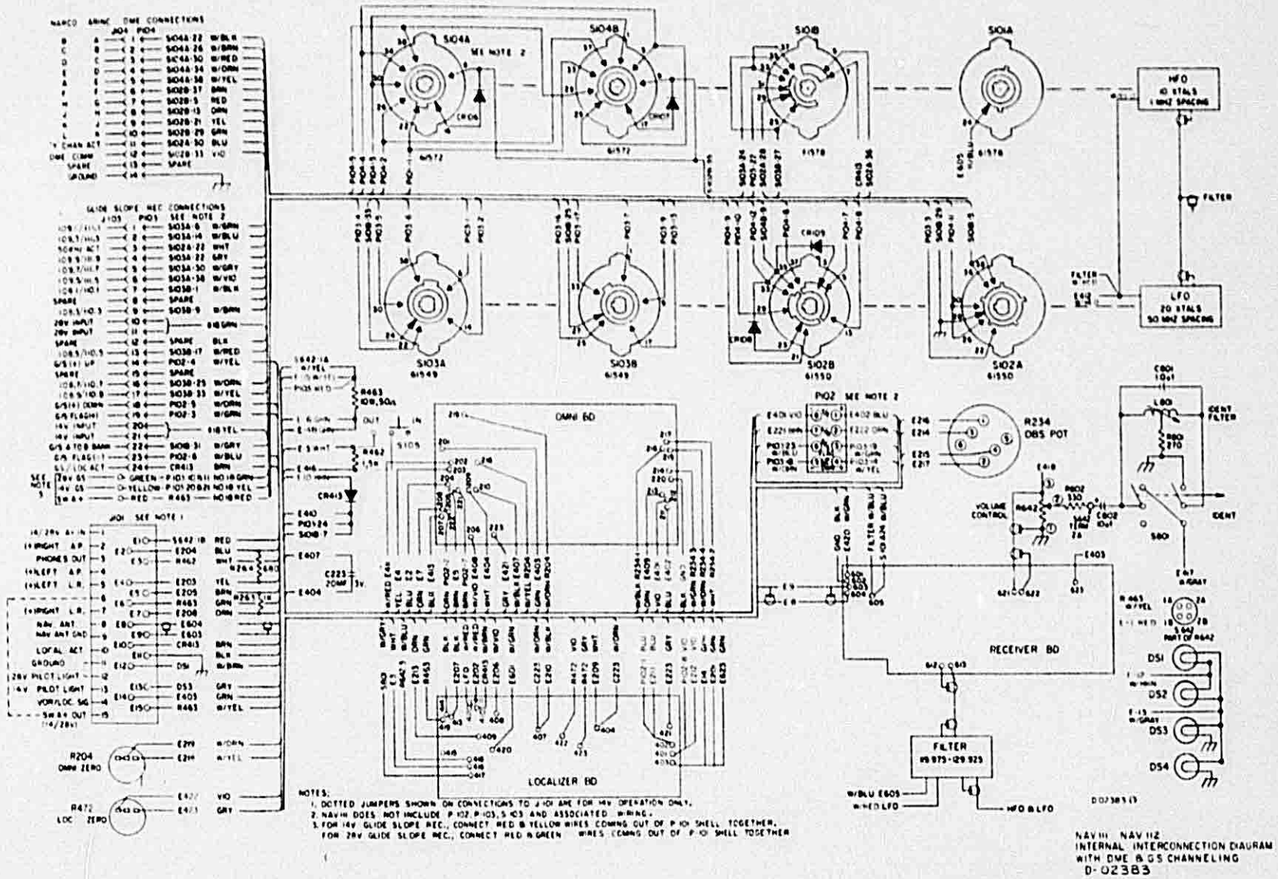
Since the introduction of this Unit, there have been two external outputs provided. One called external L/R at P101, pins 5 & 7 (to drive another meter) and one called undamped output at P101, pins 2 & 4.

Field experience has shown that the external L/R output (pins 5 & 7) is more compatable with autopilots than the undamped output (pins 2 & 4).

Therefore U202, R249, and R264 were removed from the Unit leaving pins 2 & 4 unused. This deletion started with chassis number:

NAV 10 — CNC171B11
NAV 11 — CNA194D3
NAV 12 — CNB194D3
NAV 110 — CNC219A5
NAV 111 — CND 219B3
NAV 112 — CNE 219B3

SEE BLOW-UP



D-02383-A

FIGURE 5.6-3A INTERNAL INTERCONNECTION DIAGRAM WITH GLIDE SLOPE AND DME CONNECTIONS

NOTE:

Since the introduction of this Unit, there have been two external outputs provided. One called external L/R at P101, pins 5 & 7 (to drive another meter) and one called undamped output at P101, pins 2 & 4.

Field experience has shown that the external L/R output (pins 5 & 7) is more compatable with autopilots than the undamped output (pins 2 & 4).

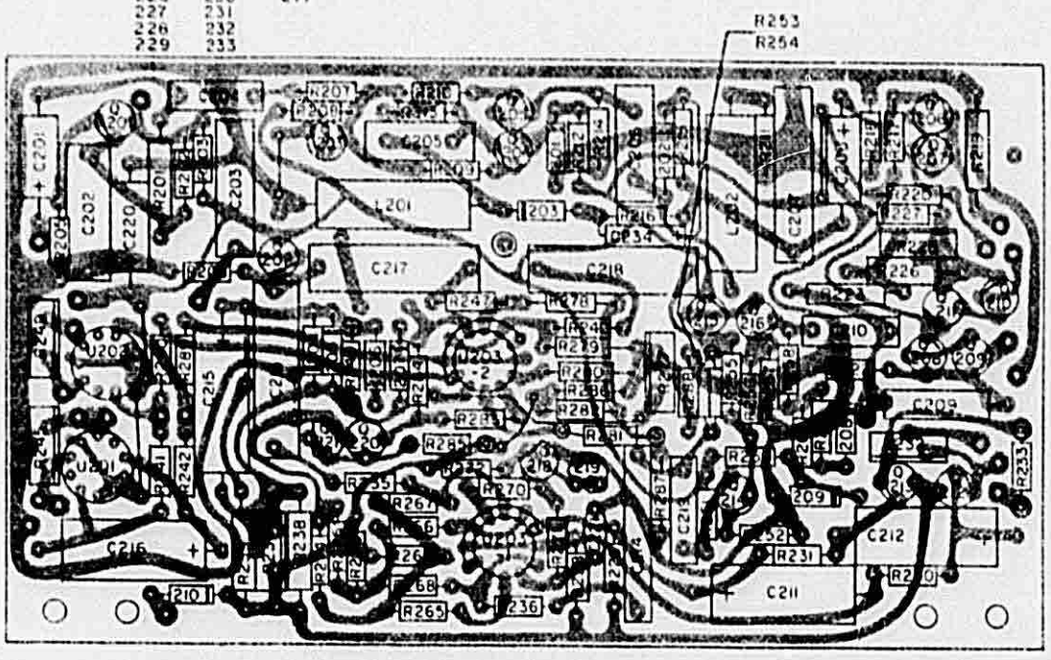
Therefore U202, R249, and R264 were removed from the Unit leaving pins 2 & 4 unused. This deletion started with chassis number:

NAV 10 — CNC171B11
NAV 11 — CNA194D3
NAV 12 — CNB194D3
NAV 110 — CNC219A5
NAV 111 — CND 219B3
NAV 112 — CNE 219B3

SEE BLOW-UP

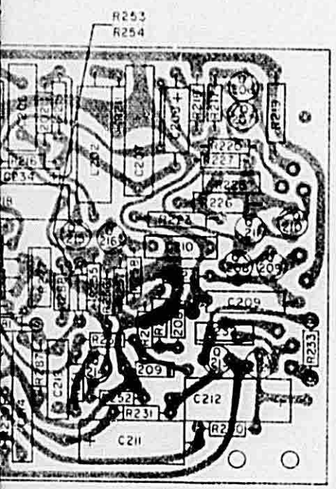
COMPONENTS ON OTHER SIDE OF BOARD

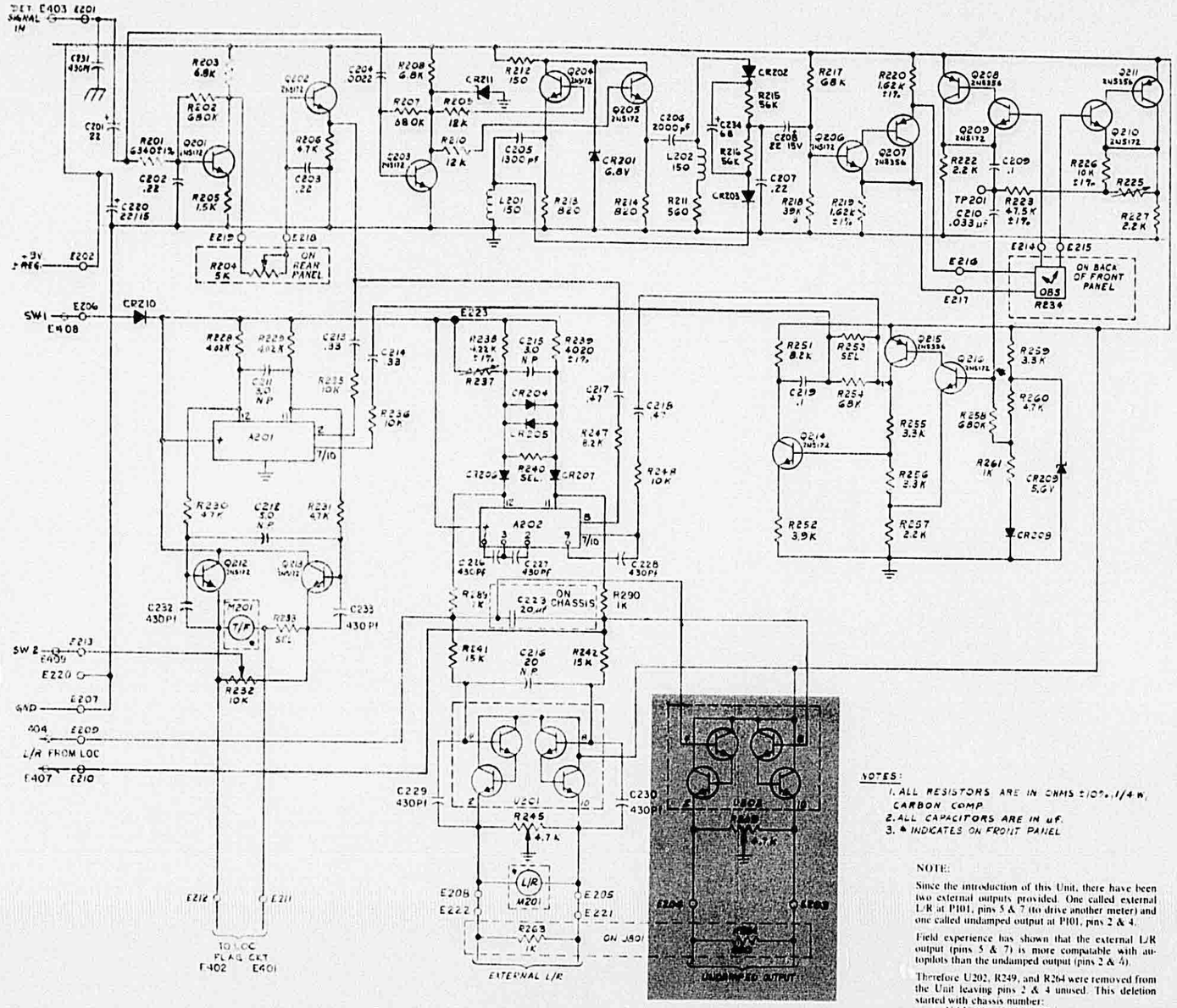
C	C	CR
226	230	211
227	231	
228	232	
229	233	



B-5769?-A

SEE BLOW-UP





NOTES:
1. ALL RESISTORS ARE IN OHMS ±10%, 1/4 W, CARBON COMP.
2. ALL CAPACITORS ARE IN μF.
3. ✱ INDICATES ON FRONT PANEL

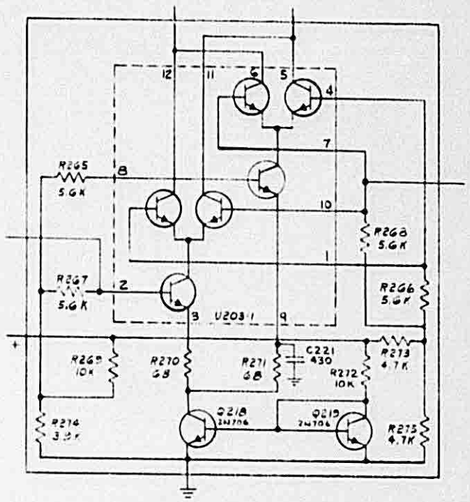
NOTE:

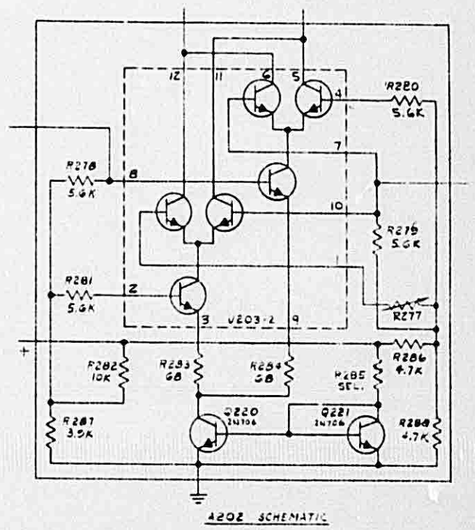
Since the introduction of this Unit, there have been two external outputs provided. One called external L/R at P101, pins 5 & 7 (to drive another meter) and one called undamped output at P101, pins 2 & 4.

Field experience has shown that the external L/R output (pins 5 & 7) is more compatable with autopilots than the undamped output (pins 2 & 4).

Therefore U202, R249, and R264 were removed from the Unit leaving pins 2 & 4 unused. This deletion started with chassis number:

NAV 10 — CNC171B11
NAV 11 — CNA194D3
NAV 12 — CNB194D3
NAV 110 — CNC219A5
NAV 111 — CND 219B3
NAV 112 — CNE 219B3

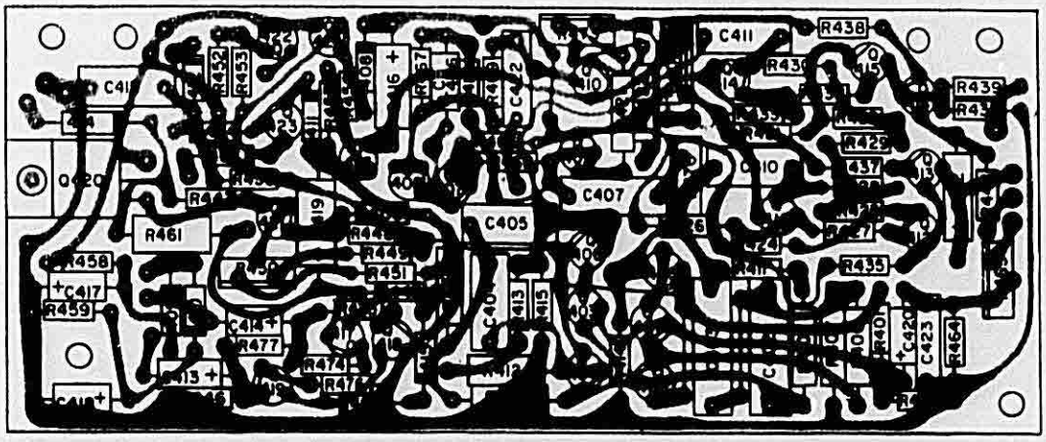




D-02343 REV.-V

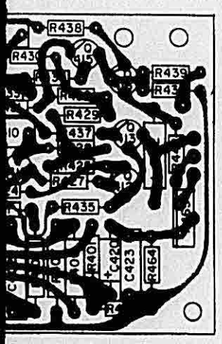
FIGURE 5.6-4 OMNI SCHEMATIC, NAV 111 TSO/NAV 112 TSO

SEE BLOW-UP



B-5768-A

SEE BLOW-UP



B-57686-A

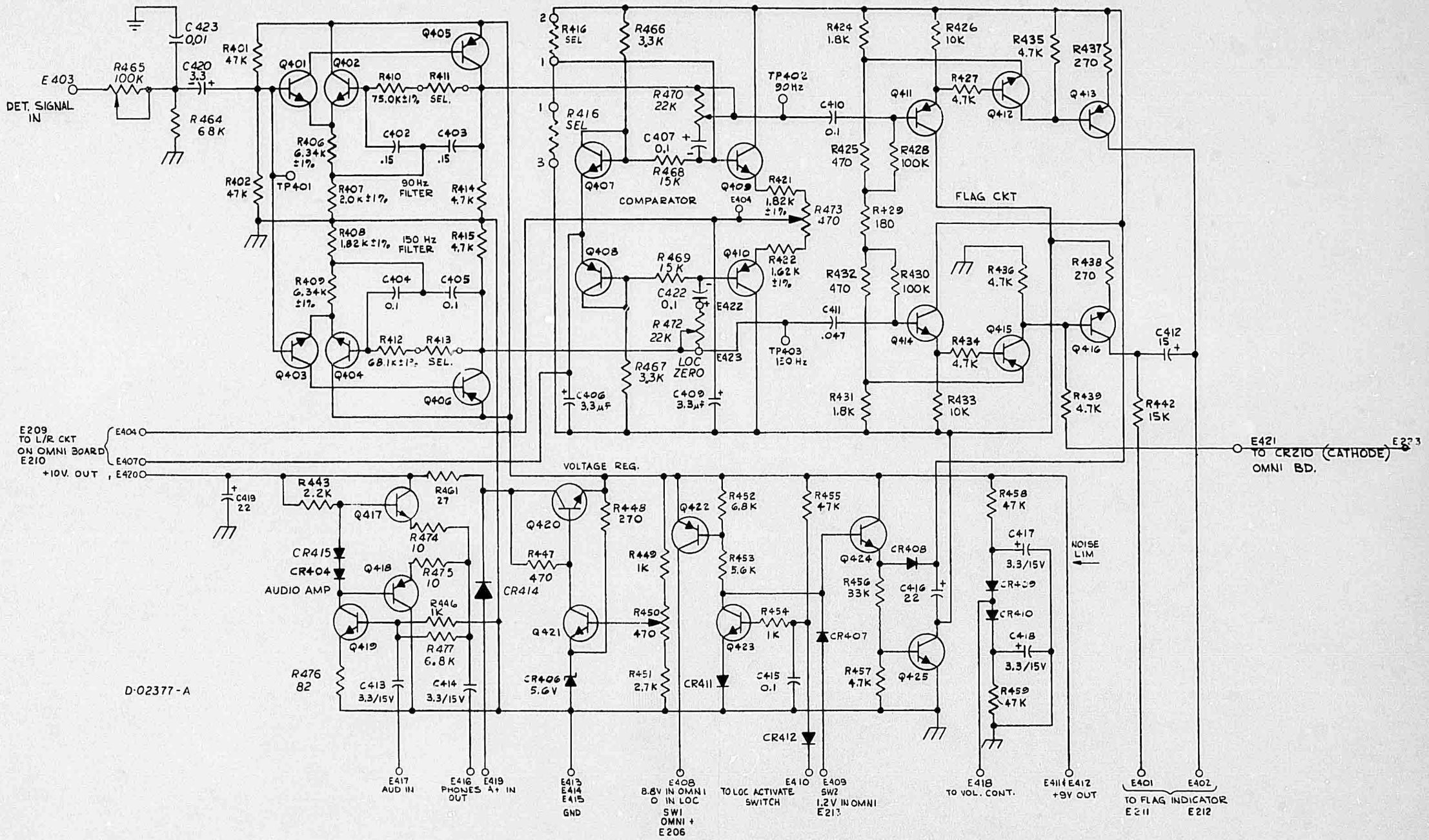
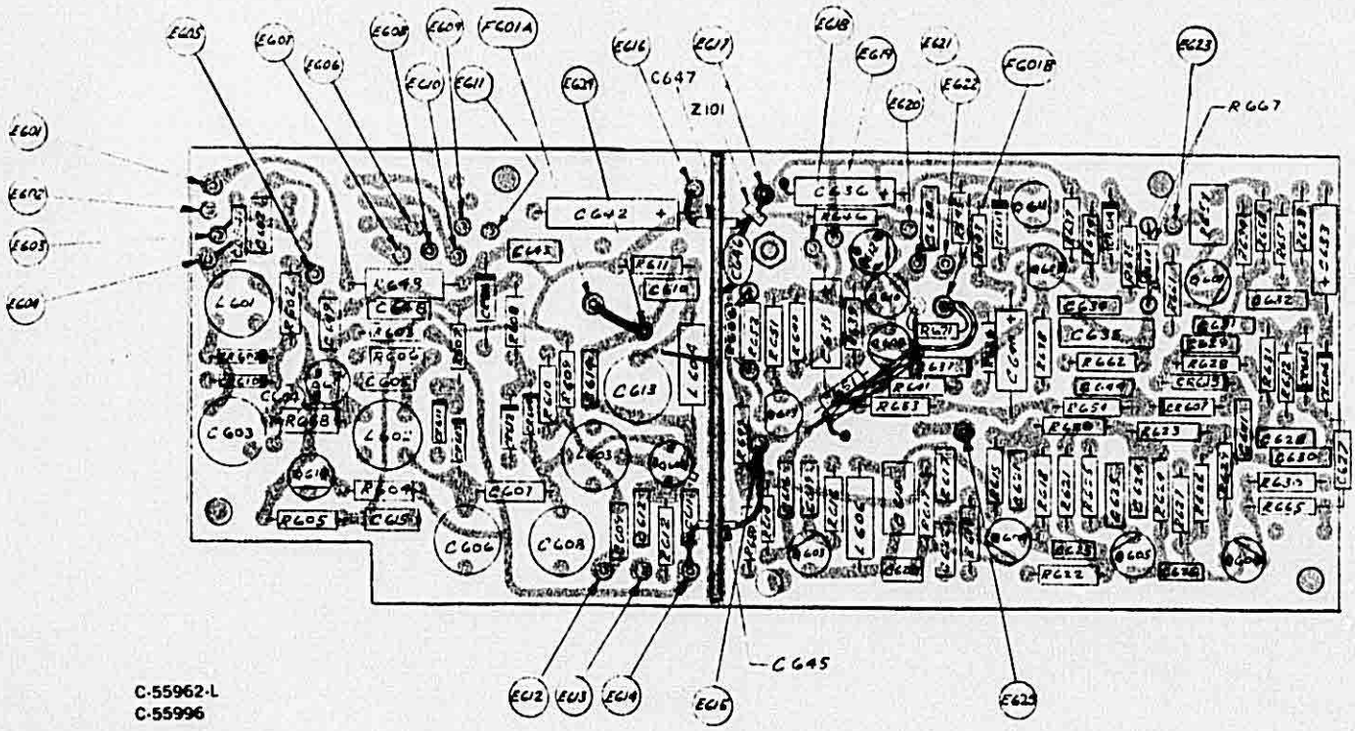


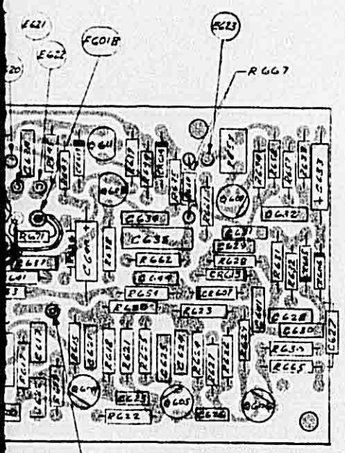
FIGURE 5.6-5 LOCALIZER SCHEMATIC, NAV 111 TSO/NAV 112 TSO

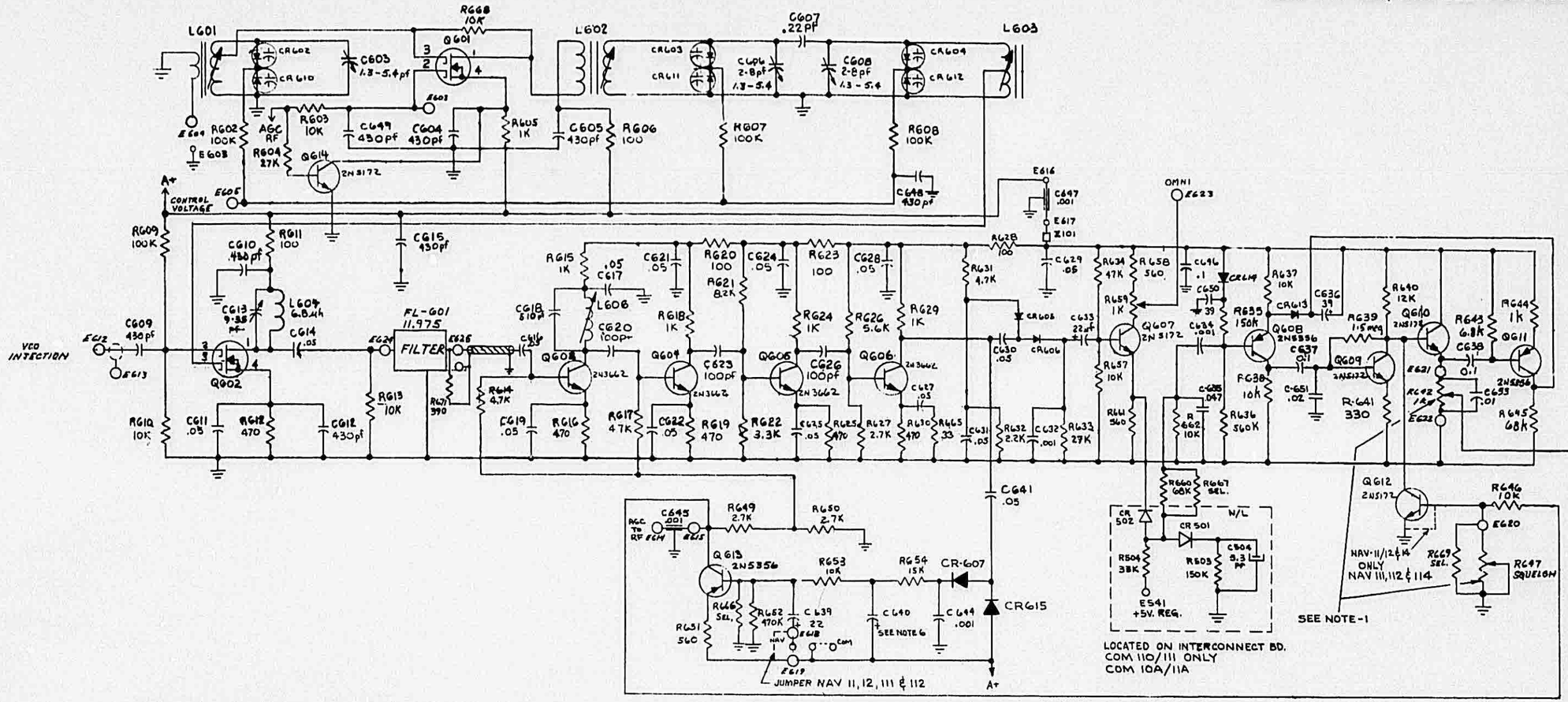
SEE BLOW-UP

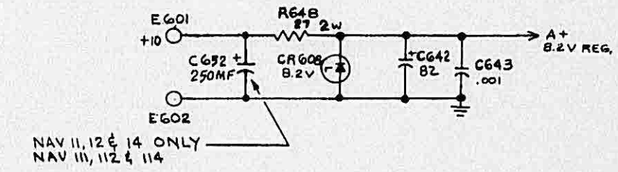


C-55962-L
C-55996

SEE BLOW-UP





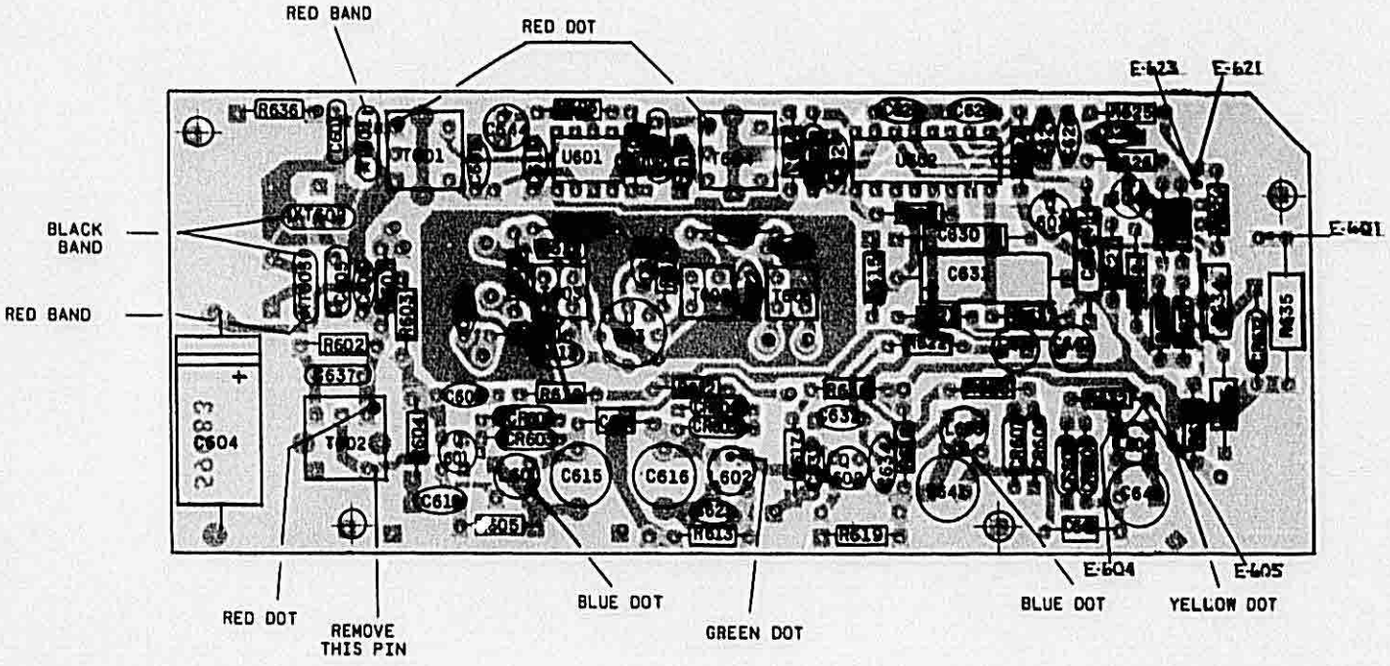


NOTES:
1- R642 & R647 ARE PART OF FRONT PANEL B 01154 PARTS LIST.
2- COM 10/10A & COM 11/11A B-01147-101 PARTS LIST AS SHOWN. (ALSO COM 110/111)
3- NAV 11, 12 & 14, B-01147-2 OMIT SYMBOLS, R656, CR 609, R663, C602, R601, CR-601, C601, R668, Q612, R647, R646. (ALSO NAV 111, 112 & 114)
4- ALL RESISTORS ARE IN OHMS ±10%, ½ W., CARBON COMP. EXCEPT AS NOTED.
5- ALL CAPACITORS ARE IN μF EXCEPT AS NOTED.
6- C640 { 10MMF COM 10A, NAV 11, NAV 12 & NAV 14, COM 110, NAV 111, NAV 112 & NAV 114.
3.3MF COM 11A, COM 111.

D-02299 REV-P

FIGURE 5.6-6 RECEIVER SCHEMATIC

SEE BLOW-UP



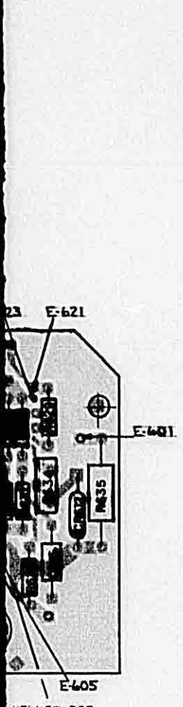
C-59084-B

D95128B

Solder runs shown in Grey
are those on the "BOTTOM" (non-component)
side of the board.

Solder runs shown in PINK
are those on the "TOP" (component)
side of the board.

SEE BLOW-UP



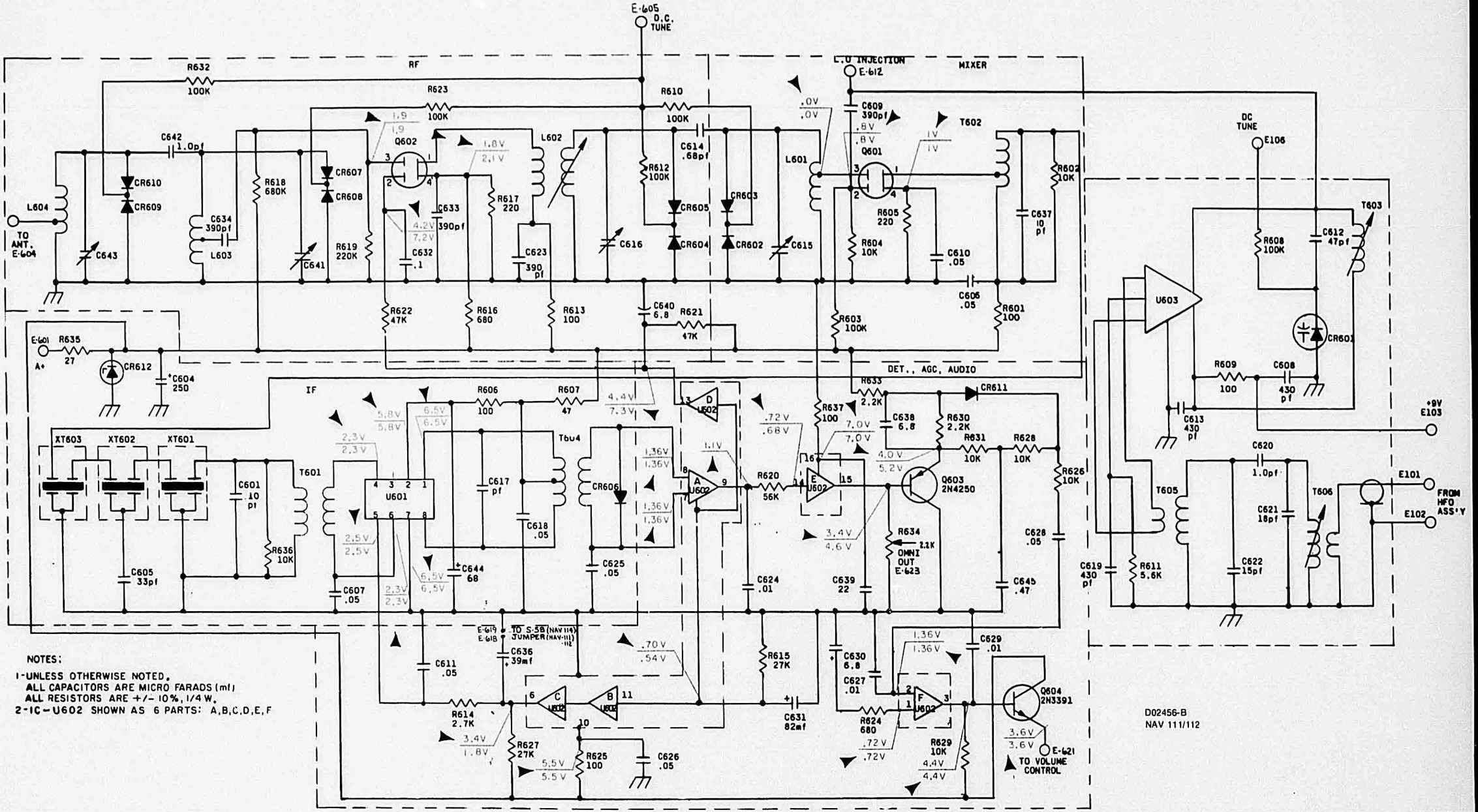
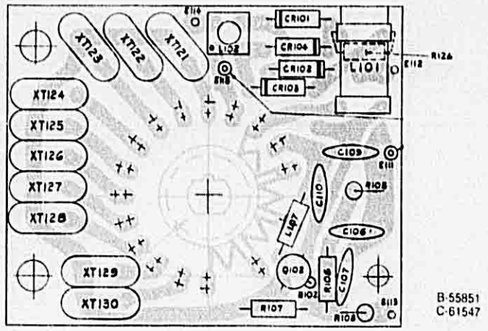
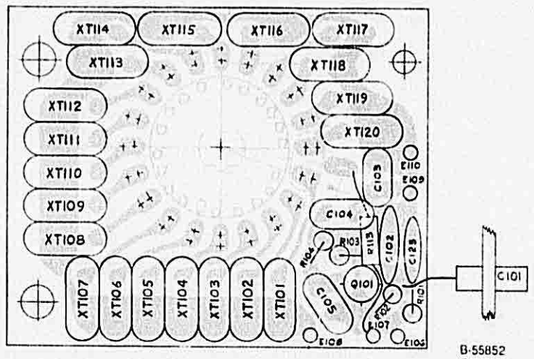
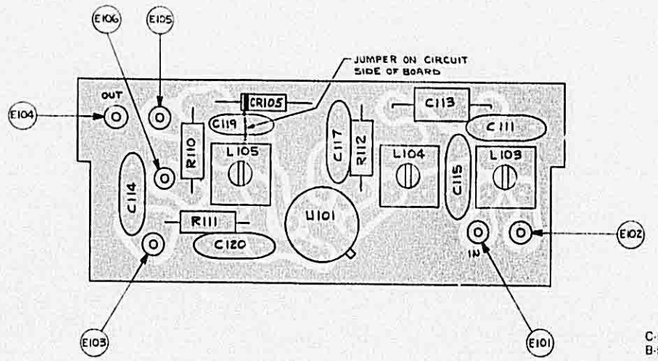


FIGURE 5.6-6A RECEIVER SCHEMATIC (CHASSIS CND219C/CNE219C

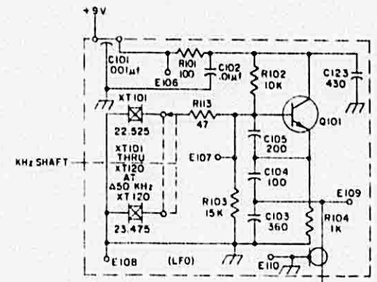
SEE BLOW-UP

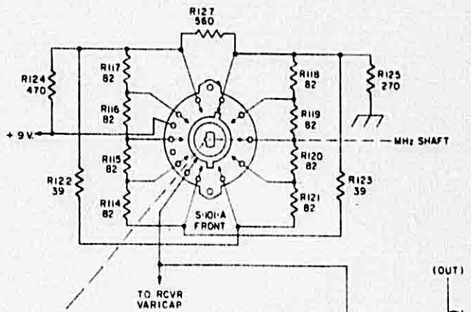


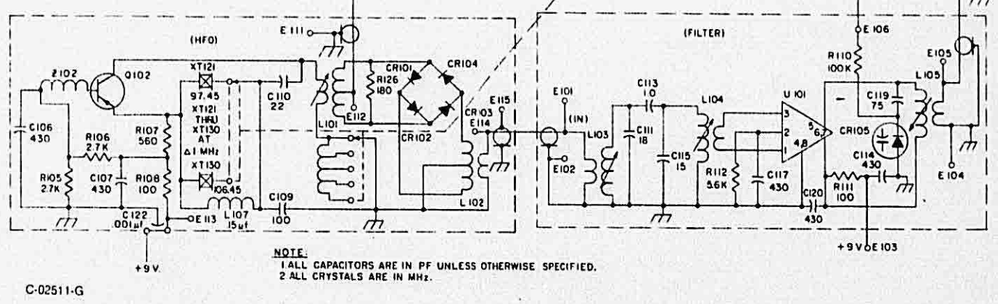




C-55853-D
B-55854-C







C-02511-G

FIGURE 5.6-7 SYNTHESIZER SCHEMATIC, NAV 111 TSO/NAV 112 TSO

SEE BLOW-UP

TABLE OF CONTENTS

SECTION	TOPIC	PAGE	ATP GRID
6	NAV 114 TSO	6-1	2G06
6.1	GENERAL	6-1	
6.2	INSTALLATION	6-1	
6.3	NAV 114 TSO CIRCUIT DESCRIPTION	6-3	2G08
6.3.1	Receiver	6-3	
6.3.2	Connector PC Board Circuits	6-4	2G09
6.3.3	Synthesizer	6-5	2G12
6.4	NAV 114 MAINTENANCE	6-11	2G18
6.4.1	Test Equipment Required for NAV 114 TSO	6-13	2G22
6.4.2	Receiver Troubleshooting	6-13	
6.4.3	NAV 114 TSO Receiver Tuning Procedure	6-16	2H03
6.4.4	Synthesizer Troubleshooting	7-17	2H06
6.5	NAV 114 TSO REPLACEMENT PARTS LIST	6-19	2H08

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE		BLOW-UP FICHE
6.1-1	NAV 114 TSO	6-1	2G06	
6.3-1	NAV 114 TSO Simplified Block Diagram	6-2	2G07	
6.3-2	NAV 114 TSO Receiver Block Diagram	6-3	2G08	
6.3-3	Synthesizer Block Diagram	6-5	2G12	
6.4-1	NAV 114 TSO Interconnections	6-12	2G19	
6.4-2	Ramp	6-18	2H07	
6.5-1	NAV 114 TSO	6-19	2H08	
6.5-2	Connector Board	6-21	2H10	NC F906
6.5-3	Synthesizer Board, NAV 114 TSO	6-23	2H12	NC F906
6.5-4	Receiver Board Assy	6-26	2H15	NC F906
6.6-1	Internal Interconnect Diagram NAV 114 TSO	6-29	2H21	NC F906
6.6-2	Receiver Schematic	6-31	2J02	NC F906
6.6-3	Synthesizer, NAV 114 TSO	6-33	2J11	NC F906
6.6-4	Connector Board Schematic	6-35	2J14	NC F906

LIST OF TABLES

SECTION	TITLE	PAGE
6.4.1	Receiver DC Voltage Measurements	6-14 2G23

The NAV 114 utilizes a newly designed Receiver Board Assembly.

