NARCO
NAV 824 TSO/825 TSO NAVIGATION RECEVERS
GENERAL INDEX

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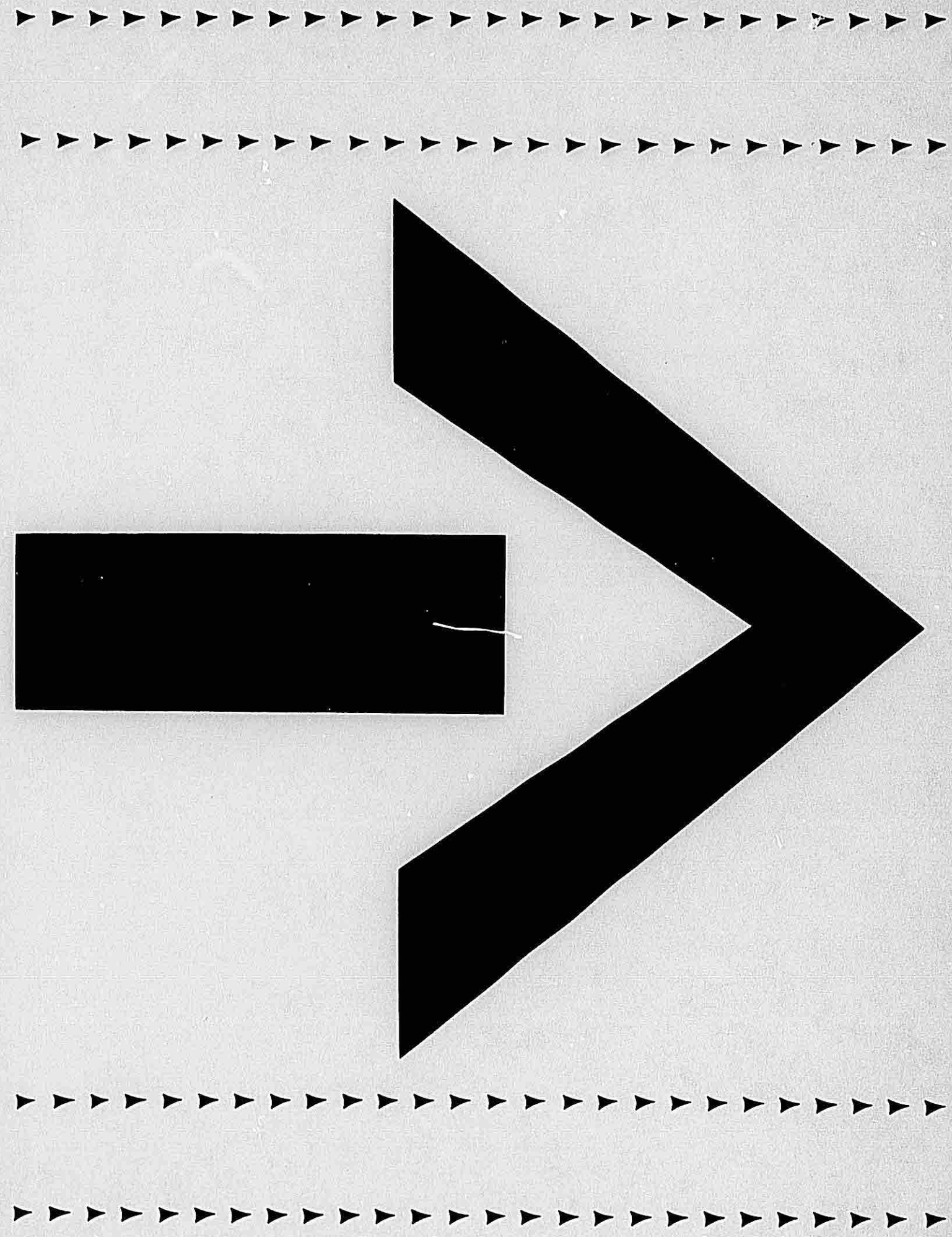

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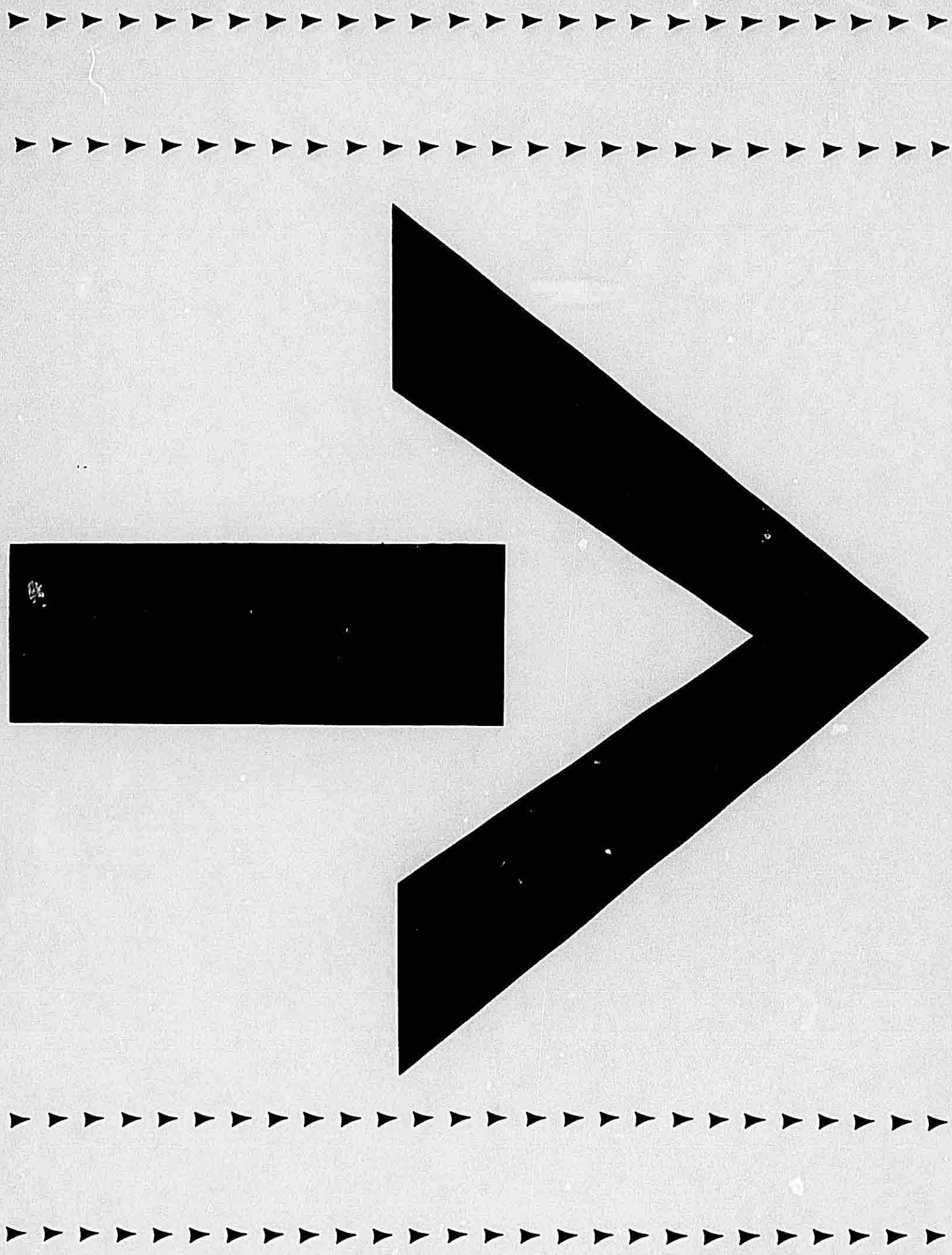
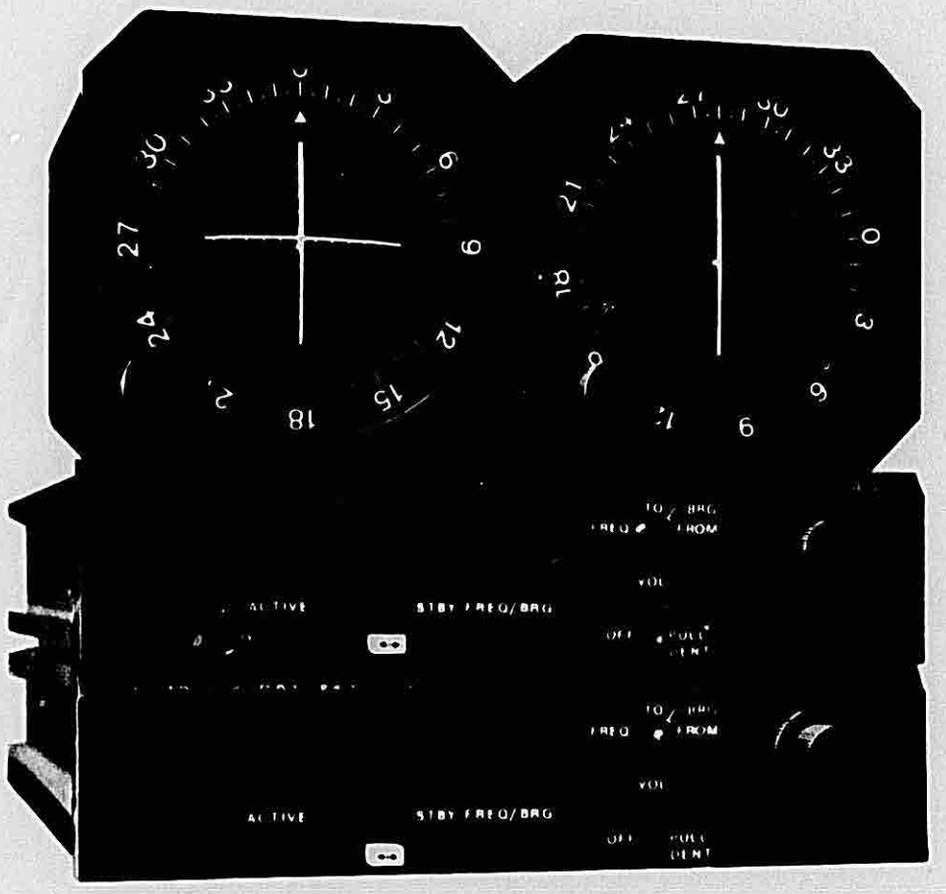


NARCO AVIONICS

NAV 824 TSO/NAV 825 TSO NAVIGATION RECEIVERS

AND

ID 824 TSO/ID 825 TSO INDICATORS



MAINTENANCE MANUAL

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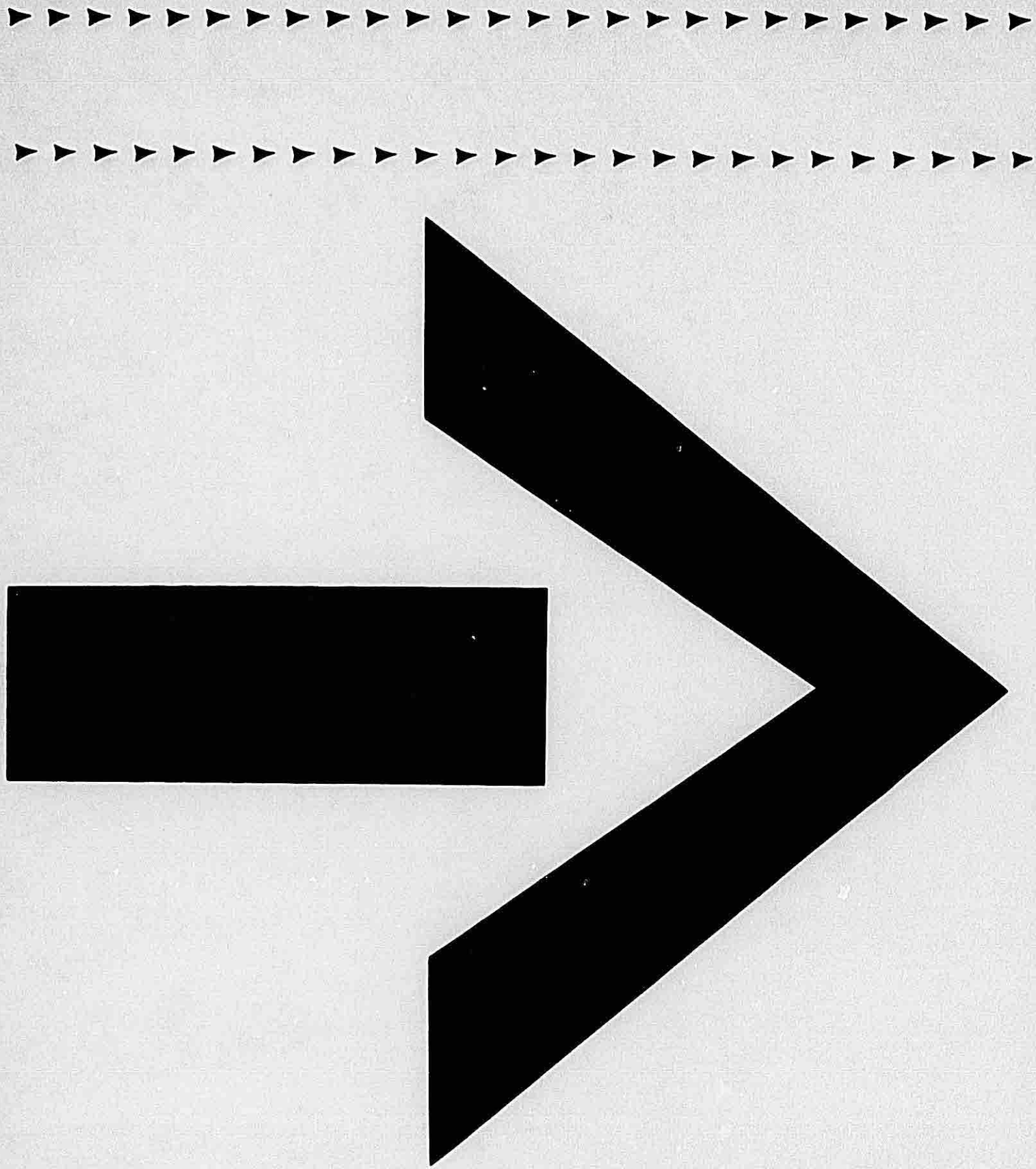

ATP
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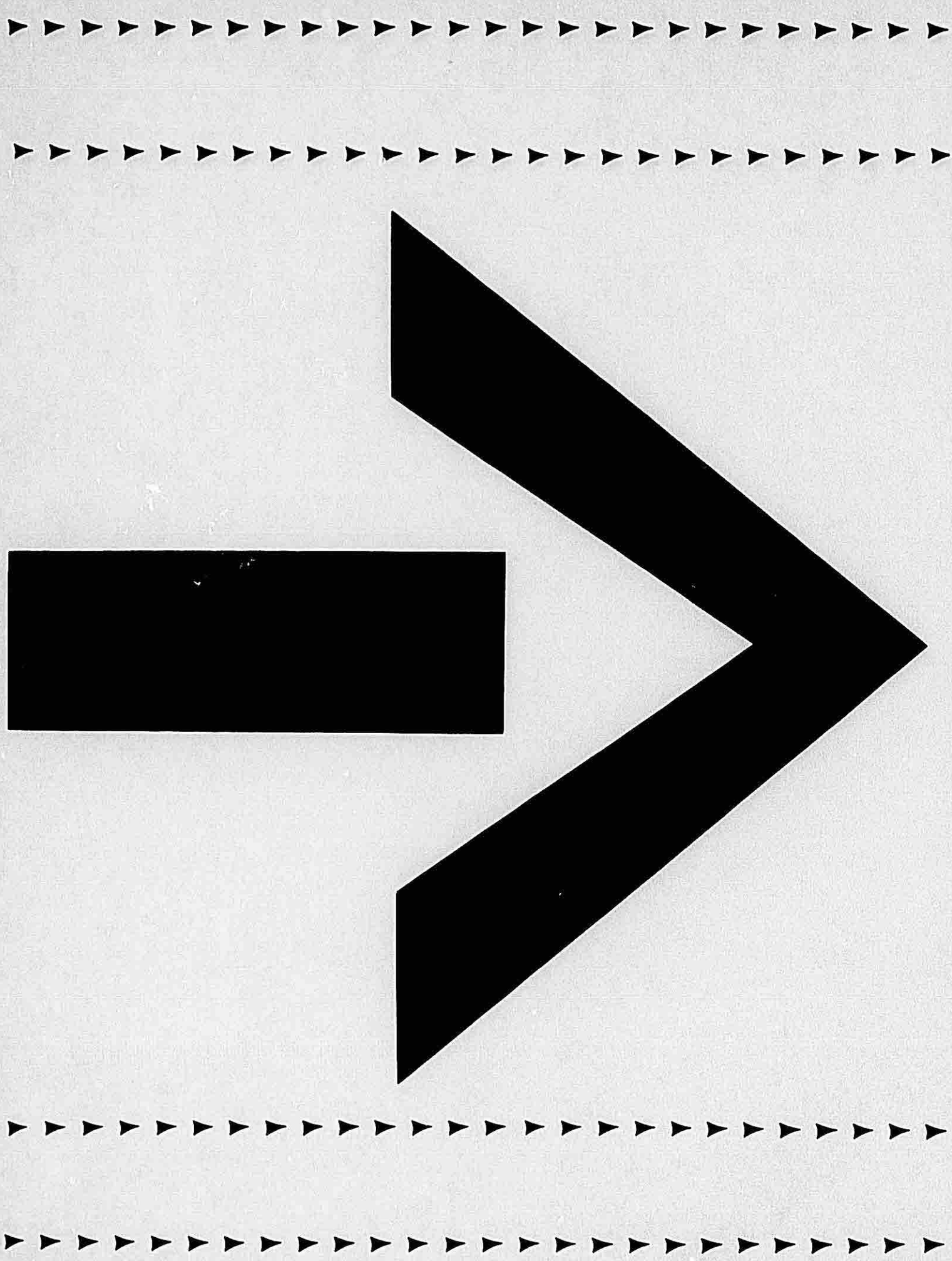

NARCO AVIONICS

NAV 824/825

(MM - 03115-0600 dtd 6/81)

IS YOUR MANUAL COMPLETE?

This page is provided, and updated as necessary, with each printing and supplement issued. As all pages are dated, it is easy to verify if the manual on hand is complete and current. Page numbers prefixed by a "B" are pages that are intentionally blank.

A complete page by page check can be made by comparing the page number and date below to that of each page. A quick check can be made by "eyeing" the bar(s) at the base of this page against the bottom edge of the whole manual. One bar on this page indicates one set of supplemental pages were issued, additional bars. . . additional supplements. Generally one will eye at least one bar per supplement.

It should be noted that the pages of Sections 1 and 2 may be dated prior to the cover date of the Maintenance Manual as those Sections are the Installation Manual which always proceeds the Maintenance Manual.

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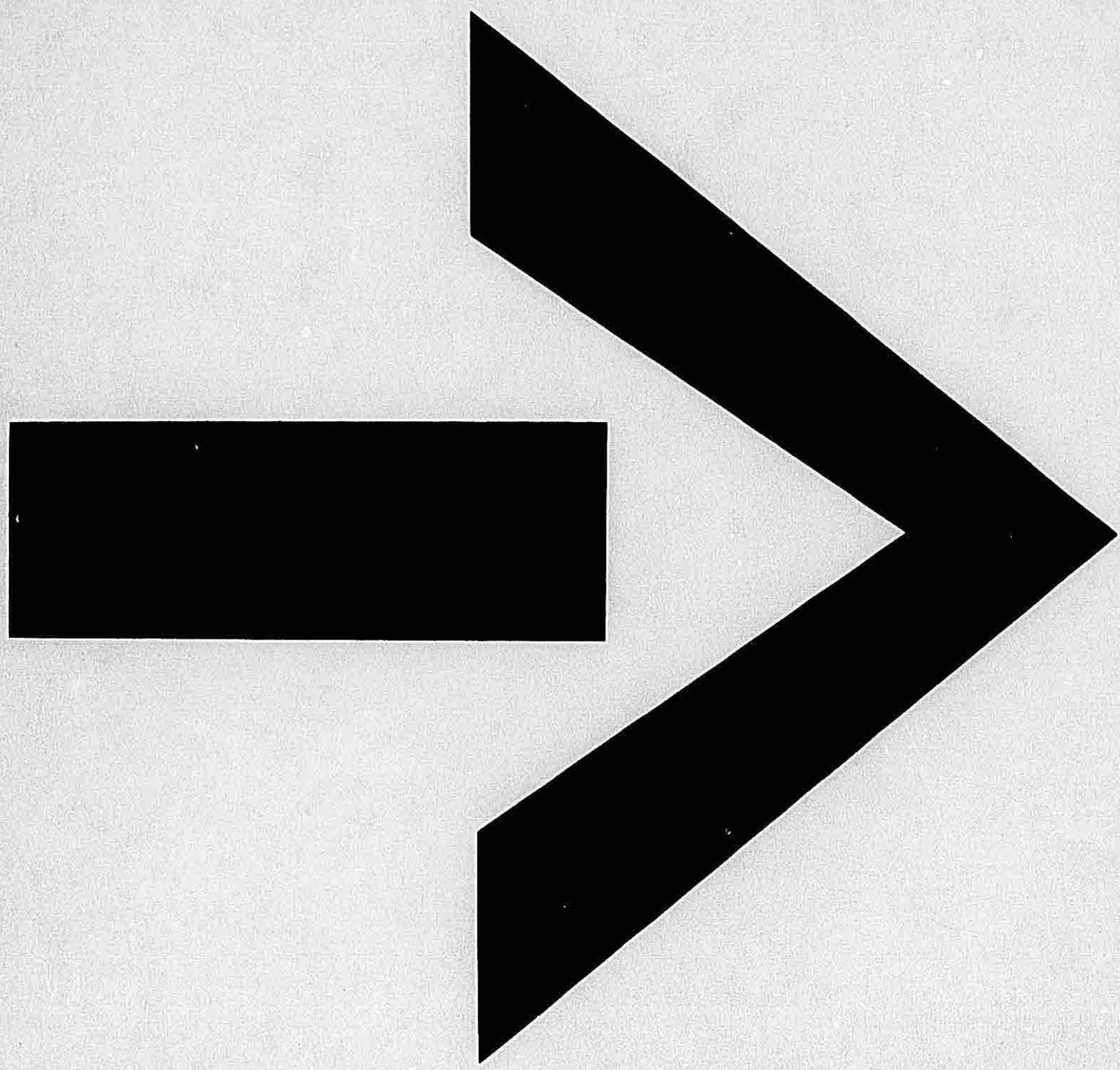

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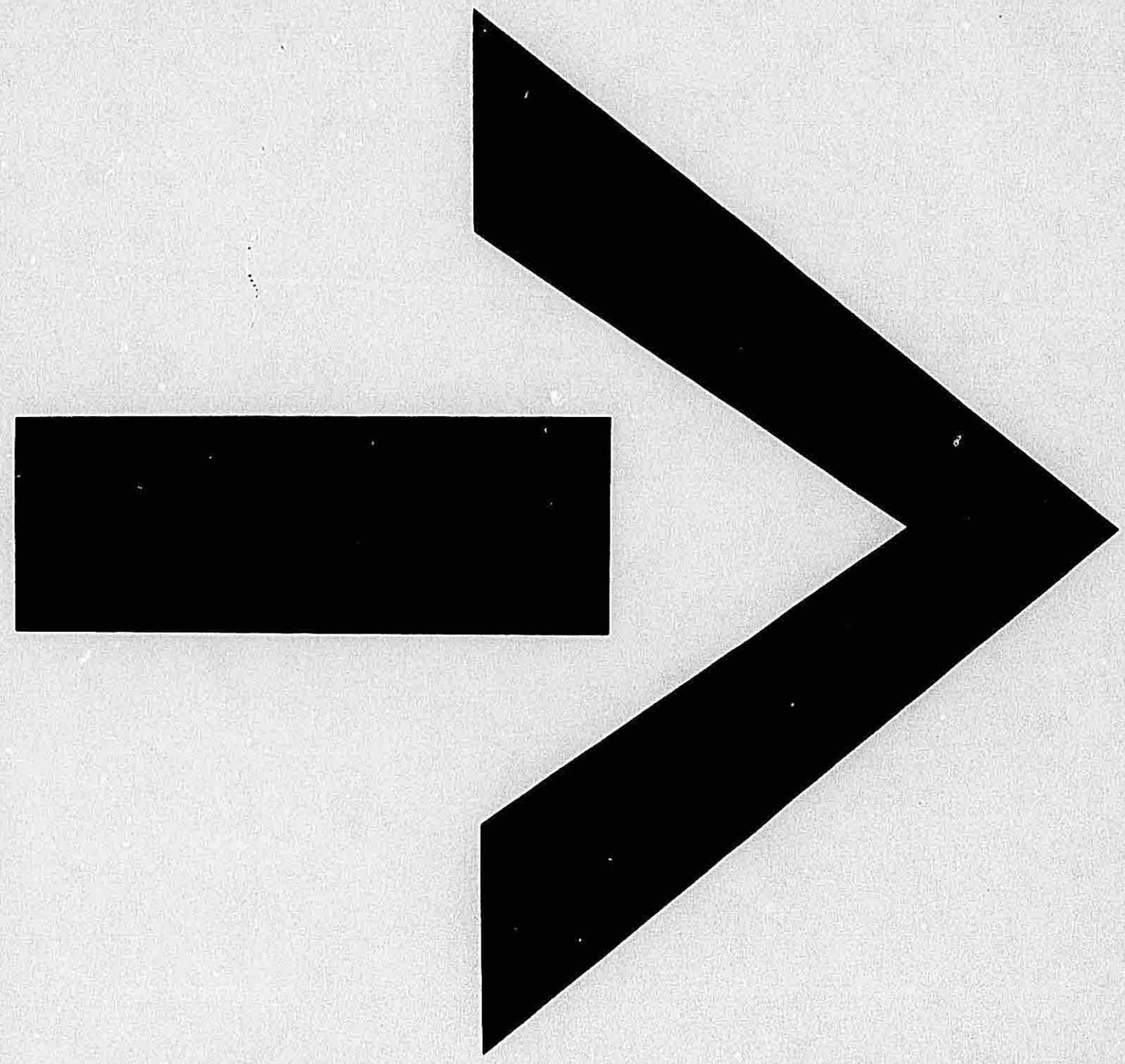
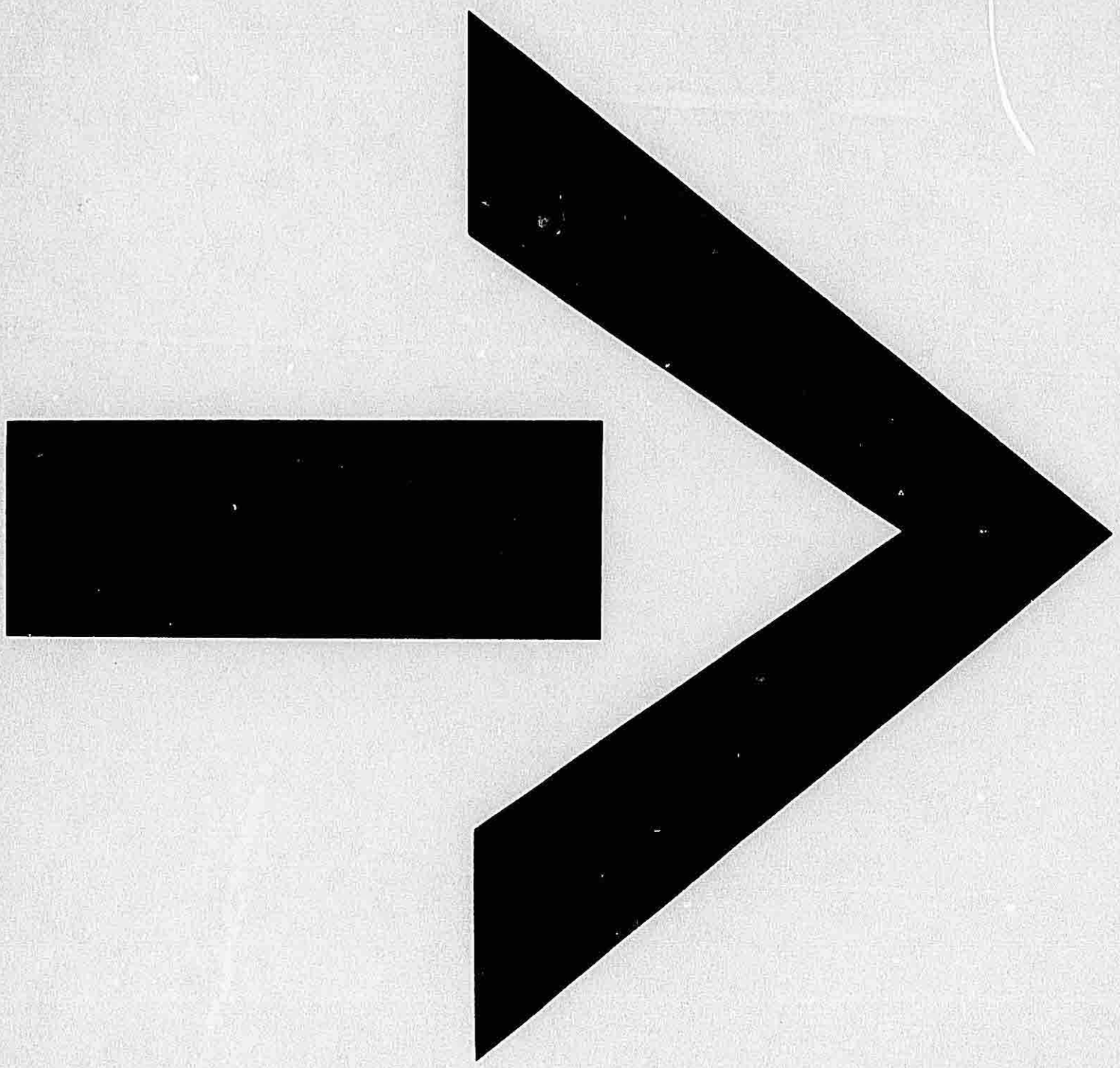




1.1 INTRODUCTION

This manual is intended to provide accurate information pertaining to the installation and maintenance of Narco's NAV 824 TSO, NAV 825 TSO as well as the ID 824 TSO, ID 825 TSO, and the ID 826 TSO.

1.2 MANUALS

Narco's Maintenance Manuals consist of six major sections and numerous subsections providing servicing information directed to the installer/avionics technician.

When applicable, Sections 1 and 2 of the Maintenance Manual are issued under its own cover. In this case the manual is identified as the Installation and Operation Manual.

Both manuals are dated. When servicing, always use the most current dated material for that specific model.

1.2.1 Manual Organization

Section 1, INTRODUCTION: defines the scope of the manual, its broad content, how to use, and a consolidated listing of features.

Section 2, INSTALLATION: provides specifications, wiring diagrams, and mechanical procedures to install the Unit. Section 2 also includes both electrical and mechanical adjustments that may be necessary to complete the installation. Operation procedures provided are directed to the installer/flight test pilot to allow quick orientation as to the Unit's use and readouts.

Section 3, CIRCUIT DESCRIPTION: this Section provides an indepth discussion of the NAV's circuits.

Section 4, MAINTENANCE: test equipment required, mechanical procedures to get to, remove, and replace major subassemblies and some specific components, are followed by YES-NO troubleshooting flow diagrams. Alignment procedures are also provided with a listing of all adjustable components and the setting of them.

Section 5, MECHANICAL PARTS LIST: this Section is dedicated to listing and showing all mechanical parts (where possible) that are considered replaceable. Electrical parts not identified on printed circuit boards as well as those mechanically attached are also listed.

All electrical parts are listed on the reverse side of their related schematics in Section 6.

1.2.1 Continued

Section 6, SCHEMATICS/ELECTRICAL PARTS LIST: provides an internal electrical wiring diagram of the Unit, separate but related sub-assembly (pc board) schematics, and test information.

To the left of each subassembly schematic is its pc board identifying each component in position by its symbol number.

Note that both the printed circuit board and schematic are provided with grid coordinates. Refer to the Electrical Parts List on the reverse of the schematic, and in line with each electrical component, will be its pc board and schematic grid coordinates. The component's location is considered in that grid box wherein the symbol letter (i.e. CR101, U101) is located even though the graphic electrical symbol may be in an adjacent grid box.

Update schematics will also contain equivalent lists, however these will identify: added, changed, and deleted parts along with the Chassis Level Code identifying when that particular action was effected on the assembly.

1.3 FEATURES:

NAV
- Solid state NAV Unit...microprocessor controlled
- Professional-style, gas discharge digital readouts
- Compact low profile, lightweight
- 200 channels (VOR); 40 channels (GS-NAV 825)
- Fast servicing-easy to get to test points
- Automatic display dimming
- Track type mounting tray
- Displays "Active" and "Standby" channels simultaneously or Active and station Bearing, To or From
- 11-32V Units (no external converter required)
- "Flip-Flop" transfer of "Active" and "Standby"
- Localizer Channel Indicator Legend
- TSO'd
- "Active" Frequency Keep-Alive Option

ID
- Rectilinear VOR/LOC left-right needle with TO-FROM flag display
- Rectilinear GS up-down needle with warning flag display (ID 825/826 only)
- ARINC type course resolver (ID 826 only) or sine/cosine potentiometer
- Uniform lighting of course card and all displays
- TSO'd
- Standard instrument panel 3" dia cutout
- Compact - lightweight

1.4 TSO

The following Units have been tested and approved in accordance with RTCA Document DO-160 Environmental Categories:

NAV 824 TSO - A2C1/A/PKS/XXXXXSZBBBA C36c Class C, C40a

NAV 825 TSO - A2C1/A/PKS/XXXXXSZBBBA C36c Class C, C40a
A2C1/A/PKS/XXXXXSZBBBA C34c Class D

ID 824 TSO - A2C1/A/PKS/XXXXXSZBBBA C36c Class C, C40a

ID 825 TSO - A2C1/A/PKS/XXXXXSZBBBA C36c Class C, C40a
A2C1/A/PKS/XXXXXSZBBBA C34c Class D

ID 826 TSO - A2C1/A/PKS/XXXXXSZBBBA C36c Class C, C40a
A2C1/A/PKS/XXXXXSZBBBA C34c Class D

An explanation of these categories will be found in Appendix A of this Section.

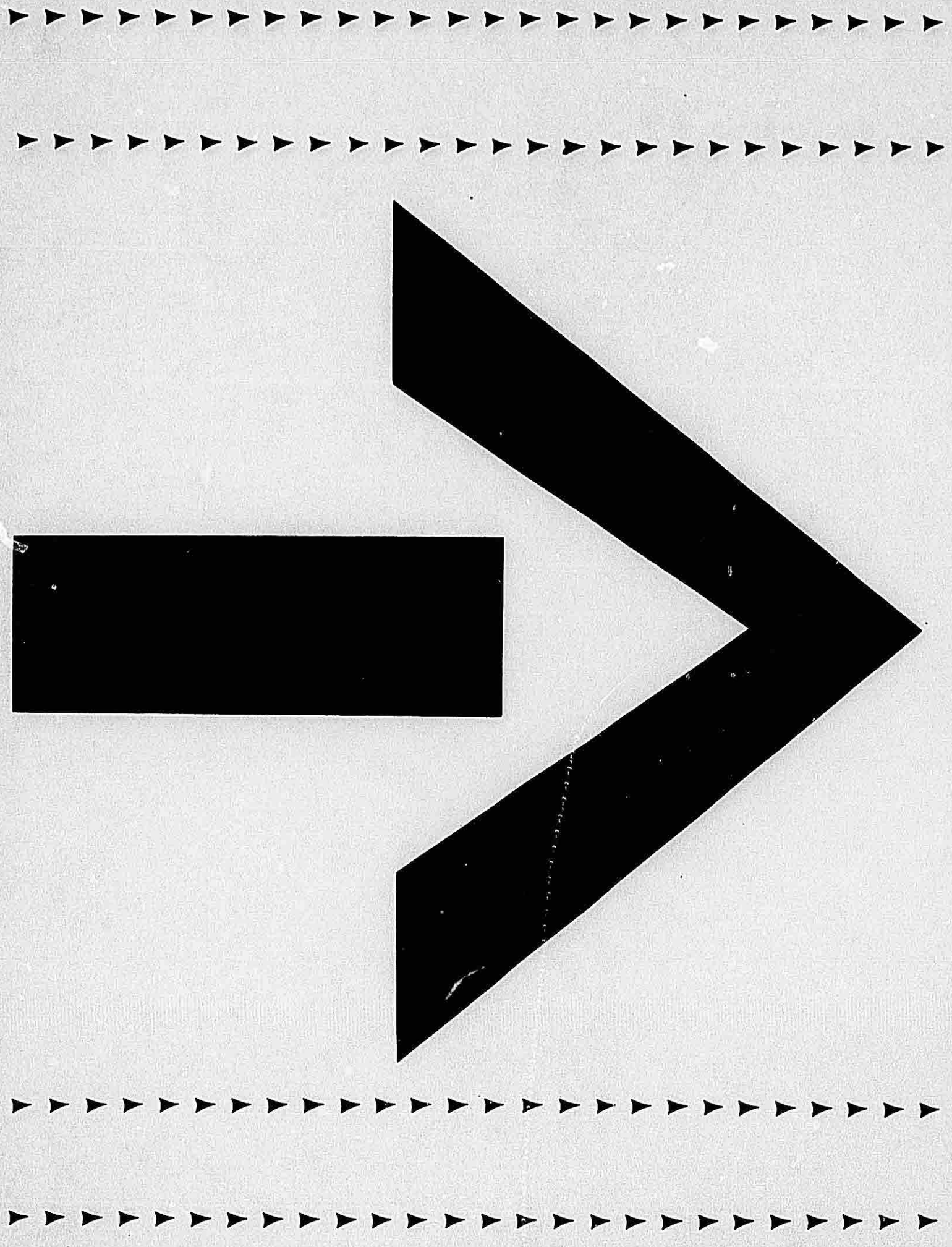
1.5 AIRCRAFT LICENSE REQUIREMENTS

There are no license requirements relating to the use of these instruments.

***

*** "This manual is intended for use only by persons who are qualified to service the equipment described in this manual pursuant to current regulatory requirements" ***

***

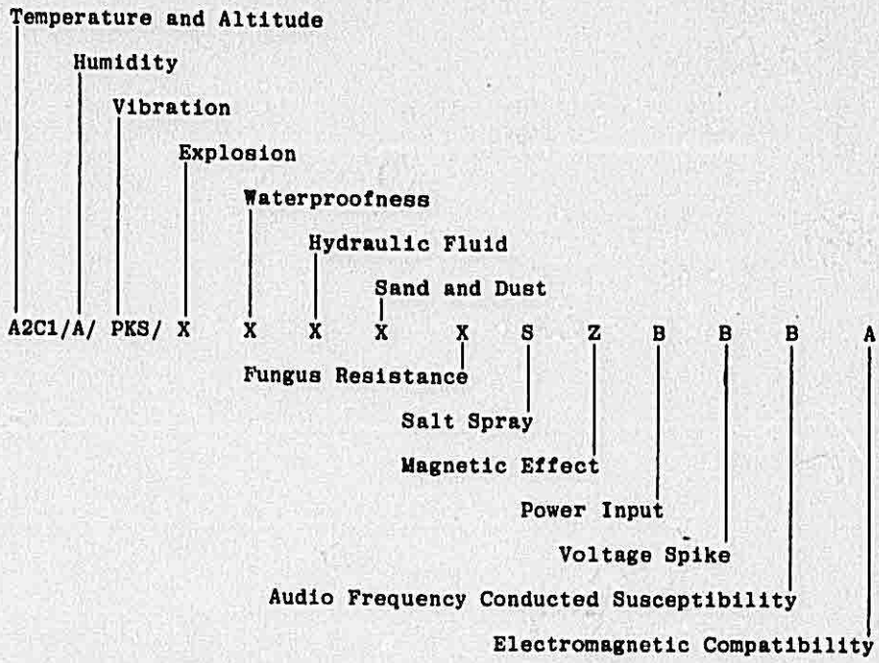


APPENDIX A

TSO EXPLANATION

This equipment is designed to be instrument panel mounted within the cabin environment of fixed and rotary wing aircraft using piston or turbine engines, in single and multiengine configurations. They are designed for non-pressurized aircraft operating up to 35,000 feet as well as for pressurized aircraft. This equipment requires direct current power, but may be installed in aircraft having additional on-board alternating current sources.

There are fourteen Environmental Test Procedures established in RTCA Document DO-160. These are identified on the TSO Nameplate(s). Following are the Environmental Categories to which the Units are designed and an explanation of each category.



Temperature and Altitude - (A2C1)/A/PKS/XXXXXSZBBBA)

Temperature, Operating:		
Low Operating Temperature	-20°C	(-4°F)
High Operating Temperature	+70°C	(+158°F)
Short Time Operating Temperature, High	+70°C	(+158°F)
Temperature, Non-Operating:		
Ground Survival Temperature, Low	-55°C	(-67°F)
Ground Survival Temperature, High	+85°C	(+185°F)
Altitude, Non-Pressurized:		
Maximum Operating Altitude	+11,000m	(+35,000 ft.)
Altitude, Pressurized:		
Not affected by decompression to	+12,000m	(+40,000 ft.)
Not affected by overpressurization to	-5,000m	(-15,000 ft.)

Humidity - A2C1/(A)/PKS/XXXXXSZBBBA

These units have been tested under the Standard Humidity Environment of +50°C (+122°F) at 95% relative humidity, reduced to +38°C (100°F) with relative humidity maintained in excess of 85%.

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 - A2C1/A/(PKS)/XXXXXSZBBBA

Maximum vibration limits are:
- 0.08G double amplitude from 5 Hz to 22 Hz.
- 2.0G constant acceleration from 22 Hz to 200 Hz.
- 1.5G constant acceleration from 100 Hz to 500 Hz.
- 0.25G constant acceleration from 500 Hz to 2000 Hz.

APPENDIX A

Not Applicable - A2C1/APKS(XXXXX)SZBBBA

The following six Environmental Conditions do not normally exist in Civil Aircraft, when recognized installation practices are adhered to, and therefore not tested.

Explosion -	Category X
Waterproofness -	Category X
Hydraulic Fluid -	Category X
Sand and Dust -	Category X
Fungus Resistance -	Category X

Salt Spray - A2C1/A/PKS/XXXXX(S)ZBBBA

This equipment has been subjected to a salt fog test in a controlled temperature and salt fog humidity environment for two periods of 48 hours each. Such exposure did not have any adverse effects to the unit due to: corrosion of metals, clogging or binding of moving parts (as a result of salt deposits) nor damage to contactors or uncoated wires.

Magnetic Effect - A2C1/A/PKS/XXXXXS(Z)BBBA

With this equipment operating, it may be placed at a distance less than 0.3 meter from a free magnet with 1°, or less, deflection of the magnet.

Power Input - A2C1/A/PKS/XXXXXSZ(B)BBA

This equipment is designed for use in aircraft electrical systems supplied by an engine driven alternator/rectifier or DC generator with a battery of significant capacity floating in the DC bus at all times.

Normal Operating Conditions (Vdc) are:

	28V System	14V System
Maximum	30.3	15.1
Nominal	27.5	13.8
Minimum	24.8	12.4
Emergency Operation	20.0	10.0

Momentary power interruptions, as defined in DO-160, have no effect upon the performance of this equipment, except that, displayed Active and/or Stored frequencies may be altered - the original frequencies will then need to be re-entered.

Voltage Spike - A2C1/A/PKS/XXXXXSZB(B)BA

This equipment has been designed to withstand the transient voltage characteristics specified by RTCA Cocument DO-160.

Audio Frequency Conducted Susceptibility - A2C1/A/PKS/XXXXXSZBB(B)A

This equipment has been designed to withstand the transient voltage characteristics specified by RTCA Document DO-160.

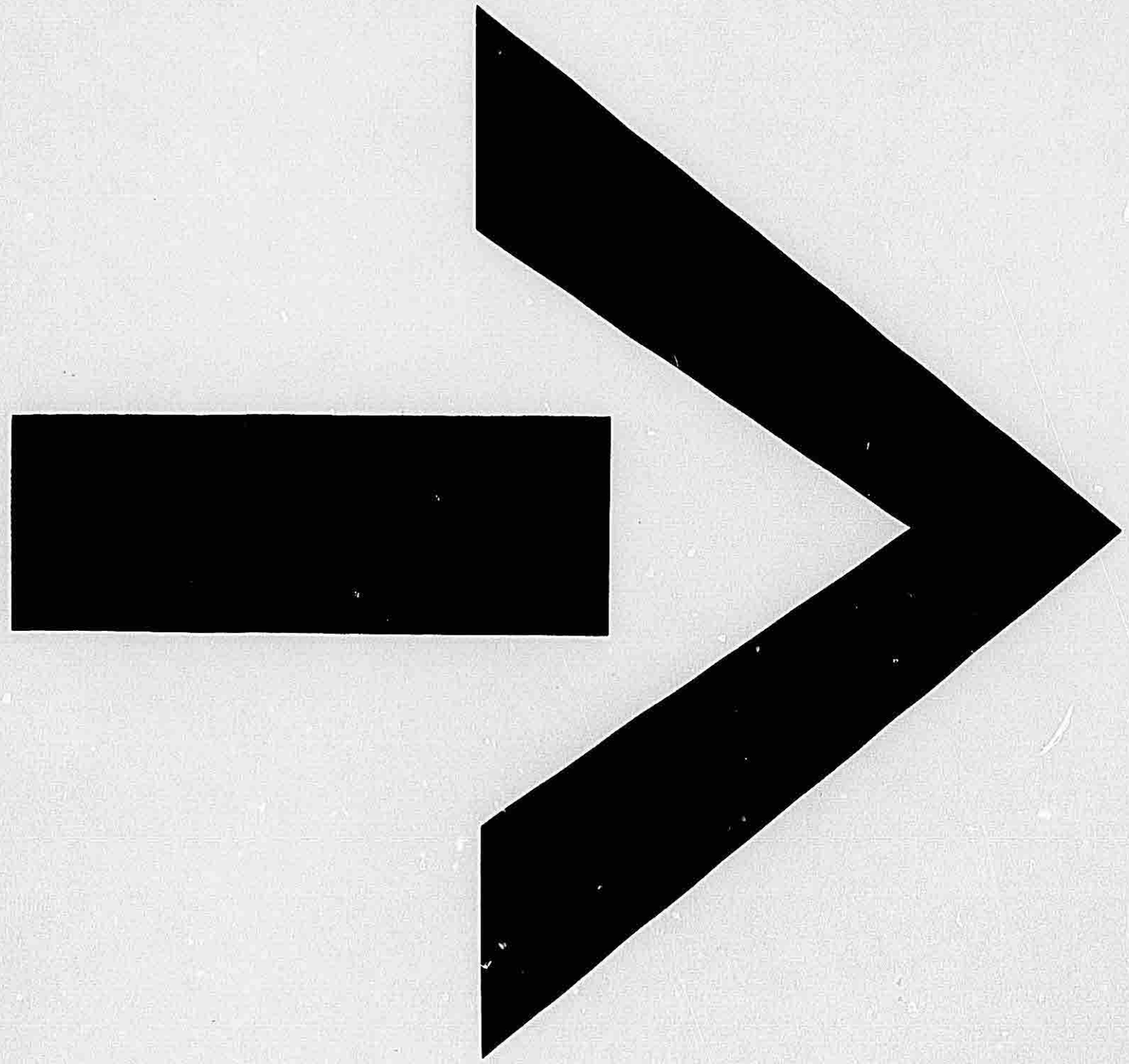
Electromagnetic Compatibility - A2C1/A/PKS/XXXXXSZBBB(A)

NOTE: For this series of tests, equipment interconnecting cables and RF transmission lines were constructed in accordance with Section 2 of this manual.

1. Induced Signal Susceptibility - This equipment has been designed to withstand the effects of audio frequency electric and magnetic fields and induced voltage spikes as specified by Category A.

2. Radio Frequency Susceptibility - This equipment has been tested and is not affected by interference from other on-board electronic equipment which meets Category A, Emission of Radio Frequency Energy Test of RTCA Document DO-160.

3. Emission of Radio Frequency Energy - This equipment has been tested and does not emit radio frequency energy in excess of that specified.



2.1 INTRODUCTION

This Section provides the necessary information for the installation of the NAV 824, 825 and the ID 824, 825, and 826.

2.2 PRELIMINARY INSPECTION

Upon receipt, inspect the shipping container to attempt to determine if equipment may have been damaged during shipment. Note damage if any.

2.2.1 Unpacking

Carefully unpack the Unit and inspect it for any damage that may have occurred during shipment. Refer to Table 2.1, and 2.2, and inventory the contents of your shipment. Table 2.3 and 2.4 identifies the contents of the Installation Kits.

2.2.2 Units, Accessories, and Options

The NAV 824 was designed as a navigation receiver to operate with indicator ID 824. This system does not have glideslope capability. The NAV 825 mated to either the ID 825 or ID 826 provide both VOR navigation capabilities and glideslope.

To order a system Tables 2.1 and 2.2 must be consulted.

TABLE 2.1. UNITS AND ACCESSORIES SUPPLIED

Item	Order Number	Description	Accessory Part No.
1	03115-0300	NAV 824 TSO with: Tray Installation Kit	 01372-0104 03115-0500
2	03115-0301	NAV 825 TSO with: Tray Installation Kit	 01372-0102 03115-0501
3	03115-0302	NAV 824 TSO only	
4	03115-0303	NAV 825 TSO only	

TABLE 2.2. OPTIONAL AVAILABLE ACCESSORIES

Item	Order Number	Description	Accessory Part No.
1	03749-0300	Indicator, ID 824 TSO (NO GS---sine/cosine OBS) with: Installation Kit	 03749-0500
2	03749-0301	Indicator, ID 825 TSO (w/GS---sine/cosine OBS) with: Installation Kit	 03749-0500
3	03749-0302	Indicator, ID 826 TSO (w/GS---Resolver OBS) with: Installation Kit	 03749-0500
4	56912-0001	KEY, Spring Release	

2.2.2 Continued

TABLE 2.3. NAV 824/825 INSTALLATION KITS

Item	Part Number	Description	Qty 03115- NAV 824 0500	Qty 03115- NAV 825 0501	See Figure
1	41407-0002	CONTACT, Crimp Type (Gold) - Strip of 24 (Contact, Individual, crimp type order No. 41407-0001	1	2	2-4/2-6
2	56912-0001	KEY, Spring Release	1	1	2-18
3	50043-0001	SHIM, Side Rail Tray	2	2	2-19
4	50042-0001	TOOL, Tray Side Rail Spacing	1	1	2-19
5	66516-0010	FUSE, 1/2 Amp	2	2	- - - -

TABLE 2.4. ID 824/825/826 INSTALLATION KIT(S)

Item	Part Number	Description	Qty Kit No. 03749-0500
1	41364-0004	CONNECTOR, 15 Pin	1
2	41307-0002	HOOD,	1
3	41308-0002	LOCKING ASSY (slide lock)	1
4	41372-0009	CONTACT, Socket	15

NOTE: See Figure 2-5.

2.3 NAV UNITS, GENERAL SPECIFICATIONS

GENERAL		NAV 824	NAV 825
A. Mechanical			
Physical Dimensions		Figure 2-22	Figure 2-22
Weight - - lb/Kgm			
Unit		2.4/1.09	2.5/1.13
Tray		0.7/0.3	0.8/0.4
B. Electrical			
NAV			
Supply Voltage		11-32 Vdc	11-31 Vdc
Current	13.75 Vdc	.5 Amp	.5 Amp
Current	27.5 Vdc	.3 Amp	.3 Amp
Circuit Breaker Rating		1.0 Ampere	1.0 Ampere
VOR/LOC Receiver:			
Frequency Range (in MHz)		108.00 to 117.95 200 channels	108.00 to 117.95 200 channels
Sensitivity (6 dB S+N/N ratio)		1.0 uV	1.0 uV
(Full VOR/LOC Flag)		1.0 uV	1.0 uV
Spurious and Image Rejection		80 dB min	80 dB min
Selectivity 6 dB		±17 KHz	±17 KHz
60 dB		-42 KHz	-42 KHz
AVC Flatness (10 uV to 10K uV)		2.0 dB max	2.0 dB max
Audio Output (300 ohm load)		50 mW	50 mW
VOR Accuracy		±2.7°	±2.7°
LOC Accuracy		-5 ua	-5 ua
VOR-LOC Detector Outputs		ARINC	ARINC
DME/GS Channeling Code		2/5	2/5
Course Selection		Resolver or sine/cosine potentiometer	Resolver or sine/cosine potentiometer
Glideslope Receiver:			
Frequency Range (in MHz		----------	329.150 to 335.00
Sensitivity (Full GS Flag)		----------	15 uV
Spurious and Image Rejection		----------	60 dB
Selectivity 6 dB		----------	±21 KHz
60 dB		----------	-90 KHz
AVC Flatness (10 uV to 10K uV)		----------	±3 dB
GS Accuracy		----------	-5 ua
External Indicator/Autopilot Loads			
Loading:			
VOR-LOC:	Left-Right	Two, 1K ohm loads	Two, 1K ohm loads
	To-From Flag	Two, 1K ohm loads	Two, 1K ohm loads
	NAV Flag	Two, 1K ohm loads	Two, 1K ohm loads
GS:	Up-Down	----------	Three, 1K ohm loads
	Warning Flag	----------	Two, 1K ohm loads
Output:			
VOR-LOC	Left-Right, LOC	90 mV for .093 ddm	90 mV for .093 ddm
	VOR	150 mV for 10° course change	150 mV for 10° course change
	TO-From Flag	250 mV	250 mV
	NAV Flag	250 mV	250 mV
GS:	Up-Down	----------	78 mV for .091 ddm
	Warning Flag	----------	250 mV

ddm - Difference in depth of modulation

2.4 INDICATORS, GENERAL SPECIFICATIONS

	ID 824	ID 825	ID 826
Physical Dimensions Weight ---lbs/Kgm	See Figure 2-23 0.9/0.4	See Figure 2-23 1.0/0.45	See Figure 2-23 1.1/0.5
Deviation Indicators VOR/LOC Left-Right GS Up-Down	 150-0-150 uA, 1000 ohms 150-0-150 uA, 1000 ohms	 150-0-150 uA, 1000 ohms 150-0-150 uA, 1000 ohms	 150-0-150 uA, 1000 ohms 150-0-150 uA, 1000 ohms
Warning Flags VOR/LOC TO-FROM GS NAV	 45 mV for full flag, 200 ohms ---------- ---------- ---------- 245 mV for full retraction, 1000 ohms	 45 mV for full flag, 200 ohms 245 mV for full retraction, 1000 ohms 245 mV for full retraction, 1000 ohms	 45 mV for full flag, 200 ohms 245 mV for full retraction, 1000 ohms 245 mV for full retraction, 1000 ohms
Pilot Lamps 14 Vdc 28 Vdc Course Selection	 0.290 Amperes 0.145 Amperes Sine/Cosine Pot	 0.290 Amperes 0.145 Amperes Sine/Cosine Pot	 0.290 Amperes 0.145 Amperes ARINC Resolver

Dwg No. TP001248A

2.5 PILOT OPTIONS

2.5.1 Initial Display

There are three initial display options available to the pilot. They should be discussed and determined prior to doing any wiring. These options are related directly to what the pilot wants to see upon turn on of the Unit.

Option one is the most recommended option.

Option one : Active Frequency will be that frequency last set into the Active display (memory). Standby frequency will be the factory pre-programmed frequency of 110.50.

P102, pin 8 to Aircraft battery.

Option two : Active Frequency will display factory pre-programmed frequency of 115.50, Standby as in option one: 110.50

P102, pin 8 wired to Ground.

Option three: In this case P102, pin 8 is not wired at all.

There will be a random frequency seen in the Active display, Standby, as before, will be 110.50.

2.5.2 Aimer Option (Mode of Frequency Entry)

All NAV Units shipped from the factory are programmed to accept all data entry into the Standby window. An illuminated Aimer arrow in the display will point to the Standby window. This entry format can be changed to give Active window entry. If Active window entry is requested, install a jumper between E112 and E113. (Refer to Figure 2-1). The illuminated Aimer arrow will now point to the Active window indicating all entries are made to this window.

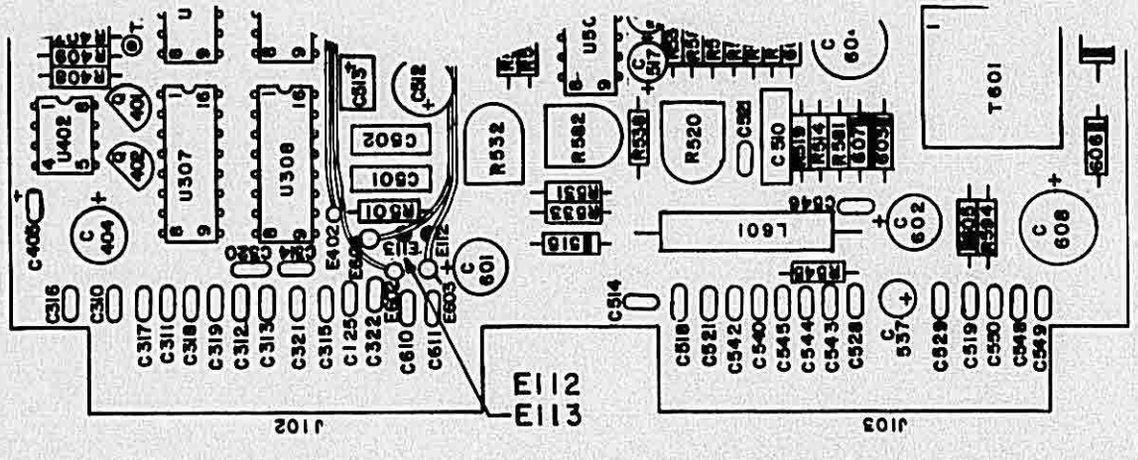
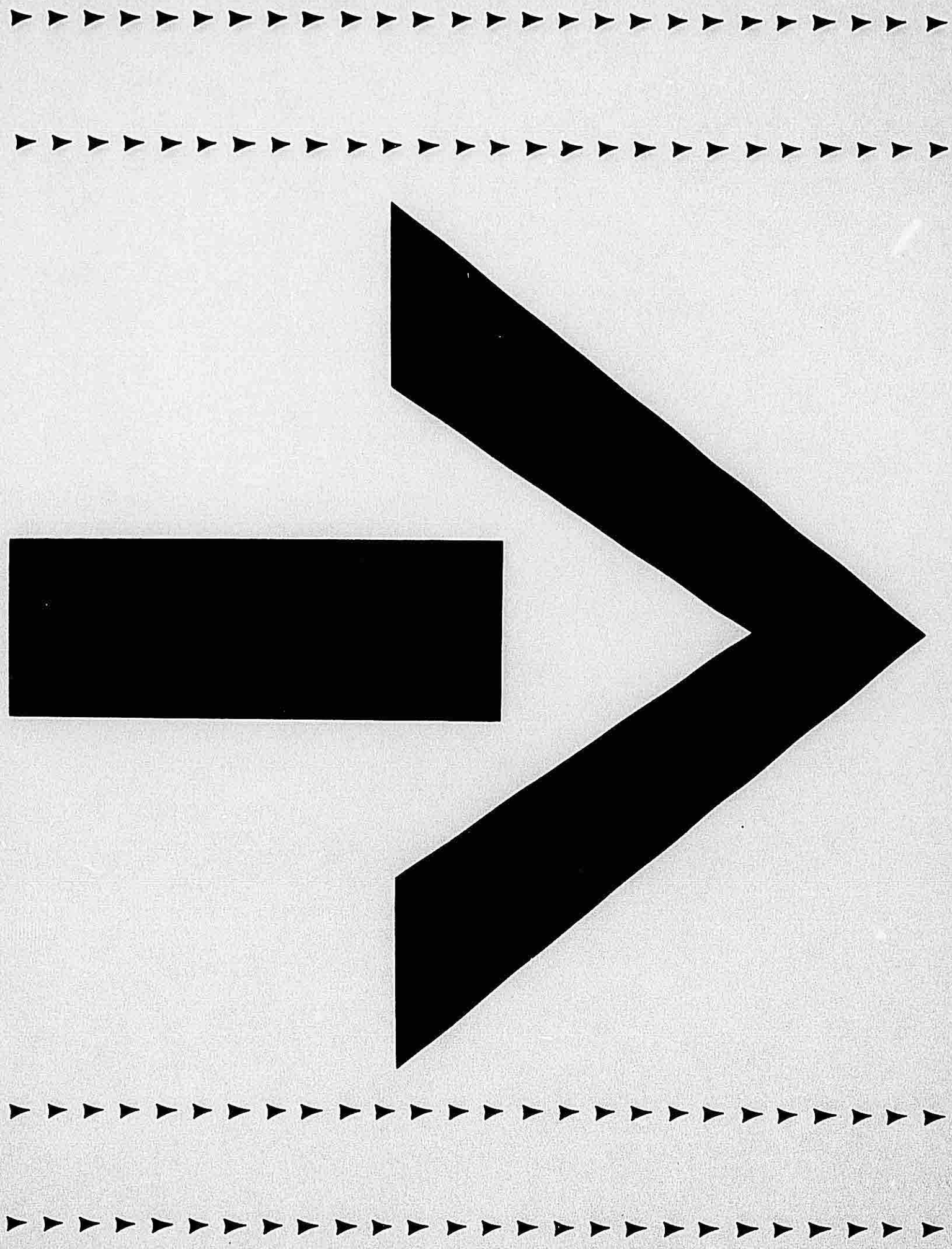
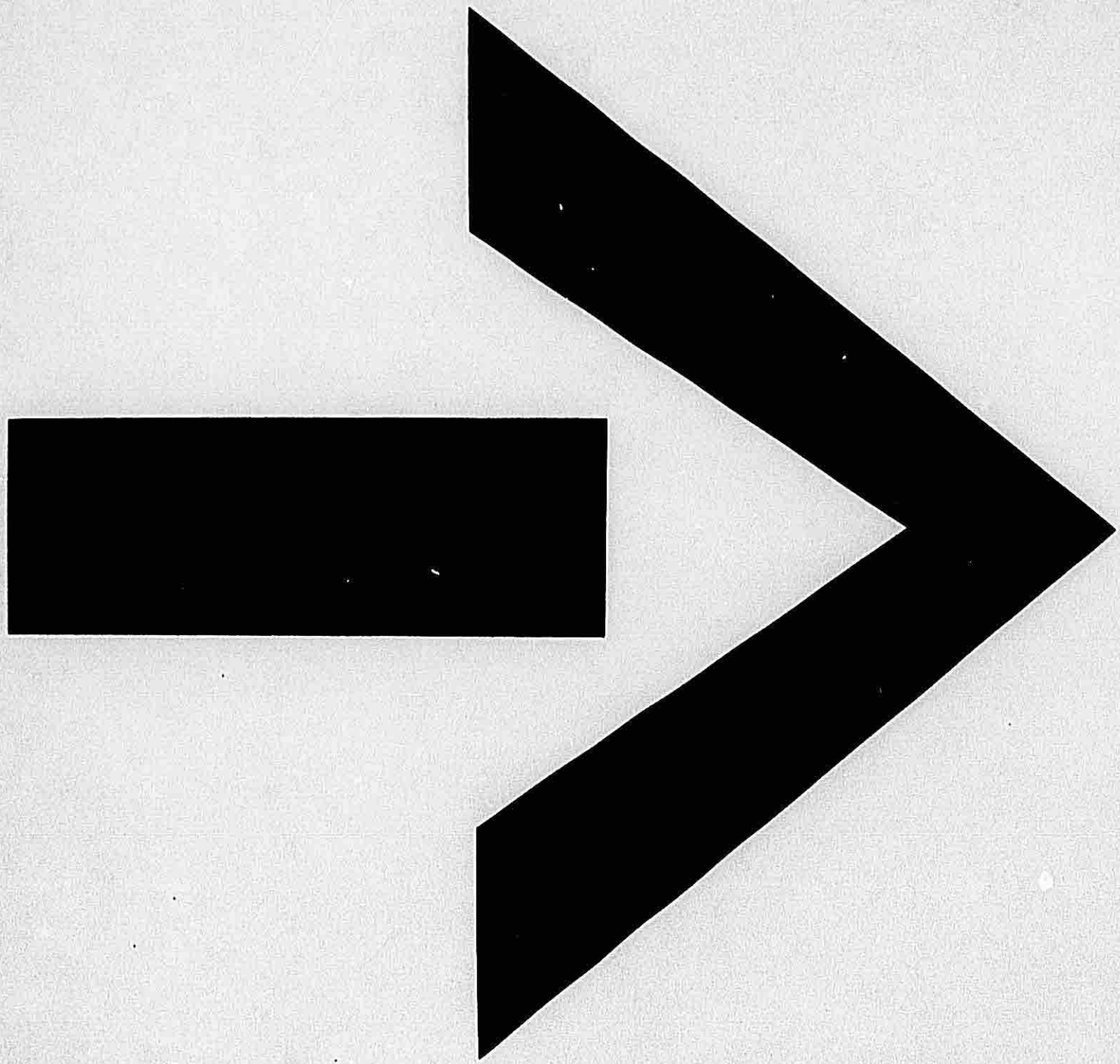


FIGURE 2-1. AIMER OPTION, ADDED JUMPER





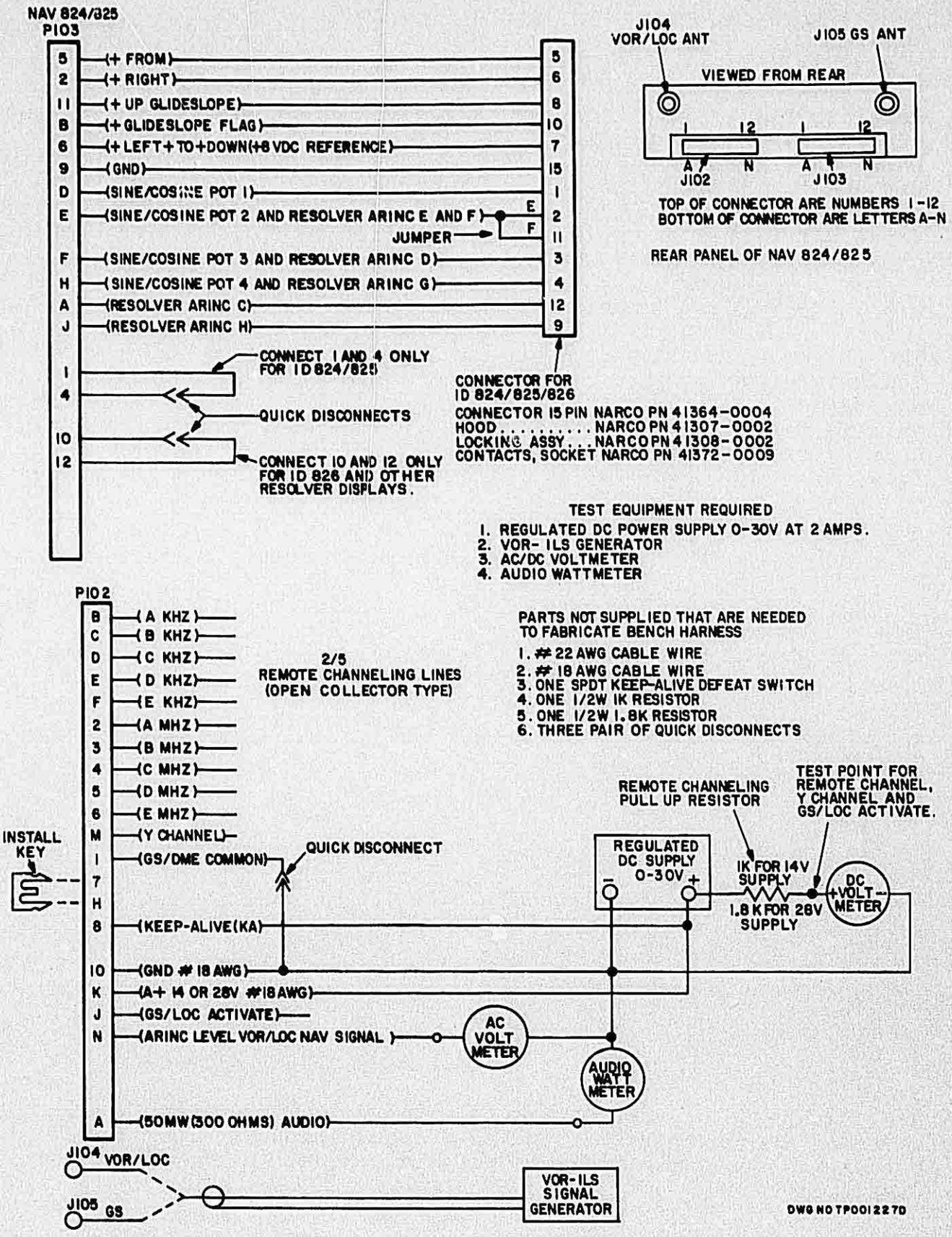


FIGURE 2-2. BENCH TEST HARNESS SET-UP

2.6 ELECTRICAL BENCH TEST AND ALIGNMENT

2.6.1 Test Equipment and Bench Test Harness

Refer to Figure 2-2 which identifies all connections and test equipment required for this Bench Test Procedure. The bench harness shown in Figure 2-2 is one that an avionics shop should fabricate and add to their equipment inventory to facilitate bench checks and troubleshooting. However, prior to installation of the Unit(s) in an aircraft, the cable and accessories to be installed should be used to provide a checkout of avionics and cabling.

2.6.2 Bench Test Procedure

The following bench checks require course deviation and flag indicators for displaying the results of signal processing by the NAV 824/825. Perform the bench test with the Indicator and the NAV Unit to be installed in the aircraft. The Indicator and NAV digital bearing should be rezeroed, this will require the removal of the NAV front trim panel. Refer to Figure 2-3 for location of adjustments.

Indicators that can be used are:

1. Narco ID 824 (sine/cosine potentiometer). No glideslope presentation. For use with NAV 824
2. Narco ID 825 (sine/cosine potentiometer). Has glideslope presentation. For use with NAV 825.
3. Narco ID 826 (ARINC resolver). Has glideslope presentation. For use with NAV 825.
4. Narco HSI-100 and Narco ID 124 Series

NOTE: The NAV 824/825 is compatible with any ARINC resolver CDI or HSI.

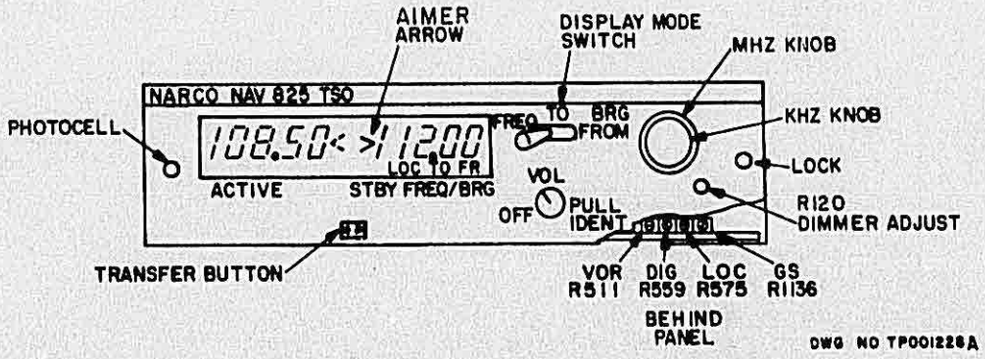


FIGURE 2-3. FRONT PANEL NAV 824/825

Preliminary Note: All NAV Units shipped from the factory are set to enter frequency data into the Standby display. The transfer button is then activated to move this frequency into the Active display.

2.6.2.1 Power-Up/Transfer/Keep-Alive Checks

1) With the power supply OFF, connect the NAV Unit into the test set-up as shown in Figure 2-2.
2) Disconnect the GS/DME common line.
3) Set the NAV display mode switch to the FREQ position. If an ID 824 or ID 825 is being used, connect pins 1 and 4 of P103. If the ID 826 or other resolver type display is being used, connect pins 10 and 12 of P103.

CAUTION

Check that the card edge connector J102 (with key set in pins 7-H) and J103 are fully engaged into the PC board before applying power.

4) Turn ON the NAV Unit by rotating the VOL (volume) knob in a clockwise direction.
5) For 14V Aircraft: Turn ON DC Power Supply. Slowly (3-5 seconds) increase the line voltage to 13.75V. (Note: At low line voltage the NAV will draw higher than normal current).

   For 28V Aircraft: Turn ON DC Power Supply. Slowly (3-5 seconds) increase the line voltage to 27.5V. (Note: At low line voltage the NAV will draw higher than normal current).
6) Observe the Active and Standby displays. Both shall show a random valid navigation frequency.
7) Rotate the channel frequency knobs to display 111.30 in the Standby display. Press the transfer button, now channel to 117.60 in the STANDBY display (See Note). As this set-up is being made observe that:
   a) When the transfer button was pressed channel 111.30 was entered into the Active display.
   b) The data entry arrow is pointing to the Standby display. (See Note)
   c) That the display increments with each clockwise detent stop: MHz Knob - increments (1) MHz per detent
      KHz Knob - increments 50 KHz per detent.

   Likewise the displays decrement with counterclockwise rotation.
8) Turn the Unit OFF by means of the front panel switch. DO NOT turn it off by turning OFF the DC Power Supply as the Supply is also (for the test set-up) being used as the aircraft battery for the Keep-Alive source.
9) Wait a minimum of 10 seconds.
10) Turn the Unit back ON and check that the displayed frequencies are: Active 111.30 Keep-Alive frequency and the preset (microprocessor) Standby 110.50.

2.6.2.1 Continued

11) Turn the Unit OFF by means of its front panel switch.
12) Disconnect the Keep-Alive power lead and ground it.
13) Turn the Unit back ON and check that the microprocessor's default preset frequencies are presented: Active 115.50, Standby 110.50.
14) Push the "arrowed" white transfer button on the front panel of the Unit. Observe that the Active and Standby frequencies exchange positions.
15) For 14V: Lower the line voltage to 11V and change back to 13.75. The displayed frequencies shall not change.
For 28V: Lower the line voltage to 22V and change back to 27.5. The displayed frequencies shall not change.

NOTE: If the data entry format was changed to the Active display, then 117.60 would be entered into the Active display first and then transferred to the Standby display. Next, channel 111.30 this would then be entered into the Active display. The data entry arrow would point to the Active display.

2.6.2.2 Dimming Check

Cover the front panel photocell with an opaque material. Note that the display dims. Remove the opaque material and the display regains its original brightness. The minimum brightness can be adjusted. Refer to Section 2.6.2.8.

2.6.2.3 Remote Channeling

Refer to Table 2.5 for channeling code.

Connect the remote channeling pull-up resistor and DCVM into the test set-up as shown in Figure 2-2. Connect the GS/DME COMMON (P102-1) to ground.

1) Program the NAV Unit to: ACTIVE Channel 111.10 MHZ, STANDBY Channel 115.50 MHz.
2) One lead at a time, touch each of the following code lines to the remote channel test point as shown in Figure 2-2. As each lead is touched to the test point, the DCVM shall indicate 0.4V or less.
   a) A MHz P102-2
   b) B MHz P102-3
   c) A KHz P102-B
   d) B KHz P102-C
   e) Touch all remaining lines to the test point. Each line shall read the supply voltage.
3) Press the transfer button on the front panel of the NAV Unit.

2.6.2.3 Continued

4) Repeat step 2 for the following code lines
   a) C MHz P102-4
   b) D MHz P102-5
   c) C KHz P102-D
   d) D KHz P102-E
   e) Touch all remaining lines to the test point. Each line shall read the supply voltage.
5) Program the Active channel to 109.75 MHz
6) Repeat step 2 for the following code lines:
   a) E MHz P102-6
   b) E KHz P102-F
   c) Y channel P102-M
   d) GS/LOC activate P102-J
   e) Touch all remaining code lines to the test point. Each line shall read open (DCVM will read supply voltage).
7) Disconnect the GS/DME common line from ground. Each remote channel line when touched to the test point shall indicate an open circuit (DCVM will read supply voltage).

TABLE 2.5. GS/DME 2-OUT-OF-5 CHANNEL CODE

	MHz Channels										
MHz ARINC	108	109	110	111	112	113	114	115	116	117	NAV 824/825 P102 Pin
A	X	X		X	X						2
B			X	X		X	X				3
C					X	X		X	X		4
D	X						X	X		X	5
E		X	X						X	X	6

	KHz Channels																				
KHz ARINC	.00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95	NAV 824/825 P102 Pin
A			X	X	X	X											X	X	X	X	B
B	X	X	X	X			X	X	X	X											C
C					X	X	X	X			X	X	X	X							D
D									X	X	X	X			X	X	X	X			E
E	X	X											X	X	X	X			X	X	F
Y CH.		X		X		X		X		X		X		X		X		X		X	M

NOTES: 1. X indicates active low
2. GS/DME COMMON (P102-1). The GS or DME must supply a switched ground to this lead to activate the remote channeling code lines.

Dwg No. TP001220

2.6.2.4 VOR/LOC Receiver and Audio Circuits

1) Connect the AC voltmeter and Audio wattmeter as shown in Figure 2-2.
2) Connect the VOR generator's RF output to the NAV connector J104 at the rear of the NAV Receiver.

   Generator Settings: RF output attenuator - 500 uv
   Turn off - 1020 Hz, Ident Tone

3) Program the NAV's Active channel to 110.10 MHz and the Standby channel to 110.00 MHz. Set the VOR generator to 110.10 MHz, and turn off the Localizer 150 Hz Modulation.
   a) measure the ARINC level signal at P102-N. Limit .33 Vrms $\pm$0.05 Vrms
   b) turn on 150 Hz modulation.
4) Set the VOR generator to 110.00 MHz and turn off the 9960 Hz FM signal.
   a) press the transfer button
   b) measure the ARINC level signal at P102-N. Limits 0.5 Vrms $\pm$0.05 Vrms
   c) turn on the 9960 Hz FM signal on the generator.
5) Reduce generator RF attenuator to 4 uV. Turn on the 1020 Hz Ident at 30% modulation.
6) Turn receiver volume control maximum CW and pull to "IDENT" position; note audio output.

   Audio: 50 mW minimum across 300 ohms

7) Reduce generator RF attenuator to 1 uV.
8) In "IDENT" mode, reduce audio power output to 20 mW (or a convenient reference); remove modulation from generator and observe decrease in audio output.

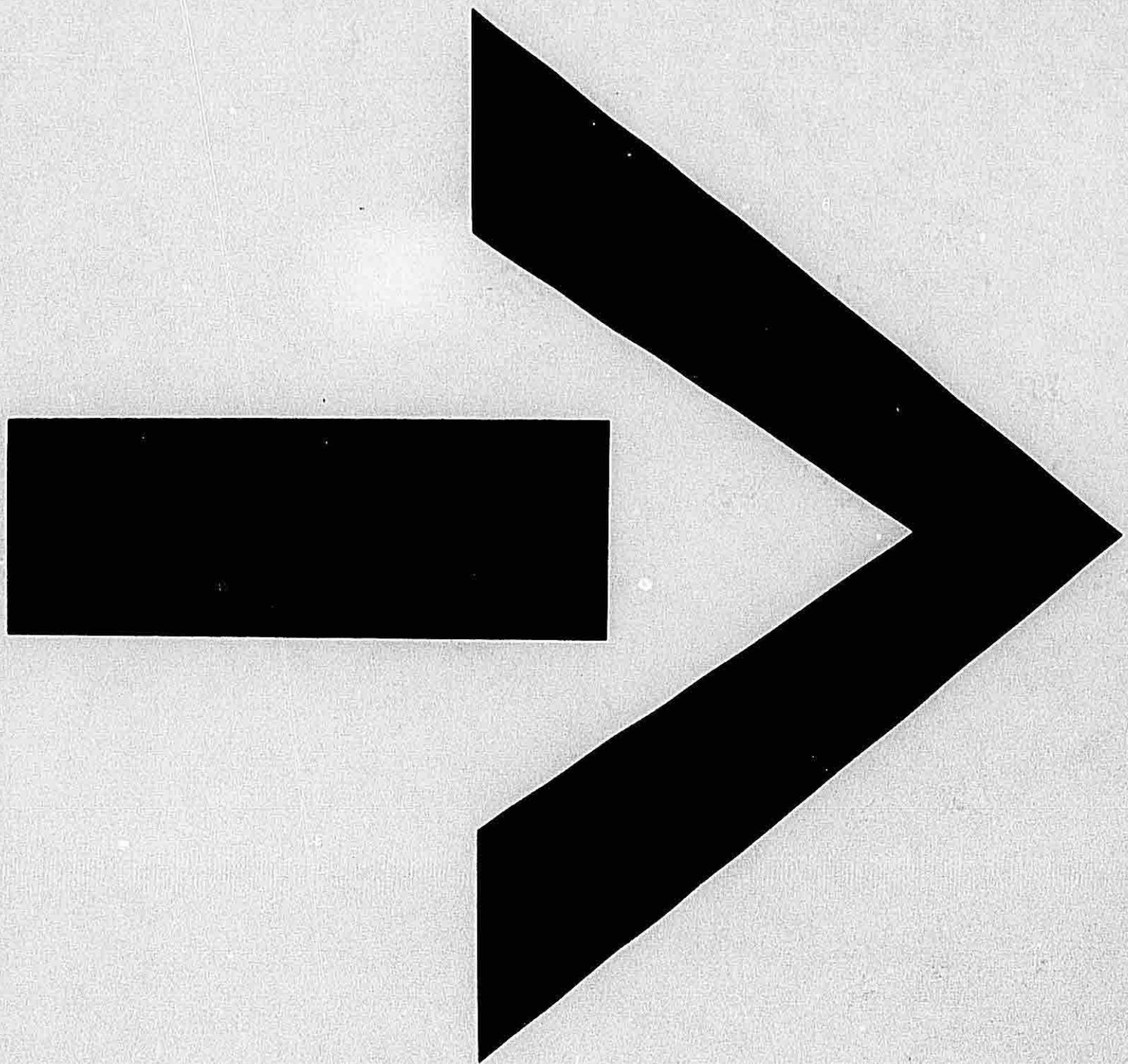
   S + N ÷ N = 6 dB minimum.

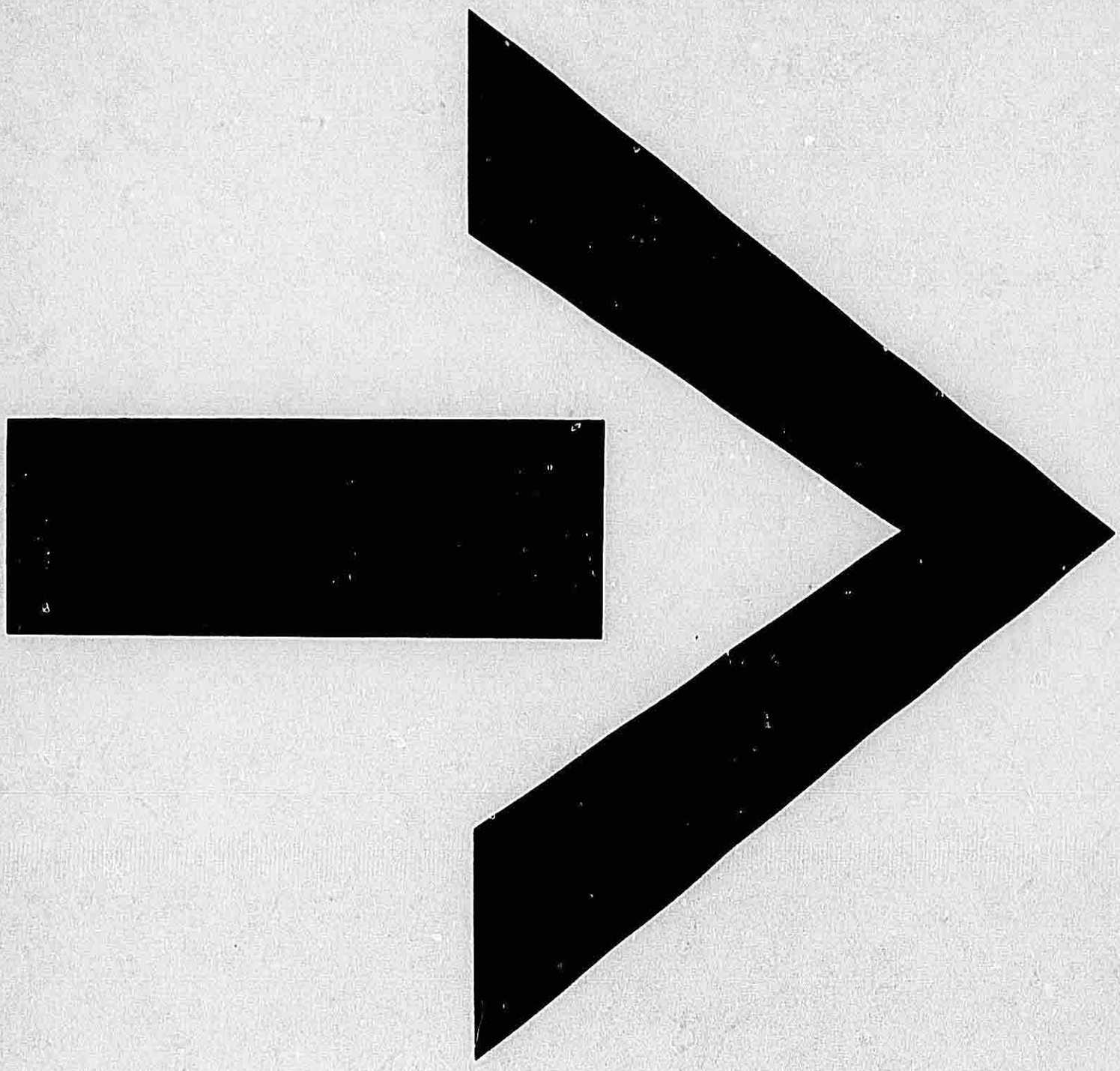
9) Set generator RF attenuator to 10 uV; set modulation to 30%, 1020 Hz.
10) In "IDENT" mode, set audio power output to 20 mW (or a convenient reference); increase generator RF attenuator to 10K uV: note increase in audio power output.

    AGC; +3 dB maximum deviation

11) Modulate generator 30% with 1020 Hz audio; set generator attenuator to 500 uV.
12) In "IDENT" mode, set power output to 20 mW; push in the NAV Receiver VOL-IDENT knob and note decrease in audio output.

    Ident Filter: 18 dB minimum attenuation





2.6.2.5 VOR Converter

1) Modulate the VOR/ILS generator with a composite VOR signal. Set RF attenuator to 500 uv. Set the bearing to zero degrees and the TO/FROM switch to the "TO" position.
2) Set the NAV 824/825 display mode switch to the "TO" position.
3) Set the CDI course knob to zero degrees.
4) Observe the following:
   a) The CDI shall show a full TO flag
   b) The legend TO shall be illuminated under the displayed digital bearing on the front panel of the NAV 824/825. (Digital bearing will be adjusted in step 8)
   c) The CDI NAV flag (if it has one) should not be visible.
   NOTE: The ID 824/825/826 do not have a separate NAV Flag.
5) Set the VOR/ILS generator TO/FROM switch to the "FROM" position and note that the legend "FR" is illuminated under the displayed digital bearing on the front panel of the NAV 824/825. Return the generator TO/FROM switch to TO position.
6) Zero the CDI that will be installed in the aircraft by adjusting the VOR zero pot, R511. See Figure 2-[illegible] for location of R511.
7) Set the VOR generator bearing to 29.5 degrees.
8) Adjust the digital (Dig) bearing Zero pot R559, so that the displayed digital bearing reads 030 degrees. NOTE: The digital bearing resolution is to the nearest degree.
9) Check VOR accuracy at 30 degree intervals from 0 to 330 degrees.
   a) CDI limits: $\pm$1.5 degrees To and From
   b) Digital Bearing limits: $\pm$1 degree To and From
10) Set CDI bearing and VOR generator bearing to Zero degree. Check CDI course width as follows:
   a) rotate the CDI course knob clockwise until the needle is at the 5th dot. The CDI bearing shall read 10 $\pm$1 degree
   b) repeat step 10a for a counterclockwise rotation: The CDI bearing shall read 350 $\pm$1 degree.
11) Check Alarm indication as follows:
   a) turn off 30 Hz Mod signal of the VOR generator and note that the NAV digital bearing display shows bars, the T/F flag is not visible and the NAV flag is fully visible. Turn on the 30 Hz Mod signal and wait for the To/From flag to appear and NAV flag to retract.
   b) turn off 9960 Hz Mod signal of the VOR generator and note the same alarm indications as in step 11a. Turn on the 9960 Hz Mod signal.
12) Check VOR alarm sensitivity as follows:
   a) set the VOR generator bearing to Zero degree
   b) center the CDI needle with the course knob
   c) set the VOR generator bearing to 10 degrees.

2.6.2.5 Continued

d) slowly reduce the VOR generator RF attenuator until an alarm indication occurs and note the following:
1. The VOR RF attenuator shall read 1 uv or less
2. The alarm indication shall have occurred by the time or before the CDI needle has reached half course width.

13) Check 90 degree crossover point as follows:
a) set VOR generator to Zero degrees and Zero the CDI needle with the course knob
b) rotate the VOR generator bearing close to 90 degrees until the T/F flag is fully OFF
c) the VOR generator bearing shall read 90 ±5 degrees.

14) Set VOR generator to Zero degrees and center the CDI needle with the course knob. Rotate the VOR generator RF attenuator from 2 to 10K uv and note any CDI needle deflection. Error limit: ±1 degree.

2.6.2.6 Localizer Converter

1) Press NAV transfer button to place 110.10 MHz in Active frequency. Set the VOR/ILS generator to 110.10 MHz. Modulate generator with a centering 90/150 Hz LOC signal. Set RF attenuator to 500 uv. Note the following:
a) NAV digital bearing display shall show bars
b) the legend LOC shall be illuminated under the bearing display
c) the T/F flag shall show a full TO
d) the NAV flag (if display has one) shall be fully retracted.

2) Zero the CDI needle by adjusting the localizer (LOC) Zero pot R575 (refer to Figure 2-3 for location).

3) Check LOC course width as follows:
a) apply a ±.093 ddm deflection signal to the NAV unit
b) course width shall be 3 dots deflection ±1 needle width.

4) Check alarm indication as follows:
a) turn off the 90 Hz modulation and observe that the To/From flag shall be fully off and the NAV flag (if display has one) shall be fully on. Turn the 90 Hz modulation back on and wait until alarm indicators retract.
b) turn off the 150 Hz modulation and observe the same alarm indications as in step 4a. Turn the 150 Hz modulation back on.

5) Check LOC alarm sensitivity as follows:
a) apply a ±.093 ddm deflection signal to the NAV Unit
b) slowly reduce the VOR/ILS generator RF attenuator until an alarm indication occurs and note the following:
1. the RF attenuator shall read 1 uv or less
2. the alarm indication shall have occurred by the time or before the CDI needle has reached half course width.

2.6.2.7 NAV 825 Glideslope Converter

1) Connect the VOR/ILS generator's RF output to the GS connector J105 at the rear of the NAV 825.
2) Modulate the VOR/ILS generator with a composite 90/150 Hz GS centering signal. Set RF attenuator to 500 uv and note that the GS flag is fully retracted.
3) Zero the display GS needle by adjusting the glideslope (GS) Zero pot R113-6 (refer to Figure 2-3 for location).
4) Check GS course width as follows:
   a) apply a $\pm$.091 ddm deflection signal to the NAV Unit
   b) course width shall be 2.5 dots $\pm$1 needle width.
5) Check alarm indication as follows:
   a) turn off GS 90 Hz Mod and observe that the GS flag is in full view. Turn 90 Hz Mod back on and wait for GS to recover
   b) turn off GS 150 Hz Mod and observe that the GS flag is in full view. Turn GS 150 Hz Mod back on.
6) Check GS flag sensitivity as follows:
   a) apply a $\pm$.091 ddm deflection signal to the NAV Unit
   b) slowly reduce the RF attenuator until the GS flag is in full view and note the following:
      1. The RF attenuator shall read 10 uv or less
      2. The alarm indication shall have occurred <u>by the time</u> or <u>before</u> the GS needle has reached half course width.

2.6.2.8 Display Dimmer Adjust (R120)

The dimmer adjust, R120, is accessible through a hole in the front panel (See Figure 2-3). A flat bladed screw driver with a shaft diameter of .062 inch or less is required. Depth to engage the pot is approximately 1/4 inch.

The purpose of the adjustment is <u>NOT</u> to increase the display intensity under bright ambient light. Maximum display intensity is non-adjustable and controlled by the dimmer circuit design. R120 is used to adjust the <u>minimum</u> acceptable display intensity under minimum ambient light and should be done with the NAV mounted in the aircraft panel.