This Assembly is also used in the NAV 14. A similar Receiver Board Assembly is used in the NAV 11/12 and the NAV 111/112, the difference being, these Assemblies have a LO Filter Assy built in.

To determine if this new assembly is in a Unit, check the Chassis Number and the number (in solder) on the board.

Unit	First Used in Units With Chassis No.	Part No. on Solder Side of the Board	Check Component Orientation with Figure No.	Replacement Module Part Number (complete and tested)
NAV 114	CNF219C	59083	6.5-4A	01221-2210

For Information Only:

NAV 11	CNA194E	59083
NAV 12	CNB194E	59083
NAV 14	CNC194E	59083
NAV 111	CND219C	59083
NAV 112	CNE219C	59083

As noted, the NAV 11, 12, 111, 112 all use the same New Receiver Board Assembly, thus they are interchangeable. This Assembly, if necessary, could be used in a NAV 14 or NAV 114, however, the LO Filter would not be connected.

The NAV 14 and NAV 114 use identical Receiver Board Assemblies, thus they are interchangeable unto themselves.

Care must be taken in any interchange as there ARE a few differences in the interconnect wiring. Should a board be removed and replaced, the interconnect wiring should be that equivalent to the Schematic (Figure 6.6-2A).

The basic differences in the new board and the original are in the following areas:

1) additional stage of RF selectivity.
2) an integrated circuit replacing four discrete stages in the IF Amplifier.
3) a different crystal filter.
4) an integrated circuit in the Detector, AGC Amplifier, Audio Amplifier, and OMNI Buffer Stages.

For technical support for the NAV 114, refer to:

Circuit Description,
Section 6.3.1A Receiver
(Chassis CNF219C) page 6-4A.

Maintenance,
Section 6.4.1A Test Equipment Required
(Chassis CNF219C) page 6-14A.
Section 6.4.2A Receiver Troubleshooting
(Chassis CNF219C) page 6-14A.
Section 6.4.3A Tuning Procedure for NAV 114
(Chassis CNF219C) page 6-16A.

Replacement Parts List,
Figure 6.5-4A Receiver and its list.
(Chassis CNF219C) page 6-28A.

Schematic,
Figure 6.6-2A Receiver Schematic
(Chassis CNF219C) page 6-32A.

6.1 GENERAL

This section, Section 6, is devoted to the NAV 114 TSO.

The Narco Avionics NAV 114 TSO is a fully independent NAV receiver designed primarily to drive the Narco Pictorial Navigation Display, the DGO 10. The NAV 114 TSO can also drive an HSI, VOR Converters such as the VOA 100/110, the VOA 40/50, the VOA 8/9, or Narco's CLC-60 RNAV System. The NAV 114 TSO has ARINC output to drive most existing HSI/Flight Director OMNI Converters.

All NAV 114 TSO units have DME channeling capability, refer to Section 2 for wiring details.

6.2 INSTALLATION

All pertinent information pertaining to specifications, licensing, and installation are provided, in detail, in Section 2 of this manual.

FIGURE 6.1-1 NAV 114 TSO

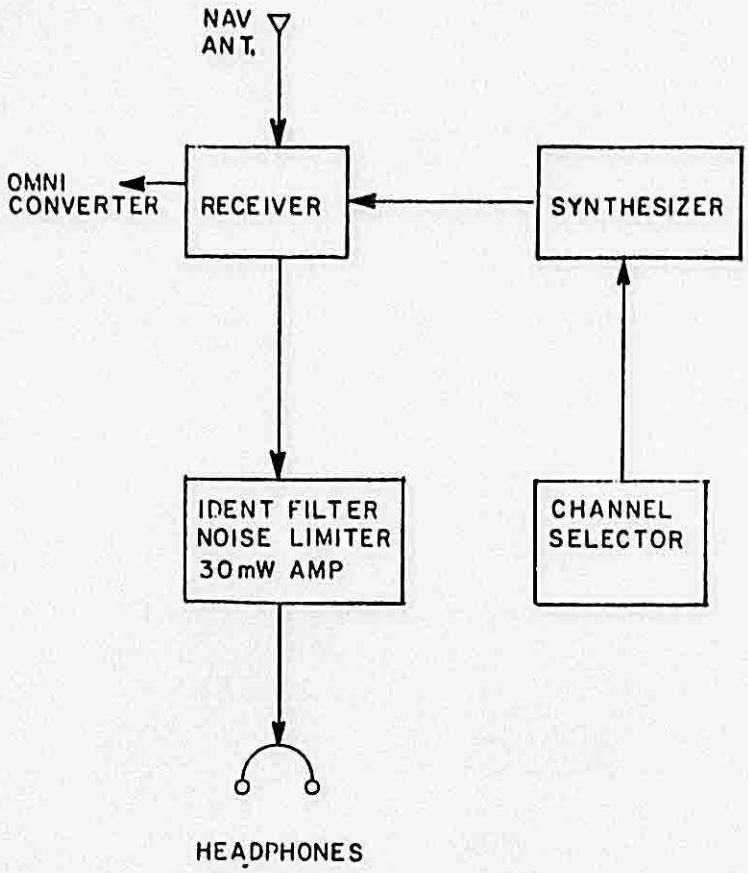


FIGURE 6.3-1 NAV 114 TSO SIMPLIFIED BLOCK DIAGRAM

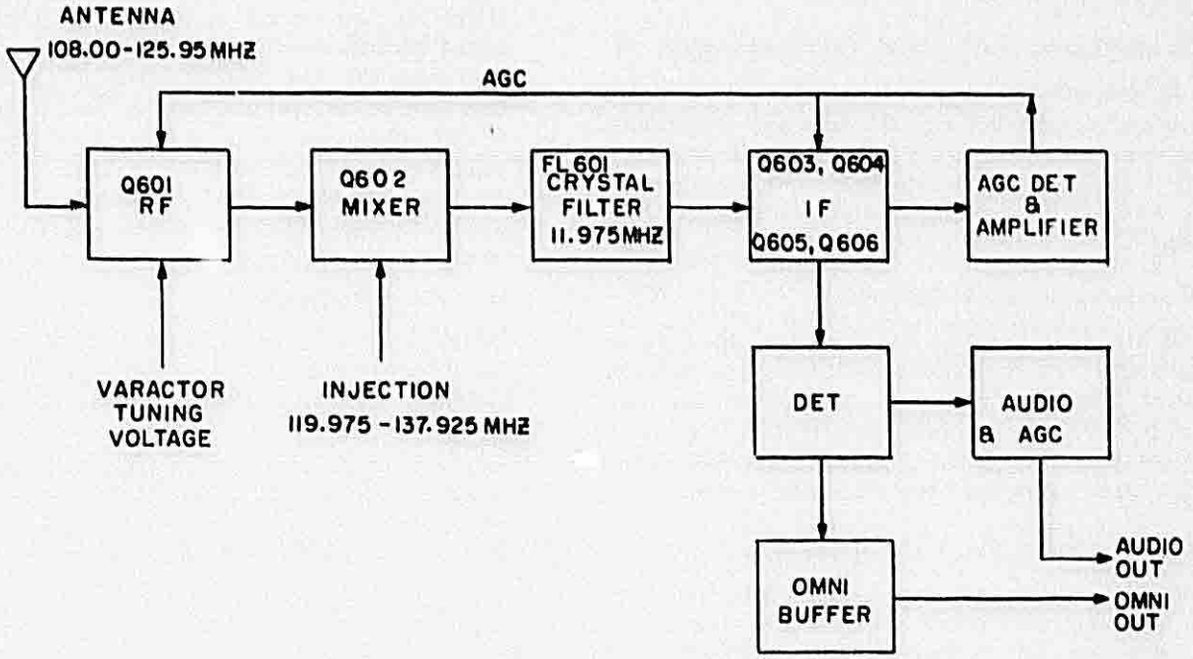


FIGURE 6.3-2 NAV 114 TSO RECEIVER BLOCK DIAGRAM

6.3 NAV 114 TSO CIRCUIT DESCRIPTION

6.3.1 Receiver

A. RF Amplifier, Q601

The RF Amplifier is a dual gate MOS-FET. Both gates of this device are protected (inside the device) so the device is not as susceptible to damage when soldering or unsoldering. The RF input to Q601 (Gate 1, pin 3) is taken from a tap on the RF input coil, L601. The drain, pin 1, is connected to L602 which is connected to A+ thru R606. Gate 2, pin 2, is connected to the AGC buss thru R603. Q614 functions as a dynamic source resistor. Under no signal conditions the AGC buss is approximately 4.5v. This forward bias on Q614 turns the transistor ON hard and it acts as a very low source resistor for the FET. As the AGC buss goes lower (with increasing signal), Q614 starts to turn OFF and its effective resistance goes up. This raises the source voltage. At the same time the Gate 2 voltage is going down. This voltage change (Vg2s) reduces the current in the FET and thus reduces the gain. The input and output tuned circuits are varactor tuned. The control voltage is supplied to the junction of CR602/CR610, CR603/CR611, and CR604/CR612. At the high end of the band this voltage is high thus causing the capacitance of the diodes to be low. This change in capacity tracks the receiver front end. The tuned circuits are aligned by tuning the capacitors (C603, C606, and C608) at the high end of the band; and the inductors, L601 and L602, and L603 at the low end of the band.

B. Mixer, Q602

The Mixer is also a dual gate MOS-FET with both gates protected. The input to the Mixer is taken from the tap on L603 and applied to the input gate (Gate 1, pin 3). VCO injection is applied to Gate 2, pin 2. The VCO injection level is 1.5v p-p. This VCO RF voltage changes the gain of the FET and thus modulates the RF signal input (pin 3). The difference frequency is selected by the crystal filter that is connected to the drain (pin 1) of the Mixer. L604 provides the drain load for the Mixer and C613 is used to tune the input to the crystal filter.

C. IF Filter, FL601

The crystal filter provides the final selectivity of the receiver. The 6 db bandwidth is 34 KHz and the 60 db bandwidth is 84 KHz.

6.3.1 Receiver Continued

D. IF Amplifiers, Q603, Q604, Q605, and Q606

The IF Amplifier consists of four R-C coupled stages. The tuned circuit (L606, C618) at the collector of Q603 is intended to reduce noise in the IF Amplifier. R665 provides degeneration in the last stage and its value may vary depending on the overall gain of the amplifier.

E. Detector and OMNI Buffer

CR605 and CR606 detect the positive half of the IF signal present at the collector of Q606. The detected signal is filtered (C632) and coupled to the omni buffer (Q607). The audio signal that is applied to the omni converters is taken from the variable resistor (R659) to allow the proper level to be set.

F. Audio Amplifier and Audio Leveling

The signal from the emitter of Q607 is coupled to the audio amplifier thru R660. Q608 is the stage to be gain controlled. The output of Q608 is amplified by Q609 and connected to the emitter follower, Q610. R642 is the volume control for the system and the output is tapped off this resistor. The output of Q610 is also connected to Q611. Q611 is used as a peak detector. As the output of Q610 increases, Q611 is turned ON harder. This causes the DC voltage at R645 to increase. This voltage is applied to the cathode of CR613 and tends to back bias the diode as the output of Q611 increases. CR613 is used as a dynamic degeneration resistor for Q608. As CR613 is back biased, the gain of Q608 decreases and the level of the audio output is controlled. Threshold action occurs due to the initial no signal condition of Q608. When no signal is applied, the emitter voltage of Q608 is pulled down due to the current flowing thru CR613. This causes Q608 to be running at a very low current and on the low end of the gain vs current curve. When an audio signal is applied CR613 starts to be back biased and this allows the voltage at the emitter of Q608 to rise slightly and the current thru Q608 to increase. This increases the gain of the stage. If there were no AC degeneration in the stage, the system would oscillate; but, since CR613 degenerates Q608, the system is stable. Thus, as an audio signal is applied, the output first rises rapidly and then remains constant as the input signal increases. R667 is selected to determine the level where the threshold action occurs.

G. AGC Detector and Amplifier

CR607 detects the positive half of the IF signal present at the collector of Q606. The IF signal causes the current flowing thru CR607 to vary as the IF signal varies. The DC return for CR607 is R652 and R666 and the voltage at the base of Q613 will vary as the current thru R652 varies. Thus under no signal conditions the voltage at the base of Q613 allows the transistor to conduct hard and as the IF signal increases this voltage increases and turns the transistor OFF. The voltage at the collector of Q613 is used as the AGC voltage to the RF amplifier and the voltage at the junction of R649 and R650 is used as the AGC voltage to the IF Amplifier.

H. Voltage Regulator

CR608 is an 8.2v Zener diode. The series resistor for the Zener is split and bypassed at the junction of the resistors. This gives added filtering for the regulated voltage.

NOTE: Half of the series resistance and bypassing is located on the Connector Board.

6.3.2 Connector PC Board Circuits

The Connector PC Board contains four separate circuits.

A. Ident Filter (C-702, L-701, R-702)

The Ident Filter filters the 1020 hertz ident signal present in the OMNI signal modulation when in the filter position (pushed in). When the Ident knob is in the Ident position (pulled out), the Ident Filter is used as a tuned circuit to enhance the 1020 signal and reduce the high and low frequency response.

B. Noise Limiter

The Noise Limiter is a peak limiting circuit connected to the high side of the volume control.

As the audio level increases, capacitors C-703 and C-704 charge-up to back bias diodes CR-702 and CR-703 thus allowing the audio to pass undistorted. With no signal (noise only) the Noise Limiter clips more heavily.

C. 30 mw Amplifier

This low level amplifier consists of a voltage amplifier driving a complementary emitter follower (Q-704 and Q-705). Input is coupled in thru a capacitor (C-710) to the base of the voltage amplifier. A feedback voltage divider provides both DC and signal feedback. Two diodes, CR-705/CR-706 provide forward bias for the complementary amplifier. The output is capacity coupled thru C-709.

D. OMNI Amplifier

The equivalent circuit of a NARCO SA 10 amplifier has been added to the NAV 114 to provide an omni output signal compatible in both amplitude and phase with standard ARINC navigation converters. This circuit inverts the phase of the omni signal from the receiver and amplifies the level to approximately .5v rms (combined omni signal).

6.3.1A Receiver (Chassis CMF219C)

A. RF Amplifier (Q602)

The RF Amplifier is a dual gate MOS-FET. Both gates of this device are protected (inside the device) so the device is not as susceptible to damage when soldering or unsoldering.

The RF input to Q602 (Gate 1, pin 3) is taken from a tap on the RF input coil, L603. The drain, pin 1, is connected to L602 which is connected to A+ thru R613. Gate 2, pin 2, is connected to the AGC bus thru R622. Gate 1, pin 3, is biased approximately .7 volts less than the source, pin 4. The source is biased to approximately 2 volts. This fixed bias is applied to the source to allow the voltage on gate 2 to swing below the source voltage and cut-off the RF Amplifier during AGC. The input and output tuned circuits are varactor tuned. The control voltage is supplied to the junction of CR609/610, CR607/608, CR604/605, and CR602/603 thru 100K resistors. At the high end of the band this voltage is high thus causing the capacitance of the diodes to be low. This change in capacity tracks the front end. The tuned circuits are tracked by tuning the capacitors (C643, C641, C616, and C615) at the high end of the band and tuning the inductors (L604, L603, L602, and L601) at the low end of the band.

B. Mixer (Q601)

The Mixer is a dual gate MOS-FET with both gates protected. The input to the Mixer is taken from the tap on L601 and applied to the input gate, pin 3. LO injection is applied to gate 2, pin 2. The level of the LO injection is 1.5 volts p-p. This LO RF voltage changes the gain of the FET and thus modulates the RF signal input. The difference frequency is selected by the Crystal Filter that is connected to the drain, pin 1, of the Mixer. T602 provides the drain load for the Mixer.

C. IF Filter Assy (XT601, XT603, and XT603).

The Crystal Filter Assy provides the final selectivity of the Receiver. The 6 db bandwidth is 34 K Hz and the 60 db bandwidth is 84 K Hz. The tuned circuits on the input (T602, C637) and output (T601, C601) provide the reactive load necessary to minimize the ripple of the Filter.

D. IF Amplifier (U601)

Integrated Circuit U601, the IF Amplifier, takes its input from the secondary of T601 and its output is coupled to the primary of T604. The output supply voltage (DC) is applied to the center tap of T604 and the low level stages of U601 are supplied thru pin 2. Pin 5 is the AGC input. Positive going voltage reduces the gain of the Amplifier.

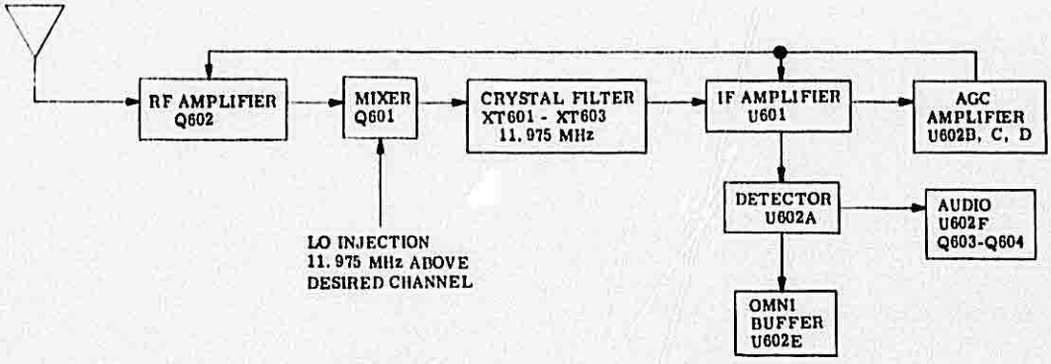


FIGURE 6.3-2A RECEIVER BLOCK DIAGRAM

6.3.1A Continued

E. Detector, OMNI Output (U602* A and E)

The input to the Detector is taken from the secondary of T604. CR606 protects the Detector from overload during transients. The Detector inputs are pins 7 and 8. Pin 9 is the Detector output. The audio at pin 9 is DC coupled to pin 14, the OMNI buffer input. Pin 15 is the OMNI buffer output. R634 is the load for the buffer and the wiper of R634 is the output that goes to the OMNI/LOC circuitry.

F. Audio Amplifier and Noise Limiter (U602* F)

The Audio at pin 15 of U602 is coupled to the Noise Limiter thru emitter follower Q603. The Noise Limiter diode (CR611) is biased to permit the equivalent of 30% modulation to pass undistorted. Any noise impulse exceeding this level will be clipped by the Noise Limiter. The cathode of CR611 is biased thru R631 and R628. C645 filters the audio from the bias network. The anode of CR611 is biased thru R633 and R630. As the current changes thru Q603 (due to RF signal level) the relative bias across CR611 changes to allow less clipping with high RF signals and more clipping only noise present. The output of the Noise Limiter is coupled to the Audio Amplifier (pin 2 of U602) thru R626 and C628. Pin 1 is the emitter of the Amplifier and pin 3 is the collector. Q604 is the emitter follower output that drives the volume control.

G. AGC Amplifier (U602* B, C, and D)

Three sections of U602 comprise the AGC Amplifier. The DC at pin 9 of U602 changes with RF input level. This DC goes positive with increasing signal level. Pin 9 is internally coupled to pin 11, the input to the first DC amplifier. The output of the first DC amplifier is internally connected to the second DC amplifier. Pin 6 is the output of the second DC amplifier. The output of pin 6 goes positive with increasing signal level. This positive going AGC voltage is applied to pin 5 of U601 thru R614. C631 and C636 provide AC filtering of the AGC line. Pin 11 is also internally coupled to a third DC amplifier. Pin 13 is the output of this amplifier. This output goes negative with increasing signal and it is applied to the AGC gate of the RF Amplifier thru R622. C640 provides the filtering for this AGC line.

* U602's multi-functions (Detector, AGC, Audio) for the Receiver are broken-out and identified as symbol numbers U602 A, B, C, D, E, and F. The Block Diagram, Text, and Schematic show these suffixes.

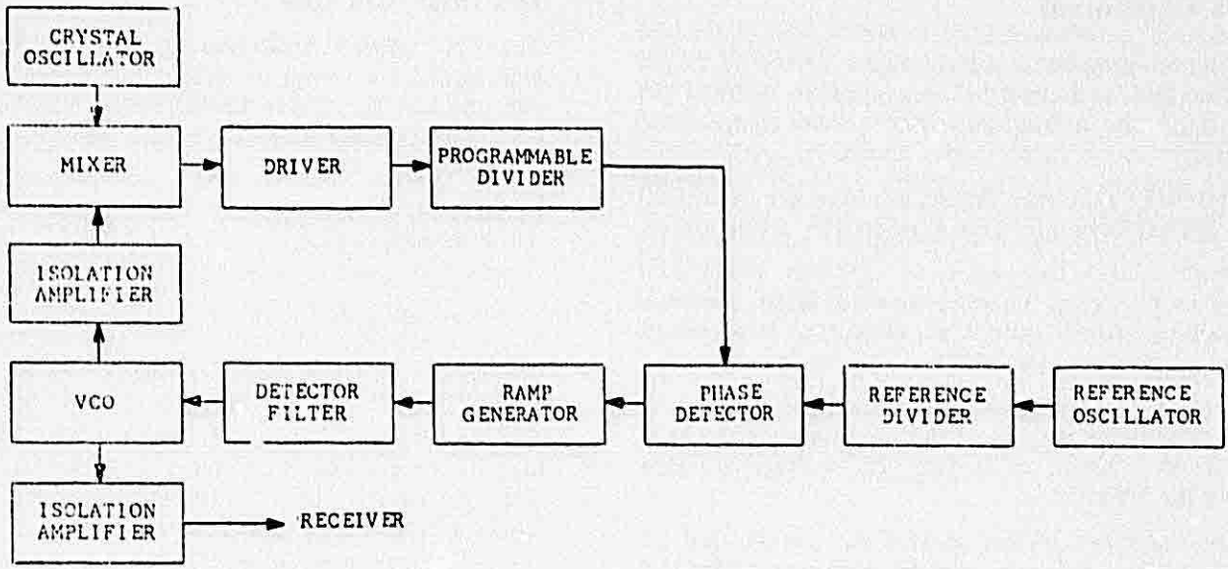


FIGURE 6.3-3 SYNTHESIZER BLOCK DIAGRAM

6.3.3 Synthesizer

Prior to the use of digital techniques, transceivers were tuned to channel by combining the outputs of two or more multiple crystal oscillators and using this resulting output to drive a transmitter or tune the receivers. In the digital synthesizer used in the NAV 114 TSO only one frequency is generated and that is the frequency needed to tune the transmitter or receiver to the correct channel.

The utmost in simplicity could be achieved in transceiver construction if a simple variable oscillator coupled to the tuning dial and readout could be used to set the transceiver on frequency. Unfortunately no oscillator with the desired stability and accuracy is feasible, so some method must be used to set a variable oscillator on channel and maintain it there.

The digital synthesizer is just such a device. A variable oscillator which is voltage tuned is controlled and monitored by digital counting circuits. Outputs from these circuits guide the voltage controlled oscillator (VCO) to the proper channel and maintain the oscillator on that channel.

In order to obtain the needed accuracy the VCO must be compared with the output of a crystal controlled oscillator. A correction voltage is developed to guide and correct the VCO. As a result, the VCO has the accuracy and stability of a crystal controlled oscillator. Rather than compare the crystal and variable oscillators at the operating frequency, the VCO is divided to a frequency of only 50 KHz where it is compared to a 50 KHz crystal reference signal. The correction voltage is developed to guide the VCO to the correct channel and maintain it there. Therefore, it is apparent that simply changing the divider ratio will move the VCO by some predetermined channel spacing.

The Synthesizer functions in the following manner:

A voltage controlled oscillator output in the 119.975 MHz to 137.925 MHz range is hetrodyned against a crystal oscillator to the 10 to 30 MHz range. This signal is then amplified and applied as a drive to the digital variable divider circuits.

The purpose of the variable divider is to reduce any of 360 possible frequencies present at the input to a fixed frequency of 50 KHz. The frequency which is selected by the channel selector knobs will be the one reduced to 50 KHz.

Channel selection is accomplished by programming the variable divider to divide by a value from 242 to 601 and then a control loop forces the voltage controlled oscillator to a frequency which will result in 50 KHz at the variable divide output.

6.3.3 Continued

In order to produce a control signal to the VCO the variable divider output is compared to a fixed 50 KHz signal by a frequency and phase compariator circuit.

The 50 KHz reference signal is produced by a 3.20 MHz crystal oscillator and a reference divide by 64 chain.

Errors in frequency between the 50 KHz reference and variable divider output are converted to a change in tuning voltage to the VCO.

A "control voltage generator" circuit is utilized to convert the pulse outputs of the "frequency and phase compariator" circuit to a pure DC voltage suitable to tune the VCO.

Voltage regulator circuits convert the unregulated 14 vdc input to the 5.4 volts and 8.6 volts needed for the synthesizer circuits. RF output of the synthesizer is used as transmitter drive and receiver local oscillator injection. DC VCO tuning voltage is also fed to the receiver for tuning the receiver front end stages.

A. Logic Symbols and Truth Tables

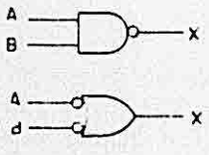
The various types of logic symbols used in the schematics are shown with the associated truth tables.

Two symbols are shown for each gate truth table. The use in the circuit determines which is shown on the schematic.

The small "o" at a terminal indicates a low state at the time of interest.

Two Input NAND Gate

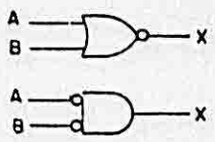
The first symbol illustrates applications where two high inputs are ANDed to produce a low output. The second symbol represents applications where two low inputs are ORed to produce a high output.



A	B	X
0	0	1
1	0	1
0	1	1
1	1	0

Two Input NOR Gate

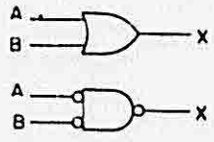
The first symbol illustrates applications where two high inputs are ORed to yield a low output. The second symbol illustrates applications where two low inputs are ANDed to give a high output.



A	B	X
0	0	1
1	0	0
0	1	0
1	1	0

Two Input OR Gate

The first symbol represents applications where two high inputs are ORed to give a high output. The second symbol represents applications where two low inputs are ANDed to give a low output.

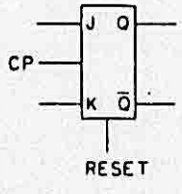


A	B	X
0	0	0
1	0	1
0	1	1
1	1	1

J-K Flip-Flop

The flip-flop triggers on the negative transition of the clock pulse. The time period prior to the negative transition of the clock pulse is denoted t_n, and the time period subsequent to this transition is denoted t_n+1.

When the J and K inputs are high, the flip-flop changes state with each clock pulse. That is, the Q output after the clock pulse will have the same level as the Q output had prior to the clock pulse. If J is low and K is high, the Q output will go low and remain low. If J is high and K is low, the Q output will go high and remain high.



t_n		t_{n+1}
J	K	Q
0	0	Q_n
1	0	1
0	1	0
1	1	$\bar{Q}_n$

6.3.3 Continued

A. Voltage Regulators

Unregulated 14 volts is converted to 5.4 volt and 8.6 volt regulated output by voltage regulator circuits.

Each regulator consists of a series pass transistor (Q121 or Q117) a Zener diode reference voltage (CR118 or CR108), and a monitor amplifier (Q120 or Q119). A driver transistor, Q118 is added to the 5 volt circuit.

A voltage rise of the 14 volt input will cause a rise at a the center arm of voltage adjust potentiometer (R134 or R139) which will be inverted in the corresponding monitor amplifier causing a correction toward proper (5.4 or 8.6v) voltage output.

B. REFERENCE OSCILLATOR AND DRIVER

The reference oscillator Q112 is an untuned Colpitts type oscillator. The oscillator output is amplified by Q113 to a level sufficient to drive the IC divider chain (3v p-p).

C. CRYSTAL OSCILLATOR

Tuned Colpitts type crystal oscillator, Q101, operate with the 7th overtone crystal.

D. VCO

The VCO is a grounded base Colpitts oscillator. The output frequency is determined by L104 in parallel with C124, C125, C126, and tuning diodes CR104 and CR105.

Amplifier, Q106, provides isolation and gain between the VCO and Mixer, Q109. Broadtuned amplifier Q107 is gated by an inhibit circuit which prevents transmitter drive when a malfunction occurs in the Synthesizer also when the Synthesizer is searching during channeling.

E. MIXER AND DRIVER

The Mixer and Driver circuits heterodyne the outputs of the VCO and crystal oscillator to produce the IC drive signal from the difference frequency. Q109 functions as a Mixer, and amplifier C170, L105, and C172 form a matching filter which rejects VHF signals and provides a proper match to Q110 in the 10 to 30 MHz range. Q110 provides voltage gain and Q111 provides current gain to drive ICs U111 and U112. The function of Z104 and Z105 (beads) is to reduce VHF radiation.

6.3.3 Continued

F. Control Voltage Generator

The Control Voltage Generator produces a variable DC control voltage for the VCO from pulse inputs from the Variable Divider and the Reference Divider.

The digital processing section functions on pulses and the VCO is controlled by pure DC. The following method is employed to change pulse information into a pure DC voltage.

To accomplish this transformation an IC gate is wired as a set-reset type flip-flop, U104 which changes alternately as negative going (high toward zero) pulses are fed into pins 9 and 13. The reference channel output will set the flip-flop to high at pin 8 and the variable channel (divide by N) output will reset the output to low at pin 8. A rectangular pulse is thus produced whose length represents the difference in timing between the two channel outputs.

Note that the two channels can take on any given timing difference (or phase difference) yet being identical in PRF (pulse repetition frequency).

One rectangular output of U104 is differentiated and turns Q114 ON causing the voltage at E107 to rise to 8 volts. The other rectangular output of U104 turns Q115 ON and charges C187 thus causing the voltage at E107 to go downward. The voltage will continue downward for the duration of the rectangular pulse. At the end of the pulse the voltage at E107 will level off until Q114 is turned ON again. The end result is a ramp as shown in Figure 6.4-2.

The ramp generator consists of Q114, Q115, R175 (adjustable), and charging capacitor C187. Q114 conducts on the leading negative going pulse from pin 11 of U104. Setting the voltage at E107 to maximum (8.6v) turns Q115 ON and C187 beings charging toward zero, the end of the rectangular output from pin 8 of U104. C187 stabilizes until the next change of U104 when the sawtooth starts again from maximum (8.6v).

Since a DC voltage is required to control to VCO, a lower peak detector is used to convert the ramp to DC. Q116 provides the current amplification necessary and the combination of R179, C190, R182, and C191 provides additional filtering.

G. INHIBIT

When the VCO is not locked on a selected channel, pulses will appear at pin 8 of U110 or pin 8 of U113. These pulses will be passed through CR109 or CR110 and cause C177 to discharge which in turn causes Q122 and Q108 to shut OFF. The VCO buffer stage, Q107, is then non-conducting since its emitter current must flow through Q108.

H. VARIABLE DIVIDER

The Variable Divider can divide an input frequency by an integer from 242 to 601. This is accomplished by three methods: (1) pulse swallowing (2) fixed dividers (3) variable dividers. In this synthesizer the pulse swallowing circuits are part of the fixed dividers. (divide by 2 and divide by 10)

Frequency division is accomplished by feeding an input signal first through a divide by two and pulse swallower then a divide by ten and pulse swallower and finally a divide by 12 to 29 circuit.

The divide by two and pulse swallower consists of U111 (divide by 2) and control flip-flop U112. If U112 is "cocked" by grounding pin 12, a pulse is "missed" by U111 every 20 microseconds thus requiring the input signal to raise by 50 KHz to make-up for the missing pulse. This results in a final VCO frequency of 50 KHz lower due to the conversion of the VCO to 12 to 30 MHz range.

The divide by ten can swallow up to nine pulses by programming the shift register U106 so that up to nine pulses are needed before the shift register outputs will satisfy "NAND" gate U105 and produce a pulse. U106 will continue to satisfy U105 once for every ten pulses applied to pin 10 of U106. Since the input signal has been divided by two, each "swallowed" pulse results in a raise of 100 KHz at the input frequency or up to .9 MHz. Thus the programming of U106 will set the .1 to .9 MHz channels. Again the VCO will go in the opposite direction due to mixing with a crystal oscillator to obtain the digital drive.

At the end of the divide chain is a programmable divider U107 and U108 which can divide by any integer between 12 and 29. Since the input signal has been divided by 20 prior to reaching this divider circuit, every increase by one results in a 20 channel change at the input or 1 MHz. Thus the programming of U107 and U108 will set the whole MHz channels.

6.3.3 Continued

I. REFERENCE DIVIDER

A 3.2 MHz crystal controlled frequency is divided by 64 to produce a 50 KHz reference signal by the reference divider consisting of 3 dual JK flip-flops, Q101, U102, U103 and a NAND gate, U113.

Since the clock pulses are connected to both flip-flop stages in an IC (i.e. U101), then both would change state every time a clock pulse was applied except that pin 6 output of one flip-flop is connected to the JK inputs pin 11 and 12 of the other allowing it to respond only to alternate clock pulses.

A narrow pulse output is desired so NAND gate U113 is used to gate through the output of Q113 once every 64 pulses from Q113.

One half of U113 is used to derive a pulse to drive U104 and the other half to inhibit flip-flop, U101 when the system has not yet "locked on."

6.4 NAV 114 TSO MAINTENANCE

The following procedure may be used to determine which sub-assembly is malfunctioning:

Check each sub-assembly for the proper inputs. If all inputs are present but the proper output is not obtained, then the sub-assembly is defective. If an input is not present, refer to the sub-assembly that generates this input and check it for proper operation.

RECEIVER BOARD

With an RF input from a signal generator modulated at 30% with 1 KHz, the following outputs should be noted:

.10V rms at E-623 with 3 uv input
.30V rms at E-623 with 500 uv input
.7V rms at E-621 with 5 uv input

If these outputs are not present or if any other receiver associated problems are noted (AGC, WEAK AUDIO, WEAK FLAG, etc.) check all receiver inputs.

INPUT	Test Point	From	Level
A+	E-601	CONNECTOR BOARD	10.5 VDC
DC TO VARACTORS	E-605	SYNTHESIZER	4 VDC (108) 7.5 VDC (125)
INJECTION	E-612	SYNTHESIZER	.5-1.0V RMS RF
RF-INPUT	E-604	ANTENNA	(Noted above)

To remove the receiver board, unsolder all connections to pins and remove the four screws.

SYNTHESIZER BOARD

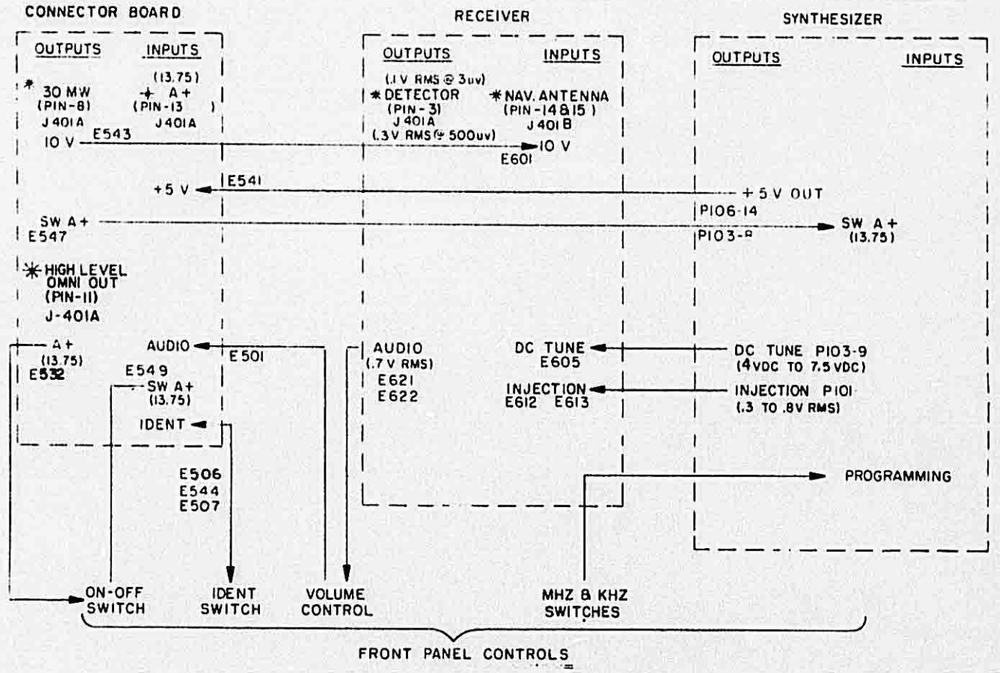
The Synthesizer provides the local oscillator injection to the receiver and the transmitter drive. The synthesizer also generates the DC control voltage for the receiver front end. To check synthesizer operation, connect the output to a counter and check the frequency in receive. The frequency should read 11.975 MHz above the desired channel and in transmit the frequency should be that of the desired channel.

Local oscillator injection level - .5 to 1.0V rms (RF)
DC Control Voltage - 4 VDC (108 MHz) to 7.5 VDC (125 MHz)

If these output are not present or if any other synthesizer problems are noted, check all inputs.

Input	Test Point	From	Level
Programming (Channeling)	A thru L	Front Panel Switches	High (1) 4 VDC + Low (0) .7 VDC -
(Refer to Programming Code)			
A+	P-103(8)	Connector Board	13.75 VDC

To remove Synthesizer Board disconnect J-103, J-104, J-106, P-101 and P-102. (To remove J-103 - first remove screw from Receiver Board.) Remove five screws from Synthesizer Board. Disconnect 1 orange and 1 white/blue lead.



* TO EXTERNAL CONNECTOR

NOTE J401A & J401B ARE REAR CONNECTOR ON UNIT

FIGURE 6.4-1 NAV 114 TSO INTERCONNECTIONS

6.4.1 Test Equipment Required for NAV 114 TSO

(1) DC Power Supply - 15v at 1.5 amps. (for entire unit)
(2) VTVM - RCA Voltohmyst or equivalent.
(3) AC Voltmeter - Ballentine 300D or equivalent.
(4) Hewlett-Packard, HP608 Signal Generator or equivalent.
(5) Resistance Substitution Box
(6) A Counter

6.4.2 Receiver Troubleshooting

If all inputs to the receiver are present but one or both outputs are defective, follow the guide to determine which section of the Receiver Board is malfunctioning. After determining which section is at fault, refer to the schematic and text for that section.

PROBLEM	SECTION
Audio Problems Det. OK	Audio Section (Q608 thru Q612)
Detector Problems No signal - No Noise	IF, Detector Section AGC Section Voltage Regulator Section
Detector Problems No signal - Noise present	RF Section Crystal filter
Detector problems AGC	AGC Section
Selectivity Problems	Crystal Filter RF Section (Varactors)

A. Voltage Regulator

The regulated voltage for the receiver board is supplied by the Zener diode CR608. The series resistance for the Zener is split with a filter capacitor in the center to provide better filtering on the 8.2v Zener. The two series resistors are each 27 ohms. Half of the filter is located on the Interconnect Board.

Always check the 8.2v line before attempting to troubleshoot any section of the Receiver Board.

B. RF Section

Active Devices:

The RF Amplifier and Mixer are described in the Circuit Description Section. To determine if the active devices (Q601 and Q602) are defective, the current thru each device must be measured. To measure the current, place the negative lead of a VTVM on the 8.2 line (the feedthru near the 82mf capacitor) and the positive lead on the drain of each FET (no signal input). Multiply the voltage reading by ten to determine the current in milliamps. This current should be approximately 4-5 milliamps for the RF stage and 2-4 milliamps for the Mixer. Gate 2 can also be checked on each device by monitoring the voltage present at this gate. Any voltage greater than that listed indicates a defective gate. See Table 6.4.1. Gate 1 cannot be checked easily since it is at DC ground potential, but if all other checks indicate the device is good and no signal can be driven thru the device, Gate 1 is probably defective. Both Gate 1 and Gate 2 are protected so there is little probability that they would be defective except under extreme conditions.

B. (1) Varactors

The Varactors can be checked by measuring the DC voltage at the junctions (at the cathode of the varactors). There should be no voltage drop across the 100K ohm resistors feeding the varactors. A voltage drop indicates a defective varactor. If any tuned circuit does not peak, especially if the inductance goes to minimum, an open varactor may be indicated.

B. (2) AGC

The AGC operation of the RF amplifier is described in the Circuit Description Section. The AGC can be checked by measuring the current of the RF amplifier as the input signal is increased. Current readings should start at approximately 4-5 milliamps with no signal and go to approximately zero with a large signal input. If this does no occur, check for a defective Gate 2 or defective Q614. Q614 can be checked by measuring its collector voltage. This voltage should start at approximately .5vdc with no signal and rise to approximately 1.0 with a large signal input.

6.4.2 Continued

C. IF Section
C. (1) Crystal Filter

The Crystal Filter provides the final selectivity for the receiver, the 6 db bandwidth is 34 KHz and the 60 db bandwidth is 84 KHz. The ultimate attenuation of the Crystal Filter is 80 db. This means that as the frequency moves further away from center frequency the rejection will get no better than 80 db.

To determine if a filter is defective, check the insertion loss thru it by first driving an 11.975 signal into the IF Amplifier (at the filter output) and monitor the detector output. After a reference level is obtained, drive the 11.975 MHz signal in the injection port (remove the VCO drive) and ground the source of the mixer. This allows the mixer to function as an amplifier and the filter can be checked without loading it. The approximate level for .10v rms detector output is 5 uv. The filter can be checked for selectivity by measuring adjacent channel rejection. This should be 60 db minimum.

C. (2) Amplifier

The IF Section is described in the Circuit Description Section. If the IF Section is functioning properly there should be some noise at the detector. If there is no noise at the detector, one stage of the IF or the detector is probably defective. The IF stages may be checked by measuring the voltages as listed in Table 6.4.1 The detector and OMNI buffer may be checked in the same manner. If all these voltage checks prove to be right, a faulty bypass might be suspect. This can be checked by monitoring the detector output and bypassing each emitter of all the IF Amplifiers with a .05 mf capacitor. If the noise level comes up significantly when this done, a defective bypass is indicated. Another means of checking the IF stages is by monitoring the detector and driving an 11.975 MHz signal (modulated at 1 KHz) in the base of the last IF stage. With a 10 mv rms signal applied, a .10v rms signal should be seen at the detector. If none is present, this stage would be suspect. If a signal is present, the injected signal can be moved back to the next base and so on, with a gain of approximately 25 db per stage noted. In this manner a defective component may be found.

D. AGC Section

The AGC Detector and Amplifier is described in the Circuit Description Section. If the AGC operation is not functioning, check the DC voltages listed in Table 6.4.1 Check tantalum capacitor (C639) for short circuit. Check CR607 and CR615 (by voltage measurements) and check C641 for an open circuit. Refer to the RF Section (AGC) if all measurements are proper.

TABLE 6.4.1
RECEIVER DC VOLTAGE MEASUREMENTS

Transistor	Pin 1	Pin 2	Pin 3	Pin 4
Q-601(A)	7.5	4.0	0	.6
Q-601(B)	8.0	2.2	0	1.1
Q-602	7.5	.8	0	1.5
	E	B	C	
Q-603(A)	1.0	1.7	3.7	
Q-603(B)	.3	1.0	6.0	
Q-604(A)	1.0	1.7	3.7	
Q-604(B)	.3	1.0	6.0	
Q-605	.8	1.5	4.5	
Q-606	1.6	2.0	4.0	
Q-607	.8	1.4	5.6	
Q-608(A)	6.6	6.0	.3	
Q-608(B)	6.6	6.0	1.0	
Q-609	.1	.6	4.0	
Q610	3.5	4.0	8.0	
Q-611	8.0	8.0	6.0	
Q-612	0	.6	0	SQUELCHED
Q-612	0	0	4.0	NO SQUELCH
Q-613(A)	7.2	6.5	4.0	
Q-613(B)	7.6	7.0	2.2	
Q-614(A)	0	.7	.6	
Q-614(B)	0	.65	1.1	

(A) No signal input
(B) 500 microvolts RF signal input 30% mod @ 1000 Hz

6.4.1A Test Equipment Required for NAV Receiver (Chassis CNF219C)

(1) DC Power Supply - 15v at 1.5 amps. (for entire unit).

(2) VTVM - RCA Voltohmyst or equivalent.

(3) AC Voltmeter - Ballentine 300 D or equivalent.

(4) Hewlett-Packard, HP608 Signal Generator or equivalent.

(5) Resistance Substitution Box.

(6) Sweep Generator, Texscan VS80 or equivalent.

(7) Oscilloscope, Tektronix 533A or equivalent.

6.4.2A Receiver Troubleshooting

If all inputs to the receiver are present but one or both outputs are defective, follow the guide to determine which section of the Receiver Board is malfunctioning. After determining which section is at fault, refer to the schematic and text for that section.

PROBLEM	SECTION
Audio Problems Det. OK	Audio Section Q603, Q604, U602
Detector Problems No signal - No Noise	IF, Detector Section AGC Section Voltage Regulator
Detector Problems No signal -	RF Section Crystal filter
Detector Problems AGC	AGC Section
Selectivity Problems	Crystal Filter RF Section (Varactors)

A. Voltage Regulator

The regulated voltage for the receiver board is supplied by the Zener diode CR608. The series resistance for the Zener is split with a filter capacitor in the center to provide better filtering on the 8.2v Zener. The two series resistors are each 27 ohms. Half of the filter is located on the Interconnect Board.

Always check the 8.2v line before attempting to troubleshoot any section of the Receiver Board.

B. RF Section

Active Devices:

The RF Amplifier and Mixer are described in the Circuit Description Section. To determine if the active devices (Q601 and Q602) are defective, the current thru each device must be measured. To measure the current, place the negative lead of a VTVM on the 8.2 line and the positive lead on the drain of each FET (no signal input). Multiply the voltage reading by ten to determine the current in milliamps. This current should be approximately 4-5 milliamps for the RF stage and 2-4 milliamps for the Mixer. Gate 2 can also be checked on each device by monitoring the voltage present at this gate. Any voltage greater than that listed indicates a defective gate. Refer to the Receiver Schematic. If all other checks indicate the device is good and no signal can be driven thru the device, Gate 1 is probably defective. Both Gate 1 and Gate 2 are protected so there is little probability they would be defective except under extreme conditions.

B. (1) Varactors

The Varactors can be checked by measuring the DC voltage at the junctions (at the cathode of the varactors). There should be no voltage drop across the 100K ohm resistors feeding the varactors. A voltage drop indicates a defective varactor. If any tuned circuit does not peak, especially if the inductance goes to minimum, an open varactor may be indicated.

B. (2) AGC

The AGC can be checked by measuring the current of the RF amplifier as the input signal is increased. Current readings should start at approximately 4-5 milliamps with no signal and go to approximately zero with a large signal input. If this does not occur, check for a defective Gate 2.

6.4.2A Continued

C. IF Section

C. (1) Crystal Filter

The Crystal Filter provides the final selectivity for the receiver, the 6 db bandwidth is 34 KHz and the 60 db bandwidth is 84 KHz. The ultimate attenuation of the Crystal Filter is 80 db. This means that as the frequency moves further away from center frequency the rejection will get no better than 80 db. To determine if a filter is defective, check the insertion loss thru it by first driving an 11.975 signal into the IF Amplifier (at the filter output) and monitor the detector output. After a reference level is obtained, drive the the 11.975 MHz signal in the injection port (remove the VCO drive) and ground the source of the mixer. This allows the mixer to function as an amplifier and the filter can be checked without loading it. The approximate level for .10v rms detector output is 5 uv. The filter can be checked for selectivity by measuring adjacent channel rejection. This should be 60 db, minimum.

To check ripple of the crystal filter, sweep the Receiver either at RF or IF frequency. If the Unit is swept at the IF frequency, the input can be thru the Mixer (remove the jumper connecting the LO to the Mixer).

1. Connect the sweep generator (608) output to the RF input or the Mixer LO input.
2. Connect the horizontal output of the generator to the external horizontal input of the scope.
3. Monitor the OMNI buffer output (wiper of R634) with the vertical input to the scope.
4. Sweep the Receiver and tune T601, T602, and T604 for maximum flat response.

   NOTE:

   Additional attenuation may be necessary to prevent the Unit from developing AGC. If the Unit is in AGC, the swept waveform will be squared-off. Level should be set to allow output at the Detector to just rise out of the noise.

C. (2) U601 IF Amplifier

To check the IF Amplifier, monitor the voltage at the center tap of T604 and pin 2 of U601. Compare these readings to the red voltage readings on the Schematic, Fig. 6.6.2A.

If the device is drawing the proper current, T604 may be defective. The voltage at pin 5 should be less than 3 volts with no signal. If this voltage is much higher than 3 volts, the device will be cut off.

D. Detector, AGC, Audio

U602 may best be checked by measuring the voltage at its terminals. Any problems in the audio **only** may be caused by Q604. Again, voltage measurements should detect a problem in this area.

6.4.2 Continued

E. Audio Section

The Audio Amplifier and Audio AGC circuits are described in the Circuit Description Section. To check the audio circuit, first measure all DC voltages listed on the chart. Be sure to remove the squelch when making the DC measurements. When the problem in the audio section is that of no output, the DC measurements should indicate the defective component. When the problem is weak output or no audio leveling, the DC measurements may not suffice. A defective diode (CR613) may cause weak output. This can be checked by shorting the diode and noting the output. If the output increases to the point of clipping, the diode would be suspect. If C636 were defective, the output would also be weak but the short across CR613 would not cause an increase in output. The audio leveling would malfunction if Q611 and/or CR613 were defective. R667 controls the threshold point of the AGC (that point where maximum gain occurs). If this value is et too low the maximum gain point could occur on noise only. This would cause a poor signal to noise ratio.

The following chart may be used to determine if each section is functioning properly. These levels are nominal values and they may vary slightly from radio to radio. Any major differences (25%) in these levels would indicate a defective section.

SECTION	INPUT	AT	OUTPUT	AT
Audio Section	.15v rms of 1000 Hz	Emitter of Q607	.7v rms	E621
IF Amplifier	5-10 uv at 11.975 MHz with 30% Mod. @ 1000 Hz (Filter disconnected)	E625	.10v rms	E623
Crystal Filter	20 uv @ 11.975 MHz with 30% Mod. @ 1000 Hz	E624	.10v rms	E623
Mixer (as Amplifier) (Source Shorted to GND)	5 uv @ 11.975 MHz with 30% Mod. @ 1000 Hz (injection disconnected)	E612	.10v rms	E623
Mixer (as Mixer)	7 uv @ RF freq. with 30% Mod. @ 1000 Hz	Gate 1 (pin 3 of Q602)	.10v rms	E623
RF	3 uv @ RF freq. with 30% Mod. @ 1000 Hz	E604	.10v rms	E623

6.4.3 NAV 114 TSO Receiver Tuning Procedure

1. Turn DC power supply ON, (A+ 13.75 vdc) and check Zener voltage (8.2v±5%)
2. Connect AC VTVM to OMNI output (E623)
3. Set channel selector to 125.00
4. Set signal generator to 125.00 (zero-beat generator)
5. Set signal generator output level to give a useable indication on AC VTVM
6. Tune C613 and L606 for maximum response (reduce generator level if necessary)
7. Tune C603, C606, and C608 for maximum output on AC VTVM
8. Set channel selector to 108.50
9. Set signal generator to 108.50 and tune L601, L602, and L603 for maximum output
10. Set channel selector to 125.50
11. Set signal generator to 125.50 and tune C603, C606, and C608 for maximum output
12. Repeat steps 8-11 and until no further increase in output is noted
13. Set channel selector and signal generator to 125.50
14. Note change in output (in db) as RF input is varied from 10 to 10K microvolts
15. If output varies by more than 1 db change R666 to bring variation within 1 db (lower value of R666)
    (When adjusting R666 monitor the voltage at the collector of Q604. This voltage should not be lower than 3.5v. If this voltage is lower than 3.5v raise the value of R666)
16. Set RF input to 500 microvolts @ 30% modulation 1000 Hz
17. Set output to .30v rms by adjusting R659 (.30 ±.02v rms)
18. Check output @ 2.0 'uv (.10v rms minimum) if level is less than the minimum allowed, lower the value of the AGC selected "R" (R666) until the minimum is achieved
19. Repeat steps 16-18 until both requirements are met (500 μv level and 2 μv level)
20. Monitor audio output with AC VTVM
21. Set the signal generator to 50 μv @ 20% modulation 1000 Hz
22. Check AGC by varying modulation from 20% to 100%, maximum increase in output = 2 db
23. If output exceeds 2 db increase, lower value of selected "R" (R667)
24. Check AGC action from 2 μv to 10K μv @ 30% modulation 1000 Hz (maximum allowed ±3 db). If output exceeds 3 db increase, lower value of selected "R"
25. Check sensitivity @ 125.50 (2 uv maximum for 6 db S+N/N)
26. Check sensitivity @ 108.50 (2 uv maximum for 6 db S+N/N)
27. Check adjacent channel rejection using AGC voltage as a reference (minimum = 50 db) @ 125.00
28. Check image using AGC as a reference (minimum = 40 db) @ 125.00.

Note: Range of values of R666 and R667 should be:
R666 - 470K to 270K
R667 - 47K to 22K

6.4.3A NAV 114 TSO Receiver Tuning Procedure (Chassis CNF219C)

1. With the Unit connected, sweep the Receiver as described in Section 6.4.2A.
2. After IF is aligned, set the Unit and generator (the 608) to the high end of the band 125.5.
3. Tune C643, C641, C616, and C15 for maximum output at the Detector (wiper of R634).
4. Set Unit and signal generator to 108.50 MHz.
5. Tune L601, L602, and L604 for maximum output at the Detector.
6. Repeat Steps 2 thru 5 until no further improvement in output is noted.
7. Set the signal generator to 10 uv and note the Detector level output.
8. Set the signal generator to 20K uv and again note the Detector level output.
9. If the output exceeds 3 db increase, select R627 to keep the level from changing more than 3 db.
10. After AGC is set, set the generator to 500 uv and adjust R634 for .3 vrms output with 30% modulation at 1 KHz.

6.4.4 Synthesizer Troubleshooting

NAV 114 TSO SYNTHESIZER SUB-ASSEMBLY TEST

A. Rotate MHz dial on NAV 114 TSO and observe stepping voltage at E105 (2.5-4. volts approximately)
B. Counter connected to P101 should read NAV 114 TSO dial frequency −11.975 +.005%.

Regulator Alignment

Set R134 for 5.4 volts at emitter of Q117
Set R139 for 8.6 volts at emitter of Q121

Test - vary input voltage from 11 to 16 volts.

5.4 volts: should not vary more than .3 volts.
8.6 volts: should not vary more than .6 volts.

NOTES:

Accidental shorts will usually damage Q120, Q118, Q119 and not the pass transistor (Q121 or Q117).

The heat sink becomes hot when synthesizer is tested unmounted.

The load on the 5.4v regulator is 510 ma.
The load on the 8.6v regulator is 90 ma.

Reference Oscillator Alignment

Select C186 to produce a frequency of 3200.590 KHz at the collector of Q113. This alignment is necessary if the crystal is replaced.

Test

4 v p-p at collector of Q113 at 3200.590 KHz ± 20 Hertz.

Crystal Oscillator Alignment

Monitor E106 with a high frequency scope or VTVM with an RF probe. Set coil slug to middle on "ON" range for troubleshotting. When synthesizer is in full operation check output frequencies and reset if necessary for:

Synthesizer Output	Frequency Selected
129.975 MHz	118.00 MHz

NOTES: Use only NARCO crystals.
Slugs are cemented to prevent detuning by vibration.

Oscillator output can be monitored with a scope or VTVM equipped with an RF probe at E106. This is a result of the mixing of the crystal and the VCO.

TABLE 6.4.2 Synthesizer Programming

MHz NAV	MHz COM	U115 8	U115 11	U115 3	U115 6	U116 11	U116 3	U116 6	Fractional MHz	U114 8	U114 11	U114 3	U114 6	U116 8
	108	1	1	0	0	1	0	1	.00	1	0	1	1	1
	109	1	1	1	0	0	1	0	.05	0	0	1	1	1
	110	0	1	1	1	0	0	1	.10	1	0	0	1	1
	111	0	0	1	1	1	0	0	.15	0	0	0	1	1
	112	1	0	0	1	1	1	0	.20	1	0	0	0	1
	113	0	1	0	0	1	1	1	.25	0	0	0	0	1
	114	0	0	1	0	0	1	1	.30	1	0	0	0	0
	115	0	0	0	1	0	0	1	.35	0	0	0	0	0
	116	0	0	0	0	1	0	0	.40	1	1	0	0	0
	117	1	0	0	0	0	1	0	.45	0	1	0	0	0
	118	0	1	0	0	0	0	1	.50	1	1	1	0	0
	119	0	0	1	0	0	0	0	.55	0	1	1	0	0
	120	1	0	0	1	0	0	0	.60	1	0	1	1	0
	121	0	1	0	0	1	0	0	.65	0	0	1	1	0
	122	1	0	1	0	0	1	0	.70	1	1	0	1	1
	123	0	1	0	1	0	0	1	.75	0	1	0	1	1
	124	0	0	1	0	1	0	0	.80	1	1	1	0	1
	125	1	0	0	1	0	1	0	.85	0	1	1	0	1
									.90	1	1	1	1	0
									.95	0	1	1	1	0

NOTE: "1" represents above 2 volts
"0" represents below 1 volt
Values in table are inverted from switch inputs.

6.4.4 Continued

VCO Alignment

Proper alignment of the VCO can best be accomplished in a radio with the Synthesizer operational.

(a) Channel radio to 108.00 MHz transmit mode, voltage on feedthru capacitor C136 should be adjusted to 2.5v ±.05v with L104.

(b) Channel radio to 125.95 receive mode, (VCO out at 147.925 MHz) adjust C126 for 5.3 ±.1 volts.

(c) Repeat steps (a) and (b) until both meet proper levels.

Test

Short collector of inhibit switch Q108 to ground to prevent inhibit circuit from turning Q107 OFF. An output of 3 milliwatts (minimum) should appear at P101 in receive mode. Voltage at C136 should vary from approximately 2.5 volts at 108.00 to 5.3 volts at 125.95 in approximately .2 volt steps as the MHz dial is channeled clockwise between two frequencies.

NOTES:

Due to restriction circuits, VCO cannot be tuned to 118.95 unless transmitter key input is grounded.

If the Synthesizer is not operational the VCO can be aligned by removing the VCO control line from E105 and applying proper tuning voltage to the VCO control line.

Adjust T101 for maximum output at 113.00 MHz. This is a very broad tuned circuit and usually does not require adjustment.

Mixer and Drive Test

(a) During normal operation, a 4v p-p signal will be present at E106.
(b) Set channel selector to 108.00, frequency reading should be 30.05 MHz.
(c) Set channel selector to 125.95, frequency reading should be 12.10 MHz.

It is important that the peaks go below .8 volts as measured on a high frequency scope.

NOTE:

If either the VCO or the Crystal Oscillator is not functioning no output will be present at E106.

Control Voltage Generator Alignment

The Synthesizer must be aligned in a working radio or suitable test fixture. Set frequency to 108.00, transmit mode, adjust R175 for the following wave-shape:

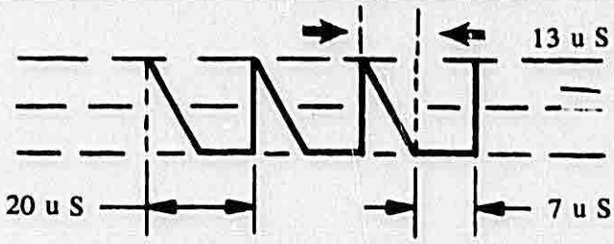


FIGURE 6.4-2. RAMP

NOTE:

Setting of R175 is not critical for troubleshooting, that is, an improperly set R175 will not stop the operation of the unit, however, it must be set properly to ensure reliable operation of the radio.

Inhibit

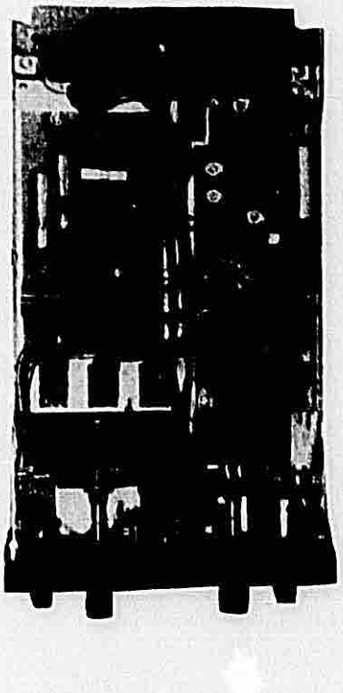
Test
Ground the VCO control line at E105. The output at P101 should drop approximately 20 db.

Variable Divider

Check pin 14 on the 14 pin IC and pin 16 on the 16 pin IC for 5vdc.
Test
Check for 3v minimum p-p at E106.
Check pin 5 of U111 for a square wave (approximately 3 v p-p) output.
Check pin 6 of U105 for negative going pulses.
Check pin 9 of U106 for negative going pulses approximately .1 microsec wide at 20 microsec spacing (during lock).

Reference Divider

Test
Check pin 1 of U101 for 4v p-p at 3.2 MHz.
Check pin 8 of U101 for approximately 3v p-p at .8 MHz.
Check pin 8 of U102 for approximately 3v p-p at .2 MHz.
Check pin 8 of U103 for approximately 3v p-p at .05 MHz.
NOTE - If system is not locked, remove U113 to perform the test.



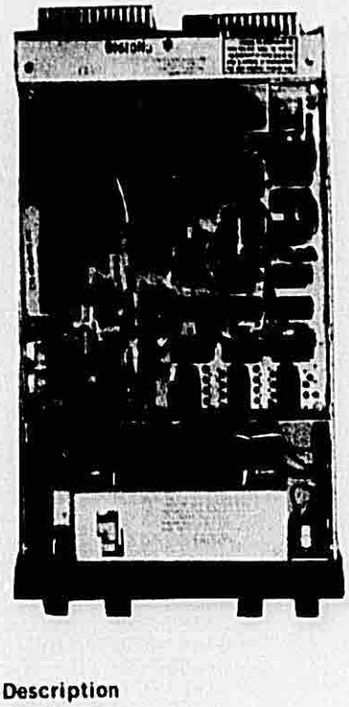
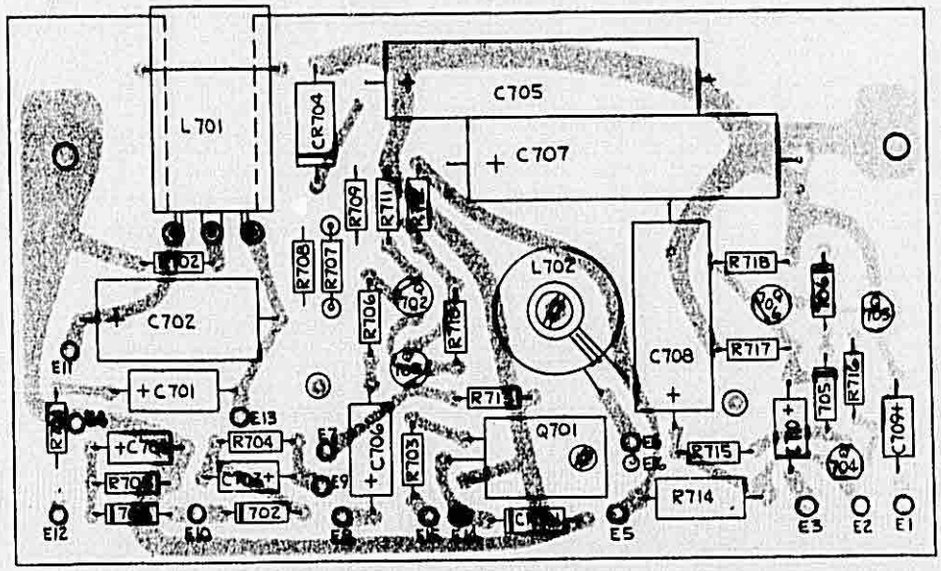


Fig & Index No.	Part Number	Description
6.5-1	01175-0102	NAV 114 TSO WITH DME CHANNELING
	56230-0106	TRAY ASSEMBLY
	57651-0101	FRONT PANEL ASS'Y SPOTWELD
	57652-0001	DRUM, MHz
	57653-0001	DRUM, KHz
	57654-0001	BRACKET, DRUM
	81307-0060	WASHER, DRUM
	57655-0101	GEAR & HUB ASS'Y
R642, S2	32059-0005	RESISTOR, VARIABLE (With DPST Switch)
	57656-0001	SHAFT, IDENT
S8	61528-0005	SWITCH, SLIDER (DPDT)
	54978-0004	SCREW, LOCKING, HEX
	54949-0001	CAM, LOCK
	82920-0013	NUT, LOCKING, REDUCED HEX
	81312-0019	WASHER, SPRING
	55941-0001	PANEL, TRIM
	55942-0001	LENS
	57648-0102	CHASSIS MAIN ASS'Y SPOTWELD
	57657-0001	COVER, TOP
	57658-0001	COVER, BOTTOM
	61585-0101	SWITCH ASS'Y & DETENT 18 POS. MHz S4, S5, S6
	61585-0102	SWITCH ASS'Y & DETENT 20 POS. KHz S1, S2, S3
	01147-0103	RECEIVER BOARD (See Fig. 6.5-4 for breakdown)
	01146-0103	SYNTHESIZER BOARD (See Fig. 6.5-3 for breakdown)
	01176-0101	CONNECTOR BOARD (See Fig. 6.5-2 for breakdown)
	57643-0101	BOARD, CONNECTOR, 30 PIN
	57644-0001	BOARD, CONNECTOR, 15 PIN
	82017-0001	CABLE, TIE
	57659-0001	BRACKET, STABILIZER BOARD
	04396-0001	PATENT NOTICE
	04432-0001	LABEL, WARNING
	04069-0001	LABEL, FCC CERTIFICATION
	83017-0005	INSULATOR
	41130-0004	PLUG PHONO (MALE)
	81206-0167	SPACER, BOARD CONNECTOR (LG.)
	81206-0168	SPACER, BOARD CONNECTOR (SHORT)
	81206-0169	SPACER, BOARD CONNECTOR (MED.)

FIGURE 6.5-1 NAV 114 TSO

Fig. & Index No.	Part Number	Description
C651	21291-0005	CAPACITOR, CERAMIC DISC .01 mf, 50V
	82819-0103	SCREW, MACH, #4-40 x 1/4, FLAT HEAD, SLOTTED
	82958-0002	SCREW, MACH, #4-40 x 3/16, PAN HEAD, SL, TAPTITE
	82962-0002	SCREW, MACH, #4-40 x 3/16 PAN HEAD, SL, (SEMS)
	82960-0002	SCREW, THD. CUTTING, #4-40 x 3/16, PAN HEAD, SL, (SEMS)
	82963-0001	SCREW, MACH, #2-56 x 1/8, PAN HEAD, SL, (SEMS)
	82889-0001	SCREW, SFT., HEX SOCKET, #4-40 x 3/32
	82814-0003	SCREW, MACH, #4-40 x 1/4, BINDING HEAD, SL
	82922-0001	NUT, HEX, #4-40, (KEPS)
	81290-0003	NUT, "U"
	81702-0004	LUG, SOLDER
	82814-0010	SCREW, MACH, #4-40 x 7/8, BINDING HEAD, SL
	81352-0001	NUT, FLUSH, SELF-CLINCHING, #2-56
	82813-0002	SCREW, MACH, #2-56 x 3/16, PAN HEAD, SL
	12000-0015	LAMP, INCADESCENT, #336
	81747-0012	FILTER, COLORED, (BLUE)
	11454-0005	FERRITE BEAD
	91018-0055	TUBING, PLASTIC, EXTRUDED
	41278-0008	LAMPHOLDER, SUBMINIATURE
	41322-0001	SOCKET, IC SOLDER TAIL
	81192-0014	RING, RETAINING (TRUARC)
	56289-0001	SPRING, GROUNDING
	82802-0057	LOCKWASHER
	04487-0002	LABEL, TRIM PANEL, NAV-114 TSO
	04486-0003	INSERT, LABEL, TRIM PANEL, NAV-114 TSO
	04488-0002	INSERT, KNOB, TSO'd
	04482-0002	LABEL, TRAY
	04485-0003	LABEL, NAMEPLATE
	82814-0011	SCREW, MACH, #4-40 x 1 BINDING HEAD, SLOTTED
	88209-0001	KNOB, MHz - KHz TSO
	88208-0001	KNOB, VOLUME & SQUELCH
C801	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C802	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C803	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C804	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C805	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C806	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C807	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C808	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C809	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C810	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C811	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C812	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C813	21291-0005	CAPACITOR, .01 mf, 50V
C814	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C815	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C816	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C817	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C818	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C819	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C820	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C821	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C822	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C823	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C824	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C825	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C826	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C827	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C828	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C829	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C830	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C831	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C832	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C833	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C834	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C835	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C836	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C837	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C838	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
CR801	75204-0045	RECTIFIER, SILICON
CR802	75204-0045	RECTIFIER, SILICON
CR803	75204-0045	RECTIFIER, SILICON
CR804	75204-0045	RECTIFIER, SILICON

Fig. & Index No.	Part Number	Description
6.5-2	01176-0101	CONNECTOR BOARD (See Fig. 6.5-1 for NHA)
	81307-0012	WASHER, FIBER
	82864-0008	SCREW, MACH, #4-40 x 5/8, RD HD, SLOTTED, (NYLON)
	82922-0001	NUT, HEX, #4-40 (KEPS)
	82814-0003	SCREW, MACH, #4-40 x 1/4 BD HD, SLOTTED
C701	21555-0026	CAPACITOR, TANTALUM, 10MF, 20V
C702	23100-0013	CAPACITOR, POLYCARB, 1.0 MF
C703	21555-0016	CAPACITOR, TANTALUM, 3.3 MF, 15V
C704	21555-0016	CAPACITOR, TANTALUM, 3.3MF, 15V
C705	21554-0003	CAPACITOR, ELECTROLYTIC, 200MF, 15V
C706	21555-0011	CAPACITOR, TANTALUM, 39MF, 10V
C707	21554-0044	CAPACITOR, ELECTROLYTIC, 500MF, 15V
C708	21554-0051	CAPACITOR, ELECTROLYTIC, 250MF, 20V
C709	21555-0016	CAPACITOR, TANTALUM, 3.3MF, 15V
C710	21555-0016	CAPACITOR TANTALUM, 3.3MF, 15V
CR701	75204-0045	DIODE, SILICON
CR702	75028-0001	DIODE, SILICON
CR703	75028-0001	DIODE, SILICON
CR704	75025-0003	DIODE, ZENER, 11V
CR705	75028-0001	DIODE, SILICON
CR706	75014-0001	DIODE, GERMANIUM
L702	11527-0001	CHOKE, FILTER
L701	11488-0001	IDENT, FILTER
Q701	75576-0002	TRANSISTOR
Q702	75595-0003	TRANSISTOR, 2N5172
Q703	75595-0003	TRANSISTOR, 2N5172
Q704	75558-0005	TRANSISTOR, 2N5810
Q705	75558-0006	TRANSISTOR, 2N5811
Q706	75595-0003	TRANSISTOR, 2N5172
R701	31192-0331	RESISTOR, CARBON 330 ±10%, 1/4W
R702	31192-0271	RESISTOR, CARBON 270 ±10%, 1/4W
R703	31192-0472	RESISTOR, CARBON 4.7K ±10%, 1/4W
R704	31192-0183	RESISTOR, CARBON 18K ±10%, 1/4W
R705	31192-0183	RESISTOR, CARBON 18K ±10%, 1/4W
R706	31192-0223	RESISTOR, CARBON 22K ±10%, 1/4W
R707	31192-SEL	RESISTOR, CARBON SELECTED ±10%, 1/4W
R708	31195-0753	RESISTOR, CARBON 75K ±5%, 1/4W
R709	31192-0103	RESISTOR, CARBON 10K ±10%, 1/4W
R710	31192-0472	RESISTOR, CARBON 4.7K ±10%, 1/4W
R711	31192-0102	RESISTOR, CARBON 1K ±10%, 1/4W
R712	31192-0471	RESISTOR, CARBON 470 ±10%, 1/4W
R713	31192-0472	RESISTOR, CARBON 4.7K ±10%, 1/4W
R714	31196-0003	RESISTOR, WIREWOUND 27 ±5%, 2W
R715	31192-0222	RESISTOR, CARBON 2.2K ±10%, 1/4W
R716	31192-0682	RESISTOR, CARBON 6.8K ±10%, 1/4W
R717	31192-0102	RESISTOR, CARBON 1.0K ±10%, 1/4W
R718	31192-0820	RESISTOR, CARBON 82 ±10%, 1/4W



C-57688-B

FIGURE 6.5-2 CONNECTOR BOARD

SEE BLOW-UP

Fig and Index No.	Part Number	Description
6.5-3	01146-0103	SYNTHESIZER BOARD ASSY, NAV 114 TSO (See Fig. 6.5-1 for NHA)
	55950-0001	HEATSINK
	55956-0001	SHIELD, VCO
	55961-0001	COVER, VCO
	55874-0001	SPRING FINGER
	74903-0001	I. C. SOCKET LOCATER, 14 PIN
	52726-0001	TRANSPAD
	99065-0004	TAPE, DOUBLE SIDED
	82814-0004	SCREW MACH. #4-40 x 5/16 BND. HD. SLOTTED
	82922-0001	NUT, HEX #4-40 (KEPS)
	81335-0015	INSULATOR, SHOULDER
	55850-0001	CAN, SHIELD
	55864-0001	CAN, SHIELD
C108	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C109	24516-0569	CAPACITOR, CERAMIC DISC, 5.6 pf 500V, NPO
C110	24516-0180	CAPACITOR, CERAMIC DISC, 18 pf ±10%, 500V, NPO
C111	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C112	24516-0569	CAPACITOR, CERAMIC DISC, 5.6 pf, 500V, NPO
C113	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf, ±10%, 500V
C114	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C112	21291-0005	CAPACITOR, CERAMIC DISC, .01 mf ±20%, 50V
C123	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C124	24516-0479	CAPACITOR, CERAMIC DISC, 4.7 pf, 500V, NPO
C125	24052-0150	CAPACITOR, DIPPED MICA, 15 pf, ±10%, 500V, NPO
C126	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C127	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C128	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C129	21555-0016	CAPACITOR, TANTALUM, 3.3 mf, ±10%, 15V
C130	24052-SEL.	CAPCITOR, DIPPED MICA, SEL.
C131	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C132	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C133	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf, ±10%, 500V
C134	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C135	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C136	21296-0003	CAPACITOR, CERAMIC FEED-THRU, .001 mf, 500V
C137	21555-0012	CAPACITOR, TANTALUM, 82 mf ±10%, 10V
C138	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C162	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C163	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-164	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-165	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-166	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-167	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-168	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-169	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-170	24516-0180	CAPACITOR, CERAMIC DISC, 18 pf ±10%, 500V
C-171	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-172	24516-0100	CAPACITOR, CERAMIC DISC, 10 pf ±10%, 500V
C-173	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-174	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-175	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-176	21556-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C-177	21291-0005	CAPACITOR, CERAMIC DISC, .01 mf ±20%, 50V
C-178	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-179	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-180	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-181	24049-0471	CAPACITOR, DIPPED MICA, 470 pf ±5%, 500V
C-182	24049-0251	CAPACITOR, DIPPED MICA, 250 pf ±5%, 500V
C-183	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-184	21555-0003	CAPACITOR, TANTALUM 47 mf ±10%, 6V
C-185	24049-0331	CAPACITOR, DIPPED MICA, 330 pf ±5%, 500V
C-186	24052-SEL.	CAPACITOR, DIPPED MICA, SEL ±5%, 500V
C-187	23094-0155	CAPACITOR, MYLAR, .0022 mf ±10%, 200V
C188	23094-0155	CAPACITOR, MYLAR, .0022 mf ±10%, 200V
C-189	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-190A	23094-0187	CAPACITOR, MYLAR, 1.0 mf ±10%, 200V
C-190B	23094-0187	CAPACITOR, MYLAR, 1.0 mf ±10%, 200V
C-191	21555-0026	CAPACITOR, TANTALUM, 10 mf ±10%, 20V
C-192	24516-0100	CAPACITOR, CERAMIC DISC, 10 pf ±10% 500V
C-193	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-194	21291-0024	CAPACITOR, CERAMIC DISC, 270 pf ±10%, 500V
C-195	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-197	21555-0018	CAPACITOR, TANTALUM, 22mf ±10%, 15V
C-198	24515-0005	CAPACITOR, CERAMIC DISC, .05 ±20%, 10V