Place an opaque material over the front panel photocell (see Figure 2-3). Adjust R120 to raise the display intensity to a minimum acceptable or to match the level of other radios with gas-discharge displays.

2.7 ELECTRICAL INSTALLATION

2.7.1 Interconnect Wiring

The installing agency must fabricate their own interconnect cable. The NAV 824/825 rear connections are shown in Figure 2-6. Note that the NAV 824 and NAV 825 do not require a power converter for use in 28 volt aircraft. Power input can range from 11 to 32 volts.

2.7.2 Antenna Connections

Antenna connections to the NAV are made through the rear panel of the tray as shown in Figure 2-6.

The NAV 824 tray will have only one antenna cable, it is stamped VOR.

The NAV 825 tray will have two antenna cables, with one stamped VOR and the other GLIDESLOPE.

2.7.3 GS/DME Remote Channeling

Channel coding 2/5 is provided by the NAV 824/825. Figure 2-6 furnishes the rear connector connections. The channeling lines in the NAV 824/825 are connected to uncommitted collectors of buffer transistors U307 and U308. Figures 2-13 through 2-17 furnish the remote channeling wiring for the DME 890, DME 195, and DME 190/190 TSO.The NAV 122/121 and NAV 124 cannot be used with a NAV 824/825 in a dual remote channeling system unless a separate channeling line isolation box is provided by the installing agency for the NAV 122/121 and NAV 124. This scheme is necessary as the NAV 122/121 and NAV 124 have dedicated channeling switches that are hard wired to ground. These channeling switches also program the synthesizers in these NAV's.

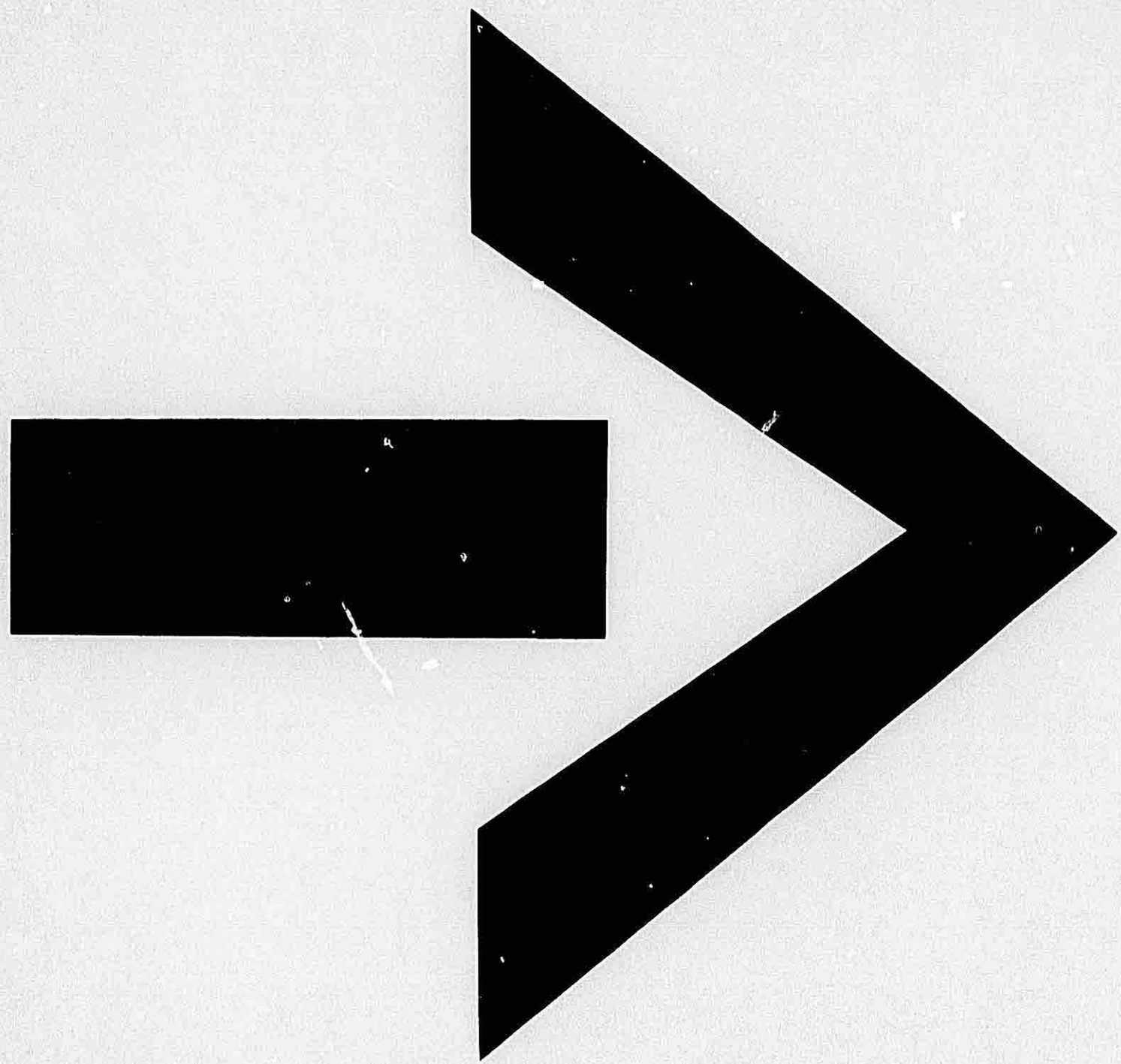
The ID 825/826 are not compatible with the combination consisting of a NAV 824 and UGR 2A 2/5 because the +DOWN lead is not available as a separate lead. However, the ID 124/124C and HSI-100 are compatible and are shown in Figure 2-11 and 2-12.

2.7.4 External LOC/GS Activate (P102, pin J)

The LOC/GS Activate line in the NAV 824/825 is connected to an uncommitted collector of a transistor in U308, and provides a ground on any LOC/GS channel. Interconnecting the NAV 824/825 with a Glideslope or Localizer not produced by Narco will require observance of the following:

1. In VOR mode, the maximum voltage rise permitted on the LOC/GS Activate line is +30 Vdc. (LOC/GS open)
2. In LOC/GS mode, the maximum sinking current allowed is 20 milliamps. (LOC/GS closed)

Reactive loads (relay coils) must be shunted with transient suppression.



2.7.5 NAV Audio (P102, pin A)

This output is intended to drive an audio control panel for NAV audio. Output level and impedance is 50 mw/300 ohms.

2.7.6 ARINC NAV Video (P102, pin N)

A detected VOR/LOC output is available for driving an RMI. A typical system could include a AIM RC75 or SC12 RMI converter with a Narco Avionics HSI-100 or AIM 800 series Indicator.

ARINC level and phasing is present at P102, pin N (.5 Vrms at 0^{o}).

2.7.7 Autopilot Output

The NAV 824/825 autopilot output characteristics are shown in Table 2-6.

TABLE 2.6. AUTOPILOT OUTPUT CHARACTERISTICS

Function	P103 Pin Number	Output	Meter Response
+RIGHT +LEFT	Pin K (see note 1) Pin L (see note 2)	VOR: 150 mv for 10^{o} course change LOC: 90 mv for .093 ddm	0.6 Sec. 0.6 Sec.
+NAV FLAG -NAV FLAG	Pin 8 Pin 9	VOR: 250 mv at full retraction LOC: 250 mv at full retraction	
+UP +DOWN	Pin 11 (see note 1) Pin 3 (see note 2)	GS; 90 mv for .091 ddm	0.6 Sec.
+GS FLAG -GS FLAG	Pin B Pin C	250 mv at full retraction	

NOTES: 1. Signals on Pins K and 11 are riding on top of an 8 volt bias level.
2. Pins 3 and L are tied internally to an 8 volt bias.

Dwg No. TP001221A

2.8 CABLE FABRICATION, NAV

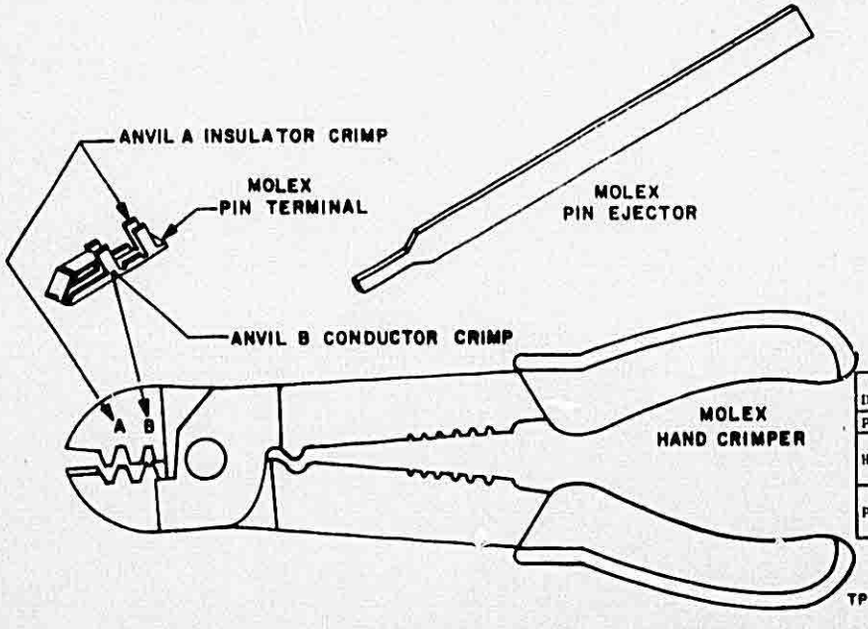
1. Strip wire 5/32" for each PIN connection.
2. Open tool (engraved side toward you), from the opposite side, place the conductor tab section of the pin on Anvil B. Close tool slightly (until tabs touch the female jaw).
3. Insert stripped conductor until insulation is flush with outside of jaw. Crimp by squeezing handles together until jaws are fully closed or sufficient crimp is made.
4. Move leads and pin to Anvil A. Crimp again until jaws are closed or sufficient crimp is made, so that insulation on wire is crimped.
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 connector housing. The pin cannot be inserted upside down. Right-side-up it slides in effortlessly. Be sure to push it all the way in, until a "click" can be felt, or heard.
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 ejection tool into the mating side of the housing, under the pin. 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.



Part Description	Molex Part No.	Narco Part No.
Pin, Terminal, Gold	08-05-0302	41407-0001
Hand Crimper	HTR-1719C or HT-1921	41314-0001
Pin Ejector	HTA-1884A	41314-0002

FIGURE 2-4. CRIMPING TOOL

2.9 INDICATORS

The NAV 824 (without GS) and NAV 825 (with GS) may be used with Indicators exhibiting the characteristics noted in Table 2.7. Typical of these Indicators are the Narco ID 824/825 and ID 826. Other Narco Indicators that can be used are the ID 124/124C and HSI-100.

External jumpers at the NAV rear connector P103 determine if the NAV will function with an ID 824/825 or ID 826 or other ARINC Resolver type display. A jumper installed between P103, pin 1 and P103, pin 4 is required for the ID 824 and ID 825 indicators only.

A jumper installed between P103, pin 10 and P103, pin 12 is required for the ID 826 or any other ARINC Resolver type display.

TABLE 2.7. INDICATOR CHARACTERISTICS

Function	Characteristic
VOR/LOC Left/Right TO/FROM	 150-0-150 ua - 1000 ohms 250 mv, 200 ohms
NAV FLAG	250 ua - 1000 ohms
GS (NAV 825 only) Up/Down GS FLAG	 150-0-150 ua 100 ohms 250 mv - 1000 ohms
Course Selection	ARINC Resolver Sine/Cosine potentiometer

Dwg No. TP001246

2.9.1 RNAV 860 Installation

The NAV 824/825 is intended as a receiver for the Narco RNAV 860 area navigation system. Refer to RNAV 860 maintenance manual for information.

2.9.2 Electrical Installation, ID 824/825/826

Interconnecting cables must be constructed by the installing agency. Rear panel connections are shown in Figure 2-7 and assembly of the connector is illustrated in Figure 2-5.

Connector Assembly Procedure (Solder)

Note: Crimping tools are available from ITT Cannon, if desired.

1. Strip wire as shown in Figure 2-5. Maximum wire size is No. 20 AWG.
2. Tin exposed lead. Be sure no individual wire strands are free!
3. Insert lead into connector pin until lead is visible at inspection port.
4. Heat pin and apply solder as shown until solder wicks into pin cavity and becomes visible through inspection port. Be carefull not to overheat pin or melt insulation on wire.
5. Pass pin through hood and insert pin in connector until a "click" is heard or felt; exert a slight pull on the wire to assure pin seating.
6. During final assembly:
   a. Inspect all wires for individual strands of wire shorting to adjacent terminals.
   b. Ease hood into place, do not force.

The connectors incorporate a "slide lock" mechanism. Before installing, move the slide to position the slide's longer tab away from the connector, mate the connectors, then push slide to lock connector to Indicator. To remove a connector from the Indicator, by feel, determine which end of the slide extends beyond the connector body, press this end toward the connector until it is flush, then remove the connector.

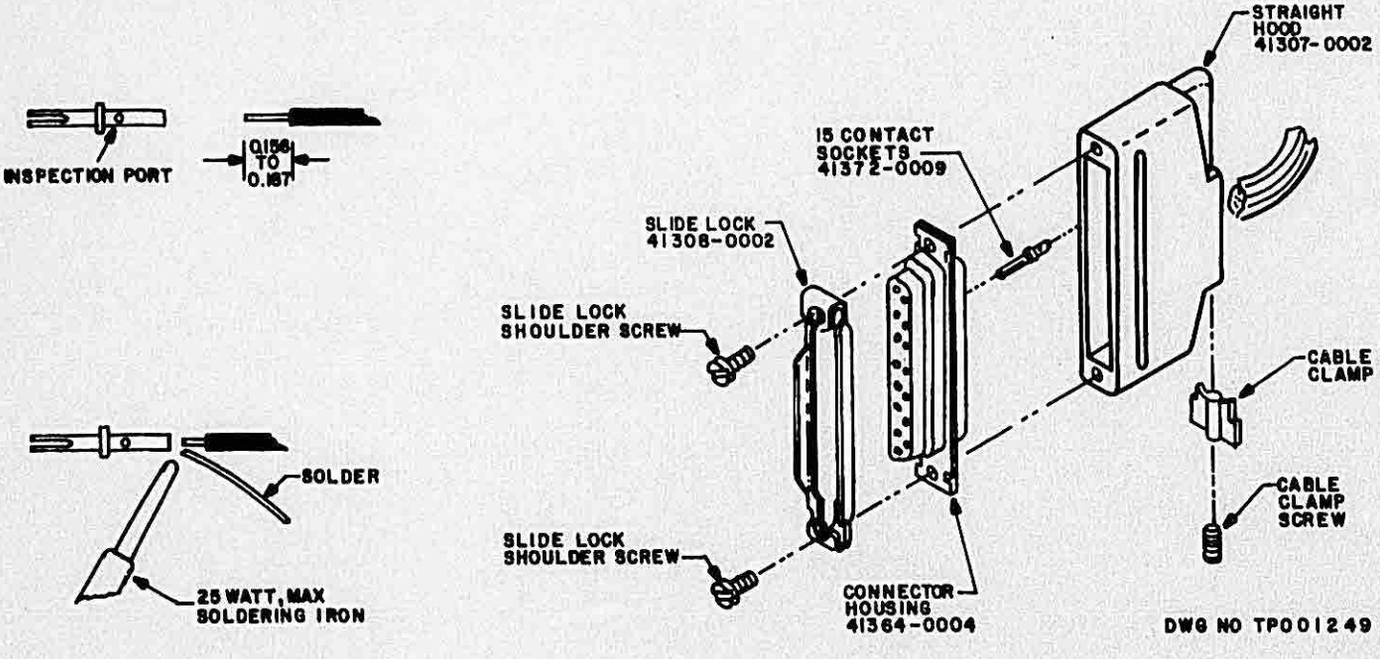


FIGURE 2-5. ID CONNECTOR

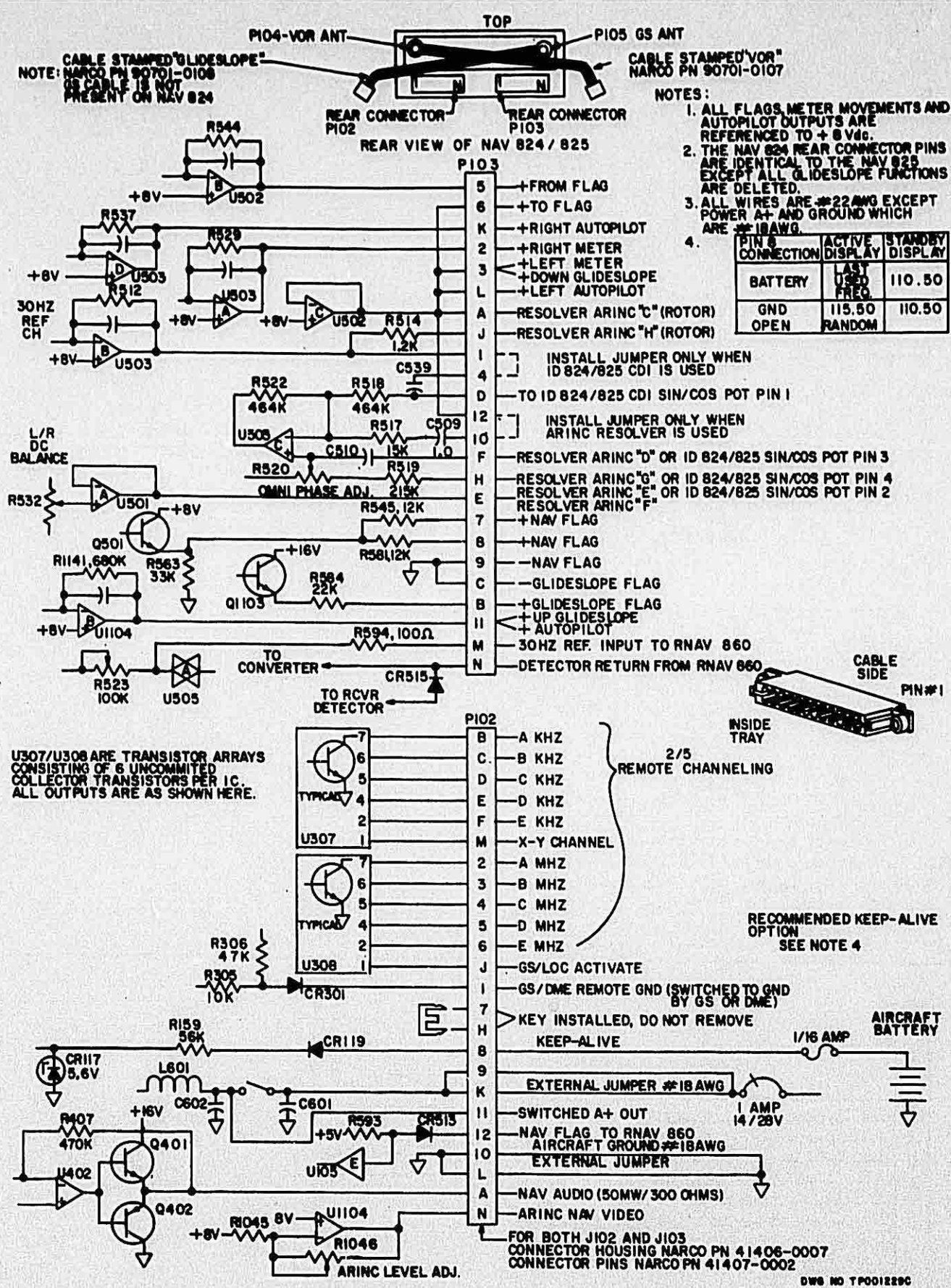


FIGURE 2-6. INTERCONNECT WIRING, NAV 824/825

SEE BLOW-UP

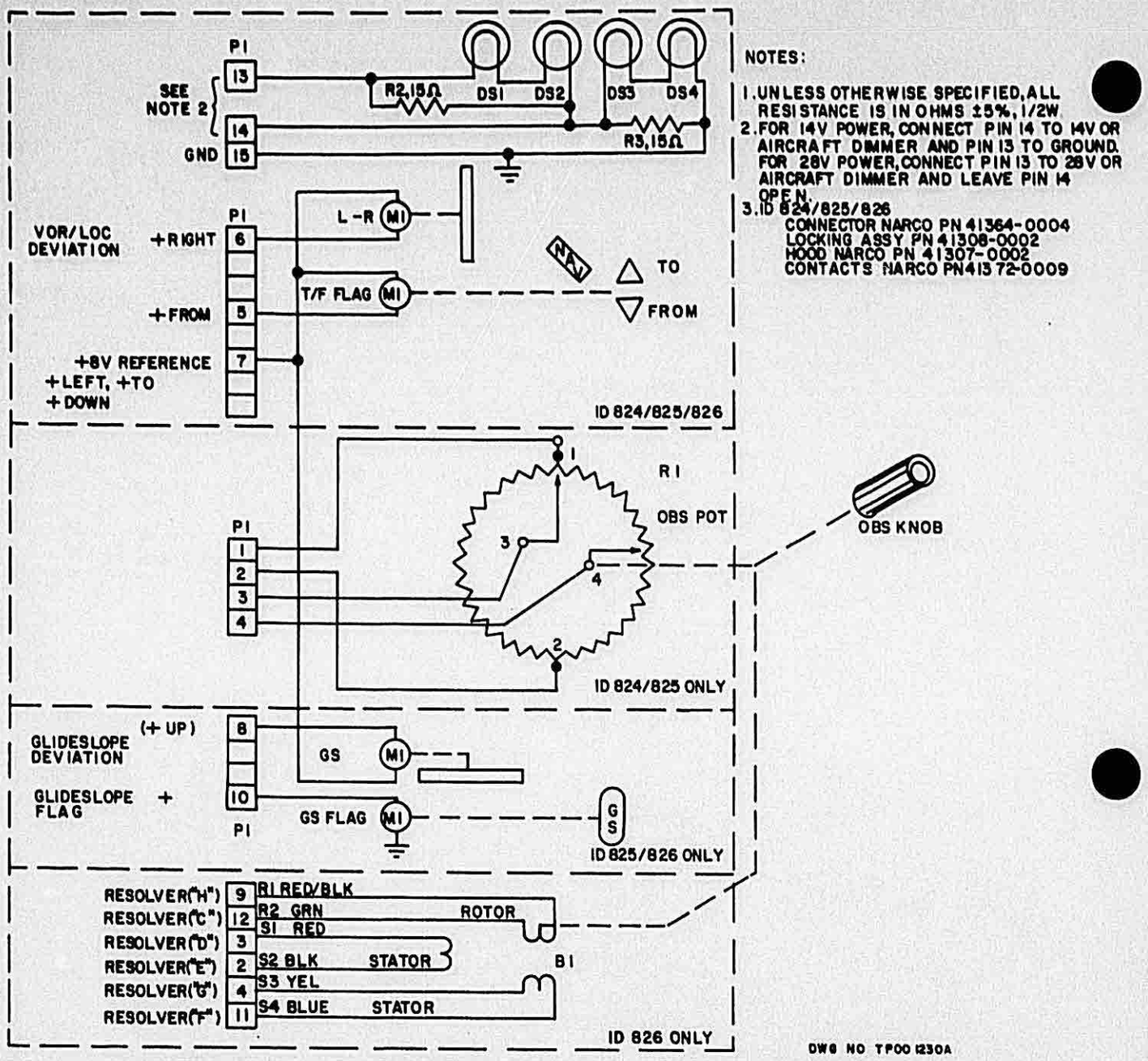


FIGURE 2-7. INTERCONNECT WIRING, ID 824/825/826

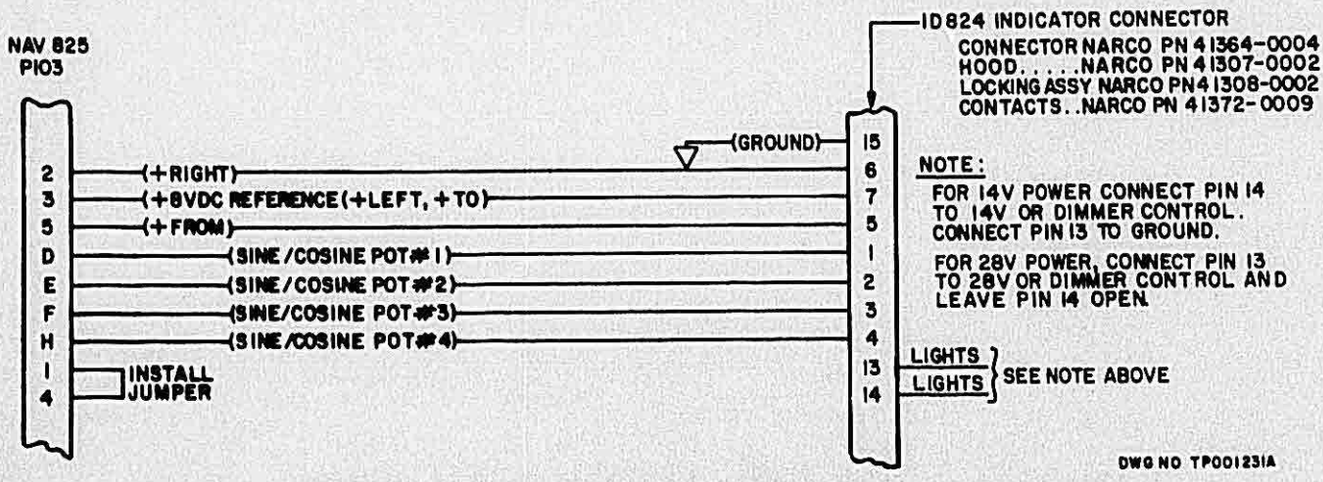


FIGURE 2-8. CABLE WIRING NAV 824 to ID 824

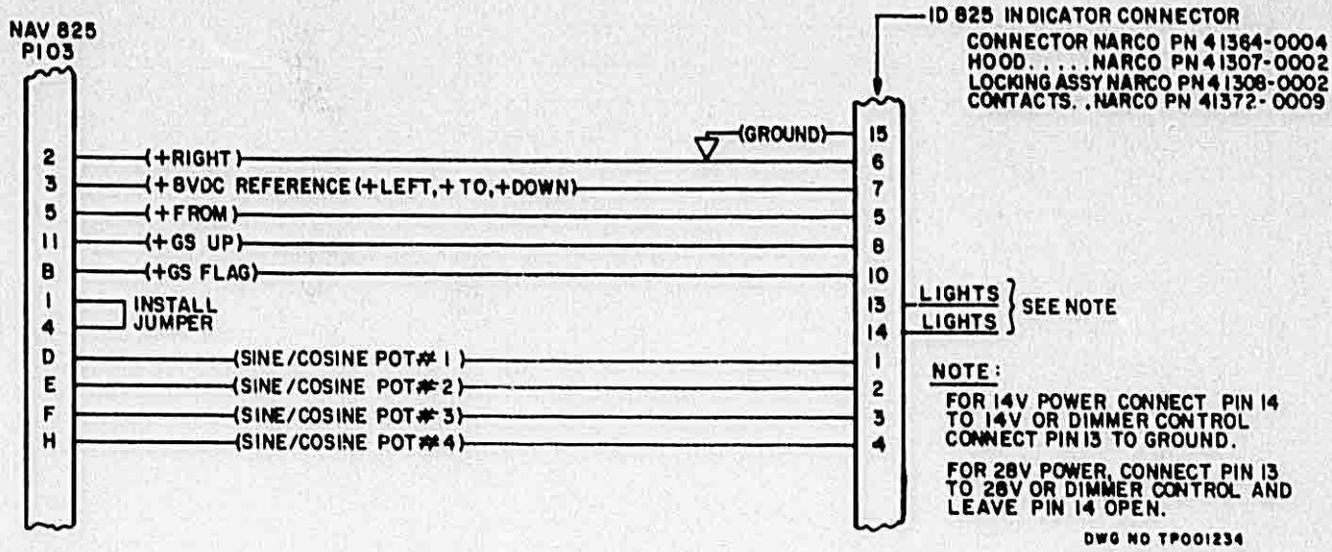


FIGURE 2-9. CABLE WIRING NAV 825 to ID 825

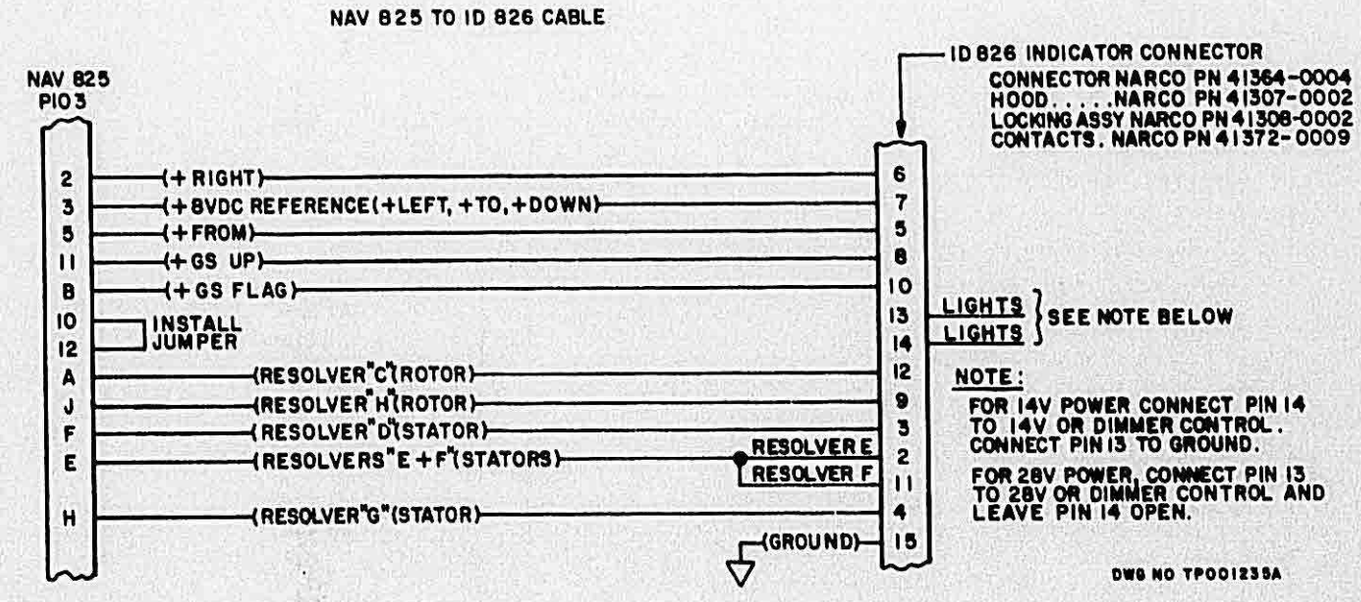


FIGURE 2-10. CABLE WIRING NAV 825 to ID 826

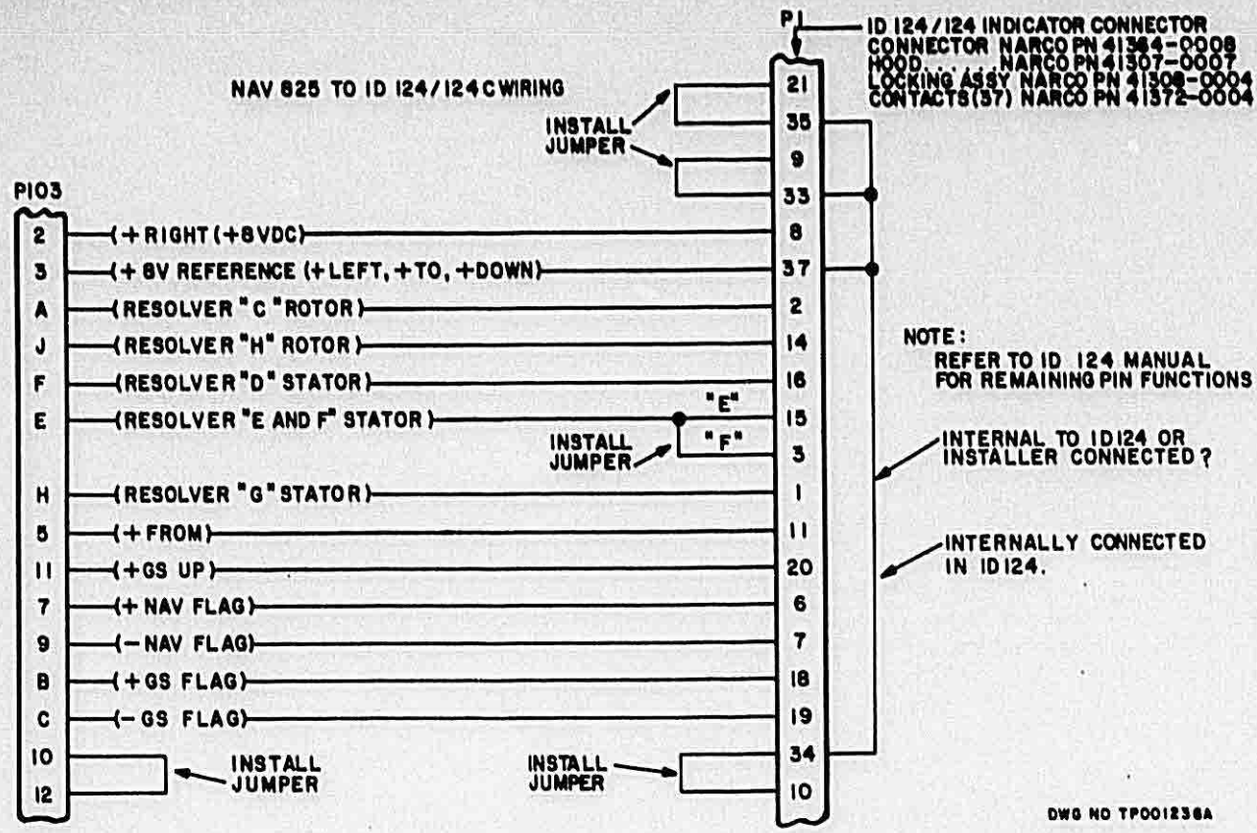


FIGURE 2-11. CABLE WIRING NAV 825 to ID 124/124C

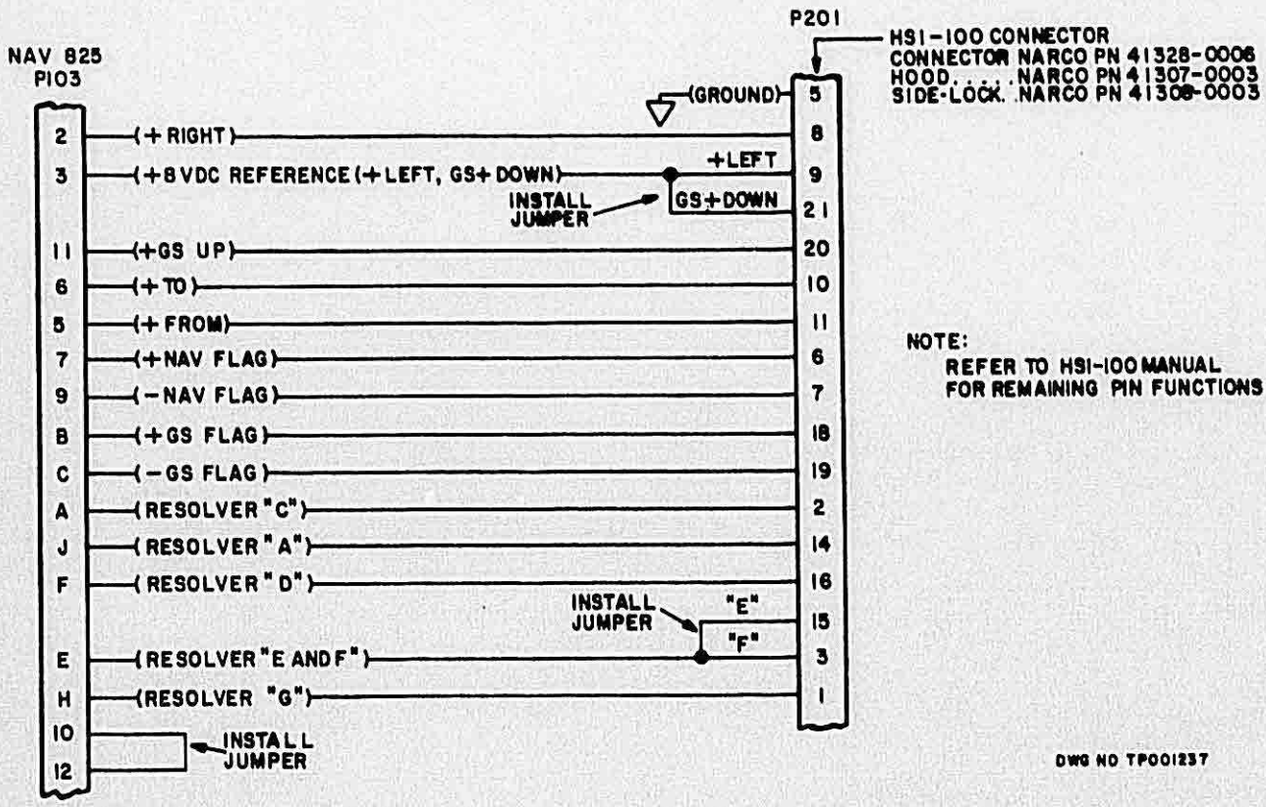


FIGURE 2-12. CABLE WIRING NAV 825 to HSI-100

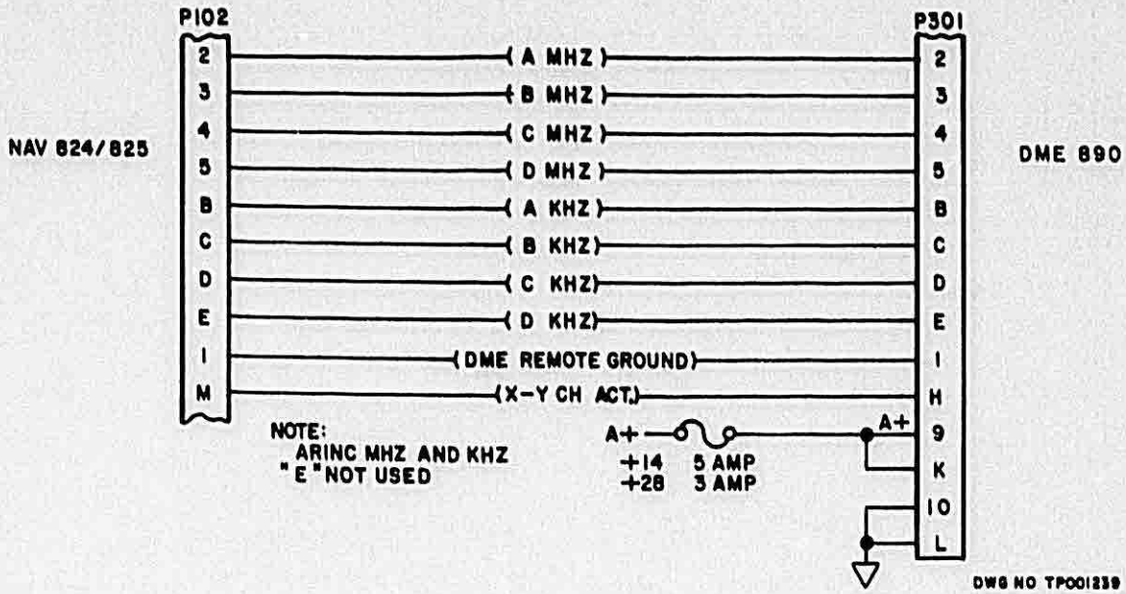


FIGURE 2-13. CABLE WIRING NAV 824/825 to DME 890 REMOTE CHANNELING

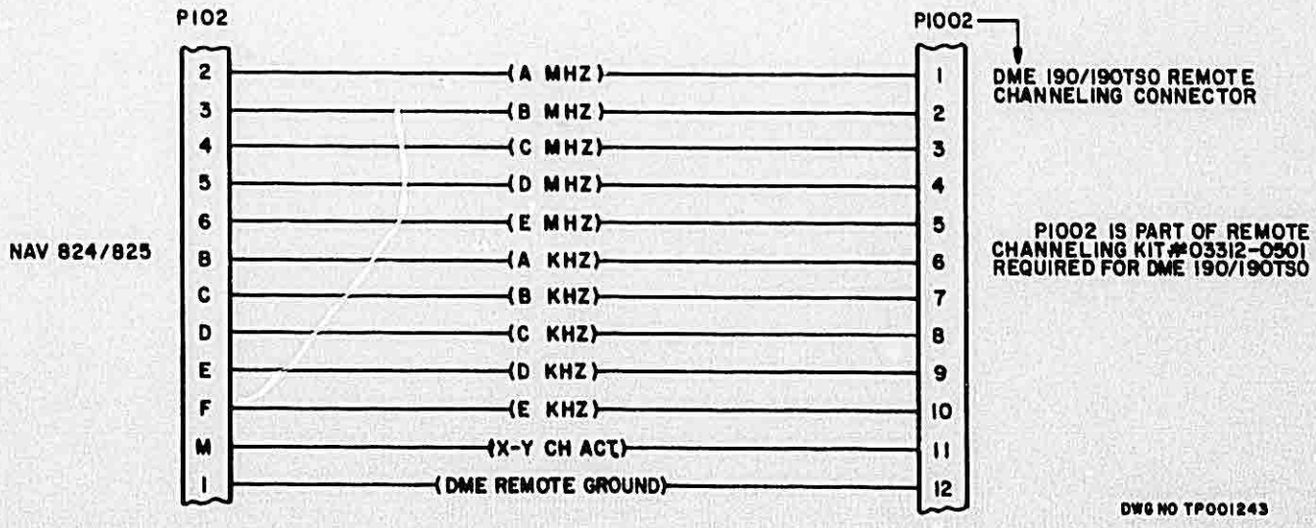


FIGURE 2-14. CABLE WIRING NAV 824/825 to DME 190 REMOTE CHANNELING

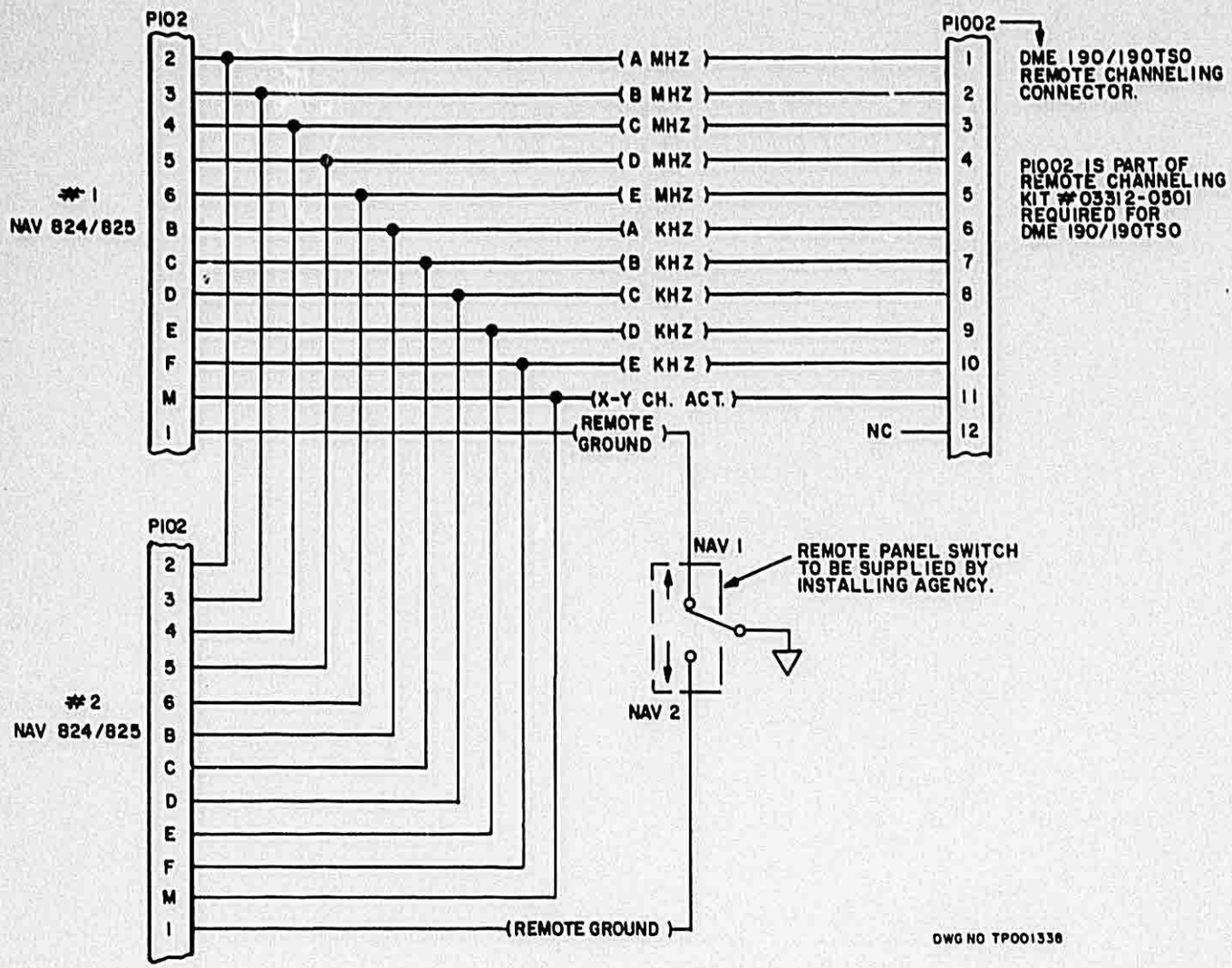


FIGURE 2-15. CABLE WIRING DUAL NAV 824/825 TO DME 190 REMOTE CHANNELING

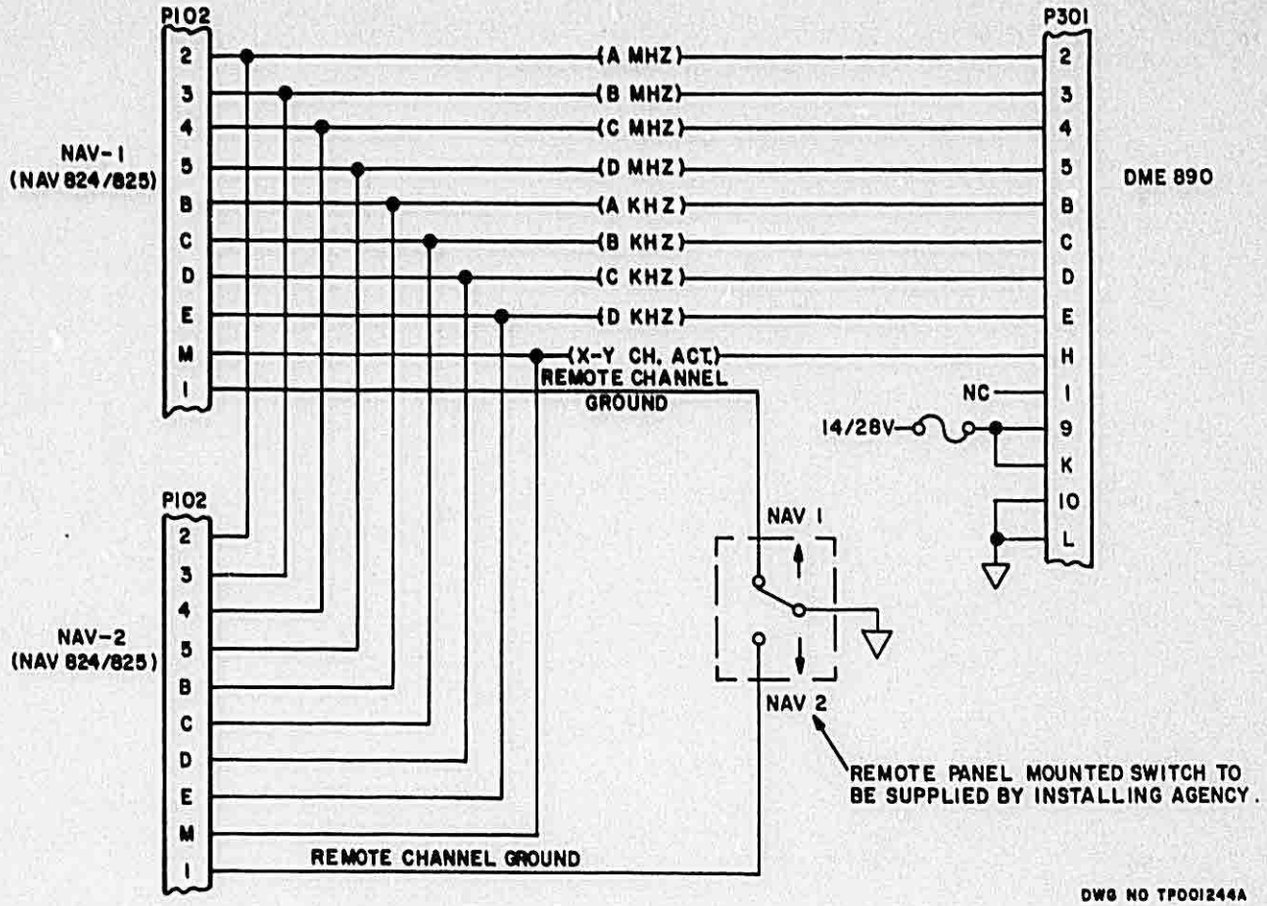


FIGURE 2-16. CABLE WIRING DUAL NAV 824/825 TO DME 890
REMOTE CHANNELING

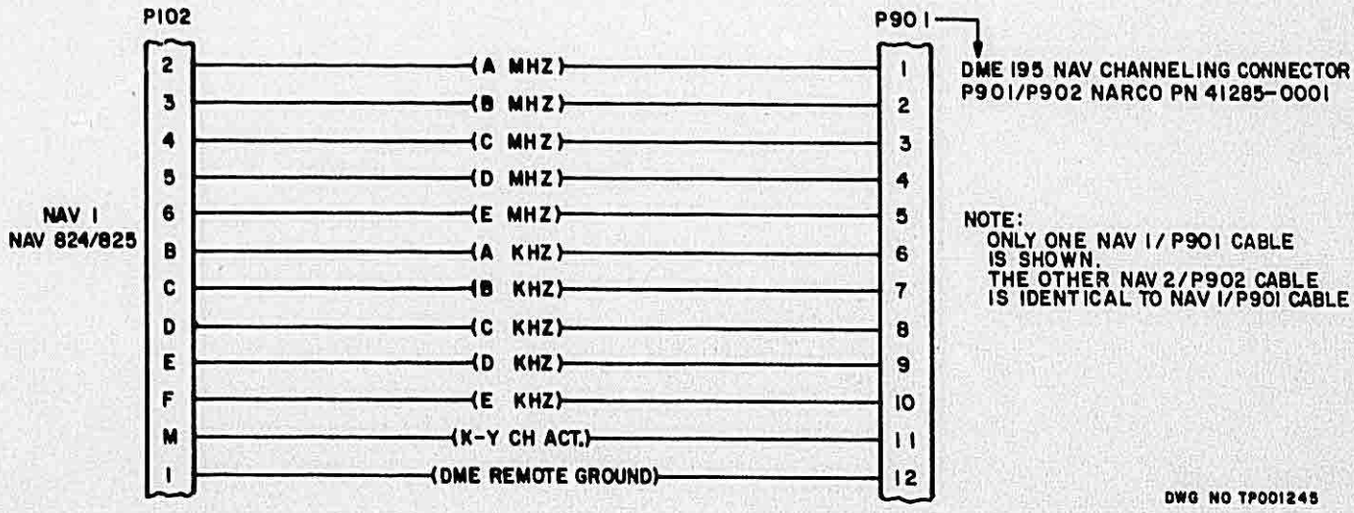


FIGURE 2-17. CABLE WIRING DUAL NAV 824/825 TO DME 195
REMOTE CHANNELING

2.10 MECHANICAL INSTALLATION

This Section provides the mechanical installation steps for mounting the tray and the rear connector.

2.10.1 Tray Lock

The tray has a built-in spring locking device. When the Unit is positioned into the tray's track and slid into the tray a tension (locking) spring contacts the Unit. When the Unit's connector(s) touch the tray connectors an additional set of tension springs can be felt holding back the inward direction of the Unit. At this point using firm pressure the Unit will continue inward approximately a half-inch stopping as the forward tension/locking spring "clicks" into position. The Unit is now locked in place.

Removal of the Unit requires an extraction key. Place the key into the small hole provided in the right corner and push it into the hole. This action clears the forward tension spring from the locking detent, and due to the rear springs, the Unit will "pop" outward an inch or two. The Unit is now disconnected from the rear connector(s) and the tray lock, and is ready to be slid out of the tray.

2.10.2 NAV Mechanical - Tray

Upon removing the Unit from its shipping container, the Unit must be removed from its mounting tray.

Position the assemblies on a flat surface, place a block behind it as shown in Figure 2-6. Insert the key straight into the key hole in the trim panel, exert sufficient pressure to release the spring lock. Upon release the tension (eject) springs will "pop" the Unit outward, freeing it. Save the key.

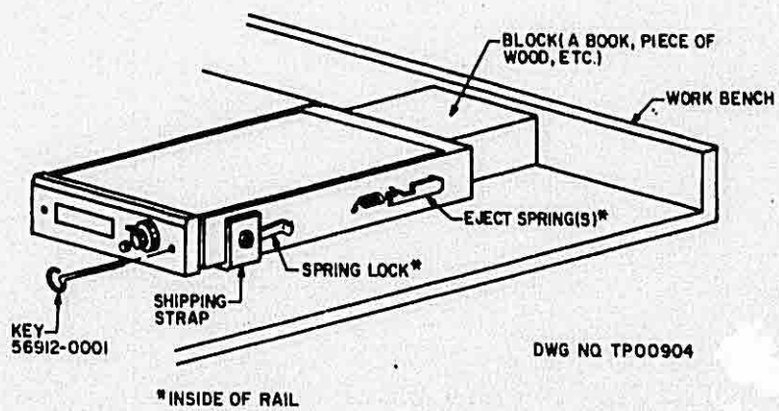


FIGURE 2-18. TRAY LOCK

2.10.2 Continued

Prepare the panel cutout for the tray. Refer to Figure 2-20 that provides dimensions and a 1:1 template.

The proper position of the tray, when installed, is that where the edges of the side rails on the open end of the tray will be flush with the cabin side of the instrument panel.

For convenience, if you are going to remove the connector(s), mark a piece of tape "TOP" and apply it to the top of the mounted connector (P102/P103) before removing.

Remove the "U" shipping strap (see Figure 2-18) from the tray. SAVE THE SCREWS, discard the strap and nuts. Handle the tray with care to avoid deforming the rails.

The installation kit contains a Rail Width Tool. It was designed to provide a exact width for optiumum unit/tray fit. This tool is to be positioned during tray installation touching the back of the nylon blocks on the rails (2-9/16 inches in). The "U" shims in the kit are used to fill voids between the forward mounting supports and the Rails (if required). Due to their simplicity, if additional shims are required, they can be quickly fabricated by the installer.

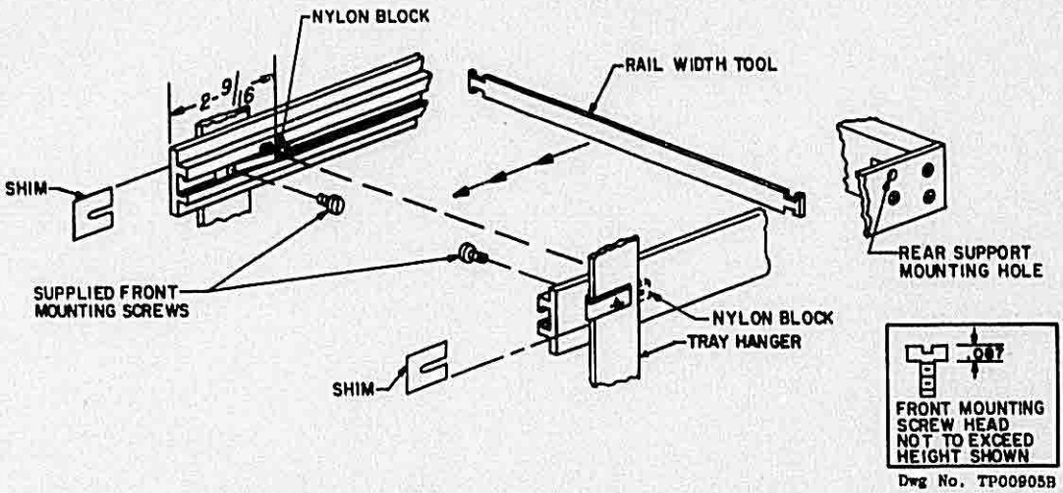
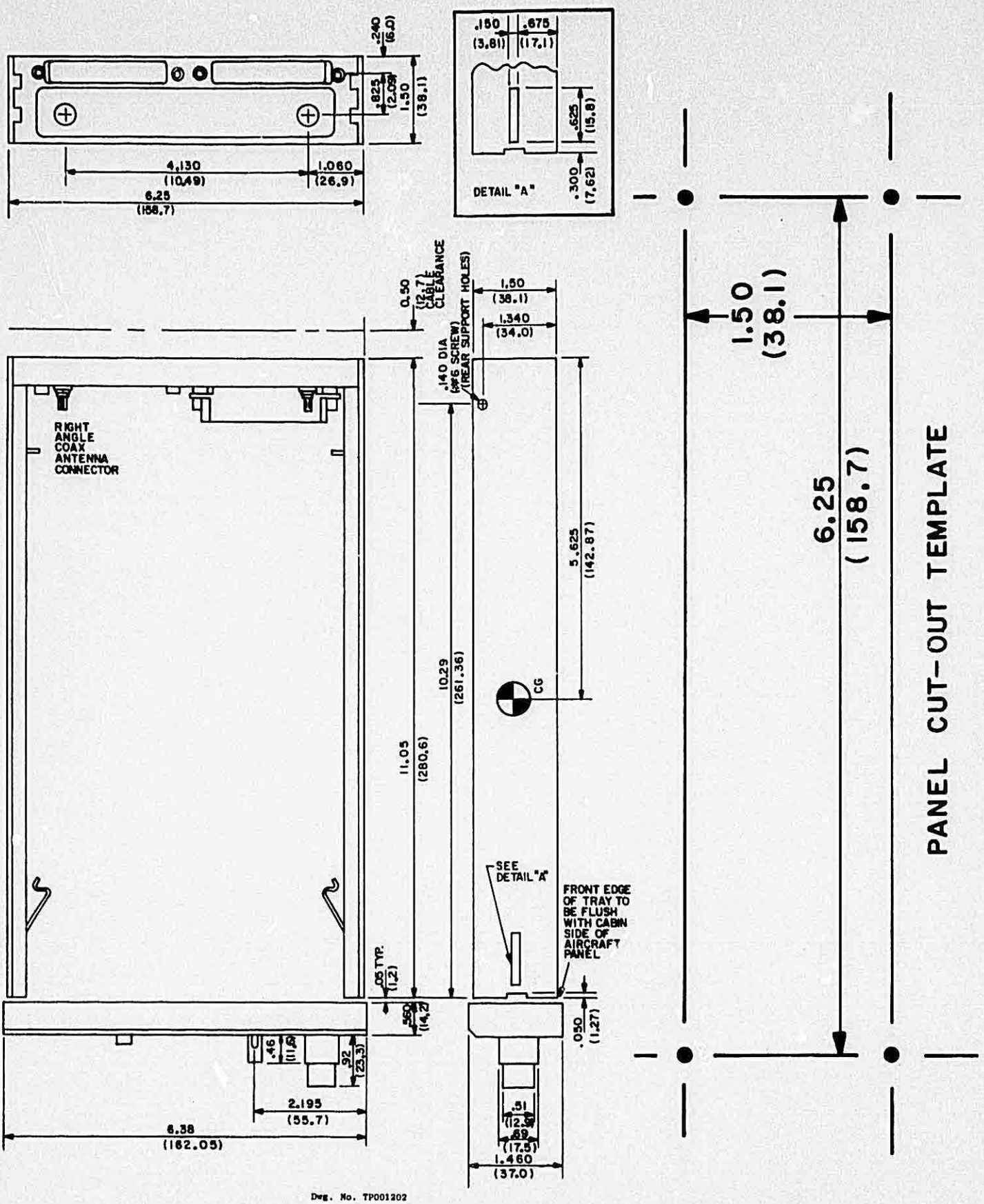


FIGURE 2-19. TRAY FRONT WIDTH

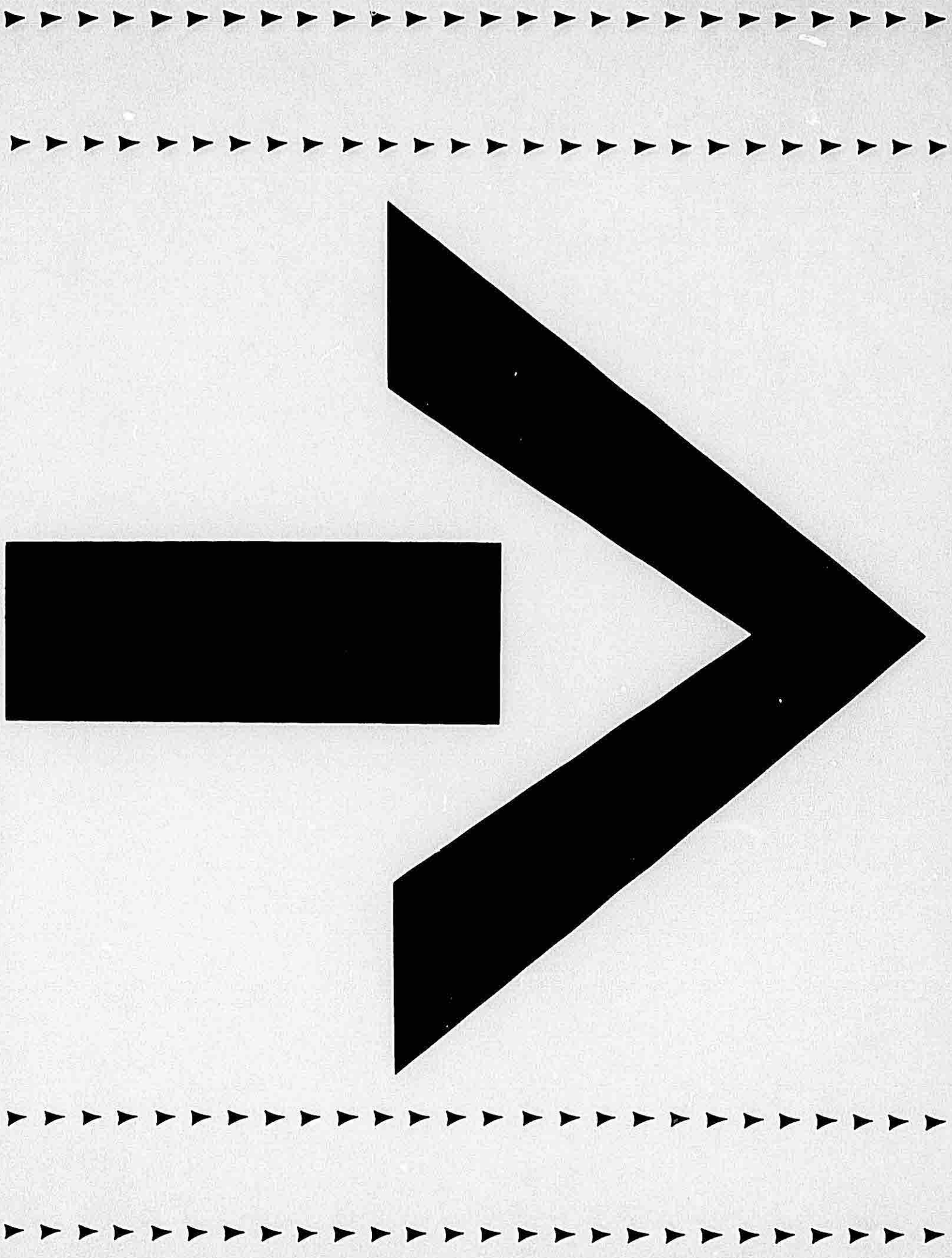
Attach these ends using the screws that attached the shipping strap. Should any other screws be used its head cannot be more than .087 high as should it be higher it may be nearly impossible to remove the unit as the KEY must be able to pass between the screw head and the Unit to disengage the spring lock! NOTE: DO NOT USE LOCKWASHERS. Locking "J" nuts or equivalent should be used. Rear support should be provided using the .140 inch diameter holes shown on the side rails (see Figure 2-20).

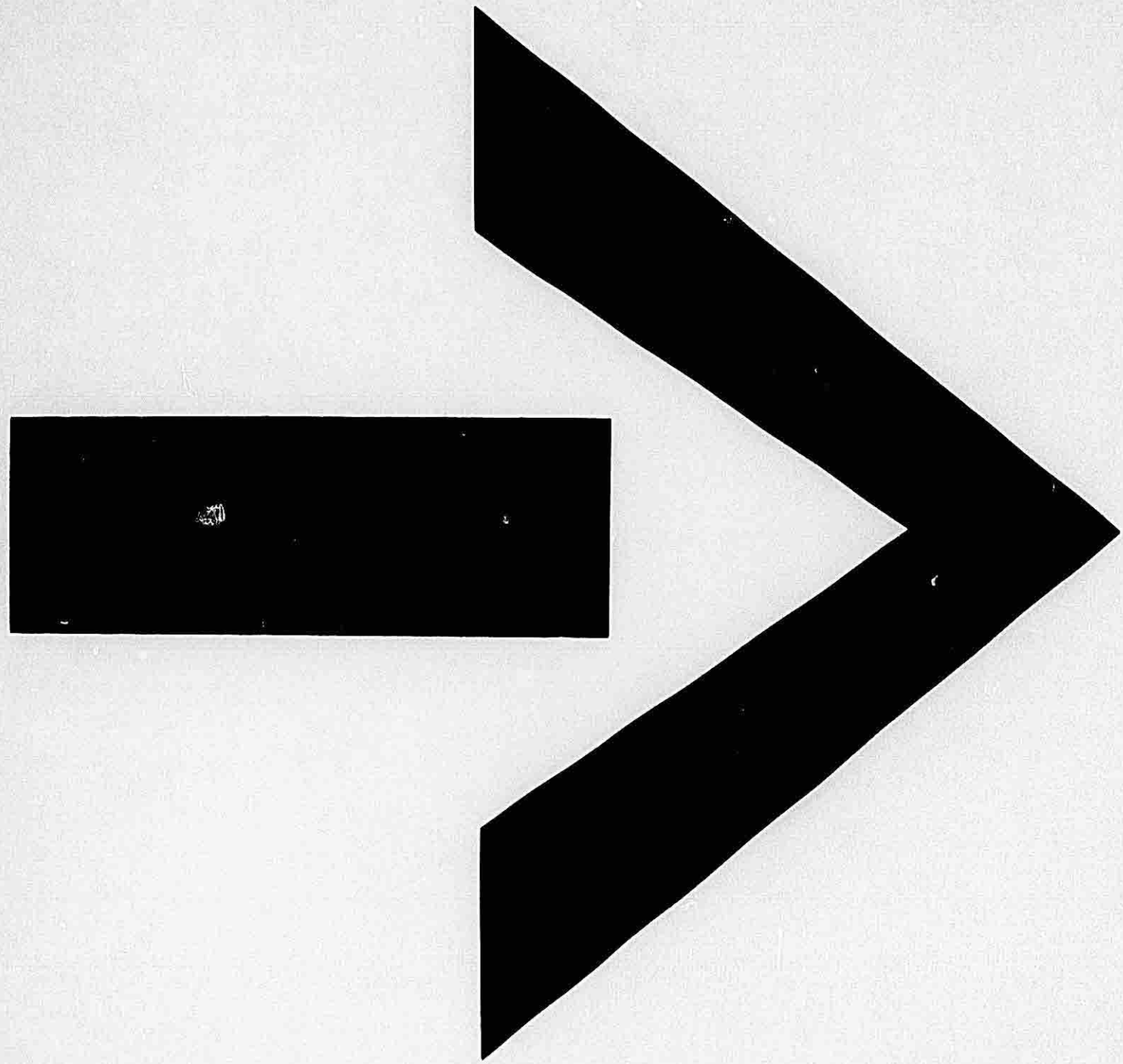
Note that the screw head height is very critical, a larger head screw will allow the Unit to slide in, but the key will not pass.



Dwg. No. TP001202

FIGURE 2-20. NAV UNIT INSTALLATION DRAWING (NAV 824 Shown)





2.10.3 ID Mechanical Installation

Front or rear mounting of an ID 824/825/826 is permitted with cut-out templates provided for both mounts. In either case rear support of the Unit is not required.

Rear mounting is by means of three screws shown in Figure 2-21. A modified 3" instrument panel cut-out, (See Figure 2-22) will accept this instrument. Front mounting requires a mounting clamp such as that shown in Figure 2-23.

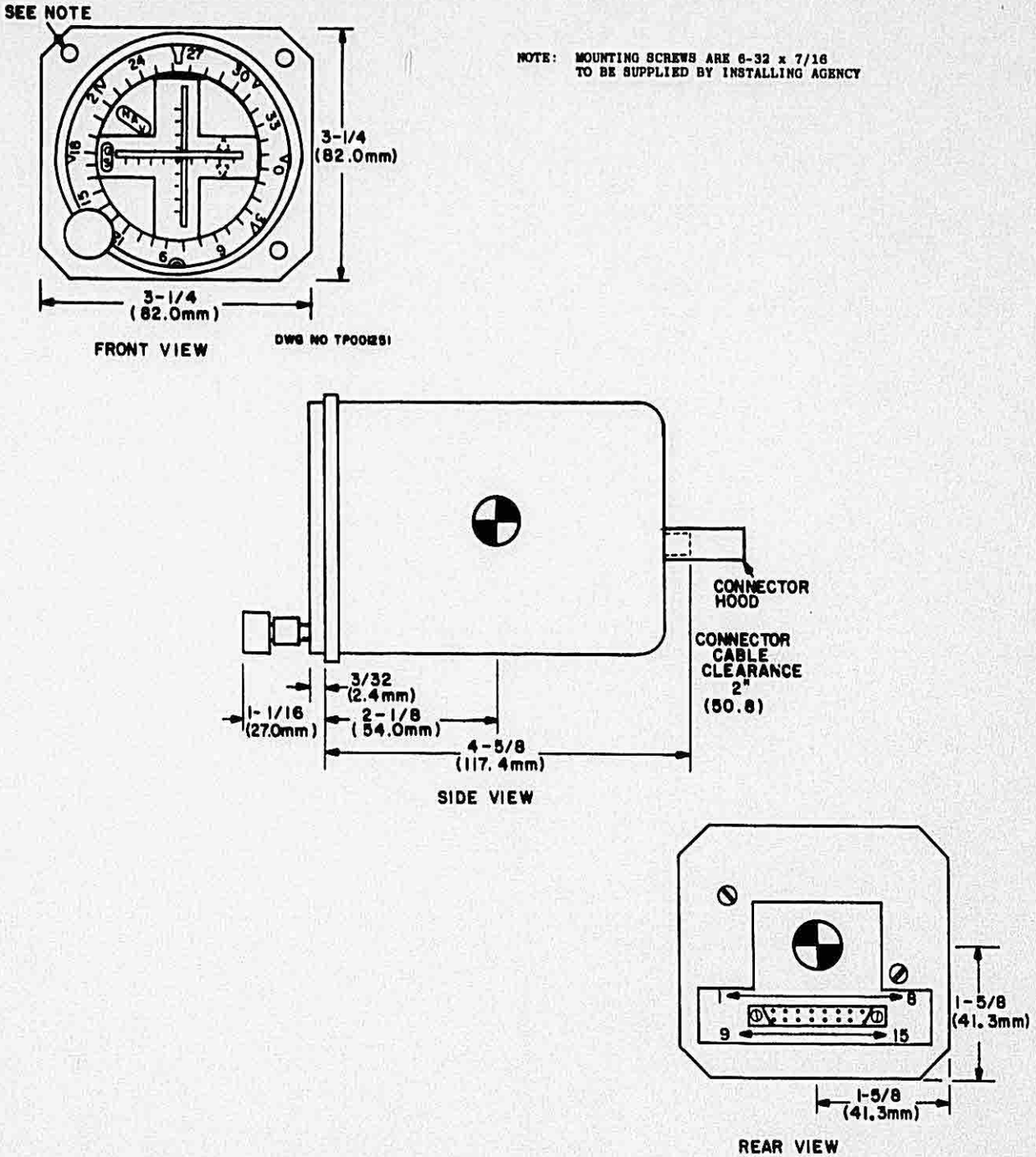
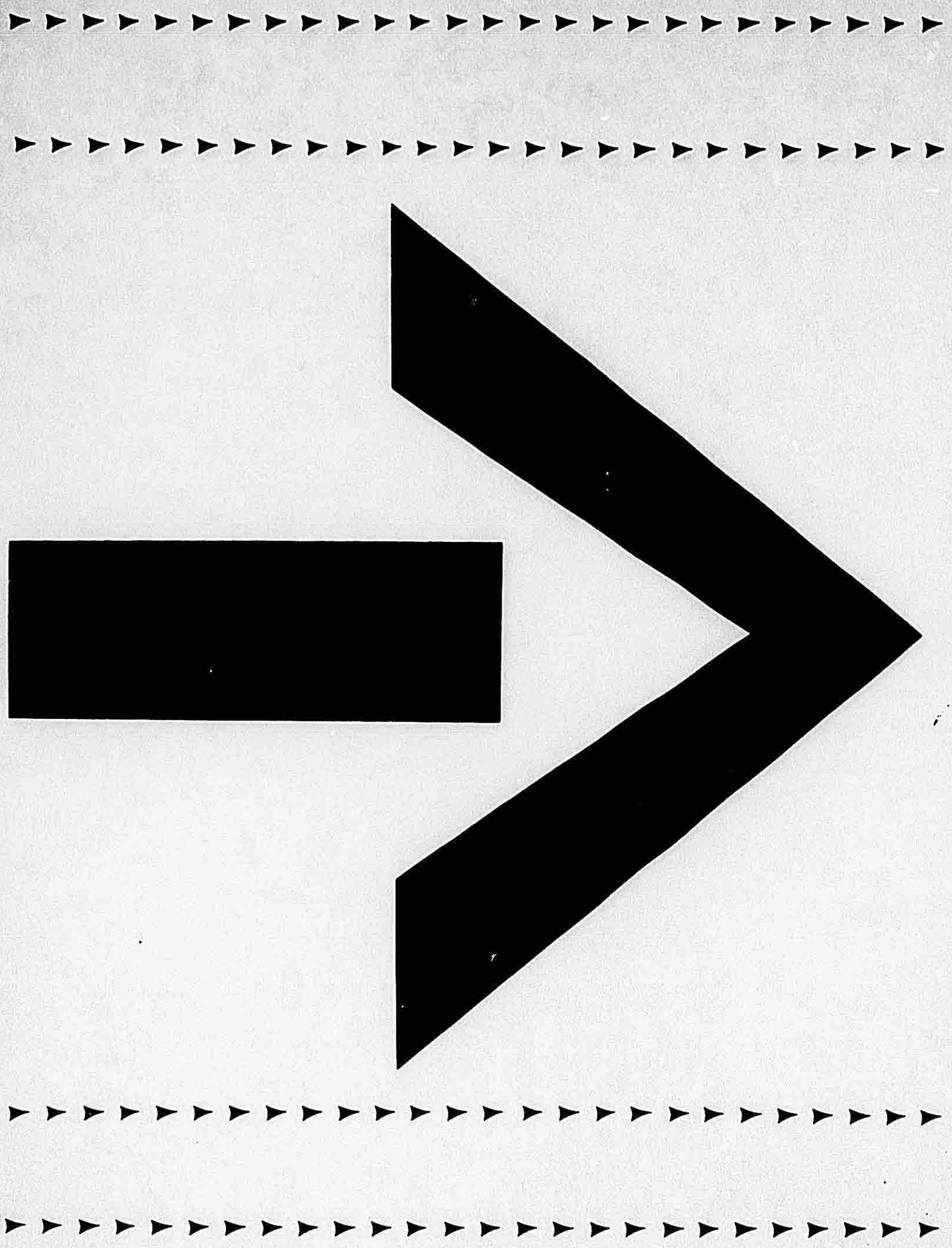


FIGURE 2-21. ID 824/825/826 INSTALLATION



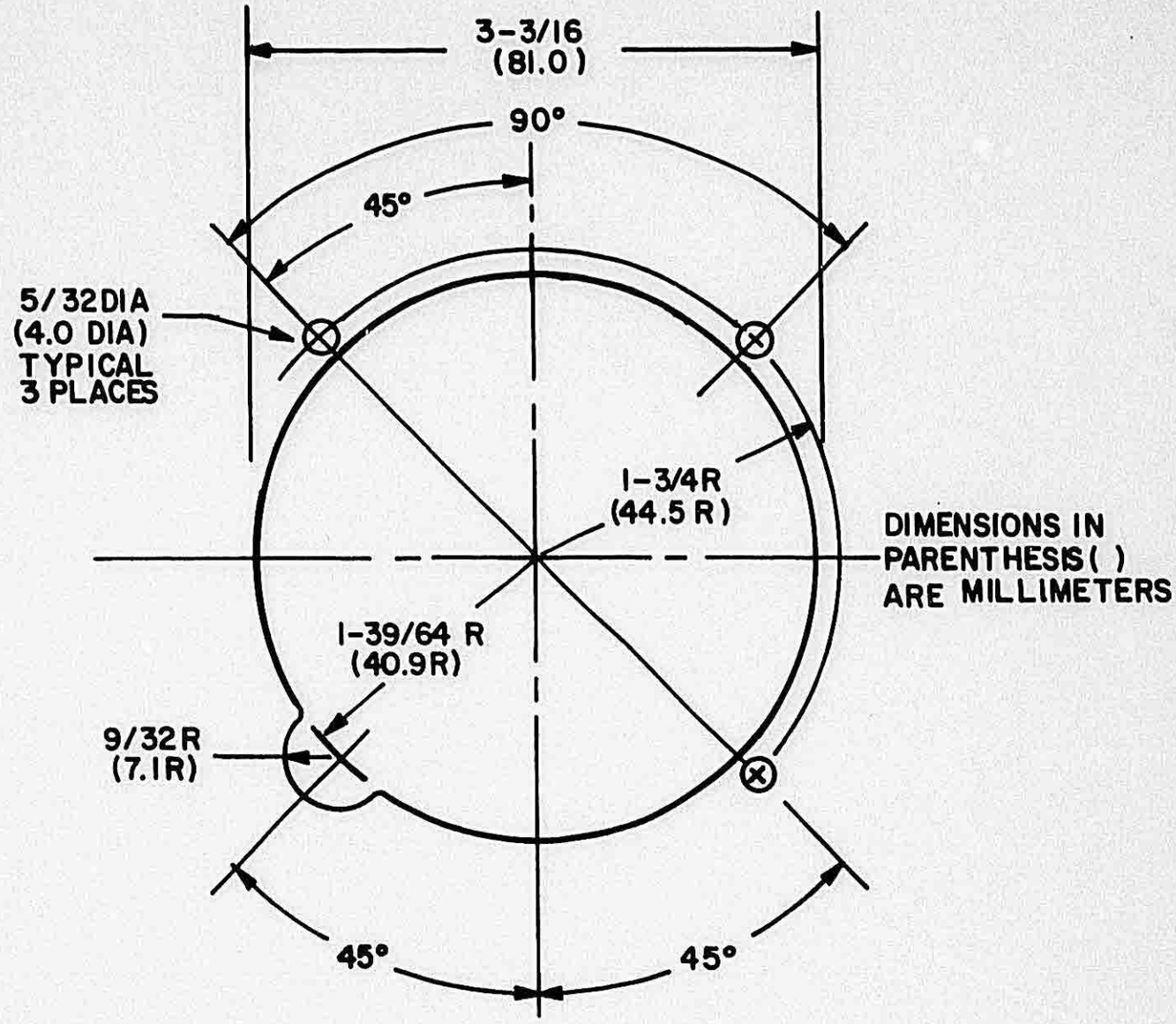
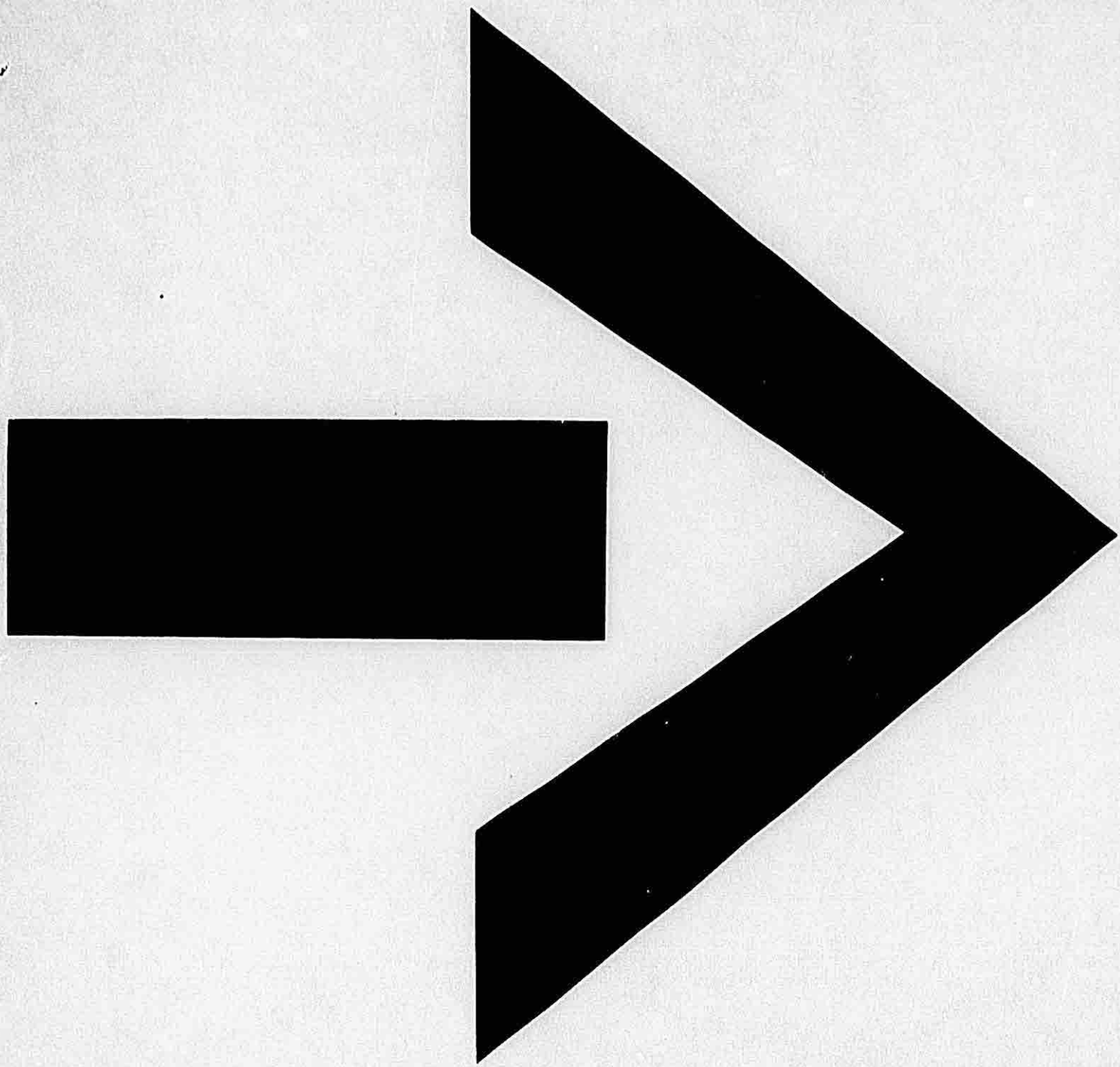
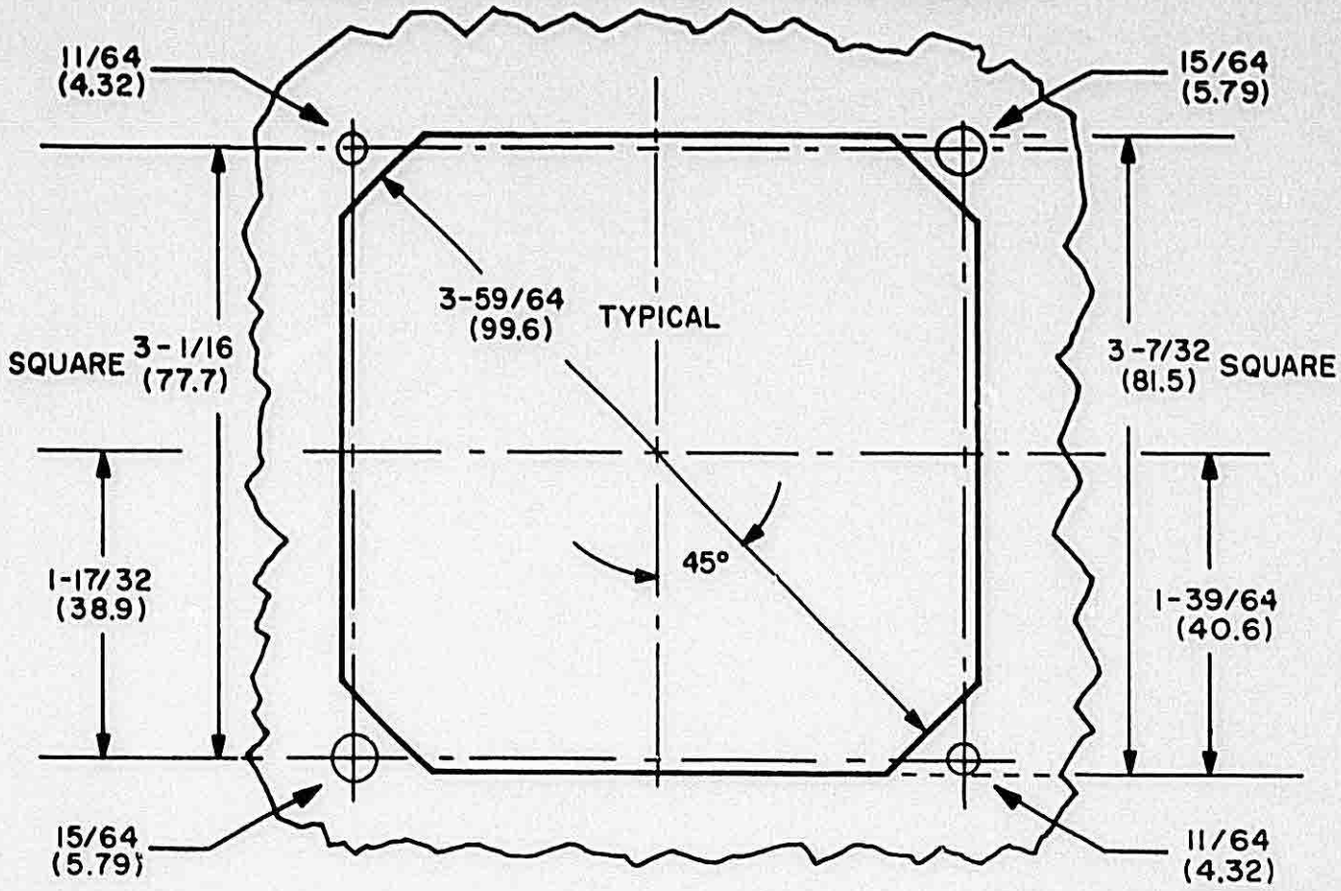


FIGURE 2-22. REAR MOUNTING TEMPLATE



DIMENSIONS IN PARENTHESIS ( ) ARE MILLIMETERS



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Installation:

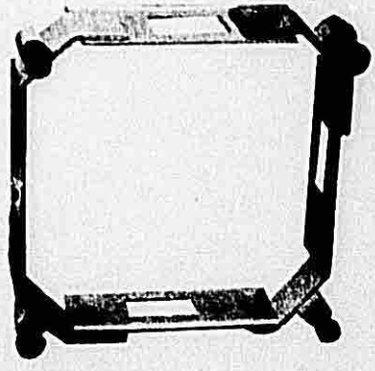
The clamp is installed from behind the panel.

1. Install the two #6 "fixed" corner screws but do not tighten.
2. Install, by only several threads, the two #8 "clamping" screws.
3. Slide the Indicator into position.
4. Tighten the "fixed" corner screws.
5. Tighten the "clamping" screws.

Removal:

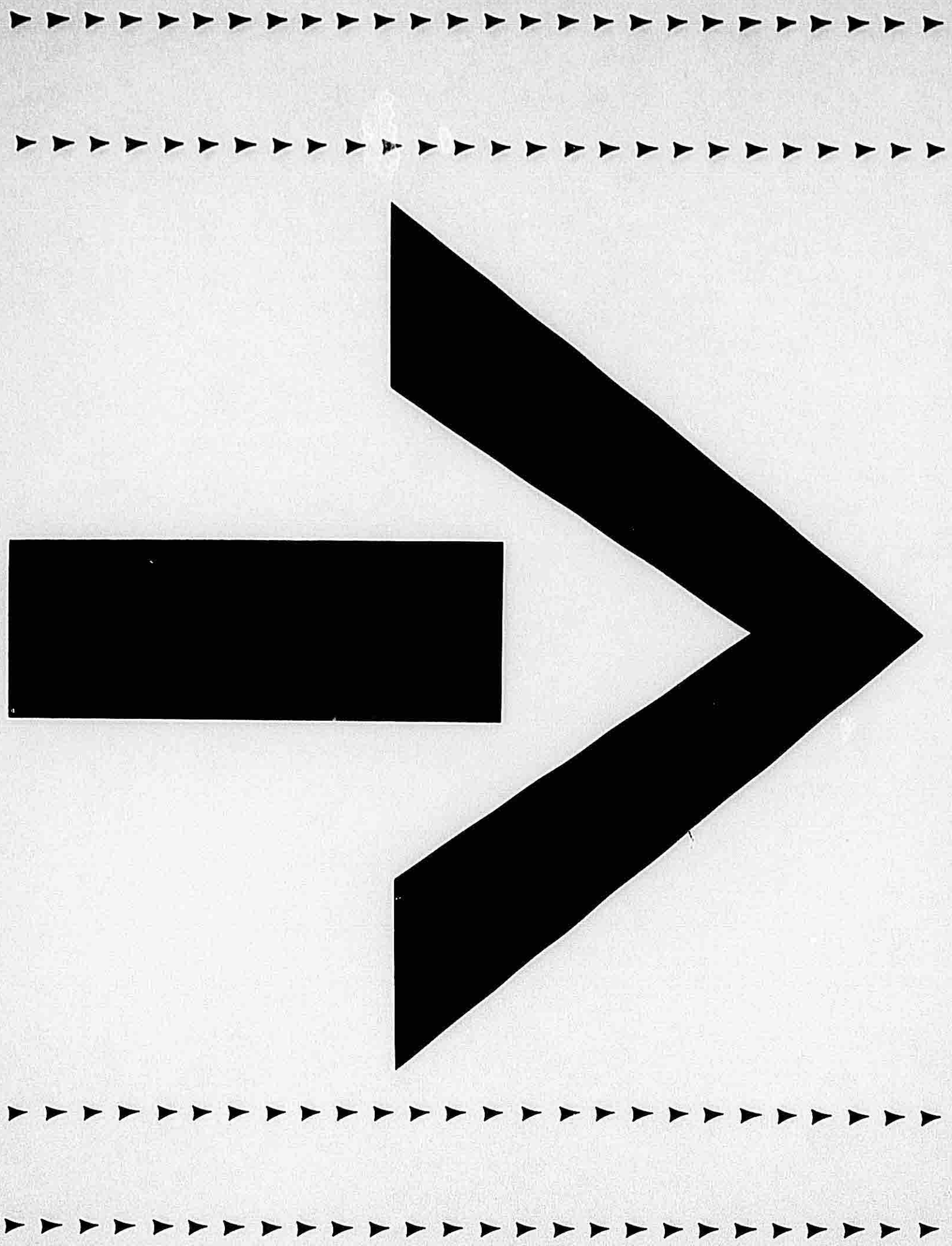
Loosen the two larger (#8) screws until the Indicator may be pulled through the clamp.

1. Be sure cables attached to rear of Unit are either disconnected or are of sufficient length to accompany Unit through the clamp.
2. In some cases it will be necessary to loosen the two #6 fixed corner screws.



NOTES:
1. FRONT MTG. USE MARMAN DIV. AERO-QUIP CORP. CLAMP PART NO. 54621, OR USE ADAPTER PLATE AND MOORING PLATE IN ACCORDANCE WITH ARINC SPECIFICATION NO. 408, ATTACHMENT 386.