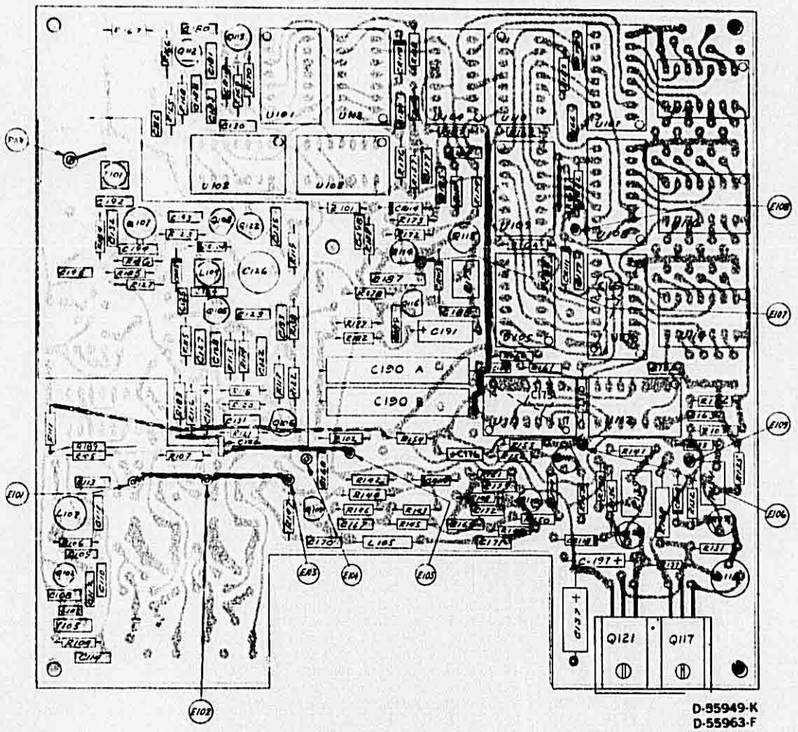


FIGURE 6.5-3 SYNTHESIZER BOARD ASSY, NAV 114 TSO

SEE BLOW-UP

List 6.5-4 Continued

Fig. & Index No.	Part Number	Description
CR-104	75037-0002	DIODE, VAR. CAP.
CR-105	75037-0002	DIODE, VAR. CAP.
CR-108	75027-0010	DIODE, ZENER, ±5%, 2.6, 1N702A
CR-109	75019-0004	DIODE, SILICON
CR-110	75019-0004	DIODE, SILICON
CR-111	75019-0004	DIODE, SILICON
CR-112	75019-0004	DIODE, SILICON
CR-113	75019-0004	DIODE, SILICON
CR-114	75019-0004	DIODE, SILICON
CR-115	75019-0004	DIODE, SILICON
CR-118	75027-0004	DIODE, ZENER, ±5%, 5.6V, 1N752A
CR-119	75036-0001	DIODE, SILICON
L-102	11713-0013	COIL, P.S., BLACK
L-104	11756-0001	COIL, VCO
L-105	11451-0011	CHOKE, RF, 2.2 uh
L-107	11752-0001	COIL, CRYSTAL OSC.
L-110	11485-0020	COIL, R.F. 3.9 uh
Q-102	75802-0001	TRANSISTOR, NPN
Q-105	75802-0003	TRANSISTOR, NPN
Q-106	75802-0004	TRANSISTOR, NPN
Q-107	75802-0005	TRANSISTOR, NPN
Q-108	75802-0006	TRANSISTOR, NPN
Q-109	75802-0007	TRANSISTOR, NPN
Q-110	75802-0008	TRANSISTOR, NPN
Q-111	75802-0009	TRANSISTOR, PNP
Q-112	75802-0010	TRANSISTOR, NPN
Q-113	75802-0011	TRANSISTOR, NPN
Q-114	75802-0012	TRANSISTOR, PNP
Q-115	75802-0013	TRANSISTOR, NPN
Q-116	75802-0014	TRANSISTOR, PNP
Q-117	75802-0015	TRANSISTOR, NPN
Q-118	75802-0016	TRANSISTOR, NPN
Q-119	75802-0017	TRANSISTOR NPN
Q-120	75802-0018	TRANSISTOR, NPN
Q-121	75802-0019	TRANSISTOR, NPN
Q-122	75802-0020	TRANSISTOR, NPN
R-104	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W
R-105	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-106	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
R-107	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-113	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-114	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-115	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-116	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-117	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-118	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-119	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-120	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-121	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-122	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-123	31192-0470	RESISTOR, CARBON, 47 ±10%, ¼W
R-127	31192-0473	RESISTOR, CARBON, 47K ±10%, ¼W
R-131	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-132	31192-0820	RESISTOR, CARBON, 82 ±10%, ¼W
R-133	31192-0181	RESISTOR, CARBON, 180 ±10%, ¼W
R-134	32054-0013	RESISTOR, VARIABLE, 220
R-135	31192-0821	RESISTOR, CARBON, 820 ±10%, ¼W
R-136	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R-137	31192-0152	RESISTOR, CARBON, 1.5K ±10%, ¼W
R-138	31141-0109	RESISTOR, CARBON, 1.0 ±10%, ½W
R-139	32054-0001	RESISTOR, VARIABLE, 470
R-140	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W
R-141	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-142	31192-0680	RESISTOR, CARBON, 68 ±10%, ¼W
R-143	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-144	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-145	31192-0680	RESISTOR, CARBON, 68 ±10%, ¼W
R-146	31192-0681	RESISTOR, CARBON, 680 ±10%, ¼W

List 6.5-4 Continued

Fig. & Index No.	Part Number	Description
R-147	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-148	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-149	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-150	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-151	31192-0221	RESISTOR, CARBON, 220 ±10%, ¼W
R-152	31192-0822	RESISTOR, CARBON, 8.2K ±10%, ¼W
R-153	31192-0122	RESISTOR, CARBON, 1.2K ±10%, ¼W
R-154	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-155	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-156	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-157	31192-0333	RESISTOR, CARBON, 33K ±10%, ¼W
R-158	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-159	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-160	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-161	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-162	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-163	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-164	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-165	31192-0223	RESISTOR, CARBON, 22K ±10%, ¼W
R-166	31192-0223	RESISTOR, CARBON, 22K ±10%, ¼W
R-167	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-168	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼ W
R-169	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-170	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-171	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-172	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-173	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-174	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-175	32054-0009	RESISTOR, CARBON, VARIABLE, 1K
R-176	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-177	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-178	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R-179	31192-0332	RESISTOR, CARBON, 3.3K ±10%, ¼W
R-182	31192-0680	RESISTOR, CARBON, 68 ±10%, ¼W
R-183	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-184	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-185	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-186	31192-0331	RESISTOR, CARBON, 330 ±10%, ¼W
R-187	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-188	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-189	31192-0822	RESISTOR, CARBON, 8.2K ±10%, ¼W
T-101	11757-0001	TRANSFORMER, VCO OUTPUT
U-101	75802-0021	INTEGRATED CIRCUIT
U-102	75802-0022	INTEGRATED CIRCUIT
U-103	75802-0023	INTEGRATED CIRCUIT
U-104	75802-0024	INTEGRATED CIRCUIT
U-105	75802-0025	INTEGRATED CIRCUIT
U-106	75802-0026	INTEGRATED CIRCUIT
U-107	75802-0027	INTEGRATED CIRCUIT
U-108	75802-0028	INTEGRATED CIRCUIT
U-109	75802-0029	INTEGRATED CIRCUIT
U-110	75802-0030	INTEGRATED CIRCUIT
U-111	75802-0031	INTEGRATED CIRCUIT
U-112	75802-0032	INTEGRATED CIRCUIT
U-113	75802-0033	INTEGRATED CIRCUIT
U-114	75802-0034	INTEGRATED CIRCUIT
U-115	75802-0035	INTEGRATED CIRCUIT
U-116	75802-0036	INTEGRATED CIRCUIT
Y-101	72032-0001	CRYSTAL, 3.20066 MHz FUND.
Y-103	72031-0004	CRYSTAL, 150.027 MHz 7th O. T.
P-101	41292-0001	JACK, PHONO
P-104	41313-0003	SOCKET, I. C. WIRE WRAP 14 PIN
P-105	41313-0003	SOCKET, I.C. WIRE WRAP 14 PIN
P-106	41313-0003	SOCKET, I.C. WIRE WRAP 14 PIN
Z-101	11454-0001	BEAD (Qty 2)
Z-102	11454-0001	BEAD (Qty 2)
Z-103	11454-0001	BEAD (Qty 2)
Z-104	11454-0001	BEAD
Z-105	11454-0001	BEAD

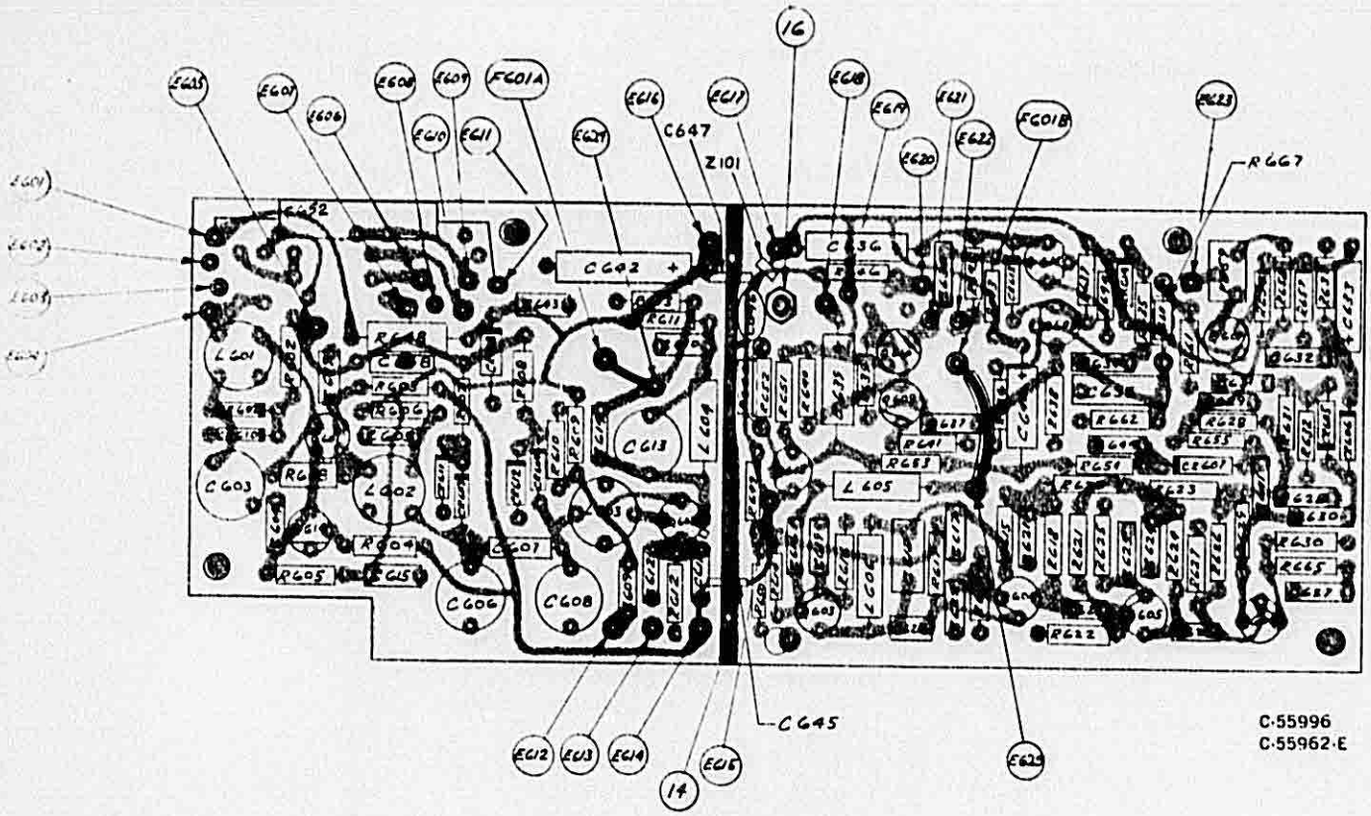


Fig. & Index No.	Part Number	Description
6.5-4	01147-0103	RECEIVER BOARD ASSY (See Fig. 6.5-1 for NHA)
	55969-0001	SHIELD
	82922-0001	NUT, HEX, #4-40
	81214-0012	SPACER, GENERAL (PHENOLIC)
	55849-0001	SPACER, FILTER
	56485-0001	CLIP, GROUNDING
C-603	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-604	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-605	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-606	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-607	24509-0228	CAPACITOR, CERAMIC, .22 pf ±5%, 500V
C-608	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-609	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-610	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-611	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-612	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-613	22041-0002	CAPACITOR, VARIABLE 9 to 35 pf
C-614	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-615	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-616	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-617	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-618	24049-0511	CAPACITOR, DIPPED MICA, 510 pf ±5%, 500V
C-619	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-620	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-621	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-622	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-623	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-624	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-625	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V

FIGURE 6.5-4 RECEIVER BOARD ASSY

SEE BLOW-UP

Fig. & Index No.	Part Number	Description
C-626	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-627	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-628	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-629	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf, ±5%, 10V
C-630	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-631	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-632	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-633	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C-634	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-635	23094-0171	CAPACITOR, MET. MYLAR, .047 mf ±10%, 200V
C-636	21555-0011	CAPACITOR, TANTALUM, 39 mf ±10%, 10V
C-637	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-638	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-639	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C-641	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-642	21555-0012	CAPACITOR, TANTALUM, 82 mf ±10%, 10V
C-643	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-644	21291-0021	CAPACITOR, CERAMIC DISC, .001 mf ±20%, 1000V
C-645	21296-0003	CAPACITOR, FEED THRU CERAMIC .001 mf GMV, 500V
C-646	24515-0001	CAPACITOR, CERAMIC DISC, .1 mf ±20%, 10V
C-647	21296-0003	CAPACITOR, FEED THRU CERAMIC .001 mf GMV, 500V
C-648	21291-0025	CAPACITOR, CERAMIC DISC, 930 pf ±10%, 500V
C-649	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-650	21555-0011	CAPACITOR, TANTALUM, 39 mf ±10%, 10V
C-651	21515-0010	CAPACITOR, CERAMIC DISC, .02 mf, 50V
CR-602	75037-0001	DIODE, TUNING
CR-603	75037-0001	DIODE, TUNING,
CR-604	75037-0001	DIODE, TUNING,
CR-605	75028-0001	DIODE, SILICON
CR-606	75028-0001	DIODE, SILICON
CR-607	75028-0001	DIODE, SILICON
CR-608	75025-0002	DIODE, ZENER, 8.2V ±5%, 1W
CR-610	75037-0001	DIODE, TUNING,
CR-611	75037-0001	DIODE, TUNING,
CR-612	75037-0001	DIODE, TUNING,
CR-613	75028-0001	DIODE, SILICON
CR-614	75028-0001	DIODE, SILICON
CR-615	75028-0001	DIODE, SILICON
FL-601	11751-0002	FILTER, CRYSTAL, 11.975 MHz
L-601	11753-0002	COIL, TUNED SLUG, (RF INPUT)
L-602	11754-0001	COIL, TUNED SLUB, (RF OUTPUT)
L-603	11755-0001	COIL, TUNED SLUB, (MIXER INPUT)
L-604	11138-0015	CHOKE, RF, 6.8 uh ±10%
L-606	11834-0001	CHOKE, TUNEABLE
Q-601	75611-0002	TRANSISTOR, FET, N CHANNEL (MOTOROLA SL119)
Q-602	75611-0002	TRANSISTOR, FET, N CHANNEL (MOTOROLA SL119)
Q-603	75588-0003	TRANSISTOR, NPN, 2N3662
Q-604	75588-0003	TRANSISTOR, PNP, 2N3662
Q-605	75588-0003	TRANSISTOR, NPN, 2N3662
Q-606	75588-0003	TRANSISTOR, NPN, 2N3662
Q-607	75595-0003	TRANSISTOR, NPN, 2N5172
Q-608	75565-0006	TRANSISTOR, PNP, 2N5356
Q-609	75595-0003	TRANSISTOR, NPN, 2N5172
Q-610	75595-0003	TRANSISTOR, NPN, 2N5172
Q-611	75565-0006	TRANSISTOR, PNP, 2N5356
Q-613	75565-0006	TRANSISTOR, PNP, 2N5356
Q-614	75595-0003	TRANSISTOR, NPN, 2N5172

Fig. & Index No.	Part Number	Description
R-602	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-603	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-604	31192-0273	RESISTOR, CARBON, 27K ±10%, ¼W
R-605	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-606	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-607	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-608	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-609	31192-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-610	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-611	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-612	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-613	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-614	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-615	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-616	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-617	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-618	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-619	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-620	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-621	31192-0822	RESISTOR, CARBON, 8.2K ±10%, ¼W
R-622	31192-0332	RESISTOR, CARBON, 3.3K ±10%, ¼W
R-623	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-624	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-625	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-626	31192-0562	RESISTOR, CARBON, 5.6K ±10%, ¼W
R-627	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-628	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-629	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-630	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-631	31192-0472	RESISTOR, CARBON, 4.7K ±10%, ¼W
R-632	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-633	31192-0273	RESISTOR, CARBON, 27K ±10%, ¼W
R-634	31192-0473	RESISTOR, CARBON, 47K ±10%, ¼W
R-635	31192-0154	RESISTOR, CARBON, 150K ±10%, ¼W
R-636	31192-0564	RESISTOR, CARBON, 560K ±10%, ¼W
R-637	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-638	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-639	31192-0155	RESISTOR, CARBON, 1.5M ±10%, ¼W
R-640	31192-0123	RESISTOR, CARBON, 12K ±10%, ¼W
R-641	31192-0331	RESISTOR, CARBON, 330 ±10%, ¼W
R-643	31192-0682	RESISTOR, CARBON, 6.8K ±10%, ¼W
R-644	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W
R-645	31192-0683	RESISTOR, CARBON, 68K ±10%, ¼W
R-646	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-648	31196-0003	RESISTOR, CARBON, 27 ±5%, 2W
R-649	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-650	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-651	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-652	31192-0474	RESISTOR, CARBON, 470K ±10%, ¼W
R-653	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-654	31192-0153	RESISTOR, CARBON, 15K ±10%, ¼W
R-655	31192-0272	RESISTOR, CARBON, 2.7K ±10%, ¼W
R-657	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-658	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-659	32054-0009	RESISTOR, CARBON, VARIABLE, 1K
R-660	31192-0683	RESISTOR, CARBON, 68K ±10%, ¼W
R-661	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W
R-662	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R-665	31192-0330	RESISTOR, CARBON 33 ±10%, ¼W
R-666	31192-SEL.	RESISTOR, CARBON, SEL. ±10%, ¼W
R-667	31192-SEL.	RESISTOR, CARBON, SEL. ±10%, ¼W
R-668	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W
R671	31192-0391	RESISTOR, CARBON, 390 ±10%, ¼W
Z-101	11454-0001	FERRITE BEAD

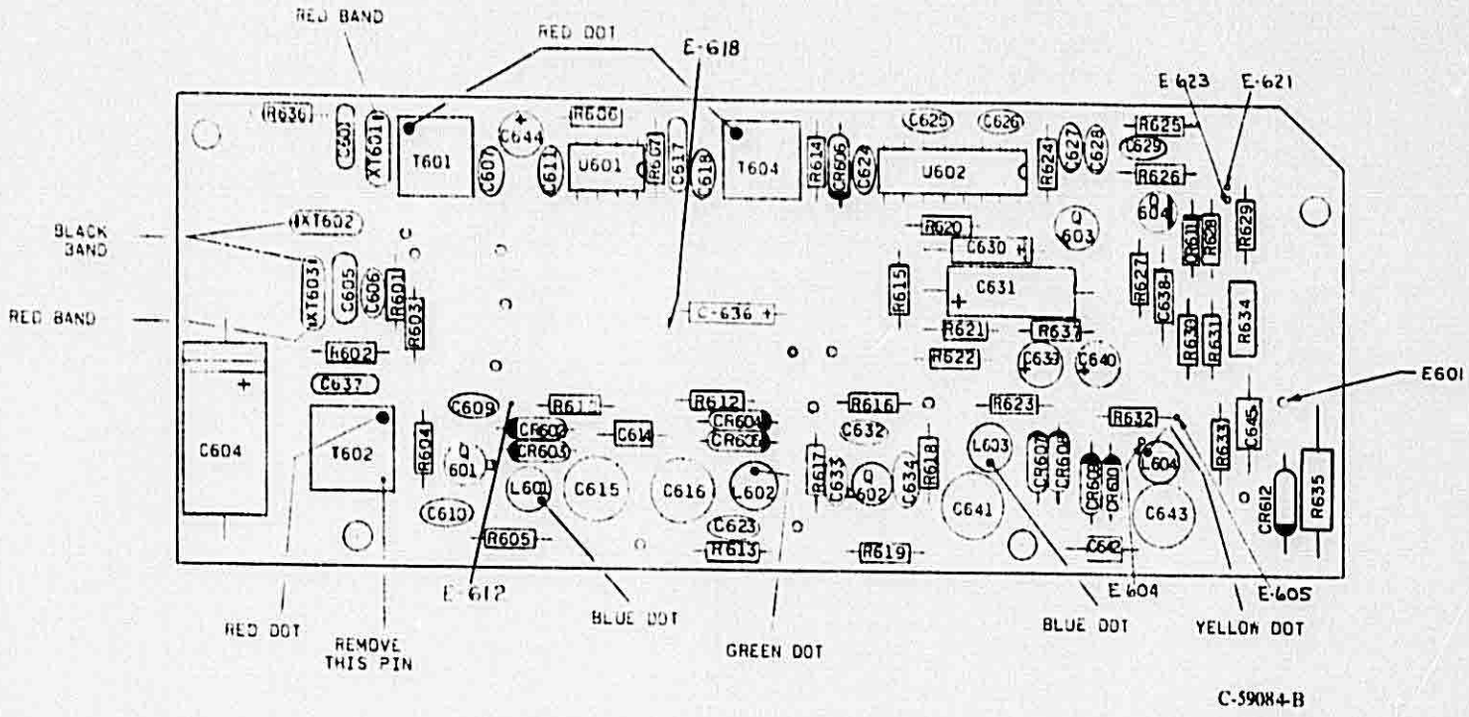


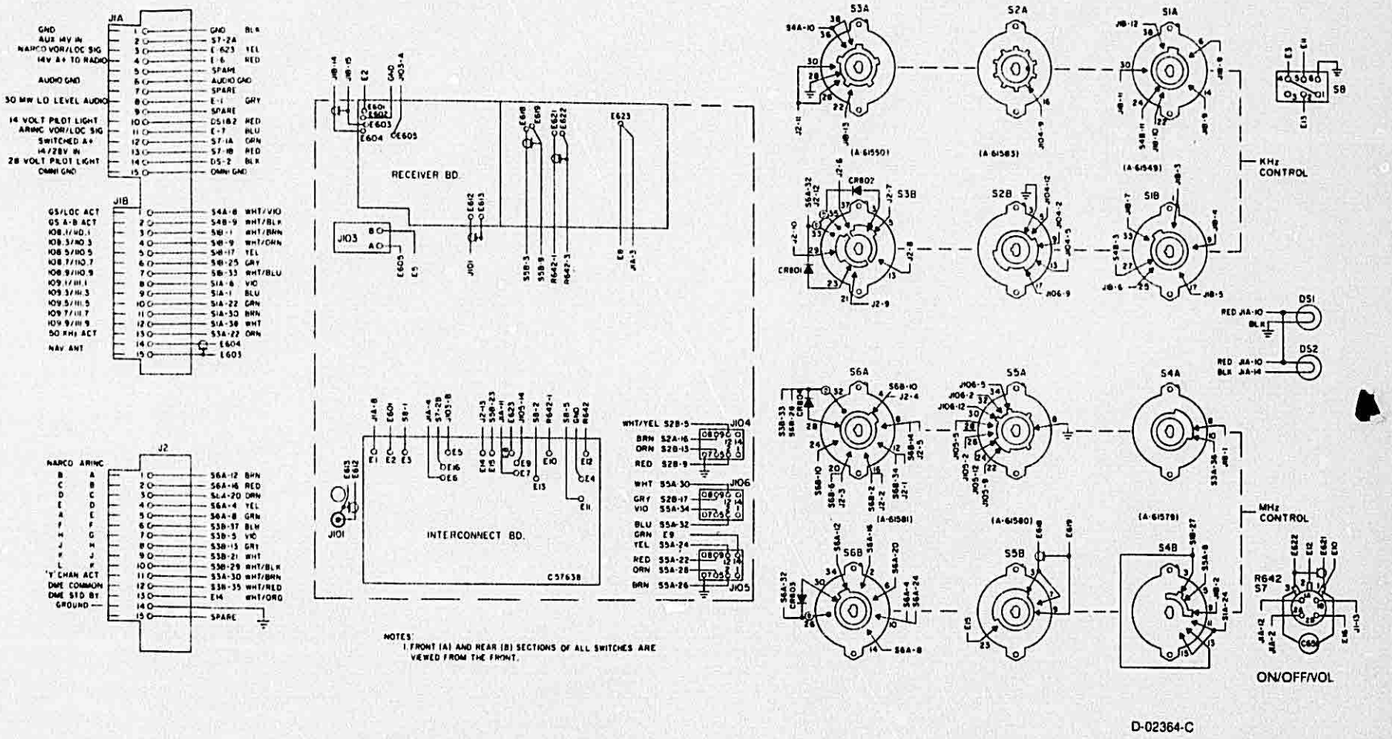
FIGURE 6.5-4A. RECEIVER PC BOARD - NAV 114

Symbol	Part Number	Description
	55850-2	CAN, SHIELD
C601	24052-100	CAPACITOR, Dipped Mica, 10 pf ±1 pf, 500V
C604	21554-51	CAPACITOR, Electrolytic, 250 mf, 20V
C605	24052-330	CAPACITOR, Dipped Mica, 33 pf ±5%, 500V
C606	24515-5	CAPACITOR, Ceramic Disc, .05 mf ±20%, 10V
C607	2415-5	CAPACITOR, Ceramic Disc, .05 mf ±20%, 10V
C609	21291-31	CAPACITOR, Ceramic Disc, 390 pf ±10%, 500V
C610	24515-5	CAPACITOR, Ceramic Disc, .05 mf ±20%, 10V
C611	24515-5	CAPACITOR, Ceramic Disc, .05 mf ±20%, 10V
C614	24509-688	CAPACITOR, Ceramic Tub, .68 pf ±5%, 500V
C615	22051-2	CAPACITOR, Variable, 1.3-5.4 pf
C616	22051-2	CAPACITOR, Variable, 1.3-5.4 pf
C617	24052-150	CAPACITOR, Dipped Mica 15 pf ±1 pf, 500V
C618	2415-5	CAPACITOR, Ceramic Disc, .05 mf ±20%, 10V
C623	21291-31	CAPACITOR, Ceramic Disc, 390 pf ±10%, 500V
C624	21291-30	CAPACITOR, Ceramic Disc, .01 mf ±20%, 50V
C625	24515-5	CAPACITOR, Ceramic Disc, .05 mf ±5%, 10V
C626	24515-5	CAPACITOR, Ceramic Disc, .05 mf ±5%, 10V
C627	21291-30	CAPACITOR, Ceramic Disc, .01 mf ±20%, 50V
C628	24515-5	CAPACITOR, Ceramic Disc, .05 mf ±5%, 10V
C629	21291-30	CAPACITOR, Ceramic Disc, .01 mf ±20%, 50V
C630	21555-58	CAPACITOR, Tantalum, 6.8 mf ±10%, 35V

SEE BLOW-UP

Symbol	Part Number	Description
C631	21555-12	CAPACITOR, Tantalum, 82 mf ±10%, 10V
C632	23107-125	CAPACITOR, Mylar, .1 mf ±10%, 100V
C633	21291-31	CAPACITOR, Ceramic Disc, 390 pf ±10%, 500V
C634	21291-31	CAPACITOR, Ceramic Disc, 390 pf ±10%, 500V
C636	21555-11	CAPACITOR, Tantalum, 39 mf ±10%, 10V
C637	24052-100	CAPACITOR, Dipped Mica, 10 pf ± pf, 500V
C638	21555-2	CAPACITOR, Tantalum, 6.8 mf ±10%, 6V
C639	21564-120	CAPACITOR, Tantalum, 22 mf ±10%, 10V
C640	21564-117	CAPACITOR, Tantalum, 6.8 mf ±10%, 10V
C641	22053-1	CAPACITOR, Variable, 2.5/5 pf, 63V
C642	24509-109	CAPACITOR, Ceramic Tub., 1.0 pf ±5%, 500V
C643	22053-1	CAPACITOR, Variable, 2.5/5 pf, 63V
C644	21564-37	CAPACITOR, Tantalum, 68 mf ±10%, 10V
C645	21555-44	CAPACITOR, Tantalum, .47 mf ±10%, 35V
CR602	75037-1	DIODE, Varactor
CR603	75037-1	DIODE, Varactor
CR604	75037-1	DIODE, Varactor
CR605	75037-1	DIODE, Varactor
CR606	75038-2	DIODE, R F Switch
CR607	75037-1	DIODE, Varactor
CR608	75037-1	DIODE, Varactor
CR609	75037-1	DIODE, Varactor
CR610	75037-1	DIODE, Varactor
CR611	75028-1	DIODE, Silicon
CR612	75025-6	DIODE, Zener, 7.5V
L601	11847-1	COIL, (Mixer Input)
L602	11846-1	COIL, (RF Output)
L603	11847-1	COIL, (RF Input)
L604	11845-1	COIL, (Ant. Input)
Q601	75611-s	TRANSISTOR, FET
Q602	75611-s	TRANSISTOR, FET
Q603	75565-6	TRANSISTOR, 2N4250
Q604	75550-22	TRANSISTOR, 2N3391
R601	31192-101	RESISTOR, Carbon, 100 ±10%, 1/4W
R602	31192-103	RESISTOR, Carbon, 10K ±10%, 1/4W
R603	31192-104	RESISTOR, Carbon, 100K ±10%, 1/4W
R604	311-103	RESISTOR, Carbon, 10K ±10%, 1/4W
R605	31192-221	RESISTOR, Carbon, 220 ±10%, 1/4W
R606	31192-101	RESISTOR, Carbon, 100 ±10%, 1/4W
R607	31192-470	RESISTOR, Carbon, 47 ±10%, 1/4W
R610	31192-104	RESISTOR, Carbon, 100K ±10%, 1/4W

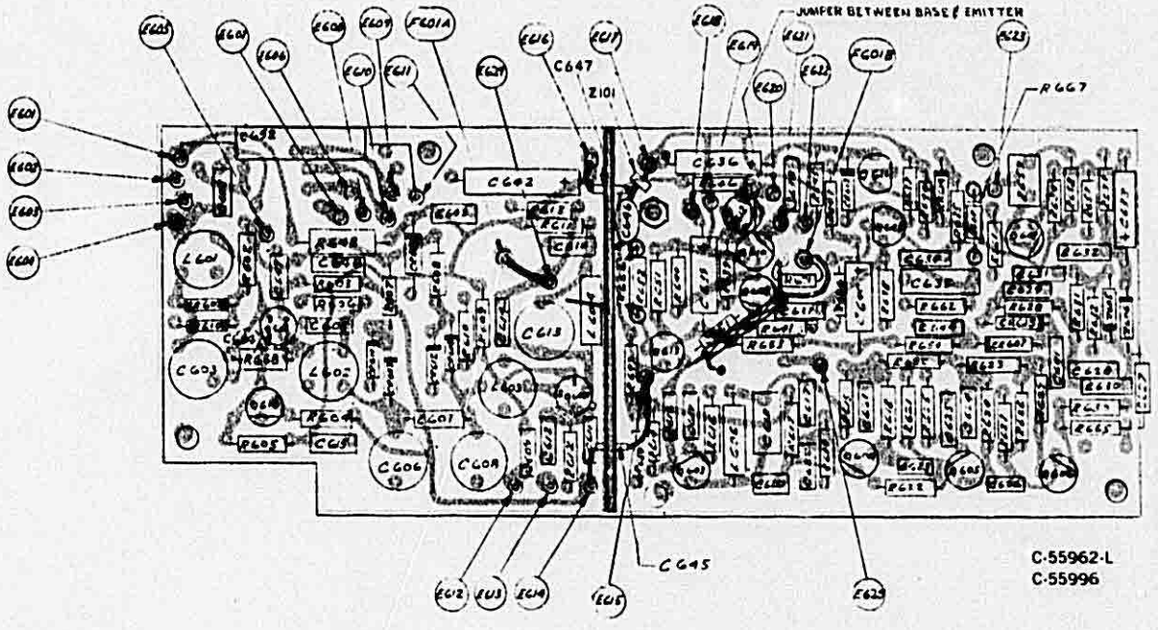
Symbol	Part Number	Description
R612	31192-104	RESISTOR, Carbon, 100K ±10%, 1/4W
R613	31192-101	RESISTOR, Carbon, 100K ±10%, 1/4W
R614	31192-272	RESISTOR, Carbon, 2.7K ±10%, 1/4W
R615	31192-273	RESISTOR, Carbon, 27K ±10%, 1/4W
R616	31192-681	RESISTOR, Carbon, 680 ±10%, 1/4W
R617	31192-221	RESISTOR, Carbon, 220 ±10%, 1/4W
R618	31192-684	RESISTOR, Carbon, 680K ±10%, 1/4W
R619	31192-224	RESISTOR, Carbon, 220K ±10%, 1/4W
R620	31192-563	RESISTOR, Carbon, 56K ±10%, 1/4W
R621	31192-473	RESISTOR, Carbon, 47K ±10%, 1/4W
R622	31192-473	RESISTOR, Carbon, 47K ±10%, 1/4W
R623	31192-104	RESISTOR, Carbon, 100K ±10%, 1/4W
R624	31192-681	RESISTOR, Carbon, 680 ±10%, 1/4W
R625	31192-101	RESISTOR, Carbon, 100 ±10%, 1/4W
R626	31192-103	RESISTOR, Carbon, 10K ±10%, 1/4W
R627	31192-273	RESISTOR, Carbon, 27K ±10%, 1/4W
R628	31192-103	RESISTOR, Carbon, 10K ±10%, 1/4W
R629	31192-103	RESISTOR, Carbon, 10K ±10%, 1/4W
R630	31192-222	RESISTOR, Carbon, 2.2K ±10%, 1/4W
R631	31192-103	RESISTOR, Carbon, 10K ±10%, 1/4W
R632	31192-104	RESISTOR, Carbon, 100K ±10%, 1/4W
R633	31192-222	RESISTOR, Carbon, 2.2K ±10%, 1/4W
R634	32054-25	RESISTOR, Variable, 2.2K
R635	31196-3	RESISTOR, Wirewound, 27, 3W
R636	31192-103	RESISTOR, Carbon, 10K ±10%, 1/4W
R637	31192-101	RESISTOR, Carbon, 100 ±10%, 1/4W
T601	11868-2	INDUCTOR, IF
T602	11868-2	INDUCTOR, IF
T604	11868-2	INDUCTOR, IF
U601	74028-1	IC, MC1350P
U602	74099-1	IC, CA3088
XT601 XT602 XT603	43207-1	CRYSTAL, Filter, 11.975 MHz,(3 sections XT601, XT602, XT603)