FIGURE 2-23. MOUNTING TEMPLATE, FRONT REMOVAL (FOR USE WITH MARMAN CLAMP)



2.11 OPERATION

This operation procedure presumes that the NAV Unit has been installed with the Keep-Alive option.

The Keep-Alive option maintains the last set ACTIVE frequency in its memory IC. When the Unit is turned ON, this "active" frequency will be seen in the Active display. The display's Standby frequency (when the mode switch is set to FREQ) will always be the factory pre-programmed frequency of 110.50.

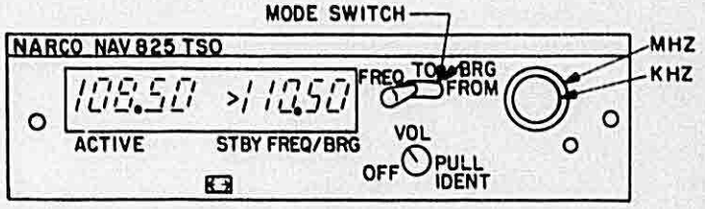
2.11.1 How to enter a frequency.

All frequencies entered into the NAV Unit enter via the Standby route, that is, the frequency is entered and then transferred to the Active by depressing the "arrowed" transfer push-button. Next, the Standby frequency is entered.

Entries can be made with the Mode switch set at any position, however, when set at FROM or TO, the bearing will be stored while the frequency knobs are rotated and the new frequenc y will be in view for 3 seconds after the final selection. At this time it will revert back to a bearing.

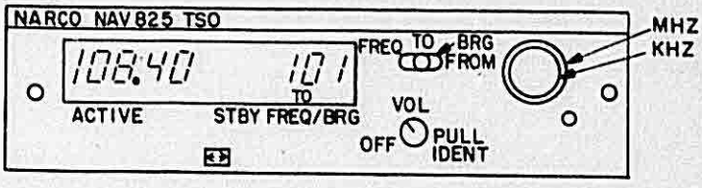
The Active frequency and its resultant data is not affected by the rotation of either of the MHz or KHz knobs.

Mode switch set to FREQ provides a display of both the Active and STBY FREQ. The "arrow" indicates the data will be entered into the Standby display

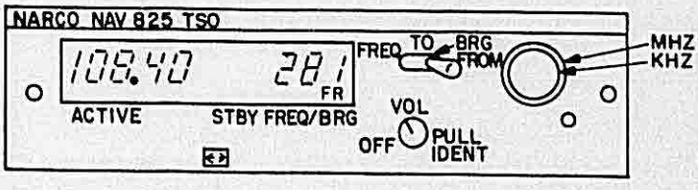


By depressing the frequency Transfer push-button switch the Active and STBY FREQ exchange positions.

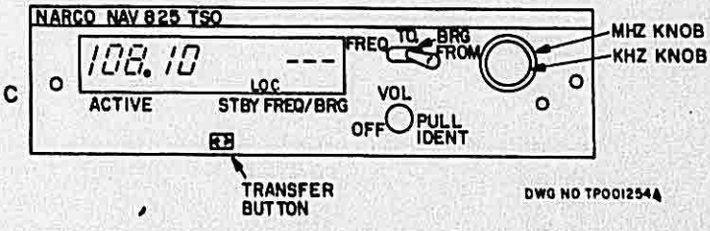
By setting the Mode switch to TO (the center position), the STBY FREQ will be stored and in its place the bearing TO the station will be seen (001 to 359). The legend TO will lite below the bearing.



By setting the Mode switch to FROM (the right position), the previous setting will be stored and the bearing FROM the station will be seen. The legend FR will lite below the bearing. (The Mode switch may be toggled back and forth providing instant reciprocal bearings.)



With the Mode switch in the bearing mode and a Localizer frequency in the Standby memory the pilot can transfer it to the Active display. In this presentation the Localizer frequency will be seen in the Active display and the bearing will bar ----. The legend LOC will lite below the bars.



2.11.2 Loss of Display

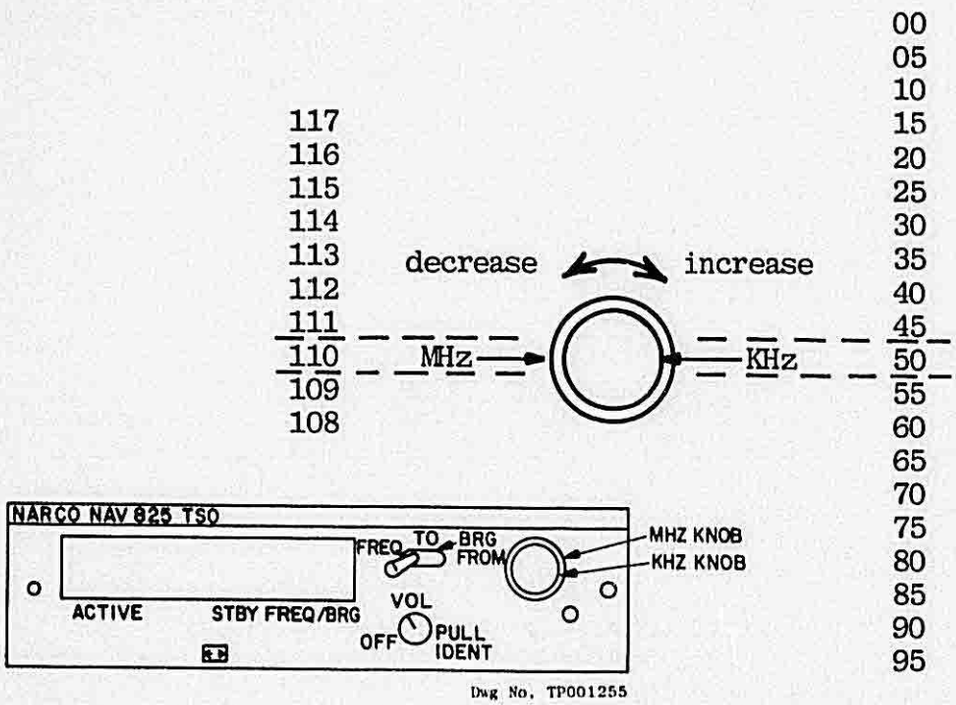
The following is not expected, however, as there is a built-in memory, it can be used if the display should blackout.

If the NAV DISPLAY should have a total blackout, yet the Indicator appears unaffected, verify that the station being received is the station selected prior to the blackout, pull IDENT. If you are still set to your desired frequency continue your flight, it can be presumed that you had a display or a display circuit failure.

2.11.2.1 Changing Frequencies With Loss Of Display

Knowing what frequency you had set in Active and Standby memories, it is now a matter of rotating the KHz and MHz knobs clockwise (incrementing) or counterclockwise (decrementing) detent-by detent: KHz, 05 steps, MHz , 1 MHz steps, to change frequencies. Remember all entries go into the STBY display memory before they can be transferred to the Active display memory.

Should it appear that in changing frequency you lost count, you may rely on the factory pre-programmed frequency of 110.50 in the Standby memory. However, you must turn the NAV Unit OFF, then ON, to automatically set 110.50 into the STBY display. (Active frequency being Kept-Alive, will not be affected by the turning ON and OFF of the Unit.) Now channel to the desired frequency using the detent-by-detent count off method. Transfer your blind Standby frequency to the Active channel, and then verify the results. Pull IDENT.



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If wrong, transfer your original navigation frequency back to Active, then repeat the turn OFF, turn ON and the detent-by-detent channel selection.

2.12 POST INSTALLATION TESTS

The purpose of this series of tests is to assure proper operation of the installed avionics equipment. First, and most important, is a complete inspection of the installation to be sure that all aircraft flight controls operate freely and with full travel or deflection.

Since these procedures cover both NAV Units, simply bypass those functions (glideslope) which do not apply to the system being tested. A remote mounted Marker Beacon or Glideslope Receiver whose operation is dependent upon the NAV Unit being tested should be considered as an integral part of the system and included in this procedure. If an audio control panel is part of the installation, remember to select the NAV and MKR audios at the appropriate points in the procedure.

2.12.1 Preflight Tests

For this series of in-aircraft tests, the aircraft's engine(s), rotating beacon, electrical and avionics equipments should be operating. Note any abnormal interaction or interference (ignition or rotating beacon noise, abnormal meter deflection, compass deviation, etc.) observed during these tests.

The following procedure requires a ramp type test equipment such as that offered by Tel-Instrument Corp. or Instrument Flight Research, Inc.

A. Keep-Alive and Transfer checks

Preliminary Note:

If system has a Keep-Alive Memory option, perform step 1 only.
If system has Preset Frequency option perform step 2 only.

1. Keep-Alive Memory

   a. Set NAV display mode control switch to the FREQ position.
   b. Turn the NAV ON. Both the Active and Standby displays shall show a valid NAV frequency.
   c. Press the NAV transfer button and observe that the Active and Standby frequencies exchange position.
   d. Reset the Active display to 114.15 and Standby to 109.75.
   e. Turn the NAV OFF and wait a minimum of 10 seconds.
   f. Turn the NAV ON and observe that the Active display reads 114.15 and the Standby 110.50.

2.12.1 Continued

2. Preset Frequency
   a. Set NAV display mode control switch to the FREQ position.
   b. Turn the NAV ON. The Active display shall read 115.50 and the Standby 110.50.
   c. Press the NAV transfer button and observe that the Active and Standby frequencies exchange positions.

B. General

1. Set NAV Receiver to a VOR frequency.
2. Rotate the VOL-IDENT control clockwise until NAV Receiver noise is heard in the speaker and headphones. (NOTE: IDENT knob must be pulled out). Note presence of NAV and GS warning flags and centered Left-Right and Up-Down needles.
3. Modulate test equipment 30% with 1020 Hz.
4. Note presence of adequate Audio level. Depress VOL-IDENT knob and note decrease in volume level.

C. VOR

1. Set NAV Active display to a desired VOR frequency. Set NAV display mode switch to the TO position.
2. Set test equipment to the desired VOR frequency. Modulation should be a composite VOR signal. TO/FROM switch set to the TO position.
3. Set test equipment and NAV Receiver OBS to Zero degree course.

   Spec: Left-Right needle must center within $\pm$1.5 degrees with a TO flag: NAV digital bearing must read within $\pm$1 degree of Zero degree and legend TO shall be illuminated. Flag shall not be visible. VOR and DIG bearing Zero set adjustments (R511/R559) are shown in Figure 2-3.
4. Turn Indicator OBS knob first to 10 degrees, then to 350 degrees.

   Spec: Left-Right needle should deflect full scale (5 dots).
5. Check remaining three cardinal points (90, 180, and 270).

   Spec: Digital bearing must read within $\pm$1 degree. Left-Right needle must center within $\pm$1.5 degrees, with a TO flag.
6. With OBS remaining at 270, set test equipment to 90.

   Spec: Left-Right needle must center within $\pm$1.5 degrees with a FROM flag.

2.12.1 Continued

7. Set NAV display mode switch to the FROM position. The legend "FR" shall illuminate.

   Spec: The digital bearing shall be 270 ±1 degree.

D. LOC

1. Set test equipment and NAV Active display to a LOC frequency. Modulation should be a standard LOC centering signal.

   Spec: The digital bearing should show bars and the legend LOC should be illuminated. Centering, ±1 needle width with a TO flag NAV Flag shall not be visible. LOC Zero Set adjustment (R575) is shown in Figure 2-3.

2. Change modulation to .093 dBm left, then right.

   Spec: Deflection, 3 dots, ±needle width.

3. Remove modulation or decrease test equipment RF output to minimum.

   Spec: NAV Flag shall be visible.

E. Glideslope

1. Set test equipment and NAV Receiver to a GS frequency. Modulation should be a standard GS centering signal.

   Spec: Centering, ±1 needle width with a TO Flag. GS Zero set, R1136 is shown in Figure 2-3.

2. Change modulation to .091 dB ddm Up, then Down.

   Spec: Deflection, 2.5 dots, ±1 needle width GS warning shall not be in view.

3. Remove modulation or decrease test equipment RF output to minimum.

   Spec: GS warning flag shall be in full view.

2.12.2 Flight Test

A flight test is reco-mended to perform the following checks and adjustments:

A. Check all avionics under actual operating conditions for abnormal indications (ignition noise, audio distortion at in-flight volume settings, rotating beacon noise, interference between avionics equipments, etc.).

B. Look for variations in performance due to various landing gear and flight control surface configurations.

All of these tests must be performed at an ILS facility, on an airway, and in an area where the ground station signal quality and strength has been verified.

2.12.2 Continued

VOR

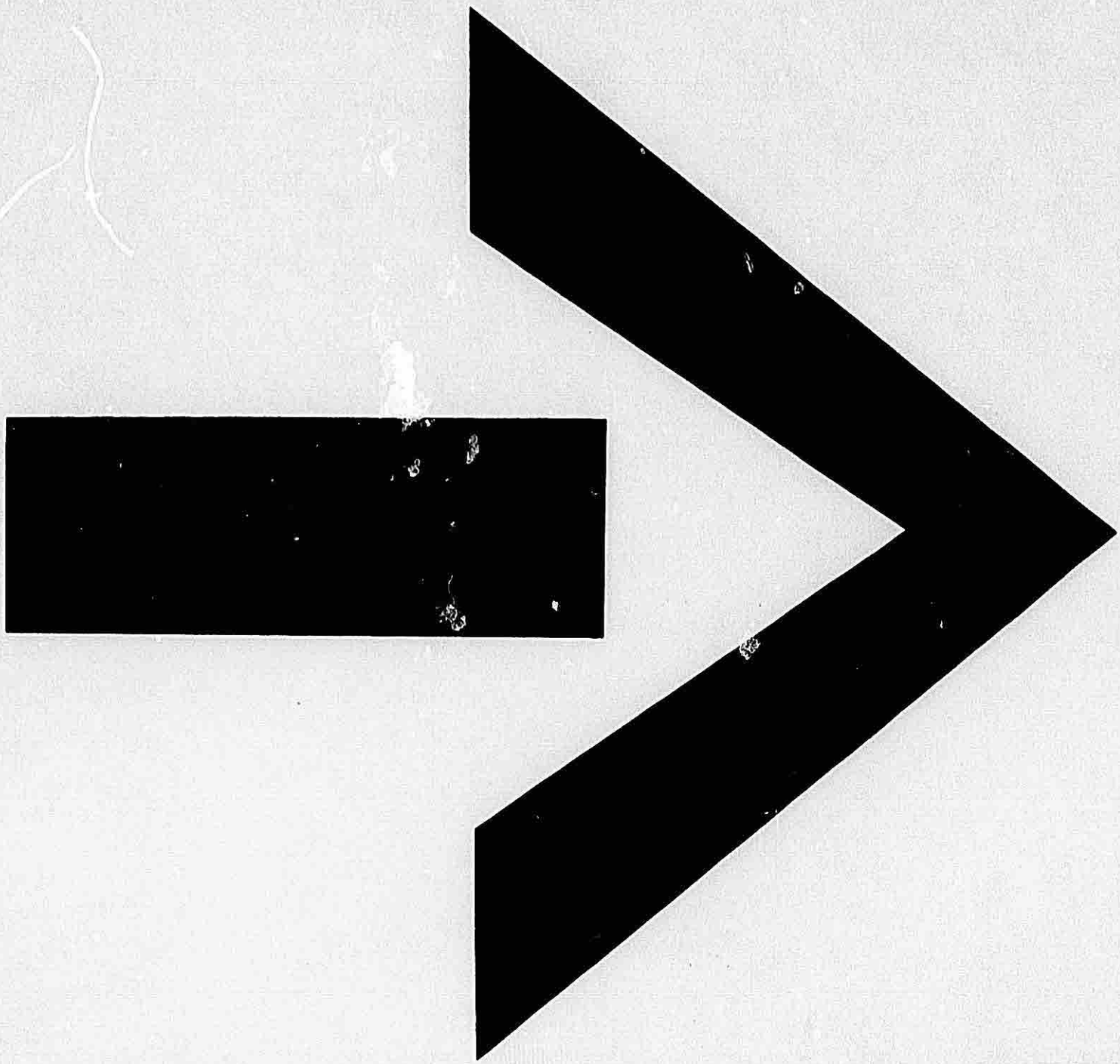
A. Flying at an altitude of 6000 feet above ground level (AGL) channel the NAV Receiver to a VOR facility 50 nm away.
   1. Check course accuracy, warning flag indication, and Left-Right needle sensing.
   2. Check the antenna pattern by flying the aircraft in a 10 degree bank completing a 360 degree turn: The warning flag should remain out of view throughout the turn and audio should remain intelligible.

B. Flying at an altitude of 6000 feet AGL, channel the NAV Receiver to a VOR facility 10 nm away and fly inbound.
   1. Check course width (±10 degrees of selected radial).
   2. Observe the VOR warning flag while approaching, passing over, and flying outbound: TO-FROM indicator shall indicate correctly and the warning flag must be observed except when passing directly over the station.

C. Flying at an altitude of 6000 feet AGL, channel the NAV Receiver to a VOR facility 25 nm away and fly inbound.
   1. Operate the communication transceiver: VOR Left-Right indicator transient deviations should not exceed 2 dots and steady state errors should not exceed 0.5 dot.

LOC and GS

A. Flying at an altitude of 3000 feet AGL, channel the NAV Receiver to a LOC frequency and fly inbound to intercept ILS.
   1. From point of intercept to termination of test, neither LOC of GS warning flags should appear.
   2. Establish glidepath and fly the ILS approach: request approach control confirmation of on-glide path condition.
   3. While on-glide path, maneuver aircraft through normal pitch and roll altitudes: Left-Right and Up-Down indicators should perform normally and a warning flag should <u>not</u> be visible at anytime.



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3.1 GENERAL

This section of the manual provides the circuit descriptions for the Narco NAV 824 and NAV 825 Navigation Receiver/Converters.

The difference between a NAV 824 and NAV 825 is that the NAV 825 has a glideslope synthesizer, receiver, and converter while the NAV 824 does not.

The Main PC boards are almost identical, however, in the NAV 824 the glideslope circuit's components, for the most part are not there, (only a few resistors will be found as they are part of an automatic insertion program.) The Receiver PC boards fall into the same catagory, identical but, no glideslope components in the 824. Other than these points, the remaining circuits are identical in both the NAV 824 and NAV 825.

NOTE: The NAV 825 does not have time sharing between the VOR and glideslope receivers as in the NAV 122, 124. The glideslope synthesizer and receiver are independent from the VOR synthesizer and receiver.

Both NAV Units require an external Indicator. The rear connector provides interface for the Indicator. The OBS control of the Indicator can be either a sine/cosine potentiometer such as the Narco ID 824/825 or any ARINC resolver type Indicator. Output levels from the VOR converter are compatible with input requirements of Narco and other manufacturers' Display Units. The digital VOR bearing, TO or FROM the station, is displayed with a resolution of one degree when the mode switch is in the bearing mode.

Remote channeling, for DME using the ARINC 2/5 format, is provided in both Units.

3.2 NAVIGATION RECEIVER, VOR/LOC

Figure 3-1 is a functional block diagram of the NAV 824/825 illustrating the signal flow and interfacing of all the circuit functions. Refer to this Figure for the VOR/LOC receiver signal flow.

The VOR/LOC receiver amplifiers and demodulates the RF carrier to provide audio to the voice circuits and navigational data to the VOR/LOC converter. Varactor tuning is used for the receiver RF circuits and the channel frequencies are determined and controlled by the microprocessor.

3.2.1 Receiver Tuning

Refer to Figure 6-2.

The synthesizer VCO tuning voltage also controls the tuning of the RF amplifier Q1001 input and output filter circuits. These circuits are tuned by varactor diodes CR1001/CR1002/CR1003/CR1004 that vary the resonant frequency of the associated RF amplifier tank circuit.

A typical varactor tuned circuit is the RF input filter circuit (L1001/CR1001 and L1002/CR1002). The control voltage from the VCO is fed through isolation resistor R907 and applied to the cathodes of CR1001/CR1002 via resistors R1002/R1003. Note that each varactor is in series with a fixed capacitor (C1002/C1004) and this combination is in parallel with L1001/L1002 and forms a parallel LC tank. The applied DC voltage to the varactors affects the capacitance of the varactor and thus the parallel resonance of the LC tank. With each frequency selection the tuning voltage changes the center frequency of the filter circuit which tracks the synthesizer. The variable inductors L1001/L1002 permit a vernier adjustment of the tracking between the circuits tuned from the common control input. The VCO will shift the filter center frequency 5 MHz per tuning volt.

3.2.2 RF Amplifier Q1001

Refer to Figure 6-2.

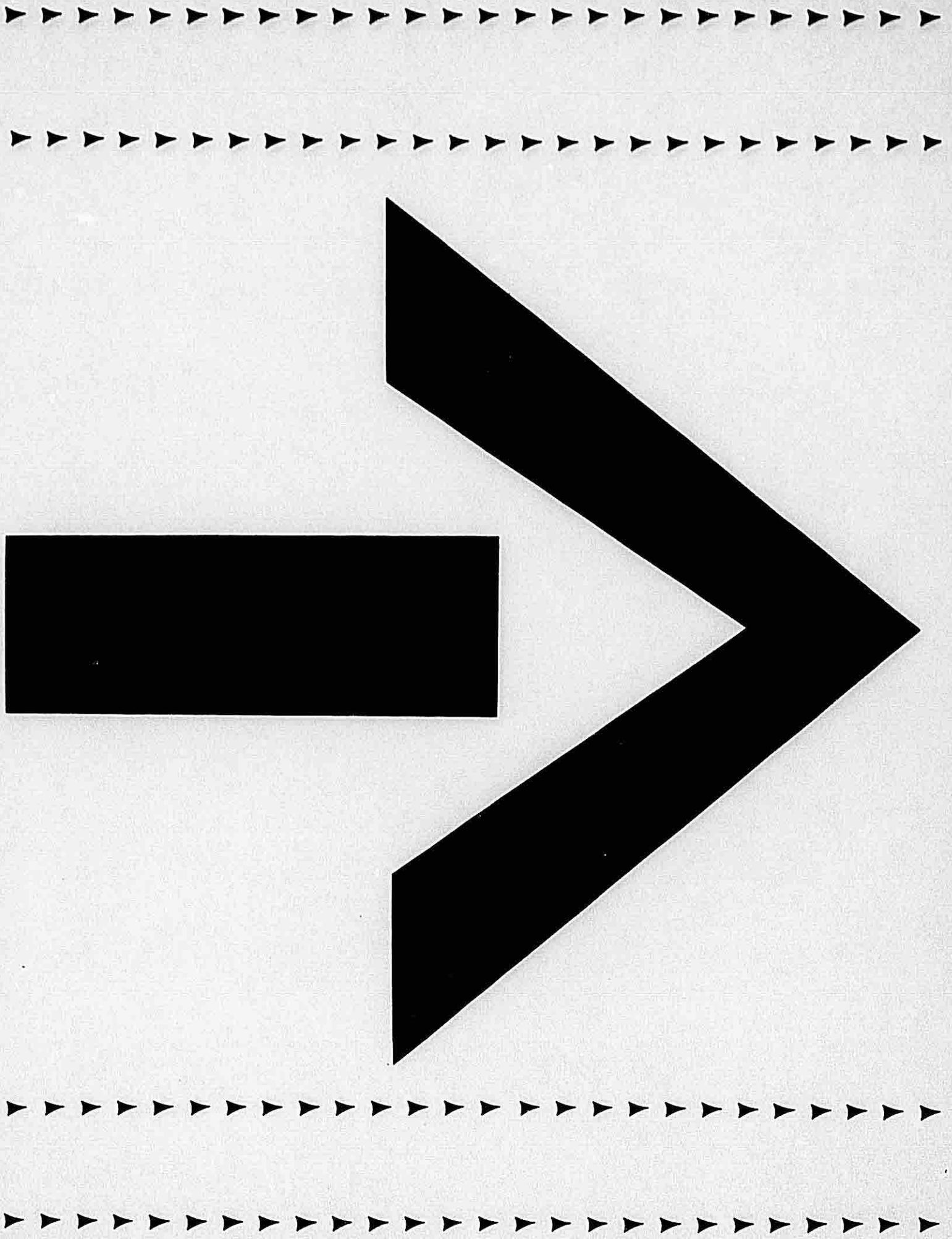
The RF amplifier is a dual gate MOS-FET. The received RF signal from the antenna is passed through the RF input filter and coupled via C1005 into gate 1. The drain is connected to T1001 which is connected to +8 volts through R1008. Gate 2 is connected to the RF AGC bus via R1047. The source is biased to 2 volts by the combination of R1006/R1007. Gate 1 is biased to 3 volts by the combination of R1004/R1005. The bias on the source is to allow the voltage on Gate 2 to swing below the source voltage and cut off the RF amplifier during AGC.

The output of Q1001 is coupled by T1001 into a second bandpass filter consisting of T1001/CR1003, L1003/CR1004 and associated capacitors. The operation of this filter is identical to the first RF filter. The inductors in both filters are tuned at midband.

3.2.3 Mixer, Q1002

Refer to Figure 6-2.

The mixer, Q1002, is a dual gate MOS-FET. The input to the mixer is taken from the top on L1003 and applied to Gate 1. The local oscillator (LO) injection is coupled into Gate 2 via C1012. The minimum required level of injection is 1 Vrms. This LO RF voltage changes the gain of the FET and thus modulates the RF signal input present on Gate 1. Since the synthesizer frequency is 17 MHz below the received frequency, the difference, 17 MHz, is tuned by T1002/C1015 and fed to crystal filter FL1001.



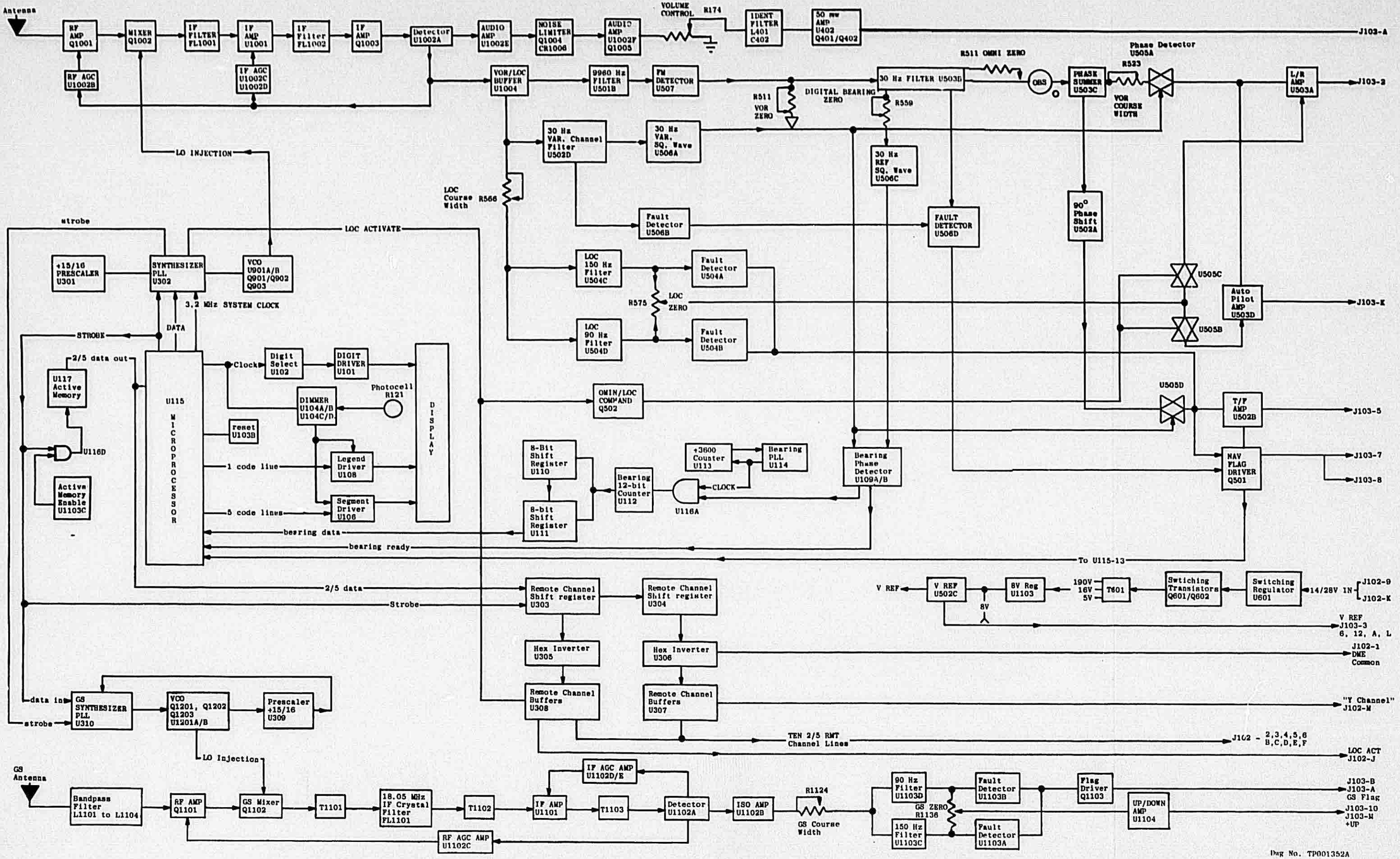
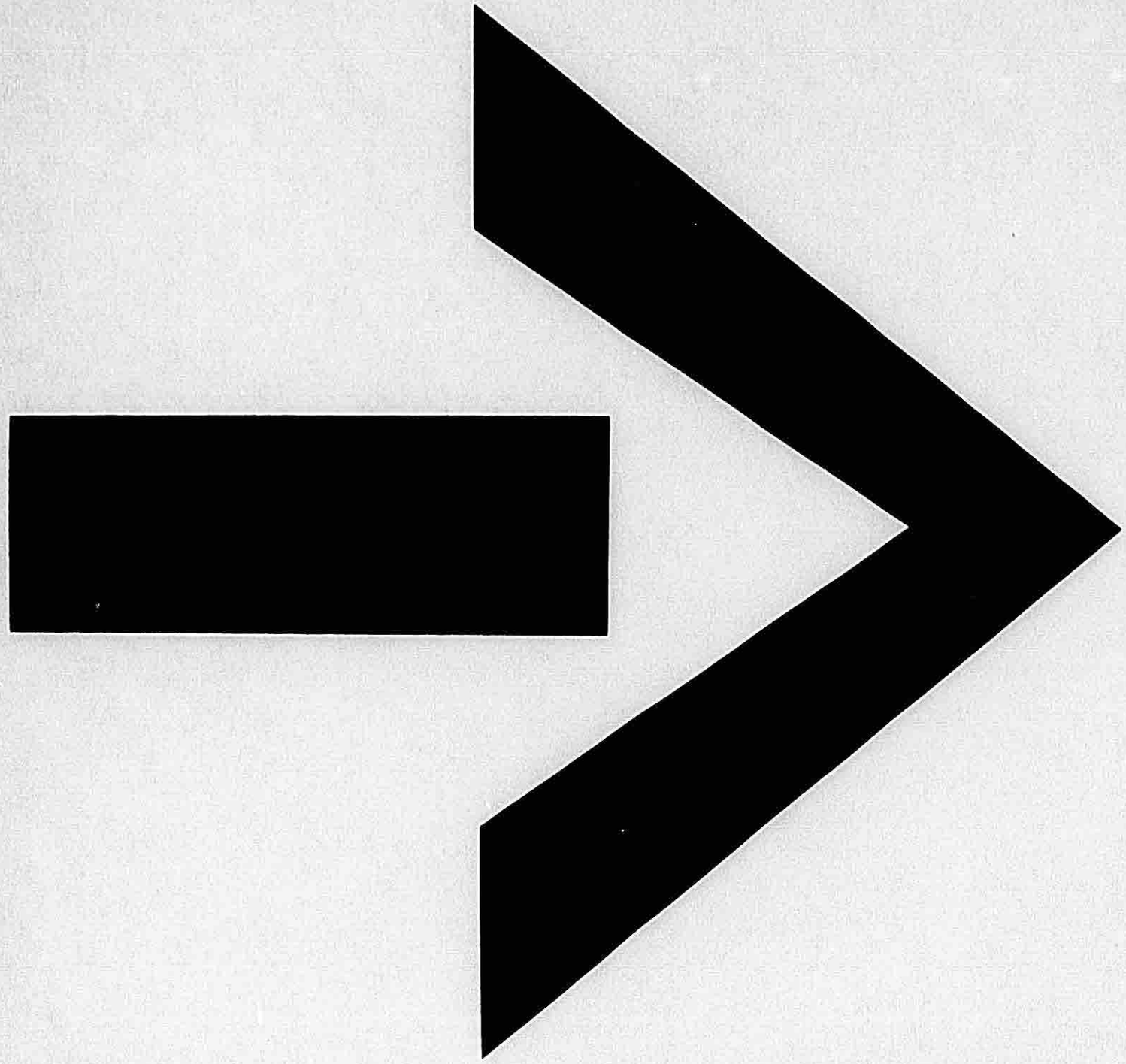


FIGURE 3-1. NAV 824/825 BLOCK DIAGRAM

SEE BLOW-UP



3.2.4 IF Crystal Filters (FL1001/FL1002) and IF Amplifiers (U1001/Q1003)

The first IF filter, FL1001, is comprised of a pair of 2-pole crystal monolithic filters that in conjunction with the second identical filter, FL1002, controls the overall selectivity of the receiver. The 6 dB IF bandwidth is ±19 KHz and the 60 dB bandwidth is ±42 KHz. The 17 MHz output of FL1001 is tuned by T1003/C1016 and fed to a linear IC amplifier, U1001. IF AGC is applied to U1001 pin 5 via R1023 and stabilizes the output. A positive going AGC voltage from U1002D reduces the gain of the amplifier.

The amplified 17 MHz IF is tuned by T1004/C1021 and fed to the inter-stage crystal filter, FL1002. This filter is identical to FL1001. The output from this filter is tuned by T1005/C1022 and applied to Gates 1 and 2 of the second IF amplifier Q1003.

3.2.5 Detector, U1002A

Refer to Figure 6-2.

The IF output from the drain of Q1003 is coupled by C1024 to the detector U1002.

U1002, an RCA CA3088 IC, contains seven amplifiers whose inputs and outputs are internally connected. The 17 MHz IF signal is applied to the detector input circuit consisting of L1004/CR1005/C1025/C1026. L1004 and C1025 form a high impedance parallel LC circuit to the 17 MHz and diode CR1005 limits the level of the applied signal to protect the detector from being overdriven. L1004 is also the DC feed back return. C1026 shunts the 17 MHz carrier to ground. The output at pin 11, detected carrier, is applied to the AGC circuits and the output at pin 9, NAV video, is applied to the audio and VOR/LOC buffer circuits.

3.2.6 RF and IF AGC Circuits (U1002B/C/D)

Refer to Figure 6-2.

The detected carrier is applied to the RF AGC amplifier U1002B and exits that amplifier at pin 13. At a very low signal level, the RF AGC voltage is approximately +4.5 to +5 volts DC. At a very high signal level the voltage drops slightly below 3 volts. The RF AGC is applied to Gate 2 of Q1001.

The detected carrier is also applied to the two stage IF AGC amplifier, U1002C/U2002D and exits this amplifier at pin 6. At a low signal level this AGC voltage is slightly below 3 volts and will rise to approximately 3.5 volts at a very high signal level. The IF AGC is applied to pin 5 of U1001.

3.2.7 VOR/LOC Buffer (U1104)

Refer to Figure 6-2

The detected NAV video is AC coupled into U1104 via R1049/C1041. U1104 is an adjustable non-inverting amplifier whose non-inverting input is referenced to +8 Vdc. The applied NAV video is adjusted by R1046 to give an ARINC phase and level output. This output is riding on an +8 Vdc bias level and is applied to the VOR/LOC converter circuits and is available from the rear connector J102, pin N.

3.2.8 Audio Amplifier/Noise Limiter (U1002E, Q1004, U1002F, Q1005)

The audio amplifier section comprises a buffer U1002E, noise limiter Q1004/CR1006 audio amplifier U1002F/Q1005.

The input to the first audio amplifier, U1002E is adjusted by R1031 (select by test) to provide a 50 millwatt signal at the rear connector J102-A when a 500 uv signal modulated by 1020 Hz at 30% is applied to the receiver. The output of U1002E is applied to the base of the noise limiter amplifier Q1004, which operates as a conventional amplifier when noise is not present. Note that the emitter load resistance of Q1004 is comprised of two equal resistors R1034/R1035. An additional circuit comprised of CR1006/R1037/R1038 shunts one half of the emitter load resistance. The noise limiter diode, CR1006, is biased to permit the equivalent of 30% modulation to pass undistorted. Any noise pulses exceeding this level will be clipped by the noise limiter. The cathode of CR1006 is biased by the filter network consisting of R1037/C1033/R1038. The anode is biased by the network consisting of R1034/R1035. As the current changes through Q1004 due to different RF signal levels, the relative bias across CR1006 changes to allow less clipping with high RF signals and more clipping with only noise present. The output of the noise limiter is coupled via C1034 into the second audio amplifier U1002F, pin 2. Pin 1 is the emitter of the amplifier and pin 3 is the collector. Q1005 is the emitter follower output that provides audio to the volume control R174 located on the main board. The wiper arm of the volume control feeds the IDENT filter and 50 mw audio amplifier.

3.2.9 IDENT Filter and 50 mw Audio Amplifier

Refer to Figure 3-2.

The purpose of the IDENT filter is to attenuate the 1020 Hz IDENT code when operating in the VOR or LOC mode. When the IDENT switch SW104 is activated, the filter is bypassed, however, the filter is returned to ground through U401B and serves to boost the signal which is fed to the speaker or phones. Switching operation is as follows: when SW104 is open, U401A and U401D are turned on by the 16 volts applied to their control inputs at (pins 12/13) via pull-up resistor R403. U401D then grounds the control inputs (U401B-5 and U401C-6) which turns off these analog switches. The receiver audio taken from the wiper arm of the volume control pot R174 is passed through U401A and applied to the IDENT filter L401/C402. The IDENT filter is adjusted to parallel resonate at 1020 Hz which blocks the IDENT signal.

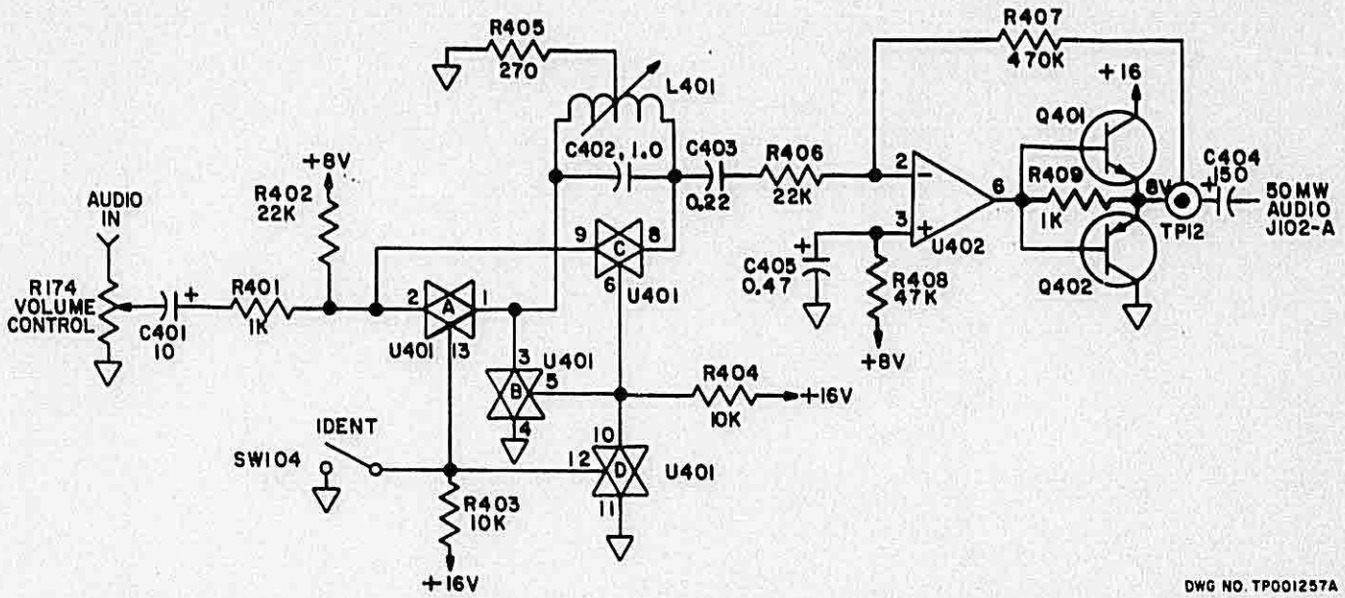


FIGURE 3-2. IDENT FILTER AND 50 mw AUDIO AMPLIFIER

When SW104 is activated, the control inputs to U401A/U401D are grounded which shuts off these switches. U401B and U401C are now turned on by the 16 volts applied to their control inputs (pins 5/6) via pull-up resistor R404. The receiver audio now bypasses the filter L401/C402 through U401C and is coupled into the audio amplifier U402. U402 is an inverting AC amplifier with a gain of approximately 21. The non-inverting input at pin 3 is referenced to 8V which causes the common emitters of the power transistors to normally sit at 8 volts. The power transistors, Q401/Q402 allow the audio signal to swing up to within 2 volts of the 16 volt supply and to swing down to within 2 volts of ground. The audio is coupled through C404 to the rear connector at J102-A.

3.3 VOR/LOC SYNTHESIZER

Refer to Figure 6-1, 6-2 and Figure 3-3.

3.3.1 General Theory

The digital frequency synthesizer is a phase-locked loop system that produces a range of output frequencies depending on the setting of a programmable counter. The NAV 824/825 VOR/LOC synthesizer can be tuned over the frequency range of 91.00 to 100.95 MHz. Shown in Figure 3-3 is a block diagram of the VOR/LOC synthesizer.

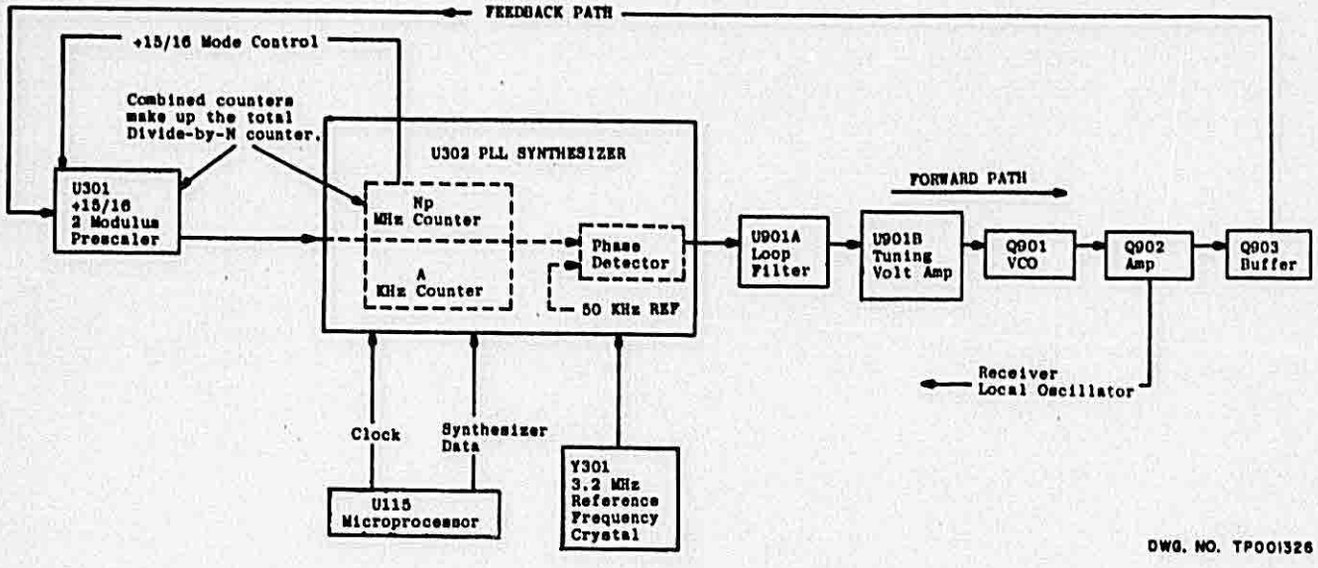


FIGURE 3-3. VOR/LOC SYNTHESIZER BLOCK DIAGRAM

The frequency synthesizer is comprised of a VCO, phase detector, loop filter, and ÷N counter. In this design the total divide-by-N chain is comprised of U301, a ÷15/16 prescaler, followed by another counter section located in U302, a programmable phase-locked loop IC. The phase-locked loop phase detector and loop filter produces an error voltage that is proportional to the phase difference between the reference and input frequency. The tuning voltage is then filtered by the loop filter U901A, amplified by U901B, and applied to the VCO, Q901. The applied voltage to the VCO is polarized to bring the input frequency at the phase detector in agreement with the reference frequency (50 KHz). The phase detector, loop filter, and VCO make up the forward path of the loop, while the divide-by-N counter constitutes the feedback path.

3.3.2 VOR/LOC Synthesizer Frequency Program

The uP, U115, determines the necessary 19-bit code that programs the VOR/LOC synthesizer. This code is for the VOR frequencies covering 108.00 to 117.95 MHz. A frequency selection is made by the MHz and KHz switches (SW101) which only commands the microprocessor to increment or decrement the frequency as it sends the 19 bit code to a programmable synthesizer chip, U302.

If a LOC/GS channel is selected, then there will be a 38-bit code output from the microprocessor. The first 19-bits are destined for the GS synthesizer (even if there is none-NAV 824) and are serially shifted through the VOR/LOC chip U302 and exit that chip at the SW1 location, pin 14. The second 19-bits then load U302 to the LOC channel. It should be understood that when a VOR channel is selected, then only one 19-bit code is issued by the uP to program U302. When a LOC/GS channel is selected, then two 19-bit codes are issued by the uP, with the second 19-bits used to program U302. The GS synthesizer is discussed in Section 3.4.10.

If the "Keep-Alive" feature has been selected, at initial turn on, the last used active frequency will be retrieved and displayed and the synthesizer programmed to this frequency. If the Keep-Alive feature was not used, and if J102-8 is grounded, the uP will program the synthesizer and display 115.5 MHz for the Active channel. If J102-8 is not grounded, then the Active channel will be a random selection.

3.3.3 Programmable Phase-Locked Loop Frequency Synthesizer (U302)

The frequency synthesizer, U302, receives its program information from the microprocessor (U115) in the following manner: an Active frequency selection will cause uP pin 24, the synthesizer clock enable line, to go logic high (+5V). This line is applied to U302, pin 13, and enables its internal counters. uP pin 24 is also applied to pin 8 of AND gate U116C. Immediately following uP pin 24 becoming active, uP pin 7 (strobe) and pin 11 (synthesizer data) become active. The strobe is applied to pin 9 of AND gate U116C. The output of U116C, pin 10, is applied to the clock input, pin 11, of U302. The synthesizer data, uP pin 11, is applied to the data input, pin 12, of U302. The data from the uP consists of a serial 19 or 38 bit data stream. There are 19 or 38 clock pulses generated by the uP to load this data into U302.

The uP synthesizer enable line, pin 24, remains logic high for the duration of the 19 or 38 clock pulses. A partial list of the 19 bit VOR Synthesizer Codes is shown in Table 3.1.

TABLE 3.1. PARTIAL LISTING OF POSSIBLE 200 VOR CHANNEL CODES FOR SYNTHESIZER PROGRAMMING

Channel MHz	MHz Synth Freq	Total +N	Np MHz Count	A KHz Count	*U302 SW_1	*U302 SW_2	Np MHz binary equivalent of Np count in column 4										A KHz binary equivalent of A count in column 5						
108.00	91.0	1820	121	5	0	1	0	0	0	1	1	1	1	0	0	1	0	0	0	0	1	0	1
109.00	92.0	1840	122	10	0	1	0	0	0	1	1	1	1	0	1	0	0	0	0	1	0	1	0
110.00	93.0	1860	124	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0
110.05	93.05	1861	124	1	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	1
110.10	93.1	1862	124	2	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	0
110.15	93.15	1863	124	3	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	1
110.20	93.2	1864	124	4	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	1	0	0
110.25	93.25	1865	124	5	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	1	0	1
110.30	93.3	1866	124	6	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	1	1	0
110.35	93.35	1867	124	7	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	1	1	1
110.40	93.4	1868	124	8	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0
110.45	93.45	1869	124	9	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0	0	1
110.50	93.5	1870	124	10	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0
110.55	93.55	1871	124	11	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0	1	1
110.60	93.6	1872	124	12	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	1	1	0	0
110.65	93.65	1873	124	13	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	1	1	0	1
110.70	93.7	1874	124	14	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	1	1	0
110.75	93.75	1875	125	0	1	0	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	0	0
110.80	93.8	1876	125	1	0	1	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	0	1
110.85	93.85	1877	125	2	0	1	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	1	0
110.90	93.9	1878	125	3	1	0	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	1	1
110.95	93.95	1879	125	4	1	0	0	0	0	1	1	1	1	1	0	1	0	0	0	0	1	0	0
111.00	94.0	1880	125	5	0	1	0	0	0	1	1	1	1	1	0	1	0	0	0	0	1	0	1
112.00	95.0	1900	126	10	0	1	0	0	0	1	1	1	1	1	1	0	0	0	0	1	0	1	0
113.00	96.0	1920	128	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
114.00	97.0	1940	129	5	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	1
115.00	98.0	1960	130	10	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	1	0
116.00	99.0	1980	132	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
117.00	100.00	2000	133	5	0	1	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	0	1
117.95	100.95	2019	134	9	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0	1	0	0	1
					Loading format— of 19 bit register in U302		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

First data bit in

12 bit MHz counter

7 bit KHz counter

Last data bit in

Channel	SW_1	SW_2
All omni	0	1
All Localizer	1	0

← The SW2 (U302-15) output is used to control the "Localizer Activate".

NOTE: This Table was derived using the method described in Table 3.3.

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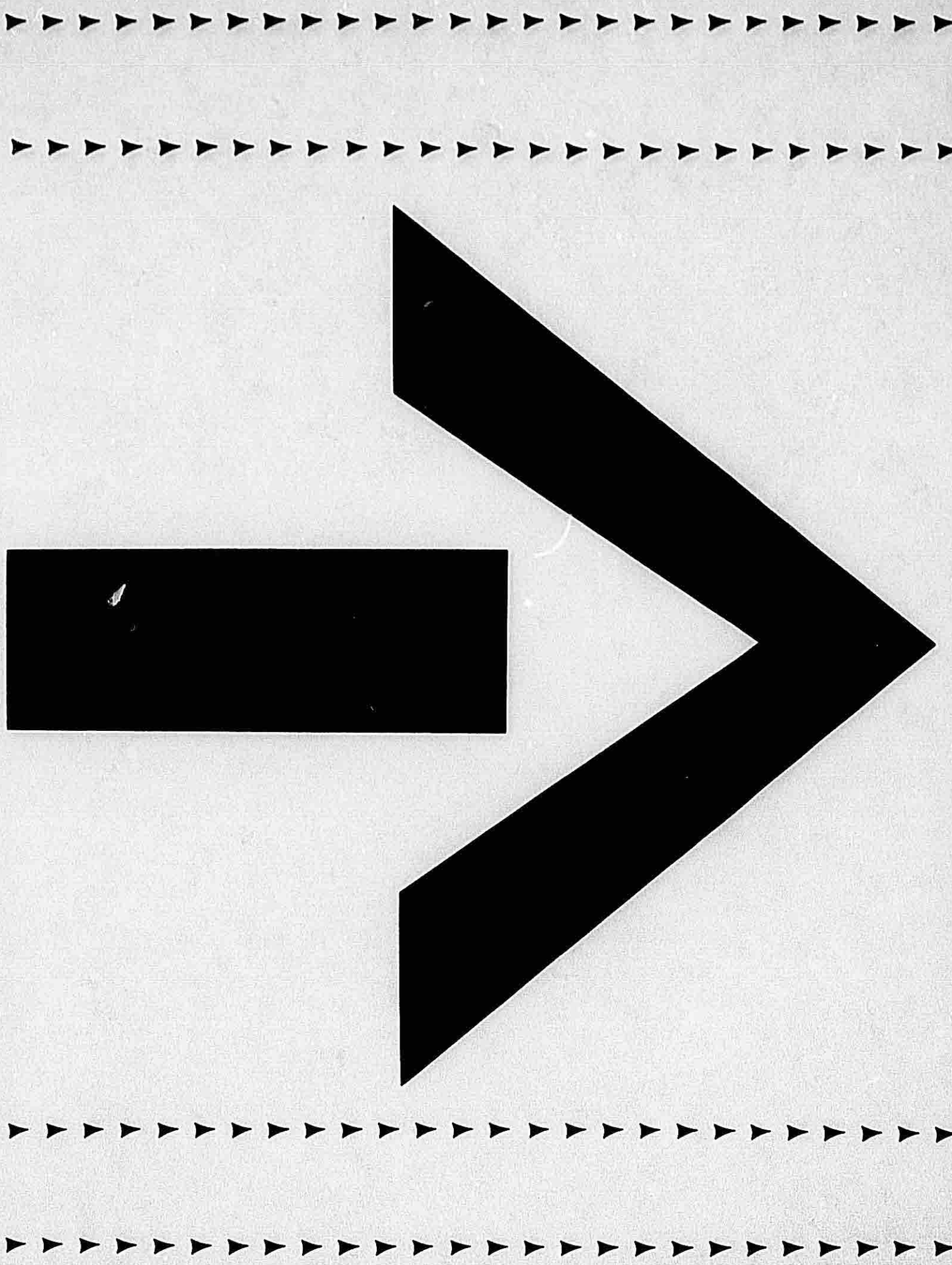
3.3.3 Continued

To better understand the operation of the PLL frequency synthesizer, U302, a review of its capabilities and pin functions will be given. U302 is an MC145156 LSI Phase-Locked Loop frequency synthesizer. It is programmed by a clocked, serial input, 19 bit data stream. This IC contains two programmable counters arranged in 10-bit and 7-bit configurations. These counters are combined with on-chip logic control that allows the MC145156 to control (pin 8 Mod Control) an external dual modulus prescaler (U301). Other on-chip features consists of a reference oscillator with buffered output, programmable reference divider, digital phase/frequency detector, and the necessary shift register and latch circuitry for accepting the serial input data. When combined with a loop filter (U901A), VCO (Q901) and prescaler (U301), the MC145156 will provide all the remaining functions required for the PLL frequency synthesizer. Listed in Table 3.2 are the pin descriptions and their functions.



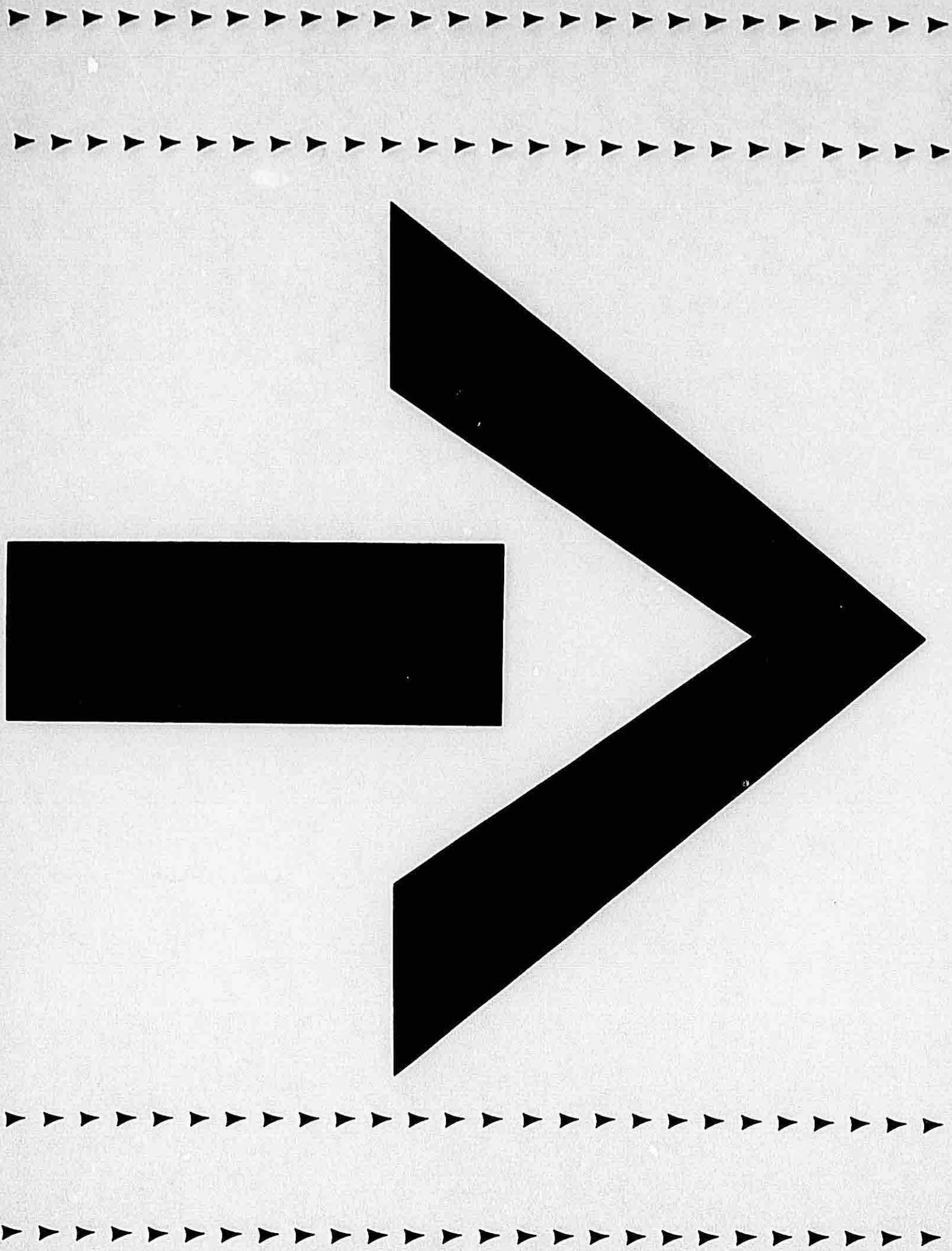


TABLE 3.2. U302 PIN DESCRIPTIONS

PIN NO.	SYMBOL	I/O	
1 2 20	RA_1 RA_2 RA_0	INPUT INPUT INPUT	3-Bit Code that establishes one of 8 possible divide values for the total reference frequency divider. U302 is set for ÷64 to give a reference of 3.2 MHz ÷64 = 50 KHz RA_2 RA_1 RA_0 — Divide by 0 0 0 — 8 0 0 1 — 64 0 1 0 — 128 0 1 1 — 256 1 0 0 — 640 1 0 1 — 1000 1 1 0 — 1024 1 1 1 — 2048
6	PDout	OUTPUT	3-state output of phase detector for use as loop error signal.
8	MOD CNTRL	OUTPUT	A signal from the on-chip circuitry for controlling an external dual prescaler (U301). The MOD CNTRL level will be low at the beginning of a court cycle and remains low until the ÷A counter has counted down from its programmed value. At this time, MOD CNTRL goes high and remains high until the ÷Np counter has counted down from its programmed value. MOD CNTRL is then set back low and the counters preset to their programmed value and the sequence repeated.
10	F_{in}	INPUT	Input to the ÷Np, ÷A counters. F_{in} will be the output from a dual prescaler (U307/U302A/B).
11	CLOCK	INPUT	Shift register clock. Each clock pulse clocks one bit into the on-chip shift register by causing the register to shift right one bit, and the data present (1 or 0) on the data input at the time of the clock pulse to be shifted into Bit No. 19 position. A total of 19 clock pulses are required.
12	DATA	INPUT	Provides programming information for the 10-bit ÷Np and 7-bit ÷4 counters and the two switch signals SW1/SW2. The data is clocked in serially. Entry format is as follows: ← KHz "A" CODE, TABEL 3. → ‖ ← MHz "Np" CODE, TABLE 3. → SW2 SW1 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 Last data bit in (Bit #19) — First data bit in (Bit #1)
13	Enable	INPUT	When high, transfers contents of shift register into programmable counters and the switch outputs SW1/SW2. When Low inhibits the above action.
14 15	SW1 SW2	OUTPUT OUTPUT	Provides a latched open drain output corresponding to data Bit #1 Same as SW1 except corresponds to data Bit #2
17	REFout	OUTPUT	Buffered output of external reference oscillator
18 19	OSCout OSCout	OUTPUT INPUT	From an on-chip reference oscillator when connected to an external parallel resonant crystal.

Dwg No. TP001340A

Each of the 200 NAV channels has a particular code that the microprocessor uses to program the Np and A counters in the synthesizer IC U302. Table 3.1 does not list all 200 possible codes. To facilitate the troubleshooting of the synthesizer, an explanation of how to derive any of the 200 binary codes is given.

3.3.3 Continued

In Table 3.3 each MHz channel from 108.00 to 117.00 is listed with the corresponding synthesizer frequency. The following formulas are needed to calculate N, Np and A:

1. $N = \frac{\text{Synthesizer frequency KHz}}{\text{50 KHz Reference Frequency}}$

2. $\frac{N}{15}$ = Np + Remainder (not used in computation)

3. A = N - (Np x 15)

For example, find N, Np, and A for channel 114.65

From the table, the synthesizer frequency for channel 114.00 is 97.0 MHz. For channel 114.65 just add the decimal .65 to the basic synthesizer frequency of 97.0 MHz which gives you the correct synthesizer frequency for 114.65, which is 97.65 MHz. Now calculate N using formula 1:

$$N = \frac{97650 \text{ KHz}}{50 \text{ KHz}} = 1953$$

$\frac{1953}{15}$ = Np + Remainder = 130.20 (remainder not used in computation)
Now calculate A from formula 3

A = 1953 - (130 x 15) = 3.

The final step is to extract the Np and A binary code from the table. Since 114.65 is an VOR channel then according to the note, SW1 = 0 and SW2 = 1. In this example Np = 130 and A = 3. From the table, Np binary = 0010000010 and A binary = 0000011. Writing the whole 19 bits gives 01 0010000010 0000011.
SW1 SW2 Np A

TABLE 3.3. DEVIATION OF VOR/LOC SYNTHESIZER CODE

First data in ↓ — Last data bit in ↓

			Np MHz Counter (U302)											A KHz Counter (U302)							
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
MHz Channel	MHz Synthesizer	Np	SW_1	SW_2	Np Binary										A Binary							A
108	91	121			0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
109	92	122			0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	1	1
110	93	123			0	0	0	1	1	1	1	0	1	1	0	0	0	0	0	1	0	2
111	94	124			0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	1	3
112	95	125			0	0	0	1	1	1	1	1	0	1	0	0	0	0	1	0	0	4
113	96	126	S		0	0	0	1	1	1	1	1	1	0	0	0	0	0	1	0	1	5
114	97	127	E		0	0	0	1	1	1	1	1	1	1	0	0	0	0	1	1	0	6
115	98	128	E		0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	7
116	99	129			0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	8
117	100	130	N		0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1	9
		131	O		0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	1	0	10
		132	T		0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	1	1	11
		133	E		0	0	1	0	0	0	0	0	1	0	1	0	0	0	1	1	0	12
		134			0	0	1	0	0	0	0	0	1	1	0	0	0	0	1	1	0	13
															0	0	0	1	1	1	0	14

NOTE: For any omni channel SW1 = 0, SW2 = 1
For any localizer channel SW1 = 1, SW2 = 0

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3.3.4 Synthesizer Detailed Circuit Theory

3.3.4.1 Phase Detector

Shown in Figure 3-3, the forward path of the synthesizer loop begins with the phase detector. All phase-locked loop systems use a circuit called a phase detector. The phase detector in the NAV 824/825 system is located internally in U302 and has a three state signal output consisting of positive and negative pulses and a high impedance when the loop is locked up. The output is often referred to as the error voltage. If the imput frequency to the phase detector is greater than the reference frequency (50 KHz) then the phase detector's output at pin 6 of U302 will be negative pulses. If the input frequency is less than the reference, then the output at pin 6 will be positive pulses. When the input agrees with the reference, the output goes to a high impedance. Since the NAV 824/825 has 50 KHz channel spacing, the reference frequency for the phase detector must be 50 KHz. U302 is programmed to divide the 3.2 MHz crystal oscillator by 64 to give a phase detector reference of 50 KHz. The ÷64 code is shown at pins 1, 2, and 20 in Table 3.2.

3.3.4.2 Loop Filter (U901A/B)

Refer to Figure 6-2.

The phase detector pulsed output from pin 6 of U302 is applied to the loop filter U901A. The loop filter has two major functions:

1. It removes the noise and high frequency components from the error voltage thus yielding an average DC voltage.
2. The loop filter controls the lock, capture, bandwidth and transient response of the synthesizer loop.

In this design, the loop filter is an active lead-lag type with an additional low pass attenuation outside the loop bandwidth. The filter consists of R901, R902, and C903. The filter output is buffered by voltage follower U901 and amplified by a factor of 1.5 by U901B. This amplification is necessary to raise the level of the applied voltage to the varactor diode CR901, so the VCO can be tuned over the range of 91.0 to 100.95 MHz.

3.3.4.3 Voltage-Controlled Oscillator, (VCO Q901)

Refer to Figure 6-2.

The VCO is a free running oscillator, whose frequency is determined by the parallel tank circuit consisting of inductor L901 and varactor diode CR901. The varactor is a voltage variable capacitor. As the applied voltage to CR901 increases, the capacity decreases and the resonant frequency of the tank circuit changes. The loop filter voltage is applied to CR901 and at the low end of the band (91.0 MHz) the tuning voltage is approximately 2.2 Vdc. At the high end of the band (100.95 MHz) the tuning voltage is 4.2 Vdc.

3.3.4.3 Continued

Q901 is forward biased by the resistor network of R909 and R910. Feedback to the base is taken from the emitter via capacitor C912. The output RF energy is coupled into the local oscillator amplifier Q902 via C914. Q902 is forward biased into Class A operation and amplifier the VCO output. The collector inductor (L902) is tuned by C917 and creates an RF impedance necessary for RF amplification. The output from the collector is split into two directions. The first path is the local oscillator injection into the receiver mixer, Q1002. The second path is to the buffer isolation amplifier, Q903. The output from Q903 drives the two modulus prescaler, U301. Both Q902 and Q903 amplifiers are tuned for the mid-range of the receiver band. Both amplifiers are biased into class A operation and Q902 supplies the mixer Q1002 with 0.9 Vrms of drive while Q903 supplies the necessary voltage level needed to trigger counter U301.

The VCO frequency from Q903 is now introduced into the loop feedback path and will be divided down by the ÷N counter and compared to the 50 KHz reference frequency at the phase detector. Any error voltage developed by the phase detector will force the VCO to change in a direction to reduce the frequency difference between the VCO and 50 KHz reference. Once the VCO starts to change frequency, the loop is in the capture state. This process continues until the VCO and 50 KHz reference are exactly the same. At this point the loop is phase-locked.

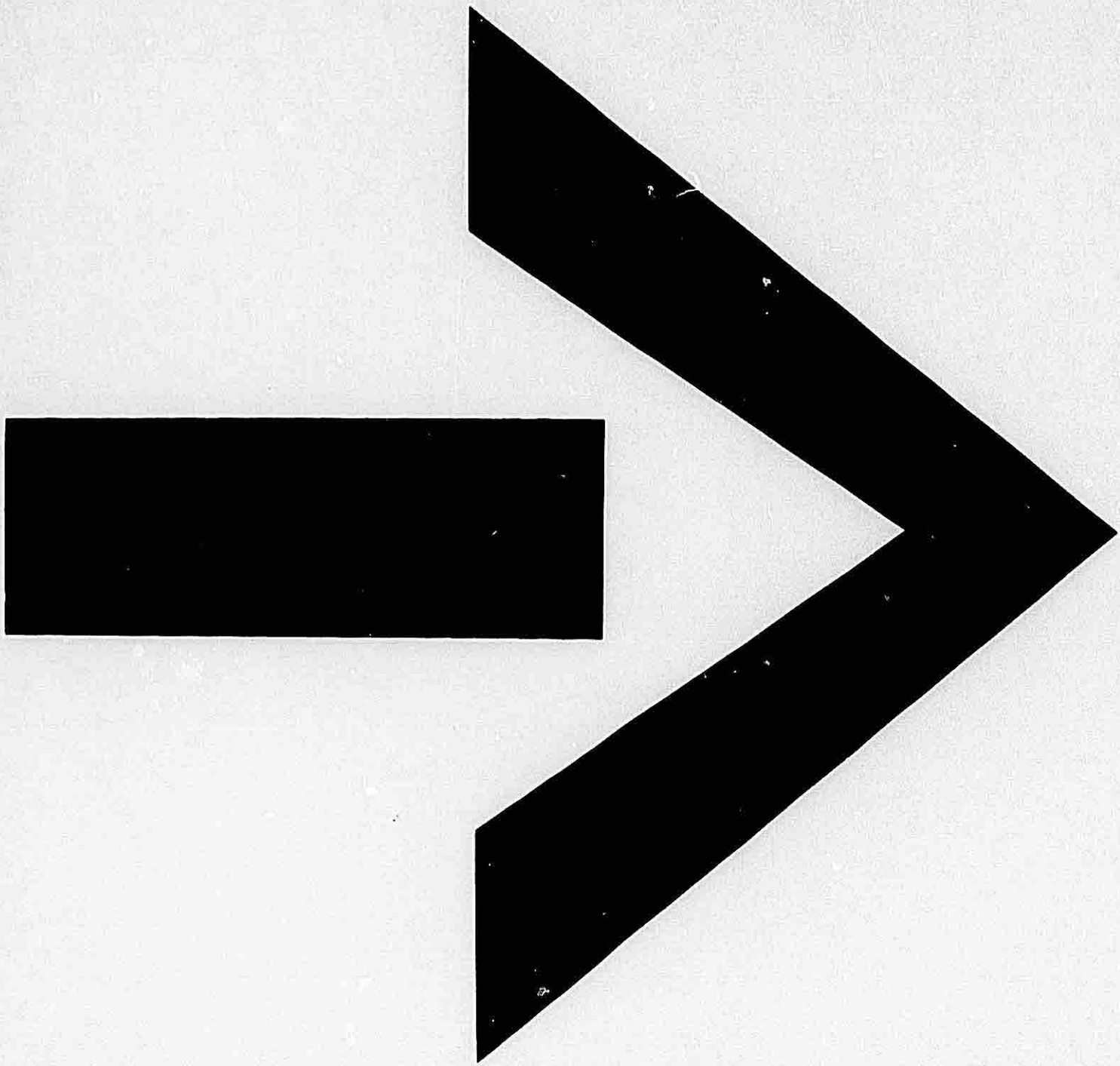
3.3.4.4 Divide-By-N Counter

Refer to Figure 6-1.

The divide-by-N counter is comprised of prescaler U301 (÷15/16) and U302's ÷Np and ÷A counters. A divide-by-N counter is a digital logic circuit that produces a single output pulse for N input pulses, where N is an integer. As the feedback path of the synthesizer loop is a divide-by-N counter, the output frequency of the synthesizer is "N" times the 50 KHz reference frequency. The divide-by-N counter is programmable so that the number N can be changed as the selected frequency is changed. U301 is a MC3393 two modulus prescaler that can be commanded to count by either 15 or 16. The Mod Control input at pin 6 determines when it will count by 15 or 16. A logic high on pin 6 puts the counter in the divide-by-15 mode while a logic low yields a divide-by-16 count.

To fully understand how the divide-by-N counter works, an explanation of what the number "N" is and its numerical derivation follows:

The NAV 824/825 has 200 channels that consists of 10 whole number MHz steps, covering 108 to 117 MHz, and 20 fractional 50 KHz steps covering .00 to .95 KHz. 10 channels (MHz) times 20 channels (KHz) equals 200 channels. Since the smallest discrete frequency change is 50 KHz, then the counter reference must also be 50 KHz. Thus: the receiver frequencies range, 108.00 to 117.95 MHz.



3.3.4.4 Continued

The IF frequency is 17 MHz. The synthesizer must cover the band from 91 MHz (108.00 MHz-17 MHz) to 100.95 MHz (117.95 MHz-17 MHz). The number "N" is found from the formula:

$N = \frac{fs\ (Hz)}{fr\ (Hz)}$ where: fs = required synthesizer frequency in Hertz
fr = reference frequency in Hertz (50 KHz)

Examples: Find N for 108.00 MHz which is 91 MHz for the synthesizer $N = \frac{91000\ KHz}{50\ KHz} = 1820$

Find N for 117.95 MHz (synthesizer 100.95 MHz)
$N = \frac{100950\ KHz}{50\ KHz} = 2019$

The significance of "N" is that the divide-by-N counter will count "N" input VCO pulses in order to produce one output pulse from the programmable ÷N- counter in U302. This output pulse, which is occurring at a 50 KHz rate, is compared with the 50 KHz reference at the phase detector.

Exactly how the programmable synthesizer, U302 achieves the divide-by-N count will now be explained.

As outlined in Sections 3.2.3 and 3.3.3 the microprocessor programs the ÷Np, (MHz) and ÷A (KHz) counters in U302. A partial program code is shown in Table 3.1. The 12 bit MHz code shown in Table 3.3 is in a binary format and represents the Np numbers 121 through 134. When this code is programmed into the ÷Np counter, the counter will count down from the number Np.

The ÷A 7-bit KHz code as shown in Table 3.3, is also in binary format and represents the numbers 0 to 14. For example: Table 3.3 shows that the 7 bit binary equivalent of the number A=9 is 0001001. When this code is programmed into the ÷A counter, the counter will count down from the number A. The ÷Np and ÷A counters allow for a total programmable divide value (N) of N = (Np x P) + A where P represents the divide-by-15 count of the prescaler. Np and A represent the numbers programmed into the Np and A counters.

NOTE: Table 3.1 is only a partial list of the 200 codes used to program the synthesizer. Section 3.3.3 explaines how to derive any of the codes not listed in that table.

The ÷A KHz counter controls the "MOD CNTRL" output of U302 and signals the prescaler, U301, when to shift its division factor.

The MOD CNTRL level from U302 pin 8 will be low at the beginning of a count cycle and will remain low until the ÷A (KHz) counter has counted down from its programmed value. At this time, MOD CNTRL goes high and remains high until the ÷Np counter has counted the rest of the way down from its programmed value. MOD CNTRL is then set back low and the sequence repeats.

3.3.4.4 Continued

A shift in the prescaler division factor (÷16 to ÷15) allows a technique to be used called pulse swallowing. Pulse swallowing is required for those A KHz numbers that are 1 through 14. The reason "why" follows: let us suppose the pilot is receiving on 110.00 MHz. From Table 3.3 the ÷Np MHz counter in U302 is programmed with the number 124 and the ÷A KHz counter is programmed with (Zeros). The total counter divide-by-N number is:

$$N = \frac{93000\ KHz}{50\ KHz} = 1860$$

The ÷Np counter in U302 requires at the Fin (pin 10) input, 124 clock pulses from the prescaler to count down from its programmed value of 124. Since the ÷A KHz counter is programmed with all zeros, the MOD CNTRL line will be logic high at the start of the count cycle. This logic high puts the prescaler in the divide-by-15 count mode. Therefore, each of the 124 pulses from the prescaler will be generated by counting 15 VCO input pulses which yields the required number "N" (N = Np x P + A) i.e. 124 x 15 + 0 = 1860. What would happen if the pilot next selects channel 110.20 MHz and WE DID NOT HAVE A DUAL MODULUS PRESCALER BUT A FIXED DIVIDE-BY-15 MODULUS?

Now the new total counter divide-by-N number is:

$$N = \frac{93200\ KHz}{50\ KHz} = 1864$$

The ÷Np MHz counter is still programmed with the number 124. If the prescaler can only count by 15, then the 124 pulses it produced would only contain 124 x 15 = 1860 pulses. This leaves us 4 pulses short of the required 1864. A way must be found to "pulse swallow" these 4 excess pulses. The selection of a dual modulus prescaler solves this problem and the following describes how it accomplishes the task:

When 110.20 MHz was selected, the ÷A counter in U302 was programmed with the number 4 as shown in Table 3.1. Both the ÷Np and ÷A counters will count down simultaneously. Since the ÷A counter is programmed with the number 4, it will require 4 pulses from the prescaler to count down to zero. Therefore at the beginning of the count cycle, the Mod Cntrl line will be logic low and stay low for 4 prescaler pulses. The logic low from the Mod Cntrl sets the prescaler to the divide-by-16 count mode so that 4 of the required 124 prescaler pulses will be generated by 64 VCO input pulses per prescaler output. The remaining 120 prescaler output pulses are generated by the divide-by-15 mode as the Mod Cntrl line goes high at the conslusion of the 4th prescaler pulse. Therefore the total divide-by-N number is (4 x 16) + (120 x 15) = 1864 which is the required number.

3.3.4.4 Continued

A timing diagram of 110.20 MHz Figure 3-4, is shown here to help clarify the previous discussion of the divide-by-N counter. Note in the timing diagram that the U301-7 output shows where the "pulse swallowing" occurs.

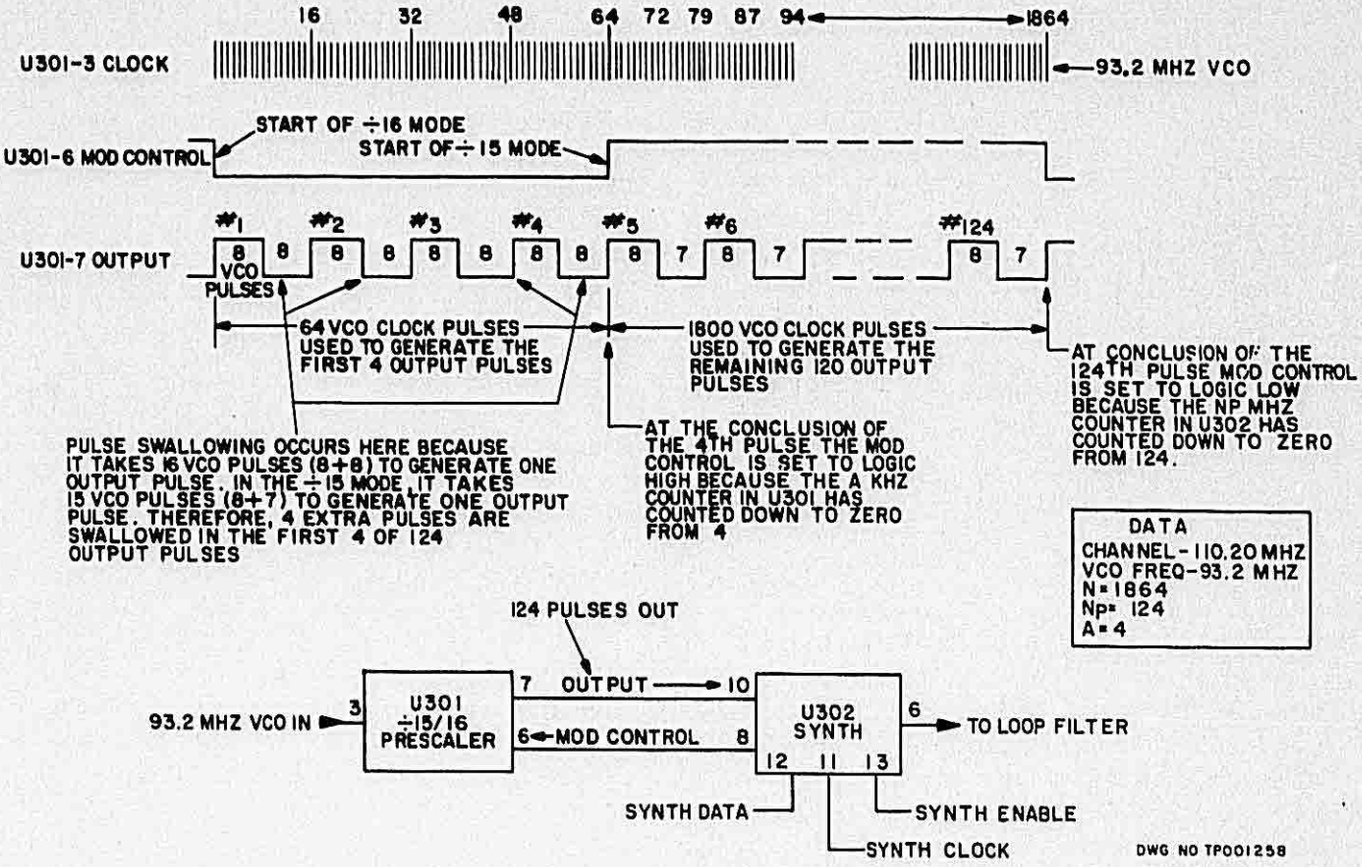


FIGURE 3-4. TIMING DIAGRAM OF ÷N COUNTER FOR 110.20 MHz

3.4 NAVIGATION GLIDESLOPE RECEIVER

The GS receiver block diagram shown in Figure 3-5 demodulates and amplifies the GS RF carrier to provide navigation data to the GS converter circuit. The GS receiver and GS synthesizer circuits are independent and are not time shared like the NAV 122/124 with the VOR/LOC circuits.

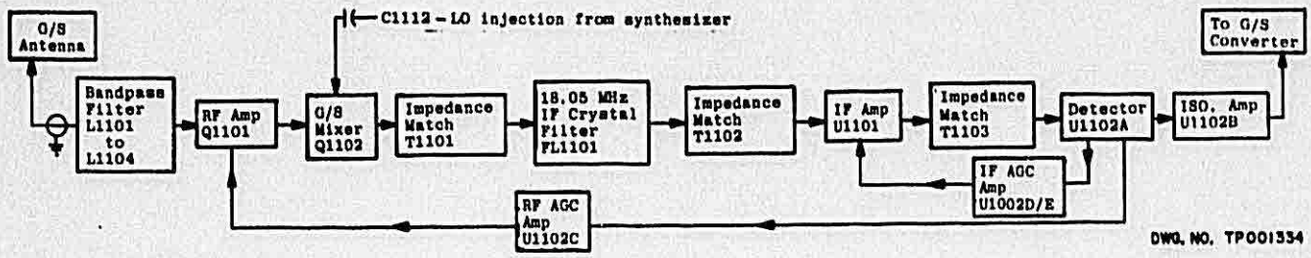


FIGURE 3-5. GLIDESLOPE RECEIVER BLOCK DIAGRAM

3.4.1 GS RF Amplifier (Q1101)

The GS RF amplifier comprises Q1101 in a common emitter configuration, and fixed tuned input and output circuits that cover the 329.15 through 335.00 MHz range of glideslope channels. The antenna is connected into a bandpass filter consisting of L1101 through L1104 and associated capacitors. DC bias to Q1101 is taken from pin 13 of U1102C, the RF AGC amplifier. Under no signal conditions, pin 13 of U1102C is sitting at approximately 5 Vdc which is applied to the base of Q1101 via R1101. As the RF signal level increases, the AGC DC from U1102-13 will decrease and lower the gain of Q1101. Capacitor C1104 feeds a portion of the RF energy back to the base for stability.

3.4.2 GS Local Oscillator (Q1202)

The LO injection is taken from isolation amplifier Q1202 which is part of the synthesizer phase-locked loop system. When the front panel frequency selector is set to odd number KHz channels between 108.1 and 111.95 MHz, the GS synthesizer is programmed by the microprocessor. It should be noted that the GS VCO operates at 1/3 the injection frequency. The VCO frequency is tripled in the GS mixer to produce the GS LO frequency. Table 3.4 lists the operating frequencies of the GS channels.

TABLE 3.4. OPERATING FREQUENCIES OF GS CHANNELS

NAV Channel	G/S RF	G/S LO	G/S VCO
108.10	334.70	316.65	105.55
108.15	334.55	316.50	105.50
108.30	334.10	316.05	105.35
108.35	333.95	315.90	105.30
108.50	329.90	311.85	103.95
108.55	329.75	311.70	103.90
108.70	330.50	312.45	104.15
108.75	330.35	312.30	104.10
108.90	329.30	311.25	103.75
108.95	329.15	311.10	103.70
109.10	331.40	313.35	104.45
109.15	331.25	313.20	104.40
109.30	332.00	313.95	104.65
109.35	331.85	313.80	104.60
109.50	332.60	314.55	104.85
109.55	332.45	314.40	104.80
109.70	333.20	315.15	105.05
109.75	333.05	315.00	105.00
109.90	333.80	315.75	105.25
109.95	333.65	315.60	105.20
110.10	334.40	316.35	105.45
110.15	334.25	316.20	105.40
110.30	335.00	316.95	105.65
110.35	334.85	316.80	105.60
110.50	329.60	311.55	103.85
110.55	329.45	311.40	103.80
110.70	330.20	312.15	104.04
110.75	330.05	312.00	104.00
110.90	330.80	312.75	104.25
110.95	330.65	312.60	104.20
111.10	331.70	313.65	104.55
111.15	331.55	313.50	104.50
111.30	332.30	314.25	104.75
111.35	332.15	314.10	104.70
111.50	332.90	314.85	104.95
111.55	332.75	314.70	104.90
111.70	333.50	315.45	105.15
111.75	333.35	315.30	105.10
111.90	331.10	313.05	104.35
111.95	330.95	312.90	104.30

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3.4.3 GS Mixer (Q1102)

The glideslope RF input to the base of mixer Q1102 is obtained from capacitive voltage divider C1107/C1109. In addition to this GS signal, the LO injection from Q1202 is connected through R1104 to the base of Q1102. Since this mixer is non-linear, heterodyning occurs and according to RF theory: there appears at the collector output, all the sum and differences of the input frequency.

The GS RF input mixes with the third harmonic of the LO frequency to provide a difference frequency of 18.05 MHz. This now becomes the GS IF frequency. This frequency multiplication is used so that the GS VCO can operate in the VHF region, close to the LO frequencies used for the VOR receiver.

3.4.4 GS IF Filter (FL1101)

The IF filter section comprises three separate two-pole crystal monolithic filters (FL1101). The 18.50 MHz IF frequency is coupled into FL1101 through T1101 which, along with C1113 and R1108, form an impedance matching network to the input of the crystal filter.

Each of the three crystal filters have a typical insertion loss of 0.5 dB with 1 dB being the maximum loss per crystal. The crystal filter controls the overall selectivity of the receiver. The 6 dB IF bandwidth is ±21 KHz and the 60 dB bandwidth is ±90 KHz. The tuned circuit at the output, T1102, C1114, and R1109 matches the filter output to the differential input of the IF amplifier U1101.

3.4.5 GS IF Amplifier (U1101)

The 18.05 MHz signal is amplified 60 dB by a linear IC amplifier U1101. In addition, IF AGC is applied to U1101 pin 5 to stabilize the output level. Under high signal level conditions, a positive going IF AGC voltage reduces the gain of the amplifier. The differential output of U1101 is coupled into the detector U1102A via transformer T1103.

3.4.6 GS Detector (U1102A)

The 18.05 MHz signal is coupled into the detector via T1103. Input diode CR1101 clamps the detector input and prevents overdriving. The secondary of T1103 is the DC return path for the input of U1102A and C1120 shunts the RF carrier to ground. The demodulated output from pin 9 provides the 90 and 150 Hz guidance signals to the GS converter buffer amplifier U1102B. An additional output, pin 11, drives the RF and IF AGC amplifiers.

3.4.7 GS RF AGC Amplifier (U1102C)

Pin 11 from the detector U1102A is connected to RF AGC amplifier U1102C to control the gain of RF amplifier Q1101. The amplified detector output is filtered by C1124/R1115 to obtain a varying DC control voltage that is indicative of the RF signal amplitude. The RF AGC filter (R1113/R1114/C1122) determines the response time of Q1101 to changes of RF input.

3.4.8 GS IF AGC Amplifier (U1102D/E)

The IF AGC is derived from the detector output at pin 9, the same source as the RF AGC. The filtered detector voltage is applied to a two stage amplifier (U1102D, U1102E) and RC filter R1123/C1117. This filtered voltage is used to control the gain of IF amplifier U1101. As the glideslope RF signal level increases, the output from U1102E increases which reduces the gain of U1101.

3.4.9 GS Buffer (U1102B)

The glideslope buffer provides the navigation signal to the glideslope converter circuits. U1102B is a buffer amplifier that isolates the detector output from the converter.

3.4.10 GS Up/Down Meter Amplifier (U1104)

The up/down meter amplifier is connected as an integrating amplifier. The meter time constant is determined by R1141 and C1135 and has the same response as the L/R meter amplifier U503A when operating in the localizer mode. The output from U1104 exits the receiver board at E1014 and connects to the main board at E414 and exits at J103-11.

3.4.11 GS Synthesizer

The glideslope synthesizer is identical both in design and operation with the VOR/LOC synthesizer that is discussed in Section 3.3.2. The VCO, Q1201, operates from 103.70 to 105.65 MHz as listed in Table 3.4. The glideslope synthesizer code for U310 is <u>different from</u> the VOR/LOC synthesizer code for U302 and is listed in Table 3.5. The programming data entry into U310 pin 12 is as follows:

When a GS/LOC frequency is selected, the microprocessor sends 38 bits of program code to U302 pin 12. The first 19 bits are the glideslope synthesizer code and are serially shifted into U302. The second 19 bits are the VOR/LOC synthesizer code and as they are shifted into U302 the first 19 bits overflows and exits from pin 14, the SW1 location in the internal Np MHz counter. Pin 14 of U302 is connected to the data input (pin 12) of U310 and as the second 19 bits pushes the first 19 bits out of U302, the first 19 bits are serially loaded into U310.

When an VOR channel is selected, the microprocessor sends only the 19 bit VOR/LOC synthesizer code to U302. The old code in U302 is shifted out into U310 which poses no problem because a VOR/LOC code cannot correctly program the glideslope synthesizer.

3.4.12 GS Converter (U1103C/D)

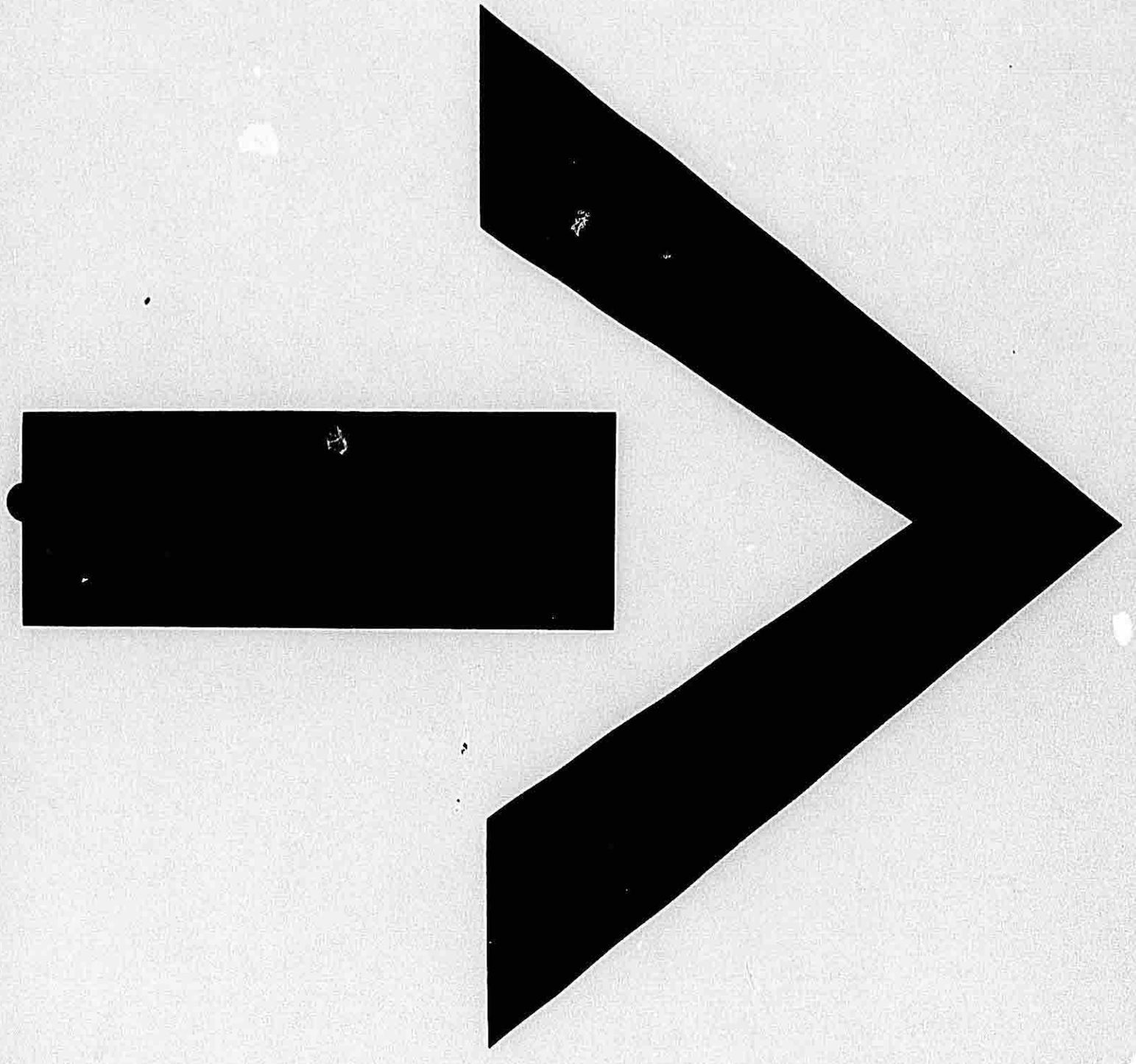
The glideslope converter is identical both in design and operation with the localizer converter which is discussed in Section 3.5.15.

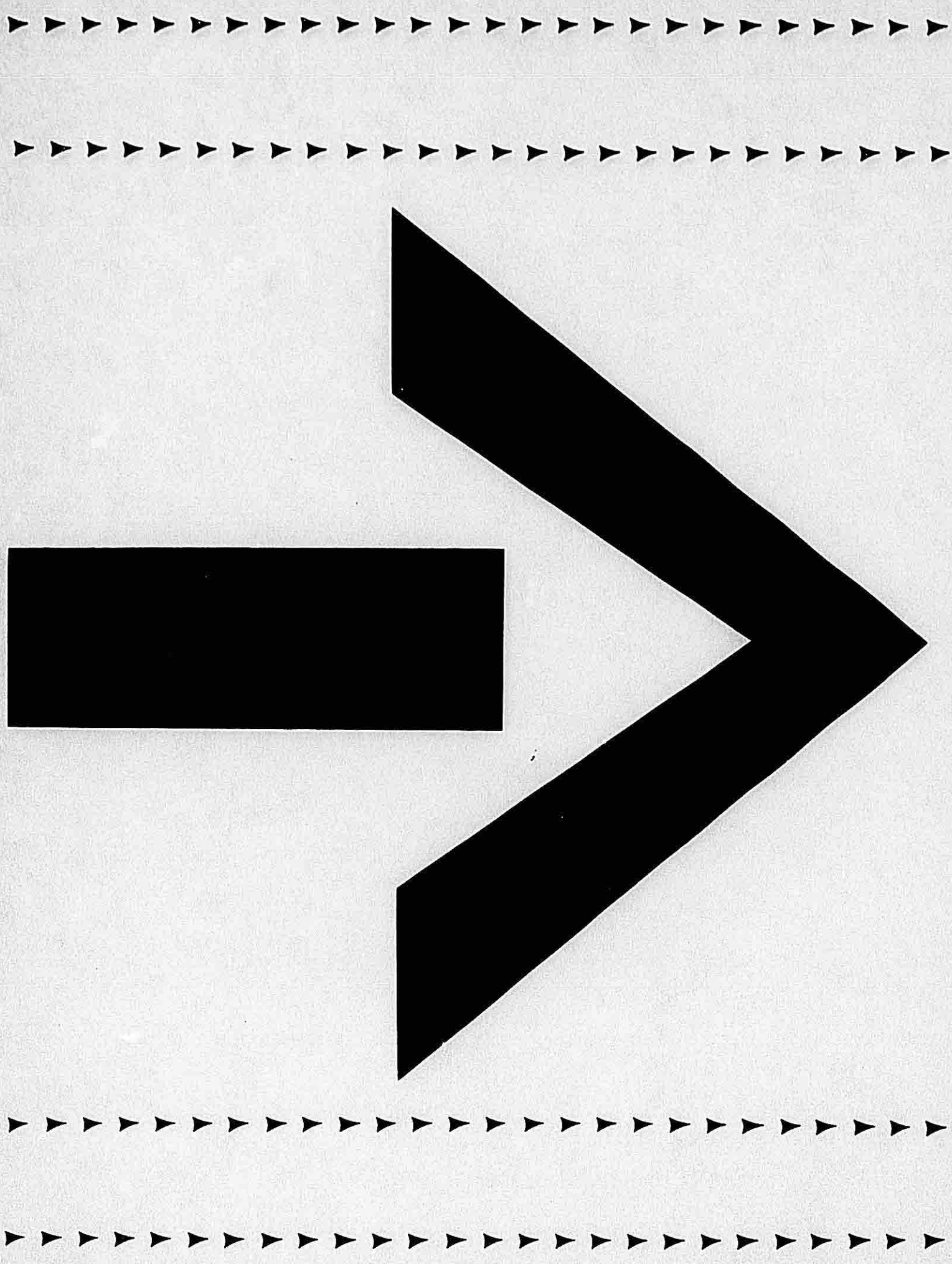
3.4.13 GS Flag Comparators (U1103A/B)

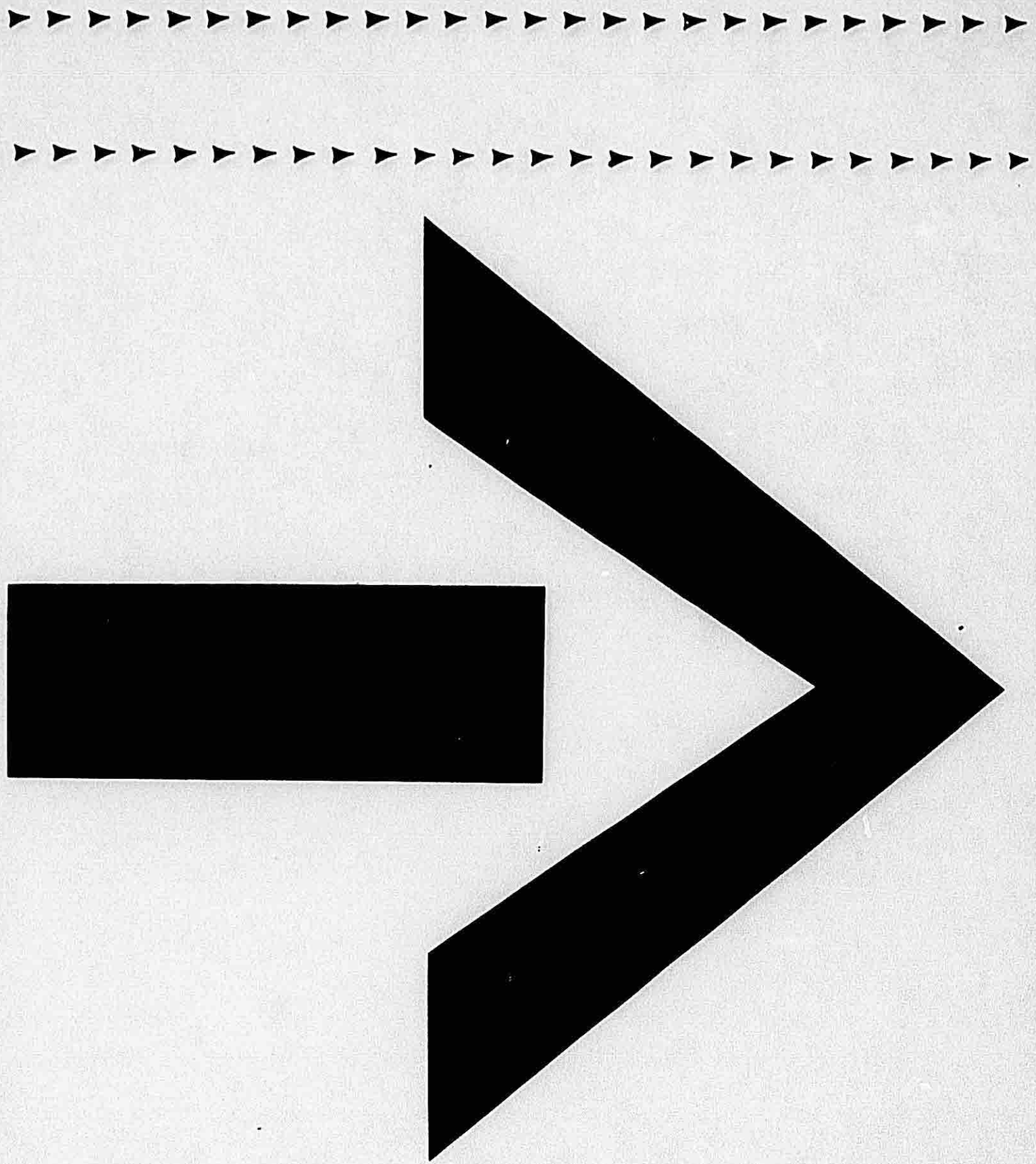
The glideslope flag comparators are identical in design and operation with the NAV flag comparators that are discussed in Section 3.5.16.

3.4.14 GS Flag Driver (Q1103)

The base of the glideslope flag driver (Q1103) is connected to the wired OR outputs of comparators U1103A/B. The outputs from these comparators are uncommitted collectors with a common pull-up resistor R1145. When a valid glideslope signal is present, the outputs of U1103A/B are open allowing the base of Q1103 to be driven by 16 volts through R1145. The emitter of Q1103, which drives the GS flag, exits the receiver board at E1008 and connects to the main board at E408. From E408, the GS flag driving voltage passes through two current limiting resistors, R584/R594, and exits the radio from the rear connector at J103-A/J103-B.







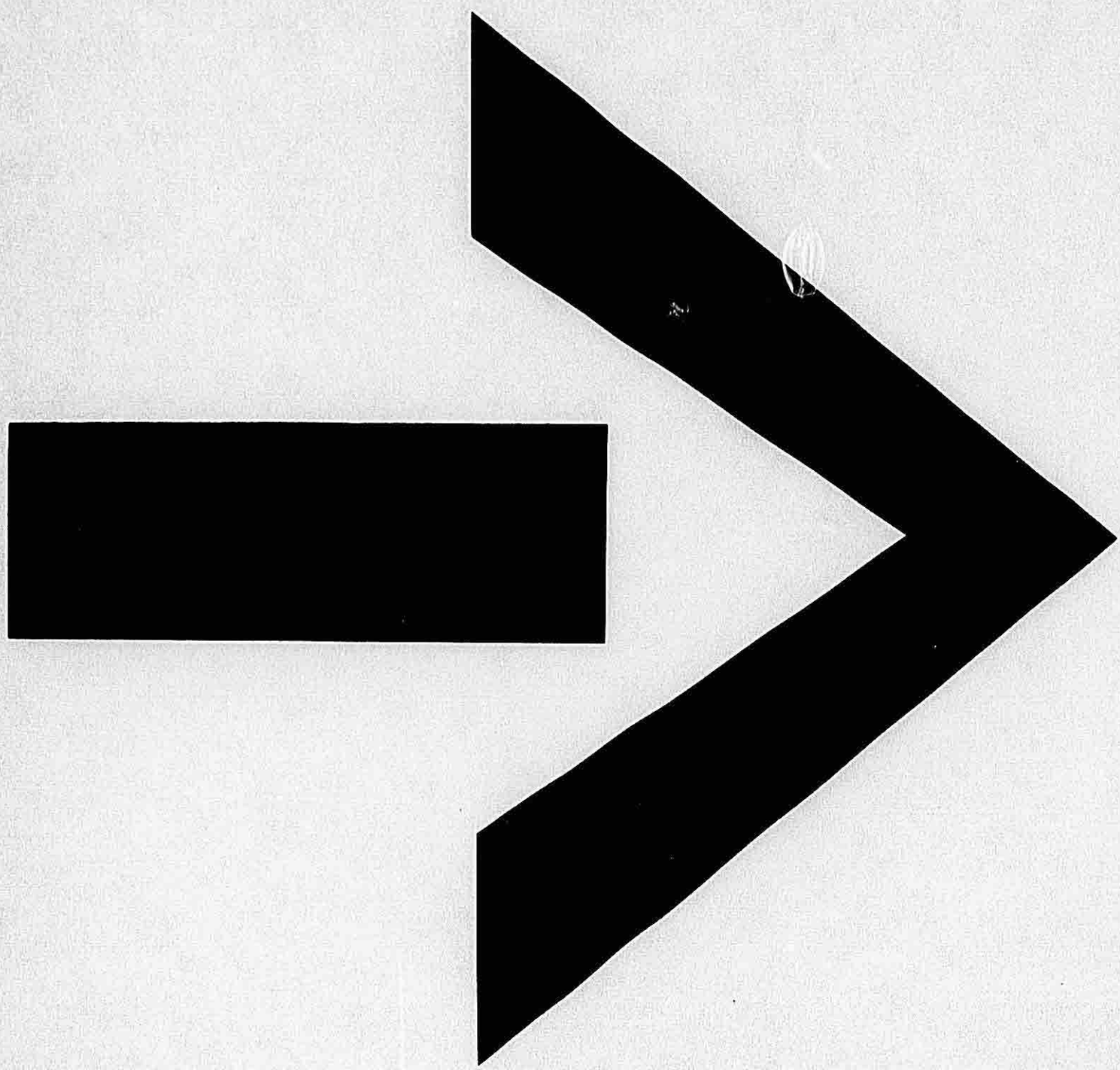


TABLE 3.5. GS SYNTHESIZER PROGRAMMING CODE

LOC/GS Channel	SW_1	SW_2	Np MHz										A KHz						
108.10	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	0	1	1
108.15	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	0	1	0
108.39	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	1	1	1
108.35	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	1	1	0
108.50	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	1
108.55	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0
108.70	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	1	1	0	1
108.75	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	1	1	0	0
108.90	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	1
108.95	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0
109.10	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	1	0	0
109.15	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	1	1
109.30	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	0	0	0
109.35	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1	1
109.50	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	1	0	0
109.55	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	0	1	1
109.70	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	1
109.75	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0
109.90	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	1	0	1
109.95	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0
110.10	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	0	0	1
110.15	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	0	0	0
110.30	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	1	0	1
110.35	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	1	0	0
110.50	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	1	1
110.55	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	1	0
110.70	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	1	1
110.75	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	1	0
110.90	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0
110.95	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	1	1	1	0
111.10	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1	0
111.15	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	1	0	1
111.30	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	0	1	0
111.35	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	0	0	1
111.50	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	1	1	0
111.55	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	1	0	1
111.70	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	1
111.75	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	0
111.90	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	1	0
111.95	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	1

First data bit in

Last data bit in

Dwg No. T0001342

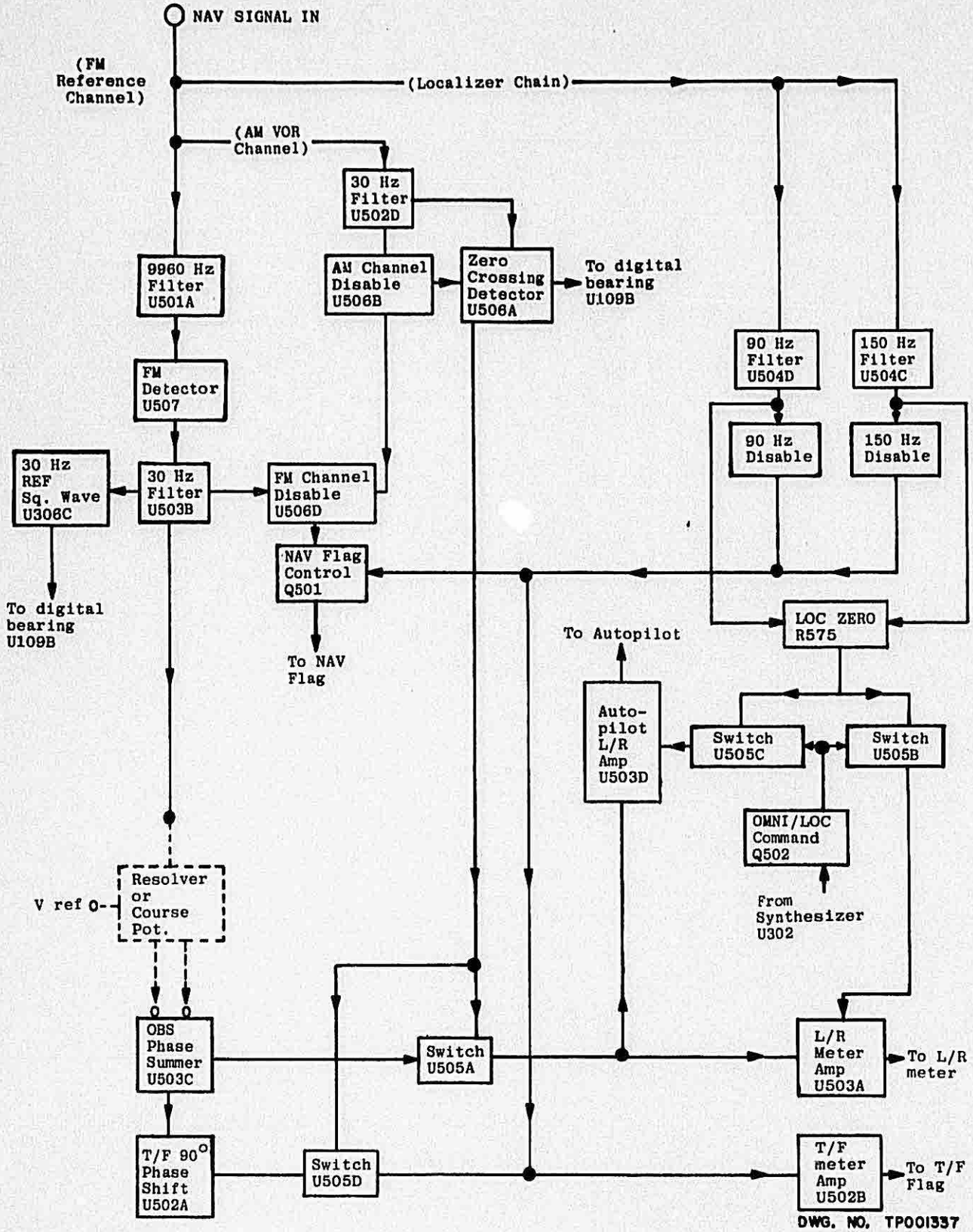


FIGURE 3-6. VOR/LOC CONVERTER BLOCK DIAGRAM

3.5 VOR/LOC CONVERTER

Refer to Figure 6-2.

The VOR/LOC converter circuits, converts the navigation information obtained from the receiver detector into data suitable for display on the L-R deviation meter and TO-FROM flag of the auxiliary display unit. It also sends station bearing information to the digital bearing circuits where this information is automatically computed and displayed, at the pilots option, in the gas discharge display as the bearing TO or FROM the station. Figure 3-6 is a block diagram showing the circuit structure.

3.5.1 Circuit Functions

Refer to Figure 6-2.

The navigation signal shall be referred to, in the following text, as the VOR/LOC signal and is obtained from buffer U1104 in the receiver section. The VOR/LOC signal is connected to the main PC board at E403 and is presented simultaniously to the localizer, variable and reference channels through CR515. The VOR/LOC signal is comprised of a 9960 Hz carrier that is frequency modulated (FM) at a 30 Hz rate and amplitude modulated (AM) by a 30 Hz signal. The 9960 Hz FM signal is the reference signal (channel). The 30 Hz AM signal is the variable signal (channel).

In the VOR mode, the reference channel phase is varied by the OBS (Omni Bearing Selector) or resolver rotor control on an associated indicator, to place the reference channel 90 degrees out of phase with the variable channel. This will null the meter. At a null of the meter, the OBS reading in degrees is the omni radial. In the localizer mode, the RF carrier is modulated by 90 or 150 Hz signals obtained by the left or right position of the aircraft (and its antenna) with relation to the geometric center of the runway. The left-right signals are electrically summed and connected to the L-R deviation meter. Equal amplitudes of the 90 and 150 Hz signals correspond to a path down the center of the runway and provide a meter null (center) indication. Unequal signals are generated by the aircraft's deviation from the centerline and will provide a left or right needle deflection that is indicative of an aircraft's position with relation to the runway center. The VOR/LOC converter also provides signals to activate associated NAV flag indicators which are used to indicate the validity of the VOR/LOC signal.

3.5.2 30 Hz AM Variable Channel Filter (U502D)

Refer to Figure 6-2.

The VOR/LOC signal is applied through R546 to U502D a 30 Hz bandpass filter. The filter tuning is determined by C522, C523, R546, R547, and R548. Since U502D has its non-inverting input referenced to V ref (8 Vdc), the output at pin 14 will be a 30 Hz sine/wave swinging around 8 Vdc. This output is fed to U506A, a zero crossing detector and U506B, the variable channel gate.

3.5.3 Zero Crossing Detector (U506A)

Refer to Figure 6-2.

The zero crossing detector is a circuit that will convert the 30 Hz sine/wave from U502D into a 30 Hz square wave. U506A is a comparator with the non-inverting input (pin 9) biased to 8 Vdc (V ref). The 30 Hz sine/wave is applied to the inverting input (pin 8) and as shown in Figure 3-7 when the sine/wave transitions through the 8 volt level, the output (pin 14) will abruptly change state to an opposite polarity from the input signal. The result is a square wave that is 180 degrees out of phase with the input signal. A small amount of feedback (hysterisis) is applied to pin 9 through C525 and R554 to stabilize the output. The zero crossing detector's output (pin 14) is applied to analog switches U505A and U505D as well as the digital bearing flip-flop, U109B.

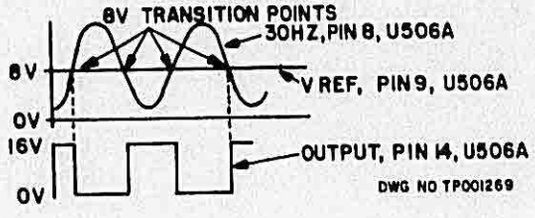


FIGURE 3-7. ZERO CROSSING DETECTOR WAVEFORMS

3.5.4 Variable and Reference Channel, Gate Circuits (U506B/D)

The variable channel 30 Hz sine/wave from U502D is half-wave rectified by CR504 and charges up C524 to a level determined by the resistor divider network of R552/R553 and the peak positive value of the sine/wave. This positive voltage is applied to pin 10, the inverting input of comparator U506B. Since the non-inverting input, pin 11, is referenced back to 8 Vdc (V ref), the output at pin 13 will be pulled low whenever the DC level on pin 10 exceeds the V ref value. A failure of the 30 Hz variable signal or a peak amplitude of 8 volts or less will cause the non-inverting input pin 11 to exceed the inverting input pin 10 level when C524 discharges to ground through R553. When the DC level on pin 10 is less than the V ref level at pin 11, the output at pin 13 will go high. This high voltage is applied to pin 8 of U506A through CR507 and forces U506A pin 14 low.

This disables analog switches U505A/U505D. This results in a disabled L-R needle and TO-FROM flag. Pin 13 of U506B is also connected to the reference channel disable circuit (U506D) through diode CR512 and forces U506D pin 2 low. This removes the base drive to Q501 and the NAV flag loses its retraction voltage. The reference channel gate circuit receives its 30 Hz sine/wave from U503B and is half-wave rectified by CR501 and applied to pin 5 of U506D.

Operation of this circuit is identical to the variable channel gate circuit just discussed. A failure in the reference channel will disable the L-R needle and TO-FROM meter amplifiers (U503A, U502B). Again the NAV flag will lose its retraction voltage because pin 2 of U506D will be clamped to ground removing the base drive to Q501, the NAV flag driver transistor.

3.5.5 NAV Flag

The NAV flag is controlled by transistor Q501 which receives base drive through pull-up resistor R521 at pin 2 of U506D the reference channel gate comparator. When there are valid variable and reference signals, then the reference comparator output is at 16 volts and Q501 is turned on applying 8 volts to the NAV flag outputs and the cathode of CR514 which back biases this diode allowing U105E to present a logic high (valid) to the microprocessor NAV flag input.

If the variable channel should fault, then the variable channel gate comparator pin 13 will be clamped through diode CR512 to pin 4 of U506D. This causes pin 2 of U506D to clamp to ground. This will remove the base drive from Q501 which shuts off, removing the voltage drive from the NAV flag and back bias from CR514 causing the bearing display to bar. If the reference channel should fault, then the charge on C508 will bleed to ground through R516 and pin 2 will clamp to ground and the NAV flag and digital bearing will be deactivated.

There are two NAV flag outputs, both are for a standard 100 ohm 200 microamp flag and are available at J103, pins 7 and 8.

3.5.6 10 KHz GM (Reference) Channel Filter (U502A)

Refer to Figure 6-2.

The VOR/LOC signal is applied through R501 to U501B a 9960 Hz bandpass filter. This filter strips the 30 Hz AM portion from the composite signal. The filter tuning is determined by C501, C502, R501, R502 and R504. The non-inverting input is referenced to 8 Vdc (V ref) causing the 9960 Hz output signal at pin 7 to swing around the V ref level.

3.5.7 FM Detector (U507)

The 9960 Hz from U501B is coupled through C503 into U507, the FM detector. Since the 9960 carrier is frequency modulated at a 30 Hz rate, it is required to extract this 30 Hz information from the carrier. U507, a CMOS 4046 Phase-Locked Loop, issued as an FM demodulator. The VCO frequency (9960 Hz) is determined by capacitor C504 and resistors R505, R506, and adjustable R507. A frequency counter is connected to the VCO output at pin 4, and R507 is used to set the frequency to 9960 Hz. The VCO loop filter is comprised of R508 and C505. The demodulated output is taken from pin 10, an internal source follower.

3.5.8 Reference Channel, 30 Hz Bandpass Filter (U503B)

The 30 Hz demodulated signal from U507 is coupled through R509 into U503B, a 30 Hz bandpass filter. The demodulated signal is of small amplitude and has 9960 Hz ripple present. The bandpass filter strips the 9960 Hz ripple from the signal and amplifies the 30 Hz to a useable level. The tuning components of the filter are: C506, C507, R509, R510, R512, and the VOR zero pot, R511. R511 will slightly shift the center frequency of the filter to facilitate the VOR zero calibration of the L-R needle in the Indicator. The output from U503B is applied to the reference channel gate comparator U506D (discussed in Section 3.5.4), the resolver rotor or OBS resistive pot, and the 30 Hz reference zero crossing detector, U506C.

3.5.9 30 Hz Reference Channel Zero Crossing Detector (U506C)

The 30 Hz reference signal from U503B is applied to the zero crossing detector, U506C, through an adjustable phase shifting circuit comprised of C527 and digital bearing zero resistor R559. As the output of this comparator is applied to the automatic digital bearing selector circuit (U109) the phase can be adjusted by R559 to make the VOR bearing readout in the gas discharge display agree with the selected VOR bearing on the VOR/LOC generator. The operation of the zero crossing detector U506C is identical to the variable channel zero crossing detector discussed in Section 3.5.3.

3.5.10 Sine/Cosine Potentiometer/Resolver/Phase Summer Circuits

3.5.10.1 Resolver (Narco ID 826)

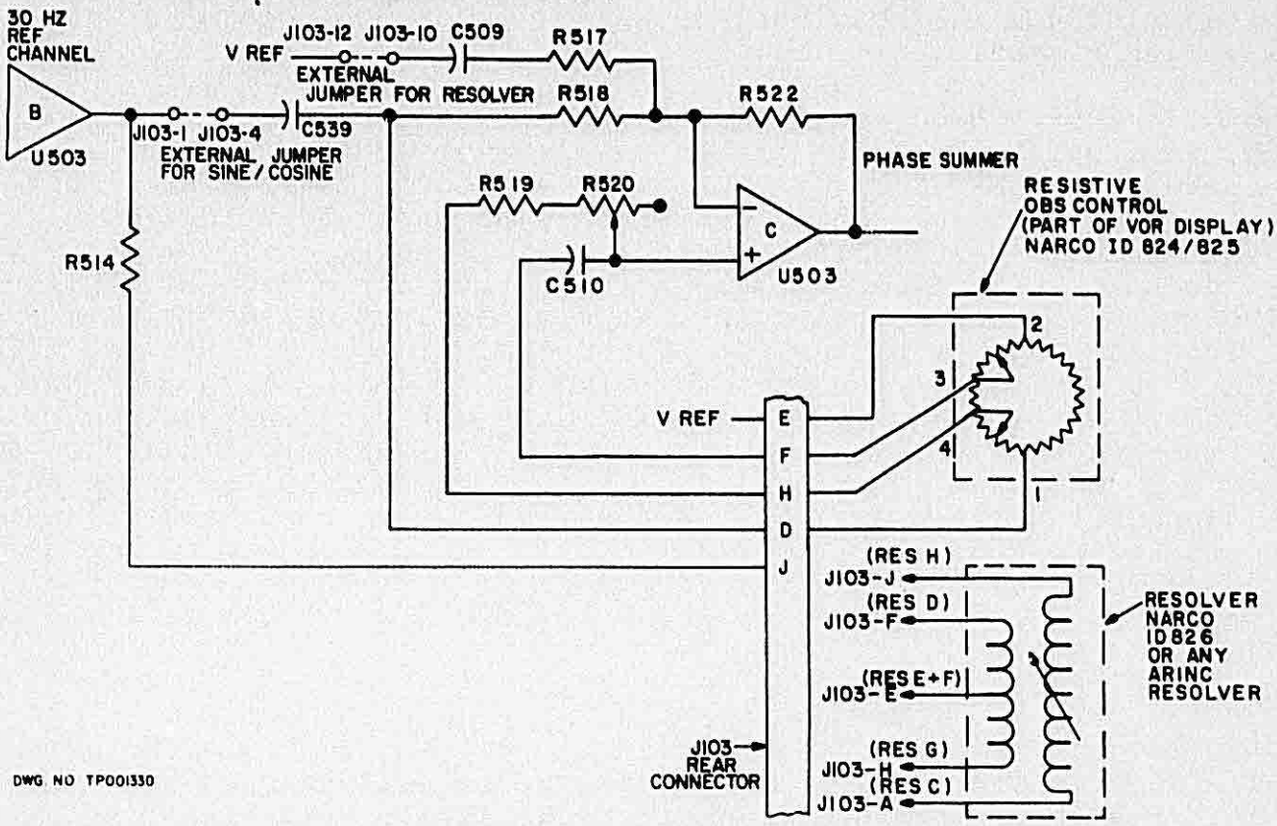


FIGURE 3-8. SINE/COSINE POTENTIOMETER/RESOLVER CIRCUITS

When a resolver is used, jumpers are connected between J103-12/ J103-10 and the jumper between J103-1/J103-4 must be removed.

The output from U503B, the 30 Hz reference channel filter, is applied to R514 and into the rotor of the resolver at the "H" connection and then returned from the resolver "C" connection to V ref at jumper connection J103A. Stator windings "E" and "F" are tied together and returned to V ref at rear connector J103-E. Stator windings "D" and "G" are fed to the phase summer U503C, through C510 and R519/R520.

The purpose of the resolver and phase summer is to generate a 30 Hz signal that can be shifted in phase, as measured from the rotor signal (reference channel), from 0 to 360°. This phase-variable signal will be controlled by the pilot when he turns the course knob on an HSI or other resolver type display. In order to find his omni bearing To or From a station the pilot will rotate the course knob until the display needle is centered. The bearing is then read from the azimuth card of the display. Electronically what happened was that the course knob was rotated until the phase angle between the variable channel (AM) signal and phase summer (FM) signal became 90°. Only this exact phase difference will give a centered display needle.

3.5.10.1 Continued

Figures 3-9, 3-10, 3-11, and 3-20 will be used as a guide in explaining how the resolver and phase summer are used as a phase shifting circuit.

Note in Figure 3-20 the relationship between the resolver "D" and "G" waveforms. They are either in phase or 180 degrees out of phase, equal amplitudes, null or maximum amplitude (E max). For simplicity, 45 degree steps are shown, but it must be made clear that at all other points (degrees) not shown in this figure, the generated signals at "D" and "G" will be present but with different amplitudes. The stator waveforms shown are exactly what you would see if a dual trace scope was connected to "D" and "G". The relationship between the rotor drive "H" and stators D and G signals show that as the rotor is turned through 360 degrees, the changing angle of coupling between the rotor and stators generates the variable amplitudes and "D" and "G" phase relationships. Note that there is no phase shift between the rotor signal (reference) and the stators other than 0 and 180 degrees. A resolver is not a phase shifter but may be thought of as a variable transformer. It is the applied stator signals to the RC combination of R519/R520 and C510 that creates a phase shift.

The resistive combination of R519/R520 equals the capacitive reactance of C510 at 30 Hz. According to AC circuit theory, in an RC circuit with applied sinusoidal voltages of the same frequency, when the reactance and resistance are equal, the applied voltages will be shifted 45 degrees. As shown in Figure 3-9 the stator voltages are despicted as generators driving into the circuit and the point of interest is the signal at the junction of R520 and C510.

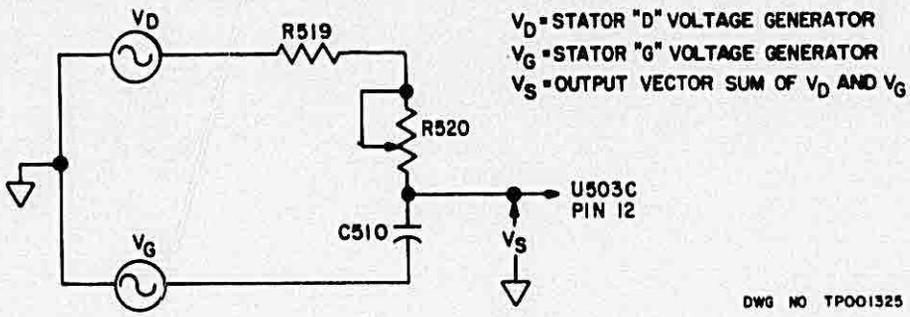


FIGURE 3-9. PHASE SHIFTER CIRCUIT

3.5.10.1 Continued

The voltage V_S is found by using the Superposition Theorem. This theorem states that the voltage, V_S, is the vector sum of the two sources V_D and V_G obtained by each source acting separately and with the other source set equal to Zero. As shown in Figure 3-20 at 0^o the stator D and G voltages are equal in amplitude and phase. With "D" applied separately, then according to the Superposition Theorem we have the circuit shown in Figure 3-10. This a phase lag circuit (integrator). As shown in the vector summation column in Figure 3-20, V_D will be displaced at -45 degrees below the 0^o axis. When "G" is applied separately, then the circuit will be as in Figure 3-11.

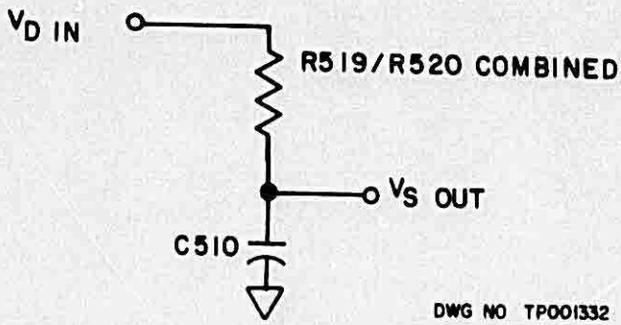


FIGURE 3-10. INTEGRATOR

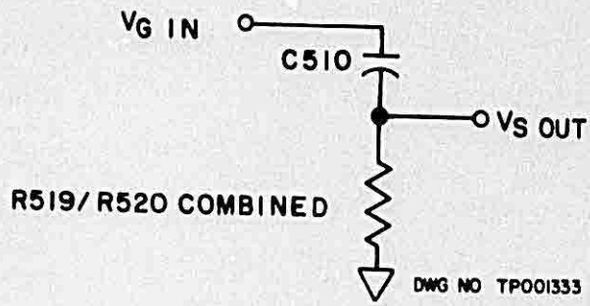


FIGURE 3-11. DIFFERENTIATOR

This is a phase lead circuit (differentiator) and the voltage V_G will be displaced $+45^o$ above the 0^o axis. The vector sum of these two voltage vectors lies on the 0^o axis. Under these conditions, the phase angle between the reference signal V_H at the rotor and V_S is 0 degrees. All this is shown in Figure 3-20. When the rotor is turned another 45 degrees to give a null at "D", then "G" alone is the driving voltage into a phase lead circuit and V_S is displaced $+45^o$ above the 0^o axis. Now the phase angle between V_H and V_S is 45 degrees. As the rotor is turned through 360^o the voltage vector V_S is generated as explained with the amplitude remaining constant and the phase shifting relative to V_H. A dual trace scope will verify the phase relation between V_H and V_S. Sync the scope to the reference channel and connect one probe to U503B pin 1 and the other probe to U503C pin 14. As the rotor is turned observe that the phase of V_S will walk through 360 degrees. An interesting peculiarity about an ARINC resolver should be mentioned here. When there is a zero phase shift between the rotor reference and phase summer output, the indicated bearing on the resolver compass card does not read 0 degrees but 345 degrees. This is because ARINC resolvers are zeroed according to the ARINC standard. Figure 3-20 shows the indicated VOR bearing for each 45 degree step.

3.5.10.1 Continued

Since the signal V_S is very small (approximately 70 millivolts) it must be amplified. As shown in Figure 3-12 the phase summer U503C needs a jumper installed between J103-10 and J102-12. This gives U503C a gain factor of R522 ÷ R517 = 32.

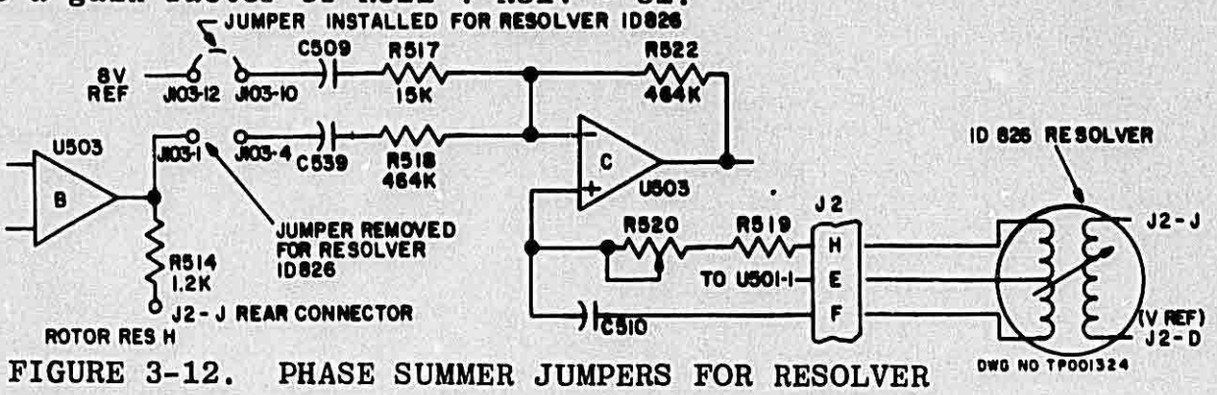


FIGURE 3-12. PHASE SUMMER JUMPERS FOR RESOLVER

3.5.10.2 Sine/Cosine Potentiometer (Narco ID 824/825)

When a Narco ID 824/825 indicator is used with the phase summer as shown in Figure 3-13 the jumper between J103-10 and J103-12 must be removed and a jumper installed between J103-1 and J103-4.

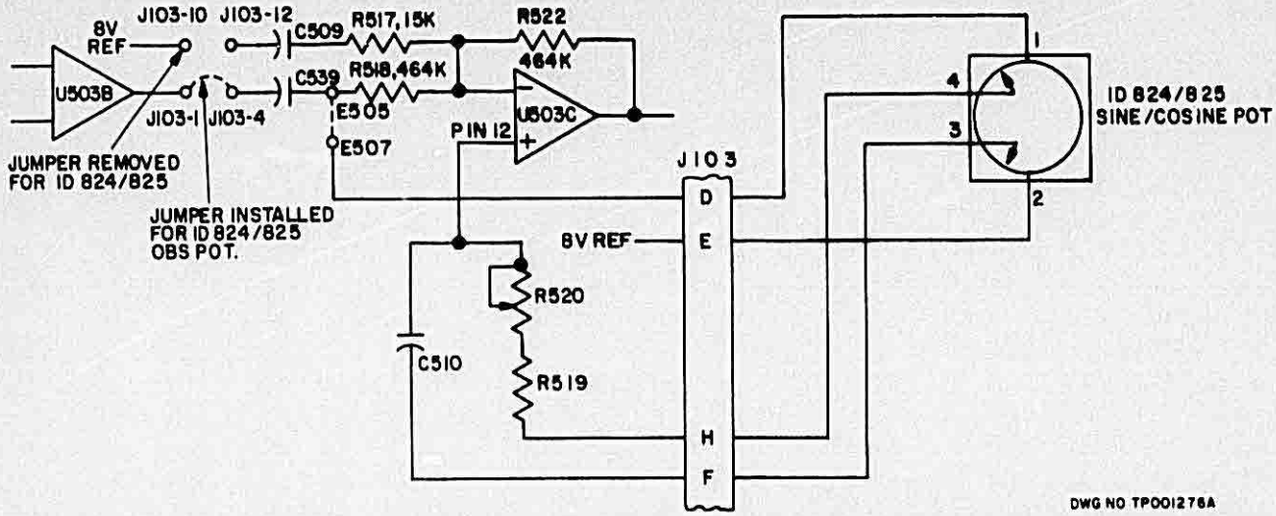
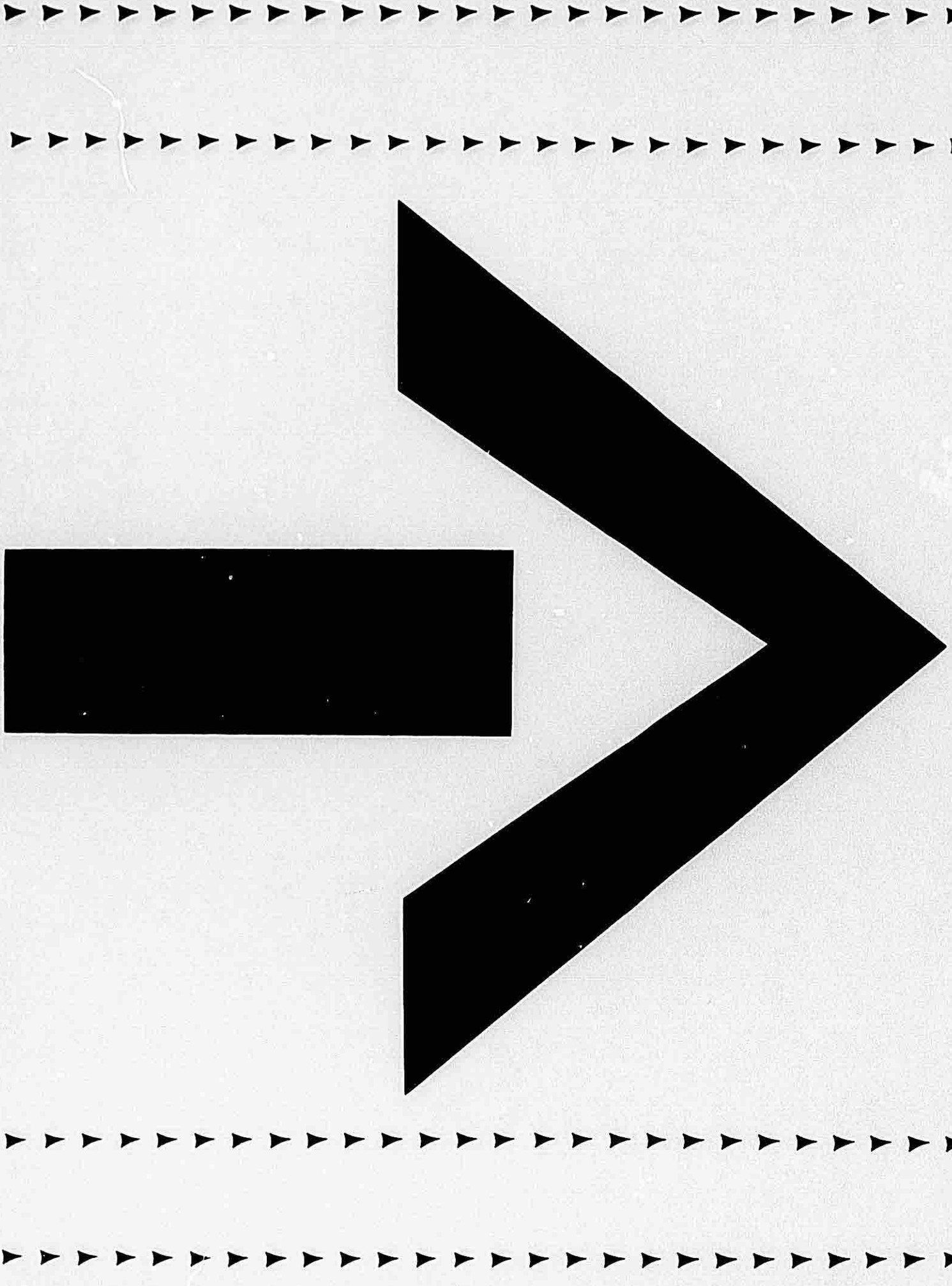


Figure 3-13. PHASE SUMMER JUMPERS FOR ID 824/825 SINE/COSINE POT.

The resistance element of the sine/cosine pot will generate a sine/cosine function by means of two wipers spaced 90 degrees apart. The voltages from the wipers drive the RC phase shifting network of R519/R520 and C510. Their vector sum is then applied to pin 12 of U503C, the phase summer. This phase shifted signal at pin 12 is again phase shifted by U503C to give the correct phase shift relative to the reference signal at U503B pin 1.

Therefore the major circuit difference between the use of a resolver or sine/cosine potentiometer lies in the fact that the phase summer shifts the phase of the applied sine/cosine signal but does not shift the phase of the applied resolver signal, it only amplifies the signal. Figure 3-14 shows, as simplified circuits, the two phase summer configurations, illustrating their major differences.



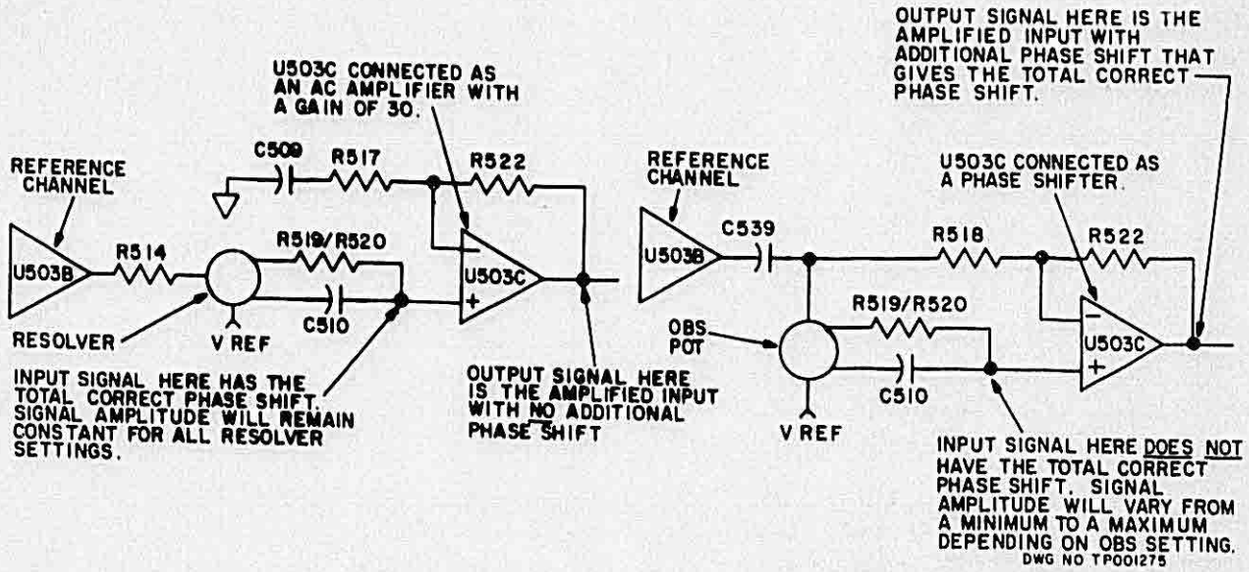


FIGURE 3-14. PHASE SUMMER SHOWING RESOLVER AND SINE/COSINE POT CONFIGURATIONS

Figures 3-15, 3-16, 3-17, 3-18, 3-21, and 3-22 will be used as a guide in explaining how the sine/cosine potentiometer and phase summer are used as a phase shifter. The specifications for the sine/cosine potentiometer are found in item A of Figure 3-21. Also shown are the wiper arms position on the potentiometer from 80 to 35 degrees in 45 degree steps. Figure 3-22 items B, C, and D show three phase shifts (0^{o}, 30^{o}, 90^{o}) examples. We will discuss the 90^{o} example which occurs when the OBS is set to 170^{o} heading.

The output from the reference channel amplifier U503B-1 is a 30 Hz, 6 Vpp signal swinging around an 8 Vdc reference level. This signal is applied to terminal 1 of the sine/cosine potentiometer. Terminal 2 is returned to the 8 Vdc reference. Referring to item B (90^{o} phase shift example) in Figure 3-22 and the 170^{o} indicated bearing in Figure 3-21 note that when the OBS heading is 170^{o} degrees, the wiper arms are in quadrants I and II and are 45 degrees above and below the reference taps.

3.5.10.2 Continued

The voltage from the wiper arm connected to terminal 4 is 5.12 Vpp as was calculated under Item A, Sine/cosine specifications. The voltage from terminal 3 at the other wiper arm is 0.88 Vpp and is calculated as follows: since the wiper arm is 45 degrees below the 3 Vpp signal at the reference tap, its value will be .707 (value of sin 45^{o}) less than the 3 Vpp - .707 3 Vpp = 0.88 Vpp). The signal from terminal 4 is applied to C510 and the signal from terminal 3 is applied to R519/R520. The resistive combination of R519/R520 is set to equal the 30 Hz impedance of C510 which gives an RC circuit that shifts the phase of each applied signal by 45 degrees.

As shown in Figure 3-15 the applied voltages may be depicted as generators driving into C510 and R510/R520 and the point of interest is the signal V_S.

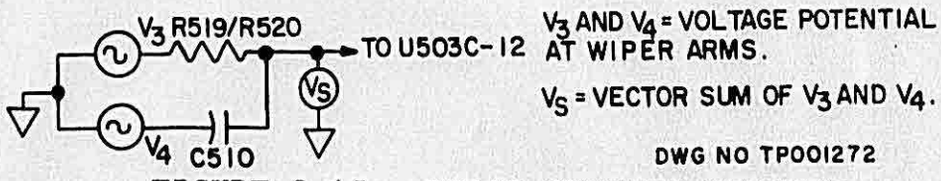


FIGURE 3-15. PHASE SHIFTER CIRCUIT

As explained in Section 3.5.10.1 the signal Vs is found by the Superposition Theorem. When voltage V3 is applied separately we have the circuit shown in Figure 3-16.

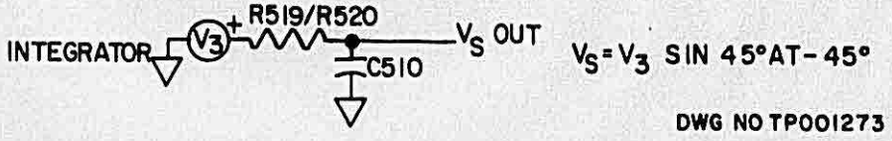


FIGURE 3-16. INTEGRATOR

This is a phase lag (integrator) circuit that will reduce the level of V3 to .707 V3 (.707 x .88 = 0.6 Vpp) and shift the phase by -45^{o}. Item C (90^{o} phase shift) of Figure 3-22 shows this voltage vector at 45 degrees below (-45^{o}) the 0^{o} axis. When voltage V4 is applied separately we have the circuit shown in Figure 3-17.

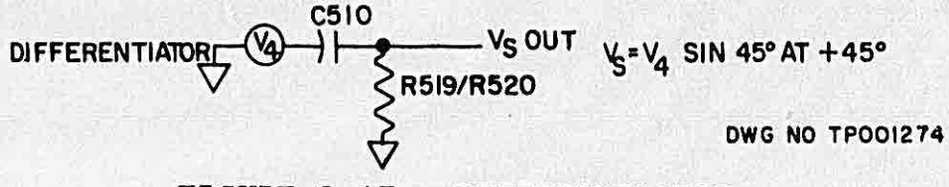


FIGURE 3-17. DIFFERENTIATOR

This is a phase lead (differentiator) circuit that will reduce the level of V4 to .707 V4 (.707 x 5.12 = 3.7 Vpp) and shift the phase by $+45^{o}$. Item C of Figure 3-22 shows this voltage vector at 45 degrees above the 0^{o} axis.

3.5.10.2 Continued

By the parallelogram law of vectors the resultant vector, V_S, is found to be 3.6 Vpp at a phase angle of +35.2 degrees. This signal is applied to the non-inverting input (pin 12) of the phase summer and will be shifted by U503C to 90 degrees. An easy understanding of how U503C works as a phase shifter may be achieved by recalling two fundamental properties of an IC OP Amp:

1. The amplifier input terminals (U503C pins 12 and 13) allows a small insignificant current to flow into or out of them because of their very high input impedance.
2. The action of the feedback (U503C pin 14 connected to inverting input pin 13 via R522) is such that the output of the amplifier will do what is necessary to force the signal at the inverting input (pin 13) to agree with the applied signal at the non-inverting input (pin 12).

Applying these two facts to the phase summer circuit shows that we end up with nothing more than a very simple voltage averaging circuit as shown in Figure 3-18.

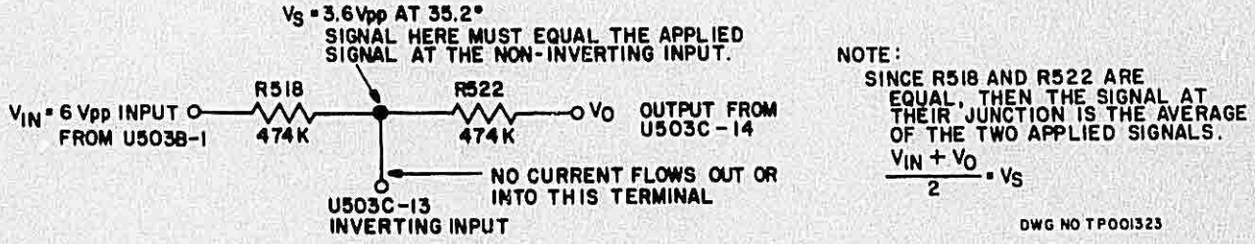


FIGURE 3-18. VOLTAGE AVERAGING CIRCUIT

Since the output V_O is our point of interest, rearranging the equation in Figure 3-18 in terms of V_O we have $V_O = V_S - V_{IN}$. This equation tells us that as we multiply the voltage vector V_S by 2 ($1 V_S = 1 \times 3.6 = 7.2$ at 35.2°) and subtract from it the 0° degree reference vector V_{IN} (6 Vpp), we will generate our resultant vector "V_O" at the correct level and phase angle. Item D in Figure 3-17 shows this vector diagram along with two other examples. (0° and 30° phase shifts).

3.5.11 Left-Right Meter Amplifier (U503A) and Phase Error Detector (U505A)

The purpose of L-R meter amplifier is to amplify the error voltage generated by the phase error detector U505A, when the aircraft deviates from its "on course" (meter null) position. The error voltage will drive the omni display needle from its centered (on course) position and indicate to the pilot in what direction (Left or Right) the aircraft must be turned to bring it back to the on-course (meter null) position.

The meter amplifier, U503A, is connected as an integrating amplifier. Capacitors C511/C512 in conjunction with R525/R526 forms a filter that partly determines the meter time constant which meets TSO specifications. Additional meter time constant is added by integrating capacitor C513. The non-inverting input pin 5 is referenced to V ref (8V) which causes the output, pin 7, to normally sit at 8 volts. The output is fed to the rear connector J103-2 and will drive two standard 1000 ohm 150 microamp Left/Right meters. The L/R meter is returned to V ref (8V) at J103-3. To facilitate the discussion of circuit operation, refer to Figure 3-19.

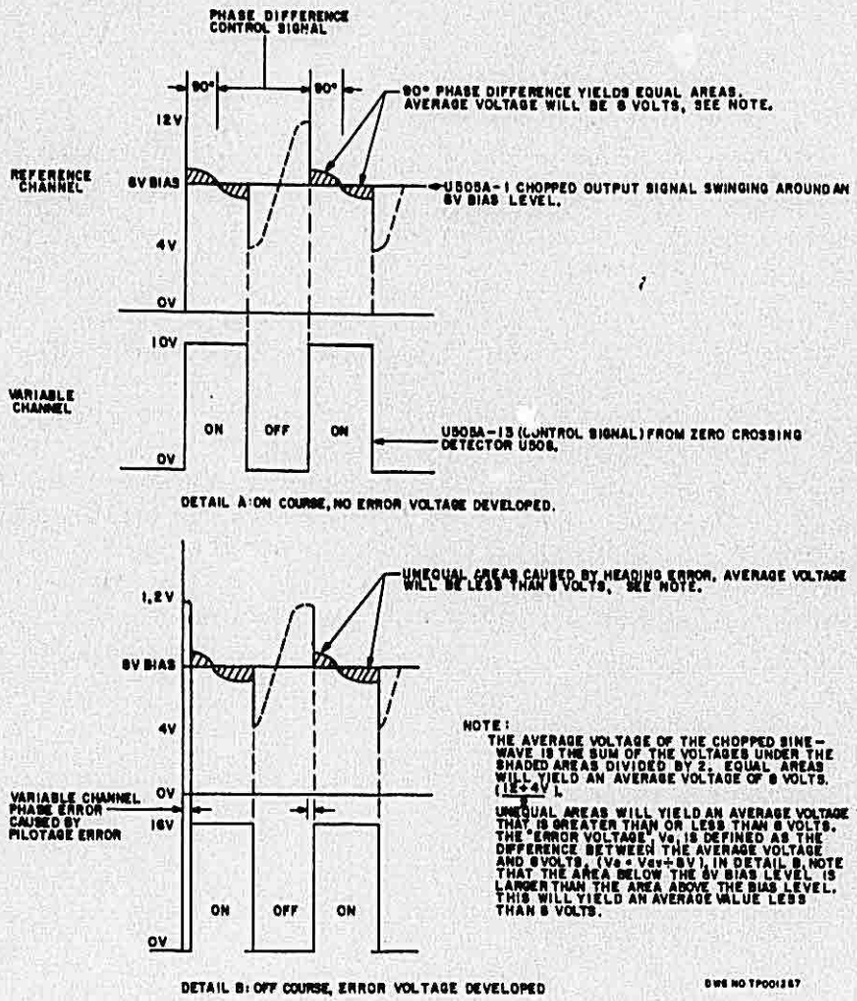
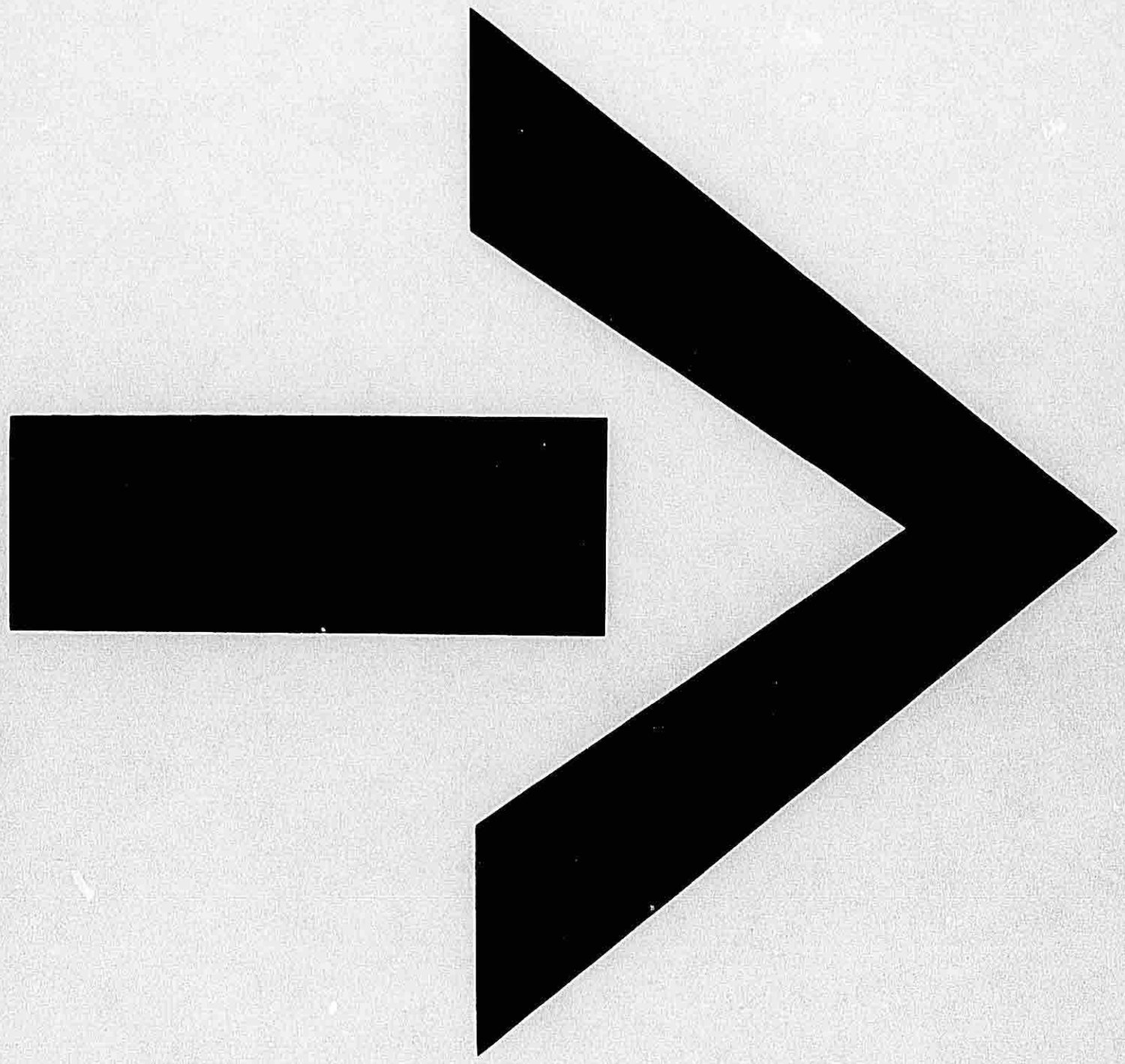
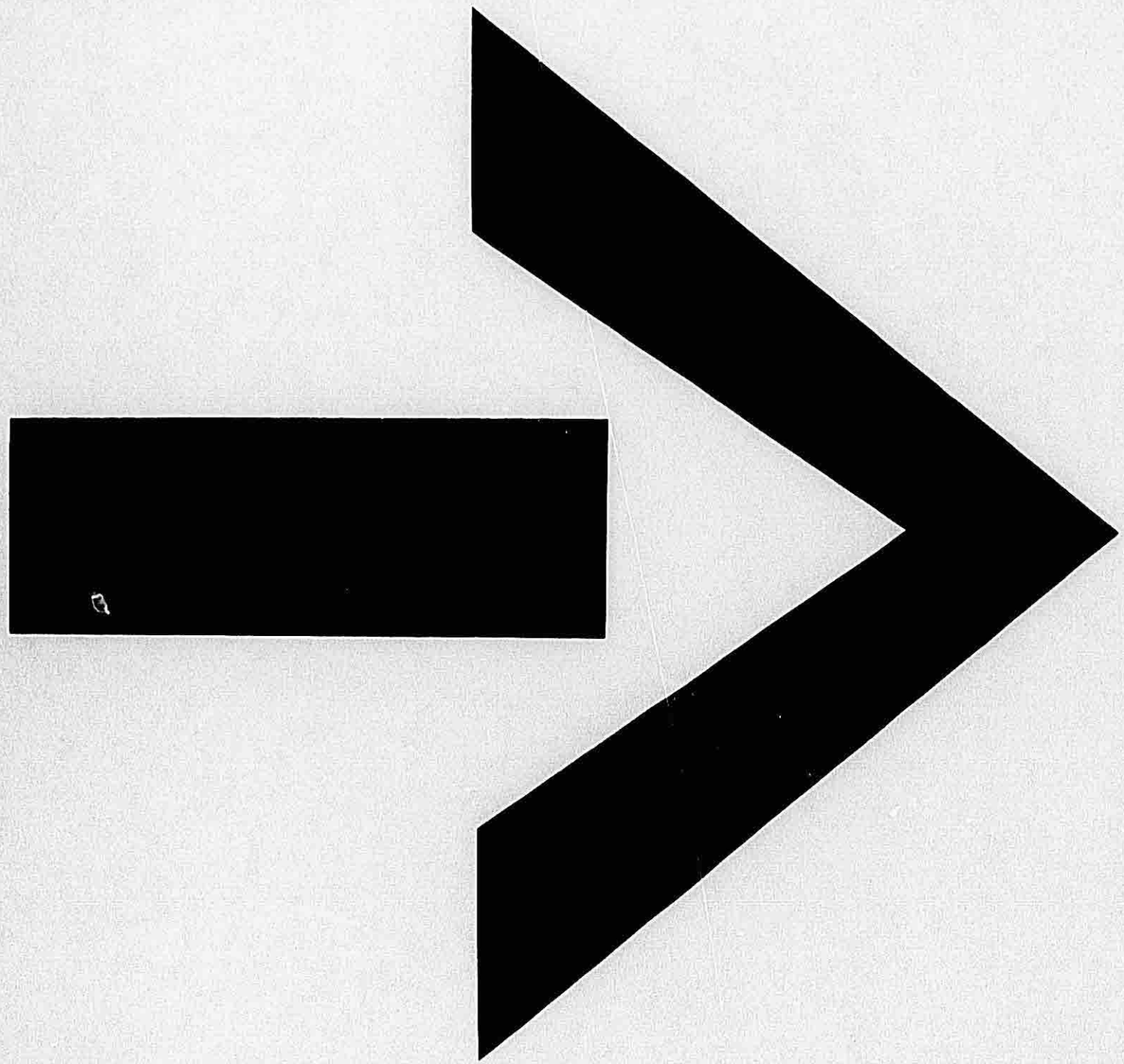


FIGURE 3-19. PHASE ERROR DETECTOR GENERATION OF ERROR VOLTAGE





3.5.11 Continued

When the pilot turns his OBS knob to center his display needle, electrically what he is doing is phase shifting the reference channel signal at the input to the phase error detector so that it is 90 degrees out of phase with the variable channel signal present at the phase error detector's control input. When these two signals differ in phase by exactly 90 degrees there will be no error voltage generated. The phase error detector U505A is a quad analog switch that is gated on and off by the variable channel zero crossing detector U506A. During the time U505A is closed (ON), the chopped 30 Hz signal from the phase summer U503C is filtered by the two stage passive filter consisting of R525/R526 and C511/C512 and amplified and filtered by U503A. As shown in Detail A of Figure 3-19, when the reference and variable channels differ in phase by 90 degrees the average voltage of the 30 Hz sine wave is 8 volts. Since the meter amplifier is referenced to 8 volts and the applied signal is an average 8 volts, then there is no error voltage to amplify and the L/R meter is centered as it too is referenced to 8 volts and is drawing no current.

After the pilot has centered the L/R needle, he will turn his aircraft to the indicated omni bearing and fly that heading To or From the station. However, if there is a crosswind component to his heading, the aircraft will drift off course. Electrically, the phase angle of the variable channel has assumed a new value which causes a lead or lag error between the null conditions at the phase error detector. As shown in Detail B, this phase error will change the average value of the chopped reference channel sine/wave, and produce an error voltage. An error voltage that averages less than 8 volts will be filtered, amplified, and inverted by U503A which deflects the L/R meter to the "Right". Error voltages greater than 8 volts give a "Left" meter deflection.

3.5.11.1 L/R Meter DC Balance

The purpose of the DC balance circuit is to compensate for the input offset voltages of the phase summer and meter amplifier so that the L/R meter will be at a null under no signal conditions. The voltage required across the OP Amp inputs to drive the output to zero is called the input offset voltage. The ideal perfect OP Amp would have a zero input offset voltage but in the real world the imperfect OP Amp exhibits a very definite offset voltage. The maximum offset voltage of U503C and U503A can be as high as $\pm$10 millivolts. If U503C had a $\pm$10 mv offset, then because this OP Amp drives the meter amplifier, the 10 mv would be multiplied by the gain of the meter amplifier. This would result in an error at the output of U503A.

3.5.11.1 Continued

The DC balance circuit corrects this problem in the following manner. The wiper arm of the DC balance pot R532 is applied to the input pin 3 of voltage follower U501A. The output of U501A is applied to pin 12 of U503C via the resolver or resistive OBS pot. With the omni working and the L/R meter centered, the 9960 Hz reference signal from the omni signal generator is turned off. The DC balance pot is adjusted to recenter the needle. What the DC balance pot is doing is raising or lowering the reference level at the input of U503C causing its output, which is applied to the meter amplifier, to match the voltage needed at U503A pin 6 to exactly null the L/R meter.

3.5.11.2 L/R Meter Course Width Adjust

The ID 824/825 L/R meter has a standard 1000 ohm 150 microamp movement. There are 10 vertical bars five each, horizontally displaced to either side of the geometeric center of the display face. Each bar is equivalent to a 2 degree course deviation from the null position. Therefore, the meter can display a course width of 20 degrees as measured from the fifth to fifth bars. A differential voltage of ±30 millivolts across the L/R meter is required to move the needle from the null position to the first bar. It requires a ±150 mv differential to move the needle to the fifth bar. The course width is adjustable and controlled by the setting of the course width pot, R523. Course width adjustment is as follows: choose any convenient bearing and "zero" the indicator to this bearing. Next, change the bearing of the VOR signal generator ±10 degrees from the chosen bearing. This 10 degree bearing change will generate at the phase error detector an error voltage that is applied to the meter amplifier. R523 is now adjusted until the needle is centered on the fifth bar. What R523 is doing is altering the charge on C511 to a level that will be amplified by the meter amplifier to a value necessary to deflect the needle to the fifth bar.

3.5.12 Autopilot Amplifier (U503D) (VOR Mode)

An independent output is provided for autopilots. The autopilot amplifier is an integrating amplifier whose operation is identical to the L/R meter amplifier. For a 10 degree course error, the output is 150 millivolts. The input filter consisting of R535/R536 and C515/C516 along with C517, determines the amplifier time constant which is faster than the L/R meter. The time constant meets TSO specifications (0.6 secs). The amplifier is DC balanced by adjusting potentiometer R582. Connect a digital voltmeter from U502C-8 to U503D-8. Delete the 9960 Hz from the VOR generator and adjust R582 until the voltmeter reads zero volts.

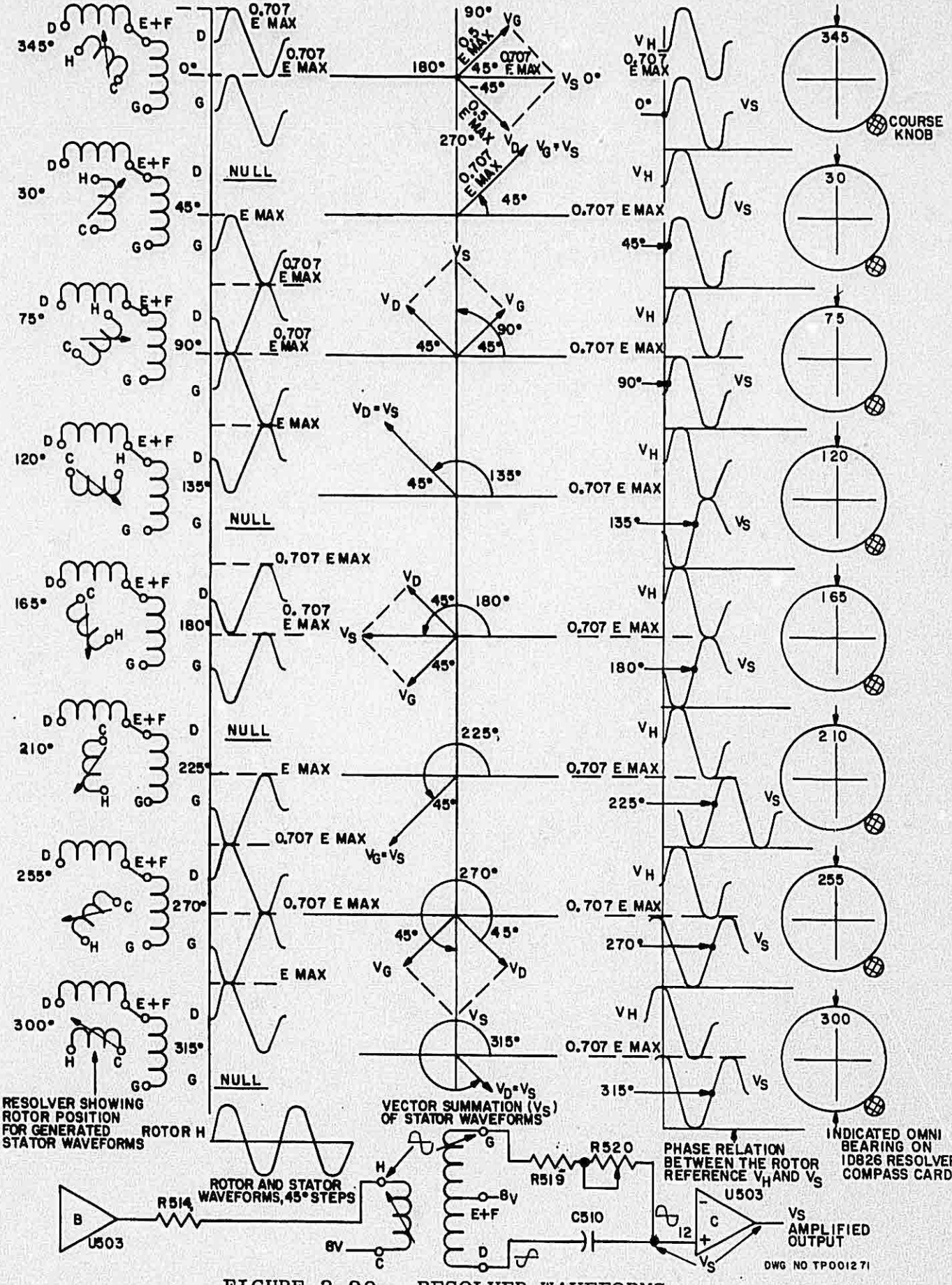
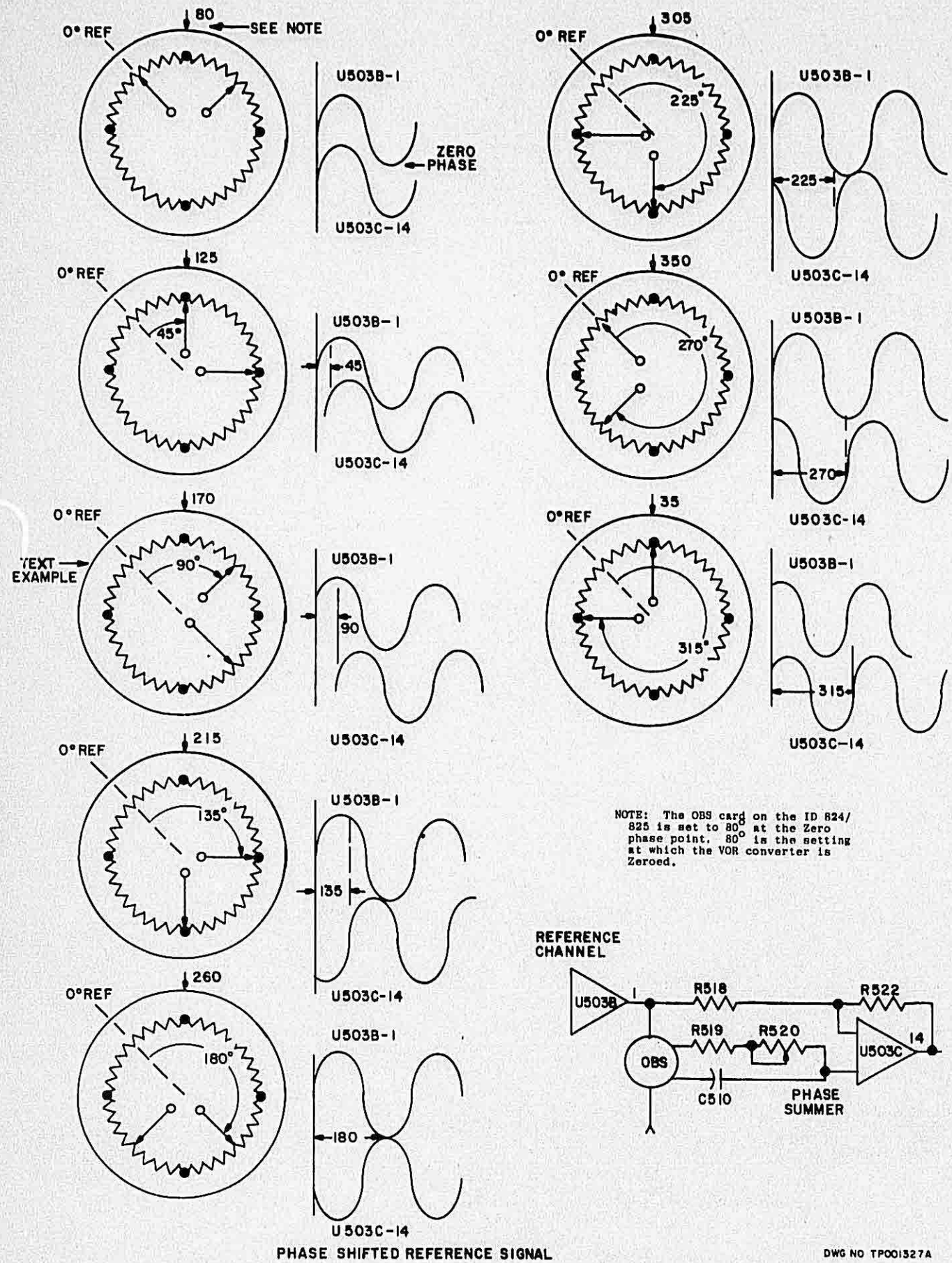


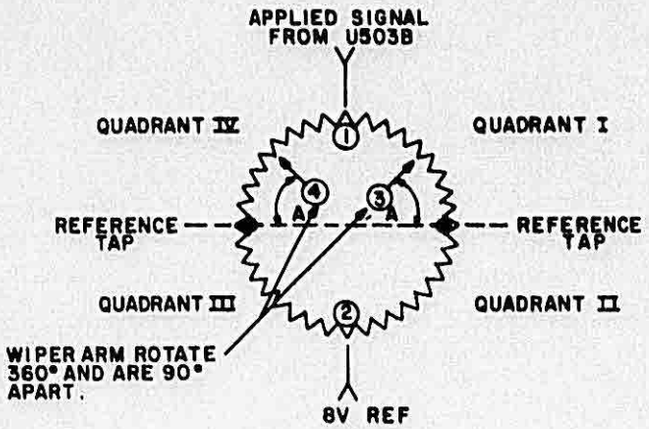
FIGURE 3-20. RESOLVER WAVEFORMS



NOTE: The OBS card on the ID 824/825 is set to 80° at the Zero phase point. 80° is the setting at which the VOR converter is Zeroed.

DWG NO TP001327A

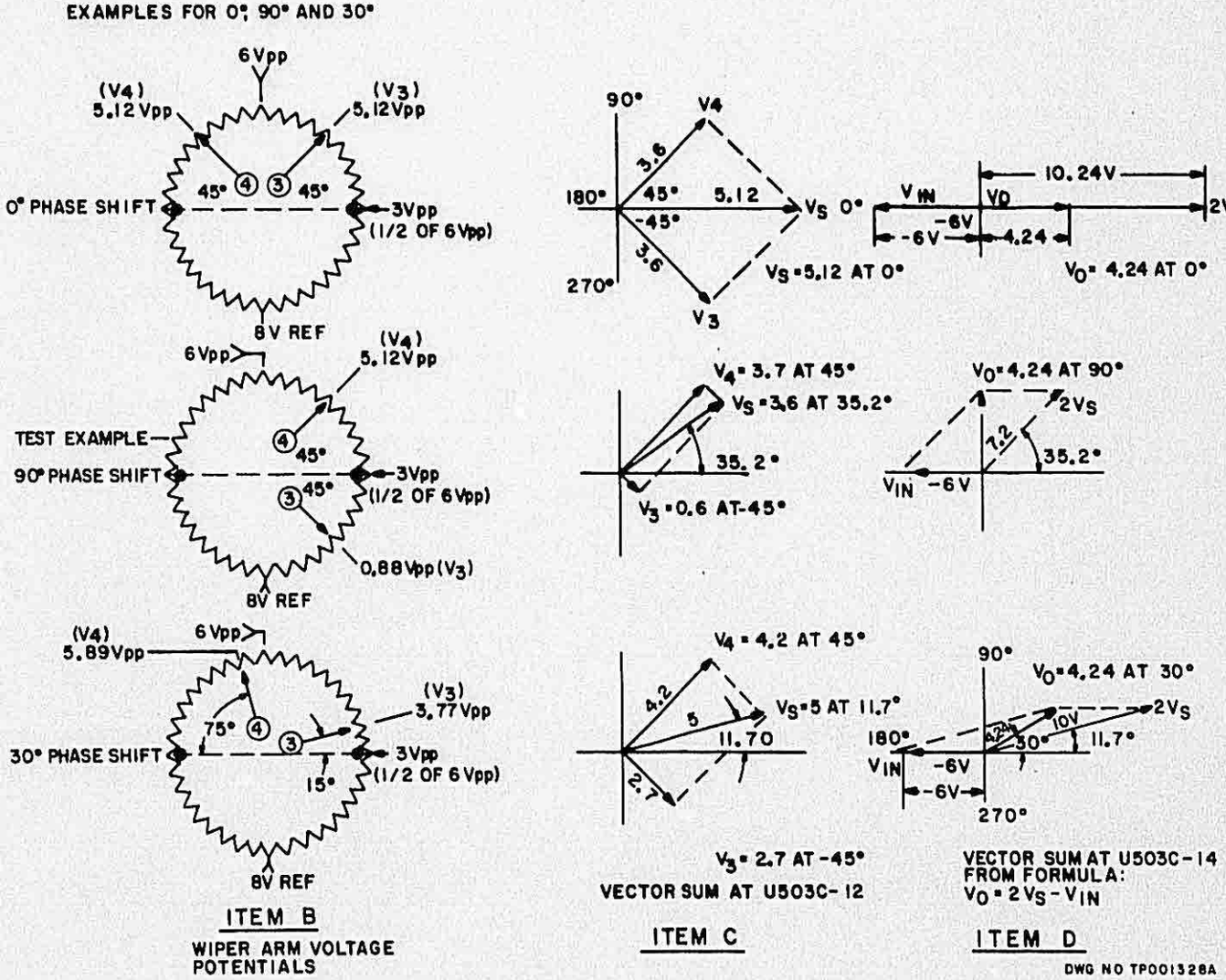
FIGURE 3-21. INDICATOR BEARING v/s SINE/COSINE POT WIPER ARMS POSITION



ITEM A

OBS Potentiometer Specifications:

1. The resistance element will generate a sine-cosine function by means of two wipers spaced 90 degrees.
2. The resistance between the terminals 1 and 2 is 65 ohms ±15%.
3. The output (terminals 3 and 4) in each quadrand shall follow a sine function within ±.5% of the applied voltage. The sine of the angle is measured from the refernece tap to the wiper arm. For example, if a 6 Vpp 30 Hz signal is applied to the Pot and angle A is 45 degrees, then the output (terminal 3) in quadrant I will be the sine 45° times the applied voltage. The voltage at the reference tap is one-half (3 Vpp) the applied 6 Vpp signal. Therefore the difference between the applied signal and reference is 3 Vpp (6 Vpp - 3 Vpp). Then the output at terminal 3 is sine 45° x 3 Vpp (.707 x 3 Vpp) = 2.12 Vpp. Since this potential is above that of the 3 Vpp at the reference tap, the total value is 3 Vpp + 2.12 Vpp = 5.12 Vpp. The output of terminal 4 in quadrant IV is the same since the angles in this example are equal.
4. The OBS compass card is set to 80° when the wiper arms are as shown.



ITEM B
WIPER ARM VOLTAGE POTENTIALS

ITEM C

ITEM D

DWG NO TP001328A

FIGURE 3-22. SINE/COSINE POTENTIOMETER PHASE SHIFT ANALYSIS

SEE BLOW-UP

3.5.13 To/From 90 Degree Phase Shifter (U502A)

The output of the phase summer is the driving source for the TO/FROM amplifier. In order to constantly display a To or From flag, the phase summer signal must be shifted another 90 degrees. The reason the phase shift is needed is because the phase summer signal will be averaged just as it was for the L/R meter amplifier (Section 3.5. 11). Unlike the L/R meter that seeks a null condition, here we need a average voltage that is appreciably above or below the 8 volt reference on pin 5 of U502A in order for the amplifier to drive the T/F flag on. Refer to Figure 3-23 to clarify this point.

U502A is connected as a "90 degrees lagging" phase shifter. The signal is applied to pin 3 and is shifted 45 degrees by the RC combination of R539/C538. Because R540 and R541 are equal in value, the applied signal on pin 3 will be phase shifted by a factor of 2. The theory of this type phase shifter was explained in Section 3.5. 10.1. The output of U502A is applied to pin 10 of quad analog switch U505D. The control input, pin 12, is driven by the variable channel zero crossing detector, U506A. Because both signals are in phase, one half of the reference channel 30 Hz sine wave will be applied to the T/F amplifier via R542. The quad analog switch is performing just like a half-wave rectifier (see Figure 3-23).

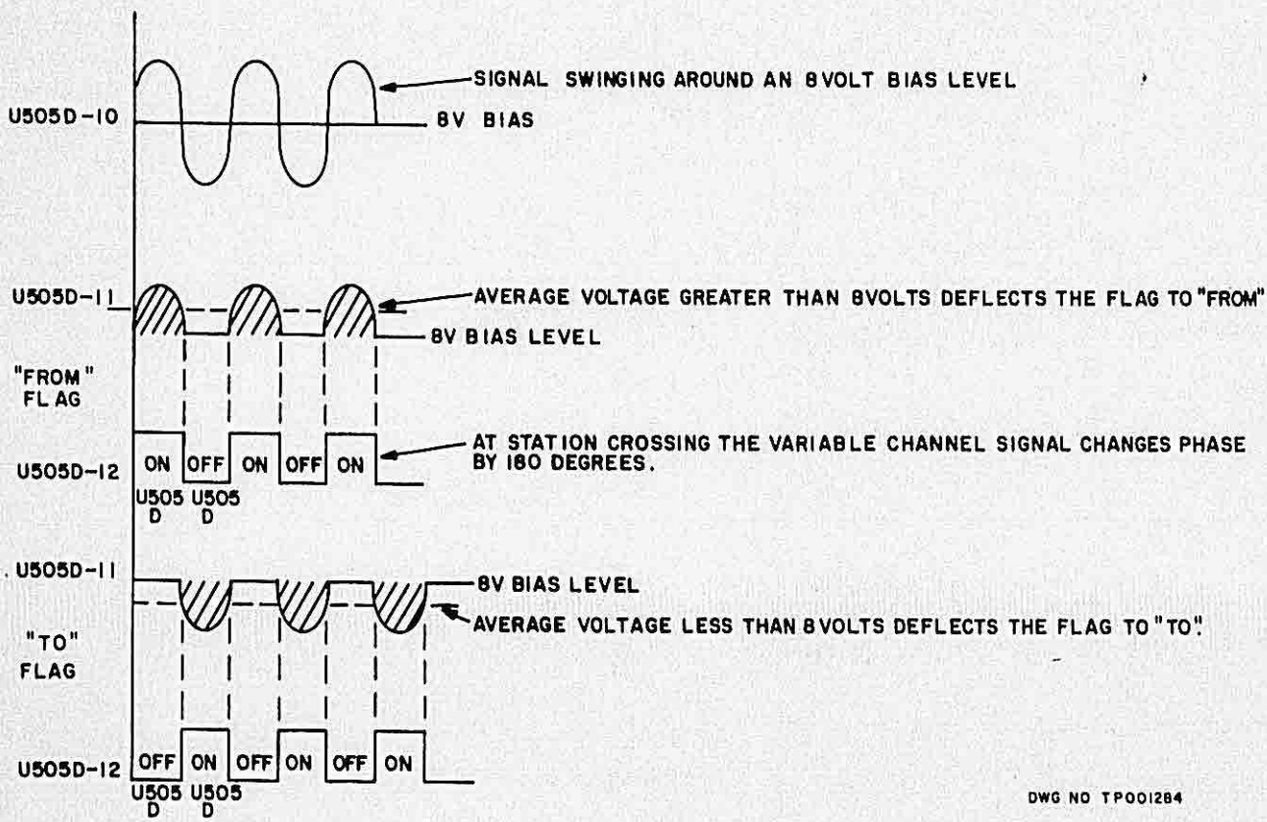


FIGURE 3-23. GENERATION OF TO/FROM AMPLIFIER DRIVING VOLTAGES

3.5.14 TO/FROM Flag Amplifier (U502B)

The T/F amplifier is connected as a integrating amplifier with a time constant equal to R542 times C520. R544 limits the gain to approximately 0.1 and the output at pin 7 will drive two standard 1000 ohm, 200 microamp flags. The output is referenced to 8 volts by the 8 volt bias applied to the non-inverting input, pin 5.

When the aircraft is flying toward the station, the voltage from U505D-11 applied to U502B as shown in Figure 3-23 will be less than 8 volts. U502B will integrate this input and the initial output will be a positive rising non-linear voltage that starts its rise from the 8 volt reference level. When quad analog switch U505D turns off, the output of U502B will decay at a rate determined by the time constant of R544 and C520. The final steady state output is a DC voltage with very low ripple that deflects the flag to the TO position. When the aircraft crosses over the VOR station, the phase of the variable channel changes by 180 degrees. Now the voltage applied to the T/F amplifier will be greater than 8 volts and the flag will be driven to the FROM position.

3.5.15 Localizer 90 and 150 Hz Filters (U504C)

The localizer signal is applied through the localizer course width pot R566 to the 90 and 150 Hz bandpass filters (BPF). The filter's outputs are biased to 8 volts by the reference voltage applied to their non-inverting (+) inputs.

The output from the 150 Hz BPF is positive half-wave rectified by CR509 and applied to one end of the "LOC ZERO" pot 575. The output of the 90 Hz BPF is negative half-wave rectified by CR510 and applied to the other end of R575. The wiper arm of R575 picks the average of these two signals from the pot which is then applied to meter amplifier and autopilot amplifier via quad analog switches U505C and U505B respectively. When the aircraft is approaching the runway on its centerline, the localizer signal contains equal levels of 90 and 150 Hz information. Therefore, the average voltage at the wiper arm of R575 will be 8 volts, which is the reference level. Under these conditions, the L/R meter is nulled as there is no error voltage to be amplified. However, if the aircraft were to the right of the centerline of the runway the output of the 150 Hz BPF would have a greater amplitude than the 90 Hz BPF. The average error voltage at the wiper arm of R575 would now be greater than the 8 volt bias level and the meter will be deflected to the left signifying that the aircraft must be turned left to the center line of the runway.

3.5.16 Localizer Flag

The output of each BPF is fed to a separate flag control comparator whose purpose is to sense an insufficient signal level or signal loss. The operation of both are identical so only the 150 Hz channel will be discussed.

In the VOR mode, the wired "OR" outputs of U504A/U504B are disabled by the diode CR506. CR506 is connected to Q502 which is turned on in the VOR mode, grounding its collector. CR506 now clamps the comparators outputs to ground, back biasing CR503/CR505.

In the localizer mode the output of the 150 Hz filter is positive half-wave rectified by CR508 and charges up C534 via R576/R577. C534 is connected to the non-inverting input (pin 2) of comparator U504A. A reference voltage of 8 volts is applied to the inverting input (pin 3). If the 150 Hz signal is of sufficient level to charge up C534 to a few mullivolts above the 8 volt reference at pin 3, then the comparator will trip and its output will be pulled up to 16 volts via R580. Note that the outputs of both comparators are wired together as a logic "OR" function and are applied to the NAV flag transistor Q501 via CR503 and the T/F amplifier via CR505. In the localizer mode, the reference channel disable comparator U506D is in the disable state because there is no VOR signal present to keep it enabled. Diode CR502 is now back biased allowing the localizer flag comparators to turn on Q501 which applies a retraction voltage to the NAV flag.

In the localizer mode, U505D will be switched off because there will be no zero crossing detector output applied to the control input at pin 12. Diode CR505 clamps the wired OR outputs of U504A and U504B to the inverting input (pin 6) of U502B which drives the T/F flag to the "TO" position.