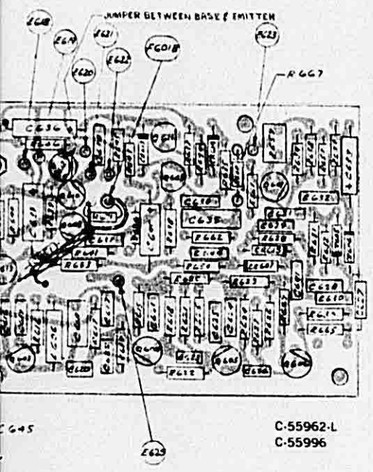
D-02364-C

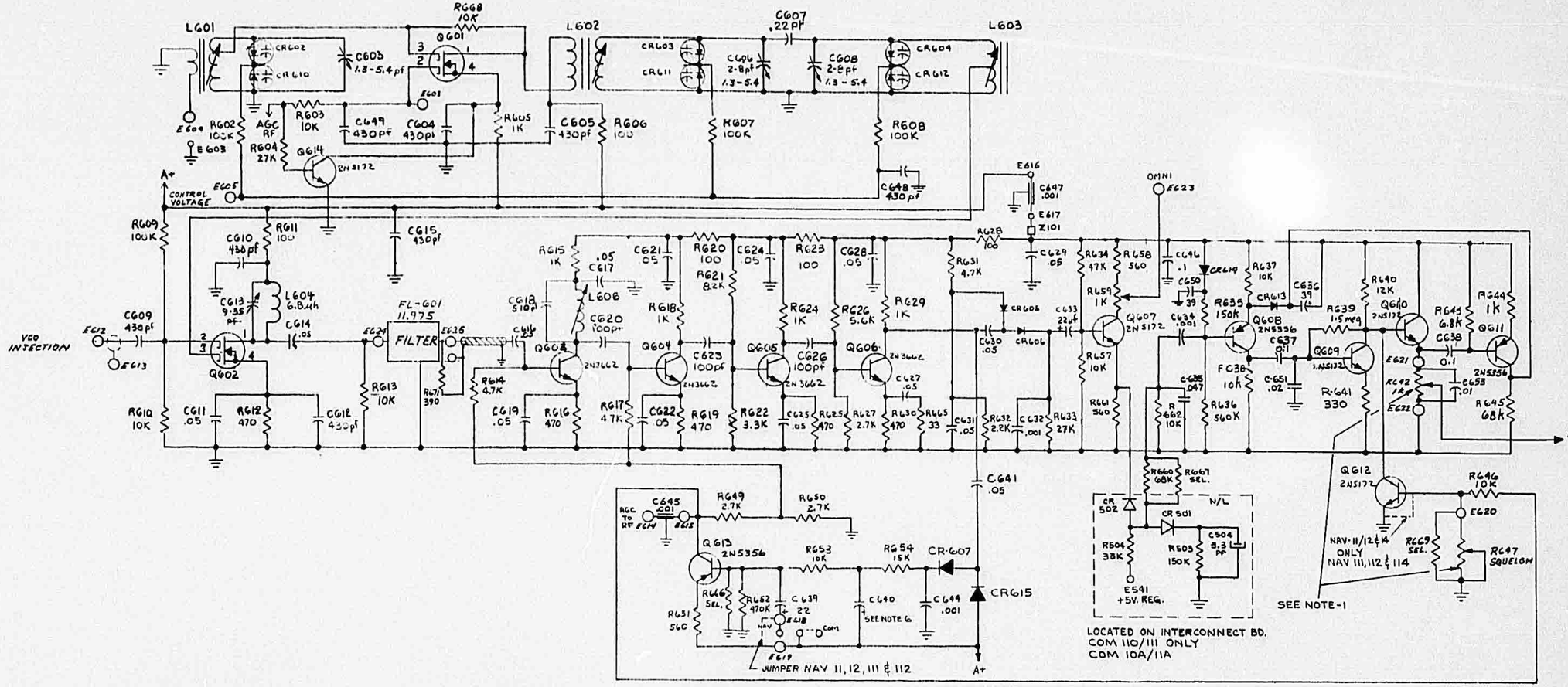
FIGURE 6.6-1 INTERNAL INTERCONNECT DIAGRAM, NAV 114 TSO

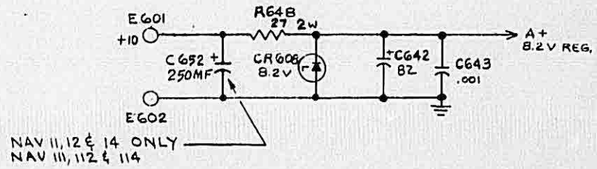
SEE BLOW-UP



SEE BLOW-UP





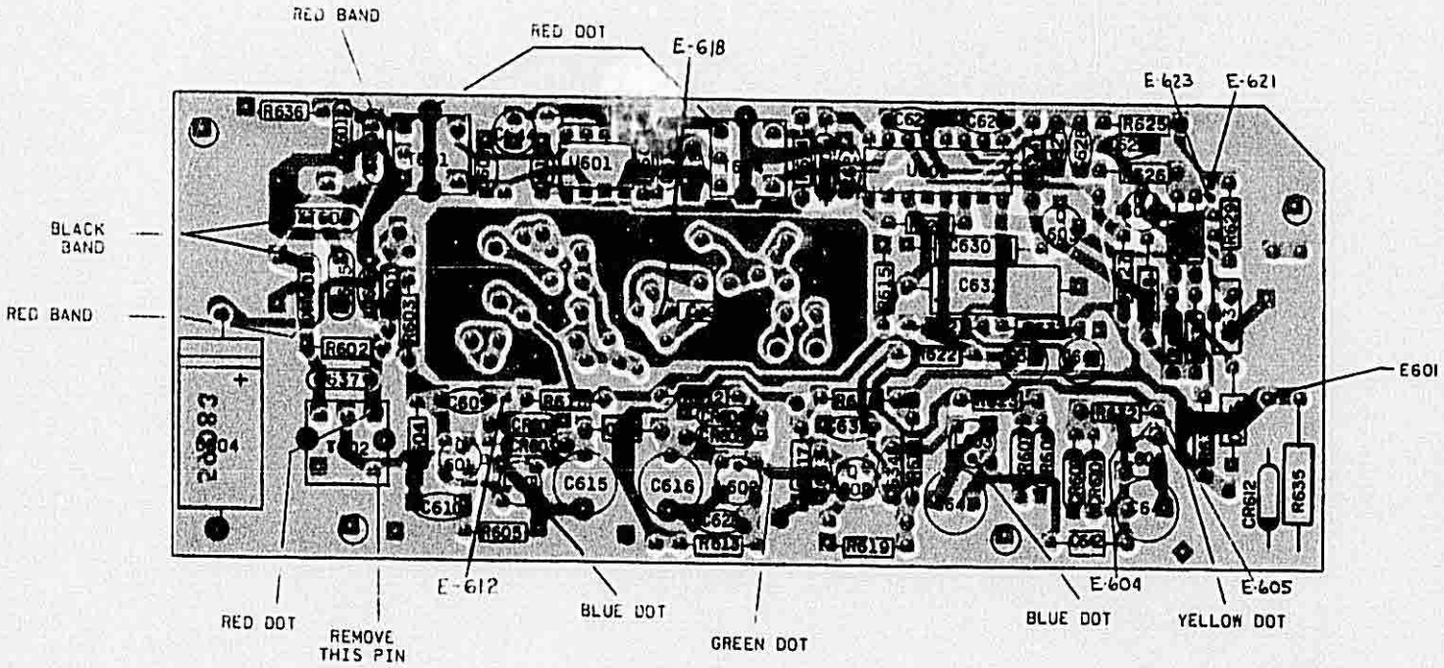


NOTES:
1- R642 & R647 ARE PART OF FRONT PANEL B 01154 PARTS LIST.
2- COM 10/10A & COM 11/11A B-01147-101 PARTS LIST AS SHOWN. (ALSO COM 110/111)
3- NAV 11, 12 & 14, B-01147-2 OMIT SYMBOLS, R656, CR 609, R663, C602, R601, CR-601, C601, R664, Q612, R647, R696. (ALSO NAV 111, 112 & 114)
4- ALL RESISTORS ARE IN OHMS ±10%, ¼ W., CARBON COMP. EXCEPT AS NOTED.
5- ALL CAPACITORS ARE IN μF EXCEPT AS NOTED.
6- C640 { 10MMF COM 10A, NAV 11, NAV 12 & NAV 14. COM 110, NAV 111, NAV 112 & NAV 114.
3.3MF COM 11A, COM 111.

D-02299 REV-P

FIGURE 6.6-2 RECEIVER SCHEMATIC

SEE BLOW-UP



Solder runs shown in PINK
are those on the "TOP" (component)
side of the board.

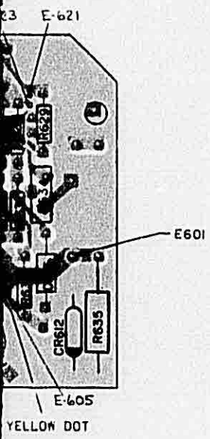
C-59084-B

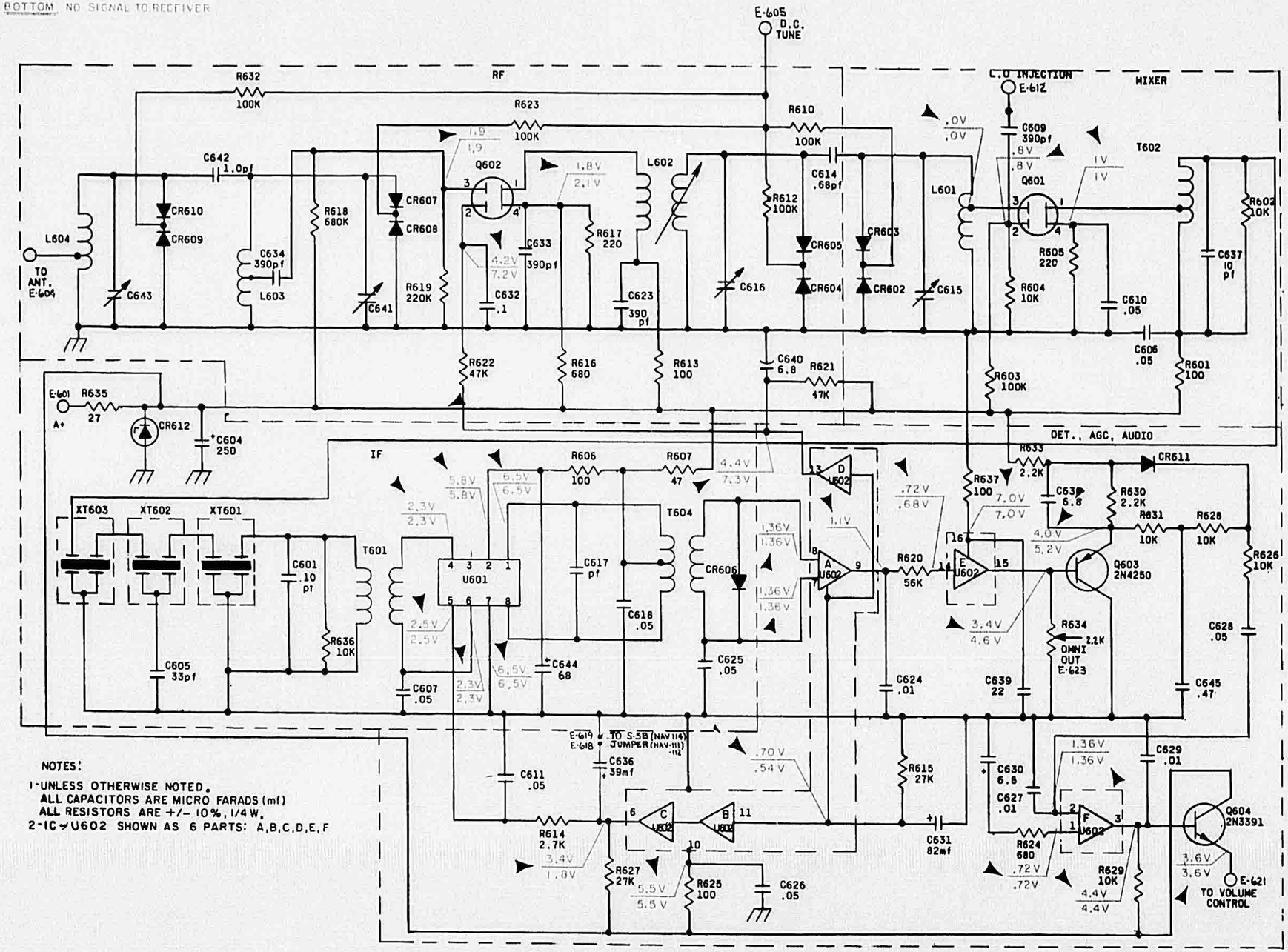
D95129B

Solder runs shown in Gray
are those on the "BOTTOM" (non-component)
side of the board.

SEE BLOW-UP

TOP 500 U.V. SIGNAL INPUT TO RECEIVER
BOTTOM NO SIGNAL TO RECEIVER



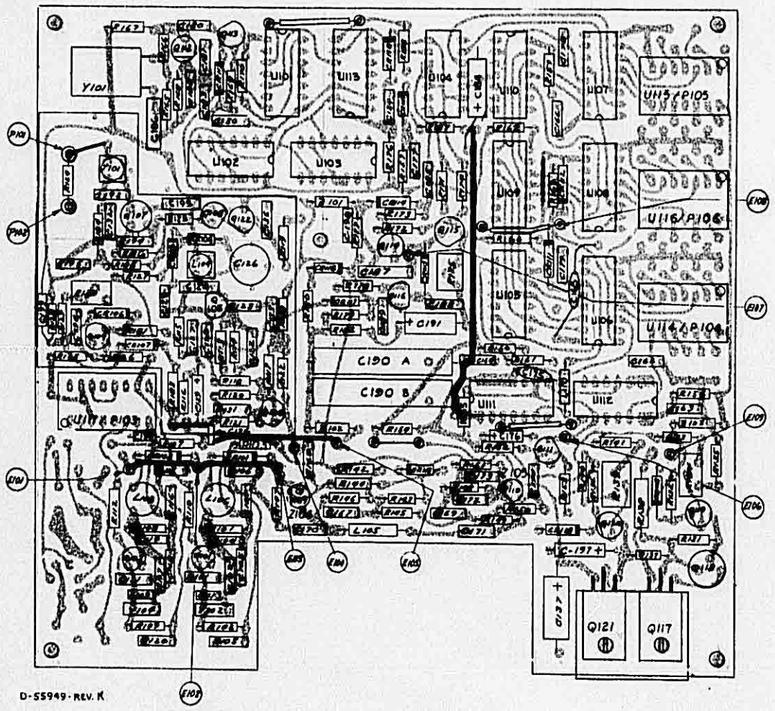


NOTES:
1-UNLESS OTHERWISE NOTED.
ALL CAPACITORS ARE MICRO FARADS (mf)
ALL RESISTORS ARE +/- 10%, 1/4 W.
2-IC #U602 SHOWN AS 6 PARTS: A,B,C,D,E,F

D02456-B
NAV 114

FIGURE 6.6-2A RECEIVER SCHEMATIC, (CHASSIS CNF219C)

SEE BLOW-UP



SEE BLOW-UP

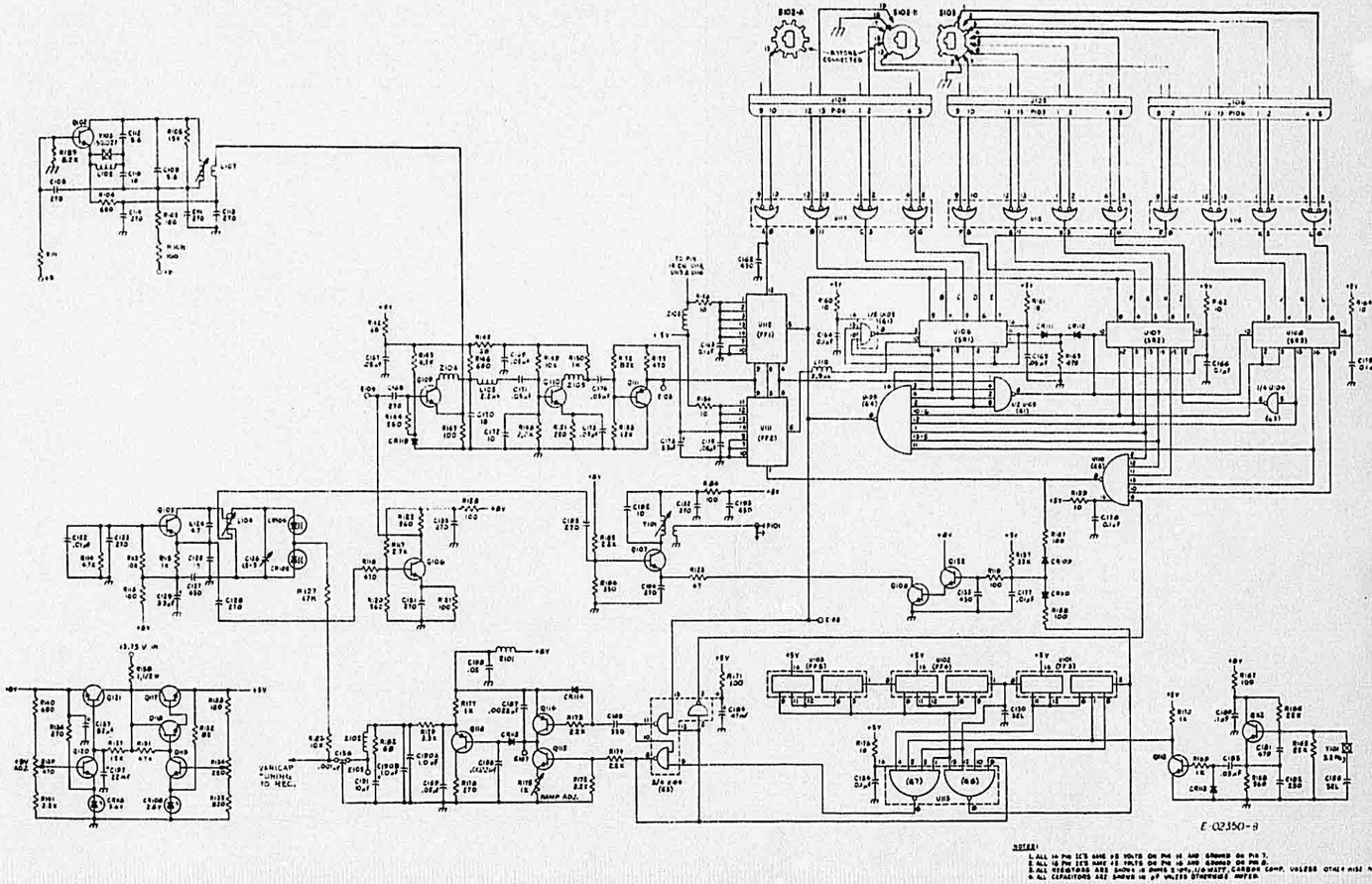
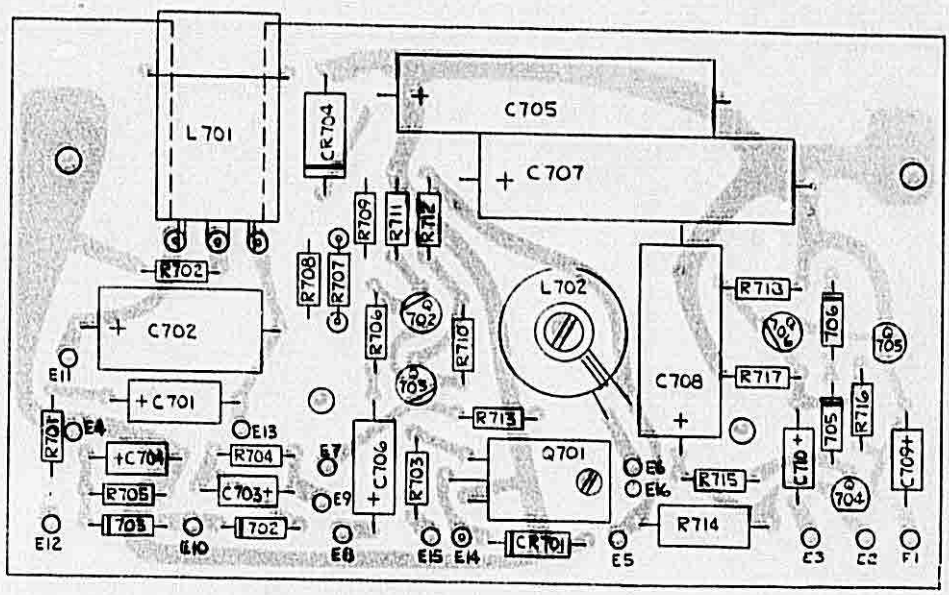
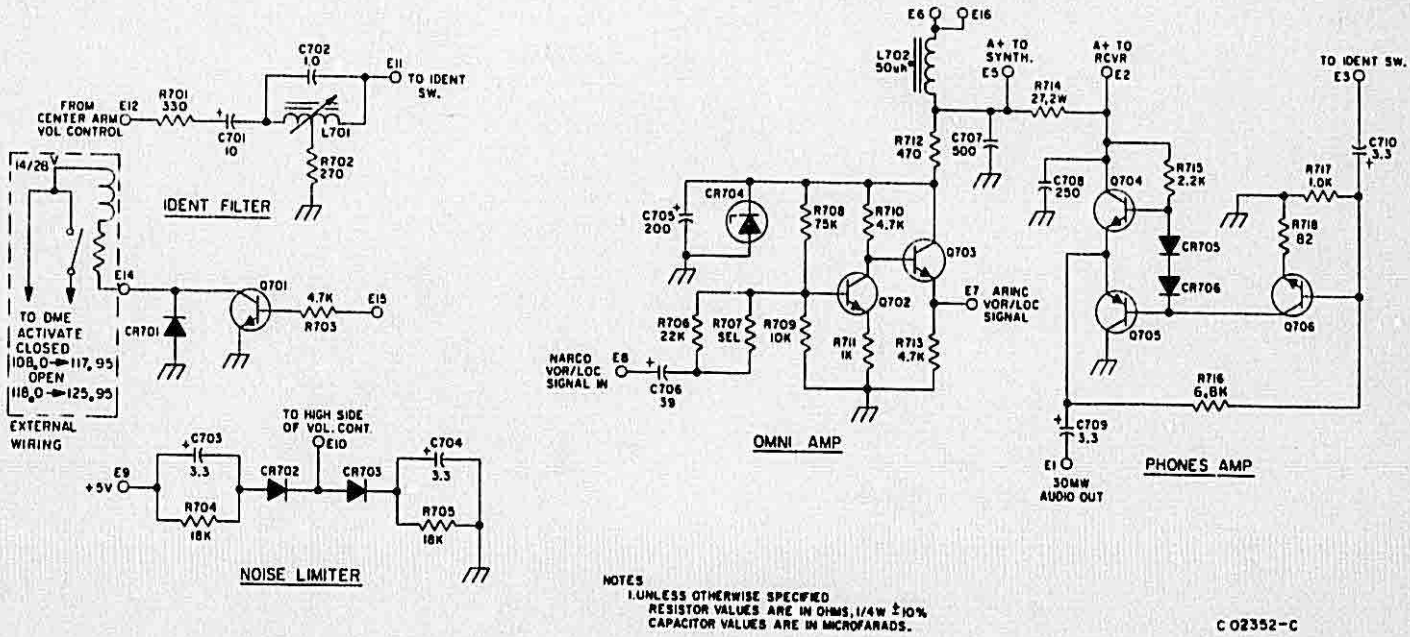


FIGURE 6.6-3 SYNTHESIZER SCHEMATIC

SEE BLOW-UP



C-57618-H



NOTES
1. UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/4W ±10%
CAPACITOR VALUES ARE IN MICROFARADS.

C02352-C

FIGURE 6.6-4 CONNECTOR BOARD SCHEMATIC

SEE BLOW-UP

TABLE OF CONTENTS

SECTION	TOPIC	PAGE	ATP GRID
7	MP 10, TSO'd		
7.1	GENERAL	7-1	1K04
7.2	INSTALLATION	7-1	
7.3	CIRCUIT DESCRIPTION	7-1	
7.4	MAINTENANCE	7-1	
7.5	REPLACEMENT PARTS LIST	7-2	1K05
7.6	SCHEMATIC	7-2	

7.1 GENERAL

The TSO'd MP 10 Voltage Converter is designed to convert 28 volts to 14 volts. The MP 10 should not be used to support two or more transceivers as should be the MP 10 have a failure, both units become disabled.

7.2 INSTALLATION

The MP 10 can be mounted in any convenient place or position within the aircraft providing that it be mounted on a clean metal surface, to provide good heat transfer. Secure the MP 10 to the aircraft using all four mounting holes and #8-32 hardware (screws, lockwashers, nuts). Secure the cable with a cable clamp approximately 2 to 3 inches away from the unit.

The Installation Kit provides the necessary cable connector and nine crimp type contacts. It is best to install all nine contacts into the connector as this provides firm mating of the connector. A circuit breaker (4 amp) is also provided. It should be installed, as shown, to prevent damage to the converter from a short circuited output.

7.3 CIRCUIT DESCRIPTION

The MP 10 is a standard series pass type of voltage regulator. The input voltage may vary from 20 volts to 32 volts and the output voltage will remain between 13.8 volts and 15.0 volts with a 1 amp load.

Regulation is provided by U1, a voltage regulating integrated circuit. The output of the integrated circuit is DC coupled to Q1. Q1 is a dual transistor emitter follower which handles the high current output of the regulator.

Inductor L1 and capacitor C1 form a low pass filter which removes A line transients.

CR1, a multipellet diode, and resistor R2 provide short circuit protection for the regulator. If a short occurs on the output, current increases thru Q1 and resistor R2. Diode CR1 will limit the voltage drop between the base of Q1 and the cathode of CR1 to 2.4 volts. Thus, the current out of the regulator will limit at approximately 6 amps which will then open the circuit breaker in series with the 28 volt input lead.

Diode CR3 raises the output voltage of U1 by approximately 0.5 volts.

Resistor R1 is a current limiting resistor to reduce the short circuit current under shorted output conditions.

Zener diode CR2 provides over voltage protection to the MP 10 load. If Q1 shorts, the 28 volt input would be applied to the MP 10 load. In the event this happens, Zener diode CR2 will short this voltage to ground causing the circuit breaker to open.

The MP 10 may be operated without a load, however, the output voltage will rise approximately a volt over its normal output voltage.

7.4 MAINTENANCE

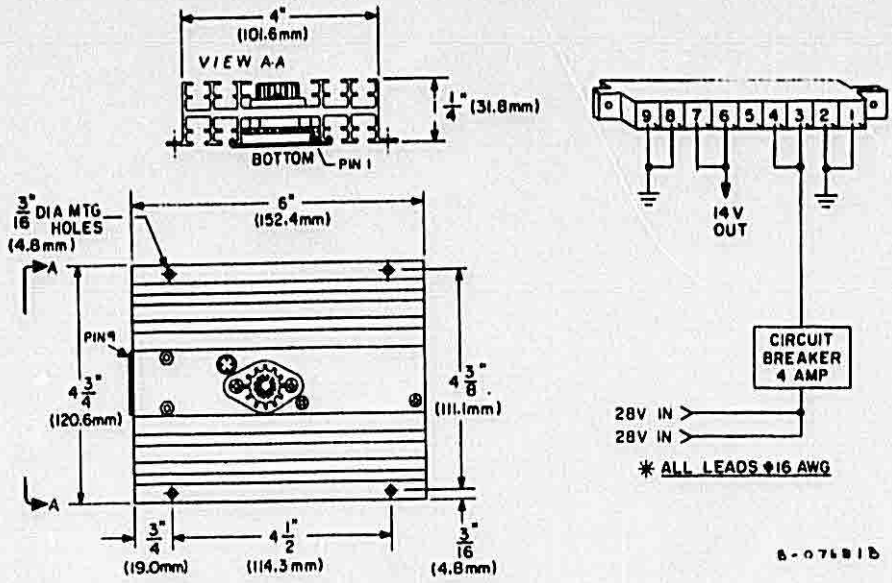
The MP 10 should require very little maintenance, refer to the schematic and the test voltages thereon.

NARCO AVIONICS TSO'd SPECTRUM NAV/COM

Weight: 1.0 pound (453 gr)

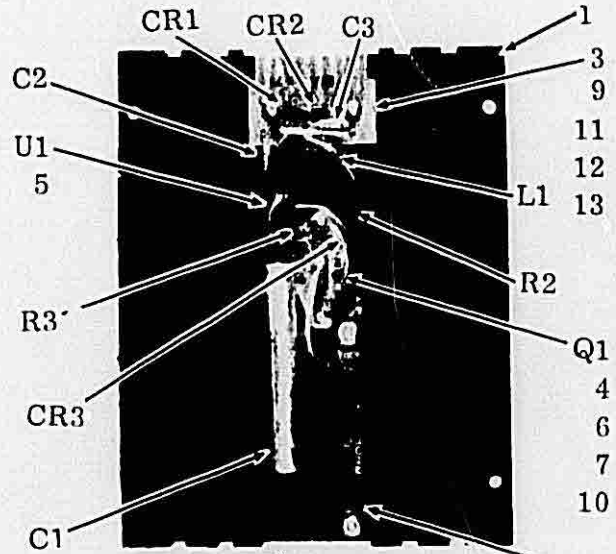
Current Capability:

2.0 amps continuous;
4.0 amps intermittent duty



7.5 REPLACEMENT PARTS LIST

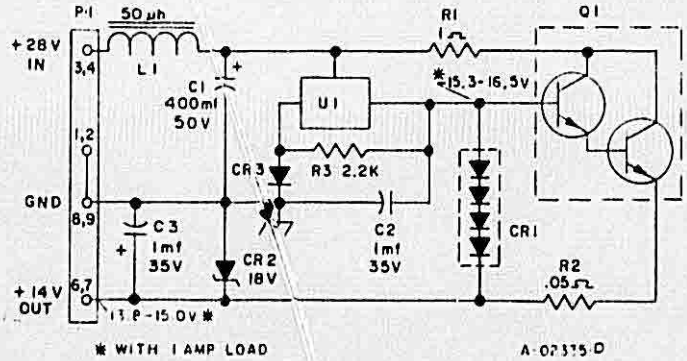
Item or Symbol #	Part No.	Description
1	55881-0001	Heat Sink
2	55882-0001	Cover, Heat Sink
3	55884-0001	PC Board
4	41325-0001	Socket, Trans. TO-3
5	41326-0001	Socket, Trans. TO-5
6	55020-0002	Insulator, TO-3
7	55880-0001	Cap, Insulator, TO-3
8	04431-0002	Nameplate
9	82804-0008	Screw, RH, 4-40 x 5/8
10	82823-0306	Screw, 6-20 x 5/8 RH
11	82802-0003	Lockwasher, Int. tooth, #4
12	82900-0004	Nut, Hex, #4-40
13	81206-0061	Spacer, .187 Lg.
14	81702-0004	Lug, Solder
C1	21554-0055	Capacitor, Elect. 400 mf 10%, 50V
C2	21555-0048	Capacitor, Tant. 1 mf 10%, 35V
C3	21555-0048	Capacitor, Tant. 1 mf 10%, 35V
CR1	75036-0003	Diode, Silicon, Multi-pellet
CR2	75025-0009	Diode, Zener, 18V
CR3	75036-0001	Diode, Silicon, Multi-pellet
L1	11487-0002	Choke, Filter, 50 mh -0 +20%, 2 amp
Q1	75609-0001	Transistor, Silicon, NPN, Darlington
R1	31134-0209	Resistor, Fixed, WW, 1 ohm, 20W
R2	31135-0012	Choke, RF (used as a resistor)
R3	31192-0222	Resistor, Fixed Comp, 2.2K 10%, 1/4W
U1	74020-0001	IC, Voltage Reg. (825CU)



Items 2 and 8 are not shown

PART LOCATION DRAWING

7.6 SCHEMATIC



SEE BLOW-UP

How are we doing?

We at Narco welcome your comments and suggestions about the manuals, both good and bad. These are the best indicators of how informative the manual is to you, the ultimate user.

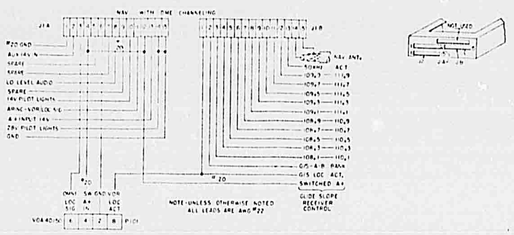
Should you have a helpful addition or find something that appears to be an error — fill in this slip and mail it right to the Technical Pubs Dept. and upon evaluation, we'll adjust the manual to include it.

All actions must include the following:

Manual Name .....

Manual No. ..... — ..... Supplement No. ..... (If any)

Page No. ....



C-02375-A

FIGURE 2-20. TYPICAL NAV 114 TSO BENCH TEST WIRING

TABLE 2.5 NAV 114 TSO DME CHANNEL PROGRAMMING

NARCO	ARINC	NAV J-2	MHz CHANNELS 108	109	110	111	112	113	114	115	116	117
B	A	1	X	X		X	X					
C	B	2			X	X		X	X			
D	C	3					X	X		X	X	
E	D	4	X						X	X		X
A	E	5		X	X						X	X
-	-	-	.00	.05	.10	.15	.20	.25	.30	.35	.40	.45
F	F	6			X	X	X	X				
H	G	7	X	X	X	X			X	X	X	X
J	H	8				X	X	X	X			
K	J	9						X	X	X	X	X
L	K	10	X	X						X	X	X
1025 CHANNEL ACT.		11		Y		Y	Y		Y		Y	
DME COMMON		12										
DME STANDBY		13										
GROUND		14										
SPARE		15										

KHz CHANNELS																				
.00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95
		X	X	X	X										X	X	X	X	X
X	X	X	X			X	X	X	X										
				X	X	X	X			X	X	X	X						
								X	X					X	X	X	X		
X	X									X	X	X	X	X	X			X	X
	Y		Y		Y		Y		Y		Y		Y		Y		Y		Y

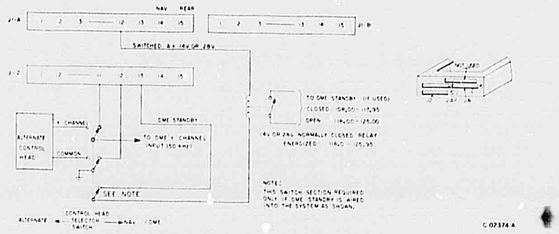
NOTES:

1. "X" indicates continuity to the DME common terminal (J2-12)
2. "Y" indicates continuity to the ground terminal (J2-14)
3. DME common (J2-12) must be grounded for DME channeling to operate

3a. For DME frequency control by NAV 114 TSO only, J2-12 may be connected to J2-14

3b. When the NAV 114 TSO is used as one of two DME frequency control heads, J2-11 and J2-12 should be wired to one side of a double throw Control Head Selector Switch. See Control Head Selector Switch Wiring Diagram below.

4. DME standby (J2-13) may be used to deactivate the DME when the NAV 114 TSO is channeled to frequencies above 117.95 MHz. A normally closed 14/28V relay should be wired between J1A-12 (Switched A+) and J2-13 as follows:



C-02374-A

FIGURE 2-21. NAV 114 TSO CONTROL HEAD SELECTOR SWITCH AND STANDBY WIRING

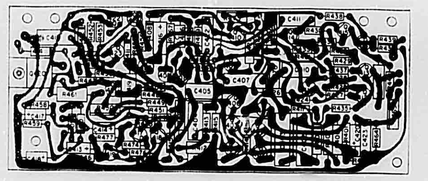


FIGURE 3.5-4 LOCALIZER BOARD

Fig. & Index No.	Part Number	Description
3.5-4	01156-0106	LOCALIZER BOARD ASSY NAV 110 TSO (See Fig. 3.5-1 for NHA)
	82814-0003	SCREW, MACH, #4-40 x 1/4, BND, HD, SL
	82922-0001	NUT, HEX
C402	23094-0177	CAPACITOR, MYLAR, METALIZED, .15 mf ±10%, 200V
C403	23094-0177	CAPACITOR, MYLAR, METALIZED, .15 mf ±10%, 200V
C404	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C405	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C406	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C407	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C409	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C410	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C411	23094-0171	CAPACITOR, MYLAR, METALIZED, .047 mf ±10%, 200V
C412	21555-0028	CAPACITOR, TANTALUM, 15 mf ±10%, 20V
C415	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C416	21555-0018	CAPACITOR, TANTALUM, 22 mf ±10%, 15V
C419	21555-0018	CAPACITOR, TANTALUM, 22 ±10%, 15V
C420	21555-0016	CAPACITOR, TANTALUM, 3.3 mf ±10%, 15V
C422	23094-0175	CAPACITOR, MYLAR, METALIZED, 0.1 mf ±10%, 200V
C423	23094-0163	CAPACITOR, MYLAR, METALIZED, 0.01 mf ±10%, 200V
CR406	75027-0004	DIODE, ZENER, 5.6V
CR407	75028-0001	DIODE, SILICON
CR408	75028-0001	DIODE, SILICON
CR411	75028-0001	DIODE, SILICON
CR412	75204-0045	RECTIFIER, SILICON, LEAD MTG
CR414	75204-0045	RECTIFIER, SILICON, LEAD MTG
Q401	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q402	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q403	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q404	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q405	75565-0006	TRANSISTOR, SILICON, PNP, 2N5956
Q406	75565-0006	TRANSISTOR, SILICON, PNP, 2N5956
Q407	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q408	75565-0006	TRANSISTOR, SILICON, PNP, 2N5956
Q409	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q410	75565-0006	TRANSISTOR, SILICON, PNP, 2N5956
Q411	75565-0006	TRANSISTOR, SILICON, PNP, 2N5956
Q412	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q413	75565-0006	TRANSISTOR, SILICON, PNP, 2N5956
Q414	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q415	75565-0006	TRANSISTOR, SILICON, PNP, 2N5956
Q416	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q420	75576-0001	TRANSISTOR, SILICON, NPN
Q421	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q422	75565-0006	TRANSISTOR, SILICON, PNP, 2N5956
Q423	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q424	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172
Q425	75595-0003	TRANSISTOR, SILICON, NPN, 2N5172

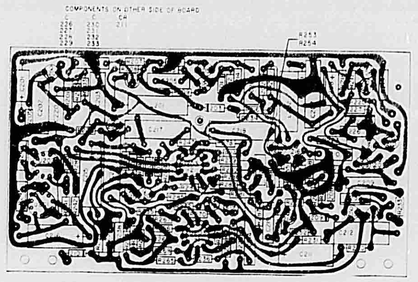
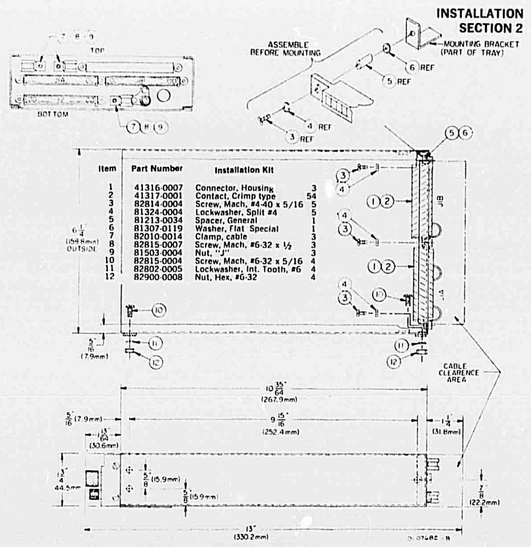


FIGURE 3.5-5 OMNI BOARD



Item	Part Number	Installation Kit	
1	41316-0007	Connector, Housing	3
2	41317-0001	Contact, Crimp type	54
3	82814-0004	Screw, Mach, #4-40 x 5/16	5
4	81324-0004	Lockwasher, Split #4	5
5	81213-0034	Spacer, General	1
6	81307-0119	Washer, Flat Special	1
7	82010-0014	Clamp, cable	3
8	82815-0007	Screw, Mach, #6-32 x ½	3
9	81503-0004	Nut, "J"	3
10	82815-0004	Screw, Mach, #6-32 x 5/16	4
11	82802-0005	Lockwasher, Int. Tooth, #6	4
12	82900-0008	Nut, Hex, #6-32	4

FIGURE 2-22. NAV 114 TSO INSTALLATION DRAWING

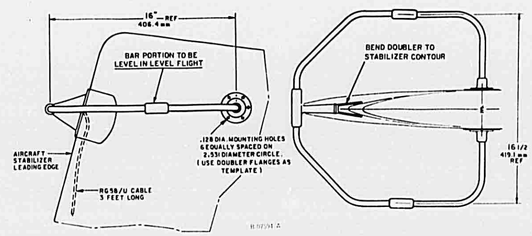


FIGURE 2-24. VNA-10 ANTENNA

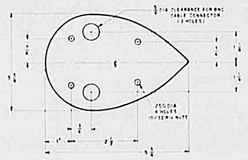


FIGURE 2-25. VCNA-1 or VCNA-2 ANTENNAS

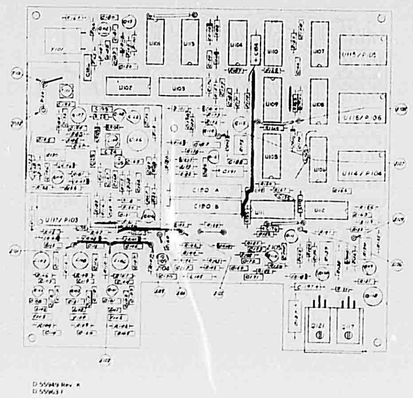


FIGURE 3.5-8 SYNTHESIZER BOARD, COM 110 TSO

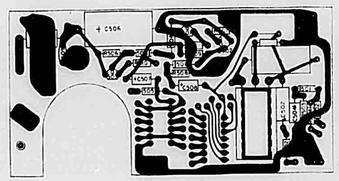


FIGURE 3.5-9 INTERCONNECT BOARD, COM 110 TSO

Fig. & Index No.	Part Number	Description
3.5-9	01148-0103	INTERCONNECT BOARD, COM 110 TSO
		(INCLUDES ITEMS NOT SHOWN)
C-502	21555-0026	CAPACITOR, TANTALUM, 10 mf, 20V
C-503	23100-0013	CAPACITOR, POLY CARB, .10 mf
C-504	21555-0016	CAPACITOR, TANTALUM, 33 mf, 15V
C-505	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-506	21554-0051	CAPACITOR, ELECTROLYTIC, 250 mf, 20V
C-507	21555-0017	CAPACITOR, TANTALUM, 3.3 mf, 15V
C-508	21555-0017	CAPACITOR, TANTALUM, 3.3 uf, 15V
C-509	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
CR-501	75028-0031	DIODE, SILICON
CR-502	75028-0031	DIODE, SILICON
CR-503	75028-0031	DIODE, SILICON
CR-504	75028-0031	DIODE, SILICON
CR-505	75028-0031	DIODE, SILICON
CR-506	75028-0031	DIODE, SILICON
Q-502	11488-0001	ZENER
Q-501	75559-0009	TRANSISTOR, 2N3811
Q-502	75559-0009	TRANSISTOR, 2N3811
Q-503	75559-0009	TRANSISTOR, 2N3811
R-501	31197-0221	RESISTOR, CARBON, 220 ohm, 5%, ½W
R-502	31197-0221	RESISTOR, CARBON, 220 ohm, 5%, ½W
R-503	31197-0154	RESISTOR, CARBON, 150K ohm, 5%, ½W
R-504	31192-0331	RESISTOR, FILM, 330 ohm, 1%, ½W
R-505	31195-0002	RESISTOR, WIREWOUND, 250 ohm, 5%, 7W
R-506	31192-0272	RESISTOR, FILM, 2700 ohm, 1%, ½W
R-507	31192-0249	RESISTOR, FILM, 2490 ohm, 1%, ½W
R-508	31192-0274	RESISTOR, FILM, 2740 ohm, 1%, ½W
R-509	31192-0249	RESISTOR, FILM, 2490 ohm, 1%, ½W
R-510	31192-0100	RESISTOR, FILM, 10 ohm, 1%, ½W
R-511	31197-0100	RESISTOR, CARBON, 10 ohm, 5%, ½W
J-503	41321-0000	SOCKET, PC, SOLDER TAIL
J-504	41321-0000	SOCKET, PC, SOLDER TAIL
J-505	41321-0003	SOCKET, PC, SOLDER TAIL
J-506	41321-0003	SOCKET, PC, SOLDER TAIL
	41278-0000	CAM HOLDER, SUBMINIATURE

2.13 Voltage converter, MP-10

The COM 110 TSO/NAV 110 TSO System, the COM 111 TSO, and the NAV 114 TSO are designed for 14 volt operation. These units may be installed in aircraft having a 28 volt system provided a converter, such as NARCO's MP 10, is used to convert the voltage for the units from 28v to 14v.