If the 150 Hz signal is lost, then the charge on the holding capacitor C534 will discharge to ground via R577. As the voltage level at pin 2 drops below the 8 volt reference level, the comparator will trip and its output will be pulled to ground disabling the NAV and To flags. When the amplitude of the 150 Hz signal drops to a level such that the meter only deflects to 50% of a standard .093 ddm deflection signal, then there shall be a full NAV flag showing and the TO flag shall be fully off.

3.5.17 L/R Meter Amplifier, Localizer Mode

In the localizer mode, quad analog switch U505A is turned off because there is no zero crossing detector signal present at the control input, pin 13. The VOR/LOC command, Q502, turns on switch U505C which circumvents the filter R525/R526, C511/C512 and applies the localizer signal to U503A-6 via R527. This alters the time constant of the meter to a quicker response than the VOR mode and enhances the precision of a localizer approach.

3.5.18 Autopilot Amplifier, Localizer Mode

Like the L/R meter amplifier, the time constant of the autopilot amplifier is changed in the localizer mode of operation. Quad analog switch U505B circumvents the omni mode filter R535/R536, C515/C516 and applies the localizer signal to U503D, pin 9. The time constant meets ARINC specifications.

3.5.19 Localizer Activate (LOC/ACT)

The LOC/ACT line is taken from the rear connector at J102-J. When the radio is turned to a localizer frequency, this line is grounded by an NPN transistor found in transistor array U308. The base of the LOC/ACT transistor is connected to the collector of Q502 via a 68K resistor. The collector of Q502 is logic low for an VOR channel and logic high for a localizer channel. The logic high turns on the NPN transistor pulling the collector to ground through the grounded emitter.

3.5.20 RNAV 860 Connections

The NAV 824/825 supplies two outputs and receives two inputs from the RNAV 860. These input/outputs are:

1. J102-N the ARINC level detector output to the RNAV 860
2. J103-N the ARINC level detector return input from the RNAV 860. This return signal is riding on a DC bias level that back biases diode CR515 so the original and returned signal are isolated.
3. J103-M the 30 Hz reference signal input to the RNAV 860. In RNAV mode, this signal will alter the L/R neter sensitivity to display approximately 1 mile/dot in enroute mode.
4. J102-12 NAV flag input to the RNAV 860. In RNAV mode, a ground will be supplied which will "bar" the digital bearing.

3.6 MICROPROCESSOR (uP), U115

General:

The microprocessor used in the NAV 824/825 is the 3870. This is a complete 8 bit microcomputer that features 2048 bytes of ROM, 64 bytes of scratchpad RAM, a programmable binary counter, 32 bits of I/O (input/output) and a single +5 Vdc power supply requirement. The outputs are latched and are of the type shown in Figure 3-24.

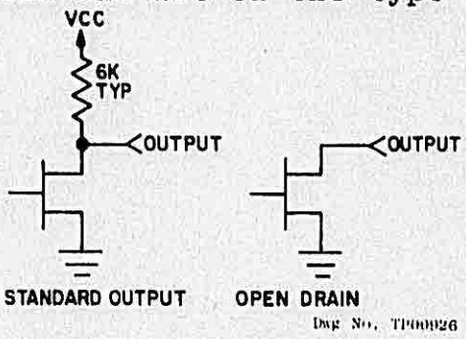


FIGURE 3-24. STANDARD LATCHED OUTPUT

Table 3.6 lists all the microprocessor pins that are used as well as describing the pin function.

3.6.1 Microprocessor, Aimer Input (U115-34)

The NAV 824 is shipped from the factory with a frequency entry format set to enter all frequency selections, made by the MHz and KHz switches, directly into the microprocessor stand-by-memory. If the mode switch is in the "FREQ" position, then the entered frequency will be displayed in the stand-by window. The transfer button must be activated to transpose the entered frequency to the active memory and window. If it is desired to have frequencies entered directly into the active display window and memory, then a jumper must be added between TP3 and TP4 which grounds pin 34 of U115.

There are illuminated aimer arrows in the display that point to the window to which the frequency is first entered. If the entry is to the active window, then the aimer pointing to that window is constantly illuminated. If the entry is to the standby window, then the aimer pointing to that window will be illuminated only when the mode switch is in the "FREQ" position. It will be extinguished in the bearing mode.

TABLE 3.6. MICROPROCESSOR PIN FUNCTIONS

PIN	SYMBOL	FUNCTION
2	System Clock	A 3.2 MHz time base input from buffered output of PLL U302-17.
3 4	KHz 1 KHz 2	Grounded inputs from KHz switch SW101 that the uP scans and stores. Will be used to determine if the frequency is to be incremented or decremented.
5	SK	Sense KHz. A momentary ground from SW101 used by the uP to determine SW101 rotational sense.
7	2/5 Strobe	A 12 clock output for remote channel and active memory registers. A 19 bit VOR synthesizer output code (omni channel) for U302. A 38 bit GS/LOC synthesizer output code (LOC/GS channel) for U302/U310.
8	2/5 data out	An 11 bit 2/5 code output used to program the Active Memory and Remote channel registers.
9	FROM	A grounded input from mode switch SW103 that commands the uP to reciprocate the bearing.
10	FREQ.	A grounded input from mode switch SW103 that commands the uP to display the "STBY" frequency.
11	Synthesizer Data	A 38 bit code output used to program the VOR/LOC and GS synthesizer.
12	Bearing Ready	A 30 Hz logic Hi signal from the digital bearing selector that commands the uP to issue 12 strobe pulses that will clock U110/ U111/U303/U304.
13	NAV FLAG	A logic low input from Q501 (NAV Flag transistor) commands the uP to "bar" the displayed bearing.
14	KA data in	(Keep-Alive data) A 12 bit 2/5 code input from U117 that is read by the uP at initial turn on of the radio. The code is validated by the uP, which then displays the stored frequency.
15	Bearing data in	A 12 bit binary coded input from the digital bearing registers (U110/U111) that is used by the uP to compute the VOR bearing.
16	Transfer	A momentary grounded input from the transfer switch SW102 that commands the uP to interchange the ACTIVE and STANDBY frequencies.
17	SM	Sense MHz. A momentary ground from MHz switch SW101 used by the uP to determine SW101 MHz rotational sense.
18 19	MHz 2 MHz 1	Grounded inputs from MHz switch SW101 that the uP scans and stores. Will be used to determine if the frequency is to be incremented or decremented.
20	GND	Microprocessor chip ground.
24	Synthesizer Clock Enable	A logic high output that enables AND gate U116C and PLL synthesizers U302/U310.
25	2/5 Clock Enable	A logic high output that enables AND gates U116 B/D.
26	Display Clock	The clock for the digit select counter and dimmer circuits.
27	Display reset	The reset for the digit select counter.
28	"B" legend driver	Output used to program the "B" input of legend driver U108.
29	I/H driver	Output used to program the I/H input of segment driver U106. I/H controls the decimal and the "fixed" number 1 in digits 1 and 5.
30	D segment driver	Output used to program the D code input of segment driver U106.
31	C segment driver	Output used to program the C code input of segment driver U106.
32	B segment driver	Output used to program the B code input of segment driver U106.
33	A segment driver	Output used to program the A code input of segment driver U106.
34	AIMER	With no jumper installed between TP3 and TP4 the frequency entries are made to the STBY window. With jumper installed, frequency entries are made to the ACTIVE window. An illuminated arrow points to the window used for entry.
39	Reset	When pulled Low, the 3870 will reset. When allowed to go high, the uP will begin program execution.
40	Vcc	+5 Vdc power supply to the chip.

NOTE: Pins not used are: 1, 6, 21, 22, 23, 35, 36, 37, and 38.

Dwg No. TP001344

3.6.2 Microprocessor, Transfer SW102 Input (U115-16)

The transfer feature allows the pilot to immediately transpose the active and standby frequencies by pressing the transfer push-button located on the front panel. Activating this switch forces pin 16 of the uP to momentary ground. This signals the uP to interchange the contents of the RAM (random access memory) location points where the active and standby program data are stored, and then update the active memory register, synthesizers, and remote channel registers.

3.6.3 Microprocessor, NAV Flag Input (U115-13)

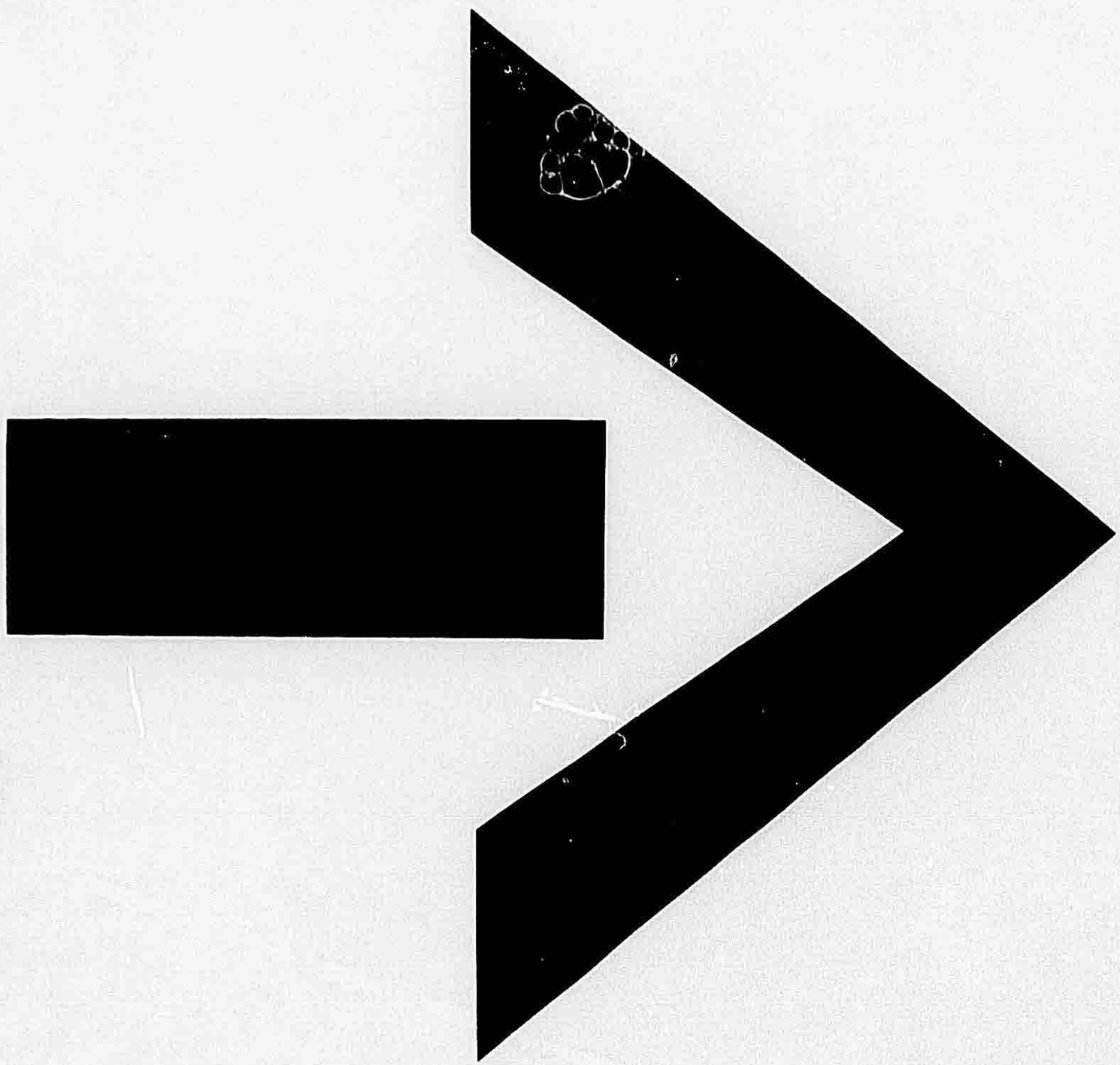
The NAV flag port (pin 13) of the uP is normally logic high as determined by the "on" state of Q501 which back biases CR514 allowing the pull-up resistor R593 to turn on buffer U105E. When the front panel mode switch is in the "BRG" position and should a fault occur in the VOR/LOC circuits, then Q501 would turn off and uP pin 13 would go logic low: this signals the uP to "BAR" the displayed bearing. If the mode switch is in the "FREQ" position with a VOR/LOC fault condition, the uP ignores pin 13 and will not "bar" the standby frequency.

When an RNAV 860 is used with the NAV 824/825, then diode CR513 will be clamped to ground in the RNAV mode by the RNAV 860 which will "bar" the bearing display.

3.6.4 Microprocessor, FREQ, TO, FROM SW103 Inputs

The mode switch (SW103) on the front panel has three positions: "FREQ", BRG TO, and BRG FR. When the switch is in the "FREQ" position, pin 10 of the uP is grounded which commands the uP to display the standby frequency and aimer. When the switch is in the "BRG TO" position, the ground from pin 10 of the uP is removed, which commands the uP to display the computed bearing to the nearest whole number degree. Digit 5 of the display will be blanked off and the legend "TO" will be illuminated. The remaining three digits will always be illuminated. If the bearing should be "one" degree then the display would show 001.

When the switch is in the "BRG FR" position, pin 9 of the uP is grounded. This commands the uP to reciprocate the displayed bearing by adding 180 degrees to the computed radial. The legend "FR" will also be illuminated.



3.6.5 Microprocessor, MHz and KHz SW101 Inputs (U115-3/4/5 and 17/18/19)

The MHz and KHz switches do not program the uP but only command it to increment (count up) or decrement (count down) the displayed frequencies. An explanation of switch operation will be given using Figure 3-25 as a guide. Since both the MHz and KHz switch sections are identical, an explanation of the MHz will cover both.

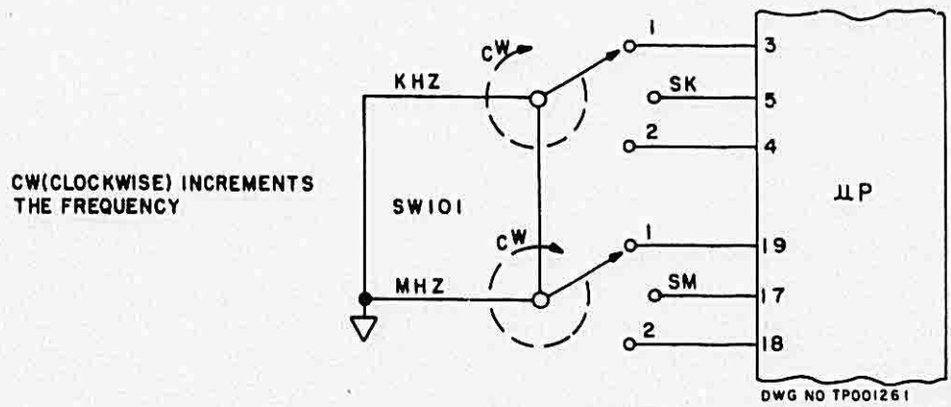


FIGURE 3-25. MHz/KHz INPUTS

The MHz switch is a rotary SPDT switch with a momentary contact between positions 1 and 2. The switch can be rotated either clockwise (increment) or counterclockwise (decrement) and has no mechanical stop to limit its rotation. The switch can be set to either position #1 or #2. If the switch is at position #1, and rotated to position #2, in a clockwise direction, then the wiper (pole) will make momentary continuity with the contact "SM", (sense MHz). This action grounds the uP pin 17 prior to grounding pin 18 at position #2. The uP interprets the sequence of a pin 17 ground followed by a pin 18 ground as a signal to increment the frequency by one MHz. If the switch is again rotated in a clockwise direction from position #2 to position #1 then the "SM" contact is bypassed. However, the frequency is still incremented by one MHz as the uP interprets this sequence of a pin 18 ground followed by a pin 19 ground (position #1) as a increment signal. To decrement the frequency, the switch is rotated counterclockwise. A counterclockwise rotation from position #2 to #1 will ground uP pin 17 prior to grounding pin 19. This sequence, a pin 17 ground followed by a pin 19 ground, is a decrement signal for the uP. Again, rotating counterclockwise from position #1 to #2 will decrement the frequency by one MHz as the sequence of a pin 19 ground followed by a pin 18 ground is a decrement signal to the uP.

3.6.6 Microprocessor, Reset Circuit (U103B)

The microprocessor (U115) has internal power-on-reset circuitry to automatically reset the device following a typical power-up situation. However, this circuitry is not guaranteed to operate under all possible power-on situations. There are three conditions to be met before the 3870 microprocessor leaves the reset state and begins operation:

1. An on-chip Vcc detector must sense a minimum Vcc value before it will allow the device to operate.
2. The integrated circuit substrate has a bias generator and detector. The detector must sense the proper bias level to release the device from the reset state.
3. The clocks of the 3870 must be functioning. Typically the clocks will begin to function at a Vcc of 3 to 3.5 volts, but since the part is tested by the manufacturer at 4.5 volts, they will not guarantee any operation below 4.5 volts.

The NAV 824/825 has a soft-start switching regulator which means that the power lines will slowly rise to their rated values. With a slowly rising power supply, the 3870 may start running before the Vcc line reaches 4.5 volts, which is below the guaranteed voltage range.

To prevent this situation is the task of the reset circuit. This circuit consists of U103B and associated components.

U103 is an IC that contains 3 pairs of NPN transistors (U103A/B/C). In U103B, the collector (pin 7) of transistor Q_{b1} is connected to the reset port (pin 39) of U115. This transistor receives its base drive from the 5 volt line via R154. The second transistor Q_{b2} receives its base drive from the +16 volt line via R156, and CR116. When the NAV is turned on, Q_{b2} is off because R155 grounds its base. The rising 5 volt line turns on Q_{b1}. When Q_{b1} is turned on, it grounds the reset port U115 pin 39. The rising 16 volt line turns on Q_{b2}, the base of Q_{b1} becomes grounded and it is turned off. The voltage on the reset line begins to rise as capacitor C116 begins to charge up to 5 volts through resistor R153.

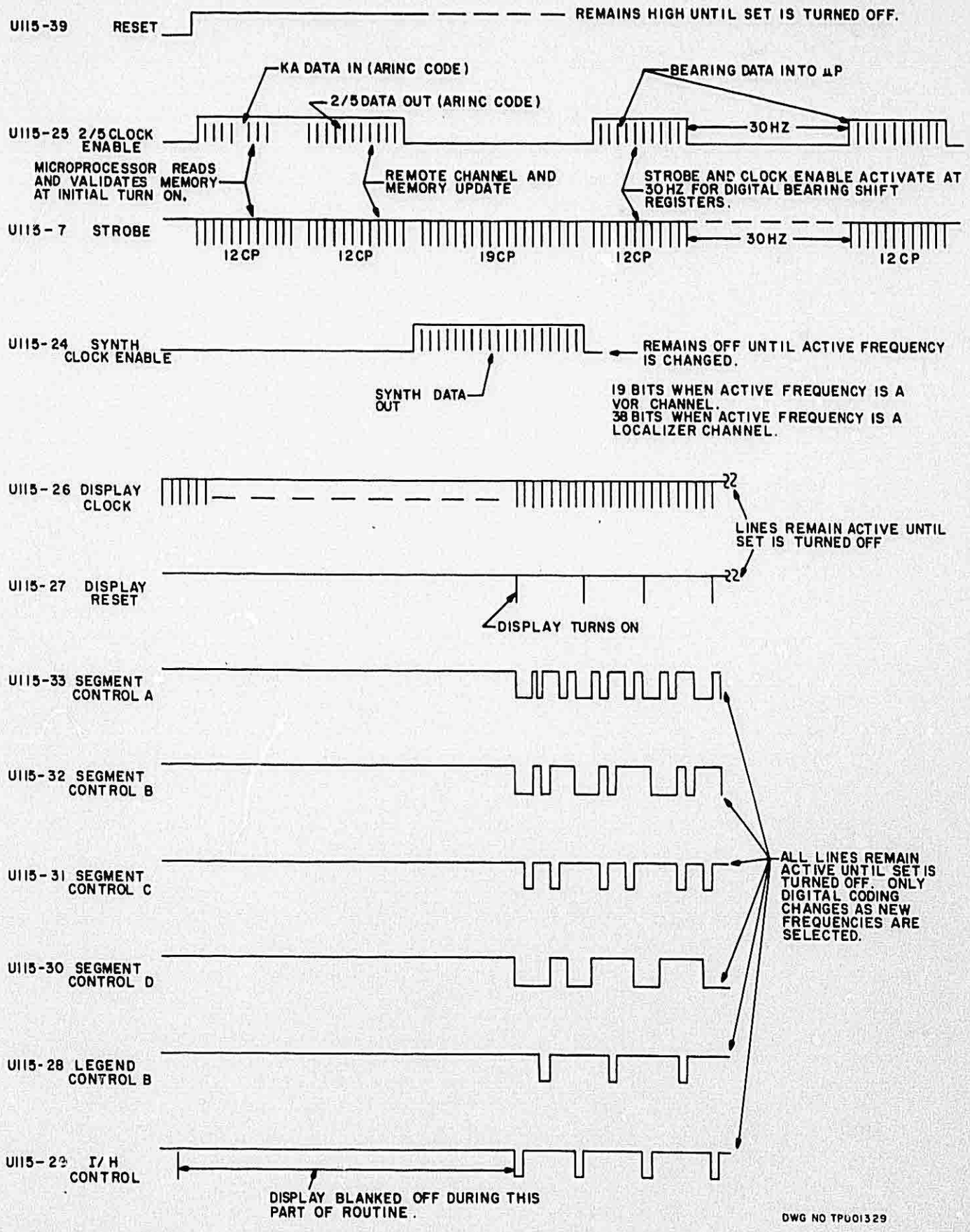


FIGURE 3-26. TIMING DIAGRAM SHOWING MICROPROCESSOR SEQUENTIAL OPERATION

3.6.7 Microprocessor's Sequence of Operation

Refer to Figure 3-26.

The sequential routine that the microprocessor follows upon initial turn on is given here:

1. NAV 824/825 turned on.
2. Microprocessor resets.
3. Reset line goes logic high releasing the uP for program execution.
4. uP display clock (U115-26) is activated. At this point in the sequence the digit and segment control lines are blanked off.
5. The uP waits for approximately 1 second for the memory enable (U103C) to rise. If it does not rise, the uP will display 115.5 MHz in the active window and 110.5 MHz in the standby window.
6. 2/5 clock enable activates (U115.25).
7. 2/5 strobe (U115-7) activates and strobes the active memory register into the uP.
8. uP validates the active memory.
9. 2/5 strobe (U115-7) and 2/5 data (U115-8) activate and update the active memory and remote channel registers.
10. 2/5 clock enable (U115-25) goes logic low.
11. Synthesizer clock enable (U115-24) activates.
12. Concurrently, synthesizer data (U115-11) and strobe (U115-7) activate. If the active frequency is an omni channel there will be 19 bits and 19 clock pulses. If the active frequency is an GS/LOC channel there will be 38 data bits and 38 clock pulses.
13. Synthesizer clock enable (U115-24) goes logic low.
14. Concurrently the strobe (U115-7) and 2/5 clock enable (U115-25) activate at a 30 Hz rate to strobe the digital bearing selector's 8 bit registers, U110/U111.
15. Concurrently the display reset segment and legend control lines are activated and the uP displays information.
16. The uP now scans the following lines.
    a) MHz and KHz switch lines (U115-3/4/5, U115-17/18/19)
    b) TRANSFER switch line (U115-16)
    c) AIMER LINE (U115-34)
    d) NAV FLAG (U115-13)
    e) Bearing ready (U115-12)
    f) Bearing data in (U115-15)*

* If the Active window is a VOR channel and the receiver is <u>not</u> flagged, the digital bearing information will be read by the microprocessor. If the front panel mode switch is in the "FREQ" position, bearing data will be processed but not displayed. If the receiver is flagged, the bearing information is not read by the microprocessor.

If the active window is a localizer channel, then <u>no</u> bearing information is processed. If the mode switch is moved to the "BRG" position, the legend "LOC" will illuminate and 3 bars will be displayed in the bearing window. To help clarify the sequence, refer to Figure 3-26.

3.7 KEEP-ALIVE (KA) CIRCUIT

Refer to Figure 6-2.

The KA circuit is comprised of U103C AND gate U116D, 18 bit static shift register U117 and associated resistors, diodes, and capacitors. The purpose of the KA circuitry is to store the last used active frequency in a non-volatile memory. A non-volatile memory requires the memory register (U117) AND gate (U116) and 2/5 clock enable (U103C) circuits to have power applied to them at all times. To facilitate this requirement pin 8 of the rear connector, J102, is available to be connected to the aircraft battery. The battery voltage is then applied to a 5.6 volt Zener diode, CR117, via CR119 and R159. The output from the Zener is applied to the Vcc inputs of U117, U116, and to the 2/5 clock enable, U103C via R160. If the KA feature is not used, then J102 pin 8 must be grounded so that the uP will recall 115.50 MHz for the Active frequency and 110.50 MHz for the Standby frequency at initial turn on of the radio.

3.7.1 Memory Enable

Refer to Figure 6-1.

The purpose of the memory enable, U103C, is to briefly inhibit the passage of the strobe through AND gate U116D by applying a logic low to pin 1. At initial turn on, it delays enabling U116D, until the uP has reached its guaranteed operating voltage.

When the NAV 824 is turned off, Q_{c1} in U103C is turned on by the KA voltage applied to its base through R160. This grounds the 2/5 clock enable line at U116D-1. When the radio is turned on, the switched A+ is applied to the base of Q_{c2} in U103C via R164, R163, and CR120. However, capacitor C118 prevents Q_{c2} from turning on immediately as it must charge up through R164 to a 9 volt level necessary to cause Zener diode CR120 to conduct. The delay is sufficient to allow the uP to attain its designed operating voltage. This delay is very important because when starting up, the uP will put out erratic pulses from its strobe port, pin 7. If these pulses are allowed to pass on to the memory shift register, U117, their true contents will be partially or fully shifted out before the system becomes fully operational. When Q_{c2} finally turns on, it grounds the base drive to Q_{c1} removing the short from U116D-1.

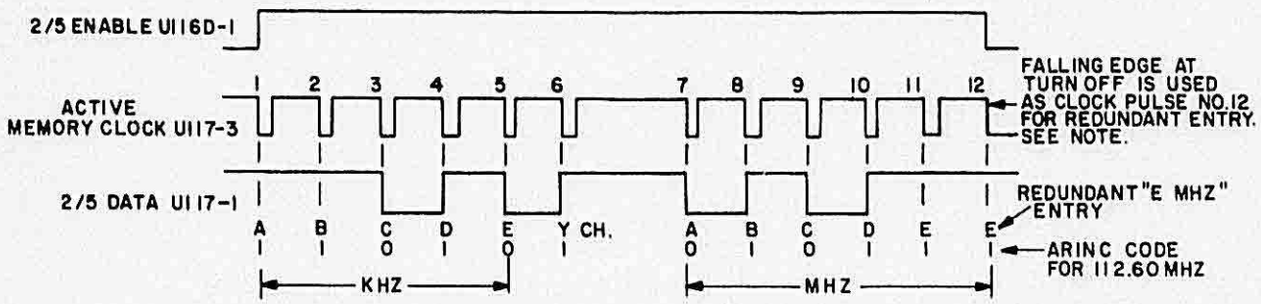
When the radio is turned off, the 2/5 clock enable line must be quickly grounded before the decaying Vcc voltage to the uP causes it to again send out erratic pulses. When the Unit is switched off, diode CR121 will quickly bleed off the charge on C118 allowing Q_{c2} to turn off. When Q_{c2} turns off, Q_{c1} is turned on by the KA voltage and the 2/5 clock enable line will be grounded.

If the 2/5 clock enable line does not go high within 1 second of initial turn on, the uP will recall 115.50 MHz for the Active frequency and 110.50 MHz for the Standby frequency.

3.7.2 Active Memory (U117)

Refer to Figure 6-2.

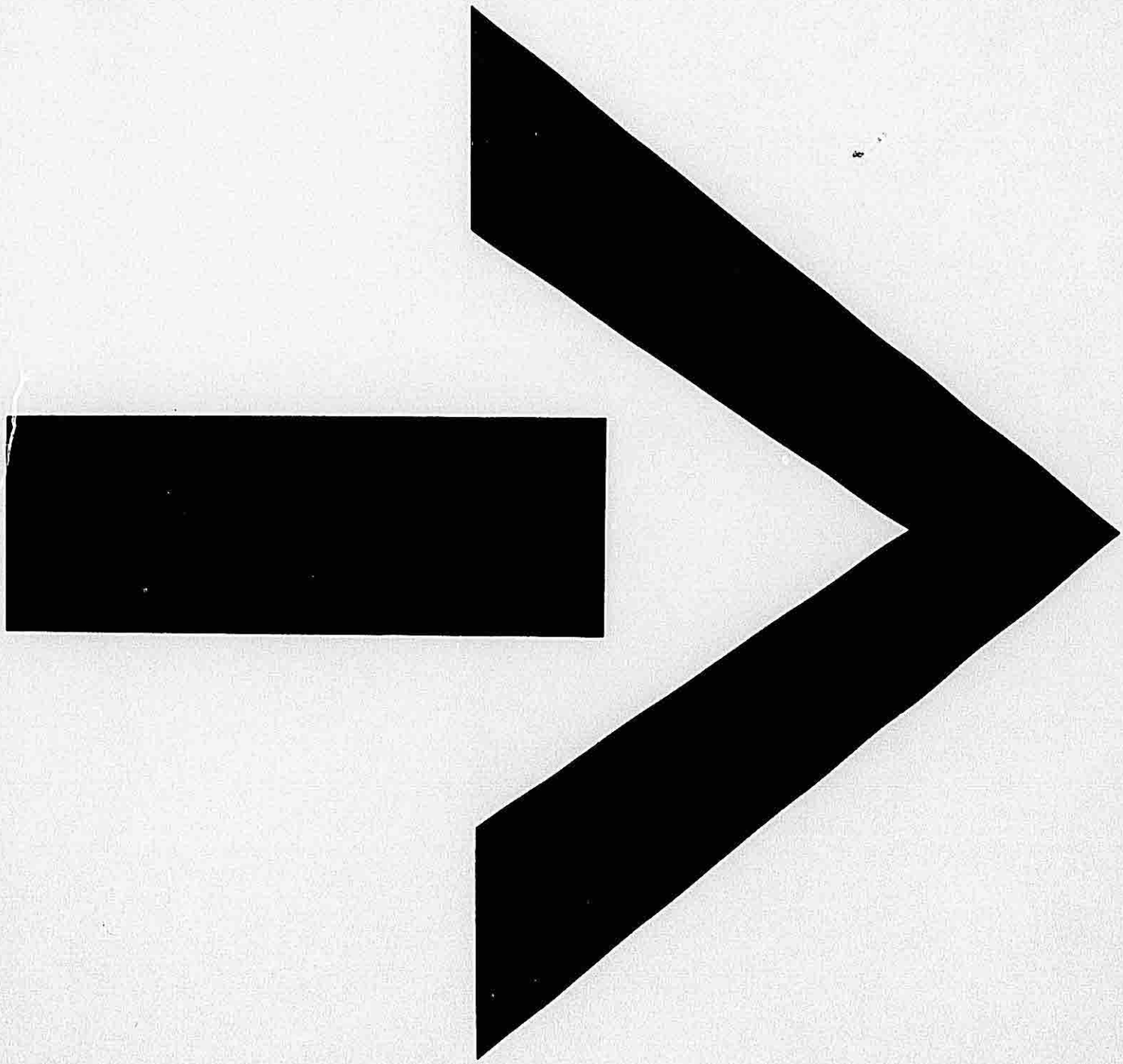
U117 is an 18 bit static shift register that is wired for 12 bit operation. Each time the Active frequency is changed, the memory register will be updated, as when the transfer button is activated and the Standby frequency is transferred to the Active window. However, the microprocessor never reads the memory contents during transfers and frequency changes. It only reads the memory at initial turn on, and if valid, updates the memory again. The 11 bit code used to program the registers is in an 2/5 format, as shown in Table 3.7 consisting of 5 bits each for the MHz and KHz frequency plus the Y channel activate. Figure 3-27 shows how the memory is programmed using 112.60 MHz as a example. This example also explains how bit number twelve is loaded into the register.



NOTE:
DATA IS ENTERED INTO U117 ON THE FALLING (NEGATIVE) EDGE OF THE CLOCK PULSE. THIS SHIFT REGISTER IS CONNECTED AS A 12 BIT SHIFT REGISTER. THE 2/5 CODE USED TO PROGRAM THIS REGISTER ONLY CONTAINS 11 BITS OF INFORMATION. BIT 12 IS ADDED BY ENTERING THE E MHZ DATA TWICE, ONCE ON CLOCK PULSE 11 (BIT 11) AND AGAIN AT TURN OFF BY USING THE FALLING EDGE OF THE GATED CLOCK (NO. 12).
TABLE 3-8 LISTS THE 2/5 PROGRAMMING CODE.

DWG NO TP001262

FIGURE 3-27. ACTIVE MEMORY PROGRAMMING FOR 112.60 MHz



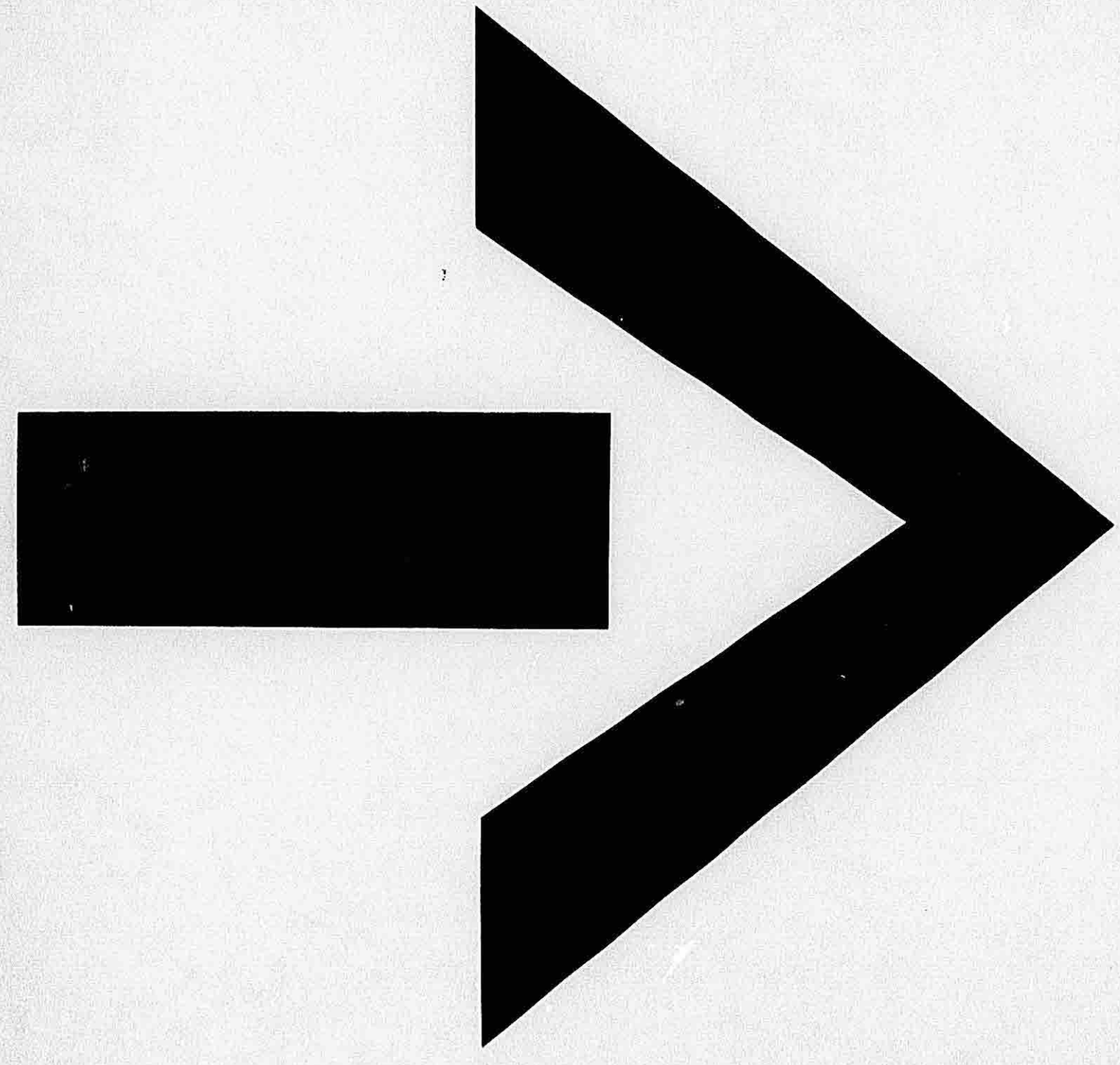


TABLE 3.7. MEMORY PROGRAMMING EXAMPLE

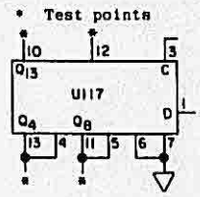
U117 PIN NO.	MHz 2/5	108	109	110	111	112	113	114	115	116	117
	A	0	0	1	0	0	1	1	1	1	1
	B	1	1	0	0	1	0	0	1	1	1
13*	C	[1]	1	1	1	0	0	1	0	0	1
	D	0	1	1	1	1	1	0	0	1	0
	E	1	0	0	1	1	1	1	1	0	0
	KHz 2/5	.00 .05	.10 .15	.20 .25	.30 .35	.40 .45	.50 .55	.60 .65	.70 .75	.80 .85	.90 .95
10*	A	1 1	0 0	0 0	[1] 1	1 1	1 1	1 1	1 1	0 0	0 0
	B	0 0	0 0	1 1	0 0	0 0	1 1	1 1	1 1	1 1	1 1
	C	1	1 1	0 0	0 0	1 1	0 0	0 0	1 1	1 1	1 1
12*	D	1 1	1 1	1 1	[1] 1	0 0	0 0	1 1	0 0	0 0	1 1
11*	E	0 0	1 1	1 1	[1] 1	1 1	1 1	0 0	0 0	1 1	0 0
	Y Channel Account	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0

NOTE: The logic state of four tapped register outputs (Q4, Q8, Q9, Q13) may be checked with a DC voltmeter after a frequency selection has been made.

For example: Channel the NAV 824 to 108.30 MHz. The table shows that U117, pin 13, pin 10, pin 12, and pin 11 will be logic high (5 volts).

1 = logic Hi = 5 Vdc
0 = logic Low = 0 Vdc

Dwg No. TP001346A



3.8 AUTOMATIC DIGITAL BEARING SELECTOR

The NAV 824/825 has digital circuitry that automatically computes the VOR bearing To or From the station. At the pilots option, this information can be displayed in the right hand window of the gas discharge display. Although the digital circuitry has a resolution of 0.1 degree, the displayed bearing will be shown only to the nearest whole number degree (3 digits).

The circuitry consists of a phase-locked loop (U114) with a divide-by-3600 counter (U113), an VOR phase detector (U109A/U109B), a 12 bit data bearing counter (U112), and two 8 bit static shift registers (U110/U111).

3.8.1 Phase-Locked Loop and Divide-by-3600 Counter (U113/U114)

The purpose of the PPL and divide-by-3600 counter is to generate a system clock that has a resolution of 0.1 degree. Using Figure 3-28 as a guide, the PPL VCO frequency is determined as follows: A 30 Hz sine wave has a period of 33.3 milliseconds. Dividing 33.3 ms by 360 degrees, converting milliseconds to microseconds, and degrees to tenths of degrees yields a time of 9.25 microseconds per 0.1 degree. The reciprocal of time is frequency and the required VCO frequency is 108 KHz (1/9.25 us).

The 30 Hz reference channel is the reference frequency for the PLL at U114-14. The phase comparator input (U114-3) from U113-1 must be the VCO frequency divided by 3600 to give the required 30 Hz comparison signal. U113 is a 12 bit ripple counter that has a maximum count of 4096 and an external automatic reset circuit. Using Figure 3-29 as a guide, the counter operation is as follows: The Q5/Q10/Q11/Q12 outputs are clamped by diodes to 8 volts through pull up resistor R168. The reset line is also diode clamped to 8 volts. When the reset line is high, the counter is in the reset state. At the beginning of the count, the Q outputs are low clamping the reset line low (count mode).

As the count progresses, the reset line remains low because until the count reaches 3600, there is always at least one Q5-10-11-12 output low at any one time which keeps the reset line low. However, at VCO pulse number 3600, all the Q5-10-11-12 outputs go logic high. Now the clamping diodes are reverse biased and the reset line is pulled up to 8 volts resetting the Q5-10-11-12 outputs to logic low. the diodes again clamp the reset line low and the count begins again.

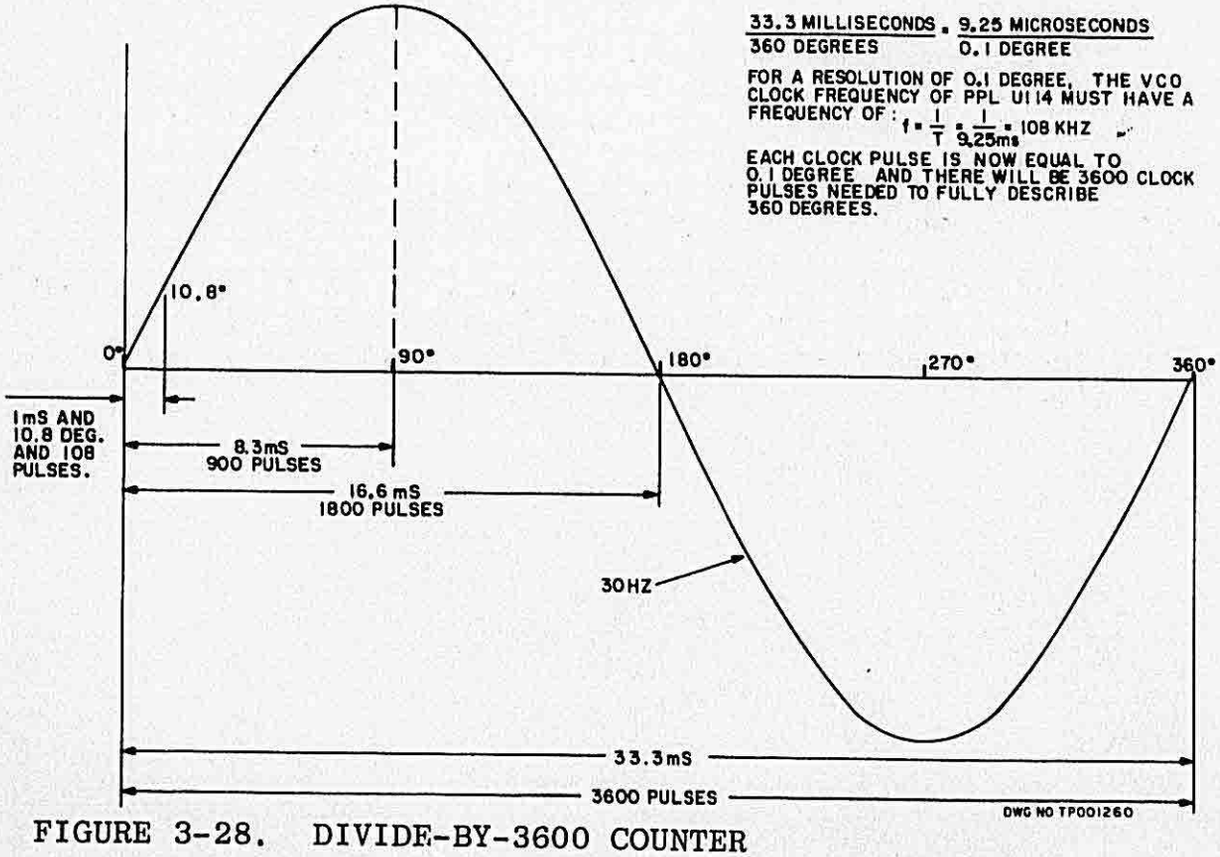
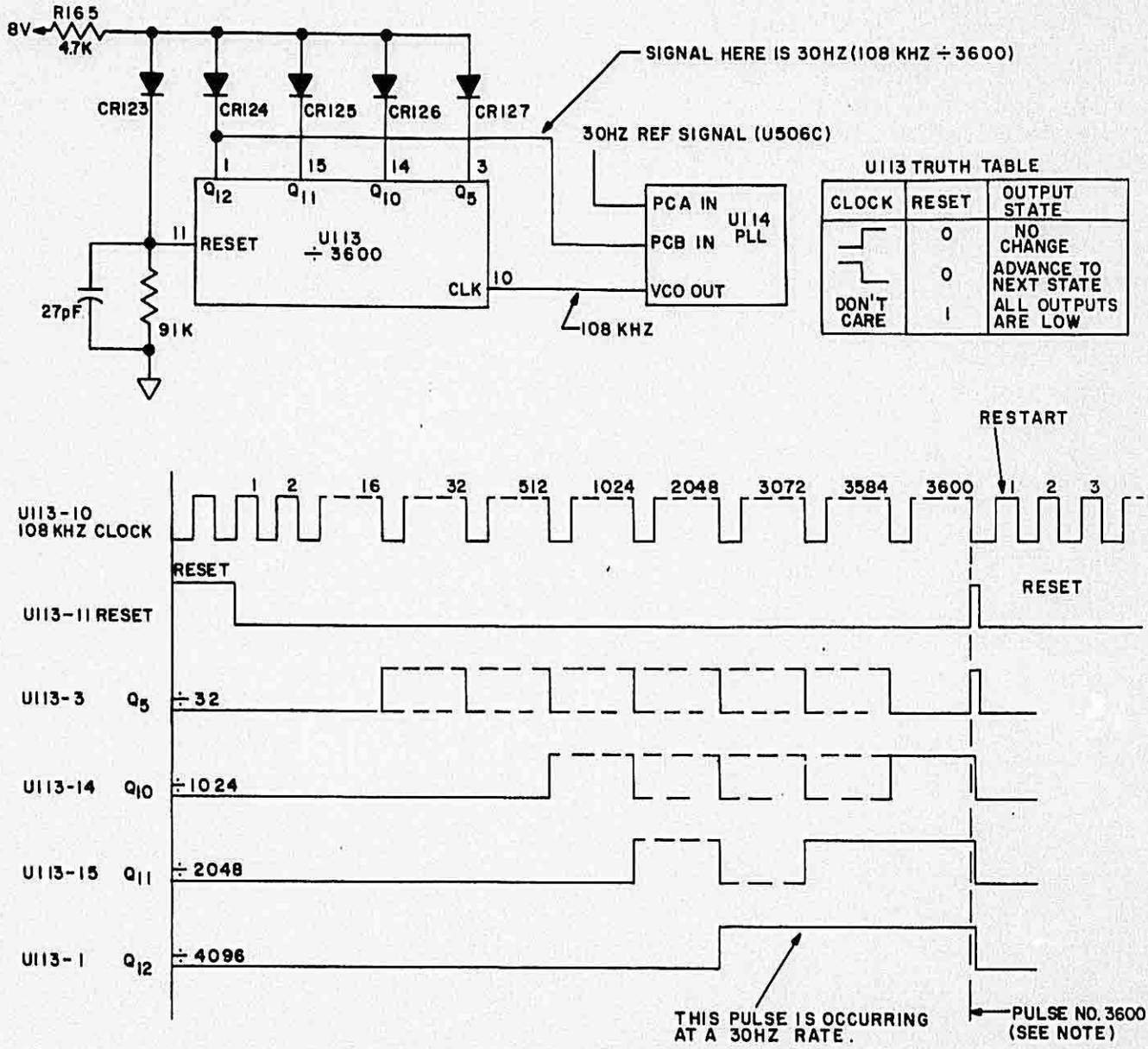


FIGURE 3-28. DIVIDE-BY-3600 COUNTER



NOTE:
WHEN Q_5, Q_{10}, Q_{11}, AND Q_{12} ARE ALL LOGIC HIGH (OCCURS AT PULSE NO. 3600), DIODES CR124 TO CR127 WILL BE BACK BIASED, REMOVING THE GROUND CLAMP FROM THE RESET LINE. THE RESET LINE NOW RISES TO 8 VOLTS AND RESETS ALL Q OUTPUTS TO ZERO AND THE COUNTS STARTS AGAIN.

DWG NO T P001265

FIGURE 3-29. DIGITAL BEARING ÷3600 COUNTER

3.8.2 VOR Phase Detector (U109A and U116A)

The VOR bearing to a station is the phase difference between the reference channel 30 Hz signal at U506C-1 and the variable channel 30 Hz signal at U506A-14. It is the purpose of U109A/U109B to detect this phase angle which will be used as a gate to pass the equivalent number of 0.1 degree pulses from the PLL VCO on to the 12 bit bearing data counter, U112. To facilitate the circuit description, Figure 3-30 will be used as a guide. As an example, let us assume a 90 degree phase difference between the variable and reference channels. The 30 Hz variable channel signal is differentiated by C109/R146 and is applied to the reset of U109B-10. The reset forces Q_b low and $\bar{Q}_b$ high. $\bar{Q}_b$ is the clock input for U109A. The data (D) input to U109A is tied logic high to 5 volts. When $\bar{Q}_b$ goes high, U109 Q_a goes high. Q_a is tied back to the reset but is delayed for approximately 30 microseconds by R147/C110. This delay is required in order to allow Q_a to remain high long enough to act as a reset pulse for the 12 bit counter, U112. The 30 Hz reference channel is the clock pulse for U109B. $\bar{Q}_a$ is tied to the b input of U109B and goes low on the reset to U109B, but 30 microseconds later when U109A resets, $\bar{Q}_a$ goes high. U109B is now primed and on the rising edge of the clock pulse, Q_b goes high and $\bar{Q}_b$ goes low. The output that we are specifically interested in is Q_b because this line detects the correct phase angle. Q_b remains high until the next reset pulse is applied to U109B at which time $\bar{Q}_b$ goes high and Q_b goes low. The positive going pulse generated at Q_b represents the VOR bearing to the station. Q_b is applied to pin 6 of AND gate U116A. The other input of U116A, pin 5, is connected to the VCO output of U114-4. Since each VCO pulse is equal to 0.1 degree, then the 90 degree phase angle will allow 900 VCO pulses to be gated through U116A (900 x 0.1 = 90°). These 900 pulses become the clock input to the 12 bit ripple counter U112.

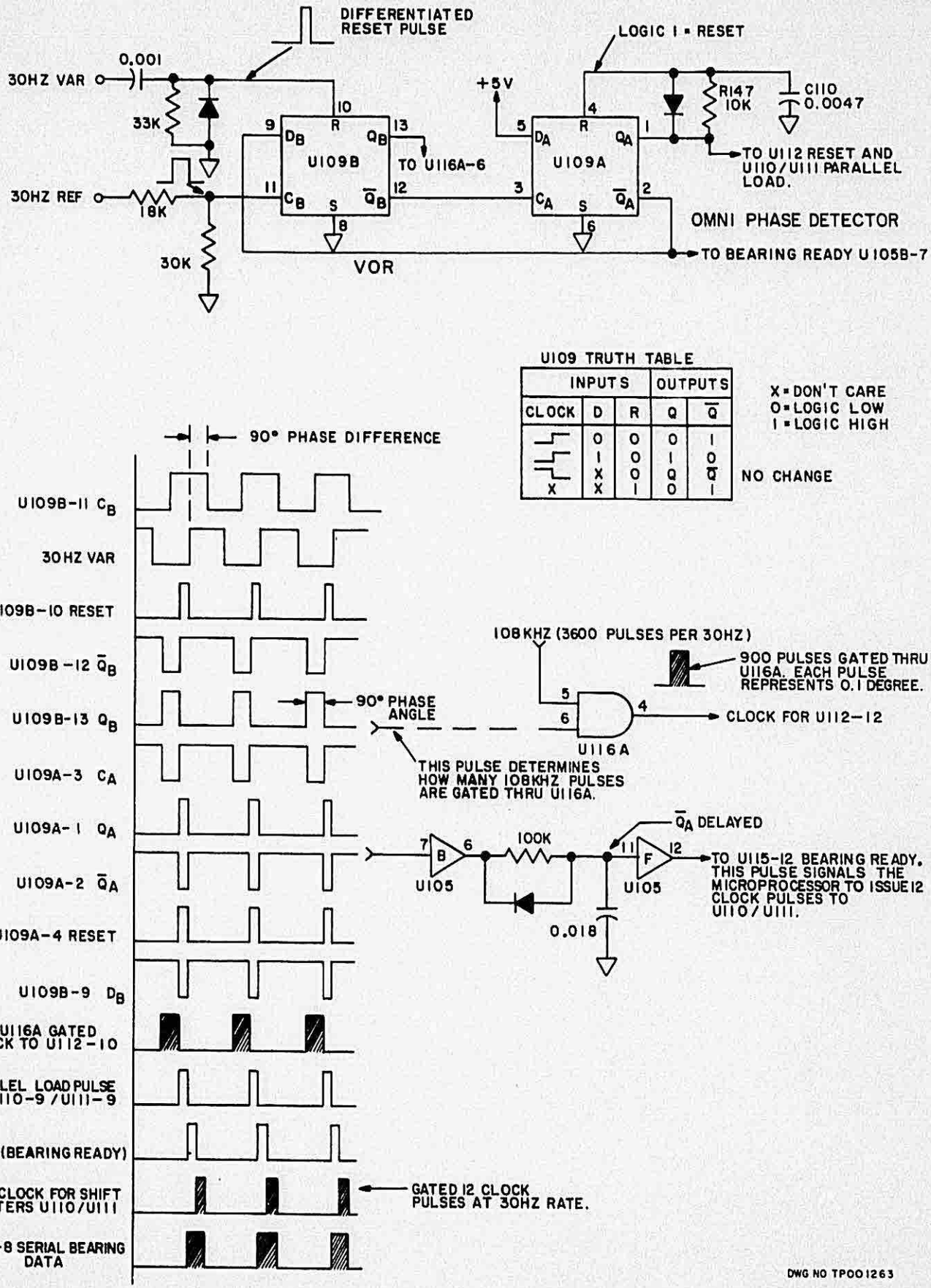


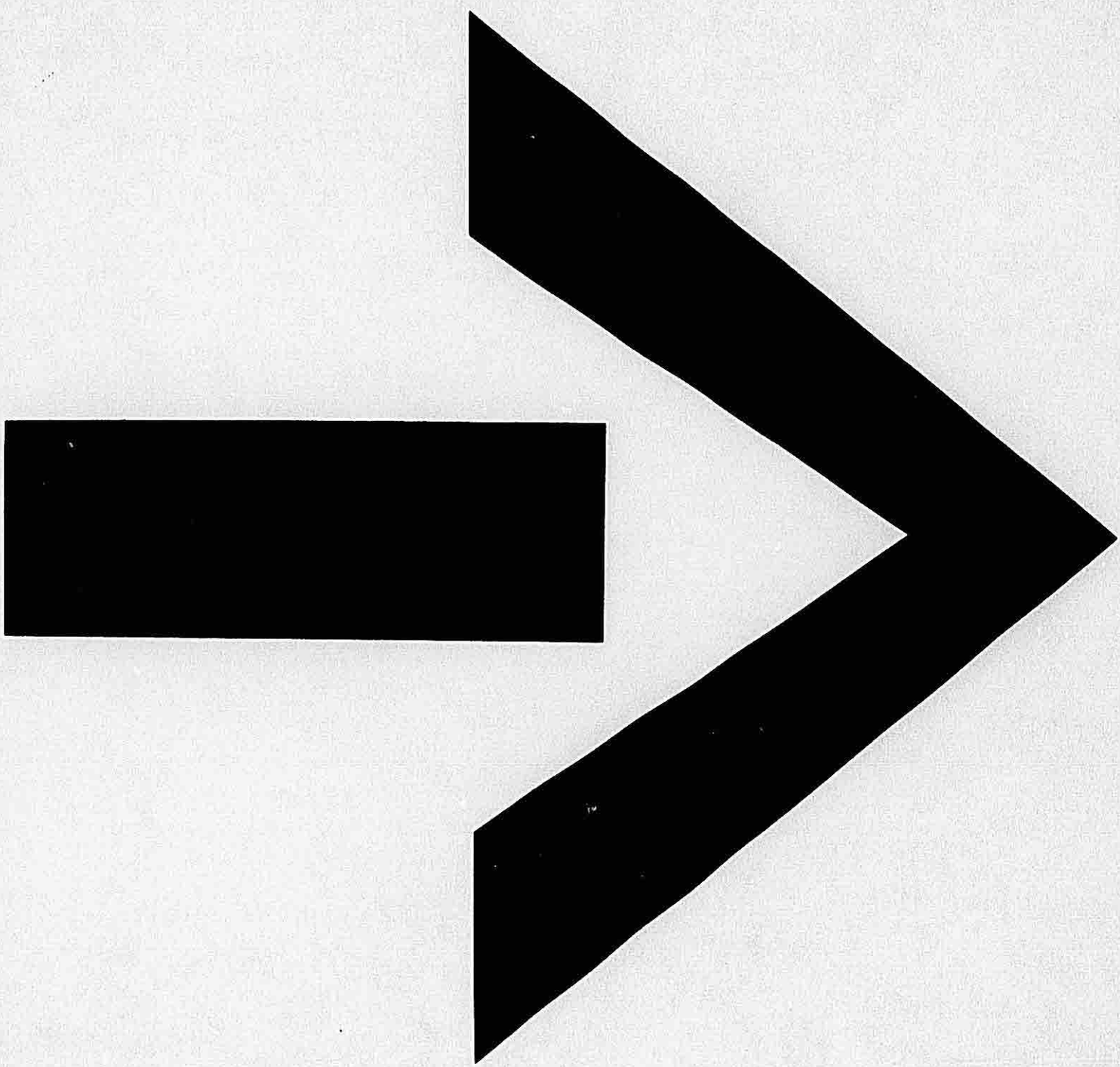
FIGURE 3-30. GENERATION OF BEARING DATA FOR MICROPROCESSOR BY VOR PHASE DETECTOR. EXAMPLE FOR 90° VOR BEARING.

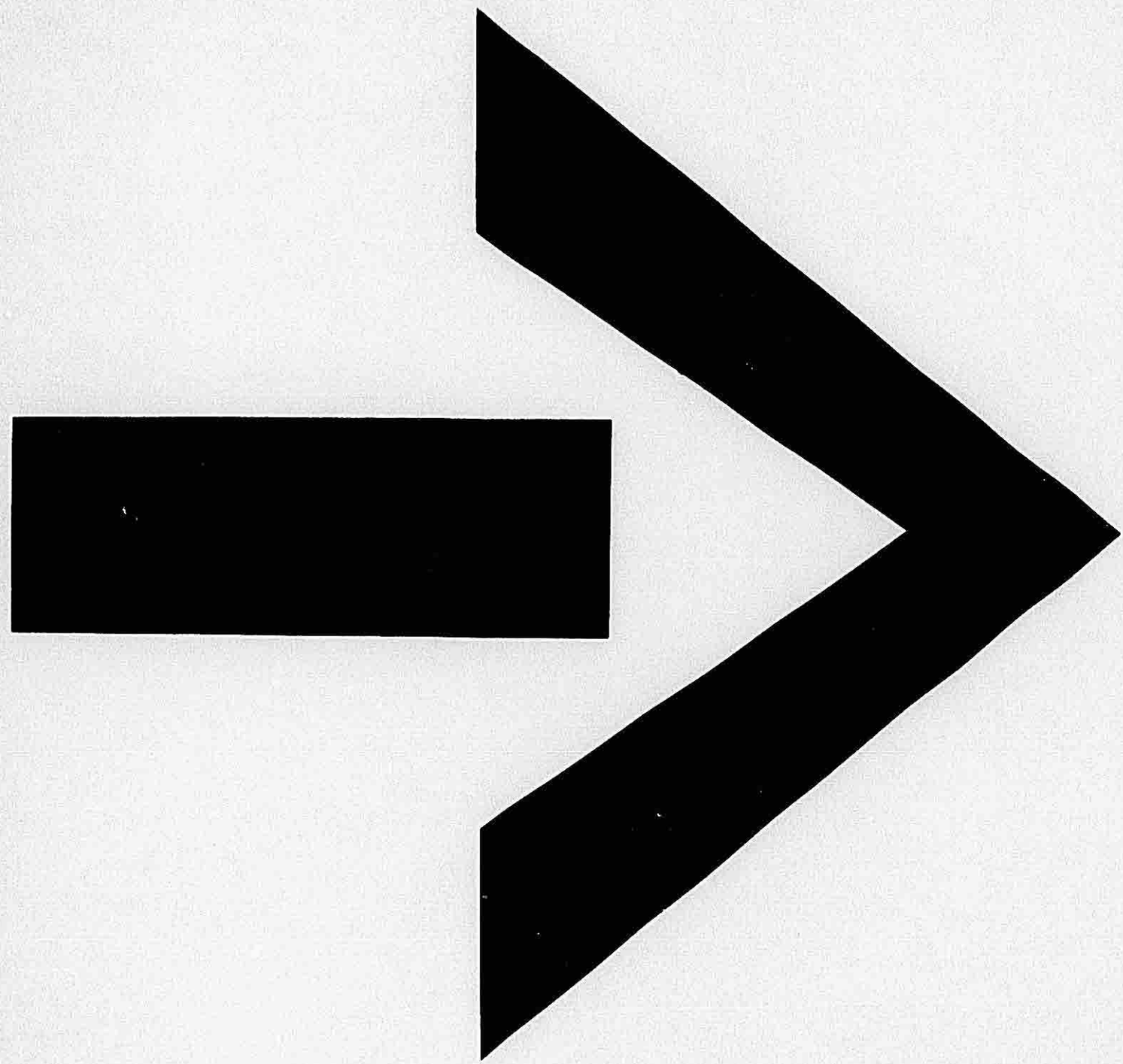
3.8.3 12 Bit Ripple Counter (U112) and 8 Bit Static Shift Registers (U110/U111)

The number of clock pulses applied to the 12 bit ripple counter represents, in digital fashion, the actual VOR bearing to the station. The purpose of the 12 bit counter is to convert these clock pulses into a binary code that is equivalent to the number of pulses being counted. This binary number will be loaded into the 8 bit shift registers and serially shifted into the microprocessor which processes the binary code and displays it as the bearing to the station.

Figure 3-31 gives an example of how a 26 degree TO bearing is transformed into a binary code. 26 degrees was chosen in order to keep the timing diagram manageable.

The VOR phase detector will generate a 26 degree pulse width, that will gate 260 clock pulses into U112-10. As the count progresses, the Q outputs change state according to the timing diagram and stop at pulse number 260. The timing diagram shows the logic state of each Q output at the end of the 260 count. As read from Q_1 to Q_{12} the outputs yield the number 260 in binary code which is 00100001000. These outputs are present at the parallel inputs of the 8 bit shift registers. As shown in Figure 3-30, upon receipt of the next reset pulse to U109B, Q_a of U109A will go logic high for 30 microseconds. This pulse is differentiated by C111/R148 and is applied to the P/S inputs of U110/U111. When a logic high is applied to this input, the data at the "P" inputs are loaded into the registers. This same reset pulse is also applied to the reset of U112, but it is delayed by C112/R149 in order that its data may be loaded into the shift registers. At the same time Q_a is resetting U112, $\bar{Q}_a$ is being applied to the "bearing ready" input of the microprocessor via buffers U105B/U105F. $\bar{Q}_a$ is delayed by C113/R150 long enough to allow the 8 bit shift registers to be loaded before the microprocessor issues 12 clock pulses to these registers. The 12 clock pulses serially shift the bearing data, which in this example is the number 260 in binary code, into the microprocessor via buffer U105C. The display will now read 026 degrees "TO". If the Pilot desires the "FROM" bearing, the three position FREQ/TO/FR switch on the front panel is moved to the FR position, and the microprocessor will internally reciprocate the bearing and display 206 degrees "FR". Should a fault occur in the VOR converter circuits, the NAV Flag input to the microprocessor at pin 13 will go low, and the displayed bearing will show bars (----).





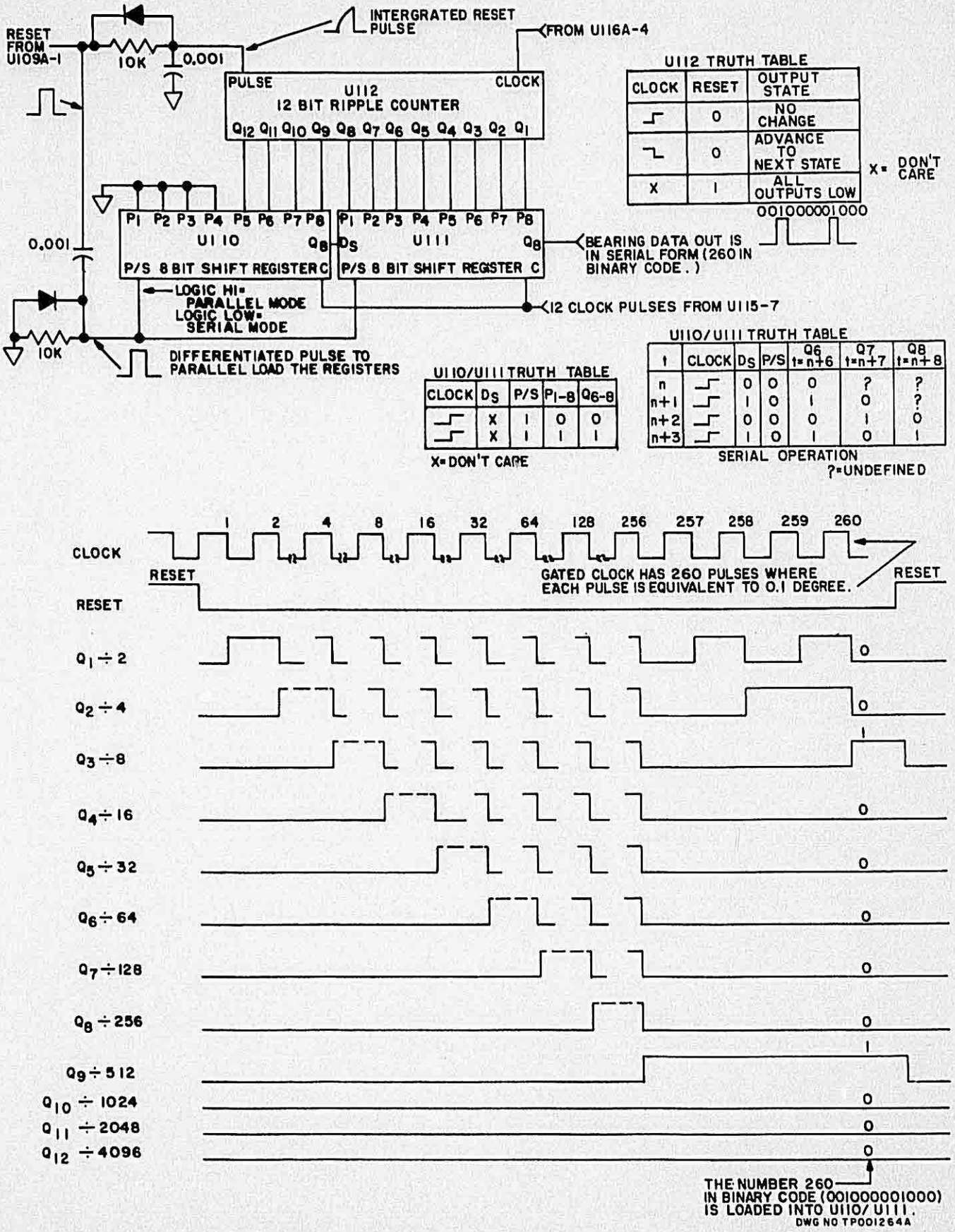


FIGURE 3-31. GENERATION OF 26 DEGREE OMNI BEARING DATA FROM U112 12 BIT RIPPLE COUNTER

3.9 GAS DISCHARGE DISPLAY

Refer to Figure 3-32.

The gas discharge display is a single piece display that is comprised of two sections with four digits per section. The numerics, except that of digits 1 and 5, use the standard 7 segment format. Digits 1 and 5 are a dual number display whose first number is a fixed "1". The second number in digit 1 is bound between the numbers 0 and 1. A decimal point is located in digits 2 and 6 and Aimer arrows in digits 4 and 5. Also included in digit 6 is the legend "LOC". When the front panel mode switch is in the "bearing mode" and the active frequency is a localizer channel, then the legend "LOC" is lighted (and digits 6, 7, and 8 will show bars). Included in digit 7 is the legend "TO" and in digit 8 the legend "FR". In the bearing mode (VOR channel), when the mode switch is in the "TO" position, the legend TO is lighted. In the "FR" position, the legend "FR" is lighted. When in either the TO or FR bearing mode, digit 5 is blanked off and digits 6, 7, and 8 display the bearing TO or FR the station while digits 1, 2, 3, and 4 display the active frequency. If a frequency change is made while in the bearing mode, the bearing information is automatically switched to read the selected frequency. It will display the frequency for 4 seconds and revert back to the displayed bearing.

When the mode switch is in the frequency position all digits are lighted with the four left hand digits displaying the active frequency and the four right hand digits displaying the standby frequency. The aimer arrow in digit 5 is illuminated signifying that all frequencies are first entered into the standby window. This is the standard entry method. If it is desired to first enter the frequency in the active window, then a jumper must be added between TP3 and TP4. The microprocessor controls the selection of the digits and segments. The digits are addressed in the following sequence: 1, 3, 5, 7, 2, 4, 6, 8. The "ON" time of each digit is 1.25 ms giving an address frequency of 100 Hz with a 12% duty cycle.

3.9 Continued

The display logic is multiplexed by the microprocessor and consists of the digit select circuit (U101, U102, U103A), segment select IC (U106) and legend select IC (U108). The display intensity is automatically adjusted by the dimmer circuit (U104, A, B, C, D) in conjunction with a panel mounted photocell, R121.

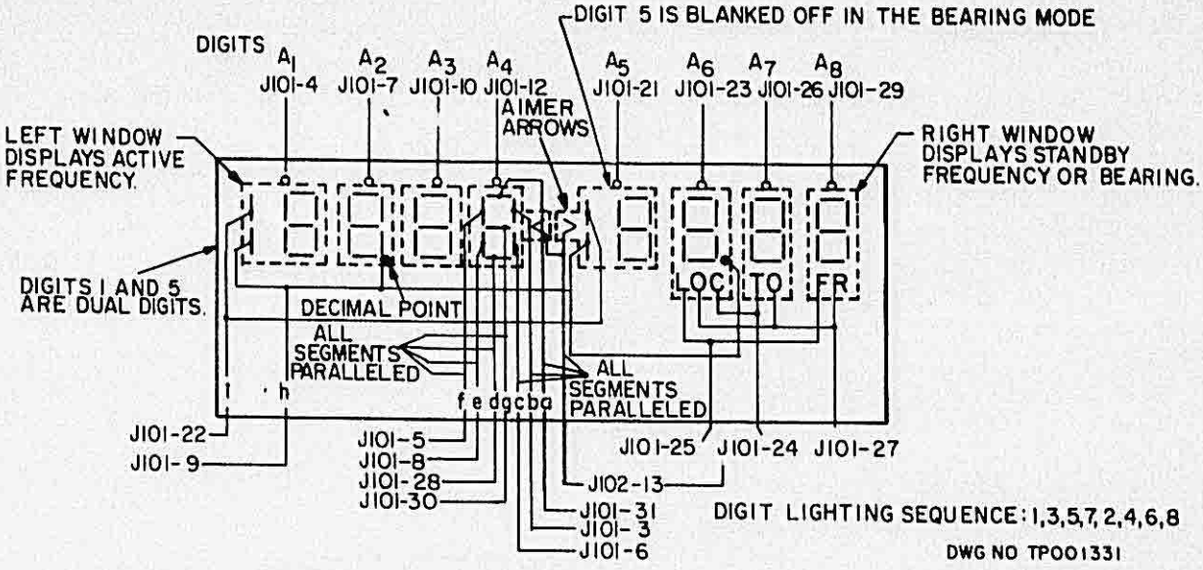


FIGURE 3-32. GAS DISCHARGE DISPLAY WIRING

3.9.1 Digit Select Circuit

Refer to Figures 6-2, and 3-33.

The purpose of the digit select circuit is to apply 190 volts to the anodes of the eight digits in the following sequence: 1, 3, 5, 7, 2, 4, 6, 8. The sequence is achieved by using an octal counter/driver, U102. This IC is a four-stage Johnson octal counter whose eight decoded outputs are normally low and go high only at their appropriate octal time period. The microprocessor clocks and resets the counter through an interfacing circuit consisting of U103A and associated resistors, diodes, and capacitors. This interface is necessary since U102 has high DC supply voltages applied to its Vdd (190V, pin 16) and Vss (110V, pin 8) inputs. Diodes CR103 and CR104 clamp the clock and reset inputs to 110 volts (Vss) which shuts down U102. The clock and reset lines from the uP are normally high and turn on transistors Q_{a1} and Q_{a2} in U103A. The collectors of both transistors are held at ground potential until the clock and reset lines go logic low and turn off Q_{a1} and Q_{a2}.

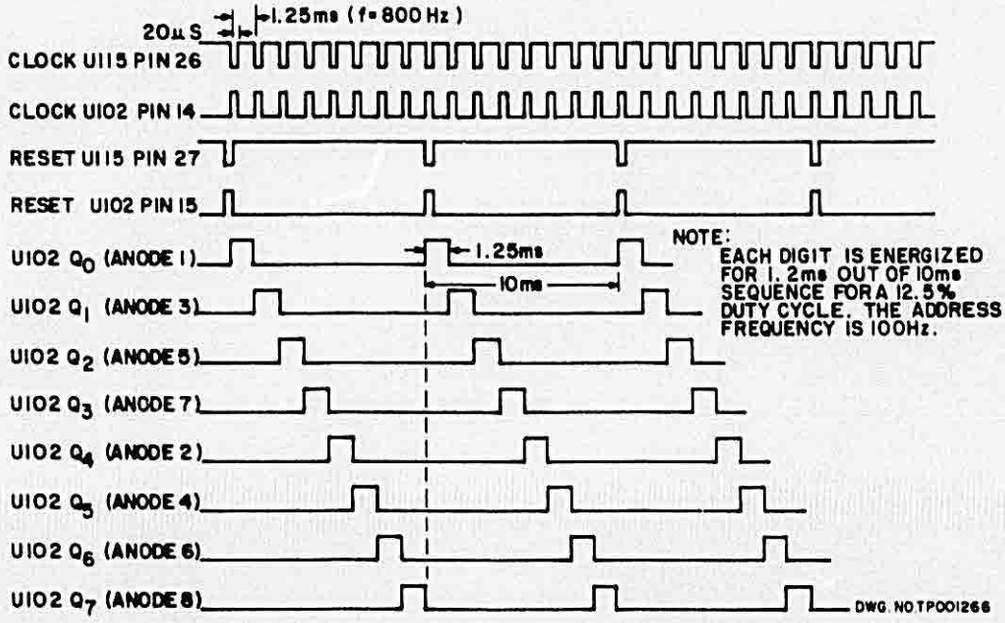


FIGURE 3-33. TIMING DIAGRAM FOR U102 SHOWING THE GAS DISCHARGE DIGIT SELECTION SEQUENCE

3.9.1 Continued

The collectors are pulled up to 16 volts through pull-up resistors R115/R116 and these voltage transitions are coupled through coupling capacitors C104/C105 to clock and reset the counter, U102. The outputs of U102 are connected to U101, a gas discharge display digit driver. U101 is the high voltage interface between the low voltage U102 and the 190 volts anode supply voltage. Note that the "Q" outputs from U102 are connected to U101 so as to give the proper digit sequence. (Q_0 = digit 1, Q_1 = digit 3, Q_2 = digit 5 ----Q_7 = digit 8). The outputs of the digit driver U101 are tied back to 110 volts through 220K resistors (R107 to R114). When a digit driver is turned off, its output can float at 130 volts or higher which could cause an unwanted illumination. Therefore, these pull-down resistors stabilize the turned off outputs at a lower voltage. Each digit is energized for 1.25 ms out of a 10 ms illumination sequence for a 100 Hz address frequency at 12.5% duty cycle. Figure 3-33 illustrates the digit select sequence.

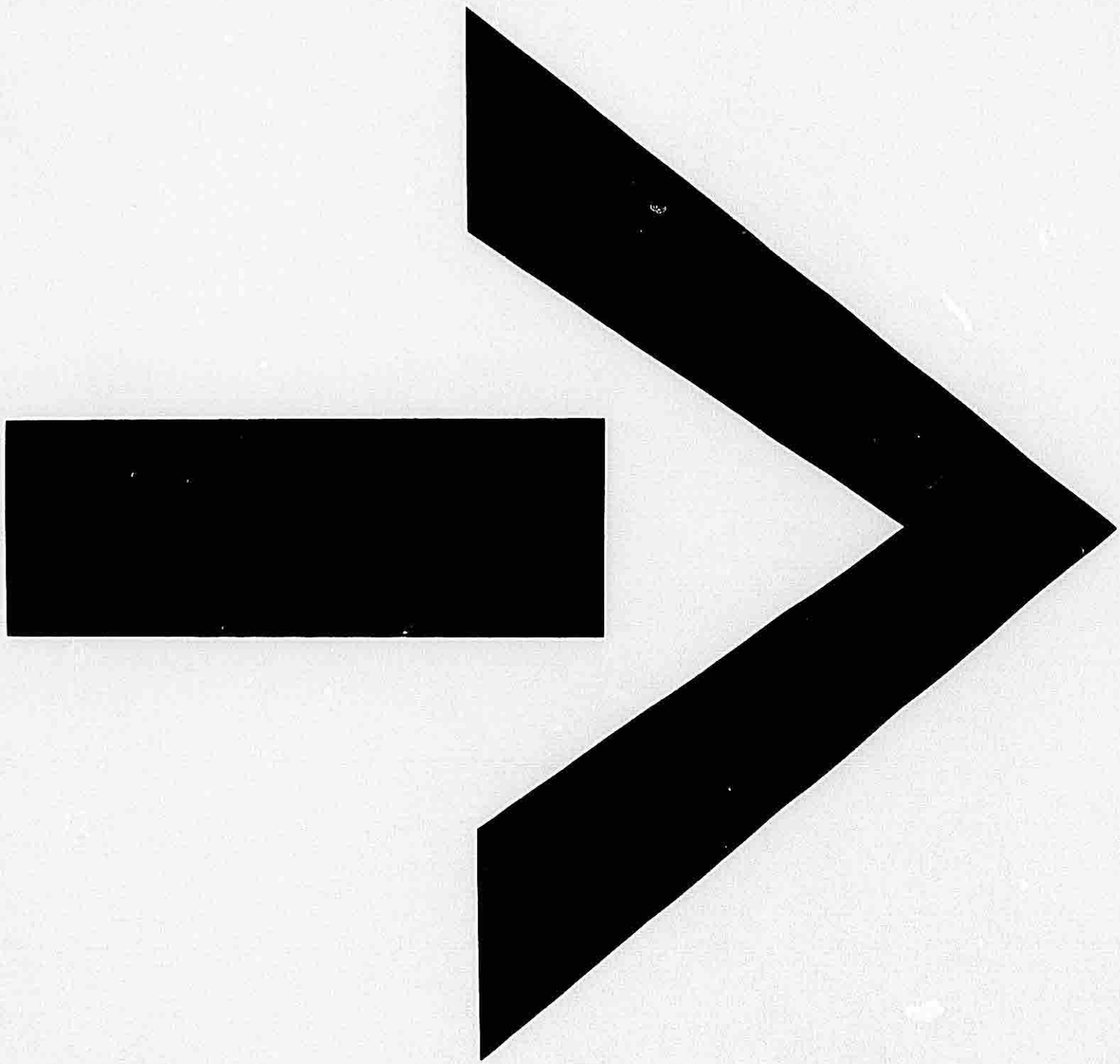
3.9.2 Segment Select Circuit

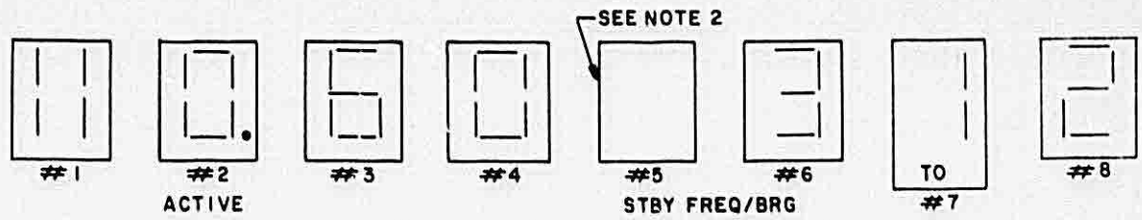
Refer to Figures 6-2, 3-32, and 3-34)

The segment select circuit consists of cathode driver U106, diode array U107 and resistor array RP101. Its purpose is to sink the cathode current of the segments that are selected by the uP to be time coincident with a particular digit. U110 is designed to decode four lines of BCD input and drive seven segment digits of gas discharge displays. All outputs consists of switchable and programmable current sinks which provide current to the tube cathodes. The output current is automatically adjusted by driving the program input (pin 1) with a current source, U104D, which is part of the dimmer circuit.

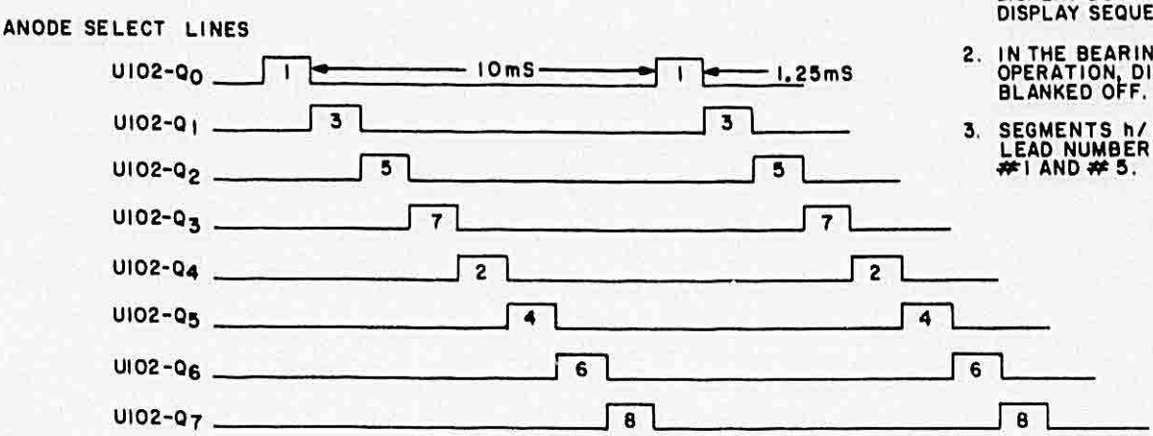
The output lines of the segment driver, U106, have a breakdown voltage of 80 volts. A characteristic of a gas discharge display is that upon turn off of the segment driver, the floating segment line will rise to a high voltage in excess of the breakdown voltage. The purpose of the diode array, U107, is to clamp the turned off segment lines to 75 volts to prevent damage to U106. The resistor array, RP101, connects the segment lines back to 75 volts. These pull-up 2 megohm resistors ensure that any line not turned on will not float to such a low potential so that a digit could illuminate because of the 110 volts present on the anodes of all turned off digits. The differential voltage on a turned off digit is ensured to be 35 volts (110V - 75V) which is far below the guaranteed extinguishing level. The purpose of diode CR108, which clamps U106, pin 8, to the 5 volt line, is to feed current into the current sink of pin 8 when it is turned on but there is no anode voltage applied to the digit. A segment line that is turned on but cannot sink any current, because there is no anode voltage, will tend to fall to ground potential. This affects those other segment lines that are turned on in such a way that the illumination of the turned on segments will not be uniform. The 2 megohm resistor clamped back to 75 volts cannot supply enough current so a diode is required.

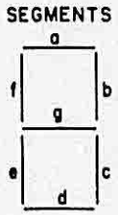
The only segment line requiring this diode current feed is "i" (pin 8). This is because the "i" and "h" inputs (pins 6 and 7) to U106 are tied together so that the "i" and "h" outputs are on at the same time. Figure 3-32 shows that "h" is tied to the decimal and the "c" segment of the fixed number "1" in the dual digits 1 and 5. When the decimal is lit (digit 2), "i" will also be turned on, but no anode voltage will be present at digits 1 and 5. To help clarify the digit and segment selection, refer to the example in Figure 3-34. Table 3.8 gives the truth table for U106 and U108.

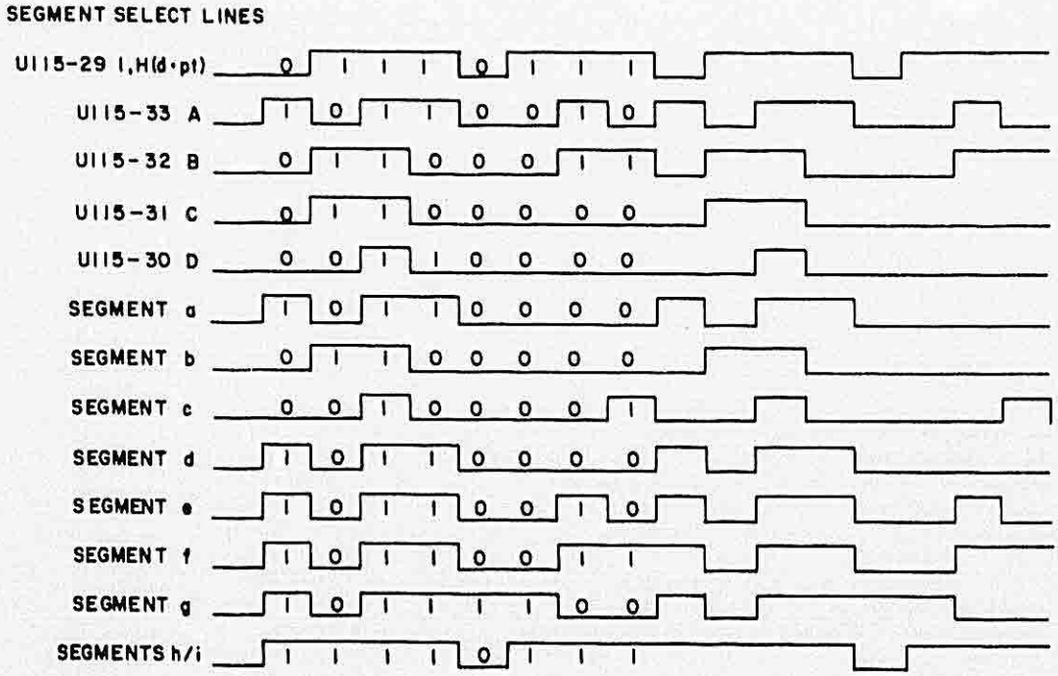


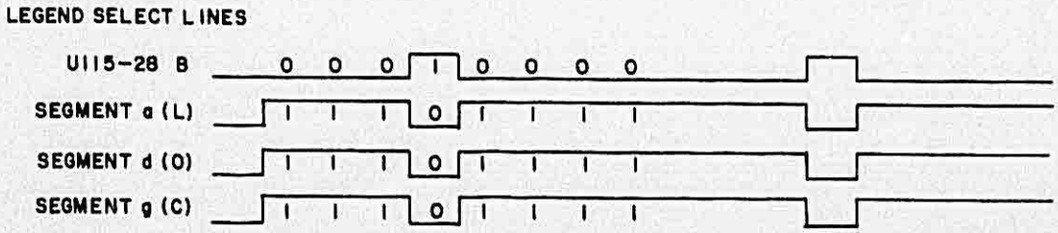


NOTES:
1. DISPLAY ADDRESS FREQ = 100 HZ
   DISPLAY DUTY CYCLE = 12%
   DISPLAY SEQUENCE: 1,3,5,7,2, 4,6,8,
2. IN THE BEARING MODE OF OPERATION, DIGIT 5 IS BLANKED OFF.
3. SEGMENTS h/i ARE THE LEAD NUMBER ¦ OF DIGITS #1 AND #5.









DWG NO TP001268

FIGURE 3-34. TIMING DIAGRAM FOR 110.60/312°

3.9.3 Legend Select Circuit

The legend select circuit consists of U108, a high voltage 7-segment decoder driver. The microprocessor controls U108 ("B" input pin 1) such that the legends LOC, TO, FR, located in digits 6, 7, and 8 will be illuminated when the mode switch is in either the TO or FR bearing mode. The "LOC" legend is only lighted when the active frequency is on a localizer channel. The operation of U108 is similar to U106 except only one input code line ("B") is used for control. The two operating states are shown in the truth table of Table 3.7. The other three code inputs, A, C, and D are held in a permanent logic state (see Figure 6-2). Figure 3-34 gives an example of how the legends are selected for illumination.

Since the "b" (U108 pin 12) and "c" (U108 pin 11) lines are not used, they must be current fed when turned on, therefore they are tied to the 5 volt line. Diodes CR110 and CR111 clamps lines "a" (pin 13) and "d" (pin 10) to 5 volts for current feeding. Figure 3-32 shows that the aimer line (J101-13) tied to the "c" line (J101-24) so that when "c" line is selected to be illuminated (digit 7), then the aimers in digits 4 and 5 are active but no anode voltage is present. Under these conditions, the diodes CR110/CR111 will supply current to the "a" and "d" lines to prevent erratic illumination of the display.

TABLE 3.8. LEGEND SELECT TRUTH TABLE

OUTPUTS h i	INPUTS H I	INPUT SEGMENT CODE D C B A	OUTPUTS a b c d e f g	DISPLAY
1 1	1 1	0 0 0 0	0 0 0 0 0 0 1	0
1 1	1 1	0 0 0 1	1 0 0 1 1 1 1	1
1 1	1 1	0 0 1 0	0 0 1 0 0 1 0	2
1 1	1 1	0 0 1 1	0 0 0 0 1 1 0	3
1 1	1 1	0 1 0 0	1 0 0 1 1 0 0	4
1 1	1 1	0 1 0 1	0 1 0 0 1 0 0	5
1 1	1 1	0 1 1 0	0 1 0 0 0 0 0	6
1 1	1 1	0 1 1 1	0 0 0 1 1 1 1	7
1 1	1 1	1 0 0 0	0 0 0 0 0 0 0	8
1 1	1 1	1 0 0 1	0 0 0 0 1 0 0	9
0 1	0 1	1 1 1 1	1 1 1 1 1 1 1	BLANK
1 0	1 0			

1=Logic High (off)
0=Logic Low (on)

The only two legends select combinations.

Dwg No. TP001345

3.9.4 Display Keep-Alive

Refer to Figure 6-1.

The gas discharge display has a Right Keep-Alive and Left Keep-Alive chamber that keeps the gas in a low state of ionization. This helps to ignite the display under low current and low temperature conditions. The anodes of the Right and Left chambers are tied to 190 Vdc through 1.2M resistors (R143 and R102). The cathodes are tied to ground through 1.2M resistors R142 and R101).

3.9.5 Display Dimmer Circuit

Refer to Figure 6-2 and Figure 3-35.

The purpose of the dimmer circuit is to automatically adjust the display intensity under ambient cockpit light that ranges from brilliant sunlight to the darkness of night. Automatic dimming is accomplished by means of a photocell, R121, located on the front panel.

The dimmer circuit consists of a quad operational amplifier U104, A, B, C, D having two sections, A and B, connected as comparators and two sections, C and D, used as current sources. Operation is as follows: A reference DC potential is established on pin 9 of U104A by the divider network consisting of R119/R123. The digit select clock line is applied to U104A, pin 10. The clock line is normally high and goes low for 20 us every 1.25 ms (f=800 Hz). When the clock is high the output of U104A is high and charges C106 through R125. When the clock goes low, diode CR105 discharges C106 to one diode drop (600 mv) above ground. Thus the voltage waveform at pin 5 of U104B is a repetitive sawtooth. (Figure 3-35)

At pin 6 of U104B is a variable DC bias that is primarily determined by the resistance of the photocell, R121, in parallel with the dimmer adjust R120 and R122. Under very brilliant sunlight, the resistance of the photocell can drop to 1K ohms. This will pull the bias voltage at pin 6 of U104B down below one volt. Under very dark conditions the photocell resistance will rise above 1 megohm and the bias voltage will be determined by the resistor network of R120, R122, and R124. As the rising sawtooth voltage on U104B-5 exceeds the bias level at pin 6 the output at pin 7 goes high. The output remains high until the next digit select clock pulse discharges C106 at which time pin 7 goes low. Figure 3-35 shows how the pulse width (duty cycle) from U104B changes for diverse ambient light. The dimmer adjust pot, R120, is accessible to the pilot through a hole in the front panel. Adjustment is made by the pilot, according to his preference for minimum acceptable brightness, by blocking light from the photocell and then adjusting R120.

3.9.5 Continued

The output from U104-7 is buffered by U105A to ensure that the pulse level will attain 5 volts when high, and ground when low. The output from U105A is then averaged by the RC network consisting of R126/R127 and C107. When the pulse width is maximum (bright light) the voltage at C107 will be maximum. When the pulse width is minimum (darkness), the charge on C107 will be reduced because U105A will be low for a longer time discharging C107 to ground through R126. The accumulated charge on C107 feeds two current sources U104C and U104D. These current sources drive the program inputs of the segment and legend select IC's U106/U108. Under bright light, the display intensity must be maximum so the programmable current input must be driven by the highest current while having the shortest off time. Dark conditions require a lower current drive with longer off time. Figure 3-35 shows a duty cycle of 93% for bright light and 50% for darkness. Diodes CR106/CR107 clamp the program inputs to ground during the off (T off) time of the duty cycle shutting off the segments and legend. Thus the dimmer circuit operation can be summerized as follows: The photocell varies the bias on U104B causing a variable output duty cycle. This varies the charge on C107 causing a variable program current source which varies the display intensity.

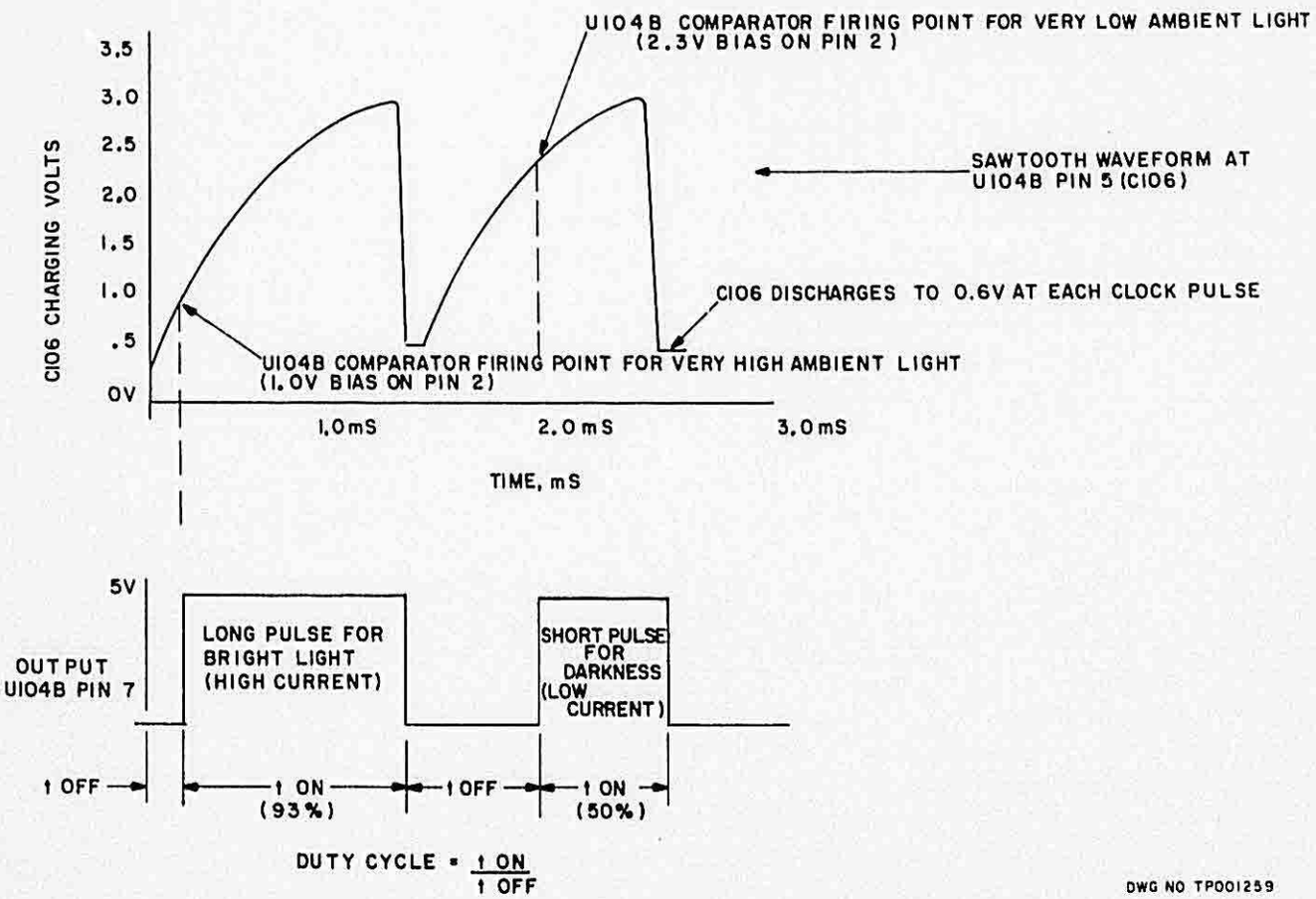
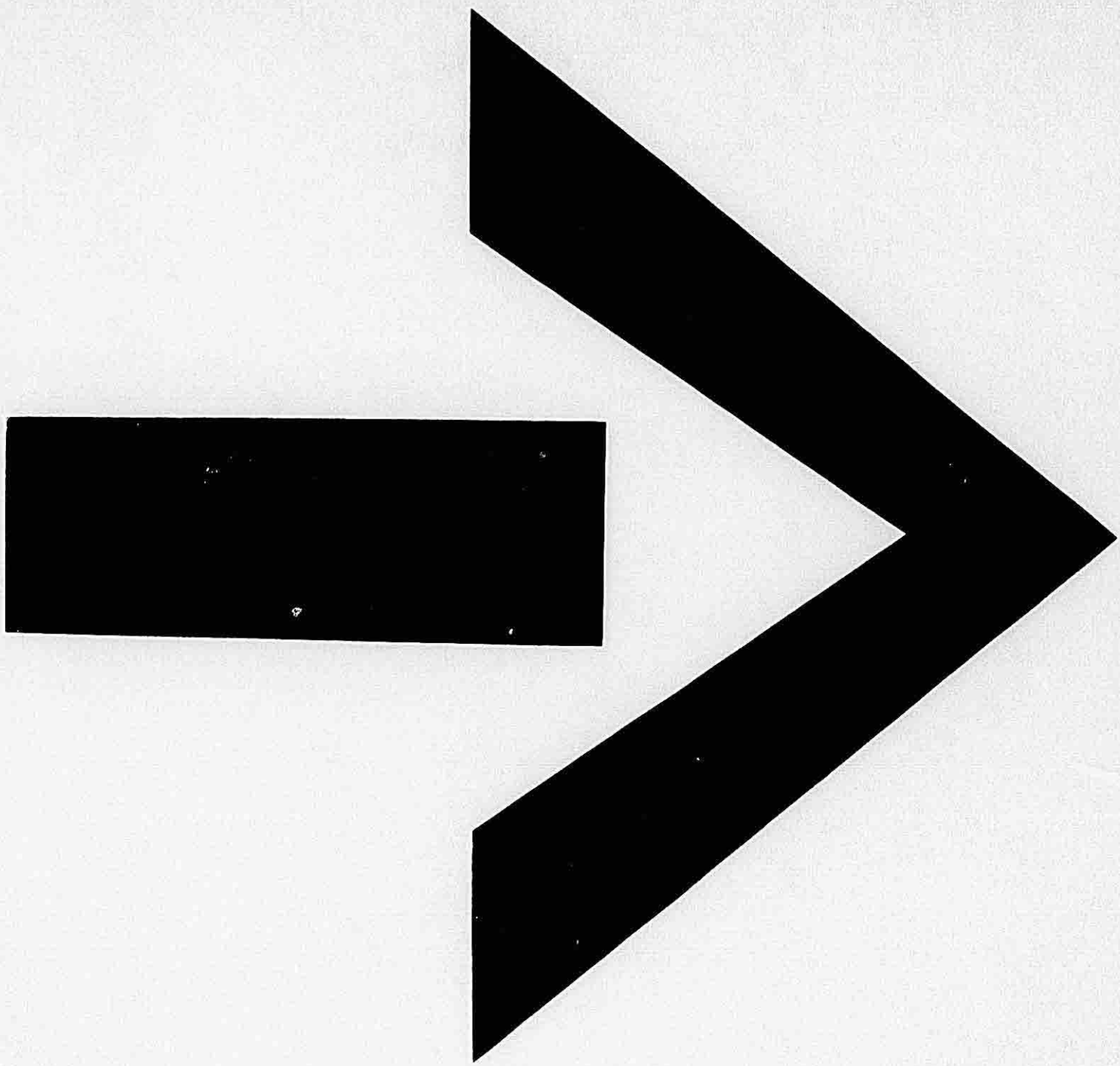
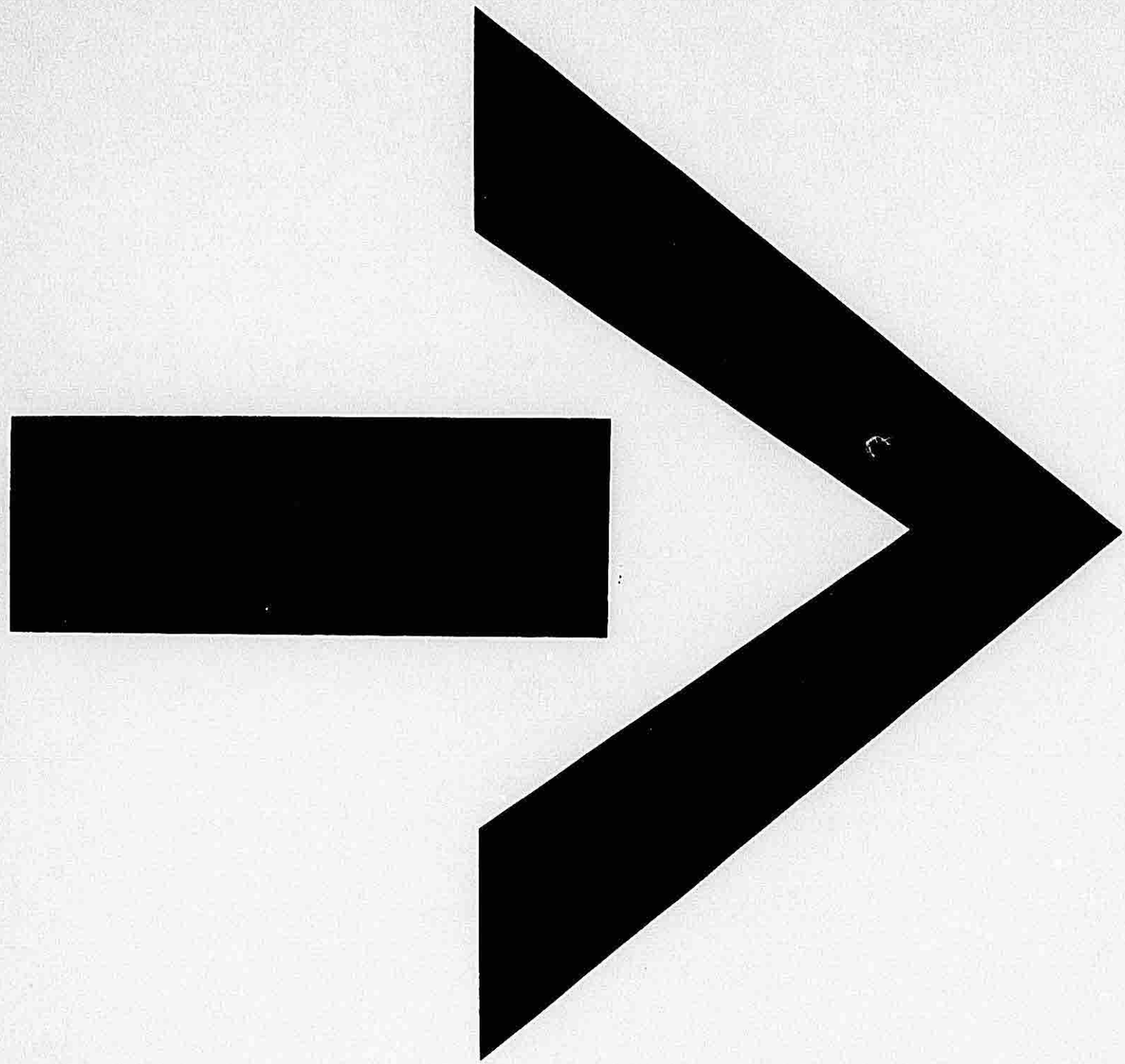


FIGURE 3-35. COMPARATOR (U104B WAVEFORMS)





3.10 POWER SUPPLY

The power supply requirements for the NAV 824/825 are met by a single-ended flyback switching regulator and a 3 terminal IC 8 Vdc regulator. The aircraft system voltage, 14 or 28 Vdc, is connected to the flyback switching regulator that supplies the following current protected and regulated voltages:

a. +190 Vdc for the gas discharge display.
b. +16 Vdc for the 3 terminal 8V regulator, gas discharge display and the VOR converter circuits.
c. +5 Vdc for the microprocessor, remote channel logic, synthesizer logic, dimmer circuits and the bearing logic.

The 3 terminal IC 8V regulator supplies voltage to the receiver circuits, VCO circuits, Omni converter, and bearing phase-locked loop.

3.10.1 Pulse-Width-Modulated, Single-Ended Flyback Switching Regulator

The "flyback" converter works by cyclically storing energy in a magnetic field and then delivering this stored energy to a load. As shown in Figure 3-36, output voltage control is achieved by varying the ratio of the closed Darlington switch Q601/Q602 (Tc) to open-switch (To) times. Therefore, output voltage depends on both the turns ratio of T601 and the Tc/To ratio, which can be controlled electronically by U601 (LM3525).

The operation of the single-ended flyback is different from a conventional transformer circuit because during the charge cycle the secondary or load is completely disconnected from the primary. The transformer (T601) secondary polarity is such that when Q601/Q602 are turned on, the anodes of CR603, CR605, and CR606 are reversed biased (negative voltage) and the secondary is open-circuited. During the time Q601/Q602 are turned on, the storage capacitors C606, C608, C609, and C607 supply the total output current.

When Q601/Q602 turns off, the energy field of T601 begins to collapse. reversing the polarity in the secondary windings such that diodes CR603, CR605, and CR606 are forward biased. The energy stored in the core is transferred into the load and the storage capacitors, replenishing the charge they lost when Q601/Q602 were closed and furnishing the load current by themselves.

3.10.2 U601 (LM3524) Regulating Pulse Width Modulator

This integrated circuit (IC) contains all the circuitry to generate the adjustable-frequency, width-modulated, 180° out-of-phase control pulses necessary to drive inputs of switching transistors for power converters. Refer to Figure 3-36.

Circuit operation is as follows: The LM3524 has two output transistors that are width-modulated, 180° out-of-phase control switches. These switches are alternately on and off for alternate half-cycles of the fundamental frequency. The "ON" times (To) are controlled by the DC voltage at the input of the triangle comparator. This control voltage is normally the output of the error amplifier and is the amplified difference between the reference voltage taken at the junction of R604/R605 and a fraction of the regulated voltage taken from the junction of R614/R615. The triangle comparator generates at its output, a negative-going rectangular pulse whose duration corresponds to the length of time the triangle amplitude is less than the error amplifier input to the comparator. This negative-going pulse is steered alternately by the binary counting flip-flop through to the positive logic NOR gates. The third input to the NOR gate is a narrow positive pulse corresponding in time to the negative-going edge of the triangle (sawtooth). It thus corresponds in time to the leading edge of the negative-going output pulse from the triangle comparator, and it ensures that there is a "dead time" between the end of a positive pulse at the base of one output transistor and the start of the next positive pulse at the base of the second output transistor. This will avoid simultaneous conduction in the output transistors.

In this design, the outputs of the two transistors are connected in parallel for an effective 0-90% duty cycle modulation and are applied to the switching transistors, Q601/Q602.

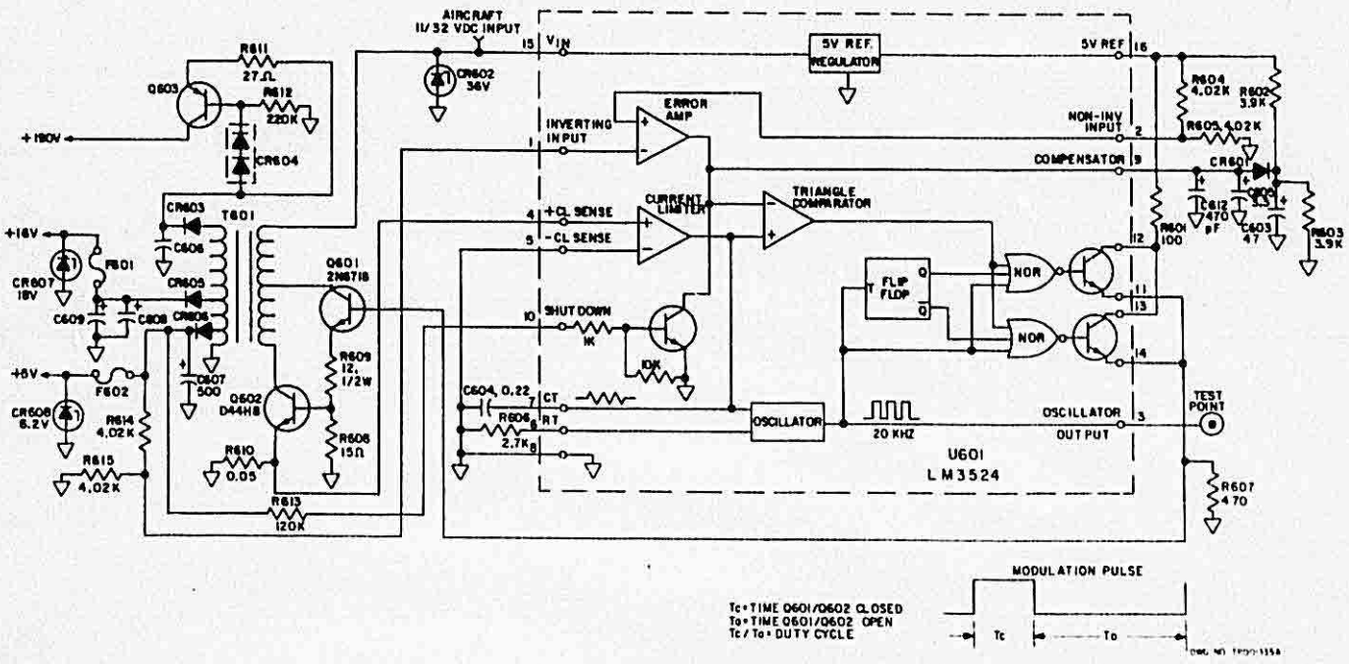


FIGURE 3-36. PULSE WIDTH MODULATED, FLYBACK SWITCHING REGULATOR

3.10.3 Protective Circuitry

A current-limiting comparator is included in this IC and is used for overcurrent sensing. Whenever the voltage at R610 rises to 200 millivolts, the output of the current-limit comparator will override the error amplifier and pull the output of the error amplifier toward ground. This will linearly decrease the output pulse width. At a threshold of 200 mv, the current limiting in this design will be 4 amps ($\frac{0.2 \text{ volts}}{0.5 \text{ ohm}}$). Overvoltage protection is provided by using the internal "shut down" transistor. A rise in the 5 volt output line will turn on the shut down transistor which will clamp the error amplifier output to ground. This will decrease the modulator pulse to 0% duty cycle.

For additional protection a "soft-start" circuit is included in this design. A soft-start is a gradual increase of the transistor duty cycle after switch-on causing a slow rise of the output voltage, which prevents an excessive inrush of current. This circuit is comprised of C605, C603, CR601, R602, and R603. Operation is as follows: At initial turn on, the diode CR601 clamps the error amplifier output to R603 which is a low impedance. This severly limits the duty cycle of the modulator pulse. As C603 begins to charge up to 2.5 volts through R602, the modulator pulse duty cycle slowly increases until diode CR601 is back biased and then the loop takes control of the duty cycle.

Two of the three output lines (+16 and +5 volts) are current protected with fuses that are soldered in place. In addition, the +16 volt line is over voltage protected by an 18 volt Zener, CR6-7. The 190 volt line is current protected by transistor Q603 and associated components. Operation is as follows:

A bias at the base of Q603 is established by a two-junction diode (CR604) called a stabistor. If the 190 volt line should demand to much current from C606, then the potential at the emitter of Q603 will drop which will tend to back bias the transistor and limit the current.

The switching transistors Q601/Q602 are connected in a modified Darlington fashion. Note in Figure 3-36 that the collector of the driver transistor Q601, is tapped to the primary of T601. This is done to allow the principle switching transistor, Q602, to saturate. If the collectors of Q601/Q602 were tied together as in a conventional Darlington, then if Q602 saturated, it would back bias the driver transistor Q601. However, since the collector of Q601 is tapped to a higher potential than that of Q602, this situation cannot occur.

The basic operating frequency of the LM3524 is determined by an external resistor (R606) and capacitor (C604) which control the frequency of the internal sawtooth oscillator. The sawtooth output is compared in the triangle comparator to the amplified error signal to derive the width-modulated control signal.

3.11 REMOTE CHANNELING CIRCUITS

The NAV 824/825 has remote channeling capability. The remote channel lines use the standard 2/5 format.

The circuitry consists of two 4 bit static shift registers U303/U304, two strobe hex inverter buffers U305/U306, and two transistor arrays U307/U308. Circuit operation will be explained using 112.60 MHz to remote channel a DME. Use Figure 3-37 to follow the explaination.

The DME to be remotely channeled must supply a ground for the "DME COMMON" line at J102-1 in order to remove U305/U306 from the "inhibit" mode.

When 112.60 MHz is selected, it is entered into the standby window and then transferred to the active memory by activating the transfer switch. At this time the 2/5 clock enable line from the microprocessor goes logic high. This line is connected to pin 13 of AND gate U116B. Approximately 30 microseconds following the clock enable, the 2/5 strobe and 2/5 data lines are activated. There will be eleven clock pulses gated through U116B and applied to the dual 4 bit static shift registers. The 2/5 data from the microprocessor is in serial form and represents the frequency 112.60 in 2/5 code. The shift registers consist of two internal identical, independent 4 state serial in-parallel output registers. Three of the four available registers are cascaded and the data is shifted from one stage to the next during the positive-going clock pulse transition. At the conclusion of the eleventh clock pulse, the 2/5 code is present at the Q outputs of U303/U304 and also the "Y channel activate" information at U303-12. U303-12 is logic high for a "X channel and logic low for a "Y" channel. The Q outputs of U303/U304 are applied to two strobed hex inverters, U305/U306, which will pass the information at their "D" inputs to their Q outputs if the "DME COMMON" is logic low. If this line is logic high, then U305/U306 will inhibit the information and all its Q outputs will be set to logic low. The inverted information at the Q outputs of U305/U306 is applied to two transistor arrays, U307/U308, consisting of three sets of NPN transistors per array. The emitters are all common and grounded. The collectors are connected to the channeling lines and each base is driven by a Q output from U305/U306. In the example in Figure 3-37, the logic highs at U305-Q2-Q4 turns on the C/E KHz transistors and U306-Q4-Q6 turns on the A/C MHz transistors, pulling their collectors to ground.

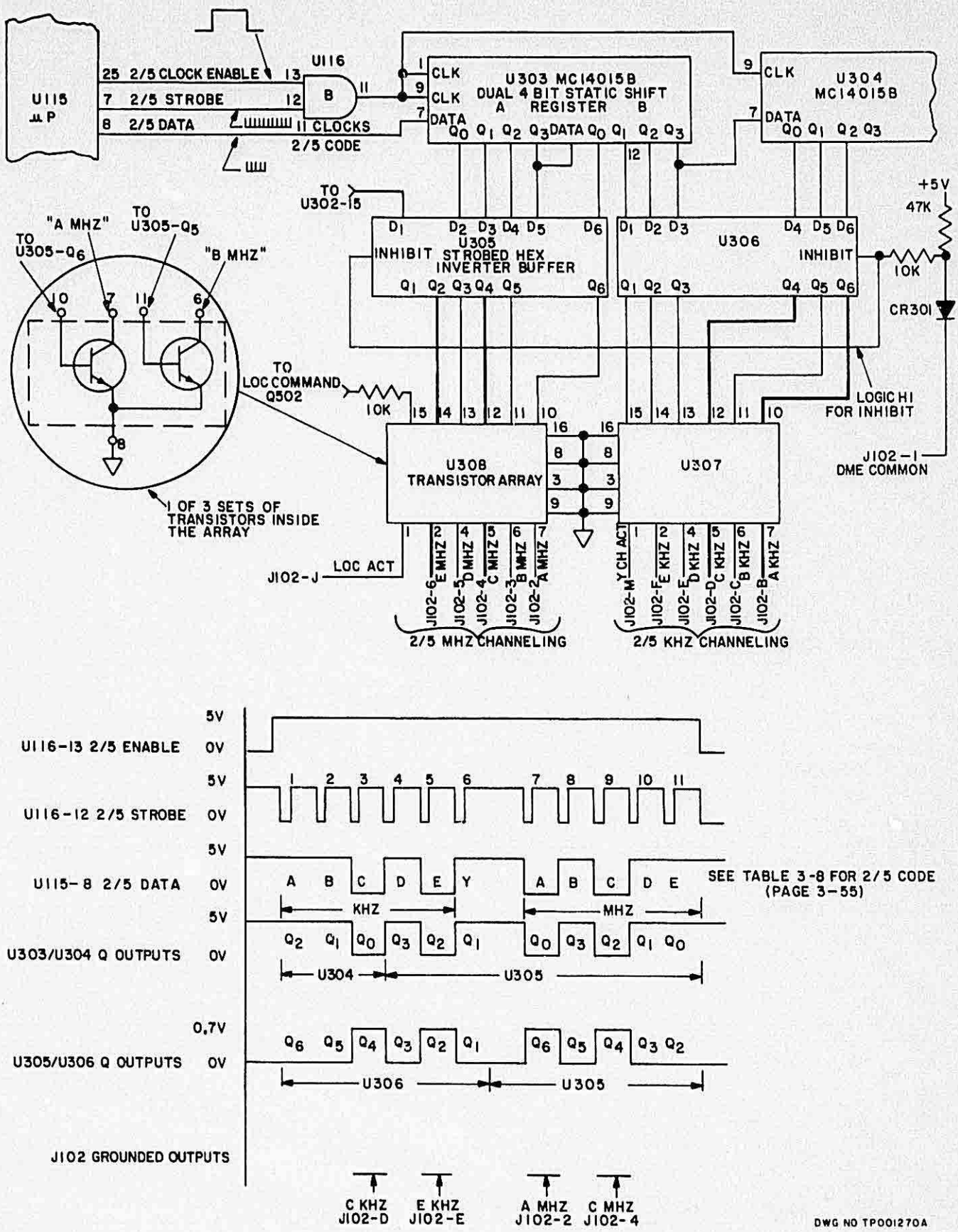
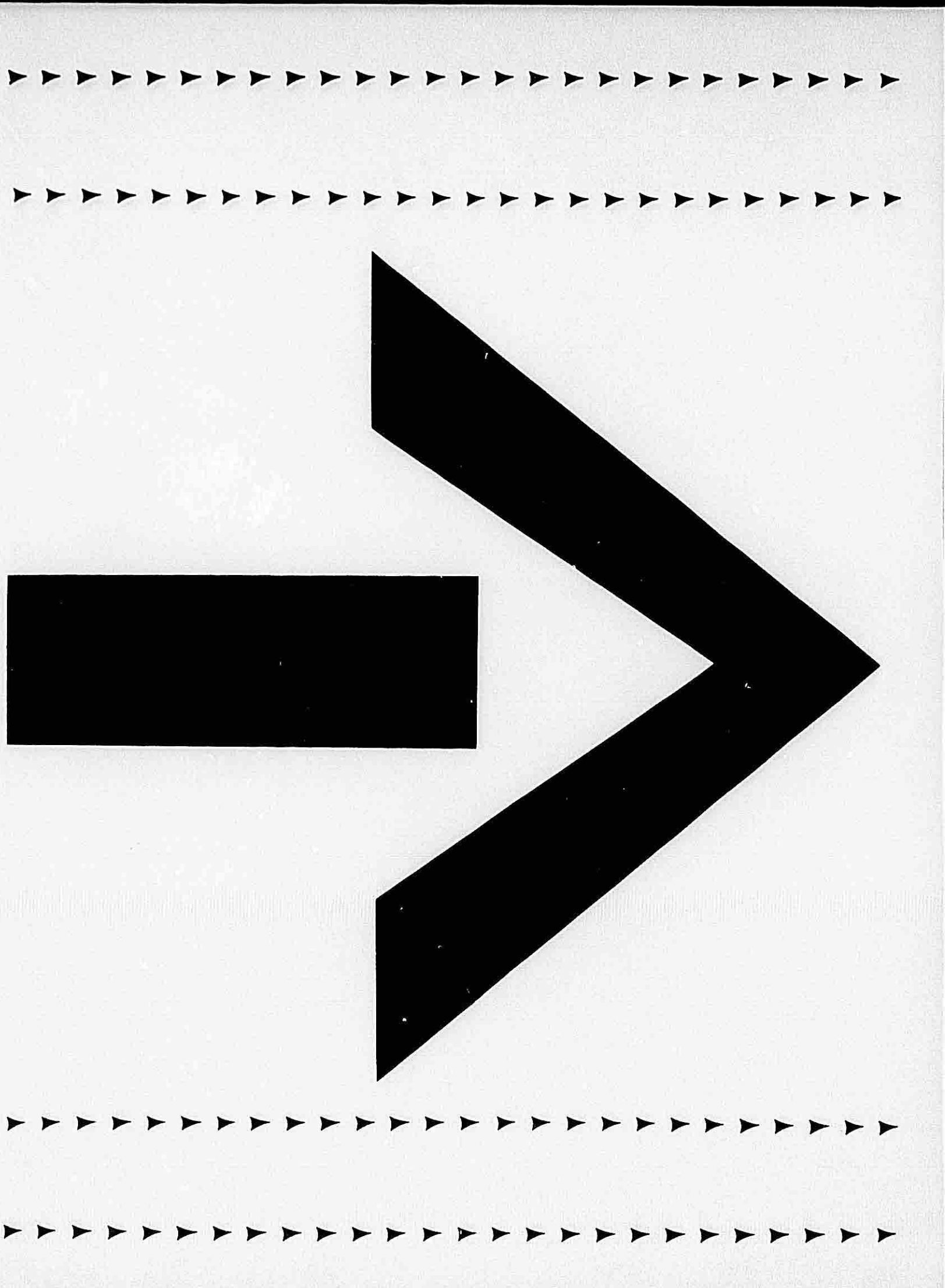


FIGURE 3-37. REMOTE CHANNELING PROGRAMMING FOR 112.60 MHz



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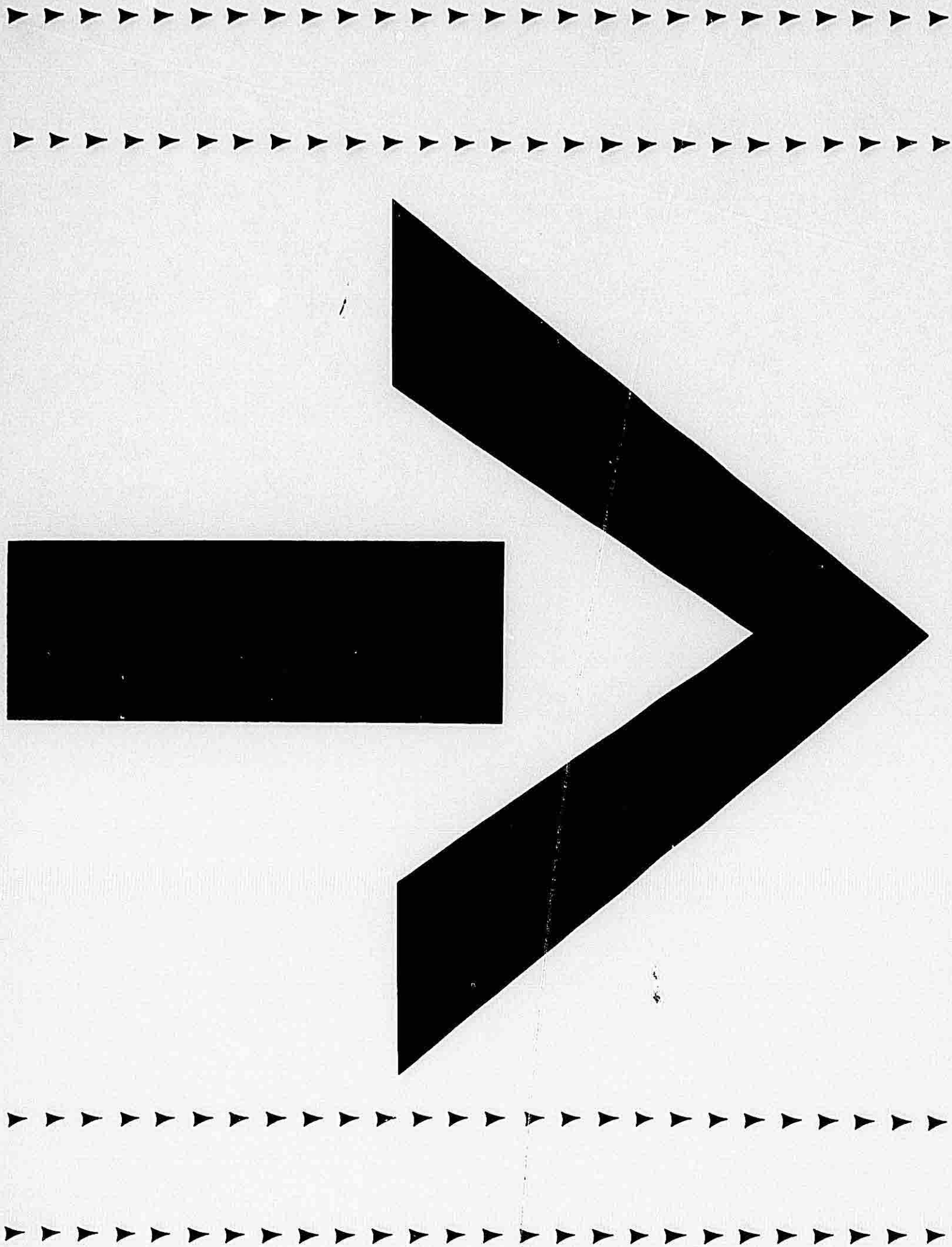
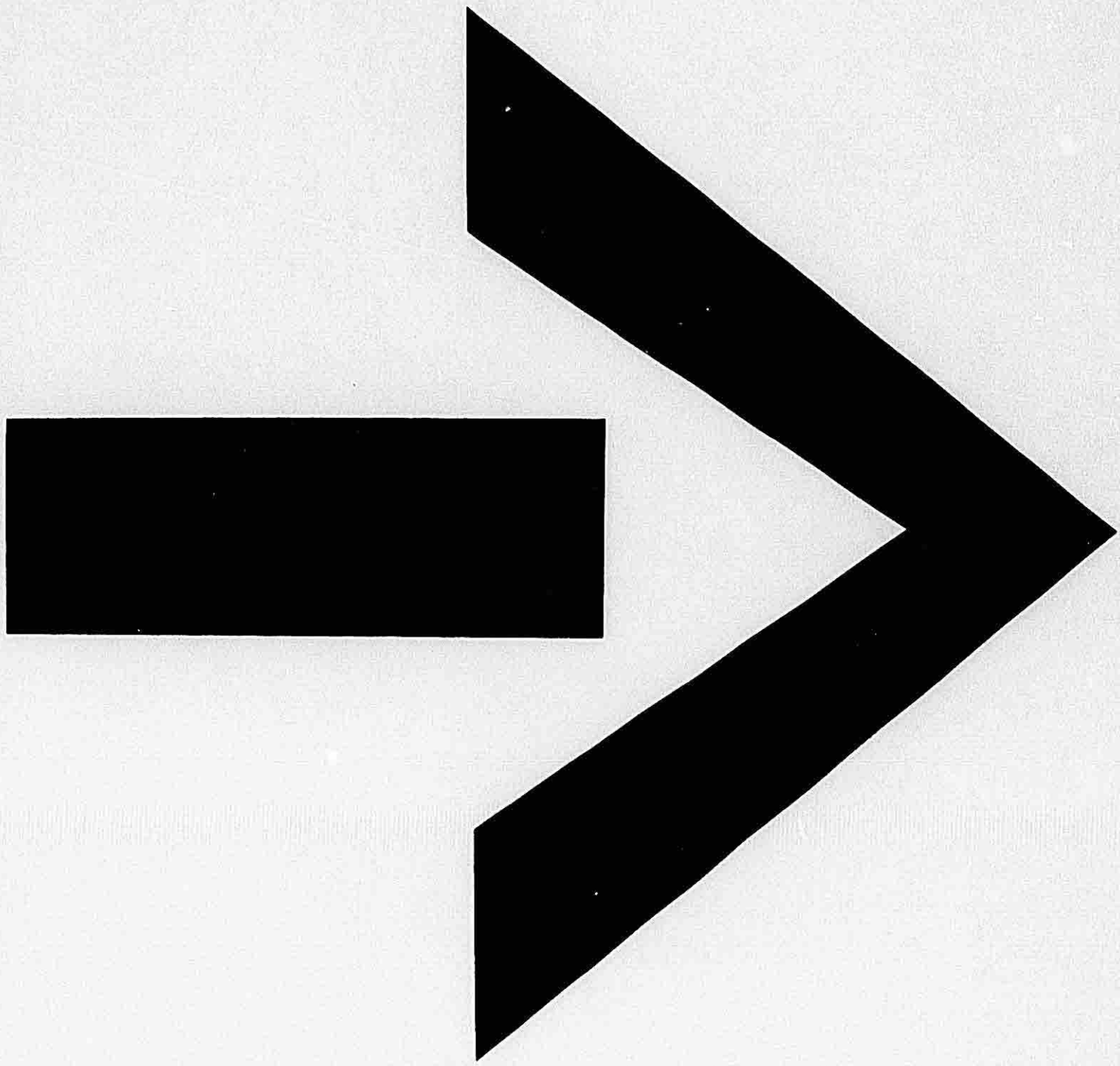
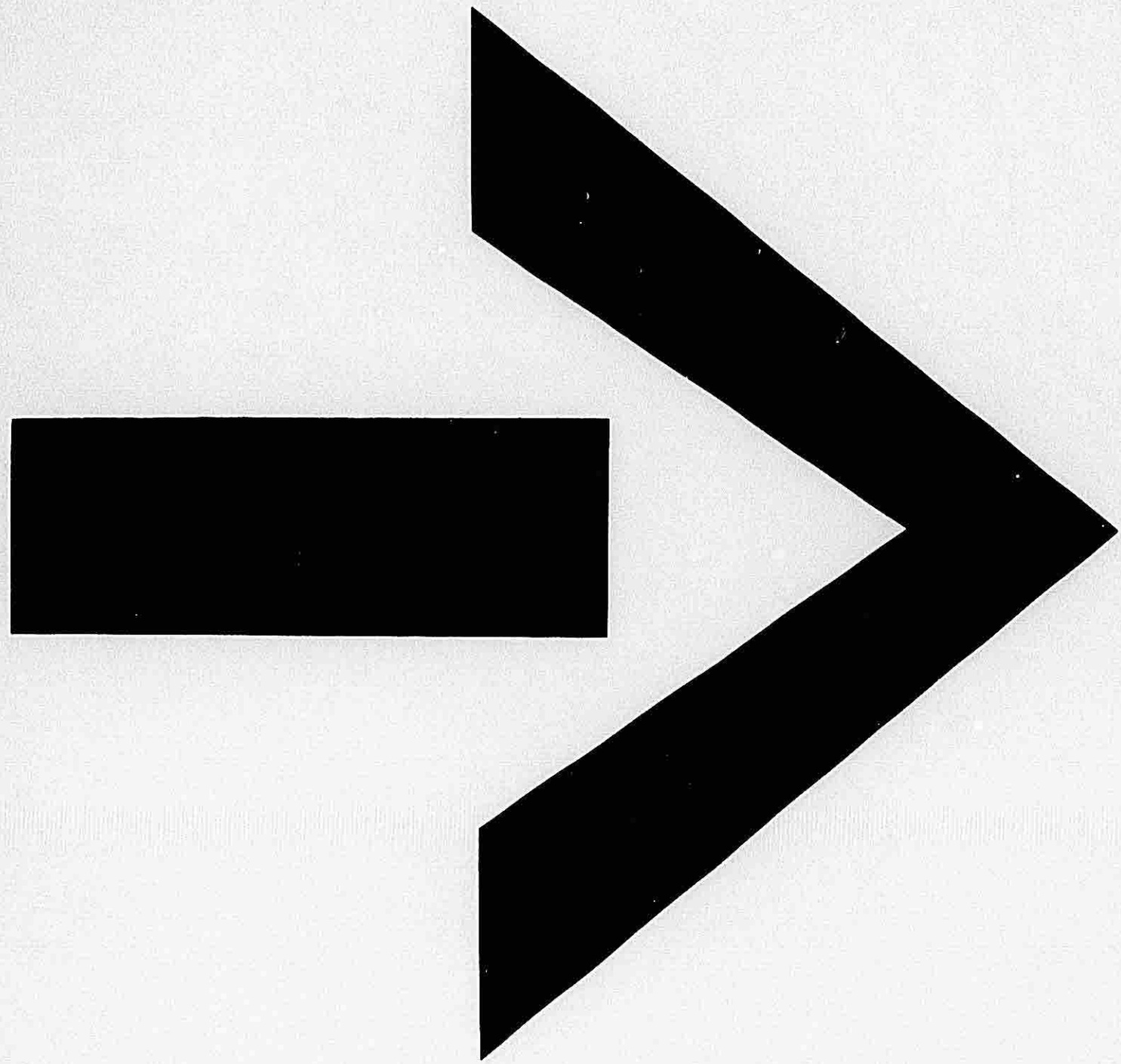






4.1 THE MICROPROCESSOR CONTROLLED NAV 824/825

The microprocessor in the NAV 824/825 is from the 3870 family of microprocessors. The microprocessor duties include the following:

1. Control of the gas discharge display
2. control of the synthesizer
3. validation of the Keep-Alive data
4. computation of the digital bearing data.

Microprocessors are relatively new to general aviation avionics and many technicians who have not kept abreast of modern technology may feel apprehensive about troubleshooting a microprocessor controlled radio. A situation like this could easily lead one to always lay the blame on the microprocessor for any malfunction of the radio. Common sense dictates that this type of oversimplification must be avoided by the service technician. The confidence level that Narco has in the 3870 series of microprocessors is very high and they feel it is the least likely component to fail.

This section of the manual will provide the service technician with information, in the form of troubleshooting flowcharts, that provide a systematic approach to remedy a malfunctioning circuit or component. In addition, alignment and adjustments are given in Section 4.4.

4.1.1 The 3870 Single-Chip Microprocessor (uP)

The 3870 is a complete 8-bit microprocessor on a single MOS integrated circuit. The device features: 4032 bytes of ROM, 64 bytes of scratchpad RAM, 64 bytes of executable RAM, a programmable binary timer, 32 bits of I/0, and a single +5 volt power supply requirement.

The four complete bidirectional input/output (I/O) ports consisting of 32 lines which are divided into groups of 8, can be individually used as either TTL compatable inputs, or as latched outputs. The standard output configuration of these lines are shown in Figure 4-1. The reset and memory enable are the only ports that are of the open drain type.

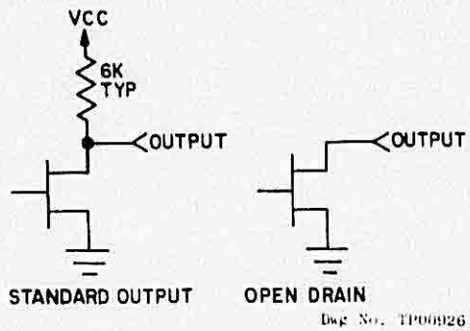


FIGURE 4-1. STANDARD MICROPROCESSOR PIN OUTPUT CONFIGURATION

4.1.1 Continued

CAUTION: All the standard precautions that apply to MOS devices should be observed. Any output line shorted directly to a voltage source will destroy the output port.

WARNING: It is not recommended that a ohmmeter be used to troubleshoot this device as the meter's high battery voltage may cause damage.

CAUTION: If it becomes necessary to replace the microprocessor the following procedure is recommended:

1. Read Section 4.1.2.
2. Cut every pin on the microprocessor as close to the top of the chip as possible. This will leave a pin length long enough to be handled by a long nose plier.
3. While unsoldering each pin, pull the pin from the PC board with the long nose plier as soon as the solder melts.

4.1.2 A Word About Soldering Irons

Probably every service technician, who worked on printed circuit boards, has at sometime during his career, ruined a board by using a soldering iron that was so hot that it destroyed the bond between the track and the board. Separation of the conducting path or plated through holes can be avoided by using a soldering iron controlled by Powerstats, Variacs, or soldering irons having temperature sensing tips.

Tip temperature of the iron should not exceed 600°F to safely remove components from a PC board.

A few temperature controlled soldering irons (and tips) are:

Ungar	Type 50T6	600°F (120 Vdc)
Ungar	Type 60T6	600°F (24V)
Weller	Type WTCPN	W/600°F Temp Sensing Tip(s)

Above irons selected from Catalog 104: Newark Electronics
500 N. Pulaski Rd.
Chicago, Ill 60624
(312-638-4411)

4.2 WIRING

The NAV 824/825 construction is modular with a ribbon cable and a RF coaxial harness connecting the receiver board to the main PC board. There are no connectors and the few individual wires present are soldered to the PC boards as point-to-point wiring.

TABLE 4.1. PC BOARD IDENTIFIERS

Symbol Number Series	CIRCUIT	Schematic Figure No.
100's	Display Circuits, Reset Circuit, Memory Enable, Transfer, Keep-Alive, Digital Bearing Selector	6-2
200's	Not Used	
300's	VOR/LOC and Glideslope Prescaler and Phase-locked Loop, 2/5 Remote Channeling	6-2
400's	IDENT Filter and 50 mw Audio	6-2
500's	VOR/LOC Converter	6-2
600's	Switching Regulator A	6-2
700's	Not Used	
800's	Not Used	
900's	VOR/LOC Synthesizer Loop Filter, VCO, VCO Buffer, Prescaler Buffer	6-3
1000's	VOR/LOC Receiver, Detector, AGC, Audio Amp	6-3
1100's	Glideslope Receiver, GS Detector, GS AGC, GS Converter	6-3
1200's	Glideslope Synthesizer Loop Filter, VCO, VCO Buffer, Prescaler Buffer	6-3

4.3 TEST EQUIPMENT

Table 4.2 lists the test equipment required to perform the alignment, test, and troubleshooting procedures described in this manual.

TABLE 4.2. TEST EQUIPMENT LIST

TYPE	CHARACTERISTICS
Oscilloscope	Frequency Range: 0 to 10 MHz
Frequency Counter	Frequency Range: DC - 500 MHz Input Impedance: 1 megohm shunted by a 25 pF capacitor.
Regulated DC Power Supply	Output: 10 to 30 Vdc, 0 to 10 Amperes
RF Signal Generator	Frequency: 10 to 480 MHz RF Output: 1 uV to 1V Modulation: 30 to 95% Generator Impedance: 50 ohms
Audio Signal Generator	Frequency: 5 Hz to 600 KHz Distortion: 1% maximum
Audio Wattmeter	Power Range: 50 mW full scale Load Impedance: 500 ohms
Voltmeter	DC Range: ±100 mV to ±1000V AC Range: 10 mV to 300V Resistance: Low power ohmmeter Imput Impedance: 10 megohms
RF Voltmeter	Voltage Range: 0.01 to 1 V rms ±3%, at 64 MHz Imput Impedance: 50K ohms at 64 MHz
Digital Voltmeter	DC Range 0 to 1000V
RF Sweep Generator	Texcan Model VS-80

4.4 ALIGNMENT PROCEDURES

This section presents alignment procedures for the NAV 824/825. These procedures require disassembly and reassembly of the Unit. For the following alignments connect the NAV for a bench check as outlined in Section 2.

4.4.1 VOR Converter Alignment

Set the VOR generator and NAV Active frequency to 115.50 MHz. Set the generator RF level to 500 uv.

A. FM detector VCO Adjustment
   Short U501 pin 5 to ground. Monitor TP13 with a frequency counter. Adjust R507 until the counter reads 9960 ±20 Hz. Leave the short at U501 pin 5 for steps B and C.

B. L/R DC Balance Adjustment
   Adjust R532 until the L/R needle of the VOR indicator is centered.

C. Autopilot DC Balance Adjustment
   Connect a digital voltmeter between U503 pin 8 and U502 pin 8. Adjust R582 to give a 0 Vdc reading on the VM. Remove the short from U501 pin 5.

D. VOR Zero, Course Width and VOR Phase Adjust Using the ID 824/825 Indicator
   Set the VOR generator and ID 824/825 OBS to 80 degrees. Adjust VOR zero, R511, to give a centered L/R needle. Set the VOR generator to 90°. Adjust R523 course width to set the L/R needle on the fifth dot. Course width from full Left to Right = 20° ±2°. Set the VOR generator and ID 824/825 OBS to 170 degrees. Adjust R520 to give a centered L/R needle. Check bearings at 30° intervals for ±1.5° accuracy.

E. VOR Zero, Course Width and VOR Phase Adjust Using a Resolver Type Display
   Set the VOR generator and resolver OBS to 345 degrees. Adjust VOR zero R511 to center the L/R needle. Set the VOR generator to 355 degrees. Adjust course width R523 to place the L/R needle at the fifth dot. Course width from full left to full right is 20° ±2°. Set the VOR generator and OBS to 75 degrees. Adjust VOR phase, R520, to center the L/R needle. Check bearings at 30° intervals for ±1.5° accuracy.

F. Digital Bearing Zero Adjustment
   Set the VOR generator bearing to 29.5 degrees "TO". Set the NAV 824/825 mode switch to the "TO" bearing mode. Adjust R559 so the NAV bearing reads 030 degrees. Check bearings at 30° intervals for ±1° accuracy.

NOTE: Whenever the VOR Zero pot R511 is adjusted, the digital bearing zero must also be rezeroed.

4.4.2 Localizer Converter Alignment

Set the VOR generator and NAV Active frequency to a localizer channel.

A. Localizer Zero Adjustment
   Apply a standard 0 ddm centering signal to the NAV Unit. Adjust R575 for a centered L/R needle.

B. Localizer Course Width Adjustment
   Apply a .093 ddm deflection signal to the NAV Unit. Adjust R566 for a 3 dot course width ±1 needle width or 90 mv as measured between U503-7 and U502-8.

4.4.3 Glideslope Converter Alignment

Set the VOR/ILS generator and NAV Active frequency to GS channel.

A. Glideslope Zero Adjust
   Apply a 0 ddm centering signal to the NAV Unit. Adjust R1136 for a centered up/down needle.

B. Glideslope Course Width Adjustment
   Apply a .091 ddm deflection signal to the NAV Unit. Adjust R1124 for a 2-1/2 dot course width ±1 needle width or 78 mv as measured between U502-8 and U1104-7.

4.4.4 3.2 MHz System Clock Adjustment

Set the NAV Active frequency to 108.00 MHz. Monitor the RF drive at E1018 with a frequency counter. Adjust C305 for a frequency reading of 91.000 MHz ±5 KHz.

4.4.5 VOR/LOC Synthesizer VCO Adjustment

Set the NAV Active frequency to 108.00 MHz. Monitor the cathode of CR901 with a digital VM. Adjust L901 so the VM reads 2.2 ±0.02 Vdc. Set the NAV Active frequency to 117.95 MHz. The VM should read 4.2 ±0.02 Vdc.

4.4.6 Glideslope Synthesizer VCO Adjustment

Set the NAV Active frequency to 108.95 MHz. Monitor the cathode of CR1201 with a digital VM. Adjust L1201 so the VM reads 4.2 ±0.02 Vdc. Set the NAV Active frequency to 110.30 MHz. The VM should read 4.7 ±0.02 Vdc.

4.4.7 IDENT Filter Adjustment

Set the NAV Active frequency and VOR generator to 115.50 MHz at a 500 uv RF level. Delete the 30 Hz AM and 9960 FM signals from the VOR generator. Set the VOR generator's 1020 Hz IDENT to 30% modulation. Monitor TP12 with a scope. Push the NAV 824/825 IDENT switch in and adjust the volumn control to give a maximum signal without distortion. Pull out the NAV 824/825 IDENT switch. Adjust L401 for a minimum signal at TP12.

4.4.8 Display Dimmer Adjust

See Section 2.6.2.8.

4.4.9 VOR/LOC Receiver Rf Front End Alignment

Set the NAV Active frequency and VOR generator to 113.00 MHz at a 5 microvolt RF level. Monitor the RF AGC line at U1002 pin 13 with a digital VM. Adjust each of the following inductors for a minimum RF AGC voltage: L1001, L1002, L1003, and T1001.

4.4.10 Glideslope Receiver RF Front End Alignment

A. Set the NAV Active frequency to 108.95 MHz and Standby to 110.30 MHz.
B. On the VOR/ILS generator set the GS 90/150 Hz modulation switch to 90 Hz only.
C. Set the VOR/ILS generator to 108.95 MHz at a 5 microvolt RF level.
D. Monitor TP25 with a scope.
E. Compress the last link only of L1102 and first link only of L1103 to give a maximum signal at TP25
F. Transfer 110.30 MHz to the NAV Active channel and set the VOR generator to 110.30.
G. Spread the last link only of L1102 and first link only of L1103 to give a maximum signal at TP25. (Refer to Figure 4-2)
H. Go back and forth between 108.95 and 110.30 MHz and by spreading or compressing L1102 and L1103, achieve a balanced amplitude at TP25.

WARNING: Do not move L1104 with respect to L1103 as L1104 has been set at the factory for optimum image rejection.

I. Spread or compress L1105 to give the best overall sensitivity.

NOTE: If Q1101 or Q1102 are changed, do not retune if the sensitivity meets specs.

The further the 3.2 MHz system clock deviates from its true frequency, the worse the GS receiver sensitivity becomes. Make sure that the clock is set as perfect as possible. See Section 4.4.4.

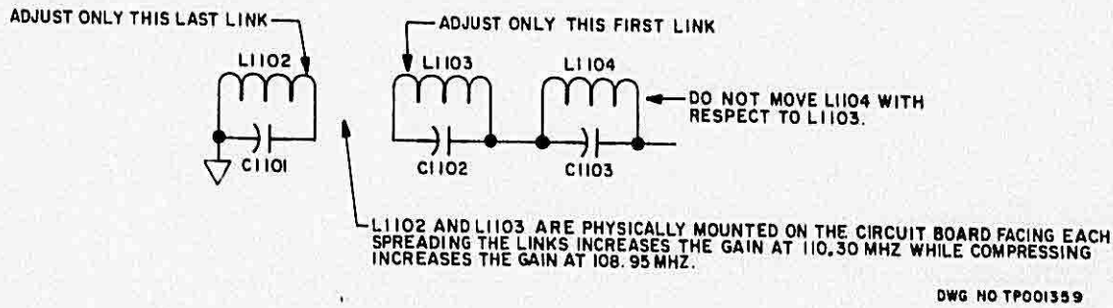


FIGURE 4-2. GLIDESLOPE RF TUNING TECHNIQUE

4.4.11 VOR/LOC Receiver IF Alignment

IF alignment is required when either crystal filter, FL1001 or FL1002 is replaced. Unless one of the tunable inductors, T1002 through T1005 is physically damaged and replaced, no other component change requires re-alignment.

A method is presented here by which the IF receiver can be swept without using a sweeper. The technique consists of applying a 100 Hz audio signal into the VOR/LOC synthesizer VCO which repetitively pulls the VCO approximately 50 KHz off frequency. This is enough to sweep the nose of the IF crystal filters. The VOR generator is set 50 KHz higher than the NAV 824/825 Active frequency.

A. Set the VOR generator to 115.550 MHz. If your VOR generator cannnot be set in 50 KHz steps, then use a standard VHF generator and set the CW signal to the exact frequency by using a frequency counter. Do not allow the generator to drift off frequency.
B. Delete the 9960 FM and 30 Hz AM signals from the VOR generator.
C. Set the VOR generator RF level to 5 microvolts.
D. Set the NAV 824/825 Active frequency to 115.50 MHz.
E. Short U1001 pin 5 to ground.
F. Monitor U1002 pin 9 with a scope.
G. Connect an audio oscillator to the VOR/LOC VCO at the junction of R906/R907/R908. The audio frequency shall be 100 Hz and initially the signal level is set to 0 Vpp. Refer to Figure 4-3 for the set-up.
H. Slowly increase the amplitude of the 100 Hz signal until the scope presentation is the same as Figure 4-4. It is very easy to overdrive the VCO so increase the 100 Hz slowly.
I. Switch the scope time base to 200 us and carefully adjust the 100 Hz audio amplitude to set the response width to 1600 us as shown in Figure 4-5. Figure 4-5 represents a correctly tuned IF receiver.
J. Tune T1002 through T1005 using Figure 4-6 as your model.

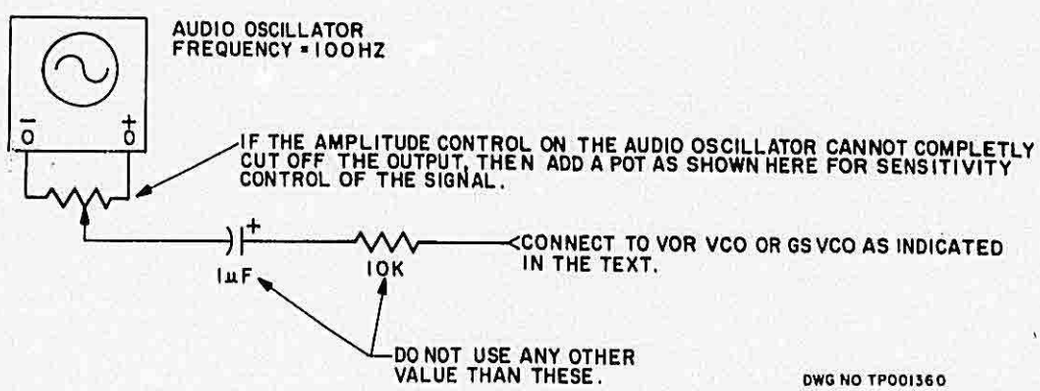


FIGURE 4-3. VOR/LOC AND GS IF ALIGNMENT TEST SET-UP

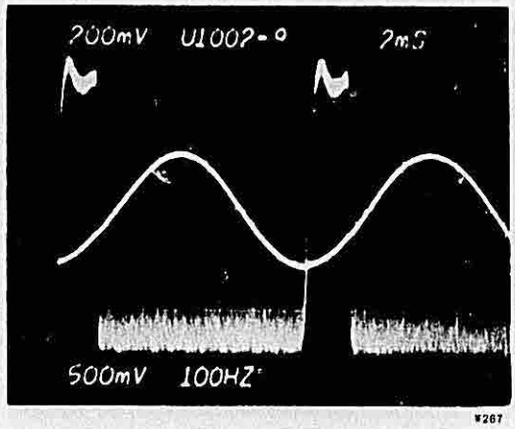


FIGURE 4-4. IF RESPONSE CURVE AND 100 Hz AUDIO

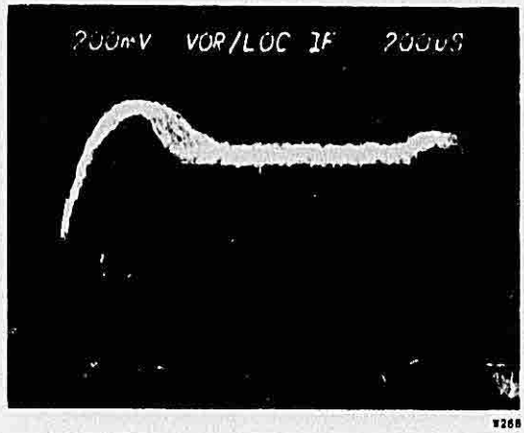


FIGURE 4-5. VOR/LOC IF RESPONSE CURVE MODEL

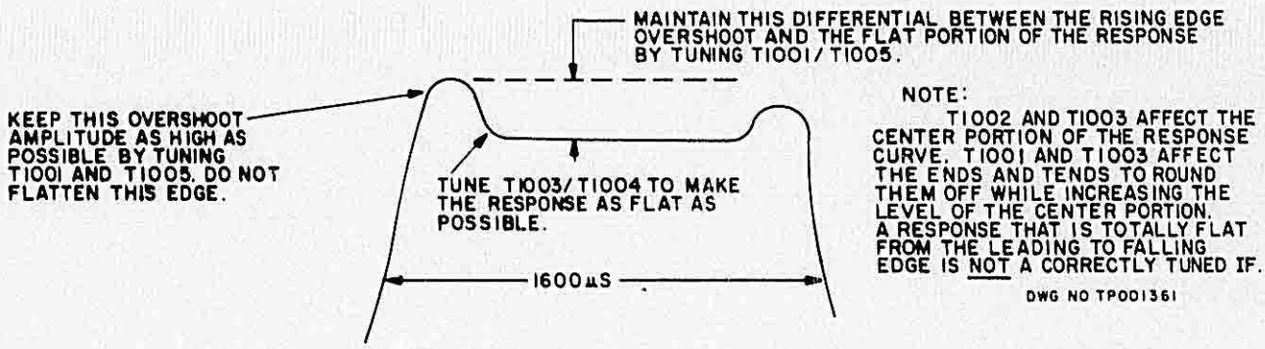


FIGURE 4-6. IF TUNING TECHNIQUE

4.4.12 Glideslope Receiver IF Alignment

Alignment is required when a crystal in FL1001 is replaced or a damaged IF tunable inductor is replaced. The sweep technique used is the same as explained in Section 4.4.11.

A. Set the VOR generator to 110.550 MHz and RF level to 50 microvolts.
B. Delete both the 90 and 150 Hz modulation.
C. Set the NAV 824/825 Active frequency to 110.50 MHz.
D. Monitor TP25 with a scope.
E. Connect a audio oscillator to the GS synthesizer VCO at the junction of R1206/R1207. The audio frequency shall be 100 Hz and initally set the output to 0 volts. Refer to Figure 4-3 for the test set-up.
F. Slowly increase the amplitude of the 100 Hz signal until the scope presentation is as shown in Figure 4-7. It is easy to overdrive the GS VCO so increase the 100 Hz very slowly.
G. Switch the scope time base to 200 us and very carefully adjust the amplitude of the 100 Hz audio to set the IF response width to 1400 us. Use Figure 4-8 as your model.
H. Tune T1101, T1102, and T1103 as shown in Figure 4-9, which represents a correctly tuned GS IF receiver. Use it as a model.

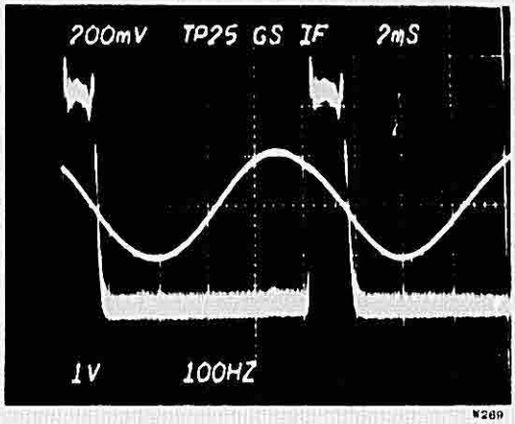


FIGURE 4-7. GS IF RESPONSE AND 100 Hz AUDIO

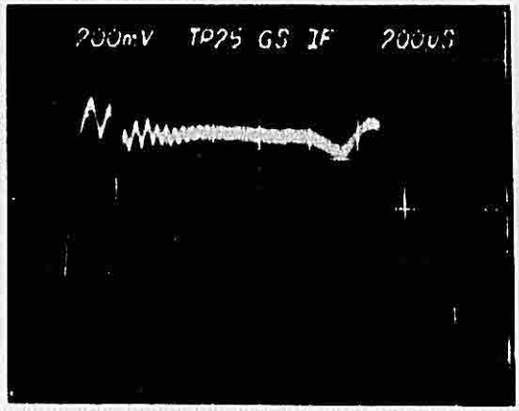


FIGURE 4-8. GS IF RESPONSE CURVE MODEL

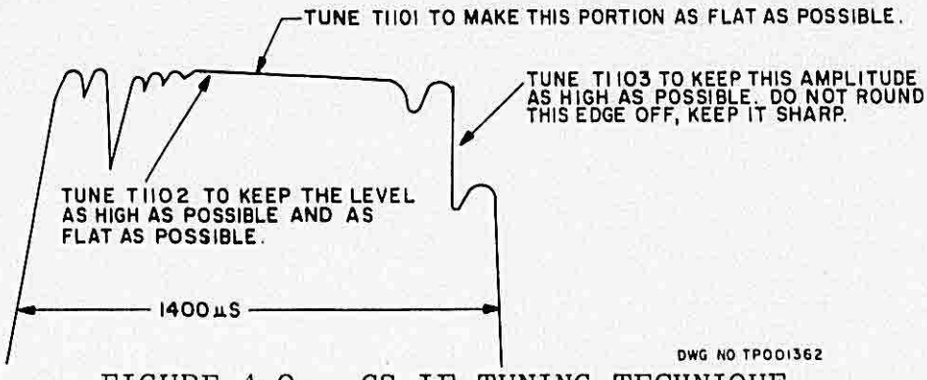


FIGURE 4-9. GS IF TUNING TECHNIQUE

4.4.13 Select By Test Resistors

The following SBT (select by test) resistors are listed and the procedure used to determine their value.

R1113: Set the NAV Unit and VOR/ILS generator to a GS channel. Set the RF input level to 10 microvolts. Monitor TP25 with a ACVM. Take a reference reading at 10 uv. Increase the RF input to 10K uv. TP25 should not increase more than 3 db with respect to the reference. If it does, change R1113 to keep it 3 db or less.

R1122: Monitor TP25 with a scope to show good noise level. Connect a R box set to 470K across R1121. Decrease the R box value until the noise level just starts to decrease. Go up one standard R value and solder this value resistor across R1121.

R1024: Monitor U1002 pin 9 with a scope to show good noise level. Connect a R box set to 1 meg across R1025. Decrease the R box value until the noise level just starts to decrease. Go up one standard R value and solder this value resistor across R1025.

R1031: When checking the IDENT filter and 50 mw audio output at TP12 according to Section 4.4.7, the audio power may be slightly increased if required. Monitor TP12 with a scope. Adjust the volume control to give a maximum undistored 1020 Hz sine wave presentation. If the peak-to-peak value is less than 14 volts, place an R box across R1032 and select a value to give a 14 Vpp signal. Solder this value across R1032.

R1048: Set the NAV Unit and VOR generator to a VOR channel. Set the RF input level to 10 microvolts. Monitor U1002-9 with a ACVM Take a reference reading at 10 uv. Increase the RF level to 10K uv. U1002 pin 9 should not increase more than 3 db with respect to the reference. If it does, change R1048 to keep it 3 db or less.

4.4.14 ARINC NAV Video Adjustment R1046 (TP24)

Set the VOR generator and NAV Active frequency to a VOR channel. Set the RF level to 500 uv and delete the 9960 Hz FM from the VOR generator. Monitor TP24 with a ACVM. Adjust R1046 to give a 0.5 Vrms signal.

4.5 NAV 824/825 TROUBLESHOOTING

Component failures within the NAV 824/825 may be readily found by using the troubleshooting flowcharts provided in this Section.

Circuit theory is furnished in Section 3 while schematics and components location diagrams are located in Section 6.

4.5.1 Gas Discharge Display and Display Circuits Troubleshooting

The gas discharge display in the NAV 824/825 is identical to and interchangeable with the COM 810/811 gas discharge display. Contained within the display are: a pair of aimer arrows, the eight digits that display Active and Standby (Standby digits represent digital bearings in TO/FR Mode) and function legends. The functional legends are: XMT, LOC, TO, and FR. The NAV 824/825 display circuits will only illuminate the legends TO, FR, and LOC. The other legend, XMT, is for use in the COM 810/811 and is normally always extinguished by the NAV 824/825 display circuitry. However, certain types of circuit malfunctions can cause the XMT, LOC, TO, and FR legends to illuminate when they should be extinguished. Because the display can visibly indicate this and other types of malfunctions, the display troubleshooting flowcharts have been designed using the SYMPTOM format. When a NAV display malfunctions, simply match the Unit's display symptom with the appropriate symptom in the troubleshooting flowchart, Figure 4-10.

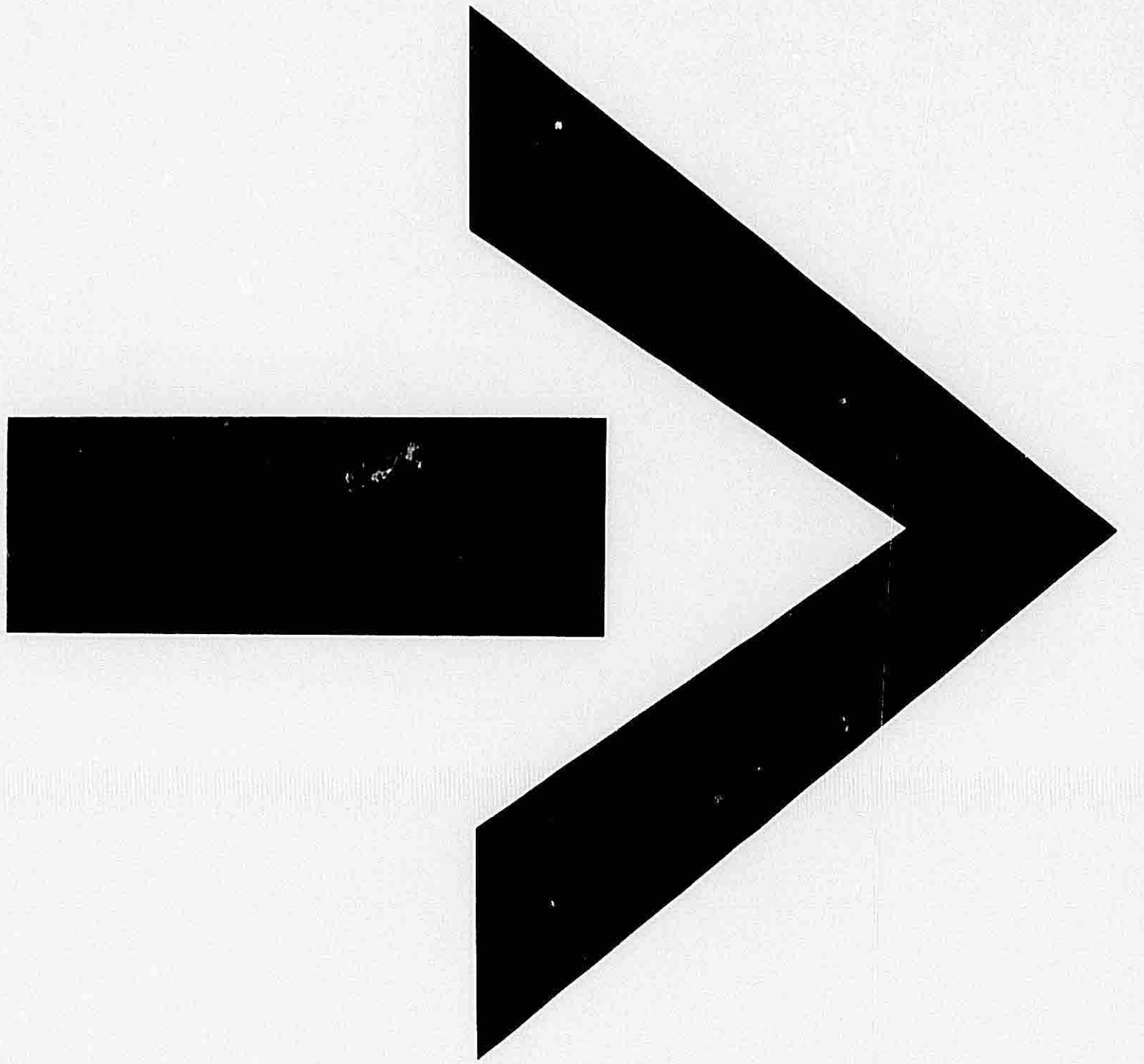
Please take note of the following:

A. The display anode voltage is +190 Vdc. Do not be careless when troubleshooting.

B. The +16 Vdc and +5 Vdc supplies are fuse protected by 0.5 amp solder-in type fuses, F601/F602. These fuses are very fast-blow types and a careless slip of a probe which causes a short will always blow a fuse. It would be wise to have a supply of these type fuses.

C. U101 (UDN6184) Digit Driver

The maximum supply voltage allowed is 120 Vdc. Note that the supply voltage to this IC is 80V (190V minus 110V) because the Vss (pin 8) is not referenced to ground but to 110 Vdc that is taken from the cathode of CR102. If CR102 should short or the 110V PC track become shorted, then a full 110V would be applied across U101 which would destroy the IC.

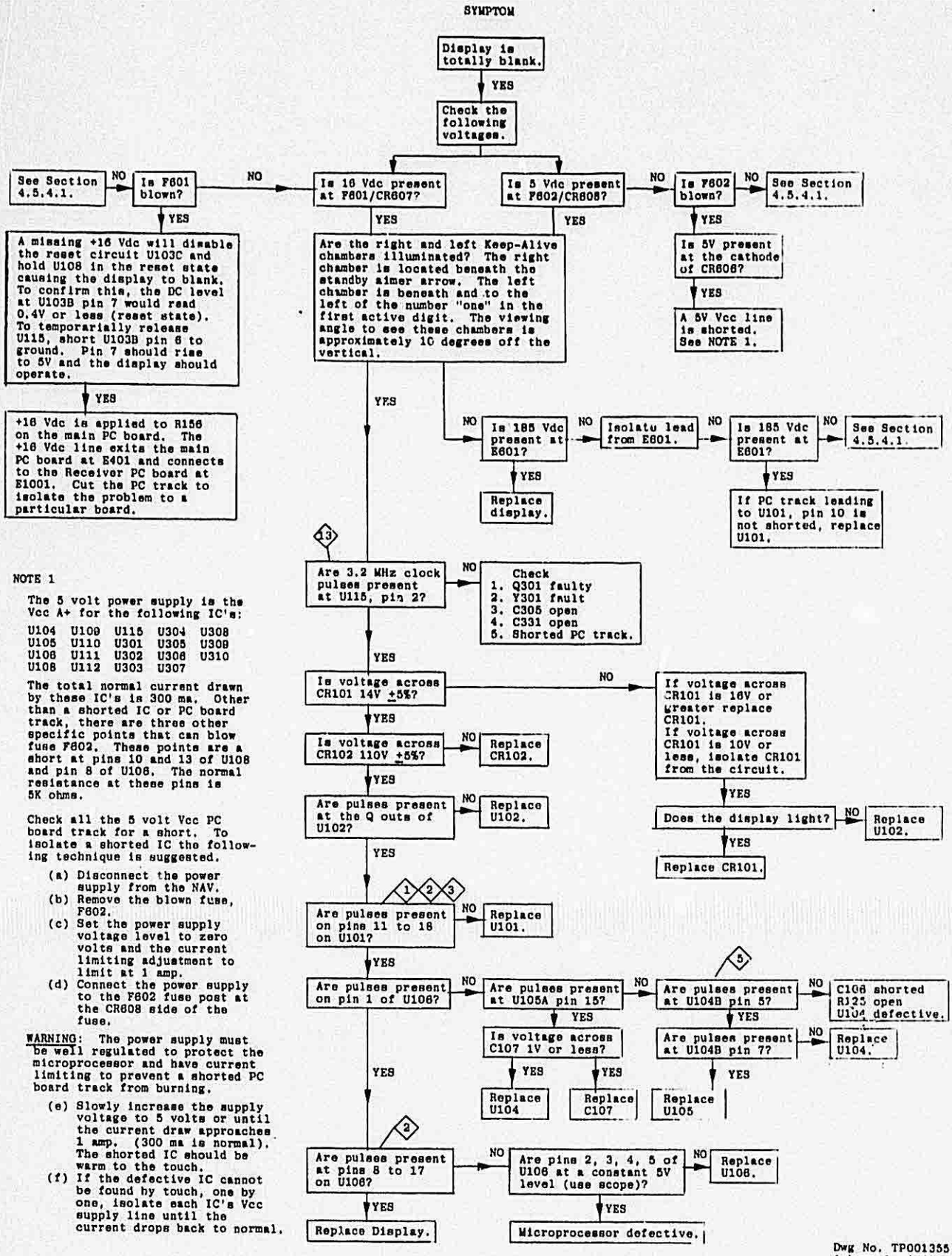


4.5.1 Continued

D. U106 (DS8884), U108 (DS8880) Segment and Legend Drivers
The maximum output voltage allowed is 80 Vdc. Note that diode array U107 clamps the outputs to 75 Vdc. The 75 volts is taken from the junction of R104/R106. If CR102 should become open then the 75 Vdc supply would rise to approximately 90 volts and U106/U108 may become damaged.

E. Display Arcing
Arcing is perceived as a "streak" between adjacent digits or segments. If it is quite noticable under average ambient light, then the time to failure is not far away. If the arcing is so faint that it can only be seen under dark ambient light, then the time to failure is much longer but it will progressively worsen.

F. U106 Pin 8, U108 Pins 10 and 13
Note that these pins are diode clamped to the 5 volt supply. Any accidental short to ground on these pins immediately blows fuse F602.



NOTE 1

The 5 volt power supply is the Vcc A+ for the following IC's:

U104	U109	U115	U304	U308
U105	U110	U301	U305	U309
U106	U111	U302	U306	U310
U108	U112	U303	U307	

The total normal current drawn by these IC's is 300 ma. Other than a shorted IC or PC board track, there are three other specific points that can blow fuse F602. These points are a short at pins 10 and 13 of U108 and pin 8 of U106. The normal resistance at these pins is 5K ohms.

Check all the 5 volt Vcc PC board track for a short. To isolate a shorted IC the following technique is suggested.

(a) Disconnect the power supply from the NAV.
(b) Remove the blown fuse, F602.
(c) Set the power supply voltage level to zero volts and the current limiting adjustment to limit at 1 amp.
(d) Connect the power supply to the F602 fuse post at the CR608 side of the fuse.

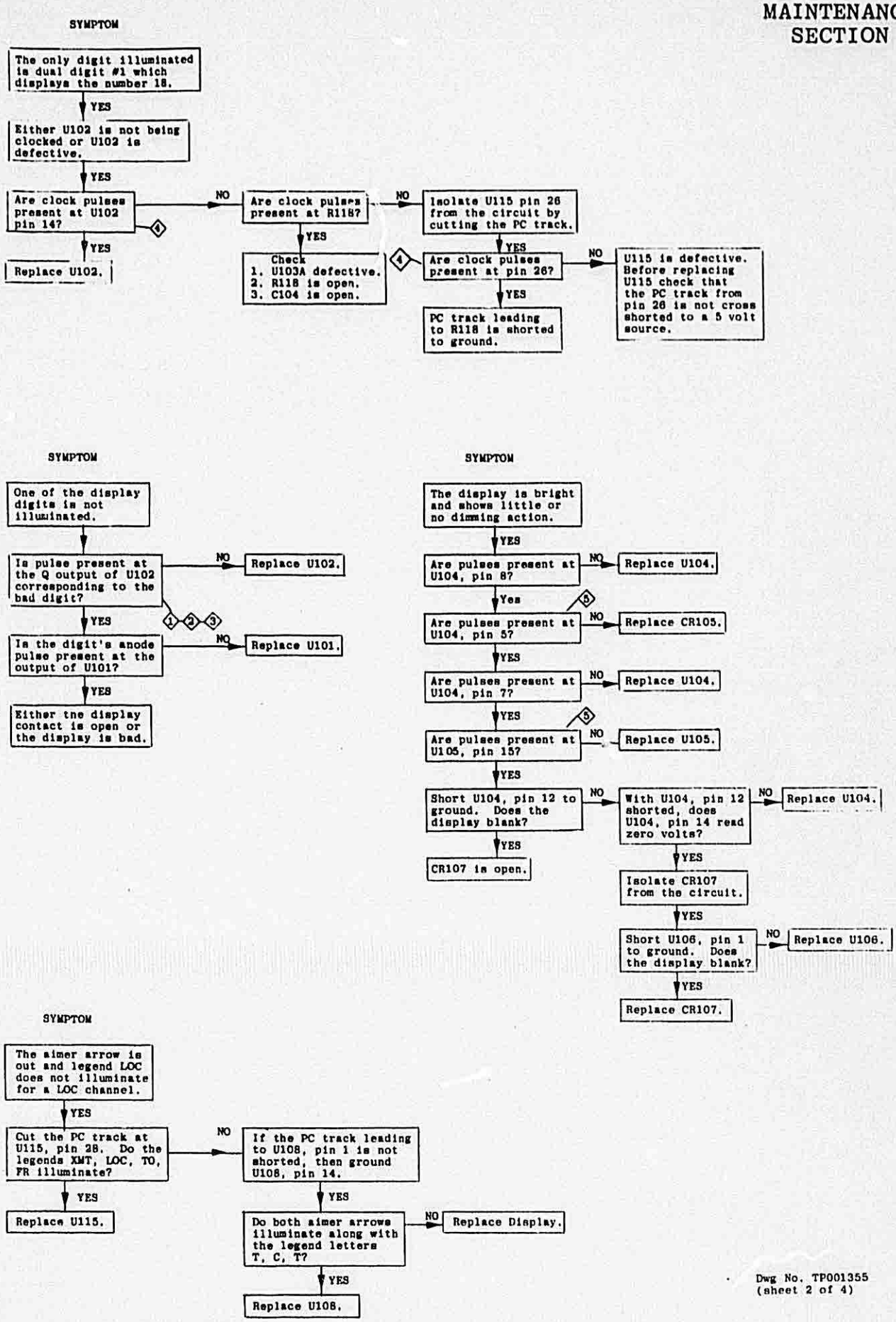
WARNING: The power supply must be well regulated to protect the microprocessor and have current limiting to prevent a shorted PC board track from burning.

(e) Slowly increase the supply voltage to 5 volts or until the current draw approaches 1 amp. (300 ma is normal). The shorted IC should be warm to the touch.
(f) If the defective IC cannot be found by touch, one by one, isolate each IC's Vcc supply line until the current drops back to normal.

Dwg No. TP001355
(sheet 1 of 4)

FIGURE 4-10. DISPLAY FLOWCHART (sheet 1 of 4)

SEE BLOW-UP



Dwg No. TP001355
(sheet 2 of 4)

FIGURE 4-10. DISPLAY FLOWCHART (sheet 2 of 4)

SEE BLOW-UP

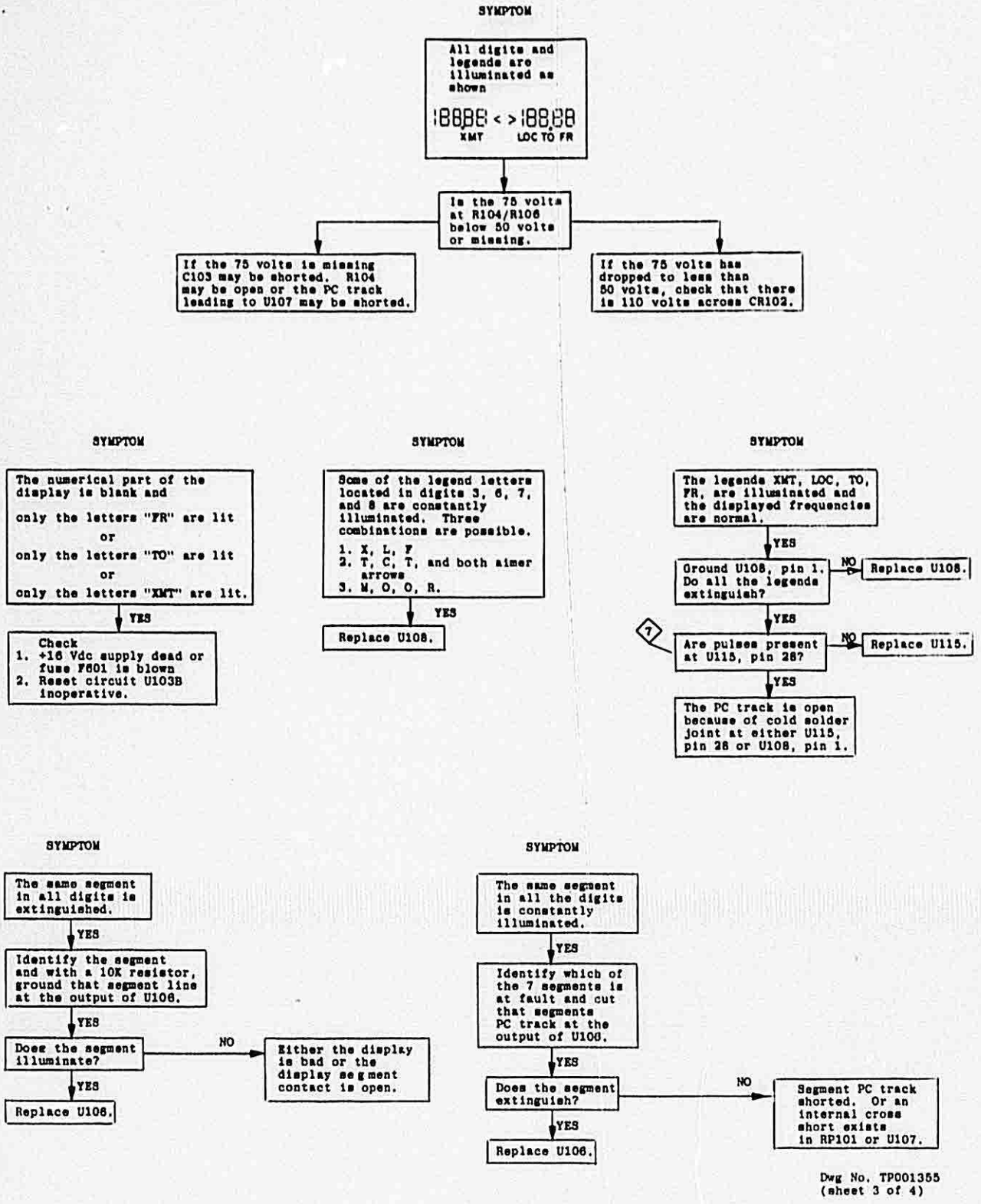


FIGURE 4-10. DISPLAY FLOWCHART (sheet 3 of 4)

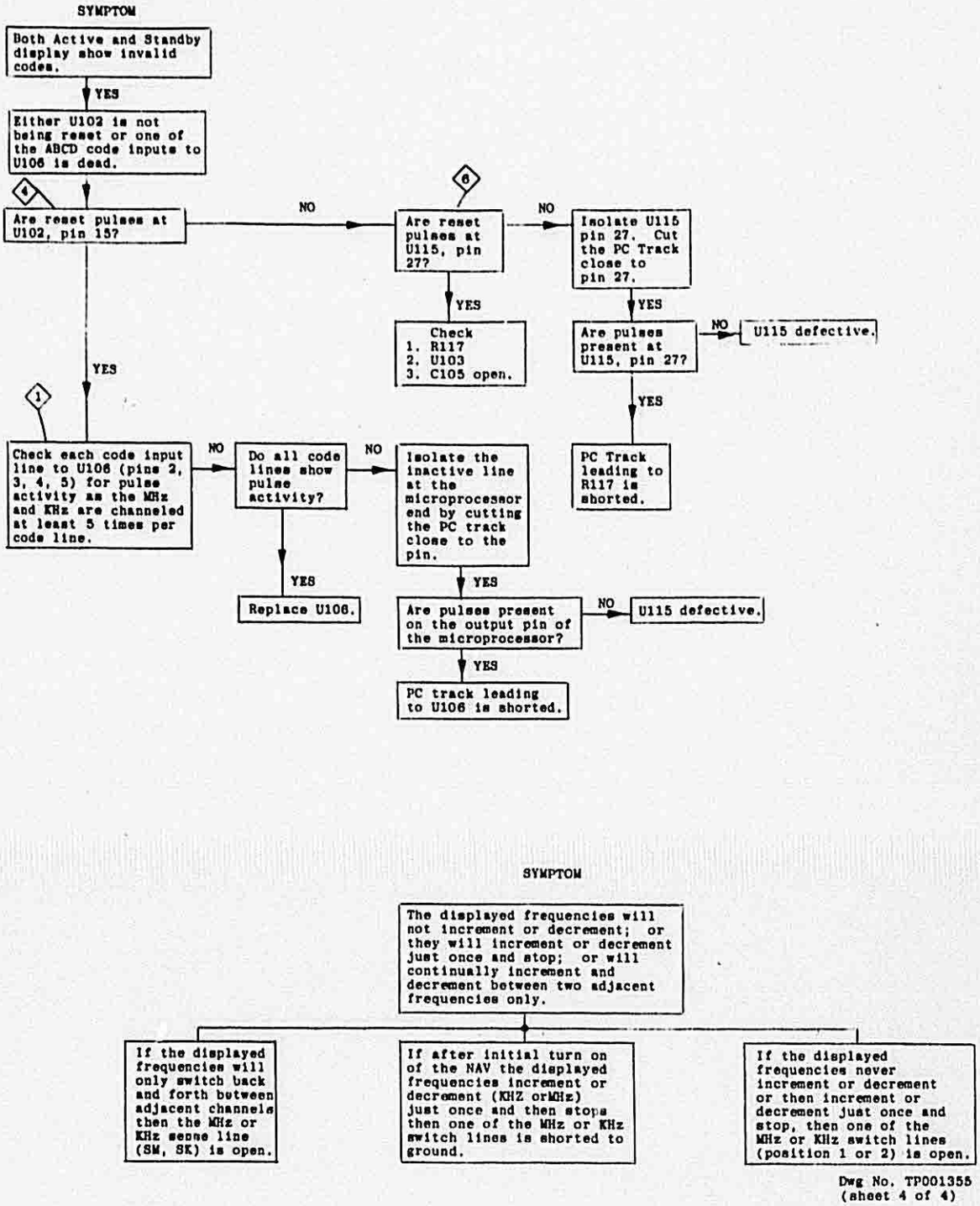


FIGURE 4-10. DISPLAY FLOWCHART (sheet 4 of 4)

SEE BLOW-UP

4.5.2 Active Keep-Alive Memory (U117) Troubleshooting

There are the three possible terminations of the Keep-Alive line, J102 pin 8, and the displays reaction to these terminations.

A. J102 pin 8 connected to the aircraft battery
   The last used Active frequency is retained in the memory shift register (U117) and will be displayed at initial turn on of the NAV. The Standby is preset to display 110.50.

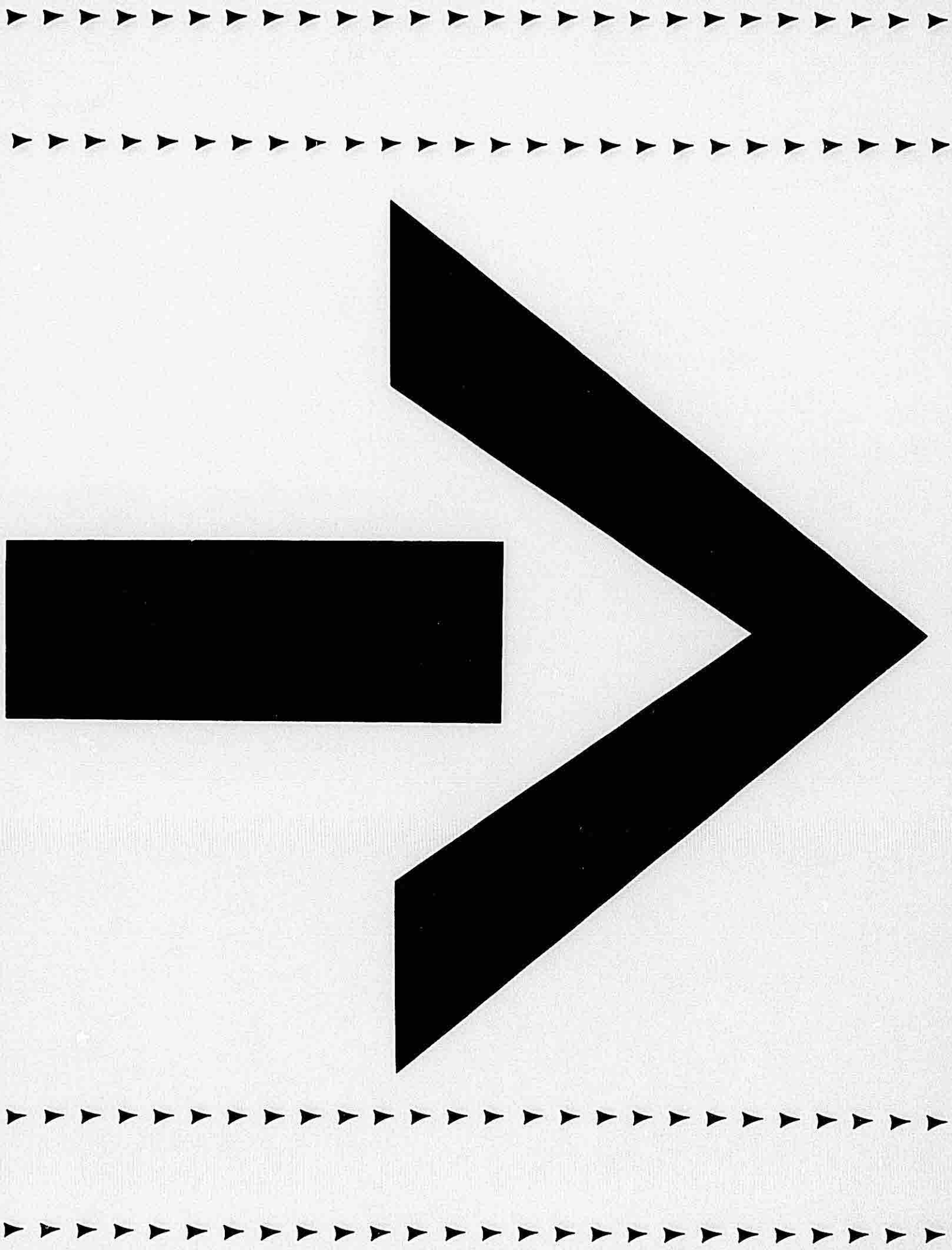
B. J102 pin 8 connected to ground
   The Active memory is defeated by a ground at J102 pin 8, and at initial turn on of the NAV, the preset frequency of Active 115.50 and Standby 110.50 will be displayed.