No attempt should be made to use one MP 10 to support two or more transceivers. In a multi-transceiver installation, an MP 10 Voltage Converter should be used for each transceiver to assure that should a converter fail, you still have the back-up transceiver. The recommended typical setup is a single COM 110 TSO/NAV 110 TSO, System or a single COM 111 TSO connected to an MP 10.

The MP 10 can be mounted in any convenient place or position within the aircraft providing that it be mounted on a clean metal surface, to provide good heat transfer. Secure the MP 10 to the aircraft using all four mounting holes and #8-32 hardware (screws, lockwashers, nuts). See Figure 2-28. Secure the cable with a cable clamp approximately 2-3 inches away from the MP 10.

The Installation Kit provides the necessary cable connector and nine crimp type contacts. It is best to install all nine contacts into the connector as this provides firm mating of the connector. A circuit breaker (4 amp) is also provided. It should be installed, as shown, to prevent damage to the converter from a short circuited output.

2.13.1 Specifications

Size and Weight, See Figure 2-28.

Environmental

TSO	ENV CAT.
C71	$\frac{B}{G}\frac{A}{T}\frac{N}{L}$ AAAXXXXXX

Weight: 1.0 pound

Current Capability:

2.0 amps continuous;
4.0 amps intermittent duty

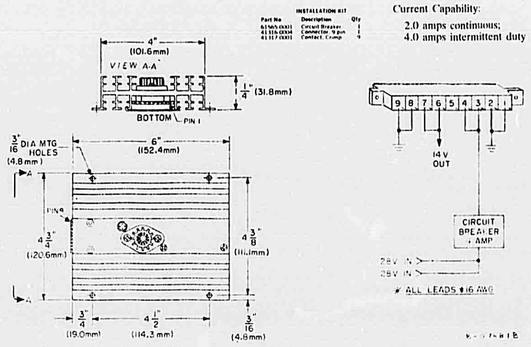


FIGURE 2-28. MP 10 INSTALLATION AND RECOMMENDED WIRING DIAGRAM

3.3.1.2 Continued

The output, E204 and E203, from the emitter followers is a voltage of approximately 150 millivolts for a 10 degree phase difference. This voltage will be only slightly effected by the load connected to the output. Therefore if a high impedance autopilot or a 1000 ohm standard meter is connected to the output, the voltage will be the same.

The output of U201 is connected to the Left-Right meter. The Left-Right meter has more damping than the undamped output of U202 because C216 damps the Left-Right needle, however C216 has little effect on the undamped U202 because it is isolated by R241 and R242.

3.3.1.3 NAV 110 TSO To-From Detector

The reference 30 Hertz channel is shifted 90 degrees and applied to the To-From Phase Detector.

Essentially this detector operates the same as the Left-Right Phase Detector. The only appreciable difference is that there is no gain adjustment connected across pins 11 and 12 of A201, A202 has resistor R240.

Flag current is set by R233.

3.3.1.4 NAV 110 TSO OMNI/LOC Switching Circuits

Electronic switching is used for OMNI and Localizer operation. Refer to Figure 3.3-3.

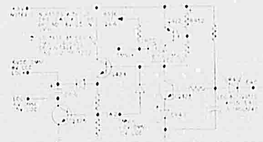


FIGURE 3.3-3 OMNI/LOC SWITCHING

OMNI MODE

In OMNI mode the Localizer activate lead (terminal E410) is open (ungrounded). Q423 is therefore turned ON by current flow thru R454 and R455. This brings SW2 (E409) to approximately ground potential.

With Q423 ON, the current thru CR411 causes a voltage drop across R452 causing Q422 ON. With Q422 ON, SW1 (E408) is brought to approximately 9 volts. With Q423 ON, the base of Q424 is connected to ground causing Q424 to be turned OFF. With Q424 OFF, there is no drive to Q425, thus Q425 is OFF.

With Q424 and Q425 OFF, the Localizer + (pins) and – (minus) leads are floating as if they were not connected. The Localizer Left-Right and To-From detectors have no voltage applied to them so that even though they are still connected to the OMNI circuit, they do not effect the OMNI Left-Right or To-From indicators. The voltage measured at each side of C416 during OMNI operation (about 6 volts) is the result of the voltage fed into the Localizer from the L-R and To-From circuits.

In OMNI operation Q424 and Q425 could be removed from the circuit with no change in operation. Also while in OMNI operation, as a result of the voltage (+9v) applied by the switching circuits (SW1), CR210, CR206, and CR207 are closed, and the wiper of R232 is grounded.

LOCALIZER MODE

In Localizer mode E410 is grounded by the channeling switches.

Diode CR412 prevents sneak paths from activating the Localizer when the Localizer activate is used for activating other equipment such as a glide slope receiver or autopilot coupling.

When Q423 is turned OFF, the current thru R452 decreases so the voltage across R452 decreases, and Q422 is turned OFF.

SW2 is no longer at ground potential so the OMNI To-From flag emitter follower drivers, Q212 and Q213, are OFF and the To-From flag is free to follow the Localizer command.

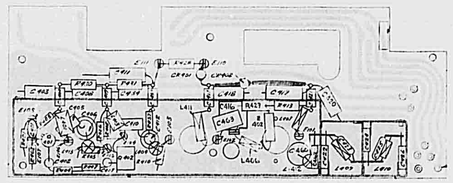
SW1 is no longer connected to +9 volts which turns OFF the OMNI Left-Right and To-From Phase Detectors.

When Q423 is OFF, the collector of Q423 increases in voltage turning Q424 ON. When Q424 is ON it turns Q425 ON. When Q424 is ON it supplies +9 volts to the Localizer circuitry. When Q425 is ON it grounds the negative side of the Localizer circuitry. The Localizer is thus operational.

CR411 gives a small (.5 volt) bias to Q423 to compensate for the .5 volt drop across CR412.

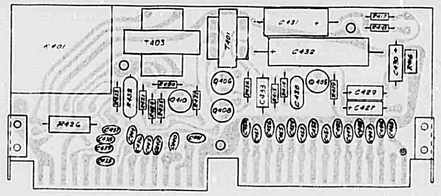
Diodes CR210, CR407, and CR408 prevent current from flowing from the OMNI circuit to the switching circuitry when in Localizer mode and prevents current from flowing from the Localizer circuitry to the switching circuitry when in OMNI mode.

In Localizer mode, Q422 and Q423 could be removed with no change in operation.



C 55158
C 55983

FIGURE 3.5-11 TRANSMITTER PC BOARD, COM 110 TSO



C 55159
C 55997

FIGURE 3.5-12 MODULATOR PC BOARD, COM 110 TSO

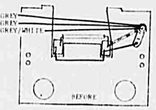
2.3.4.2 Modifications Required for 28V Operation

This system is manufactured for 14 volt service, however, with the use of a voltage converter and the addition of a few jumpers, the units can be used in aircraft having 28 volt service.

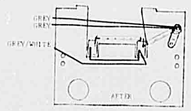
2.3.4.2.1 Procedure

1. Install a 28 to 14v Voltage Converter as outlined in Section 2.13.
2. The COM unit's pilot light power source is via a dimmer switch or directly from the aircraft buss, therefore the pilot light circuit must be modified (a change from parallel to series wiring). Refer to the Interconnect Board, partial drawing.
   A. Remove the wire from pin 4 to P502 which mates J502 and connect it to Pin 5 of P502.
   B. Remove the black wire from E537, on the Interconnect Board, and connect it to E529.
3. The NAV 110 TSO receives it's power source directly from the COM 110 TSO, therefore its A+ is that of the COM 110 TSO. The pilot lights, like the COM units must be modified for proper operation.

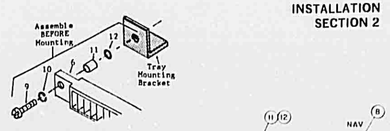
A. Remove the wire, in its entirety, which is attached to the ground lug and the bottom terminal of the LOWER pilot light pair.



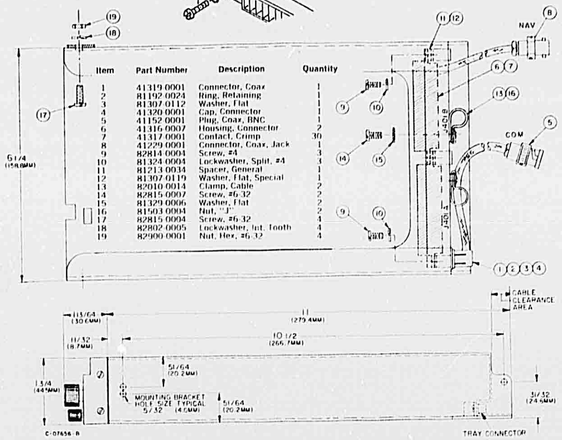
B. Remove the white/grey wire from the standoff on the Front Panel Assembly and connect it to the bottom terminal of the LOWER pilot light pair.



NOTE: No modification is necessary to pilot lights if the pilot light input is connected to the switched A+ output of the COM 110 TSO.



Item	Part Number	Description	Quantity
1	41319-0001	Connector, Coax	1
2	81192-0024	Ring, Retaining	1
3	81307-0112	Washer, Flat	1
4	41320-0001	Cap, Connector	1
5	41152-0001	Plug, Coax, BNC	1
6	41316-0007	Housing, Connector	7
7	41317-0001	Contact, Crimp	10
8	41229-0001	Connector, Coax, Jack	1
9	82914-0004	Screw, #4	3
10	81324-0004	Lockwasher, Split, #4	3
11	81213-0034	Spacer, General	1
12	81307-0179	Washer, Flat, Special	1
13	82010-0014	Clamp, Cable	2
14	82915-0007	Screw, #6-32	2
15	81329-0006	Washer, Flat	2
16	81503-0004	Nut, "J"	2
17	82915-0004	Screw, #6-32	3
18	82802-0005	Lockwasher, Int. Tooth	4
19	82900-0001	Nut, Hex, #6-32	4



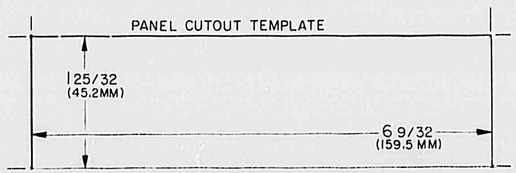
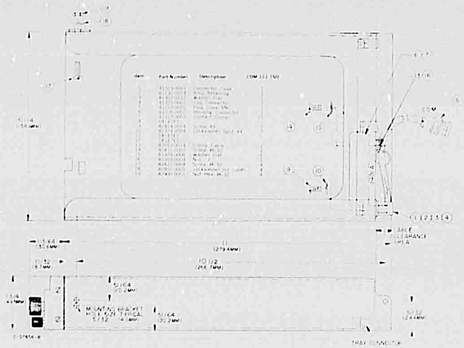


FIGURE 2-2. COM 110 TSO INSTALLATION DRAWING



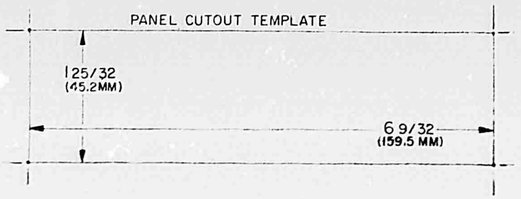
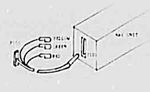


FIGURE 2-8. COM 111 TSO INSTALLATION DRAWING



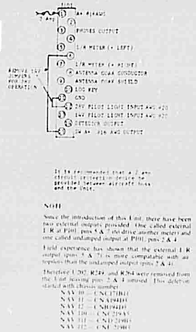


FIGURE 2-9. NAV 111 TSO WIRING

2.8.5 Pre-Installation Bench Test

The equipment required to perform this test is listed below:

A speaker load box, 15w capability

A low voltage dc supply, 12-15 vdc at 10-15 amps such as an Electro Products Laboratories Model NFB or equivalent

A VHF Signal Generator, Hewlett Packard Model 608D or equivalent

An OMNI Signal Generator, Aircraft Radio Corp. Model H-14A or equivalent

2.8.5.1 Test Set-Up and Test for NAV 111 TSO

Plug the connector into the NAV 111 TSO being sure that the contacts mate the contacts of the printed circuit board (The plug can be put on upside down and no contact will be made).

Refer to the Interconnection Diagram connector.

Connect a suitable power source to:
Pin 1 for 14 or 28 volt operation

Connect a VHF signal generator to the NAV antenna (pin 8 and pin 9).

Connect, for pilot light operation, a suitable power source to:
Pin 12 for 28 volt
Pin 13 for 14 volt

A. Apply power (13.75 or 27.5 VDC)

B. Turn VOL knob full cw, position IDENT Switch to IDENT, Channel radio to a generator frequency.

C. Switch to a NAV channel. Reading should be 1.5μv for 6 db S+N/N, audio output should be 30 mw when RF input is 3.0μv (modulated at 30% - 1000 Hz).

D. Check omni operation using a crystal controlled omni channel at the Four Cardinal Points (0, 90, 180, 270°) reading should be ±1.5°.

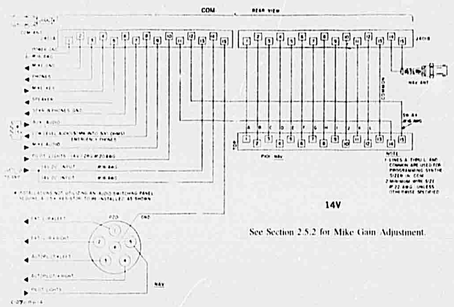
E. Check internal lighting
   1. 14v — jumper pin 13 to 15.
   OR
   2. 28v — jumper pin 12 to 15.

F. To check NAV programming, check 108 MHz on all KHz steps and check all MHz steps on .00 KHz.

2.8.5.2 Post Installation

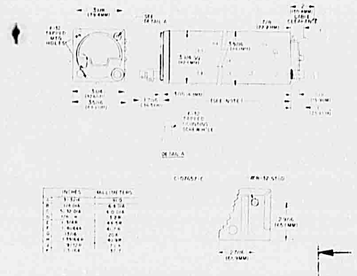
After the installation has been completed, the system should be operated on the ground, with all normal power turned on and the engine running. The receiver should be checked for proper operation by channeling to available signals.

A FLIGHT TEST IS RECOMMENDED.



See Section 2.5.2 for Mike Gain Adjustment.

FIGURE 2-3. COM 110 TSO/NAV 110 TSO INTERCONNECTION DIAGRAM

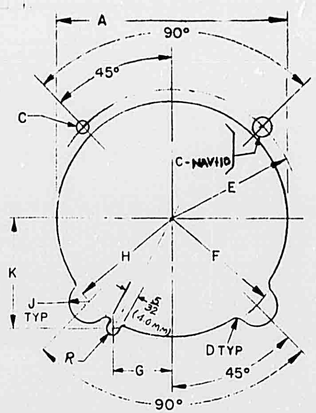


NOTES:

These equipments are rear panel mounted.
Chassis length 8½" (215.9MM)
Mounting screws to be No. 6-32,
Length to be: 7/16 Min ¼" Max
Plus thickness of panel.

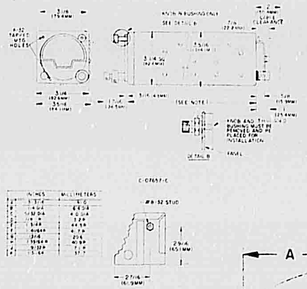
Rear connections:
Has connector and connector assy.

Part Number	Installation Kit	Quantity
41316-0007	CONNECTOR, SHELL, 15 pin	1
41317-0001	CONTACT, CONNECTOR	15
82019-0002	STRAP, CABLE	1
82814-0004	SCREW, 4-40 x 5/16	3
82802-0003	LOCKWASHER, No. 4	3
82900-0004	NUT, HEX, No. 4-40	3
82815-0109	SCREW, 6-32 x ⅛	3
55951-0001	HANDLE, CONNECTOR without eyelet	1
81254-0012	EYELET (to be installed in) handle)	1
41116-0002	CONNECTOR, 6 pin	1



INSTALLATION

FIGURE 2-4. NAV 110 TSO INSTALLATION DRAWING



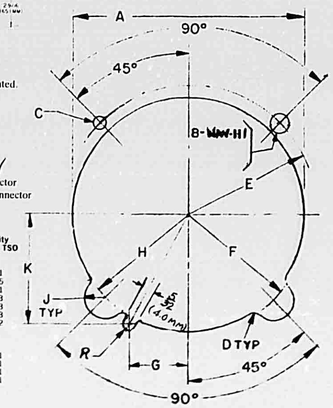
NOTES:

These equipments are rear panel mounted.
Chassis length 8½" (215.9MM)
Mounting screws to be No. 6-32,
Length to be: 7/16 Min 3/4" Max.
Plus thickness of panel.

Rear connections:

Has one rear connector, units wired for DME channeling also have a connector on a pigtail as well as a G/S pigtail connector

Part Number	Installation Kit	Quantity NAV 111 TSO
41316-0007	CONNECTOR, SHELL, 15 pin	1
41317-0001	CONTACT, CONNECTOR	15
82019-0002	STRAP, CABLE	1
82814-0004	SCREW, 4-40 x 5/16	3
82802-0003	LOCKWASHER, No. 4	3
82900-0004	NUT, HEX, No. 4-40	3
82815-0109	SCREW, 6-32 x ⅛	2
55951-0001	HANDLE, CONNECTOR without eyelet	
81254-0012	EYELET (to be installed in) handle)	1
84038-0001	ADAPTER, Cable to BNC	1
90058	CABLE, RG-188A/U, 18"	1
41229-0001	CONNECTOR, BNC	1



INSTALLATION TEMPLATE

FIGURE 2-11. NAV 111 TSO INSTALLATION DRAWING

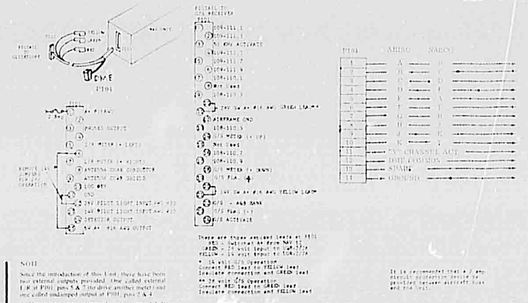


FIGURE 2-12. NAV 112 TSO WIRING

TABLE 2.2 NAV 112 TSO GLIDESLOPE PROGRAMMING

NAV Connector P101 Pin #		108 MHz										109 MHz										110 MHz										111 MHz									
		10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	00	05	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	00	05	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
GS LOC Act	24	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
GS A/B Act	22	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
(108.1-110.1)	7	x	x																																																						
(108.3-110.3)	9		x	x																																																					
(108.5-110.5)	13			x	x																																																				
(108.7-110.7)	16				x	x																																																			
(108.9-110.9)	17					x	x																																																		
(109.1-111.1)	1						x	x																																																	
(109.3-111.3)	2							x	x																																																
(109.5-111.5)	4								x	x																																															
(109.7-111.7)	5									x	x																																														
(109.9-111.9)	6										x	x																																													
50 kC Act	3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

x Indicates pins that are grounded

If because of a high noise level environment more headphone audio is desired, one can add a transformer to step-up the audio voltage.

4. Because of the usually long leads and high audio level in the helicopter, it is recommended that shielded wire be used for at least the microphone and aux. audio lead, if it is used.

5. MIKE GAIN ADJUSTMENT — The mike gain pot will affect both transmitter operation and intercom level. The mike gain should be adjusted for full modulation of the transmitter with normal talking into the microphone.

   This will automatically give full audio output into the headphone during intercom operation. If the intercom is too loud a series resistor can be added to the headphone level.

   DO NOT USE THE MIKE GAIN THE ADJUST INTERCOM LEVEL.

6. Sidetone level will be the same as the intercom audio level.

7. If speaker operation is desired, a switch should be provided to turn the speaker off when headphones are used.

   This is necessary with intercoms to prevent audio feedback and is desirable even when one is not using intercom because with the receiver set for a comfortable headphone level, the speaker would be blasting.

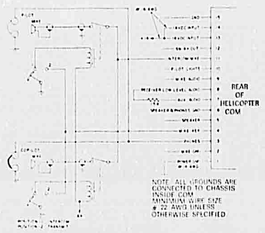


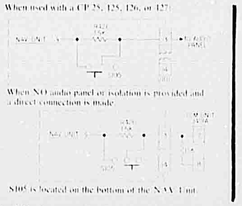
FIGURE 2-6. BASIC COM 111 TSO HELICOPTER INTERCOM WIRING

2.7.4.3 COM 111 TSO Audio Input Connections

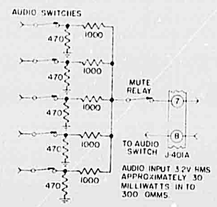
The COM Interconnection diagram shows a 1.5K resistor between J401A, pin 7 and pin 8. This resistor is required when an installation does NOT use an audio switching panel containing an isolation amplifier. When an audio switching panel with an isolation amplifier is used (i.e.: Narco's VP22 or CP25), the resistor is removed.

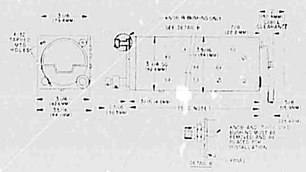
In installations where several switched audio inputs are desired for the COM 111 TSO system and an isolation amplifier is not used, an audio summing network must be utilized for optimum performance. The following diagrams show examples of such a network. In all installations, terminal 3 can be used for headphone connection.

There is an internal 1500 ohm resistor in series with terminal 3.



The following example of a summing network can be utilized. Mute relay is controlled by the mike key.





NOTES:

These equipments are rear panel mounted.

Chassis length, 8½" (215.9MM).

Mounting screws to be No. 6-32.
Length to be: 7/16 Min /3/4" Max
Plus thickness of panel.

Rear connections:
Has connector and 2
Pigtails with connectors.

INSTALLATION KIT		Qty
41316-0007	CONNECTOR, SHELL, 15 pin	1
41317-0091	CONTACT, CONNECTOR	15
82019-0702	STRAP, CABLE	1
82814-0704	SCREW, 4-40 x 5/1-	3
82802-0-03	LOCKWASHER, No. 4	3
82999-0004	NUT, HEX, No. 4-40	3
82815-0109	SCREW, 6-32 x 3	2
55951-0001	HANDLE, CONNECTOR without eyelet	1
81254-0012	EYELET (to be installed in handle)	1
41116-0002	CONNECTOR, 6 pin	1
84038-0001	ADAPTER, Cable to BNC	1
90058	CABLE, RG-188A/U, 18"	1
41285-0006	CONNECTOR, 24 pin	1
41229-0001	CONNECTOR, BNC	1

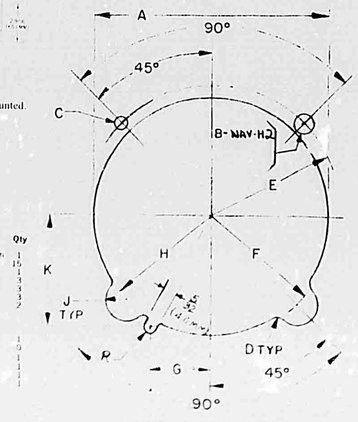


FIGURE 2-14. NAV 112 TSO INSTALLATION DRAWING

2.7.6 COM 111 TSO Operation

VOL/ON-OFF Knob

This knob energizes the COM unit. Turning the knob CW past the "click" turns the unit ON and continued rotation increases volume. Conversely CCW reduces volume and turns the unit OFF.

COM Frequency Channeling

The two large knobs have no stops, thus allowing shortest (CW or CCW) rotation to the desired frequency. The left knob selects the MHz (the whole number) the right knob selects the KHz (the fractional number).

SQUELCH

The SQUELCH knob establishes the input signal level required to give an audio signal output from the COM receiver. The input signal level is increased by turning the knob CCW. Maximum signal level is with the tick at the 7 o'clock position.

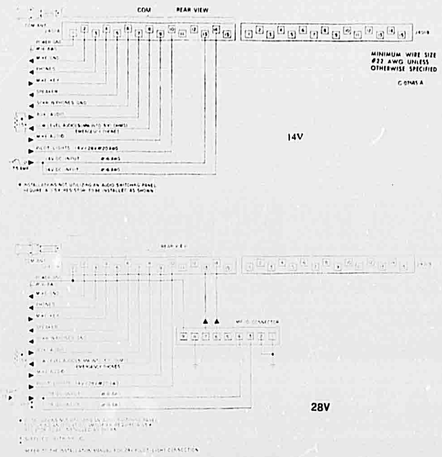


FIGURE 2-7. COM 111 TSO INTERCONNECTION DIAGRAM

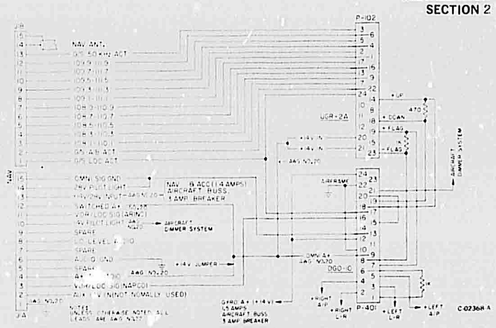


FIGURE 2-18. 14V INTERCONNECT WIRING DIAGRAM FOR NAV 114 TSO DME-UGR2A-DGO 10

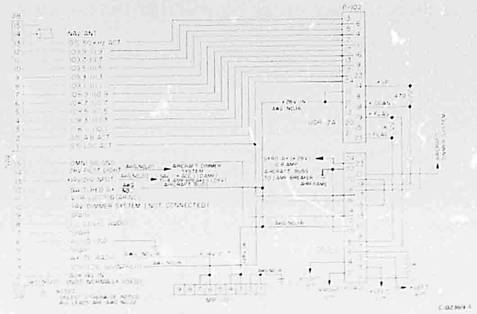
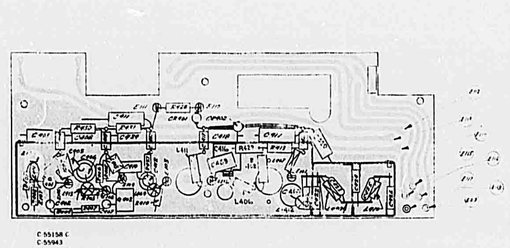
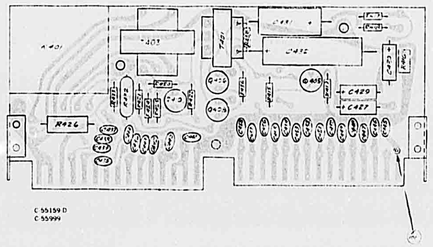


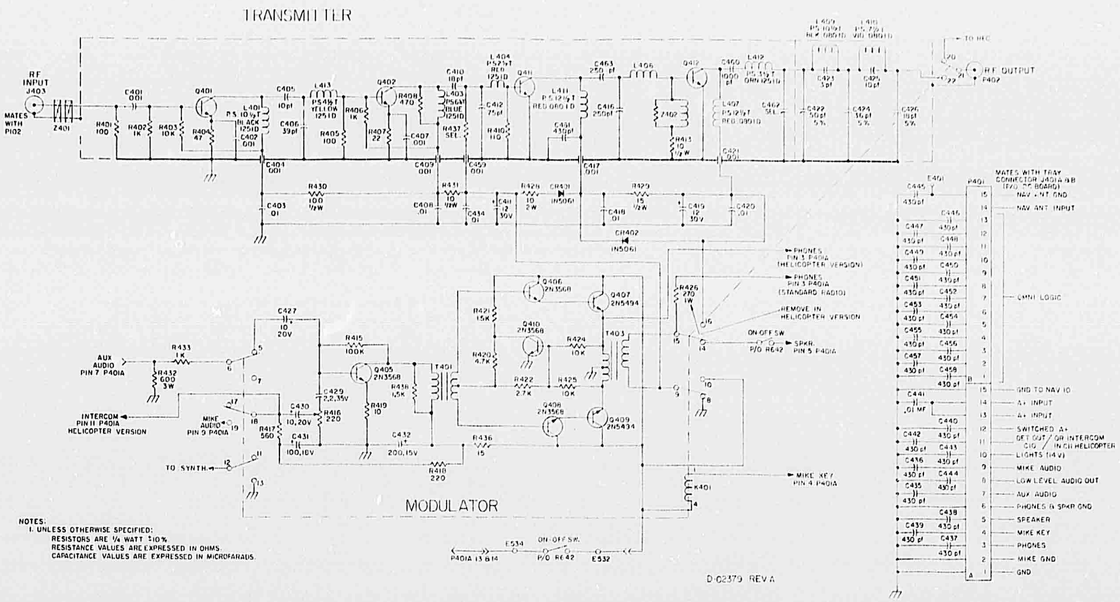
FIGURE 2-19. 28V INTERCONNECT WIRING DIAGRAM FOR NAV 114 TSO DME-UGR2A-DGO 10



C 55158 C
C 55943



C 55159 D
C 55999



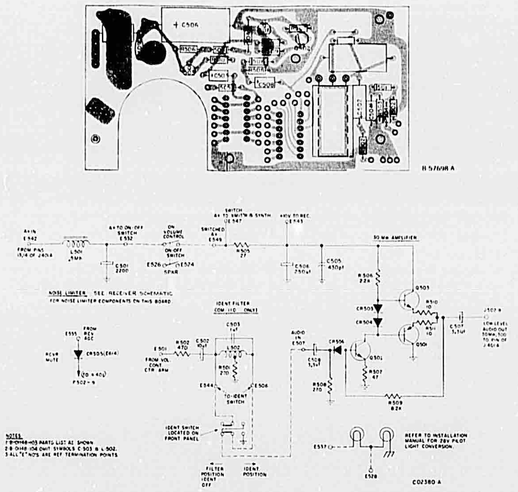


FIGURE 3.6-10 COM 110 TSO INTERCONNECT PC BOARD SCHEMATIC

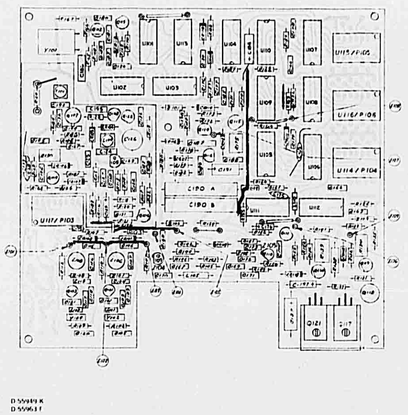


FIGURE 4.5-3 SYNTHESIZER BOARD, COM 111 TSO

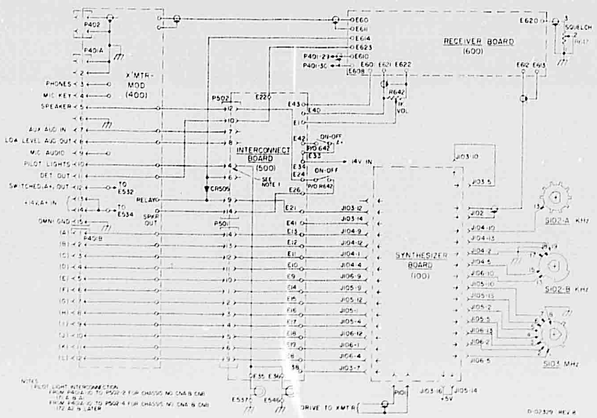
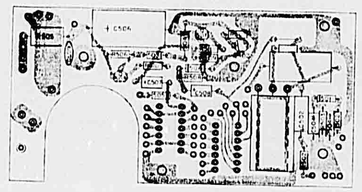


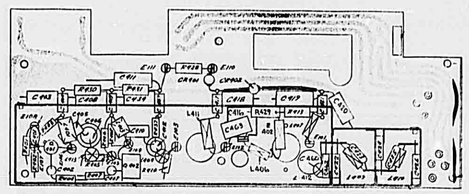
FIGURE 4.6-1 INTERNAL INTERCONNECT DIAGRAM, COM 111 TSO



B 5761/68 A

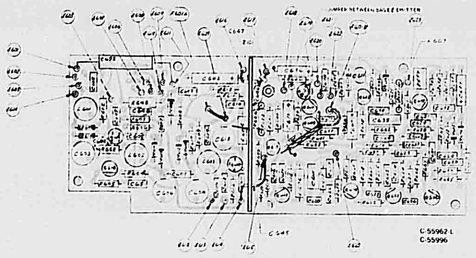
FIGURE 4.5-4 INTERCONNECT BOARD, COM 111 TSO

Fig. & Index No.	Part Number	Description
4.5-4	01148-0104	INTERCONNECT BOARD, COM 111 TSO (See Fig. 4.5-1 for NHA)
C-502	21555-0026	CAPACITOR, TANTALUM, 10 mf, 20V
C-504	21555-0016	CAPACITOR, TANTALUM, 3.3 mf, 15V
C-505	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf, ±10%, 500V
C-506	21554-0051	CAPACITOR, ELECTROLYTIC, 250 mf, 20V
C-507	21555-0016	CAPACITOR, TANTALUM, 3.3 mf, 15V
C-508	21555-0016	CAPACITOR, TANTALUM, 3.3 uf, 15V
C-509	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-510	21554-0019	CAPACITOR, 100 mf, 18V (CNB17JA2 and later)
CR-501	75028-0001	DIODE, SILICON
CR-502	75028-0001	DIODE, SILICON
CR-503	75028-0001	DIODE, SILICON
CR-504	75028-0001	DIODE, SILICON
CR-505	75028-0001	DIODE, SILICON
CR-506	75028-0001	DIODE, SILICON
Q-501	75558-0006	TRANSISTOR, 2N5811
Q-502	75550-0002	TRANSISTOR, 2N3391
Q-503	75558-0005	TRANSISTOR, 2N5810
R-502	31192-0471	RESISTOR, CARBON, 470 ±10%, ¼W
R-503	31192-0154	RESISTOR, CARBON, 150K ±10%, ¼W
R-504	31192-0333	RESISTOR, CARBON, 33K ±10%, ¼W
R-505	31196-0003	RESISTOR, WIREWOUND, 27 ±5%, 2W
R-506	31192-0222	RESISTOR, CARBON, 2.2K ±10%, ¼W
R-507	31192-0470	RESISTOR, CARBON, 47 ±10%, ¼W
R-508	31192-0271	RESISTOR, CARBON, 270 ±10%, ¼W
R-509	31192-0822	RESISTOR, CARBON, 8.2K ±10%, ¼W
R-510	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
R-511	31192-0100	RESISTOR, CARBON, 10 ±10%, ¼W
J-104	41322-0001	SOCKET I. C. SOLDER TAIL
J-105	41322-0001	SOCKET I. C. SOLDER TAIL
J-106	41322-0001	SOCKET I. C. SOLDER TAIL
J-103	41322-0002	SOCKET I. C. SOLDER TAIL
	41278-0008	LAMPHOLDER, SUBMINIATURE

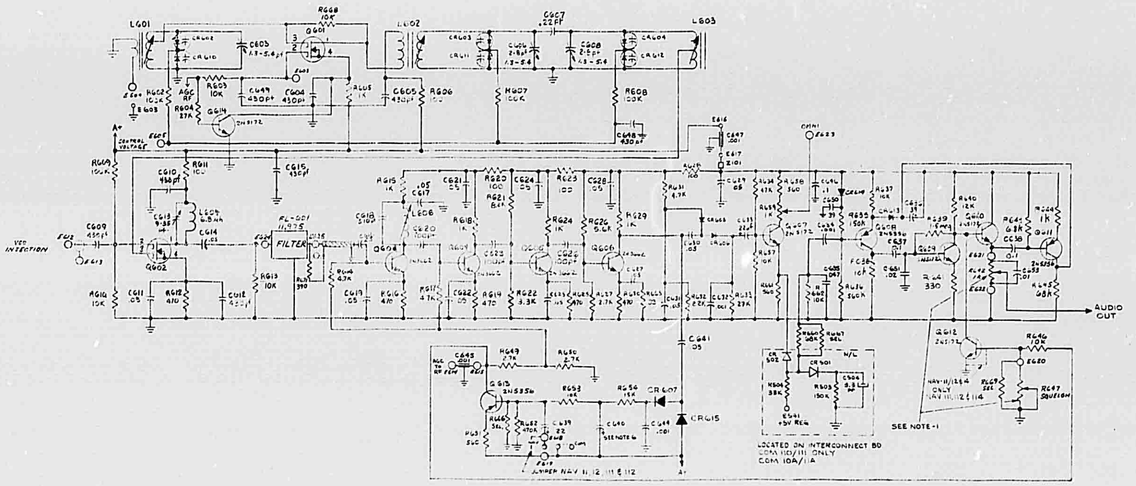


C-55158
C-55943

FIGURE 4.5-6 TRANSMITTER PC BOARD, COM 111 TSO



C-55962 L
C-55996



NOTES:
1- R642 & R643 ARE PART OF FRONT PANEL B-01154 PARTS LIST.
2- COM 110/11A & COM 111/11A B-01147-111 PARTS LIST AS SHOWN. (ALSO COM 110/111)
3- NAV 111/112/114 B-01147-2 CKT SYMBOLS R656, CR609, R655, C602, R651, CR 601, C601, R658, C612, R657, R660 (ALSO NAV 111, 112, 114)
4- ALL RESISTORS ARE IN OHMS ±5% ¼ W, CARBON COMP EXCEPT AS NOTED.
5- ALL CAPACITORS ARE IN MF EXCEPT AS NOTED.
6- 240 MMF FOR COM 110, NAV 111, NAV 112 & NAV 114 COM 110 NAV 111, NAV 112 & NAV 114.
3.3MF COM 11A, COM 111.