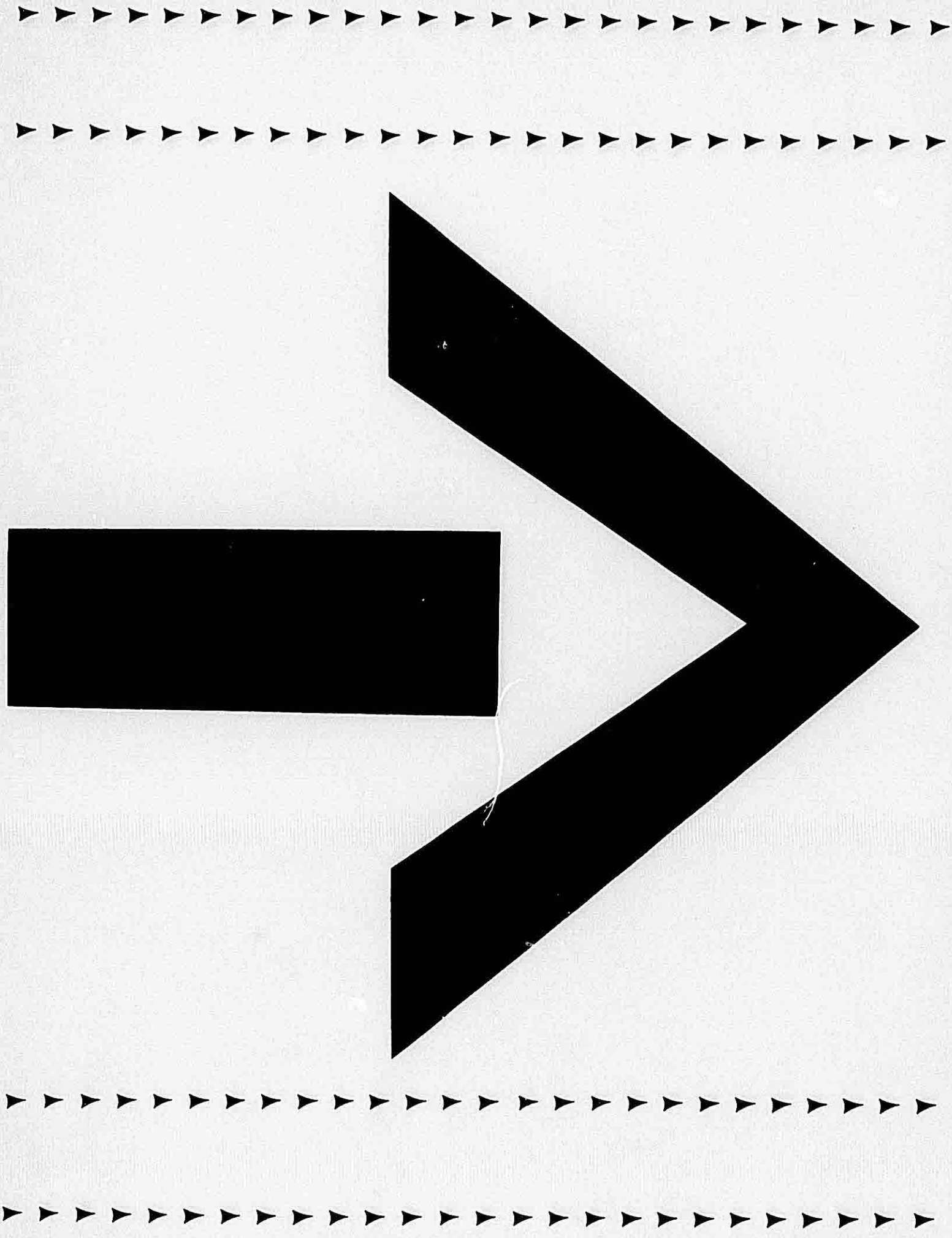
C. J102 pin 8 is left open-circuited
   At initial turn on of the NAV, the shift registers can theoretically come up on any valid code or an invalid code. If the code is valid, that frequency will be displayed. If the code is invalid, the microprocessor will ignore the invalid code and display the preset Active frequency of 115.50.

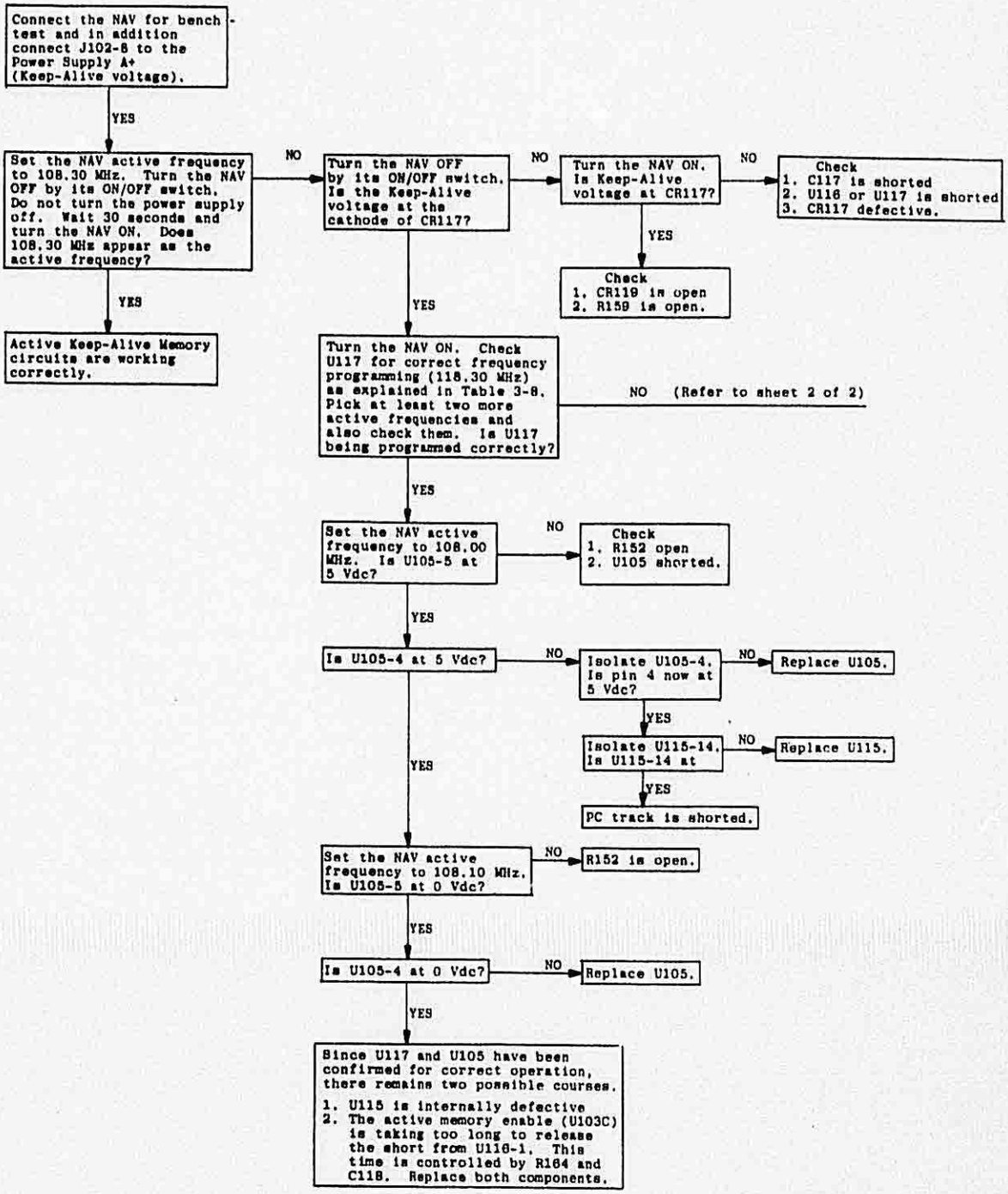
There are two important points to remember. The first point is that the active memory enable (U103C) must release the short from U116 pin 1 within one second after the reset circuit (U103B) has released the microprocessor or else it will ignore the Keep-Alive memory and display the preset frequency.

The second point is that the only time the microprocessor reads the contents of the Keep-Alive memory is at initial turn on of the NAV. At this time the microprocessor validates the code, and if found to be valid, updates the Keep-Alive memory with this same code and then programs the synthesizer. Thereafter, as the pilot makes his frequency changes, the Keep-Alive memory is updated but never read by the microprocessor. The Keep-Alive memory has nothing to do with the programming of the synthesizer so don't go looking here for a synthesizer problem.

The troubleshooting flowchart for the Keep-Alive Memory is given in Figure 4-11.







Dwg No. TP001351
(sheet 1 of 2)

FIGURE 4-11. ACTIVE KEET-ALIVE MEMORY FLOWCHART (sheet 1 of 2)

SEE BLOW-UP

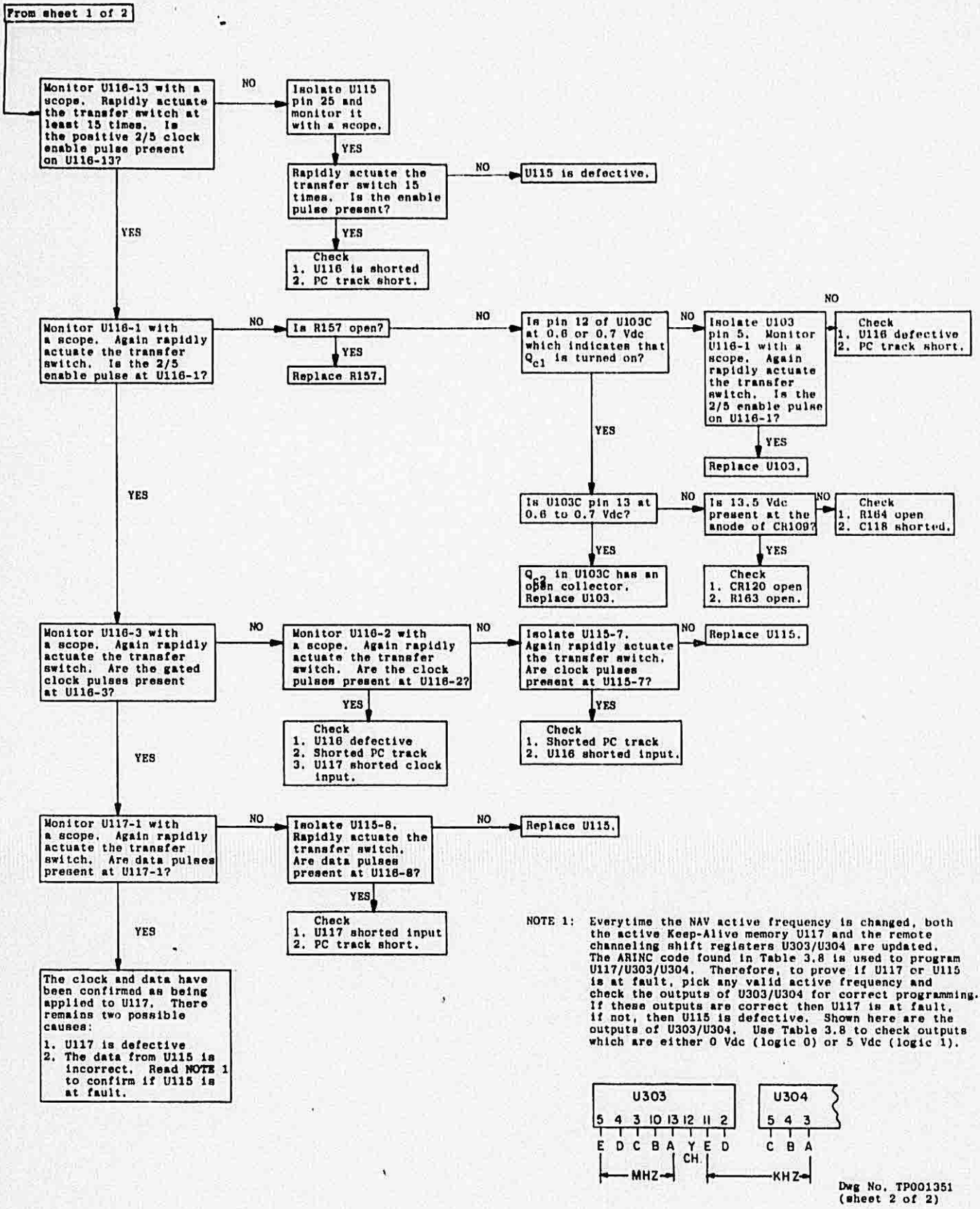


FIGURE 4-11. ACTIVE KEET-ALIVE MEMORY FLOWCHART (sheet 2 of 2)

SEE BLOW-UP

4.5.3 VOR/LOC and GS Synthesizer Troubleshooting

The synthesizer theory is covered in Section 3.3 and it is suggested that the technician read this theory so that the synthesizer troubleshooting flowchart Figure 4-21 can be utilized more efficiently.

CAUTION NOTE: The RF coupling and tuning capacitors associated with stages Q901/Q1201, Q902/Q1202, Q903/Q1203, are very small NPO ceramic capacitors. They cannot withstand a soldering iron whose temperature exceeds 600°F, as excessive heat causes them to crack internally. Cracked capacitors are destined to become open capacitors, if not immediately, then later on under normal panel vibration. Whenever a coupling or tuning capacitor is removed and it is gound that this was not the problem, never reuse the old capacitor, always replace it with a new one.

The following sub-sections will discuss several important topics to facilitate the successful troubleshooting of the synthesizer.

4.5.3.1 U301 and U309, The ÷15/16 Prescalers

The ÷15/16 prescaler division mode is controlled by the Mod Control output, pin 8, of U303/U310. The ÷15 mode occurs when U301/U309 pin 8 is high (+5 Vdc). The ÷16 mode requires a low (0 Vdc). U301 can be permanently set in the ÷15 mode by setting the NAV Active channel to 108.50. In this case the Mod Control output from U302 pin 8 will remain at a constant +5 volts. If U301 is driven by a VHF signal generator, as shown in Figure 4-12, then the output can be checked for correct level and correct ÷15 division. If U301 pin 6 is grounded, then the output can be checked for correct ÷16 division. To put U309 in the ÷15 mode, set the NAV Active frequency to a omni channel. To put U309 in the ÷16 mode, ground U309 pin 6.

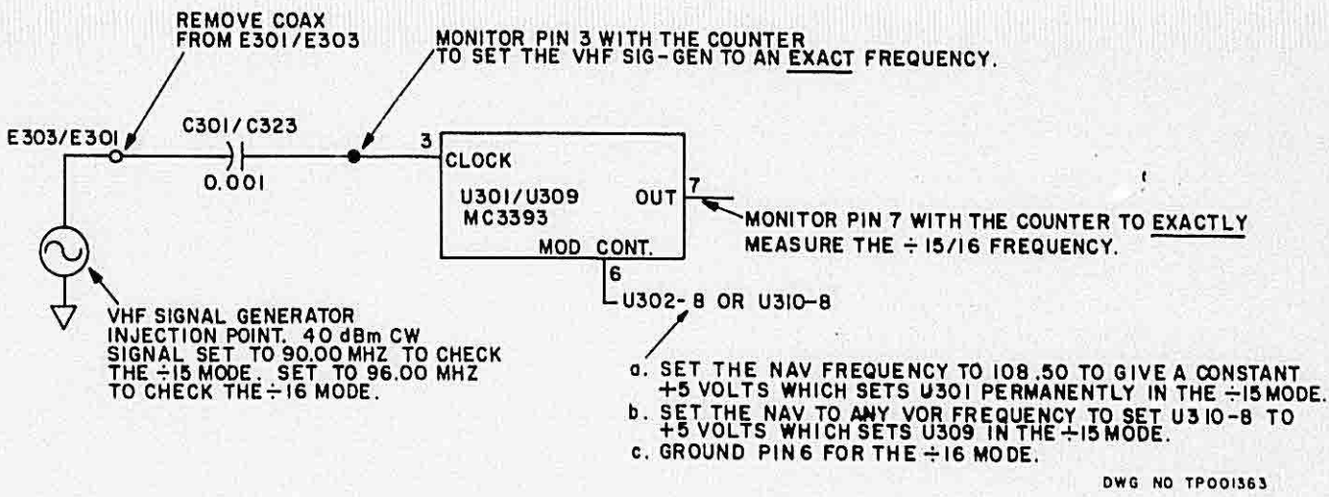


FIGURE 4-12. U301 AND U309 ÷15/16 PRESCALER

4.5.3.2 U302, VOR/LOC Synthesizer Phase-Locked Loop (MC14512)

The operation of this device is covered in Section 3.3.3 and Table 3.2. To prove that U302 is working correctly requires that the synthesizer programming data be checked and the Mod Control, lock detector, and phase detector outputs be monitored for correct pulse activity.

When the entire synthesizer is working correctly, pin 9 of U302 will show a phase-lock condition by going logic High (4.5V) except for a small, minimum time period that is necessary to keep the divided down VCO frequency in phase with the 50 KHz reference frequency. This waveform is shown in Figure 4-13. When the system is out of lock, the output from pin 9 shows negative pulses that are in uncontrolled oscillation. When troubleshooting the synthesizer and a signal generator or separate voltage is substituted for the VCO, pin 9 of U302 will never indicate a locked condition. This is because while you can set the exact frequency you want, you cannot control the phase of the injected signal and a phase beat occurs between the 50 KHz reference and the divided down frequency in U302 which prevents a lock condition.

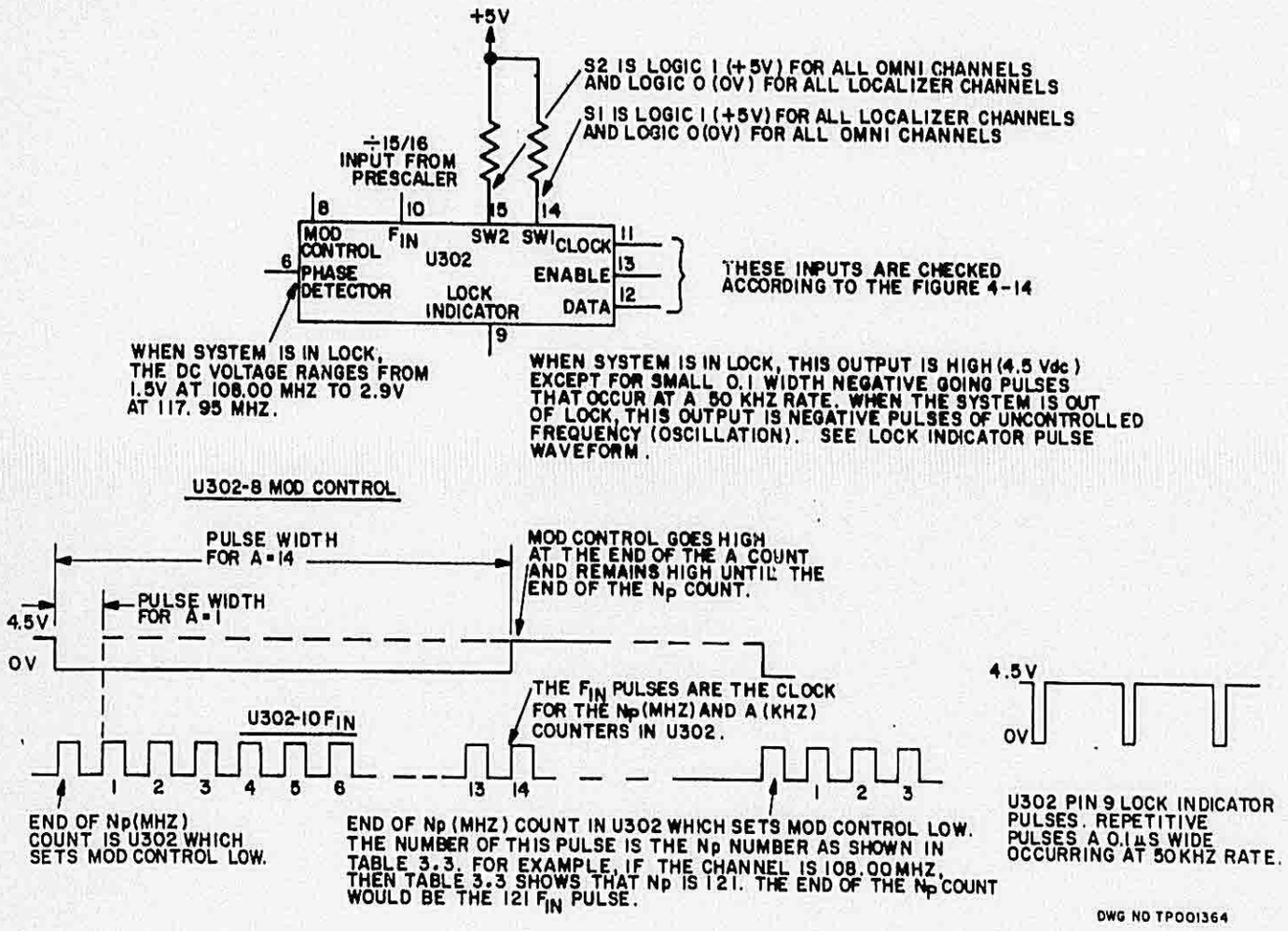
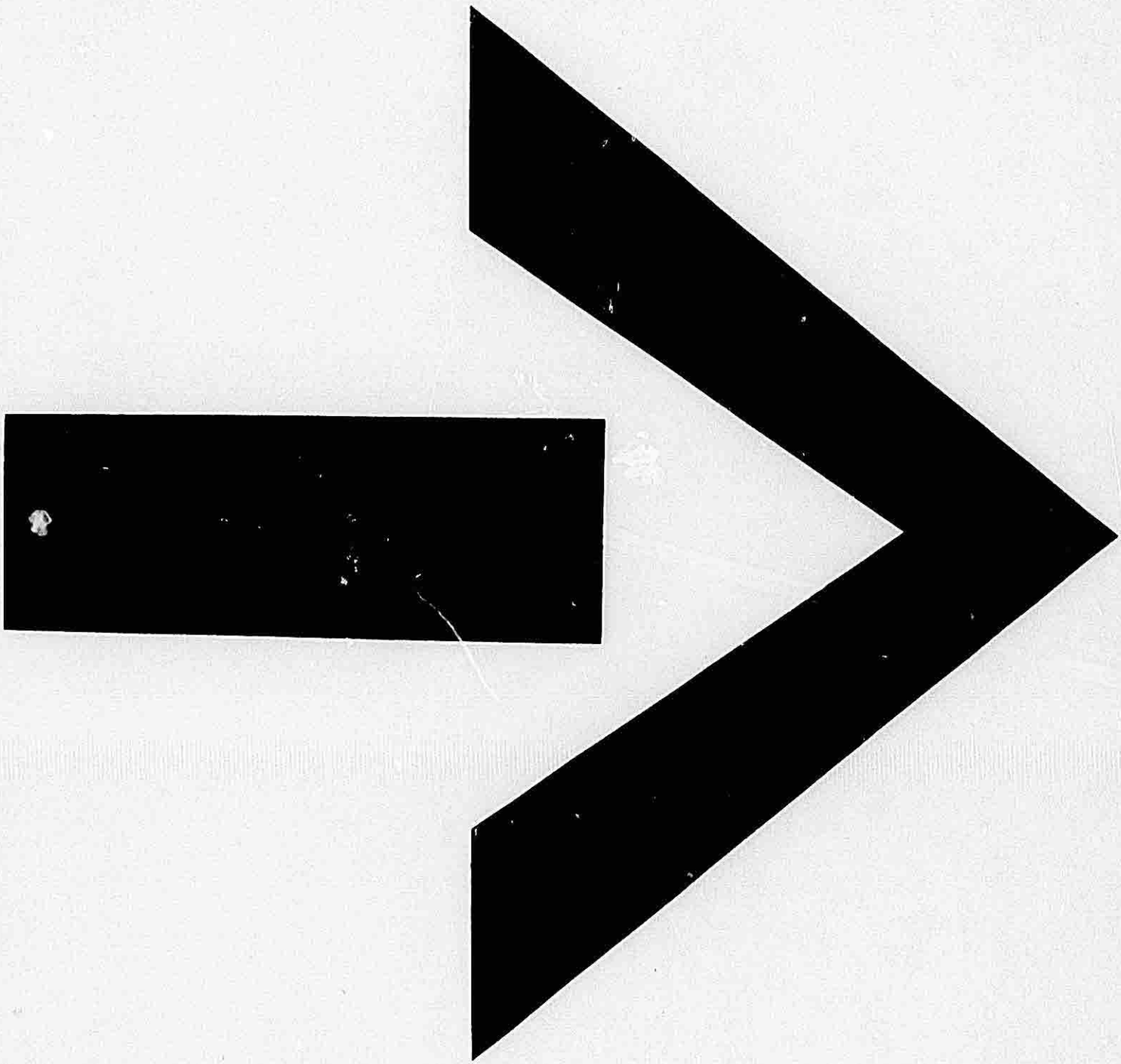
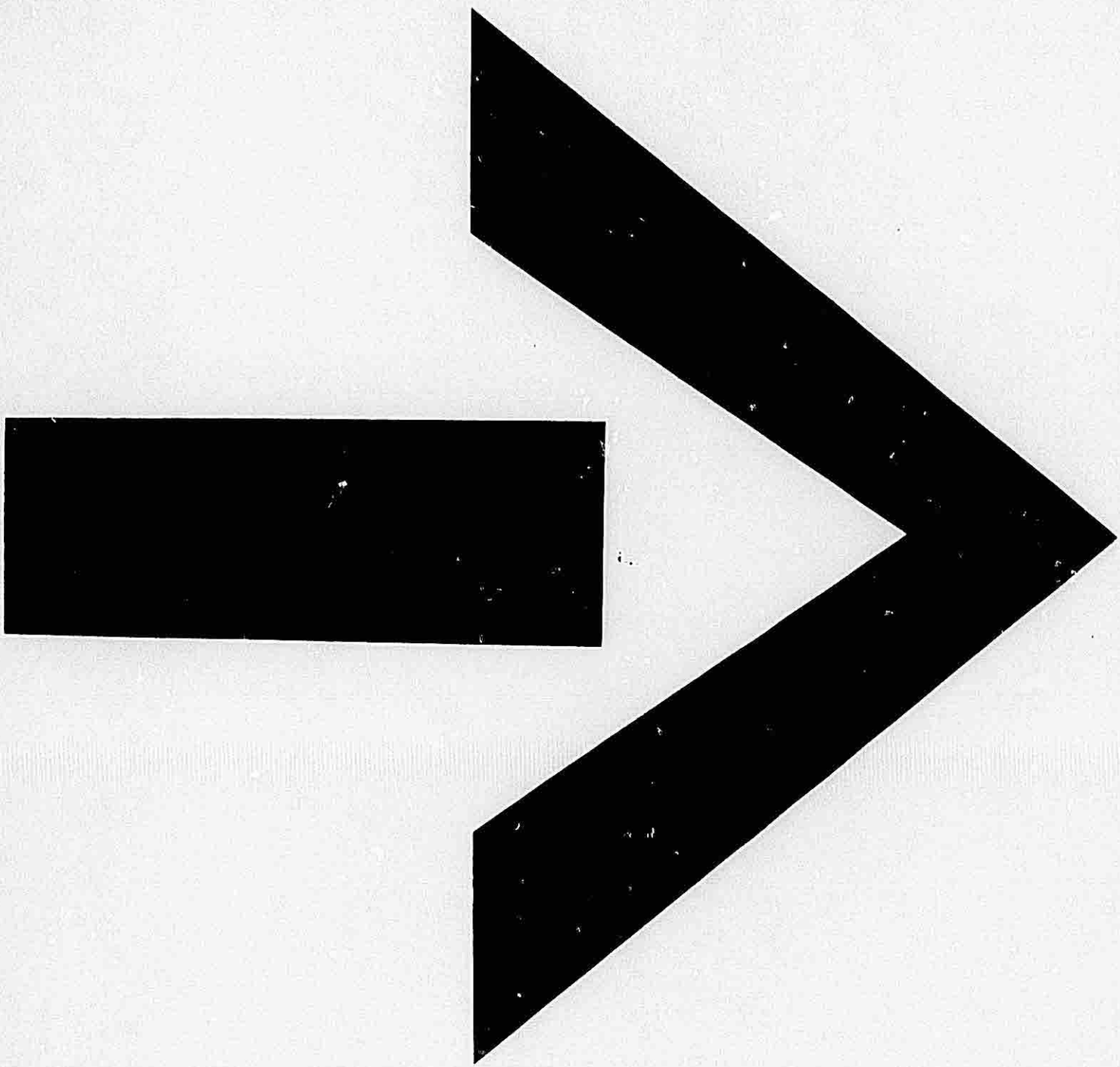


FIGURE 4-13. U302/U310 PLL FREQUENCY SYNTHESIZER



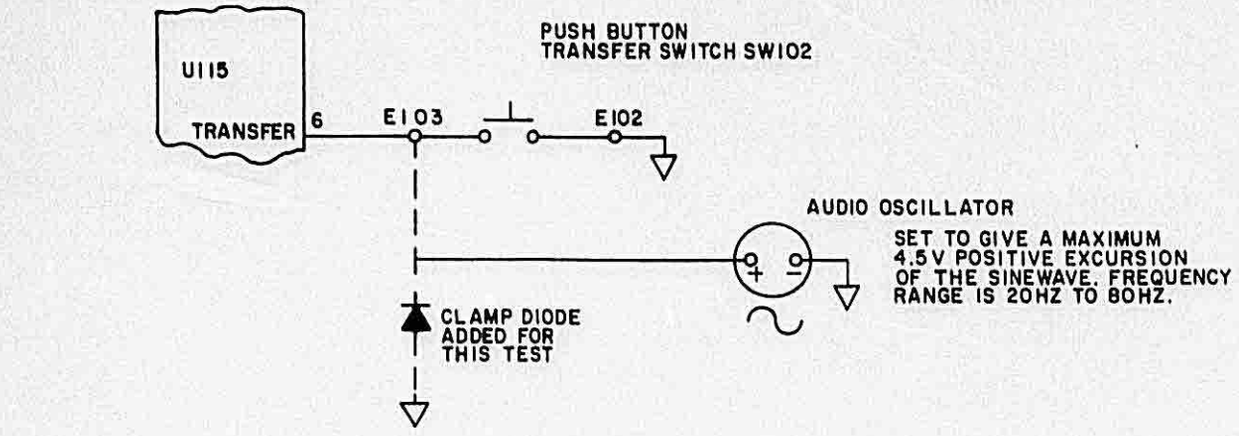


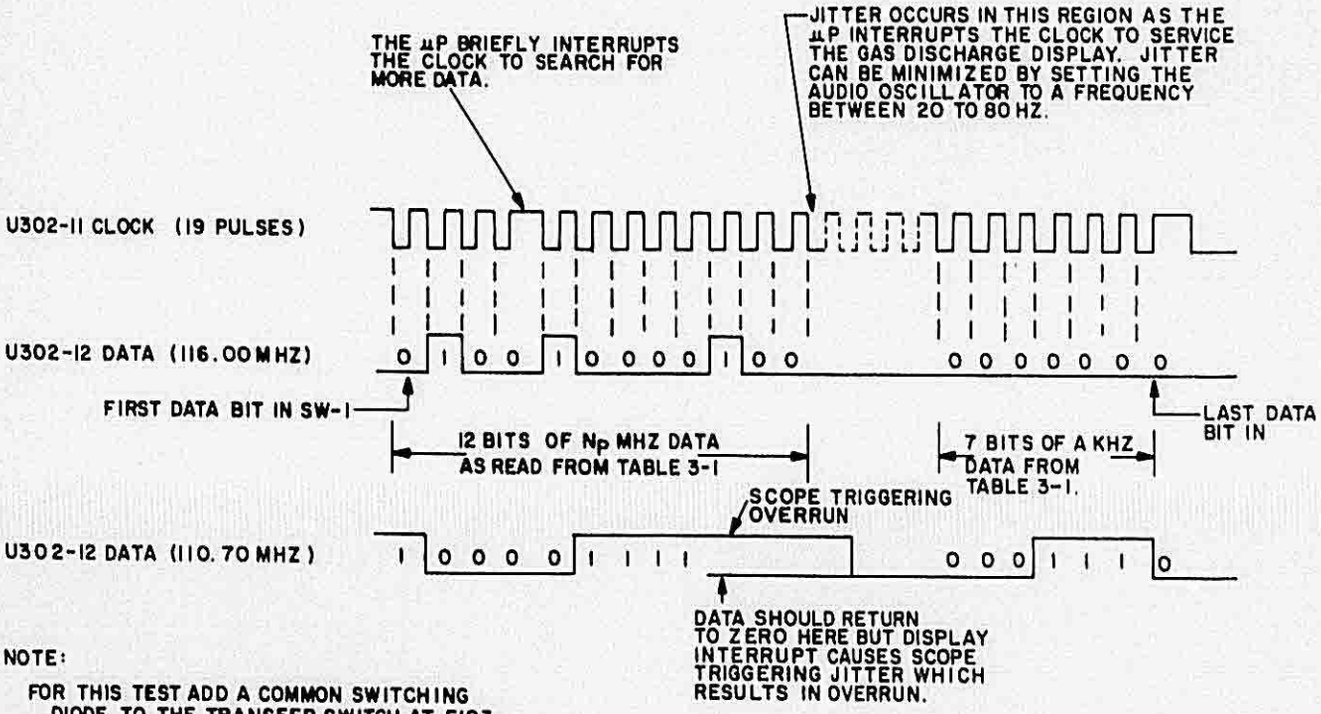
4.5.3.2 Continued

To check U302 for correct operation, use the following procedure:

A. Drive U301 with a VHF generator set to 96 MHz as shown in Section 4.5.3.1.
B. Monitor U302 pins 14 and 15 with a DCVM. Set the NAV to a VOR frequency. As shown in Table 3.1, pin 14 (SW1) must be logic 0 (0 volts) and pin 15 (SW2) must be logic 1 (5 volts).
C. Set the NAV to a localizer frequency, pin 14 must read logic 1 (5V) and pin 14 must read logic 0 (0V). If pins 14 and 15 give correct indications, for VOR and LOC frequencies then the following assumptions can be made: The enable pulse, the clock pulses, and Np counter data from the microprocessor are present and the Np counter in U302 is being programmed. However, only the first two bits of the 12-bit Np code have been confirmed. Step 5 will cover total confirmation of the code.
D. Next check the A counter programming by monitoring U302 pins 8 and 10 with a dual trace scope. Externally sync the scope from U302, pin 8. The trigger slope is negative, trigger mode is DC. The waveforms are shown in Figure 6-2.

    1. Set the NAV frequency to 113.00 MHz. U302, pin 8 should indicate a constant +4.5 Vdc which is the ÷15 mode for U301. Next, channel the KHz from .05 to .70 KHz and observe that the Mod Control pulse width changes one F_{in} pulse period for each KHz step. Remember that the F_{in} pulses from the ÷15/16 prescaler are the clock pulses for both the Np and A counters in U302. The maximum A count is 14. You can see on the dual scope presentation that the Mod Control pulse will expand in width, out to the 14th F_{in} pulse. If Mod Control checks OK, then you know that the microprocessor programming data is correct and is being loaded into U302. If any one of the preceeding steps did not check correctly, then you must have visible proof that the program data from the microprocessor is correct, before you can say that U302 is defective. Step E covers this procedure.





NOTE:

FOR THIS TEST ADD A COMMON SWITCHING DIODE TO THE TRANSFER SWITCH AT E103. CONNECT THE AUDIO OSCILLATOR TO THE CATHODE OF THE CLAMP DIODE. SET THE FREQUENCY TO 72 HZ TO START. MAKE SURE THE POSITIVE SINEWAVE EXCURSIONS DO NOT EXCEED 4.5 VOLTS. BOTH THE ACTIVE AND STANDBY DISPLAYS MUST BE SET TO THE SAME FREQUENCIES. ADJUST THE OSCILLATOR FREQUENCY SOMEWHERE BETWEEN 20 TO 80HZ TO MINIMIZE THE JITTER.

DUAL SCOPE SETTINGS:
EXT. NEG. SYNC. TO U302-11 CLOCK
TRIGGER MODE = DC
TIME BASE = 1mS
VOLTS/DIV = 0.2 WITH x10 PROBE
CHANNEL MODE = ALTERNATE OR CHOPPED.

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FIGURE 4-14. SYNTHESIZER PROGRAMMING

4.5.3.2 Continued

E. To directly check the synthesizer programming data refer to Figure 4-14. To visibly confirm the microprocessor synthesizer data requires that the transfer input be driven with an audio oscillator. The reason being that U302 is programmed in one quick burst, so this scheme forces the microprocessor to program U302 at a rate that can be seen on a scope. Check the program data by the following procedure:
   1. Monitor U302 pin 11 and U302, pin 12 with a dual trace scope. Externally negative sync the scope from the clock, pin 11.
   2. Set BOTH the Active and Standby channels to 116.00 MHz
   3. Inject, by clip lead, the Audio Oscillator test signal onto the clamp diode that was added to the transfer circuit per Figure 4-13.
   4. Using Table 3.1 confirm that the synthesizer data is correct. The actual photograph of this channel is shown in Figure 4-15. You only need to confirm one set of data, because a failure in the microprocessor would affect all the codes. A second photograph of a localizer channel, 110.70 MHz, (Figure 4-16) is included here and clearly shows in the center of the photo the jitter resulting from the microprocessor interrupting the clock and data in order to service the gas discharge display. If you carefully examine the photo and refer to Table 3.1 you can, in spite of the interruption, confirm that 110.70 MHz data is correct.

F. The last check performed on U302 covers the phase detector. Use the following procedure:
   1. Monitor U302, pin 6 with a DCVM.
   2. Set the Active channel to 113.00 MHz which corresponds to a VCO frequency of 96.00 MHz.
   3. Shift the frequency to the VHF generator that is driving U301 to approximately 100 MHz. This places the incoming frequency to U302 above the required 96.00 MHz so the phase detector's response would be to lower its output to the VCO in order to drive the frequency down. Pin 6 should be 0.5 volts or less.
   4. Shift the VHF generator frequency to approximately 90 MHz. The response from the phase detector would be to raise the VCO tuning voltage to increase the VCO frequency. Pin 6 should indicate 4.5 to 5 volts.

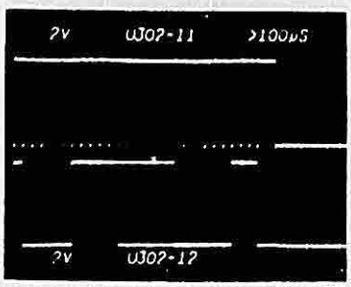


FIGURE 4-15. CLOCK AND DATA INPUTS TO U302 FOR 116.00 MHz

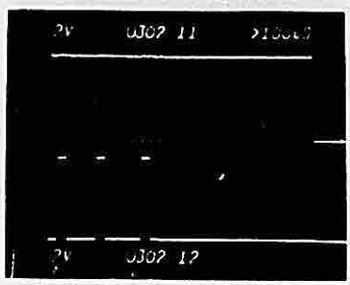


FIGURE 4-16. CLOCK AND DATA INPUTS TO U302 FOR 110.70 MHz

4.5.3.3 U310 Glideslope Synthesizer Phase-Locked Loop

The glideslope phase-locked loop operates identically to the VOR/LOC phase-locked loop except the data for U310 is received from pin 14 of U302. When a GS/LOC frequency is selected, then the microprocessor will issue two sets of clock and data. The first set is for the GS and it is serially shifted out of U302 at pin 14 and into U310 pin 12 when the second set (localizer) is being shifted into U302. Figure 4-17 shows the two sets of clock and data issued by the uP for 111.30 MHz.

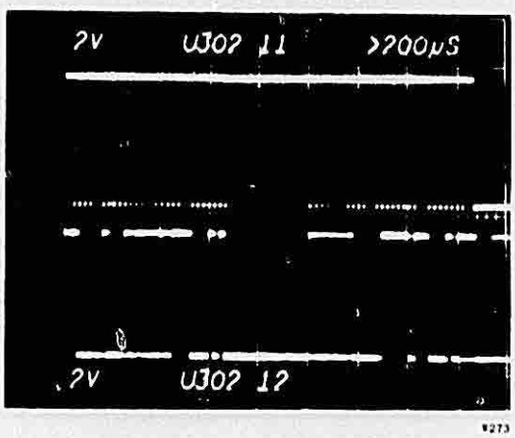


FIGURE 4-17. CLOCK AND DATA FOR U302 AND U310

To check U310 for correct operation, use the following procedure:

A. Drive U309 with a VHF generator set to 105 MHz as shown in Section 4.5.3.1.
B. Monitor U310 pins 14 and 15 with a DCVM. Set the NAV to 109.60 MHz. Pin 14 (SW1) must be logic 0 (0 volts) and pin 15 (SW2) must be logic 1 (5 volts).
C. Set the NAV to 109.75 MHz. Pin 14 must read logic 1 (5V) and pin 14 must read logic 0 (0V). If pins 14 and 15 give correct indications, then the following assumptions can be made: The enable pulse, the clock pulses, and Np counter data from the microprocessor are present and the Np counter in U310 is being programmed. However, only the first two bits (SW1, SW2) of the 12-bit code have been confirmed. Step 5 will cover total confirmation of the code.
D. Next check the A counter programming by monitoring U310 pins 8 and 10 with a dual trace scope. Externally sync the scope from U310, pin 8. The trigger slope is negative, trigger mode in DC.

4.5.3.3 Continued

1. Set the NAV frequency to 108.00 MHz. U310, pin 8 should indicate a constant +4.5 Vdc which is the ÷15 mode for U310. Next, channel the KHz from .10 to .95 KHz and observe that the Mod Control pulse width changes for each GS KHz channel. If Mod Control checks OK, then you know that the microprocessor programming data is correct and is being loaded into U310. If any one of the preceeding steps does not check correctly, then you must have visible proof that the program dats from the microprocessor is correct, before you can say that U310 is defective. Step E covers this procedure.

E. To directly check the synthesizer programming data refer to Figure 4-14. Check the program data by the following procedure:
   1. Monitor U310 pin 11 (clock), and U310, pin 12 (data), with a dual trace scope. Externally negative sync the scope from the clock, pin 11.
   2. Set BOTH the Active and Standby channels to the same frequency, 110.70 MHz.
   3. Inject, by clip lead, the Audio Oscillator test signal into the transfer switch per Figure 4-14.
   4. Using Table 3.5, confirm that the synthesizer data is correct. Refer to Figure 4-18.

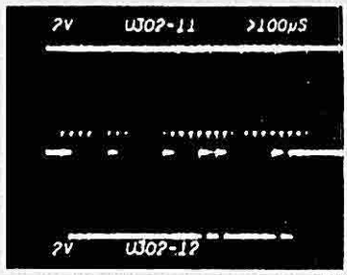


FIGURE 4-18. CLOCK AND DATA

F. The last check performed on U310 covers the phase detector. use the following procedure:
   1. Monitor U310, pin 6 with a DCVM.
   2. Set the Active channel to 109.75 MHz which corresponds to 105 MHz VCO frequency.
   3. Shift the frequency of the VHF generator that is driving U309 to approximately 110 MHz. This places the incoming frequency to U310 above the required 105 MHz so the phase detector's response would be to lower its output to the VCO in order to drive the frequency down. Pin 6 should be 0.5 volts or less.
   4. Shift the VHF generator frequency to approximately 100 MHz. The response from the phase detector would be to raise the VCO tuning voltage to increase the VCO frequency. Pin 6 should indicate 4.5 to 5 volts.

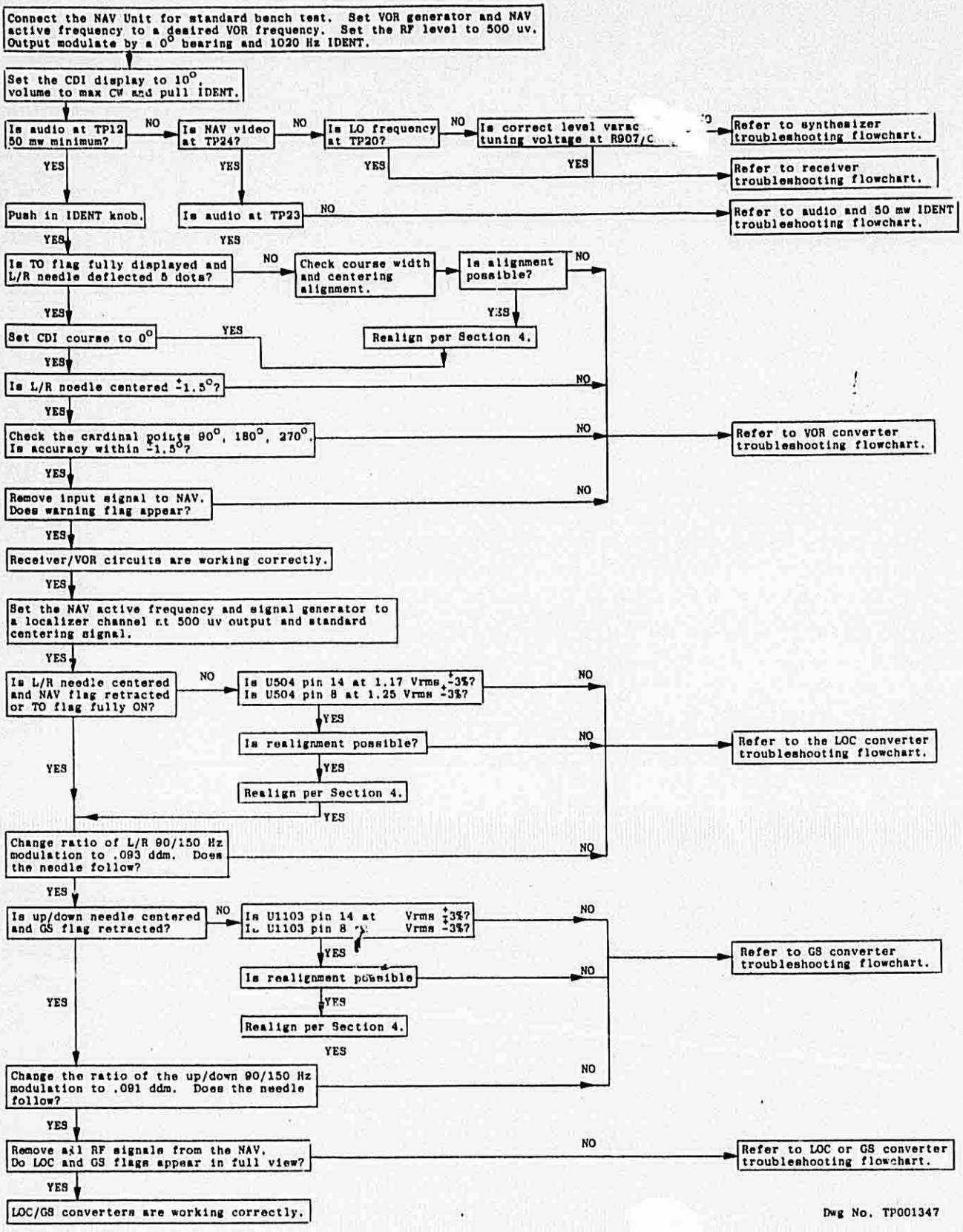
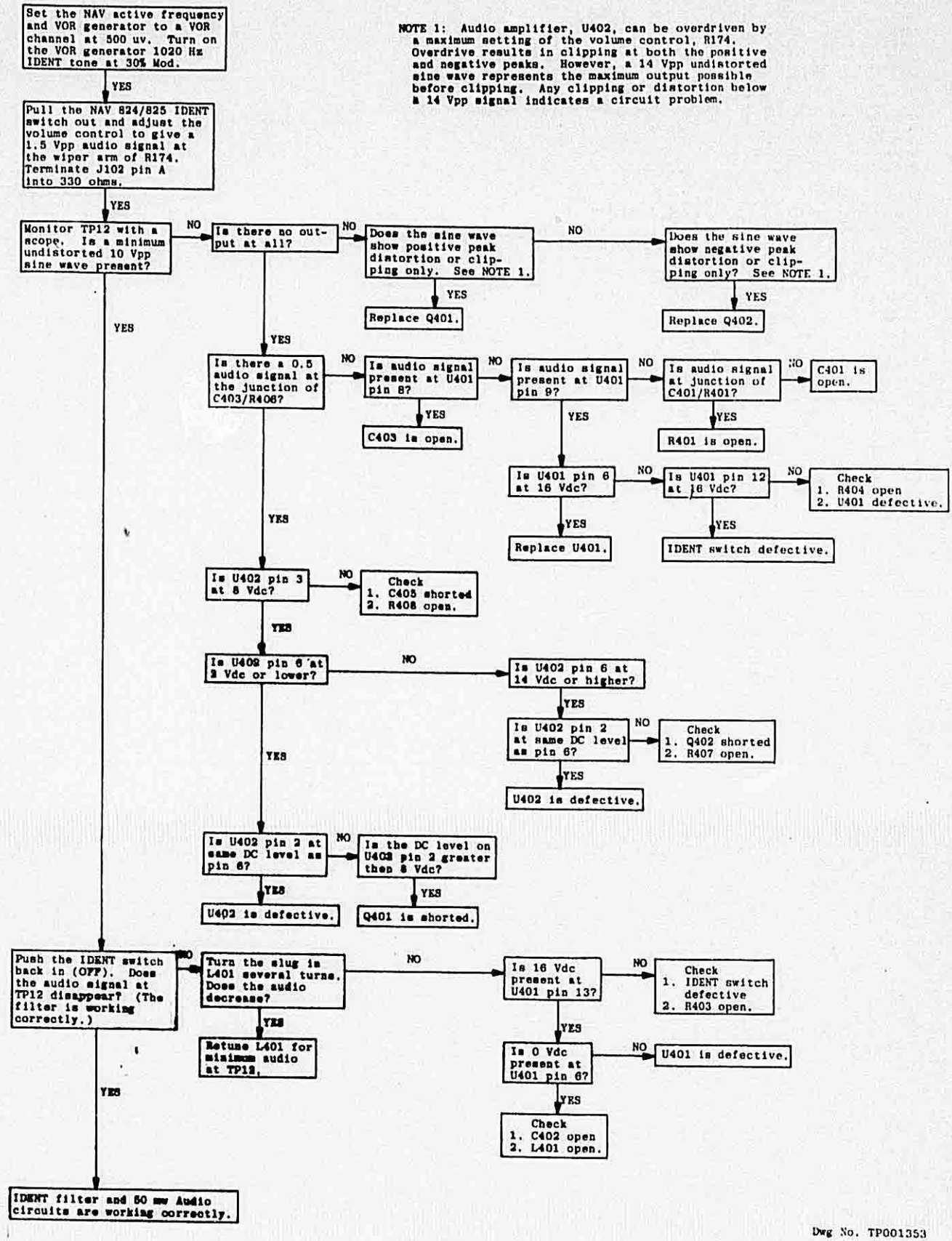


FIGURE 4-19. RECEIVER AND VOR CONVERTER FLOWCHART

SEE BLOW-UP



Dwg No. TP001353

FIGURE 4-20. IDENT AND 50 mw AUDIO FLOWCHART

SEE BLOW-UP

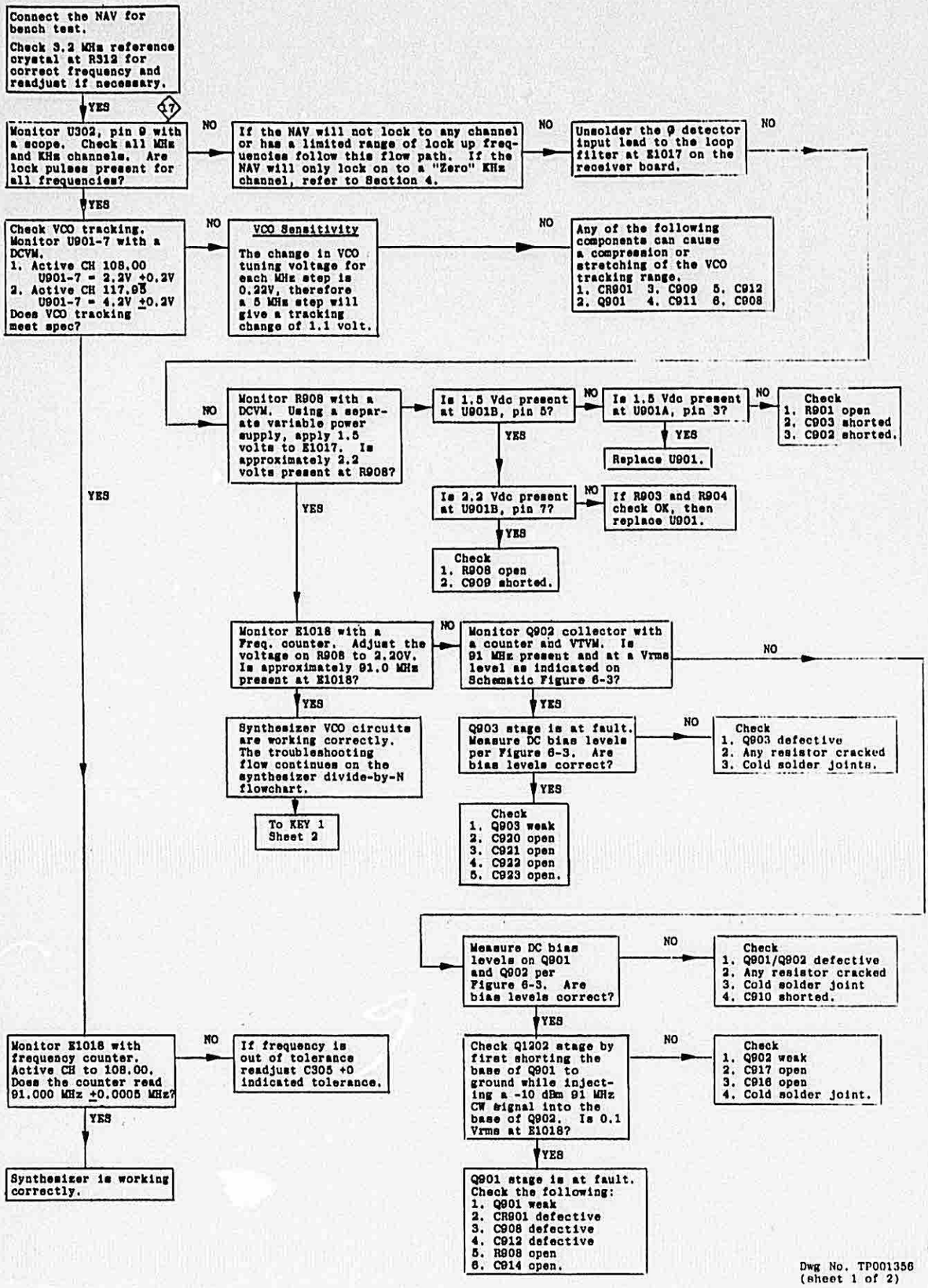
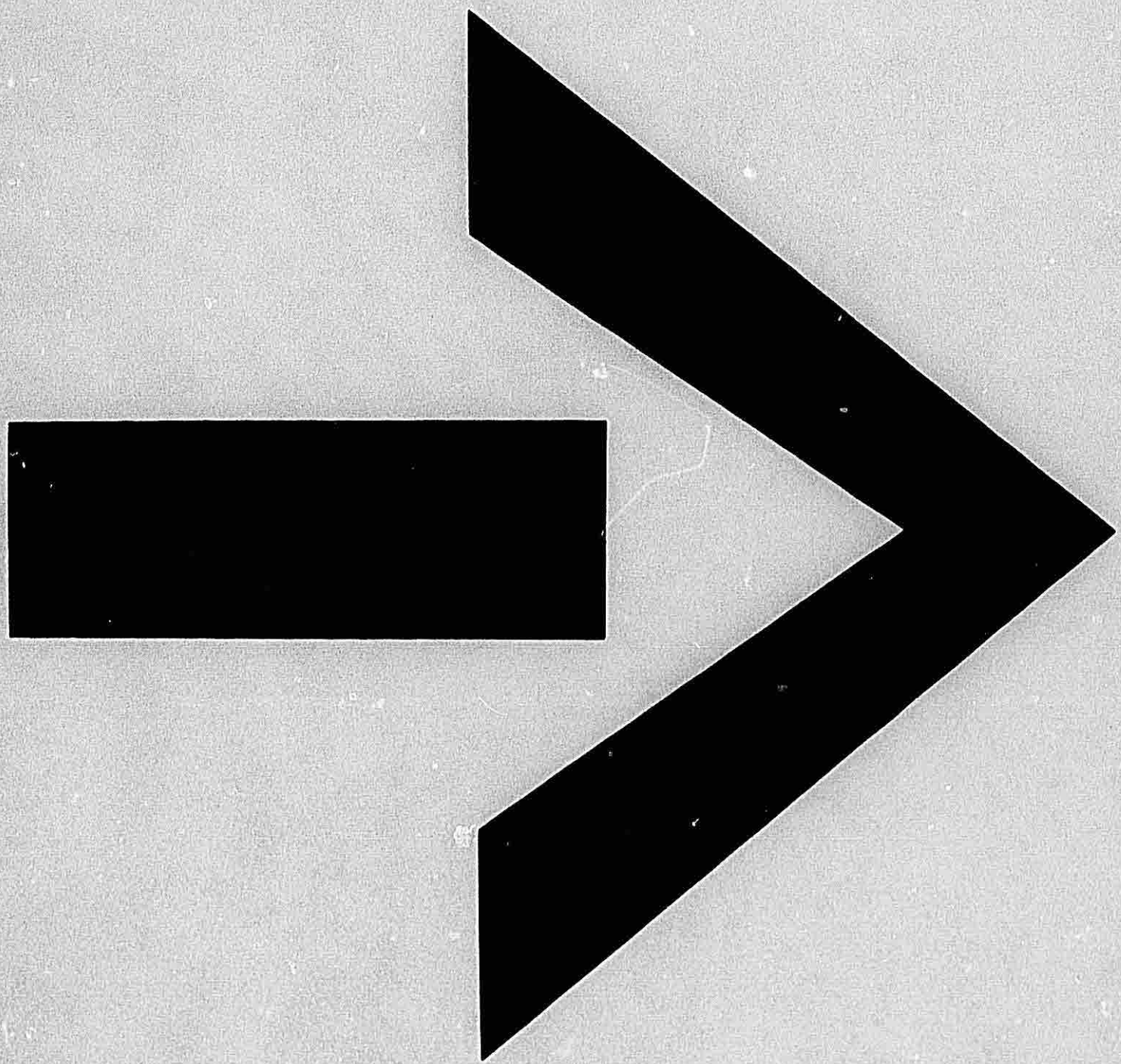


FIGURE 4-21. NAV SYNTHESIZER FLOWCHART (sheet 1 of 2)

SEE BLOW-UP

M23



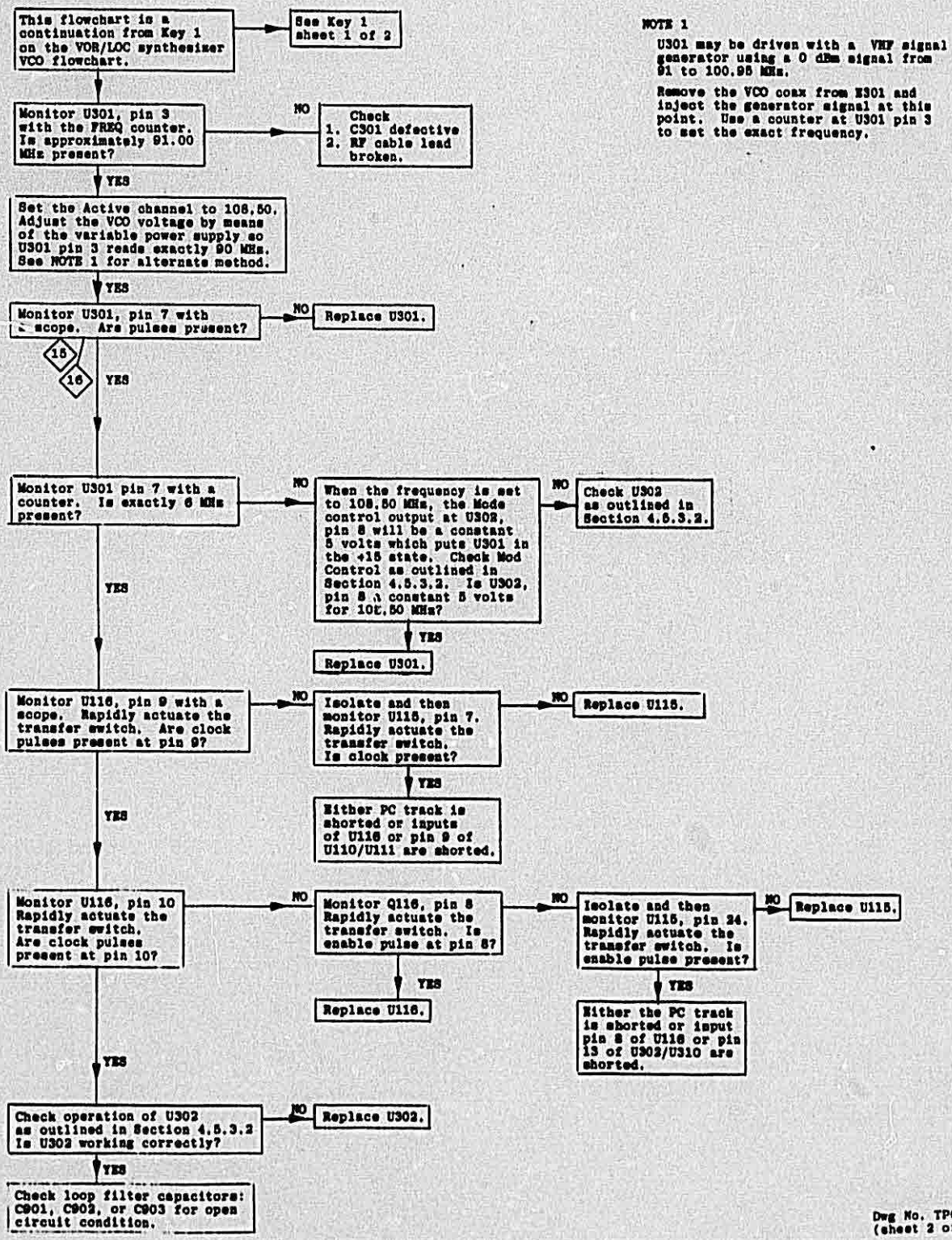
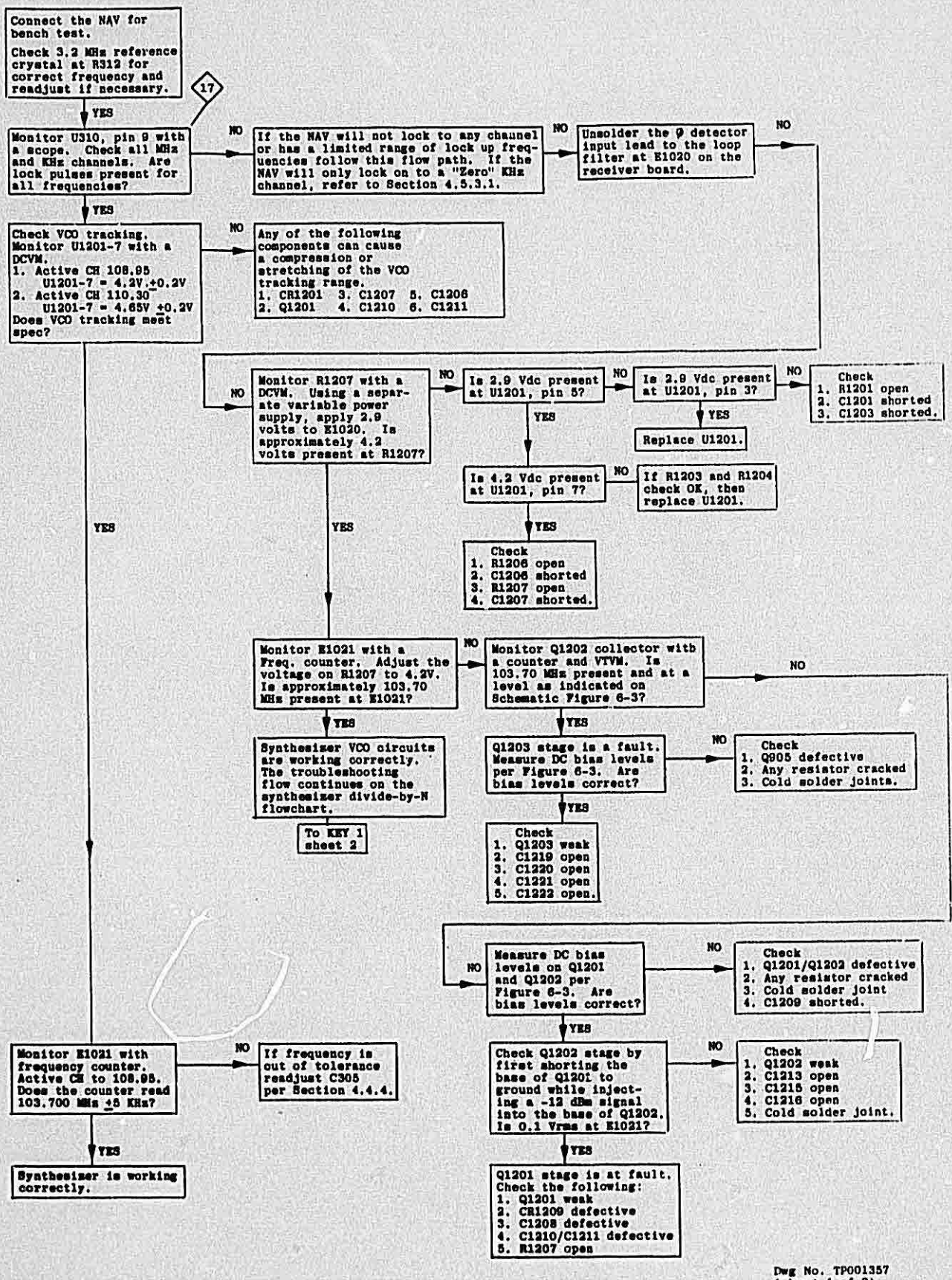


FIGURE 4-21. NAV SYNTHESIZER FLOWCHART (sheet 2 of 2)

SEE BLOW-UP



Dwg No. TP001357
(sheet 1 of 2)

FIGURE 4-22. GLIDESLOPE SYNTHESIZER FLOWCHART (sheet 1 of 2)

SEE BLOW-UP

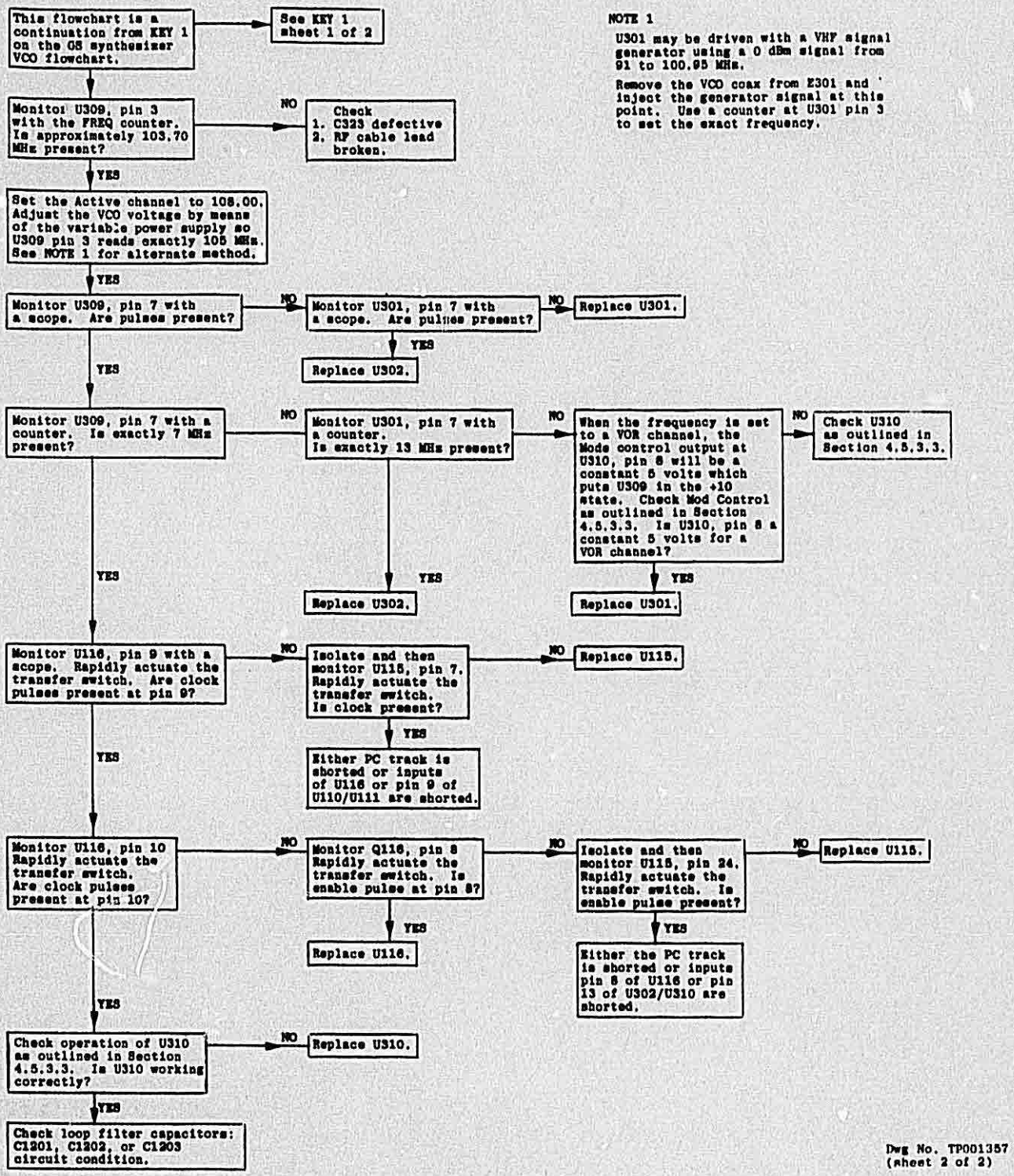
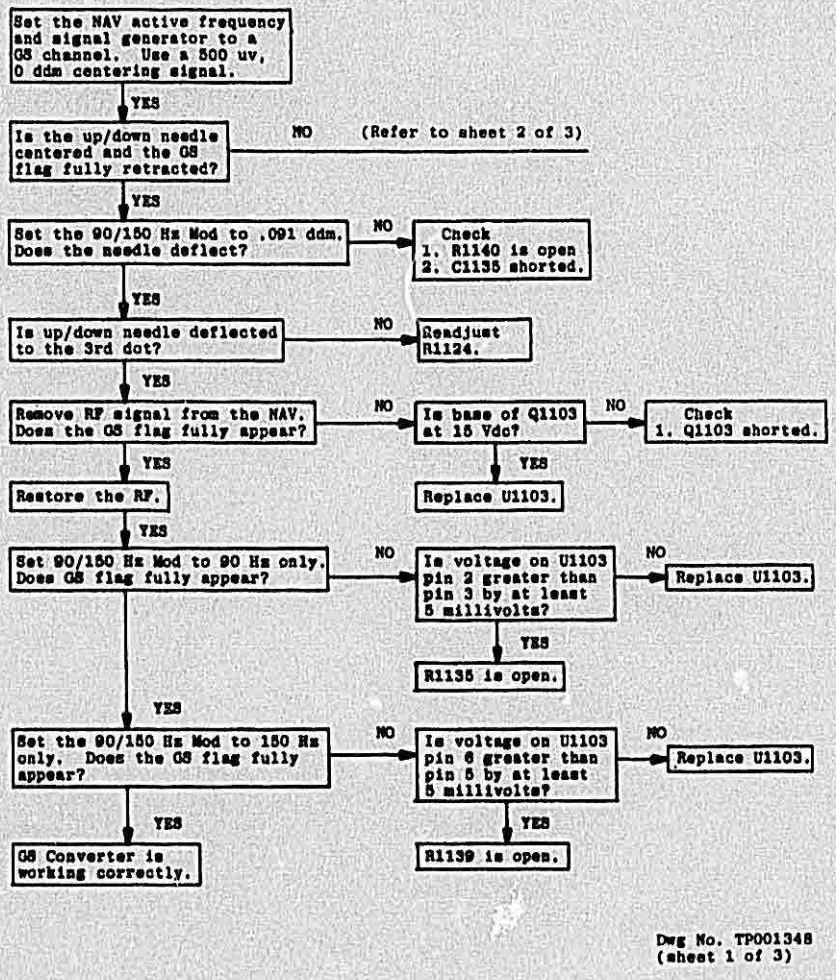


FIGURE 4-22. GLIDESLOPE SYNTHESIZER FLOWCHART (sheet 2 of 2)

SEE BLOW-UP



Dwg No. TP001348
(sheet 1 of 3)

FIGURE 4-23. GLIDESLOPE CONVERTER FLOWCHART (sheet 1 of 3)

SEE BLOW-UP

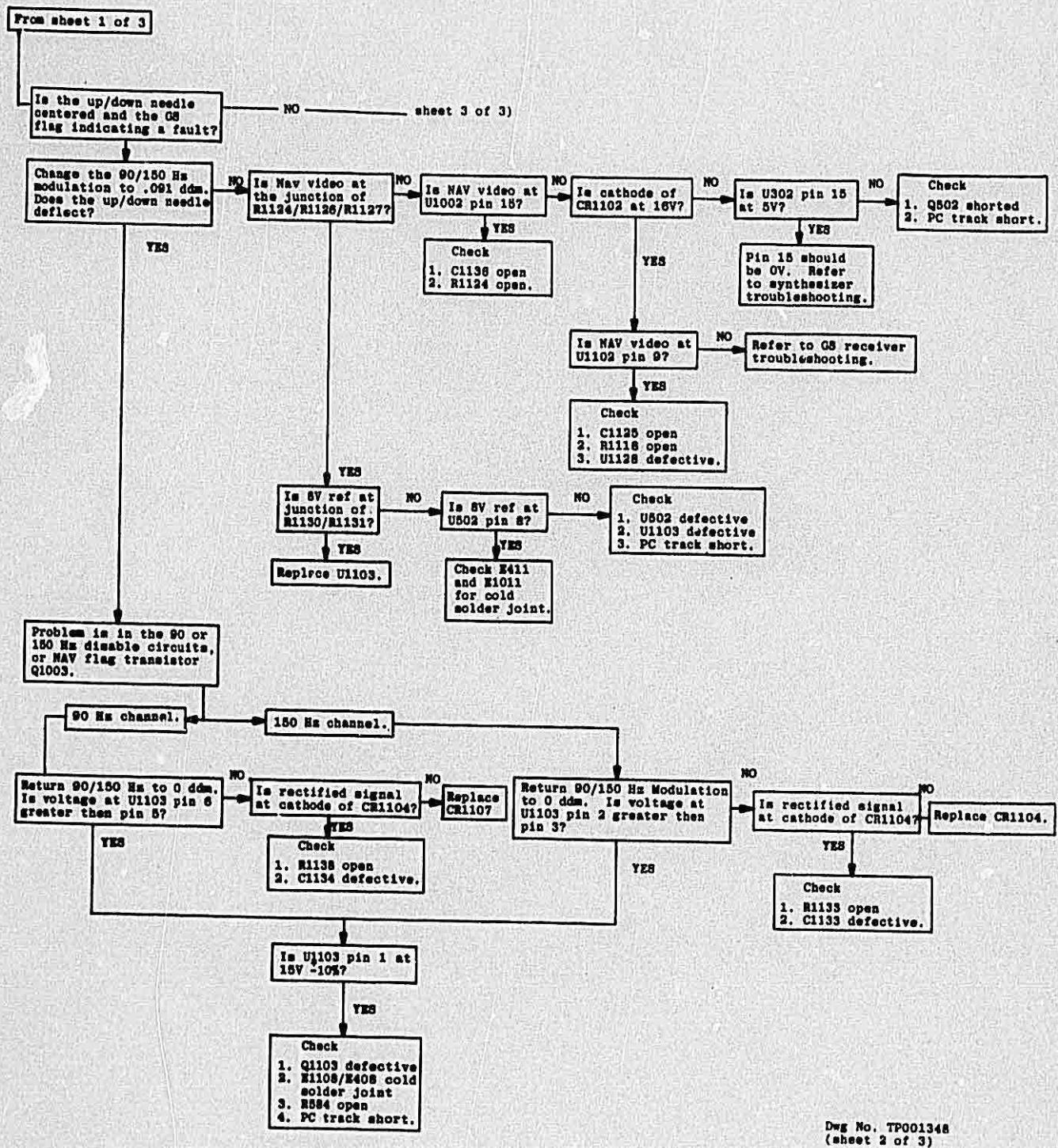
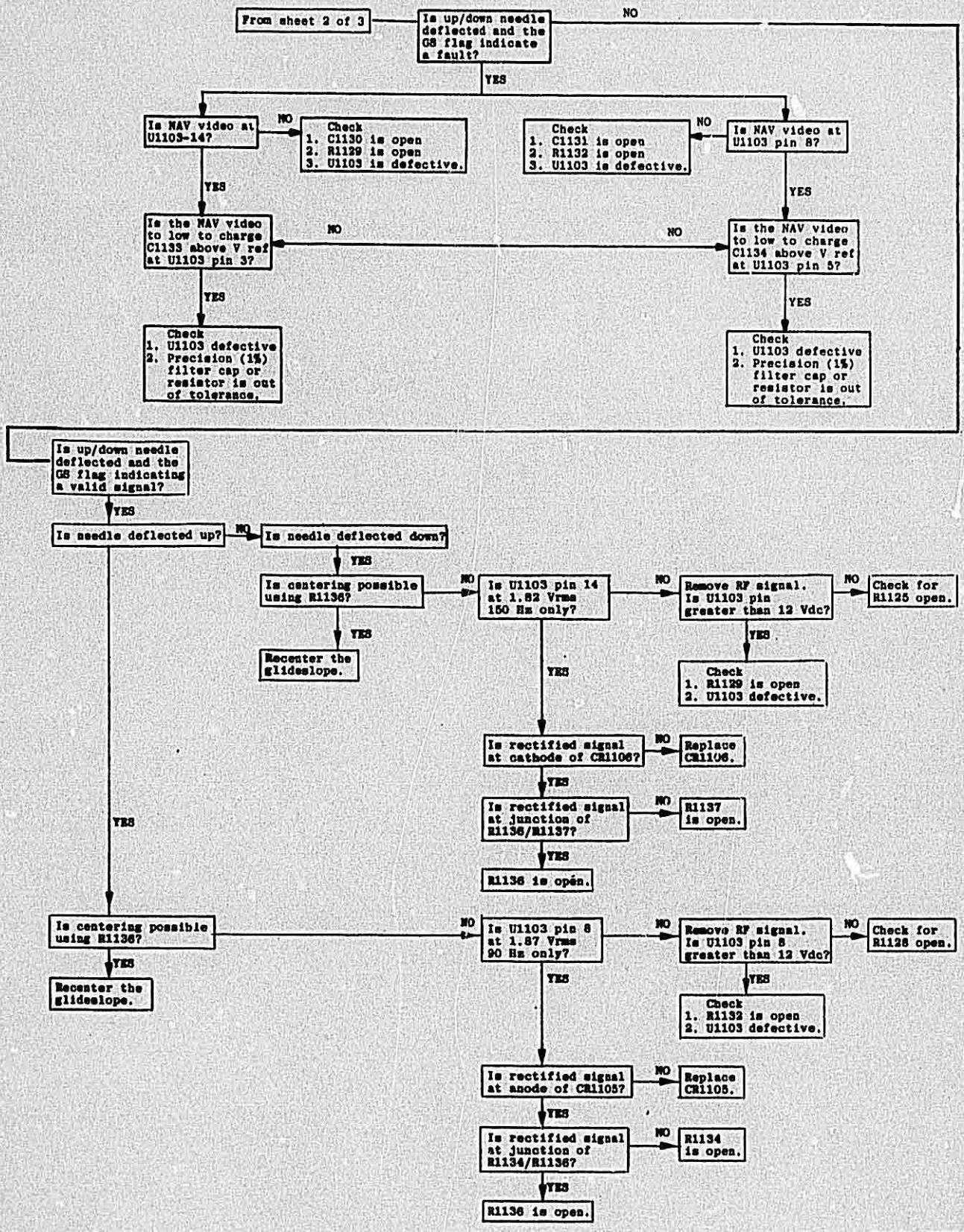


FIGURE 4-23. GLIDESLOPE CONVERTER FLOWCHART (sheet 2 of 3)

SEE BLOW-UP



Dwg No. TP001348
(sheet 3 of 3)

FIGURE 4-23. GLIDESLOPE CONVERTER FLOWCHART (sheet 3 of 3)

SEE BLOW-UP

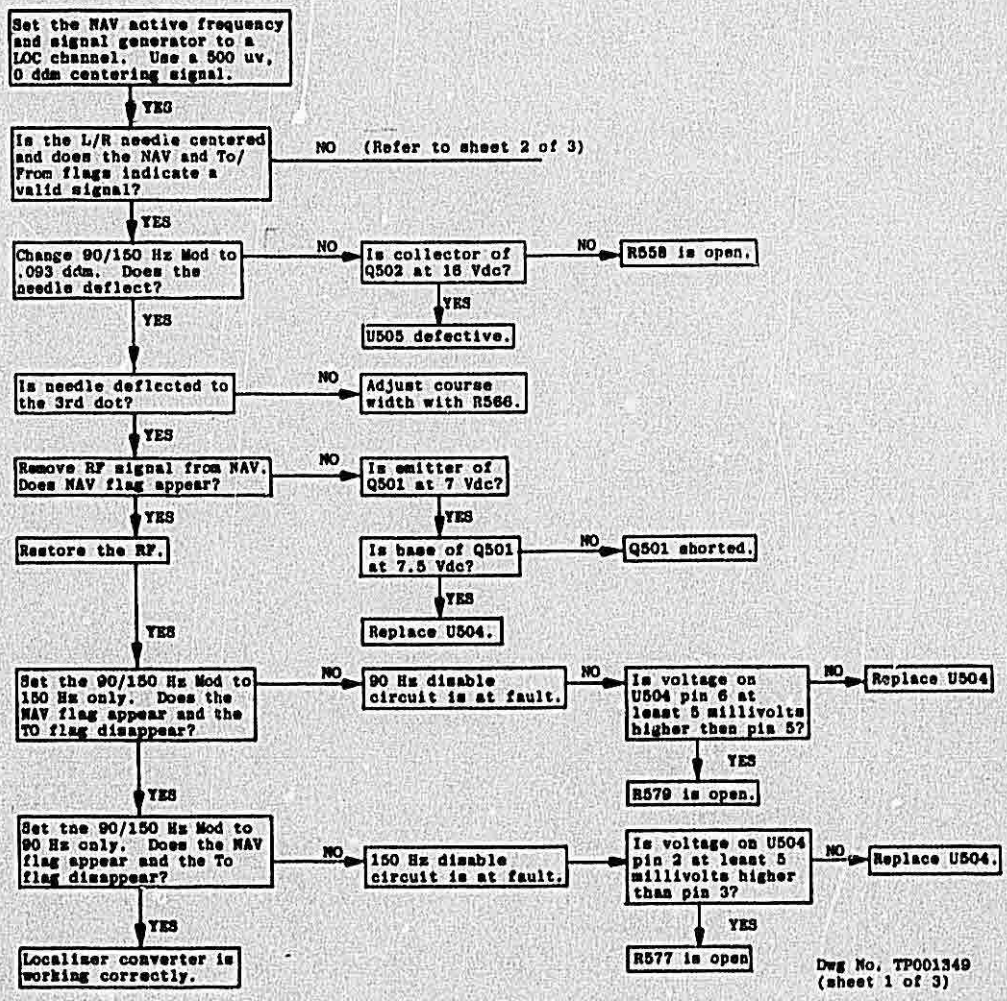


FIGURE 4-24. LOCALIZER CONVERTER FLOWCHART (sheet 1 of 3)

SEE BLOW-UP

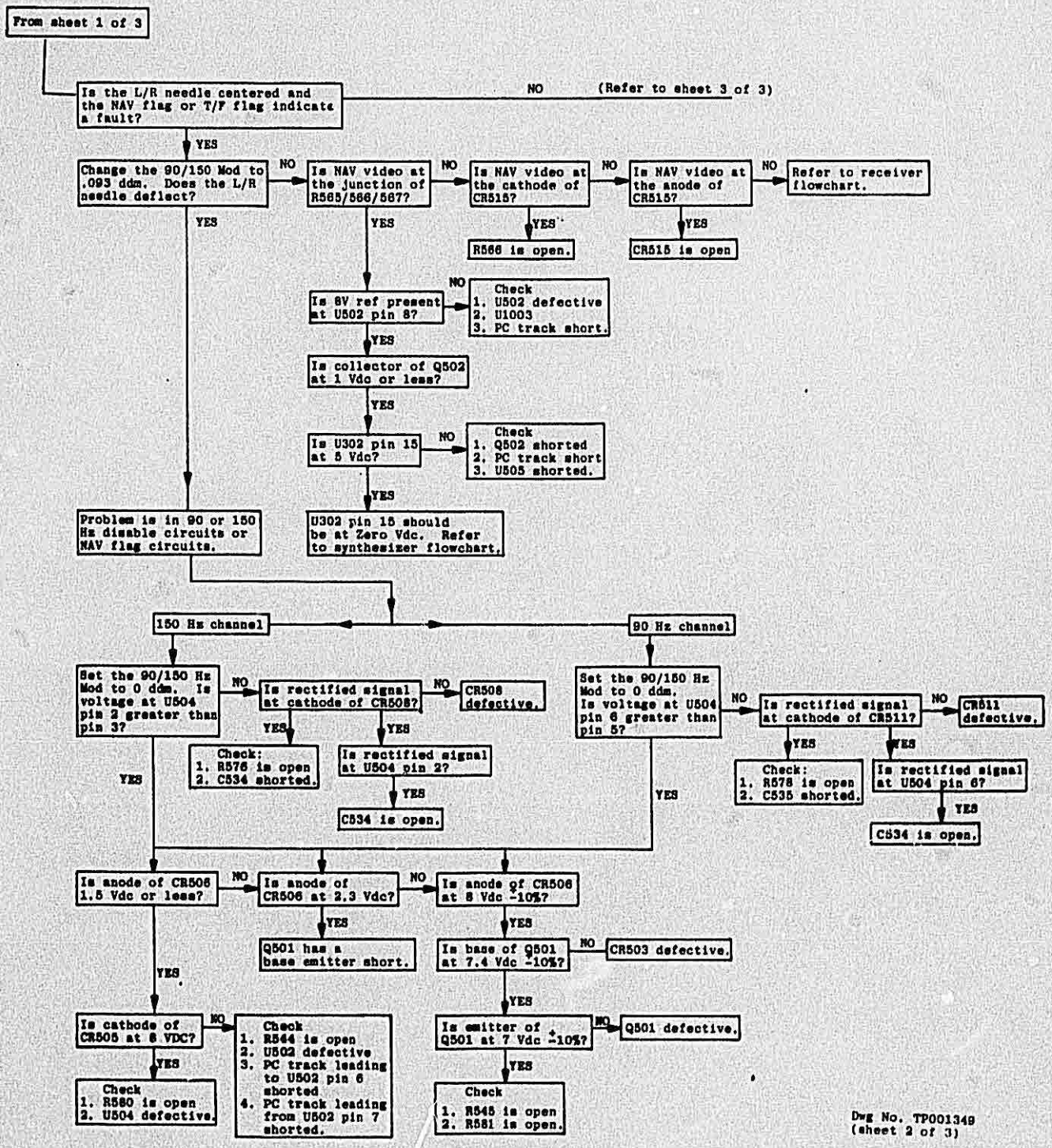


FIGURE 4-24. LOCALIZER CONVERTER FLOWCHART (sheet 2 of 3)

SEE BLOW-UP

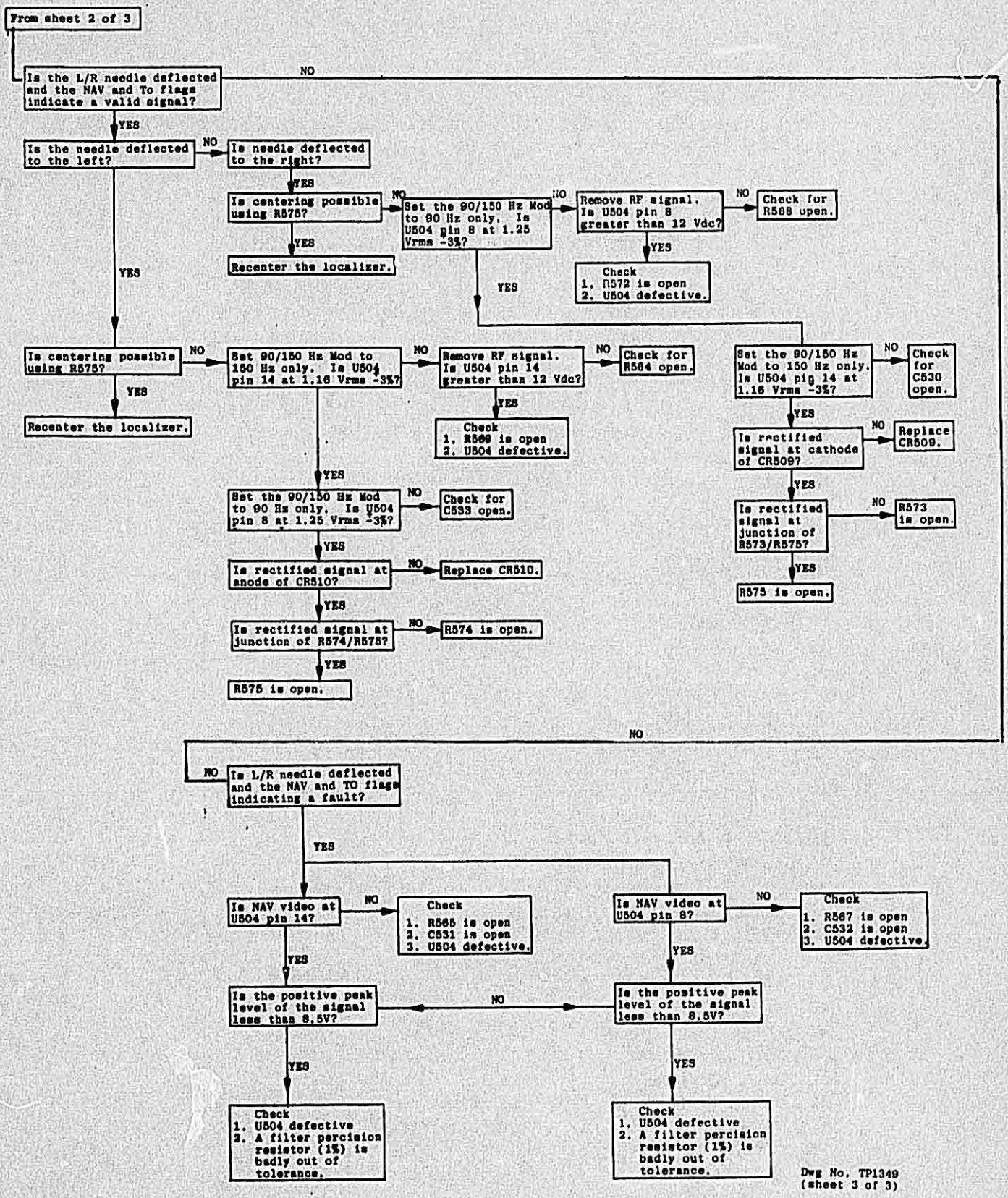


FIGURE 4-24. LOCALIZER CONVERTER FLOWCHART (sheet 3 of 3)

SEE BLOW-UP

4.5.4 Switching Regulator Troubleshooting

The theory of operation is given in Section 3.10.1 and it is recommended that this be read prior to troublehsooting this circuit. Figure 4-25 gives the normal DC operating voltages and waveform reference numbers at various circuit points.