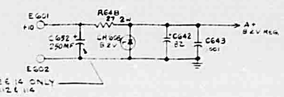
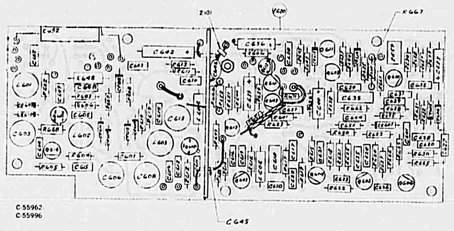


FIGURE 4.6-2 RECEIVER SCHEMATIC, COM 111 TSO



C 55962
C 55996

FIGURE 3.5-13 RECEIVER BOARD, COM 110 TSO

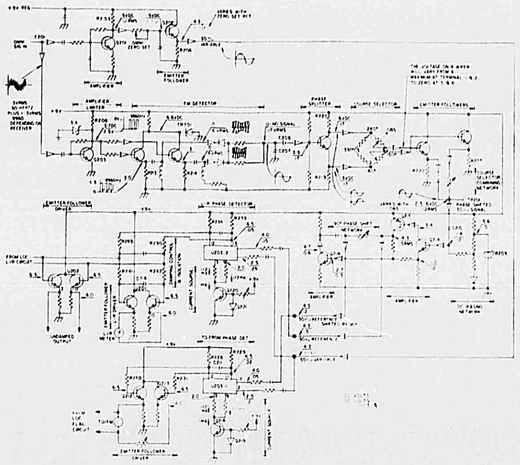
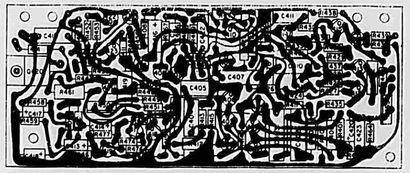


FIGURE 3.6-1 NAV 110 TSO OMNI MAINTENANCE INFORMATION



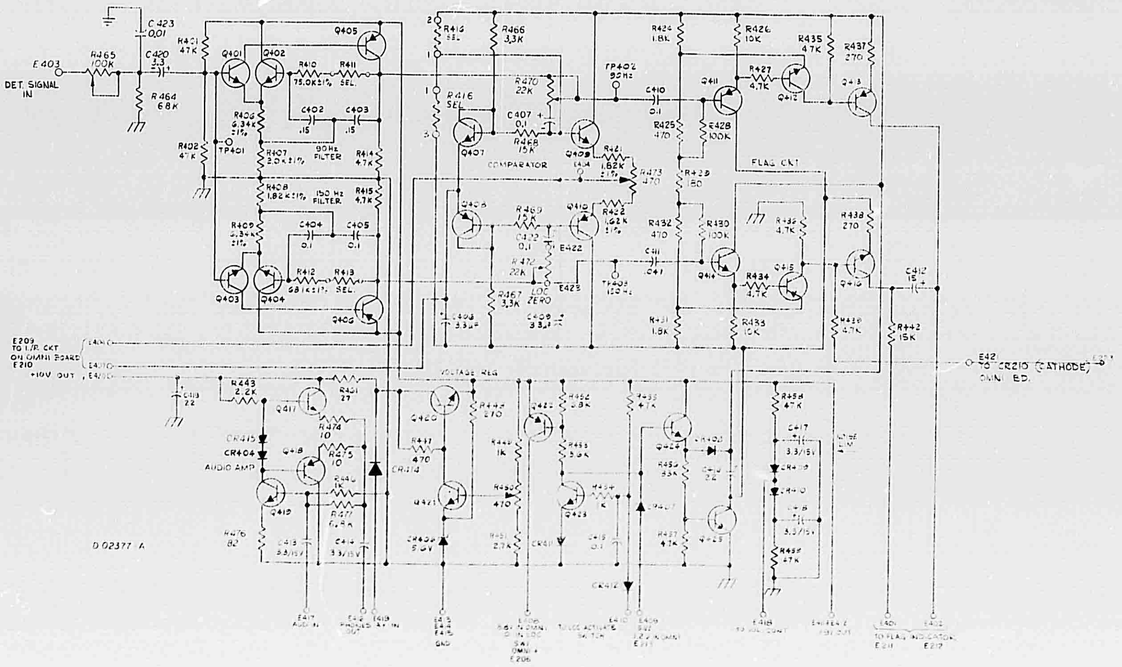


FIGURE 3.6-5 NAV 110 TSO LOCALIZER SCHEMATIC

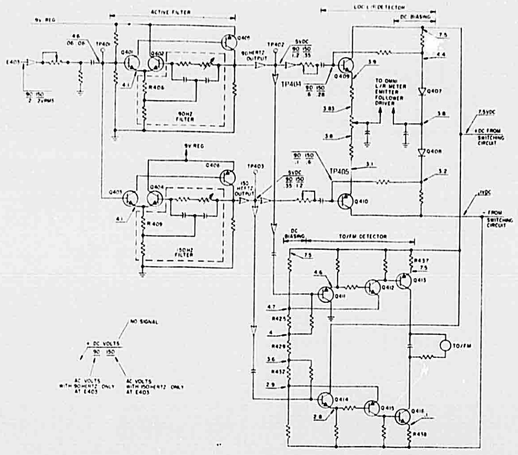


FIGURE 3.6-2 NAV 110 TSO LOCALIZER MAINTENANCE INFORMATION

NAV 110 TSO DME CHANNEL PROGRAMMING

NARCO	ARINC	NAV J104	MHz CHANNELS 108	109	110	111	112	113	114	115	116	117
B	A	1	X	X		X	X					
C	B	2			X	X		X	X			
D	C	3					X	X		X	X	
E	D	4	X						X	X		X
A	E	5		X	X						X	X

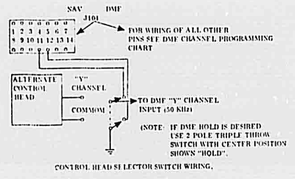
			KHz CHANNELS .00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95
F	F	6			X	X	X	X											X	X	X	X
H	G	7	X	X	X	X			X	X	X	X										
J	H	8					X	X	X	X			X	X	X	X						
K	J	9									X	X	X				X	X	X	X		
L	K	10	X	X										X	X	X	X	X			X	X
"Y" CHANNEL ACT.		11		Y		Y		Y		Y		Y		Y		Y		Y		Y		Y
DME COMMON		12																				
SPARE		13																				
GROUND		14																				

NOTES:

1. "X" indicates continuity to the DME common terminal, P104-12
2. "Y" indicates continuity to the ground terminal, P104-14
3. DME common P104-12 must be grounded for DME channeling to operate

A. For DME frequency control by NAV 110 TSO only, P104-12 may be connected to P104-14.

B. When the NAV 110 TSO with DME is used as one of two DME frequency control heads, P104-11 and P104-12 should be wired to one side of a double pole double thrown control head selector switch.



NAV 110 TSO DME PIGTAIL CONNECTOR

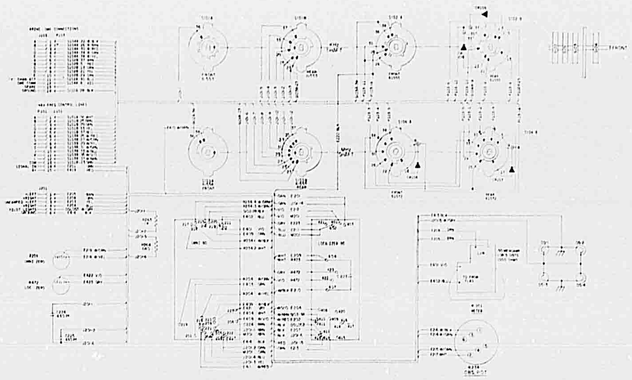


FIGURE 3.6-3 NAV 110 TSO INTERNAL INTERCONNECT DIAGRAM

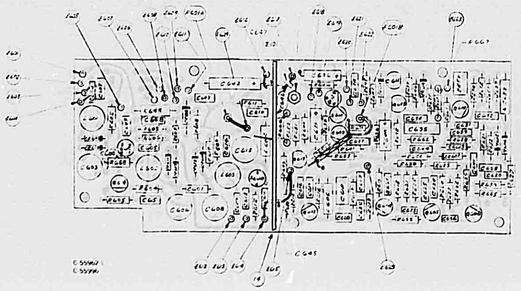
NOTE:

Since the introduction of this Unit, there have been two external outputs provided. One called external L/R at P101, pins 5 & 7 (to drive another meter) and one called undamped output at P101, pins 2 & 4.

Field experience has shown that the external L/R output (pins 5 & 7) is more compatable with autopilots than the undamped output (pins 2 & 4).

Therefore U202, R249, and R264 were removed from the Unit leaving pins 2 & 4 unused. This deletion started with chassis number:

NAV 10 — CNC171B11
NAV 11 — CNA194D3
NAV 12 — CNB194D3
NAV 110 — CNC219A5
NAV 111 — CND 219B3
NAV 112 — CNE 219B3



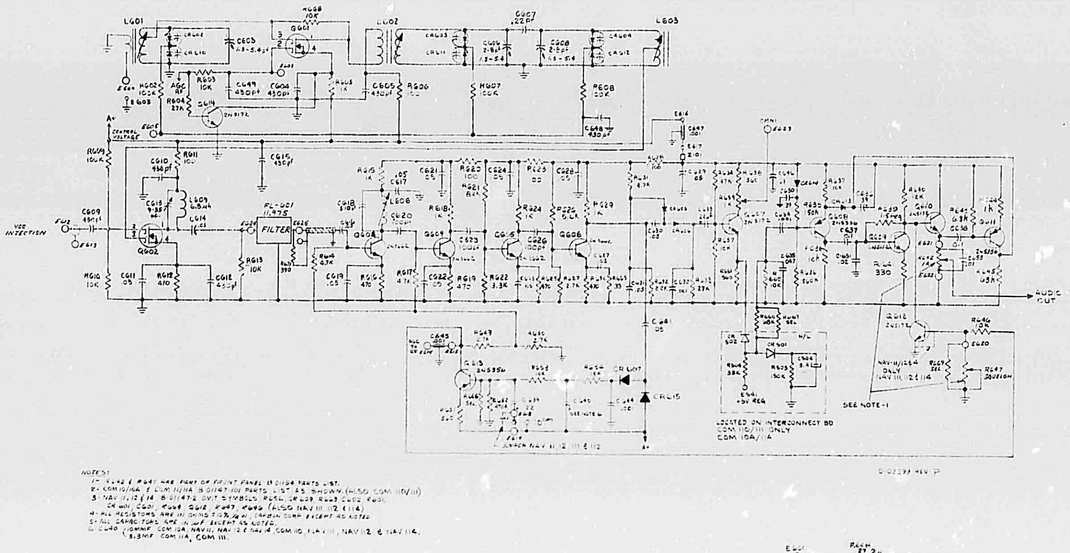
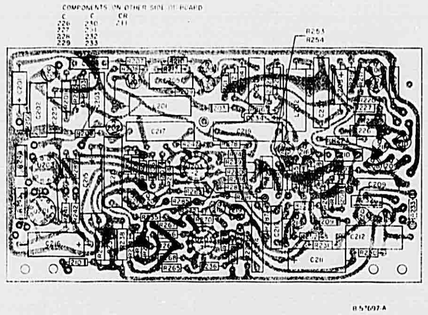
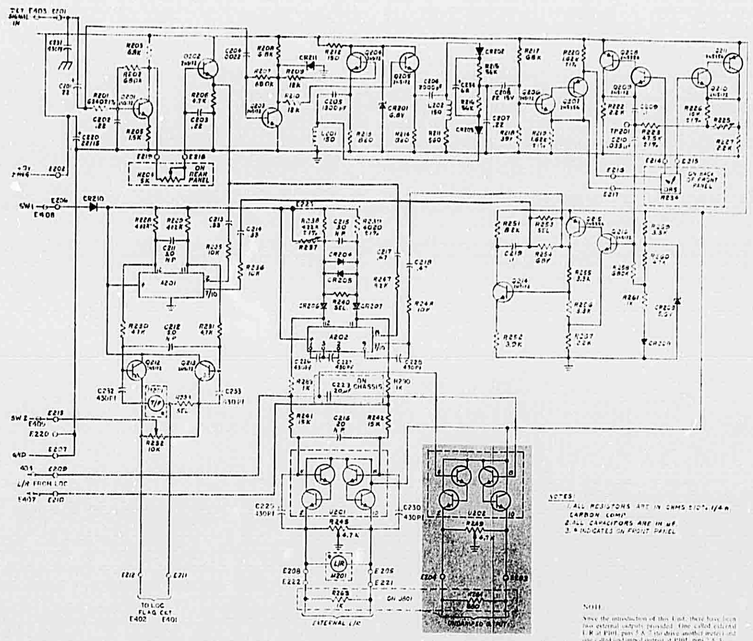
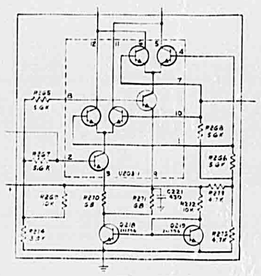


FIGURE 3.6-7 COM 110 TSO RECEIVER SCHEMATIC







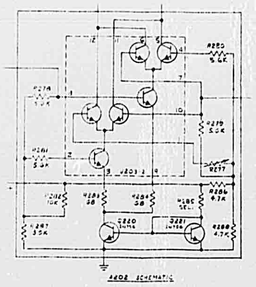
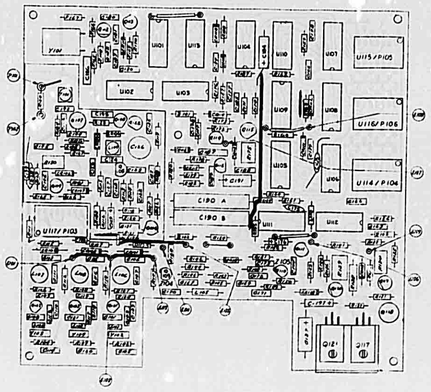


FIGURE 3.6-4 NAV 110 TSO OMNI SCHEMATIC



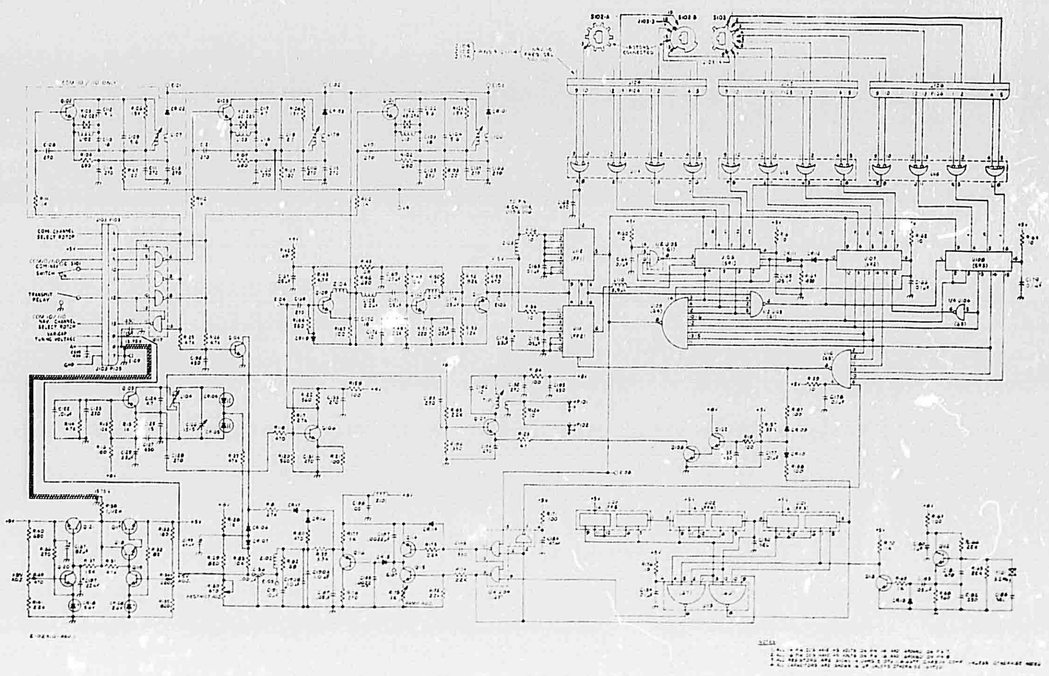
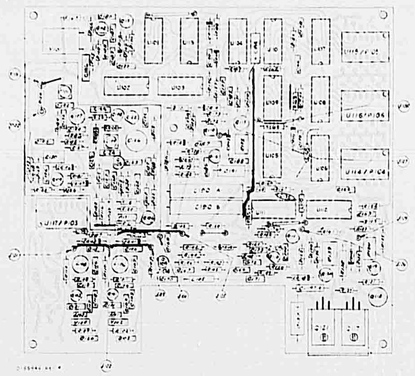


FIGURE 3.6-8 COM 110 TSO SYNTHESIZER SCHEMATIC



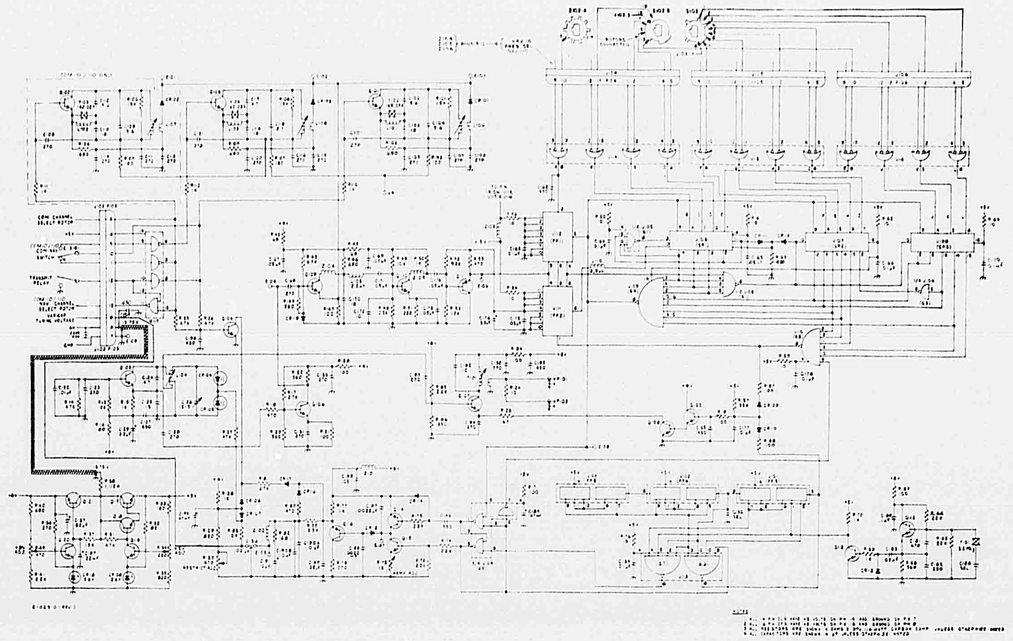


FIGURE 4.6-3 SYNTHESIZER SCHEMATIC, COM 111 TSO

FIGURE 4.6-3 SYNTHESIZER SCHEMATIC, COM 111 TSO

5.3.5 Localizer Circuitry

The signal from the receiver is applied to the Localizer Circuitry at E403.

R465, controls the signal level to the active filters and thus controls the LOC course width.

A. 90 Hz Filter

The 90 and 150 Hertz audio signal is fed thru C420 to the electronic filter. R401 and R402 bias the base of Q401 to about 4.6 volts DC.

Q401 and Q402 form a differential amplifier with the output taken from the collector of Q401. This output drives the base of the single stage amplifier, Q405. The output from Q405 is developed across load resistor R414 and drives the To-From and Left-Right Detectors. The output from Q405 also feeds a bridge T audio filter (R410, R411, R407, C402, C403, and R406) that is tuned to 90 Hz.

NOTE: For determining the filter frequency the two resistors (R406 and R407 etc.) act as if they are connected in parallel. The bridge T filter has a notch response.

The output of the bridge T filter is applied to the base of Q402 (1/2 of the differential amplifier). If an audio frequency signal other than the notch frequency is applied to the base of Q401, it is amplified by Q401, applied to the base of Q405, amplified by Q405, and passed back thru the bridge T filter to the base of Q402. This voltage at the base of Q402 is of the proper phase (negative feedback) to oppose the voltage applied to the base of Q401. The net result is that because of the feedback canceling, the voltage output at the collector of Q405 is low.

If a signal is applied at the notch frequency, the process is the same, except that the filter passes very little of the signal. There is thus little voltage applied to the base of Q402 and little canceling, and the voltage at the collector of Q405 will be large. Since the feedback network plays a dominant role in determining the gain of the circuit, the gain is quite independent of variations among transistors.

The gain and center frequency of the filter amplifiers is dependent on the exact values of the bridge T filter components. Because of normal component tolerances, R411 is selected during production to tune the filter to 90 Hz.

B. 150 Hz Filter

The 150 Hertz filter is the same as the 90 Hertz filter except for the values of the components in the bridge T filter that tune it to 150 Hertz instead of 90 Hertz.

C. Left-Right Detector

The 90 and 150 Hertz signal amplitudes are attenuated by R-470 and R-472 and then applied to the Left-Right Detector. Q409 and Q410, Q407 and Q408 are connected as diodes and along with R466 and R467 form a DC biasing network. Q409 amplifies the 90 Hertz signal and Q410 amplifies the 150 Hertz signal. If equal 90 and 150 Hertz signals are applied, the voltage at E404 will not change. If the 90 and 150 Hertz signals are unequal, the voltage at E404 will move and the Left-Right needle will deflect.

D. To-From Detector

R424, R425, R429, R432, and R431 form a DC biasing network for the To-From Detector, the 90 and 150 Hertz signals are amplified and applied to Q413 and Q416. If both signals are present, Q413 and Q416 are both turned ON and current will be applied to the flag meter.

FIGURE 5.3-4 BRIDGE T FILTER

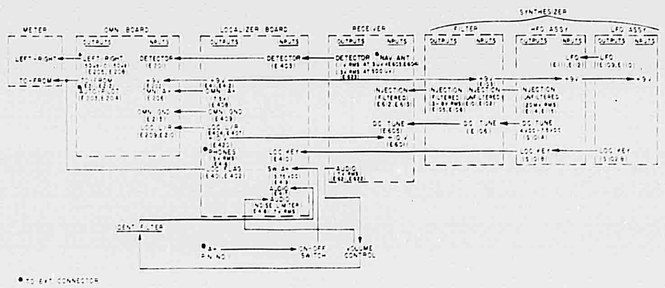


FIGURE 5.4-1. NAV 111 TSO/NAV 112 TSO INTERNAL INTERCONNECT

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
RESISTORS ARE 1/4 WATT ±10%
RESISTANCE VALUES ARE EXPRESSED IN OHMS.
CAPACITANCE VALUES ARE EXPRESSED IN MICROFARADS.

FIGURE 4.6-4 TRANSMITTER/MODULATOR SCHEMATIC, COM 111 TSO

FIGURE 5.5-5 LOCALIZER BOARD, NAV 111 TSO/ NAV 112 TSO

FIGURE 5.5-6 OMNI BOARD, NAV 111 TSO/ NAV 112 TSO

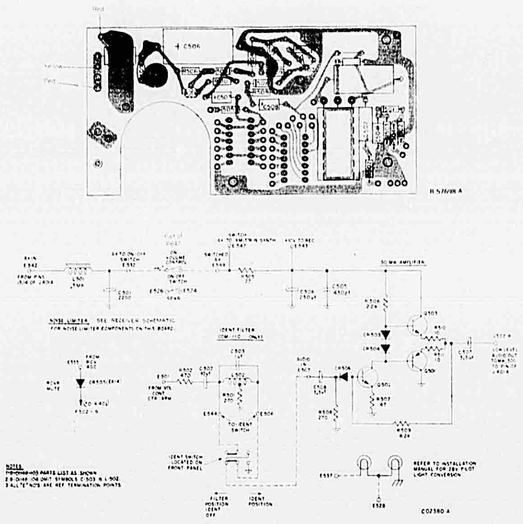


FIGURE 4.6-5 INTERCONNECT PC BOARD SCHEMATIC

5.3.2 Continued

The output, E204 and E203, from the emitter followers is a voltage of approximately 150 millivolts for a 10 degree phase difference. This voltage will be only slightly effected by the load connected to the output. Therefore if a high impedance autopilot or a 1000 ohm standard meter is connected to the output, the voltage output will be the same.

The output of U201 is connected to the Left-Right meter. The Left-Right meter has more damping than the undamped output of U202 because C216 damps the Left-Right needle, however C216 has little effect on the undamped U202 because it is isolated by R241 and R242.

5.3.3 NAV 111 TSO/NAV 112 TSO To-From Detector

The reference 30 Hertz channel is shifted 90 degrees and applied to the To-From Phase Detector.

Essentially this detector operates the same as the Left-Right Phase Detector. The only appreciable difference is that there is no gain adjustment resistor connected across pins 11 and 12 of A201. (A202 has resistor R240) Flag current is set by R233.

5.3.4 NAV 111 TSO/NAV 112 TSO OMNI/LOC Switching Circuits

Electronic switching is used for OMNI and Localizer operation. Refer to Figure 5.3-3.

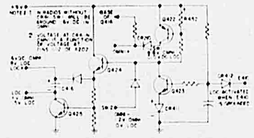


FIGURE 5.3-3. OMNI/LOC SWITCHING

OMNI MODE

In OMNI mode the Localizer activate lead (terminal E410) is open (ungrounded). Q423 is therefore turned ON by current flow thru R454 and R455. This brings SW2 (E409) to approximately ground potential.

With Q423 ON, the current flow causes a voltage drop across R452 turning Q422 ON. With Q422 ON, SW1 (E408) is brought to approximately 9 volts. With Q423 ON, the base of Q424 is connected to ground causing Q424 to be turned OFF. With Q424 OFF, there is no drive to Q425, thus Q425 is OFF.

With Q424 and Q425 OFF, the Localizer + (plus) and – (minus) leads are floating as if they were not connected. The Localizer Left-Right and To-From detectors have no voltage applied to them so that even though they are still connected to the OMNI circuit, they do not effect the OMNI Left-Right or To-From indicators. The voltage measured at each side of C416 during OMNI operation (about 6 volts) is the result of the voltage fed into the Localizer from the L-R and To-From circuits.

In OMNI operation Q424 and Q425 could be removed from the circuit with no change in operation. Also while in OMNI operation, as a result of the voltage (+9v) applied by the switching circuits (SW1), CR210, CR206, and CR207 are closed, and the wiper of R232 is grounded.

LOCALIZER MODE

In Localizer mode E410 is grounded by the channeling switches.

Diode CR412 prevents sneak paths from activating the Localizer when the Localizer activate is used for activating other equipment such as a glide slope receiver or autopilot coupling.

When Q423 is turned OFF, the current thru R452 decreases so the voltage across R452 decreases and Q422 is turned OFF.

SW2 is no longer at ground potential so the OMNI To-From flag emitter follower drivers, Q212 and Q213, are OFF and the To-From flag is free to follow the Localizer command.

SW1 is no longer connected to +9 volts which turns OFF the OMNI Left-Right and To-From Phase Detectors.

When Q423 is OFF, the collector of Q423 increases in voltage turning Q424 ON. When Q424 is ON it turns Q425 ON. When Q424 is ON it supplies +9 volts to the Localizer circuitry. When Q425 is ON it grounds the negative side of the Localizer circuitry. The Localizer is thus operational.

CR411 gives a small (.5 volt) bias to Q423 to compensate for the .5 volt drop across CR412.

Diodes CR210, CR407, and CR408 prevent current from flowing from the OMNI circuit to the switching circuitry when in Localizer mode and prevents current from flowing from the Localizer circuitry to the switching circuitry when in OMNI mode.

In Localizer mode, Q422 and Q423 could be removed with no change in operation.

NAV 111 TSO/NAV 112 TSO REPLACEMENT PARTS LIST

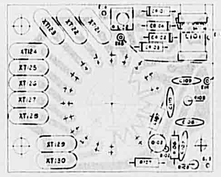


FIGURE 5.5-7 SYNTHESIZER HFO ASSY

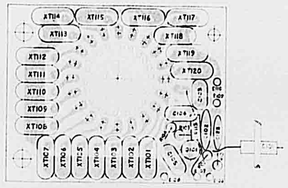


FIGURE 5.5-8 SYNTHESIZER LFO ASSY

Fig. & Index No.	Part Number	Description	Used on
		A - SYNTHESIZER LFO ASSY, NAV 111 TSO and NAV 112 TSO	
		B - SYNTHESIZER LFO ASSY, NAV 111 TSO and NAV 112 TSO with DME	
5.5-8	01150-0102	SYNTHESIZER LFO ASSY (without DME) (See Fig. 5.5-1 for Next Higher Assy)	A
5.5-8	01150-0106	SYNTHESIZER LFO ASSY (with DME) (See Fig. 5.5-1 for Next Higher Assy)	B
	82901-0101	NUT, SWAGE, #4-40	ALL
	55888-0001	BOX, LFO	ALL
	55889-0001	COVER, LFO	ALL
	82900-0003	NUT, HEX, #4-40 x 3/16	ALL
	81290-0001	NUT, U, #2	ALL
	82958-0002	SCREW, TAP TITE, PAN HD, #4-40 x 3/16, SLOTTED	ALL
	81307-0099	WASHER, FLAT	ALL
	82814-0007	SCREW, MACH, 4-40 x ½ BIND HD, SLOTTED	ALL
	55740-0003	BEARING PLATE	ALL
	81206-0061	SPACER .187 LG	ALL
	82802-0003	LOCKWASHER, INTERNAL TEETH, #4	ALL
	82801-0001	LOCKWASHER, EXTERNAL TEETH, #4	ALL
	81254-0037	EYELET, SE-43	ALL
	82814-0010	SCREW, MACH, #4-40 x ⅝ BINDING HD, SLOTTED	ALL
C 101	21296-0003	CAPACITOR, CERAMIC, FEEDTHRU, .001, 500V	ALL
C 102	21291-0005	CAPACITOR, CERAMIC DISC, .01 ±20%, 50V	ALL
C 103	24052-0361	CAPACITOR, DIPPED MICA, 360 pf	ALL
C 104	24052-0101	CAPACITOR, DIPPED MICA, 100 pf	ALL
C 105	24052-0201	CAPACITOR, DIPPED MICA, 200 pf	ALL
C 123	21291-0029	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V	ALL
Q 101	75588-0003	TRANSISTOR, 2N3662	ALL
R 101	31192-0101	RESISTOR, CARBON, 100 ±10%, ¼W	ALL
R 102	31192-0103	RESISTOR, CARBON, 10K ±10%, ¼W	ALL
R 103	31192-0153	RESISTOR, CARBON, 15K ±10%, ¼W	ALL
R 104	31192-0102	RESISTOR, CARBON, 1K ±10%, ¼W	ALL
R 113	31192-0470	RESISTOR, CARBON, 47 ±10%, ¼W	ALL
R 127	31192-0561	RESISTOR, CARBON, 560 ±10%, ¼W	ALL
S 102	61548-0001	SWITCH, KHz, LOCALIZER	B
S 102	61550-0001	SWITCH, KHz, LOCALIZER/DME	A
XT 101	72033-0001	CRYSTAL, FUND MODE, 22.525 MHZ	B
XT 102	72033-0002	CRYSTAL, FUND MODE, 22.575 MHZ	ALL
XT 103	72033-0003	CRYSTAL, FUND MODE, 22.625 MHZ	ALL
XT 104	72033-0004	CRYSTAL, FUND MODE, 22.675 MHZ	ALL
XT 105	72033-0005	CRYSTAL, FUND MODE, 22.725 MHZ	ALL
XT 106	72033-0006	CRYSTAL, FUND MODE, 22.775 MHZ	ALL
XT 107	72033-0007	CRYSTAL, FUND MODE, 22.825 MHZ	ALL
XT 108	72033-0008	CRYSTAL, FUND MODE, 22.875 MHZ	ALL
XT 109	72033-0009	CRYSTAL, FUND MODE, 22.925 MHZ	ALL
XT 110	72033-0010	CRYSTAL, FUND MODE, 22.975 MHZ	ALL
XT 111	72033-0011	CRYSTAL, FUND MODE, 23.025 MHZ	ALL
XT 112	72033-0012	CRYSTAL, FUND MODE, 23.075 MHZ	ALL
XT 113	72033-0013	CRYSTAL, FUND MODE, 23.125 MHZ	ALL
XT 114	72033-0014	CRYSTAL, FUND MODE, 23.175 MHZ	ALL
XT 115	72033-0015	CRYSTAL, FUND MODE, 23.225 MHZ	ALL
XT 116	72033-0016	CRYSTAL, FUND MODE, 23.275 MHZ	ALL
XT 117	72033-0017	CRYSTAL, FUND MODE, 23.325 MHZ	ALL
XT 118	72033-0018	CRYSTAL, FUND MODE, 23.375 MHZ	ALL
XT 119	72033-0019	CRYSTAL, FUND MODE, 23.425 MHZ	ALL
XT 120	72033-0020	CRYSTAL, FUND MODE, 23.475 MHZ	ALL

Fig. & Index No.	Part Number	Description
5.5-9	011501-0103	SYNTHESIZER FILTER ASSY (See Fig. 5.5-1 for Next Higher Assy)
	55964-0001	COVER, FILTER
	55960-0002	BRACKET, FILTER
	81704-0037	EYELET, SE-43
	50838-0002	CAN, SHIELD
	81795-0001	RECEPTACLE
C-111	24516-0180	CAPACITOR, DIPPED MICA, 18 pf
C-113	24309-0109	CAPACITOR, CERAMIC, 1.0 pf ±5%, 500V
C-114	21291-0025	CAPACITOR, CERAMIC DISC, 4.30 pf ±10%, 500V
C-115	24516-0150	CAPACITOR, CERAMIC DISC, 15 pf
C-117	21291-0025	CAPACITOR, CERAMIC DISC, 4.30 pf ±10%, 500V
C-119	24052-0750	CAPACITOR, DIPPED MICA, 75 pf
C-120	21291-0025	CAPACITOR, CERAMIC DISC, 4.30 pf ±10%, 500V
CR-105	76087-0001	DIODE, VAR. CAP.
L-103	11783-0001	COIL, FILTER
L-104	11783-0001	COIL, FILTER
L-109	11783-0002	COIL, FILTER
R-110	51252-0104	RESISTOR, CARBON, 100K ±10%, ¼W
R-111	51252-0101	RESISTOR, CARBON, 100 ±10%, ¼W
R-112	51252-0562	RESISTOR, CARBON, 5.6K ±10%, ¼W
U-101	74018-0001	INTEGRATED CIRCUIT, LINEAR

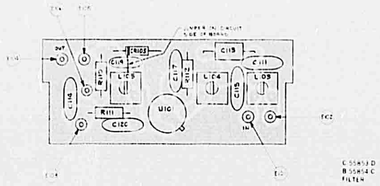


FIGURE 5.5-9 SYNTHESIZER FILTER ASSY

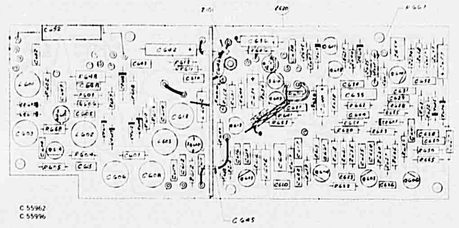


FIGURE 5.5-10 RECEIVER BOARD ASSY

FIGURE 5.6-3A INTERNAL INTERCONNECTION DIAGRAM WITH GLIDE SLOPE AND DME CONNECTIONS

NOTE

Since the introduction of this Unit, there have been two external outputs provided. One called external L/R at P101, pins 5 & 7 to drive another meter and one called undamped output at P101, pins 2 & 4.

Field experience has shown that the external L/R output (pins 5 & 7) is more compatible with autopilots than the undamped output (pins 2 & 4).

Therefore R 202, R249, and R264 were removed from the Unit leaving pins 2 & 4 unused. This deletion started with these numbers:

NAV 10 — CNC7B11
NAV 11 — CNA1429
NAV 12 — CNB1429
NAV 108 — CNC2945
NAV 109 — CND2948
NAV 112 — CNF2985

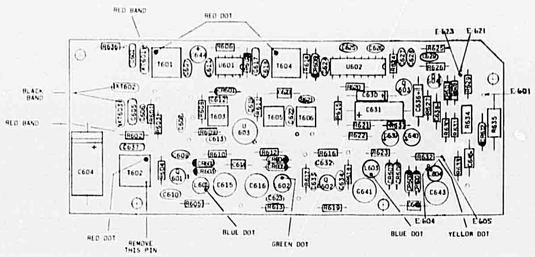


FIGURE 5.5-10A. RECEIVER (CHASSIS CND217C/CNE217C)

Symbol	Part Number	Description
	55850-2	CAN, SHIELD
C601	24052-100	CAPACITOR, Dipped Mica, 10pf ±1pf, 500V
C603	21554-51	CAPACITOR, Electrolytic, 250mf,20V
C605	24052-330	CAPACITOR, Dipped Mica, 33pf ±5%, 500V
C606	24515-5	CAPACITOR, Ceramic Disc, .05mf ±20%, 10V
C607	2415-5	CAPACITOR, Ceramic Disc, .05mf ±20%, 10V
C608	21291-25	CAPACITOR, Ceramic Disc, 430pf ±10%, 500V
C609	21291-31	CAPACITOR, Ceramic Disc, 390pf ±10%, 500V
C610	24515-5	CAPACITOR, Ceramic Disc, .05mf ±20%, 10V
C611	24515-5	CAPACITOR, Ceramic Disc, .05mf ±20%, 10V
C612	24052-470	CAPACITOR, Dipped Mica, 47pf ±5%, 300V
C613	21291-25	CAPACITOR, Ceramic Disc, 430pf ±10%, 500V
C614	24509-688	CAPACITOR, Ceramic Tub., 68pf ±5%, 500V
C615	22051-2	CAPACITOR, Variable, 1.3-5.4pf
C616	22051-2	CAPACITOR, Variable, 1.3-5.4pf
C617	24052-150	CAPACITOR, Dipped Mica, 15pf ±1pf, 500V
C618	2415-5	CAPACITOR, Ceramic Disc, .05mf ±20%, 10V
C619	21291-25	CAPACITOR, Ceramic Disc, 430pf ±10%, 500V
C620	24509-109	CAPACITOR, Ceramic Tub., 1.0pf ±5%, 500V
C621	24516-180	CAPACITOR, Ceramic Disc, 18pf ±10%, 500V
C622	24516-150	CAPACITOR, Ceramic Disc, 15pf ±10%, 500V
C623	21291-31	CAPACITOR, Ceramic Disc, 390pf ±10%, 500V
C624	21291-30	CAPACITOR, Ceramic Disc, .01mf ±20%, 50V
C625	24515-5	CAPACITOR, Ceramic Disc, .05mf ±5%, 10V
C626	24515-5	CAPACITOR, Ceramic Disc, .05mf ±5%, 10V
C627	21291-30	CAPACITOR, Ceramic Disc, .01mf ±20%, 50V
C628	24515-5	CAPACITOR, Ceramic Disc, .05mf ±5%, 10V
C629	21291-30	CAPACITOR, Ceramic Disc, .01mf ±20%, 50V
C630	21555-58	CAPACITOR, Tantalum, 6.8mf ±10%, 35V

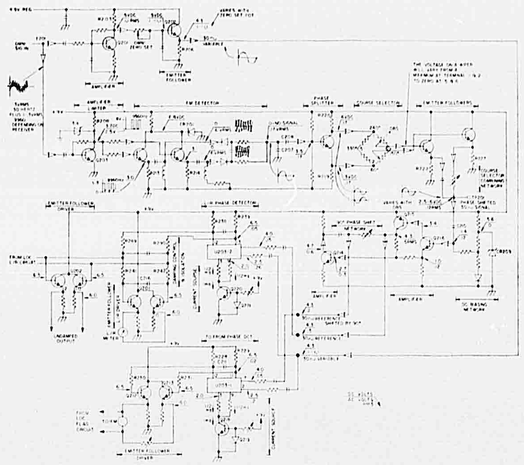
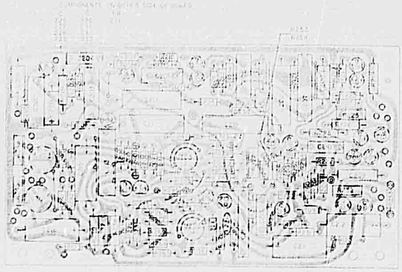
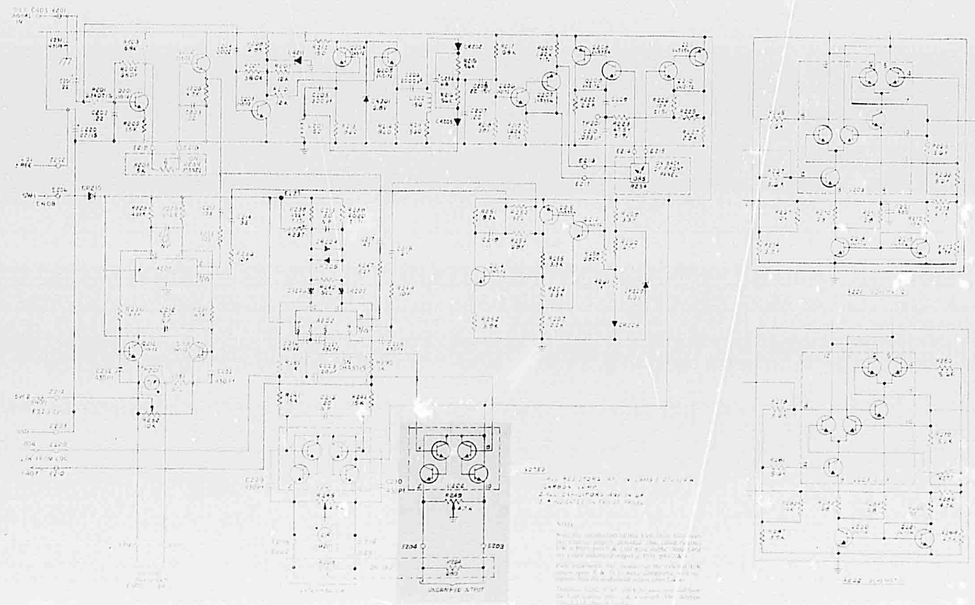


FIGURE 5.6-1 OMNI MAINTENANCE INFORMATION, NAV 111 TSO/NAV 112 TSO





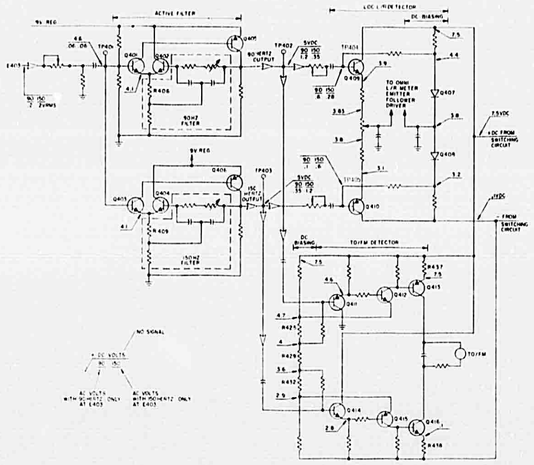
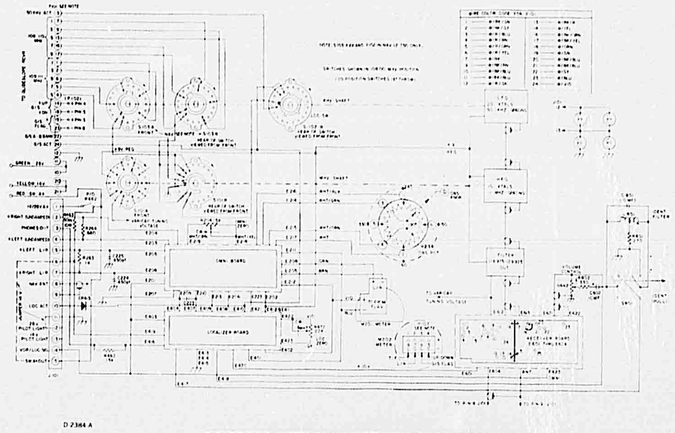


FIGURE 5.6-2 LOCALIZER MAINTENANCE INFORMATION, NAV 111 TSO/NAV 112 TSO



D 2364 A

FIGURE 5.6-3 INTERNAL INTERCONNECTION DIAGRAM WITH GLIDE SLOPE CONNECTIONS

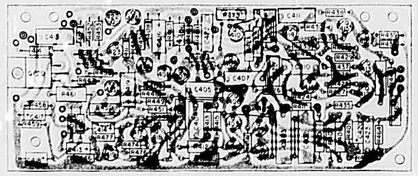
Note

Since the introduction of this Unit, there have been two external outputs provided. One called external L/R at P101, pins 5 & 7 to drive another meter) and one called undamped output at P101, pins 2 & 4.

Field experience has shown that the external L/R output (pins 5 & 7) is more compatible with receptors than the undamped output (pins 2 & 4).

Therefore U202, R249, and R264 were removed from the Unit leaving pins 2 & 4 unused. This deletion started with chassis number:

NAV 09 — CNU17H01
NAV 11 — CNA19D01
NAV 12 — CNB19D01
NAV 109 — CNU20A01
NAV 111 — CNA21D01
NAV 112 — CNE21D01



D 5496 A

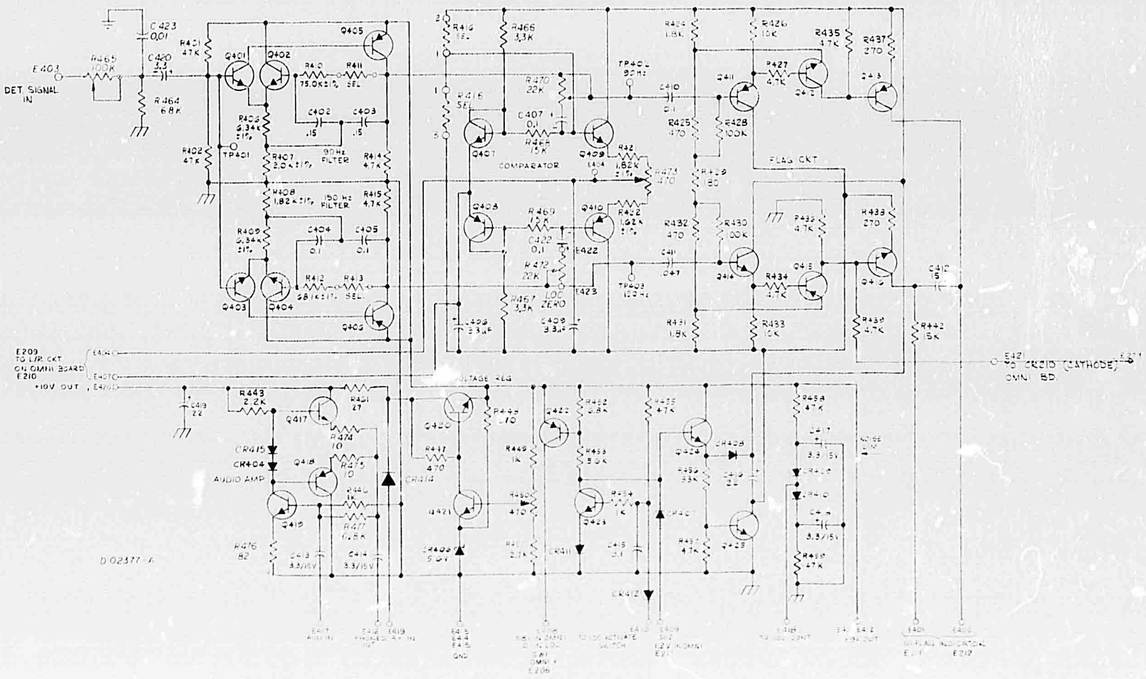
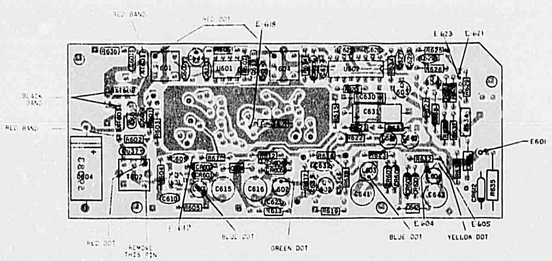


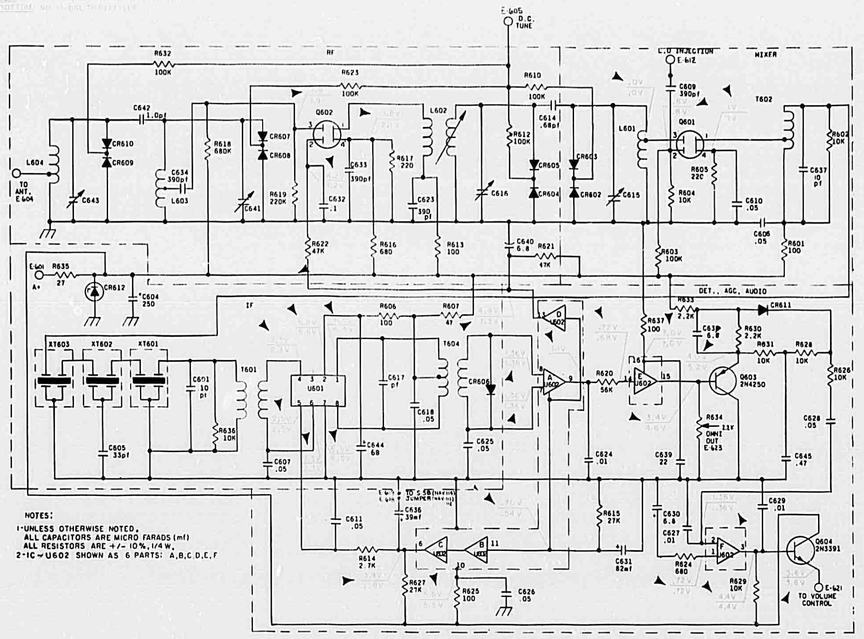
FIGURE 5.6-5 LOCALIZER SCHEMATIC, NAV 111 TSO NAV 112 TSO



Solder runs shown in PINK
are those on the TOP (component)
side of the board.

Solder runs shown in Gray
are those on the BOTTOM (non-component)
side of the board.

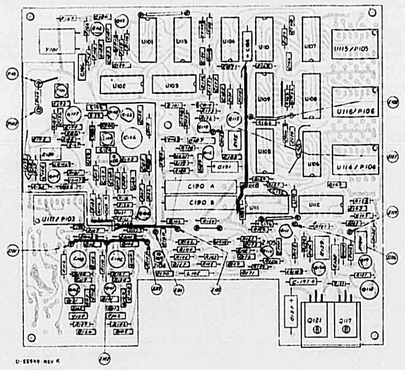
C-59084-B
D95129B



D92456-B
NAV 114

FIGURE 6.6-2A RECEIVER SCHEMATIC, (CHASSIS CNF219C)

FIGURE 6.6-2A RECEIVER SCHEMATIC, (CHASSIS CNF219C)



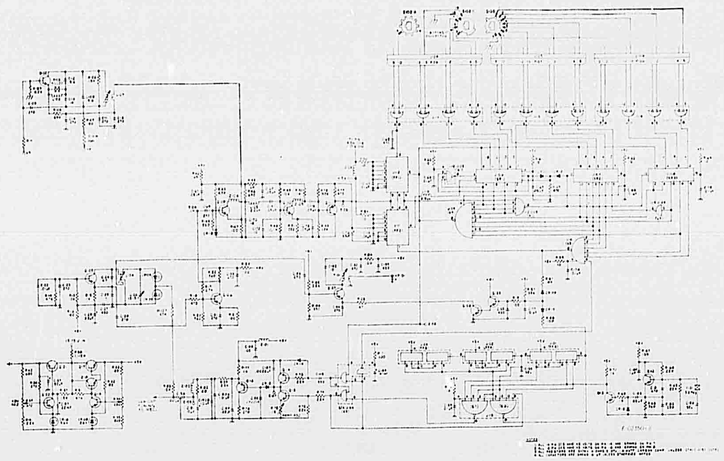


FIGURE 6.6-3 SYNTHESIZER SCHEMATIC

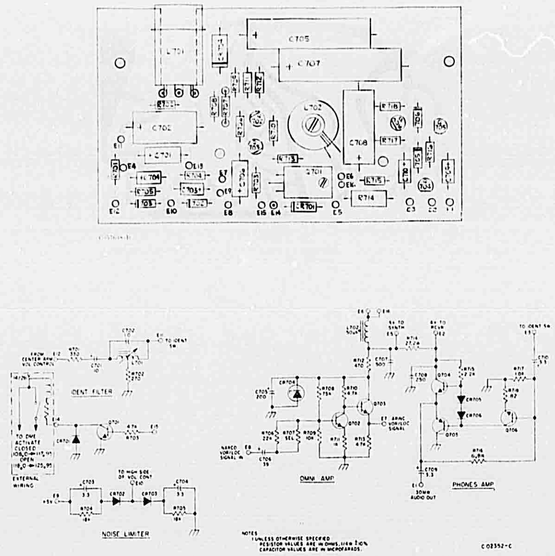
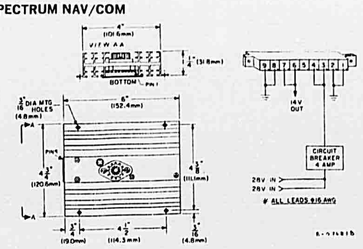


FIGURE 6.6-4 CONNECTOR BOARD SCHEMATIC

Weight: 1.0 pound (453 gr)

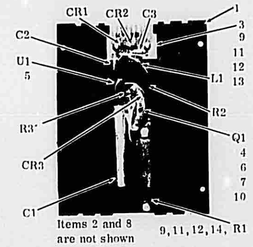
Current Capability:

2.0 amps continuous;
4.0 amps intermittent duty



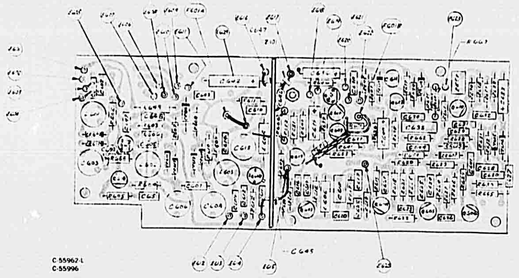
7.5 REPLACEMENT PARTS LIST

Item or Symbol #	Part No.	Description
1	55881-0001	Heat Sink
2	55882-0001	Cover, Heat Sink
3	55884-0001	PC Board
4	41325-0001	Socket, Trans. TO-3
5	41326-0001	Socket, Trans. TO-5
6	55020-0002	Insulator, TO-3
7	55880-0001	Cap, Insulator, TO-3
8	04431-0002	Nameplate
9	82804-0008	Screw, RH, 4-40 x 5/8
10	82823-0306	Screw, 6-20 x 3/8 RH
11	82802-0003	Lockwasher, Int. tooth, #4
12	82900-0004	Nut, Hex, #4-40
13	81206-0061	Spacer, .187 Lg.
14	81702-0004	Lug, Solder
C1	21554-0055	Capacitor, Elect. 400 mf 10%, 50V
C2	21555-0048	Capacitor, Tant. 1 mf 10%, 35V
C3	21555-0048	Capacitor, Tant. 1 mf 10%, 35V
CR1	75036-0003	Diode, Silicon, Multi-pellet
CR2	75025-0009	Diode, Zener, 18V
CR3	75036-0001	Diode, Silicon, Multi-pellet
L1	11487-0002	Choke, Filter, 50 mh -0 +20%, 2 amp
Q1	75609-0001	Transistor, Silicon, NPN, Darlington
R1	31134-0209	Resistor, Fixed, WW, 1 ohm, 20W
R2	F1135-0012	Choke, RF (used as a resistor)
R3	31192-0222	Resistor, Fixed Comp, 2.2K 10%, 1/4W
U1	74020-0001	IC, Voltage Reg. (8250)

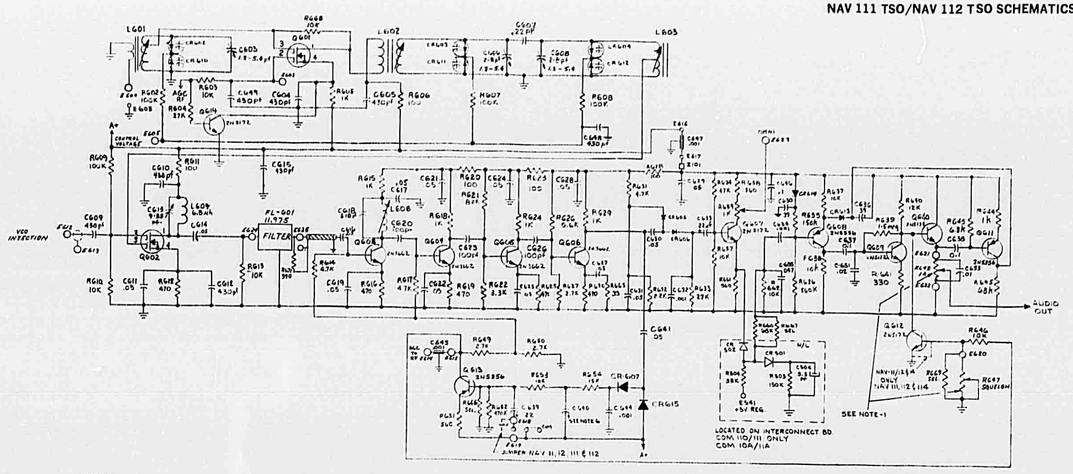


PART LOCATION DRAWING

7.6 SCHEMATIC



C 55962 L
C 55996



NOTES:
1- R642 & R647 ARE PART OF FRONT PANEL B 01154 PARTS LIST.
2- COM 10/10A & COM 11/11A B 01147-101 PARTS LIST AS SHOWN. (ALSO COM 110/111)
3- NAV 11, 12 & 14 B 01147-2 UNIT SYMBOLS, PL64, CR609, R663, C602, R601, CR601, C601, C606, C616, C617, C647, P662 (ALSO NAV 111, 112 & 114)
4- ALL RESISTORS ARE IN OHMS ±10%, ½ W, CARBON COMP EXCEPT AS NOTED.
5- ALL CAPACITORS ARE IN µF EXCEPT AS NOTED.
6- C640 150MMF, COM 10A, NAV 11, NAV 12 & NAV 14, COM 110, NAV 111, NAV 112 & NAV 114. 1.5MF COM 11A, COM 111.

D-02239 REV: P

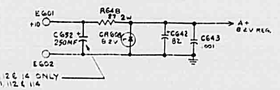
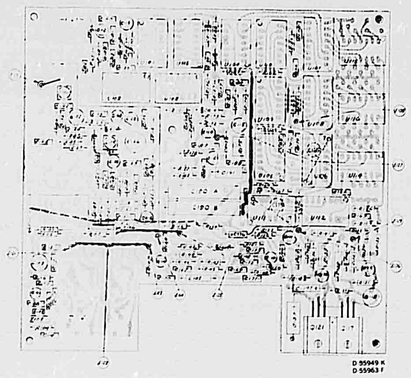
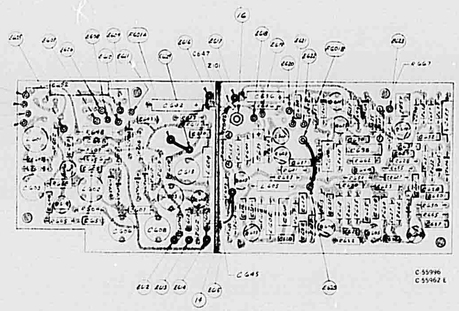


FIGURE 5.6-6 RECEIVER SCHEMATIC



D 55949 K
D 55963 F

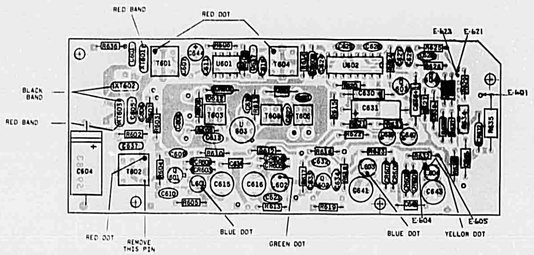
FIGURE 6.5-3 SYNTHESIZER BOARD ASSY, NAV 114 TSO



C 55990
C 55962 L

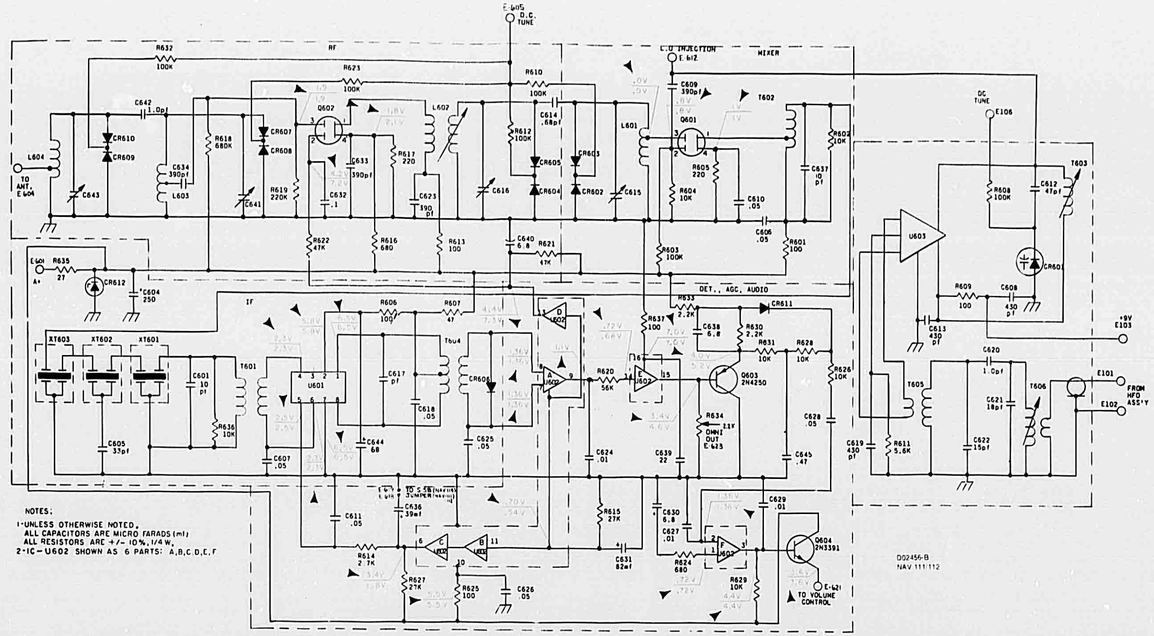
Fig. & Index No.	Part Number	Description
6.5-4	01147-0103	RECEIVER BOARD ASSY (See Fig. 6.5-1 for NHA)
	55969-0001	SHIELD
	82922-0001	NUT, HEX, #4-40
	81214-0012	SPACER, GENERAL (PHENOLIC)
	55849-0001	SPACER, FILTER
	56485-0001	CLIP, GROUNDING
C-603	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-604	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-605	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-606	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-607	24509-0228	CAPACITOR, CERAMIC, 22 pf ±5%, 500V
C-608	22051-0002	CAPACITOR, VARIABLE, 1.3-5.4 pf
C-609	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-610	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-611	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-612	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-613	22041-0002	CAPACITOR, VARIABLE 9 to 35 pf
C-614	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-615	21291-0025	CAPACITOR, CERAMIC DISC, 430 pf ±10%, 500V
C-616	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-617	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-618	24049-0511	CAPACITOR, DIPPED MICA, 510 pf ±5%, 500V
C-619	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±20%, 10V
C-620	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-621	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-622	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-623	24052-0101	CAPACITOR, DIPPED MICA, 100 pf ±5%, 300V
C-624	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V
C-625	24515-0005	CAPACITOR, CERAMIC DISC, .05 mf ±5%, 10V

...RECEIVER BOARD ASSY



Solder runs shown in Grey
are those on the "BOTTOM" (non-component)
side of the board.

Solder runs shown in PINK
are those on the "TOP" (component)
side of the board.



NOTES:
1. UNLESS OTHERWISE NOTED, ALL CAPACITORS ARE MICRO FARADS (mf) ALL RESISTORS ARE +/- 10%, 1/4 W.
2. IC-U602 SHOWN AS 6 PARTS: A,B,C,D,E,F

FIGURE 5.6-6A RECEIVER SCHEMATIC (CHASSIS CND219C/CNE219C

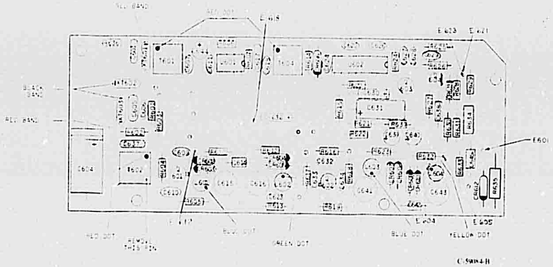


FIGURE 6.5-4A. RECEIVER PC BOARD - NAV 114

Symbol	Part Number	Description
	55650-2	CAN, SHIELD
C601	24052-100	CAPACITOR Dipped Mica, 10 pf ±1 pf, 500V
C604	21554-51	CAPACITOR Electrolytic, 250 mf, 20V
C605	24052-330	CAPACITOR Dipped Mica, 33 pf ±5%, 500V
C606	24515-5	CAPACITOR Ceramic Disc, .05 mf ±20%, 10V
C607	2415-5	CAPACITOR Ceramic Disc, .05 mf ±20%, 10V
C609	21291-31	CAPACITOR Ceramic Disc, 390 pf ±10%, 500V
C610	24515-5	CAPACITOR Ceramic Disc, .05 mf ±20%, 10V
C611	24515-5	CAPACITOR Ceramic Disc, .05 mf ±20%, 10V
C614	24509-680	CAPACITOR Ceramic Tub., .68 pf ±5%, 500V
C615	22051-2	CAPACITOR Variable, 1.3-5.4 pf
C616	22051-2	CAPACITOR Variable, 1.3-5.4 pf
C617	24052-150	CAPACITOR Dipped Mica, 15 pf ±1 pf, 500V
C618	2415-5	CAPACITOR Ceramic Disc, .05 mf ±20%, 10V
C623	21291-31	CAPACITOR Ceramic Disc, 390 pf ±10%, 500V
C624	21291-51	CAPACITOR Ceramic Disc, .01 mf ±20%, 50V
C625	24516-5	CAPACITOR Ceramic Disc, .05 mf ±5%, 10V
C626	24516-5	CAPACITOR Ceramic Disc, .05 mf ±5%, 10V
C627	21291-51	CAPACITOR Ceramic Disc, .01 mf ±20%, 50V
C628	24516-5	CAPACITOR Ceramic Disc, .05 mf ±5%, 10V
C629	21291-51	CAPACITOR Ceramic Disc, .01 mf ±20%, 50V
C630	21556-64	CAPACITOR Tantalum, 6.8 mf ±10%, 35V

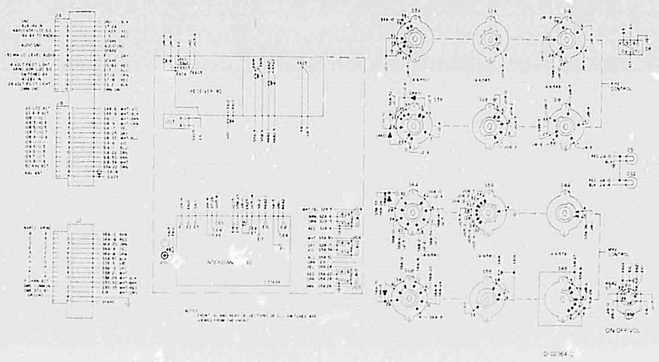
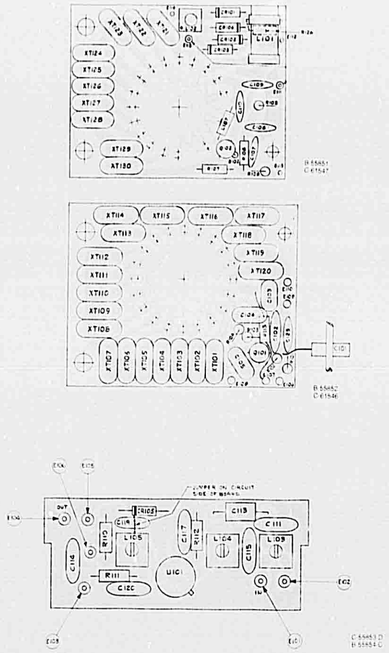


FIGURE 6.6-1 INTERNAL INTERCONNECT DIAGRAM, NAV 114 TSO



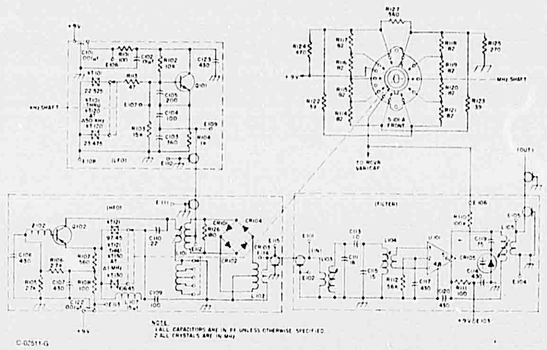


FIGURE 5.6-7 SYNTHESIZER SCHEMATIC, NAV 111 TSO/NAV 112 TSO

Fig. & Index No.	Part Number	Description
6.5-2	01176-0101	CONNECTOR BOARD (See Fig. 6.5-1 for NHA)
	81307-0012	WASHER, FIBER
	82864-0008	SCREW, MACH, #4-40 x 5/8, RD HD, SLOTTED, (NYLON)
	82922-0001	NUT, HEX, #4-40 (KEPS)
	82814-0003	SCREW, MACH, #4-40 x 1/4 RD HD, SLOTTED
C701	21555-0026	CAPACITOR, TANTALUM, 10MF, 20V
C702	23100-0013	CAPACITOR, POLYCARB, 1.0 MF
C703	21555-0016	CAPACITOR, TANTALUM, 3.3 MF, 15V
C704	21555-0016	CAPACITOR, TANTALUM, 3.3MF, 15V
C705	21554-0003	CAPACITOR, ELECTROLYTIC, 200MF, 15V
C706	21555-0011	CAPACITOR, TANTALUM, 39MF, 10V
C707	21554-0044	CAPACITOR, ELECTROLYTIC, 500MF, 15V
C708	21554-0051	CAPACITOR, ELECTROLYTIC, 250MF, 20V
C709	21555-0016	CAPACITOR, TANTALUM, 3.3MF, 15V
C710	21555-0016	CAPACITOR TANTALUM, 3.3MF, 15V
CR701	75204-0045	DIODE, SILICON
CR702	75028-0001	DIODE, SILICON
CR703	75028-0001	DIODE, SILICON
CR704	75025-0003	DIODE, ZENER, 11V
CR705	75028-0001	DIODE, SILICON
CR706	75014-0001	DIODE, GERMANIUM
L702	11527-0001	CHOKE, FILTER
L701	11488-0001	IDENT, FILTER
Q701	75576-0002	TRANSISTOR
Q702	75595-0003	TRANSISTOR, 2N5172
Q703	75595-0003	TRANSISTOR, 2N5172
Q704	75558-0005	TRANSISTOR, 2N5810
Q705	75558-0006	TRANSISTOR, 2N5811
Q706	75595-0003	TRANSISTOR, 2N5172
R701	31192-0331	RESISTOR, CARBON 330 ±10%, 1/4W
R702	31192-0271	RESISTOR, CARBON 270 ±10%, 1/4W
R703	31192-0472	RESISTOR, CARBON 4.7K ±10%, 1/4W
R704	31192-0183	RESISTOR, CARBON 18K ±10%, 1/4W
R705	31192-0183	RESISTOR, CARBON 18K ±10%, 1/4W
R706	31192-0223	RESISTOR, CARBON 22K ±10%, 1/4W
R707	31192-SEL	RESISTOR, CARBON SELECTED ±10%, 1/4W
R708	31195-0753	RESISTOR, CARBON 75K ±5%, 1/4W
R709	31192-0103	RESISTOR, CARBON 10K ±10%, 1/4W
R710	31192-0472	RESISTOR, CARBON 4.7K ±10%, 1/4W
R711	31192-0102	RESISTOR, CARBON 1K ±10%, 1/4W
R712	31192-0471	RESISTOR, CARBON 470 ±10%, 1/4W
R713	31192-0472	RESISTOR, CARBON 4.7K ±10%, 1/4W
R714	31196-0003	RESISTOR, WIREWOUND 27 ±5%, 2W
R715	31192-0222	RESISTOR, CARBON 2.2K ±10%, 1/4W
R716	31192-0682	RESISTOR, CARBON 6.8K ±10%, 1/4W
R717	31192-0102	RESISTOR, CARBON 1.0K ±10%, 1/4W
R718	31192-0820	RESISTOR, CARBON 82 ±10%, 1/4W

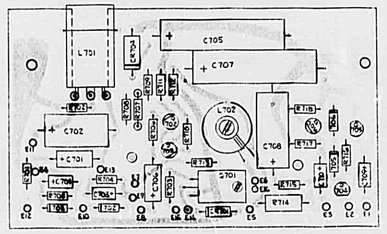
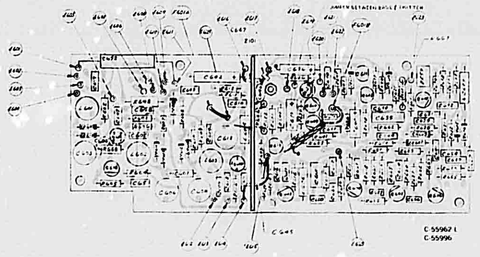


FIGURE 6.5-2 CONNECTOR BOARD



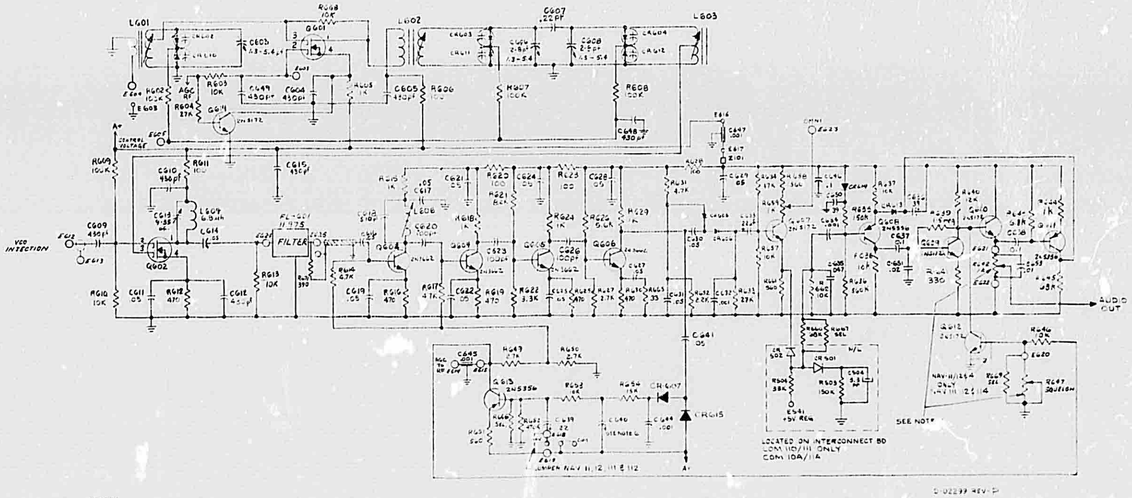


FIGURE 6.6-2 RECEIVER SCHEMATIC