The following facts are given to facilitate troubleshooting:

A. The 5 and 16 volt output lines prior to fuses F601 and F602 can withstand a dead short to ground, such as a shorted C606/C607/C608/C609, and not destroy any component. The same is true for the 190 volt output line. The circuit does not stop operating, it just goes into current limiting by reducing the pulse width (on time) of the control pulse that drives Q601.

B. If the 5 volt fuse, F602, should blow due to a circuit malfunction beyond the fuse, the switching regulator will repetitively turn on and off (oscillate). This is because an unloaded (blown fuse) 5 volt supply line allows a higher than normal positive peak charging voltage which is sensed by the internal shut down at U601 pin 10 and the error amplifier at U601 pin 1. When the overvoltage shuts down U601, the charge on C607 quickly bleeds off through R614/R615 releasing the internal shut down transistor and U601 turns on again repeating the cycle.

C. A collector to emitter short in Q602 will load the incoming A+ line with .05 ohms (R610) to ground causing a massive current draw from the bench power supply.

D. An open collector to emitter failure in Q602 drastically alters the voltage generating efficiency of T601. The error amplifier at pin 1 senses a low input from the 5 volt line and increases the on time of the control pulse at pins 12 and 14. This pulse which is normally 10 to 14 us wide, increases to approximately 50 us. However, the 190 volt output is far below normal and the display is blanked out. A scope probe at the emitter of Q602 will reveal an open collector to emitter as there will be no current limiting pulses as shown in Figure 6-2's waveform #18.

E. A collector to emitter short in Q601 causes both R608 and R609 to burn as they would have the full A+ line voltage briefly applied to them before Q601 turns on and shorts the A+ line.

F. An open collector to emitter in Q601 is evidenced by no switching waveform at its collector and a 50-50 duty cycle control pulse at its base. The reason for the 50-50 duty cycle is because the internal error amplifier would see no input voltage and its output would rise to increase the on time of the control pulse, however, CR601 will clamp the error amplifier to 2.5 volts and limit the control pulse duty cycle to 50-50.

4.5.4 Continued

G. C604 and R606 determine the frequency of the internal oscillator in U601 which is a nominal 16 KHz. The sawtooth waveform for pin 7 is shown in waveform #22. The square wave oscillator output at pin 3 is shown in waveform #22. If the internal 5 volt reference is present at pin 16 then there should be activity at pins 3 and 7, if not, then either the internal oscillator is defective or C604/R606 are at fault.

H. The switching regulator, U601, is guaranteed to work at an A+ input to the NAV as low as 8 Vdc, however, many will work at 6 Vdc.

I. A resistance subtitution box placed across R603 will give the technician the means by which he can control the output pulse at U601 pins 11 and 14. If the resistance box is set to 47 ohms, the output of the internal error amplifier will be clamped almost to ground and the internal triangle comparator will shut down the output transistors. When the resistance box value is raised to approximately 470 ohms, the error amplifier's input to the triangle comparator is just high enough so that the sawtooth waveform on the other input (+) to the triangle comparator will trip the comparator. Under these conditions, the output pulses at 12/13 and 11/14 will be at a minimum width. The width can be as narrow as 0.2 us which creates such a low duty cycle that Q601/Q602 are not on long enough to generate full output voltages and the NAV circuits are inoperative. As the resistance box value is raised higher, step by step, the duty cycle increases until CR601 becomes back biased and normal operation resumes. This technique allows the technician to activate the regulator circuits so he can begin his troubleshooting without fear of damaging the circuitry.

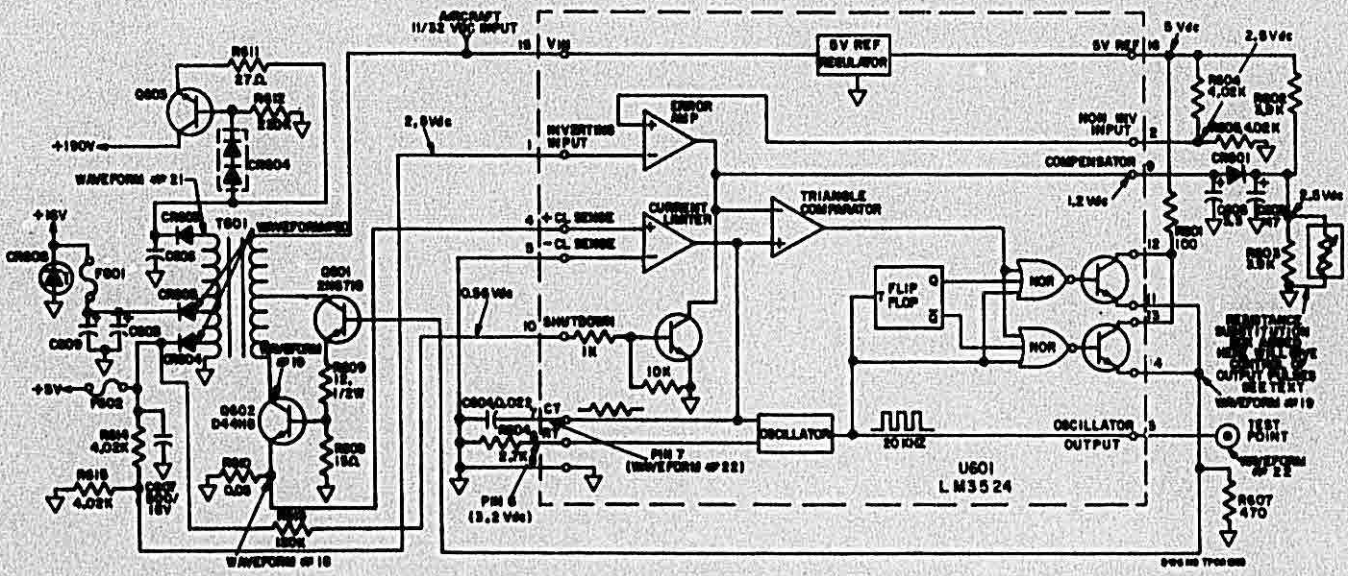


FIGURE 4-25. SWITCHING REGULATOR A, VOLTAGE AND WAVEFORM TEST POINTS

4.5.4.1 Suggested Technique For Checking U601 (LM3524)

NOTE: When using this technique unsolder the 190 volt lead from E601 to "blank" the display.

The following procedure will expose internal problems in U601. In order to perform these checks Q601 and Q602 must not be defective.

A. Place a resistance subtitution box across R603. Set the R value to 47 ohms and unsolder 190 volt lead from E601.

B. Internal 5V ref. regulator check
Monitor pin 16 with a DCVM. Starting at zero volts, slowly increase the power supply voltage until pin 16 reads 5 volts. The supply voltage must read 8 volts or less. If it requires more than an 8 volt input, U601 is defective.

C. Internal oscillator check
Monitor pins 3 and 7 with a scope. Leave the power supply voltage at its minimum setting from step A until told to change. The signals should be as shown in waveform #22. (Figure 4-19) If signal at pin 7 is missing, first check C604 and R606 for cold solder joints before changing U601.

D. Internal triangle comparator, T flip-flop, Nor gates and output transistors check
Monitor pins 12 and 13 with a scope there should be no pulses present. If there are pulses, check for open CR601. Increase the "R" value on subtitution box until pulses appear at pin 12 and 13. If no pulses appear by the time the "R" value is at 1.5K check C603 and C605 for a short. If these capacitors are OK, then U601 is defective. Leave the subtitution box across R603.

E. Internal shutdown transistor check
Monitor pin 12 and 13 with a scope. Short pin 10 to pin 15. The pulses at pins 12 and 13 should disappear. If not, U601 is defective.

F. Error amplifier check
Short pin 1 to pin 16. The pulses at pins 12 and 13 should disappear. If not, U601 is defective.

G. Internal current limiter check
With a dual track scope, monitor the emitter of Q602 and pins 12 and 13. Remove the resistance box from R603. Force a current limiting condition by shorting the cathode of CR605 to ground with a clip lead. Note that the voltage spikes on the emitter of Q602 increase above 200 millivolts which is the level at which current limiting begins. Briefly short the emitter to ground and observe that the pulse width at pins 12 and 13 shows an increase. If no increase is noted, U601 is defective.

4.5.5 VOR RF Amplifier (Q1001) and Mixer (Q1002) Troubleshooting

To troubleshoot the RF front end, it is required that the synthesizer, IF circuits, and detector be working properly in order to see the detected signal on a scope at U1002 pin 9.

Problems in the RF section most of the time will be confined to three areas:

1. Defective MOSFETs (Q1001, Q1002).
2. Defective tuning varactors (CR1001/CR1002/CR1003/CR1004).
3. Cold solder joint at a component.

The RF AGC voltage applied to gate 2 of Q1002, will decrease with increasing RF signal level, which decreases the gain of Q1001. With no RF signal the applied voltage is approximately 5.2 Vdc. At 1 uv it is 4.95 Vdc, at 100 uv it is 4.1 Vdc, and at 500 millivolts, 3.0 Vdc.

The tuning voltage applied to each varactor diode is fed through a 100K resistor (R1002, R1003 and R1009, R1010). A DCVM, using its most sensitive scale, when placed across any of these resistors should not measure a voltage drop greater than 10 millivolts. Voltage drops greater than 10 mv indicate a defective varactor diode. The VCO tuning voltage will range from 2.2 Vdc at 108.00 MHz to 4.2 Vdc at 117.95 MHz. The tuning voltage changes 1 Vdc per 5 MHz.

The principal failure mode of MOSFET (Q1001/Q1002) transistors are blown gates.

4.5.5.1 Troubleshooting MOSFETs Q1001/Q1002

The drain current that is drawn by Q1001 through R1008 is directly proportional to the RF AGC voltage. At a RF signal level of 5 uv, the RF AGC voltage has turned on Q1001 fairly hard so the voltage drop across R1008 (100 ohms) will be approximately 400 millivolts which is equivalent to a drain current of 4 ma. At a 500 uv signal level, the voltage drop has decreased to 150 millivolts (1.5 ma). If there is no voltage drop across R1008and the RF AGC voltage is 1 Vdc or greater, then Q1001 is probable defective. If an abnormally high voltage drop (800 mv or greater) exists across R1008, then Q1001 is defective.

The drain current drawn by Q100- through R1014 (100 ohms) is approximately 3 to 4 ma and is determined by the fixed DC bias (0.7 Vdc) on gate 2 and the injected local oscillator signal. Abnormally high or no voltage drop across R1014 indicates a defective Q1002.

The principal failure mode of both these MOSFETs will be a blown Gate 1, which is the gate to which the RF signal is applied. A blown Gate 1 will hardly have any effect on the drain current. The only way to diagnose this situation is to inject an RF signal on Gate 1, then the drain at pin 1, while monitoring detector U1002-9 with a scope to prove that Gate 1 has blown open.

4.5.5.2 RF Capacitor Troubleshooting

The RF capacitors found in the receiver are one of two types: cylindrical ceramic (C1003, C1010) and ceramic disc for all others. The physical construction of these capacitors rules out the possibilty of an internal short. As for the rated value changing significantly, that too is a remote possibility but could occur if the capacitor coating was cracked and the capacitor exposed to repeated prolonged high humidity. Therefore, the chances for encountering a truly defective capacitor is very remote. If a receiver is going to have a capacitor problem, it will be caused by a COLD SOLDER JOINT or physical damage. When a trouble has been isolated to a particular circuit area, it would be wise to resolder all capacitors to ensure that the solder has flowed into the PC board plated through mounting hole. Remember, a cold solder joint renders any component "Open".

4.5.5.3 Signal Generator Injection Level and Troubleshooting Technique

The test signal required to generate a 200 mVpp response at the detector, U1002-9 is 5 microvolts with a modulation of 400 Hz at 30%. Set the NAV active and signal generator to 110.50 MHz.

To isolate a problem to a particular circuit section the following technique is suggested: (Refer to Figure 4-26 for injection points.)

A. Monitor U1002-9 with a scope. The response level for all test injection points is the same, 200 millivolts peak-to-peak. See Figure 4-27.
B. Before injecting an RF signal check all DC bias levels as shown in Figure 6-3.
C. Inject test signal into the antenna connector, J104.
D. If the signal on U1002-9 is missing or weak, inject the test signal into Gate 1 of Q1001. Use a 330 pF coupling capacitor and be sure to ground the coax shield.
E. If U1002-9 shows the proper response then the problem is in the input filter. Check the varactor diodes CR1001/CR1002 and all components for cold solder joints.
F. If the signal is still weak or missing, inject the test signal into the drain of Q1001 at pin 1. If U1002-9 is now normal, the problem is Q1001, however, you were told that the RF AGC circuits had to be properly working in order to troubleshoot the receiver front end. For a 5 uv test signal the RF AGC voltage applied to Gate 2 of Q1001 should be approximately 4.7 Vdc. If it is less than this, Q1001 is being biased off far too soon and you have a RF AGC problem.

4.5.5.3 Continued

G. If U1002-9 is still weak or missing, inject the test signal into Gate 1 of Q1002. If U1002-9 is now normal, the problem is in the second filter stage. Check varactor diodes CR1003/CR1004 and other components for cold solder joints.

H. If U1002-9 is still weak or missing, inject the test signal into the drain of Q1002 at pin 1. U1002-9 MUST now be normal because we have previously stated that the IF circuits had to be working properly in order to check the RF front end. Before replacing Q1002, check that you do have a 0.9 Vrms LO signal at gate 2 of Q1002.

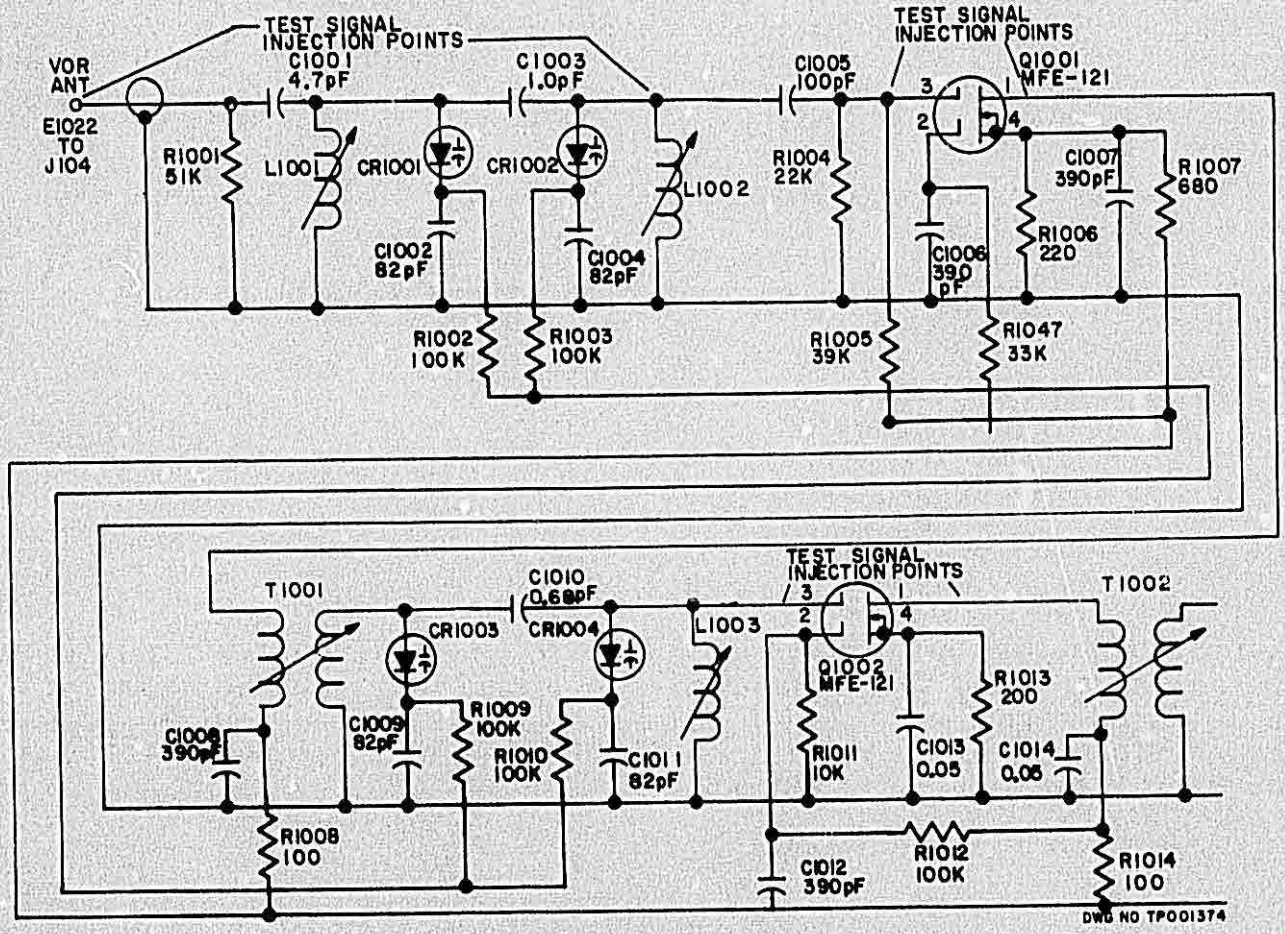


FIGURE 4-26. RF TEST SIGNAL INJECTION POINTS FOR RF FRONT END

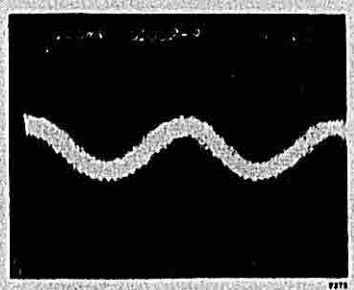


FIGURE 4-27. U1002-9 DETECTOR RESPONSE TO 110.50 MHz RF TEST SIGNAL, 400 Hz Mod 30% AT A 5 MICROVOLT LEVEL INPUT

4.5.6 VOR IF Receiver Troubleshooting

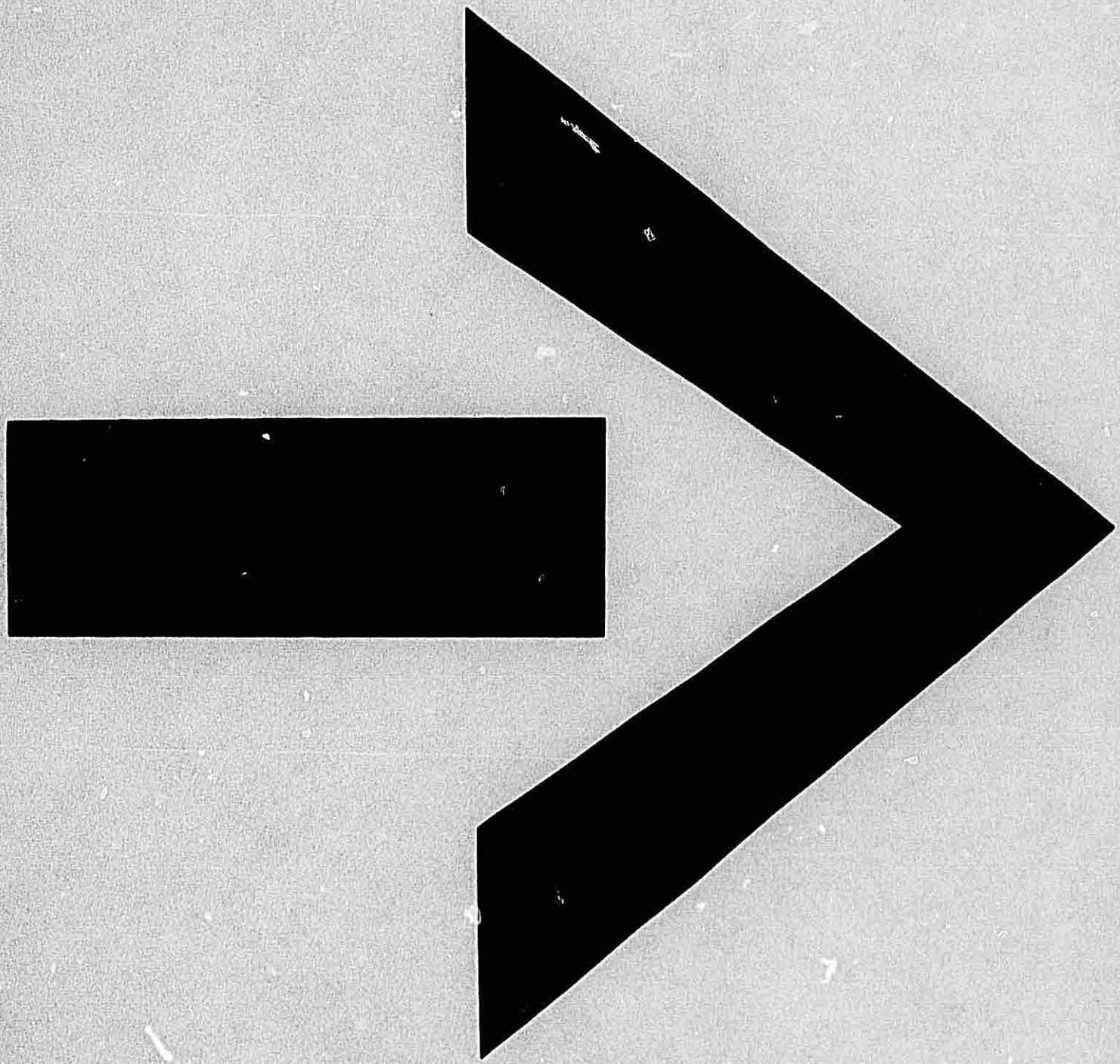
The suggested method of troubleshooting the IF circuits consists of monitoring U1002-9 with a scope while injecting a 17 MHz test signal, 400 Hz, Mod 30% into selected points throughout the circuit in order to identify the problem area.

Crystal filters, FL1001 and FL1002, are comprised of two individual monolithic two pole crystal filters. The nominal insertion loss per individual crystal is 0.5 db. Two crystals together are specified by Narco to have a maximum insertion loss of 1.5 db. Please note that each crystal has a color coded polarity dot on its top. The receiver board component layout shows how the crystals are arranged according to their dots. When replacing a defective crystal you MUST replace both crystals. Insert the new crystals with their colored dots in the correct position and realign the IF by the sweep method. Failure to do so will result in a altered bandpass characteristic. See Section 4.4.11 for sweep method.

If AGC is applied to pin 5 of the IF amplifier U1001. An increasing voltage decreases the gain. The IF AGC characteristic at U1002D pin 6 is as follows: (The levels shown are what you would expect to see from an RF signal applied to the front end through antenna connector, J104.)

No RF signal	= 3.15 Vdc	
1 uv RF signal	= 3.5 Vdc	
5 uv RF signal	= 3.65 Vdc	
10 uv RF signal	= 3.7 Vdc	±5%
100 uv RF signal	= 3.85 Vdc	
500 uv RF signal	= 3.95 Vdc	
5K uv RF signal	= 4.0 Vdc	

Pin 5 of U1001 may be directly shorted to ground to allow U1001 to deliver its maximum gain. When pin 5 is shorted, the amplitude of the detected signal at U1002-9 will increase. This serves to prove that the internal AGC circuits in U1001 are working. Use a 100 uv test signal when checking AGC action.



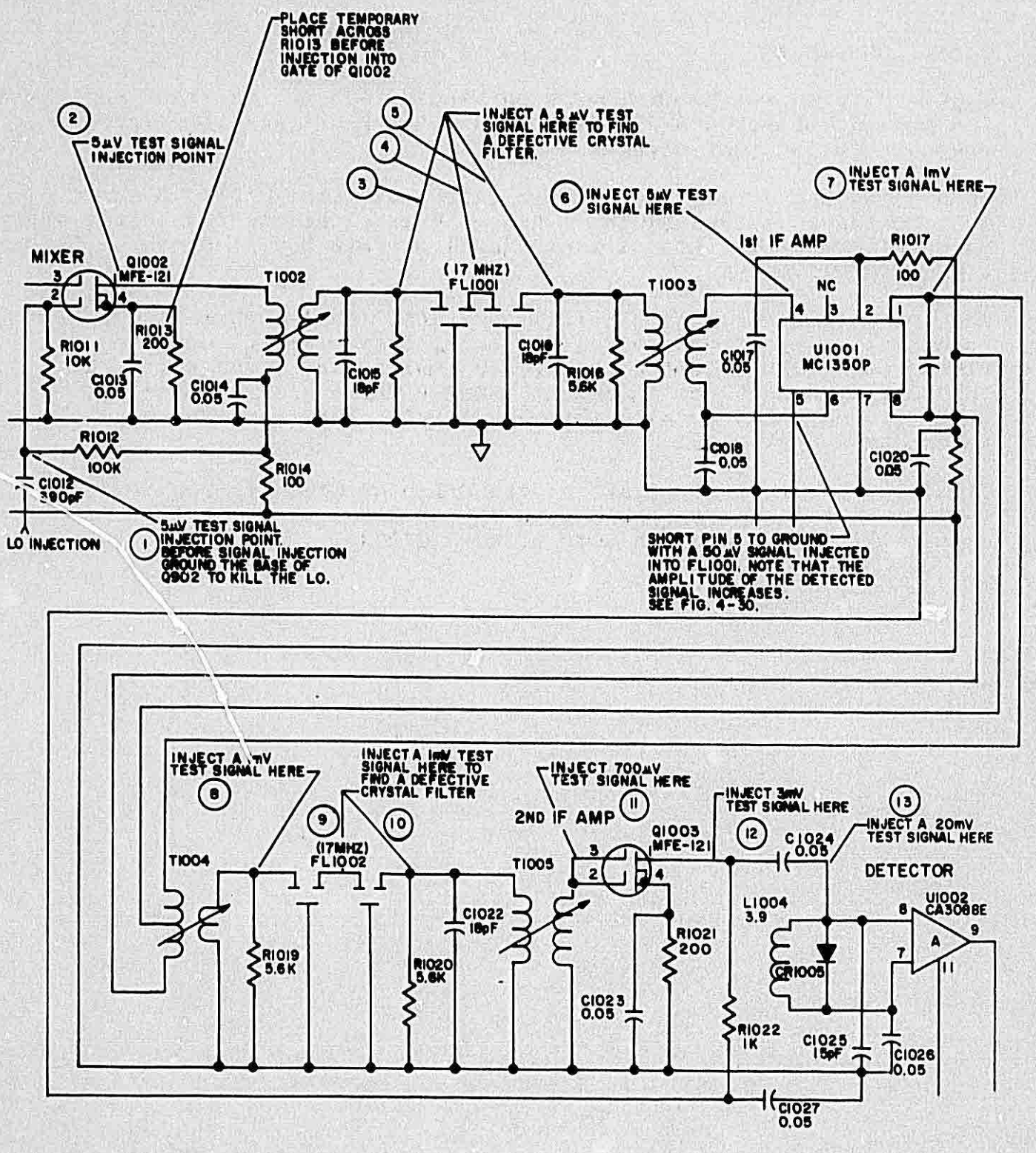
4.5.6 Continued

Figure 4-26 shows the DC levels on U1001/Q1003 and the test injection points. Figures 4-27, 4-28, and 4-29 illustrate the expected response to the test signal.

When injecting a test signal into gate 2 of mixer Q1002, a short must be placed across R1013. This will make the mixer a better and more uniform amplifier. A test signal at gate 2 will prove if Gate 2 of Q1002 is blown.

The test signal injection points in FL1001 and FL1002 will quickly point out a defective crystal filter or open circuit condition by virtue of a COLD SOLDER JOINT. Note that a 5 uv level signal at FL1001 yields a 150 mv signal at U1002-9 while a 1 mv level at FL1002 is required to give the same level. This fact can be used to expose a weak U1001.

Finally, an 3 mv test signal at the drain of Q1003 is required to achieve the same response as a 700 uv level at its gate. This check will expose a blown Gate or weak Q1003.



NOTE:
TEST SIGNAL INTO POINTS (*) IS 17MHZ 400HZ MOD 30% AT INDICATED LEVELS, SIGNAL IS COUPLED INTO TEST POINT THRU A 330pF COUPLING CAPACITOR. DWG NO TP001370

FIGURE 4-28. VOR IF RECEIVER TEST INJECTION POINTS

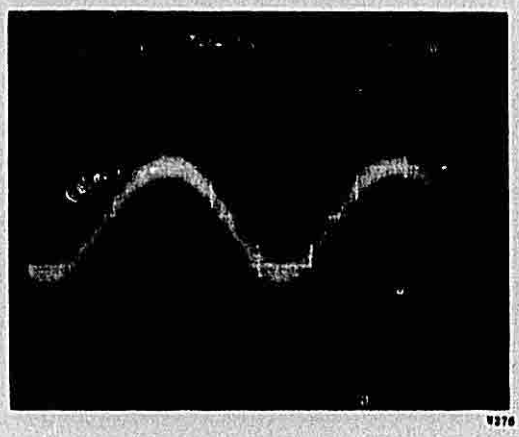


FIGURE 4-29. TEST SIGNAL RESPONSE FOR TEST POINTS 1 TO 6 WITH IF AGC

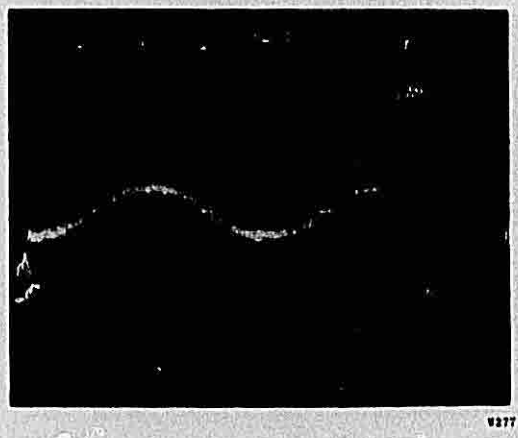


FIGURE 4-30. TEST SIGNAL RESPONSE FOR TEST POINTS 1 TO 6 WITH PIN 5 OF U1001 SHORTED

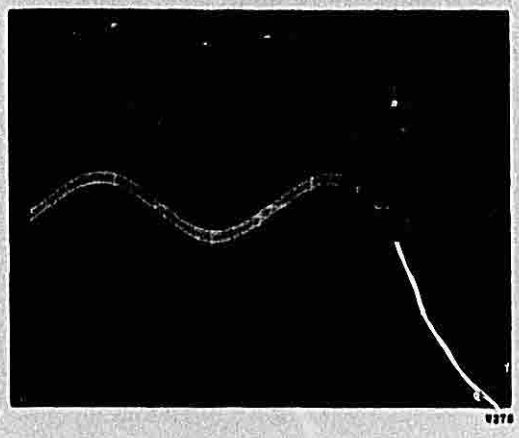


FIGURE 4-31. TEST SIGNAL RESPONSE FOR TEST POINTS 7 TO 13

4.5.7 GS RF Receiver Troubleshooting

The suggested method of troubleshooting the glideslope RF front end consists of setting the NAV Active frequency to 110.70 MHz and monitoring the detector, TP25, with a scope while a 330.20 MHz, 400 Hz, Mod 30% test signal is injected into selected points to identify the problem area.

To use this method, the GS IF, detector, and GS VCO circuits must be working correctly.

Figure 4-32 gives the DC bias levels and the test injection points with the indicated level. Figure 4-33 shows the expected response to the test signal. Check to ensure that the LO signal level at the junction of C1217/R1215 is 0.44 Vrms before you begin your tests.

The RF AGC that is applied to Q1101 will decrease with increasing signal level. The characteristics are given here:

Glideslope RF AGC (U1102-13)		RF Signal Level
1.40 Vdc		No Signal
1.35 Vdc		2 uv
1.25 Vdc	±10%	10 uv
1.05 Vdc		500 uv
0.95 Vdc		5K uv
0.9 Vdc		10K uv

WARNING: The RF coupling capacitors in the GS RF receiver are small NPO ceramic disc types. These capacitors cannot stand a very hot soldering iron. Use a 600°F soldering iron for these components. NEVER reuse any NPO capacitor that has been removed from the PC board.

Transistors Q1101/Q1102 are also sensitive to heat, use the 600°F soldering iron.

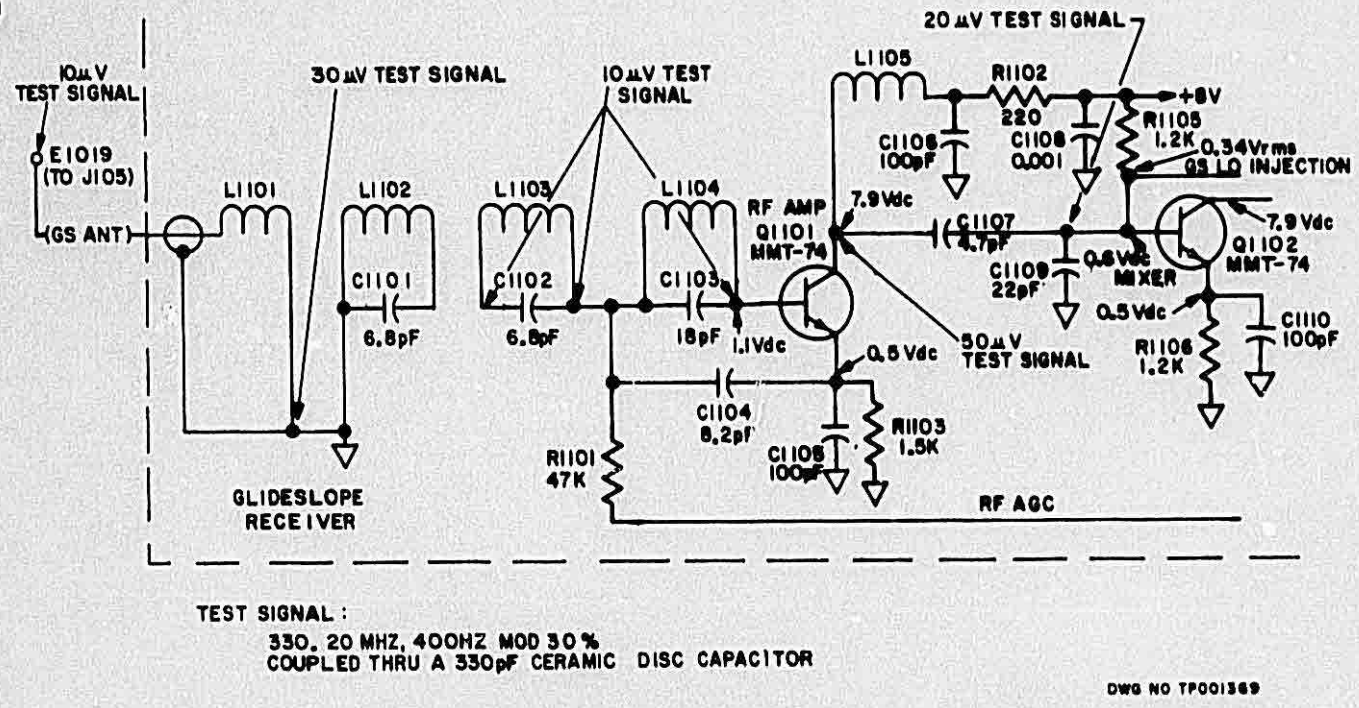


FIGURE 4-32. TEST SIGNAL INJECTION POINTS FOR GS RF FRONT END

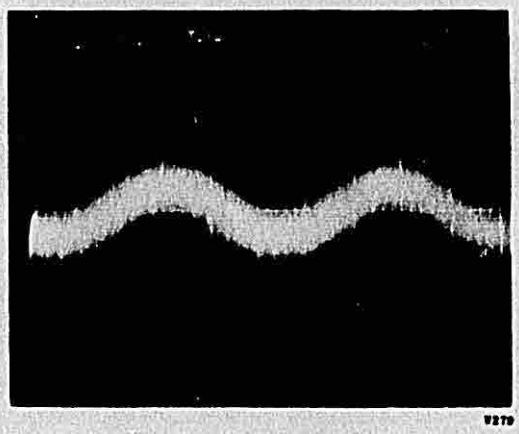


FIGURE 4-33. GS DETECTOR TP25 RESPONSE TO TEST SIGNAL OF 330.20 MHz 40 Hz Mod 30%

4.5.8 Glideslope IF Receiver Troubleshooting

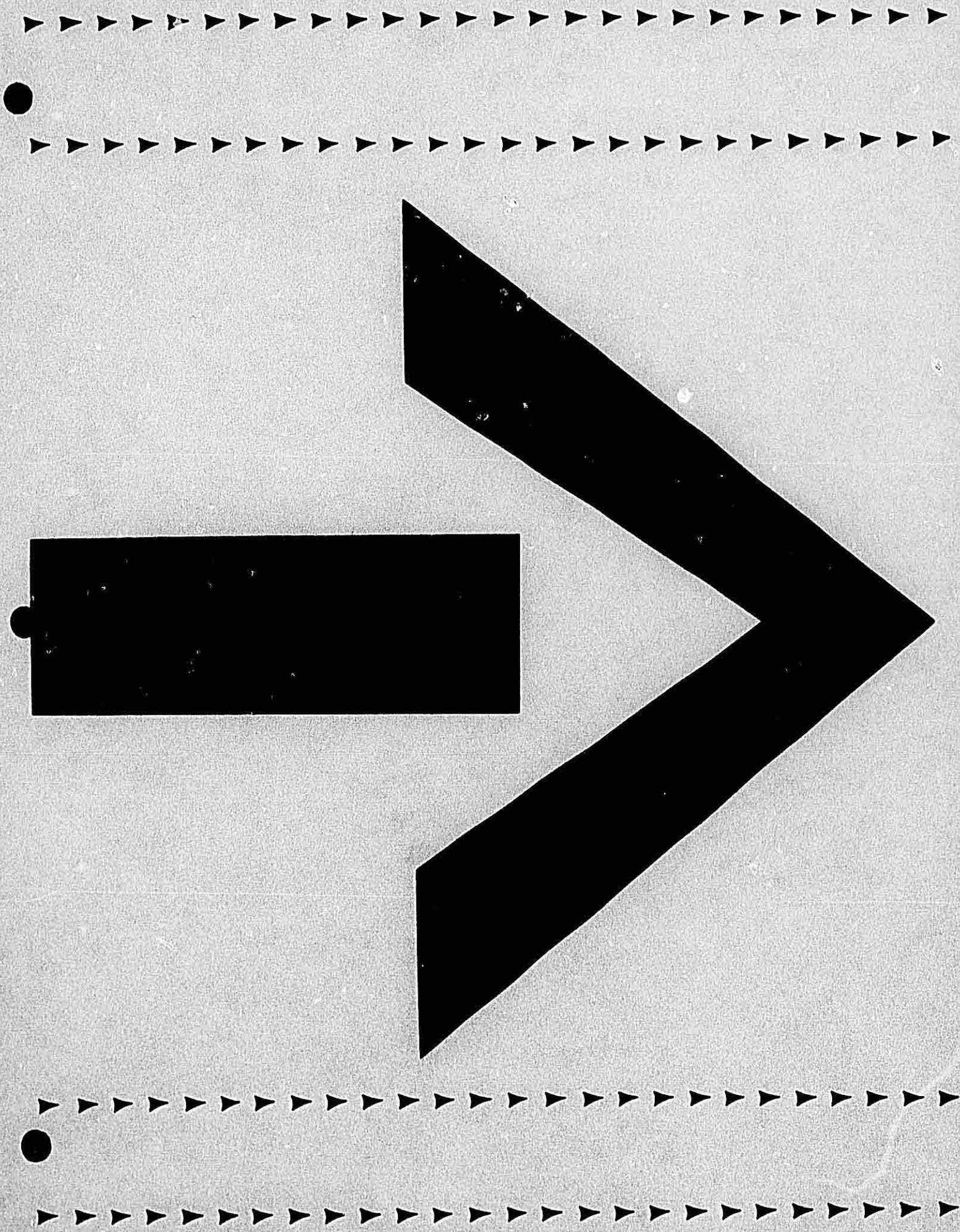
The recommended method of troubleshooting the IF circuits is to inject a 18.05 MHz 400 Hz Mod 30% test signal into selected points in order to expose a crystal filter or IF amp failure. The crystal filter FL1101 is comprised of three monolithic two pole crystal filters. The nominal insertion loss is 0.5 db. The three cryatals together are specified by Narco to have a maximum insertion loss of 2 db. Please note that each crystal has a color coded polarity dot on its top. The receiver board component layout shows how the crystals are arranged according to their dots. When replacing a defective crystal, you MUST replace all three and insert them with their colored dots in the correct position and realign the IF by the sweep method. Failure to do so will result in an altered band-pass characteristic. See Section 4.4.12 for sweep method.

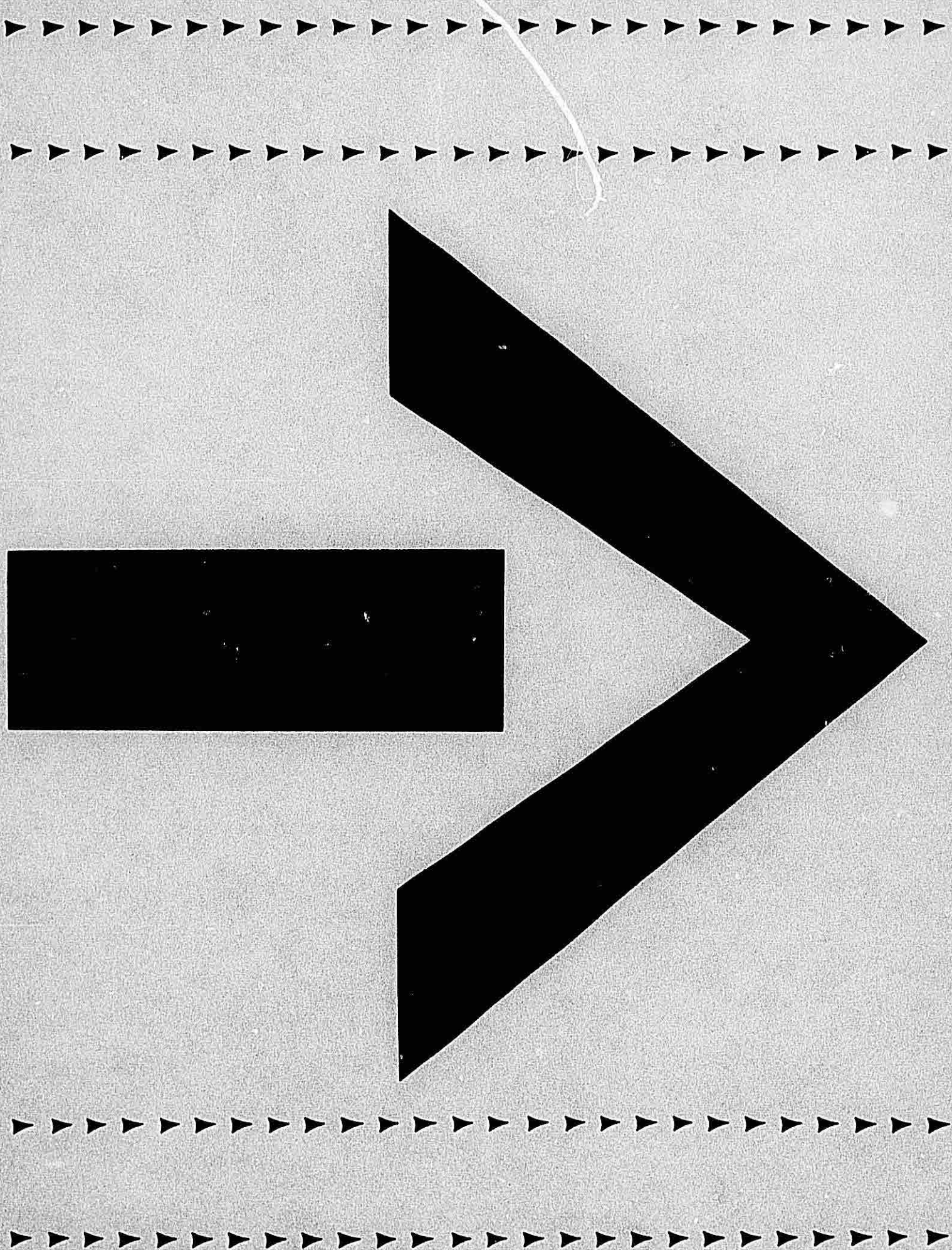
The IF AGC voltage applied to U1101 pin 5 will increase with increasing signal level. The IF AGC characteristic is given here:

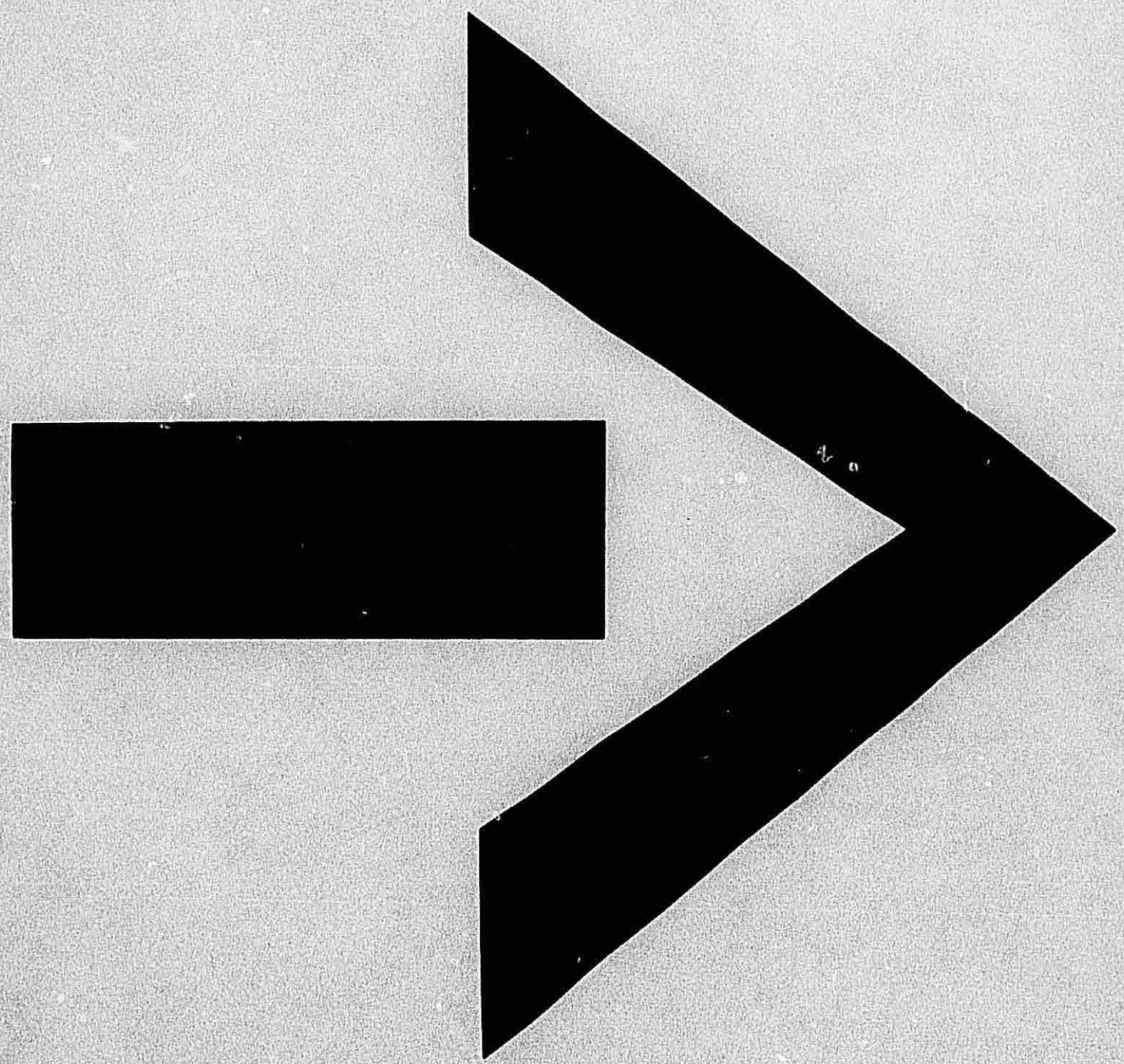
GS IF AGC (Q1104 emitter)		RF Signal Level
3.30 Vdc		0 uv
3.35 Vdc		2 uv
3.40 Vdc	±10%	10 uv
3.60 Vdc		500 uv
3.70 Vdc		5K uv
3.70 Vdc		20K uv

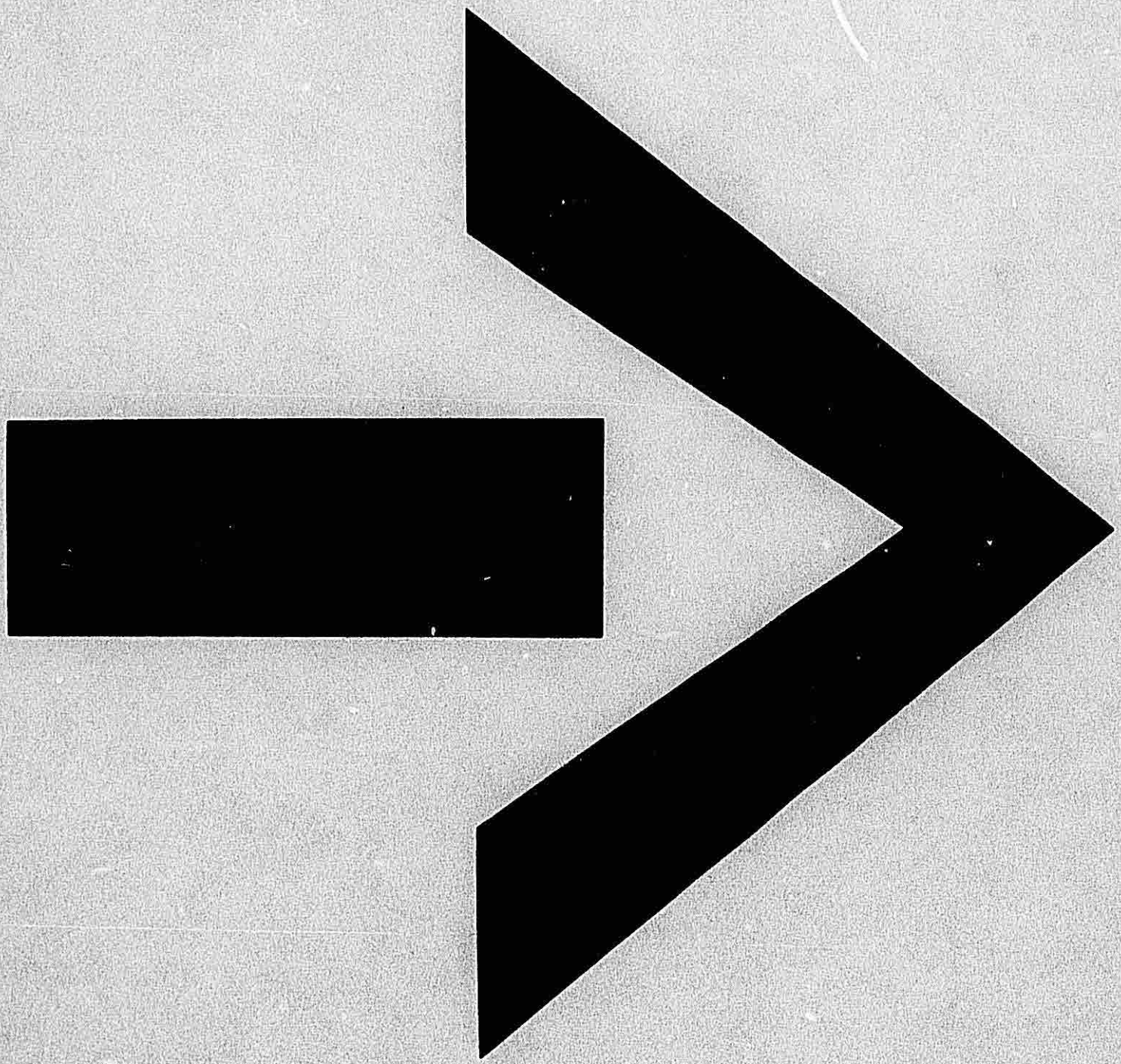
WARNING: The glideslope VCO frequencies range from 103.70 to 105.65 MHz. The third harmonic of these frequencies is used for the LO injection into the mixer Q1102. If the 3.2 MHz clock (Q301) is not within tolerance, then the glideslope receiver will suffer a loss of sensitivity. If the glideslope receiver shows poor sensitivity, first check the 3.2 MHz clock for proper alignment (Section 4.4) before troubleshooting the GS receiver circuit.

Figure 4-34 shows the test injection points for the Glideslope IF circuits and Figure 4-35 shows the response to the test signal at TP25.









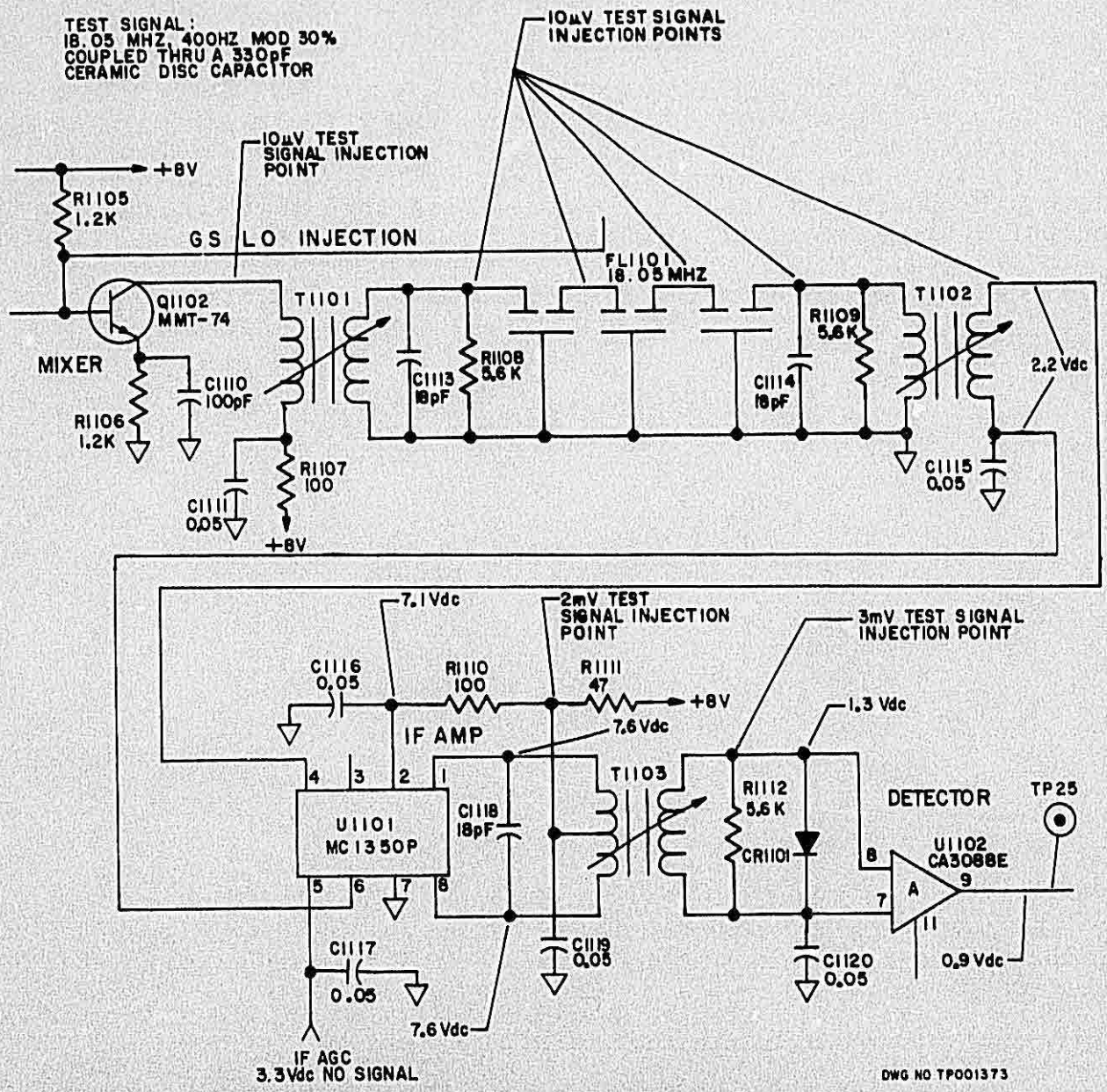


FIGURE 4-34. GLIDESLOPE IF RECEIVER DC BIAS LEVLES AND TEST INJECTION POINTS

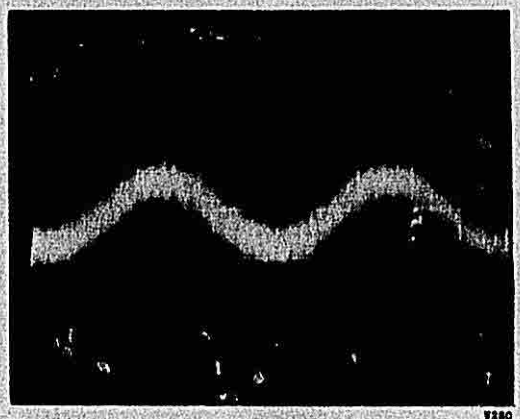


FIGURE 4-35. TP25 RESPONSE TO 18.05 MHz TEST SIGNAL

4.5.9 VOR Receiver Detector, 1st and 2nd Audio Amp, RF and IF AGC Circuit Troubleshooting

Detector, 1st and 2nd Audio Amp, RF/IF AGC functions are provided by an RCA-CA3088E integrated circuit (U1002) which features four independent transistor amplifiers. It is felt that most internal circuit failures can be exposed by checking the DC voltages on various pins under no signal conditions, and then forcing responses at output pins by shorting a few select input pins to ground.

The following are the expected pin voltages on U1002 with NO RF signal applied to the receiver and the NAV Active frequency set to 115.50 MHz.

U1002 PIN	+DC VOLTS ±20%
1	0.73
2	1.37
3	3.9
4	0.65
5	IC ground
6	3.1
7	1.35
8	1.35
9	0.83
10	5.6
11	0.52
12	NOT USED
13	5.6
14	0.67
15	5.5
16	7.5

The following are static tests that will expose an internal catastrophic failure. Checks are performed without an RF signal applied to the receiver.

A. Detector Section Check (U1002A)
   Short pin 8 to ground. Pin 9 should rise from 0.8 to 4 volts ±10%. Short pin 6 to pin 7. Pin 9 should drop to 0.35 volts ±10%.
B. First Audio Amplifier Section Check (U1002F)
   Short pin 14 to the base of Q1005. Pin 15 should drop to 0 volts.
C. RF AGC Section Check (U1002B)
   Short pin 11 to pin 6. Pin 13 should drop from 5.0 to 0.1 volts.
D. IF AGC Section Check (U1002C/D)
   Short pin 4 to ground. Pin 6 should rise from 3.1 to 4.0 volts ±10%.
E. Second Audio Amplifier Section Check (U1002F)
   Short pin 2 to ground. Pin 3 should rise to 7.6 Vdc ±10%.

4.5.10 Glideslope Receiver Detector, Video Amp, RF and IF AGC Circuit Troubleshooting

Detector, Video Amplifier, RF/IF AGC functions are provided by an RCA-CA3088E intergrated circuit (U1102) which features four independent transistor amplifiers. It is felt that most internal circuit failures can be exposed by checking the DC voltages on various pins under no signal conditions and then forcing responses at output pins by shorting a few select input pins to ground.

The following are the expected pin voltages on U1102 with NO RF signal applied to the glideslope receiver and the NAV Active frequency set to 110.50 MHz.

U1002 PIN	+DC VOLTS ±20%
1	NOT USED
2	NOT USED
3	NOT USED
4	0.65
5	IC ground
6	3.9
7	1.35
8	1.35
9	0.83
10	5.6
11	0.67
12	NOT USED
13	1.42
14	0.74
15	4.3
16	8.0

The following are static tests that will expose an internal catastrophic failure. Checks are performed without an RF signal applied to the receiver.

A. Detector Section Check (U1102A)
   Short pin 8 to ground. Pin 9 should rise from 0.83 to 4 volts ±10%. Short pin 6 to pin 7. Pin 9 should drop to 0.35 volts ±10%.

B. Video Amplifier Section Check (U1102B)
   Short pin 14 to ground. Pin 15 should rise from 4.3 to 7.2 volts ±10%. Short pin 14 to the emitter of Q1104. Pin 15 should drop to 1.4 volts.

C. RF AGC Section Check (U1102C)
   Short pin 11 to pin 6. Pin 13 should drop from 1.42 to 0.1 volts.

D. IF AGC Section Check (U1102 D/E)
   Short pin 4 to ground. Pin 6 should rise from 3.9 to 7.9 volts ±10%

4.5.11 VOR FM Demodulator U507 (CD4046A) Phase-Locked Loop Troubleshooting

U507 is used to demodulate the 9960 Hz FM modulated reference signal portion of the composite VOR video signal. The phase comparator "I" section of the CD4046A IC is used. With no signal or noise on the signal input, this phase comparator has an average output voltage equal to 1/2 the supply voltage. The low pass filter R508/C505 connected to the output of the phase comparator "I" supplies the average voltage to the internal VCO and causes the VCO to oscillate at the center frequency of 9960 Hz. The center frequency is set by R507.

The following procedure is given to checkout U507. Use Figure 4-36 for reference.

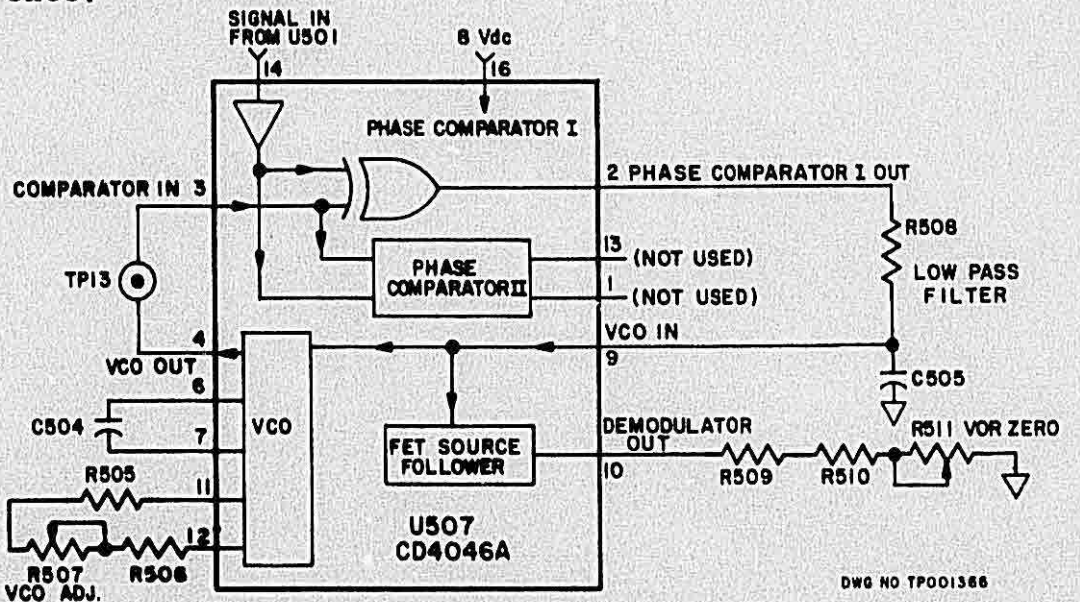


FIGURE 4-36. U507, FM DEMODULATOR

A. Demodulator Output Check

Monitor U507-10 with a scope. The demodulated signal should be as shown in Figure 4-37. It is assumed that the input signal from U501 is present and of correct level. If not, consult the VOR/LOC converter flowchart (Figure 4-45). The demodulator output is taken from a source follower which used R509/R510/R511 for its ground. If any of these resistors should become open by virtue of damage or cold solder joints, the demodulated output will be missing. If the output is incorrect proceed to step B.

B. VCO Check

Short U501-5 to ground to kill the input signal to U507-14. Monitor U507-7 with a scope. The waveform should be as shown in the bottom trace of Figure 4-38. The VCO frequency is determined by components C504/R505/R506/R507. If the waveform is missing then check these components for an open circuit. If they check OK, then U507 is at fault.

4.5.11 Continued

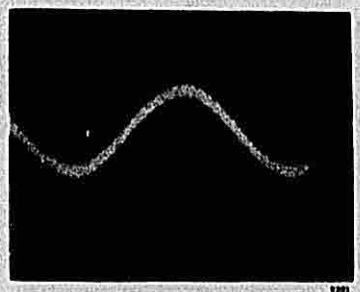


FIGURE 4-37. U507-10, DEMODULATED OUTPUT

C. VCO Center Frequency Check

Monitor TP13 with a scope. The waveform should be as shown in the top trace of Figure 4-39. If waveform is missing then U507 is at fault. If waveform is present, connect a counter to TP13. The frequency should read 9960 Hz ±20 Hz. Adjust R507 to bring it into tolerance. The VCO minimum frequency, approximately 8100 Hz, is when the VCO input at pin 9 is at 0 volts. The maximum frequency, approximately 12,300 Hz, is when pin 9 is at 8 volts. If the counter should read one of these extremes, then the phase comparator "I" output at pin 2 is probably stuck low (0 Vdc) or High (8 Vdc). Proceed to step D.

D. Phase Comparator "I" Output Check

Monitor U507-2 with a scope. The waveform should be as shown in the top trace of Figure 4-38. If the waveform is missing or the peak amplitude of the square waves are not equal to the supply voltage (8 Vdc) then U507 is at fault.

E. Low Pass Filter Check

Monitor U507-9 with a scope. The waveform should be as shown in the bottom trace of Figure 4-39. The sawtooth waveform is the result of the low pass filter intergrating the square wave output of phase comparator "I". If C505 were open because of a cold solder joint, then the scope would show square waves at pin 9. If there is no sawtooth wave present, then either R508 is open, C505 shorted, or U507-9 input is shorted.

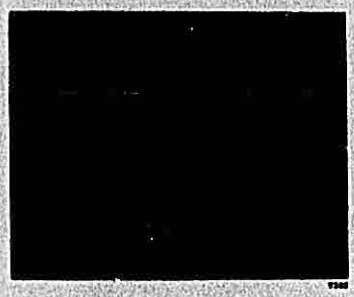


FIGURE 4-38. U507-2 AND U507-7

FIGURE 4-39. TP13 AND U507-9/10

4.5.12 U114, Digital Bearing Selector (CD4046A) Phase-Locked Loop Troubleshooting

U114 is used to generate a 108 KHz clock in which each clock pulse represents a 0.1 degree bearing. In this application, phase comparator "II" is used along with U113, a divide-by-3600 counter. Phase comparator "II" is an edge-controlled digital memory network that acts only on the positive edges of the incoming 30 Hz reference and comparator input from U113. For phase comparator "II", no phase difference exists between the 30 Hz reference signal at pin 14 and the comparator input at pin 3. This allows the signal at "phase pulses" output at pin 1 to be used to indicate a locked condition. The following procedure is given to checkout U114. Use Figure 4-40 for reference.

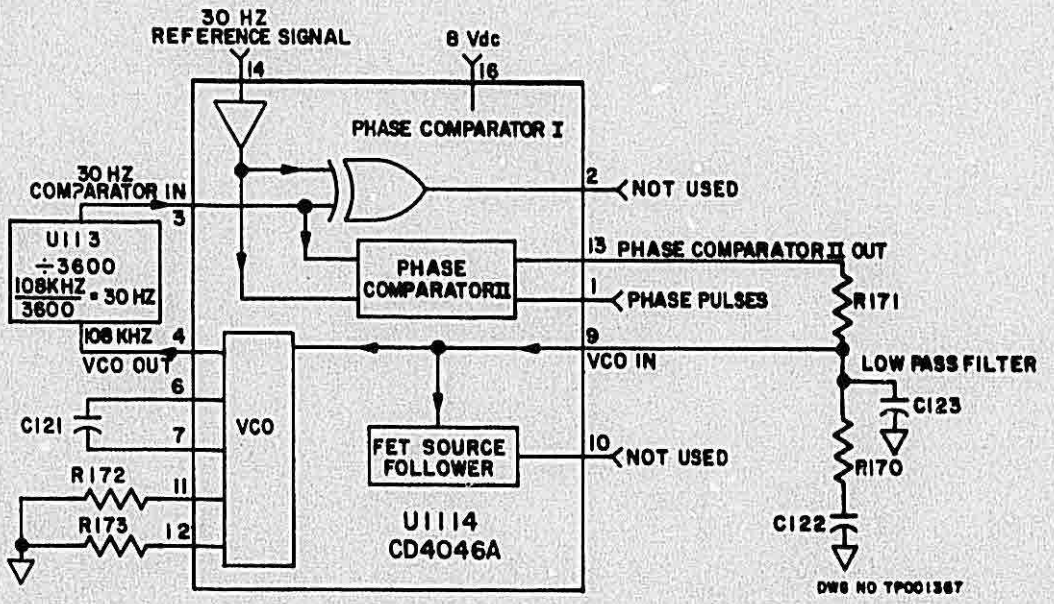


FIGURE 4-40. DIGITAL BEARING PHASE-LOCKED LOOP

NOTE: This checkout procedure is concerned with U114 only. In order to checkout U114, the ÷3600 counter, U113, must put out pulses to U114. The ÷3600 counter can have a malfunction in which it does not divide-by-3600, but some other number. This fact does not stop U114 from working; it just means the VCO output will not be 108 KHz but some other frequency. However, U113 cannot have a type malfunction in which there are no pulses being sent to U114 as this condition will cause phase comparator "II" output at pin 13 to sit at 8 Vdc. Problems with U113 should be corrected by referring to the digital bearing selector flowchart (Figure 4-44).

A. System Lock Check

Monitor U114-1 with a scope. The waveform should be as shown in the top trace of Figure 4-41. This waveform shows that pin 1 is constantly high (8 Vdc) except for narrow negative pulses occurring at a 30 Hz rate during which the phase comparator "II" output slightly adjusts the VCO input voltage to keep the system in phase-lock. Any other waveform indicates a problem.

4.5.12 Continued

B. VCO Check

Monitor U114-6 with a scope. The waveform should be as shown in the bottom trace of Figure 4-42. Operation of the VCO is determined by C121, R172, R173. If the waveform is missing, check the components for an open condition. If they check OK, then U114 is at fault.

C. VCO Output Check

Monitor U114-4 with a scope. The waveform should be as shown in the top trace of Figure 4-42. Short U114-9 to ground. The pulse period should lengthen showing that the frequency is at its minimum point. Short U114-9 to U114-16. The pulse period should shorten, indicating a maximum frequency. If the output pulses are missing or do not respond to the checks, replace U114.

D. Phase Comparator "II" Output Check

Monitor U114-13 with a scope. The waveform should be as shown in the bottom trace of Figure 4-41. This waveform shows the phase comparator adjusting the VCO voltage for a very brief period of time at a 30 Hz rate in order to keep the system in phase-lock. Short U114-14 to ground. U114-13 should drop to 0 Vdc. Short U114-3 to ground. U114-13 should rise to a constant 8 Vdc. If there are no output pulses or U114 fails to respond to the check, replace U114.

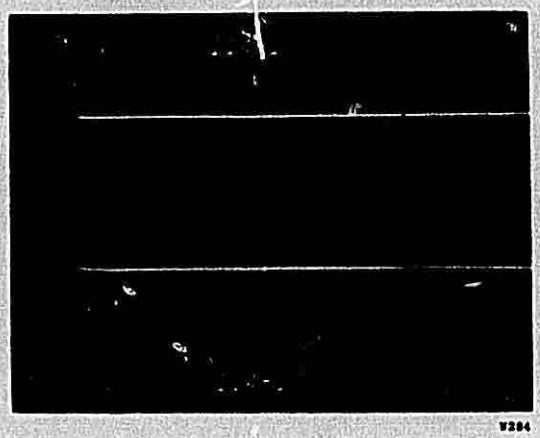


FIGURE 4-41. U114-1 AND U114-13

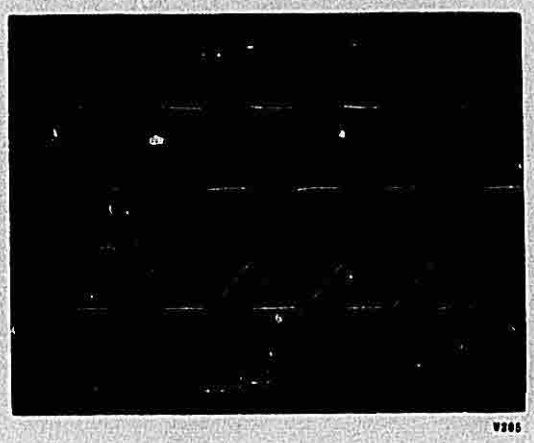


FIGURE 4-42. U114-4 AND U114-6

4.5.12 Continued

E. Low Pass Filter Check

1. Short the cathode of CR124 to ground. This will force U114-13 to above 7 Vdc. Whatever pin 13 reads on a DCVM, this level should be present at U114-9. If no voltage is present, then either R171 is open or C123 is shorted, or pin 9 input is internally shorted. If the voltage reads approximately 2.7 Vdc then C122 is shorted.
2. Remove the short from CR124. Short U114-14 to U114-9. Monitor the junction of C122 and R170 with a scope. Set the scope volts/div to high gain. There should be a sawtooth waveform present if C122 is not open. If C122 is open, then the waveform will be the 30 Hz square wave. If no waveform is present then R170 is open.
3. Remove the short from pins 14 and 9. Monitor pins 9 and 13 with a dual trace scope. Short the junction of C122/R170 to ground. Observe that the pulses at pin 9 have rounded leading and trailing edges showing that C123 is charging up and not open. Refer to Figure 4-43.

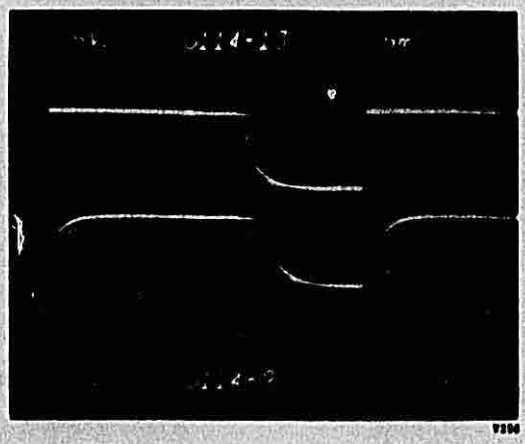


FIGURE 4-43. U114-13 AND U114-9

4.5.13 Digital Bearing Selector Troubleshooting

Listed here are a few points to keep in mind when troubleshooting the digital bearing selector circuits. The detailed troubleshooting flowchart is found in Figure 4-44.

A. The microprocessor averages the number of gated VCO pulses passed through U116A and rounds this number UP to the nearest whole degree. The digital bearing is calibrated by R559 to read 30 degrees when the VOR generator is set to 29.5 degrees.

B. The VCO frequency of U114 is 108 KHz which corresponds to 0.1 degree per pulse. If U113 is not dividing by 3600 the number of degrees per pulse will be incorrect. To check for a correct VCO frequency, monitor U109 pin 13 and TP12 with a dual trace scope. Adjust the VOR generator bearing to give a 92 microsecond gate at U109-13. The VOR generator bearing will be in the vicinity of ONE degree. System jitter is present so set the gate to an average 92 us. When the gate is 92 us wide, the number of pulses at TP12 should be exactly 10. Any gross error in the ÷3600 counter will be evident as the number of pulses per 92 microseconds will be different.

C. An important timing sequence exists between U109A, U112, and U110/U111. When U109A is triggered, the Q output at pin 1 goes high. This positive transition is the load command for U110/I111 and the reset for U109A and U912. The positive pulse is immediately coupled through C111 and loads the bearing information present at the Q outputs of U112. At the same time, the positive pulse is applied to the resets of U109A and U112. However, the pulse is delayed to U112 by R149/C112 and to U109A by R147/C110. This delay is vital because U112 cannot be reset before its information is loaded into U110/U111. Always check the reset pulses to make sure they are being integrated (delayed) by their respective RC combination.

D. The bearing ready pulse at U105 pin 11 should be checked against waveform photo #10 found in Figure 6-2. Any large change in pulse width will cause a bearing error.

E. U114 phase-locked loop troubleshooting is found in Section 4.5.12.

F. If the VOR indicator is working correctly and the digital bearing is not, then the problem lies in the digital bearing selector circuits. If both the VOR indicator and digital bearing are incorrect, then the problem lies in the VOR converter circuits.

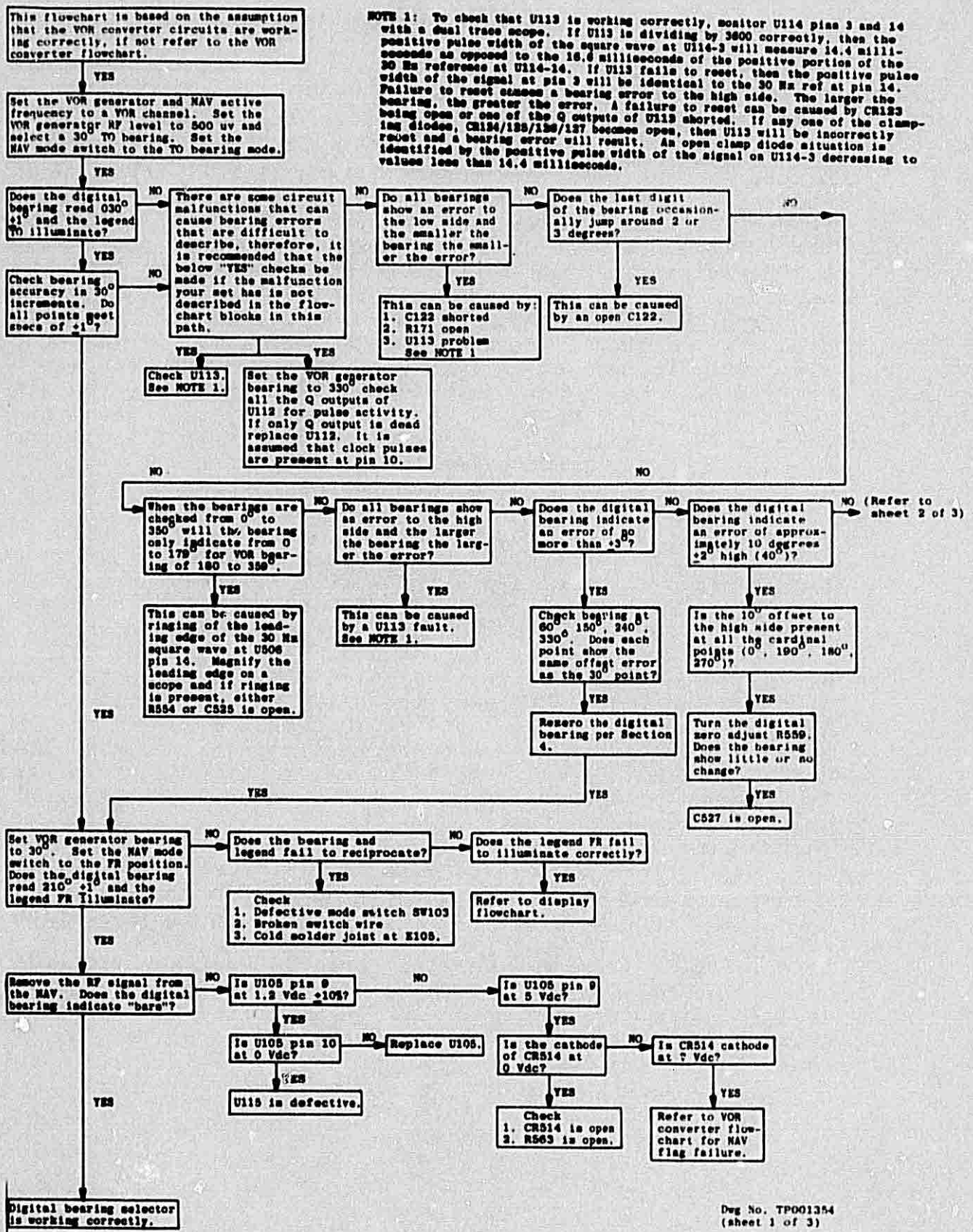


FIGURE 4-44. DIGITAL BEARING SELECTOR FLOWCHART (sheet 1 of 3)

SEE BLOW-UP

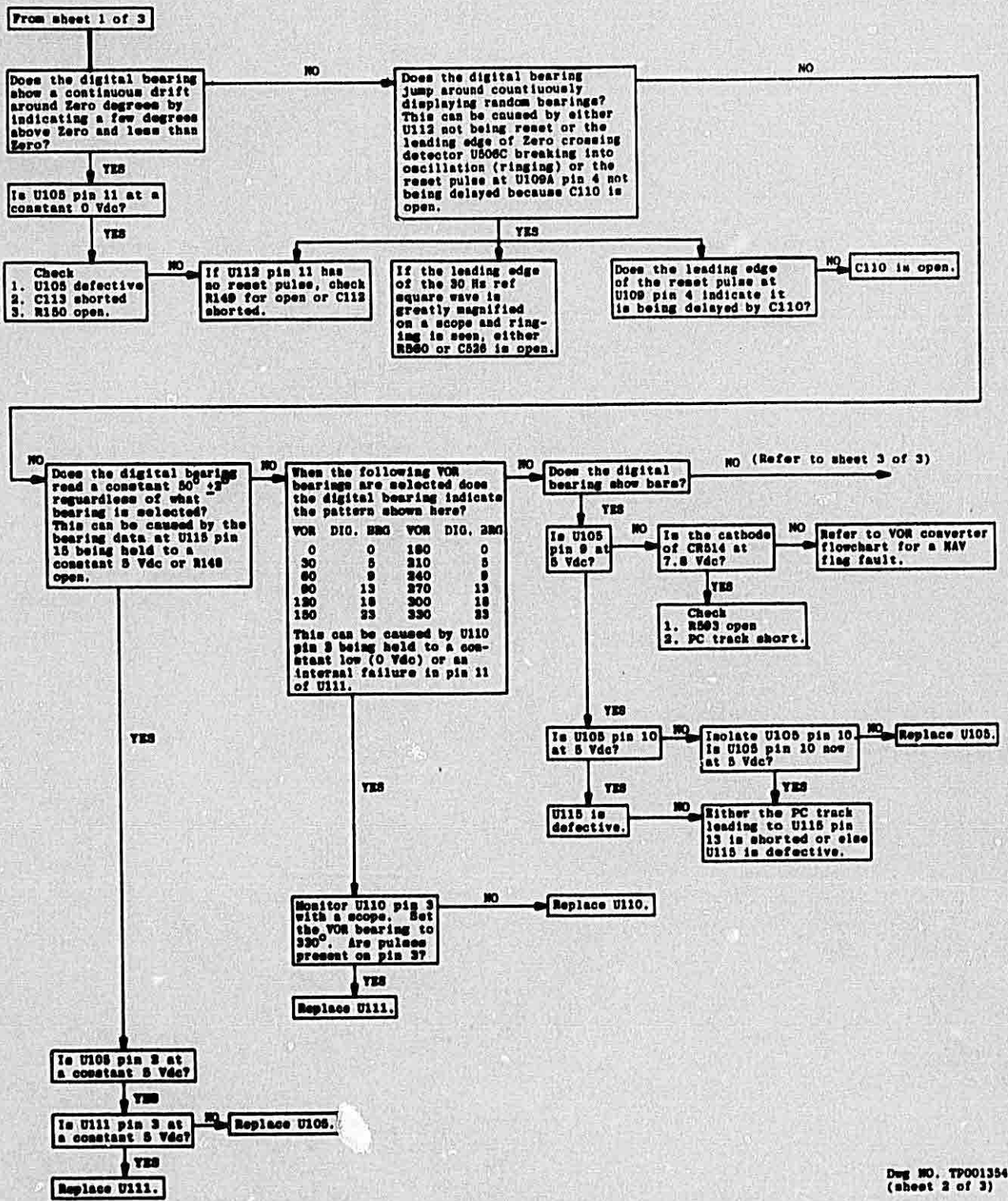


FIGURE 4-44. DIGITAL BEARING SELECTOR FLOWCHART (sheet 2 of 3)

SEE BLOW-UP

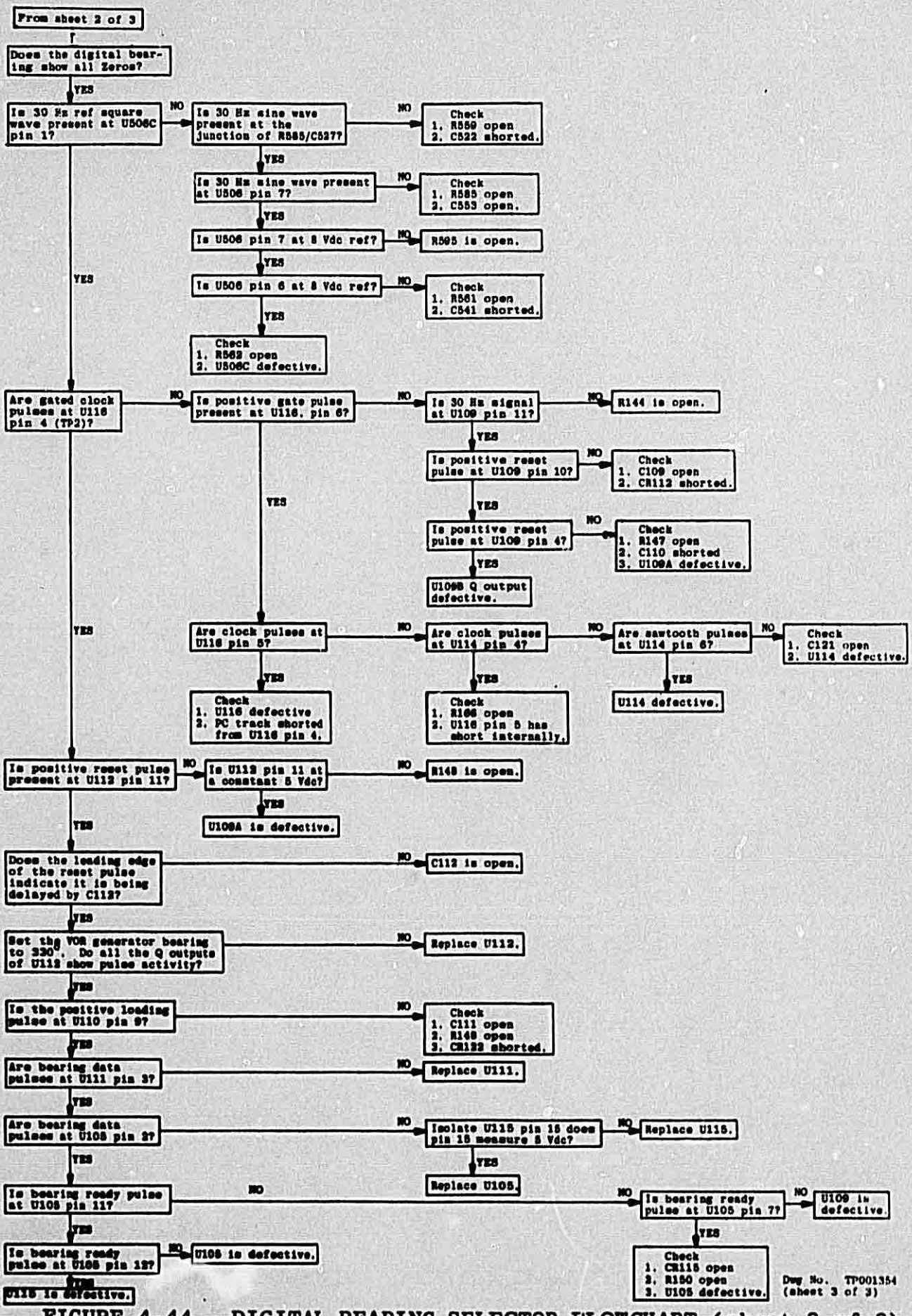
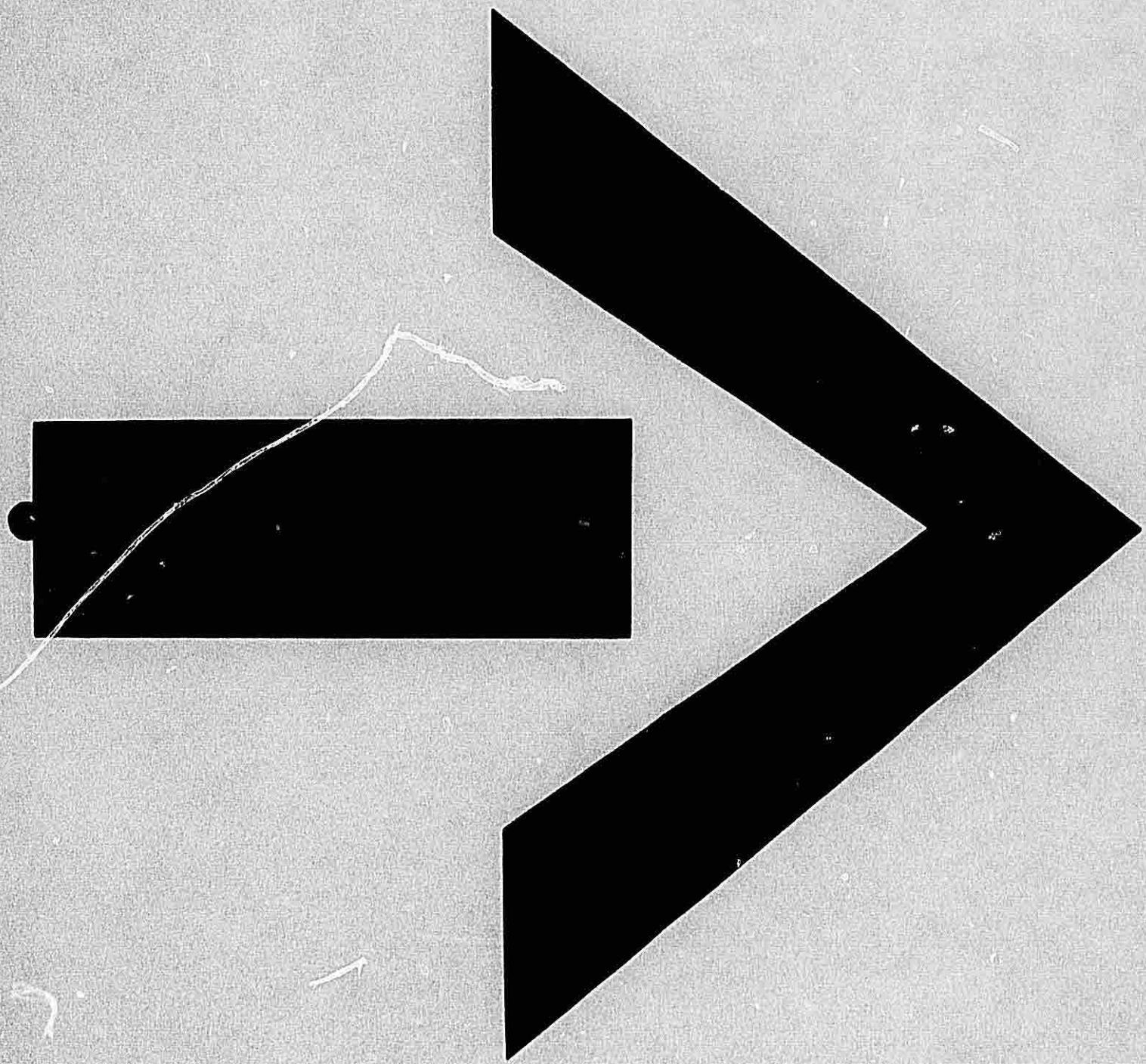
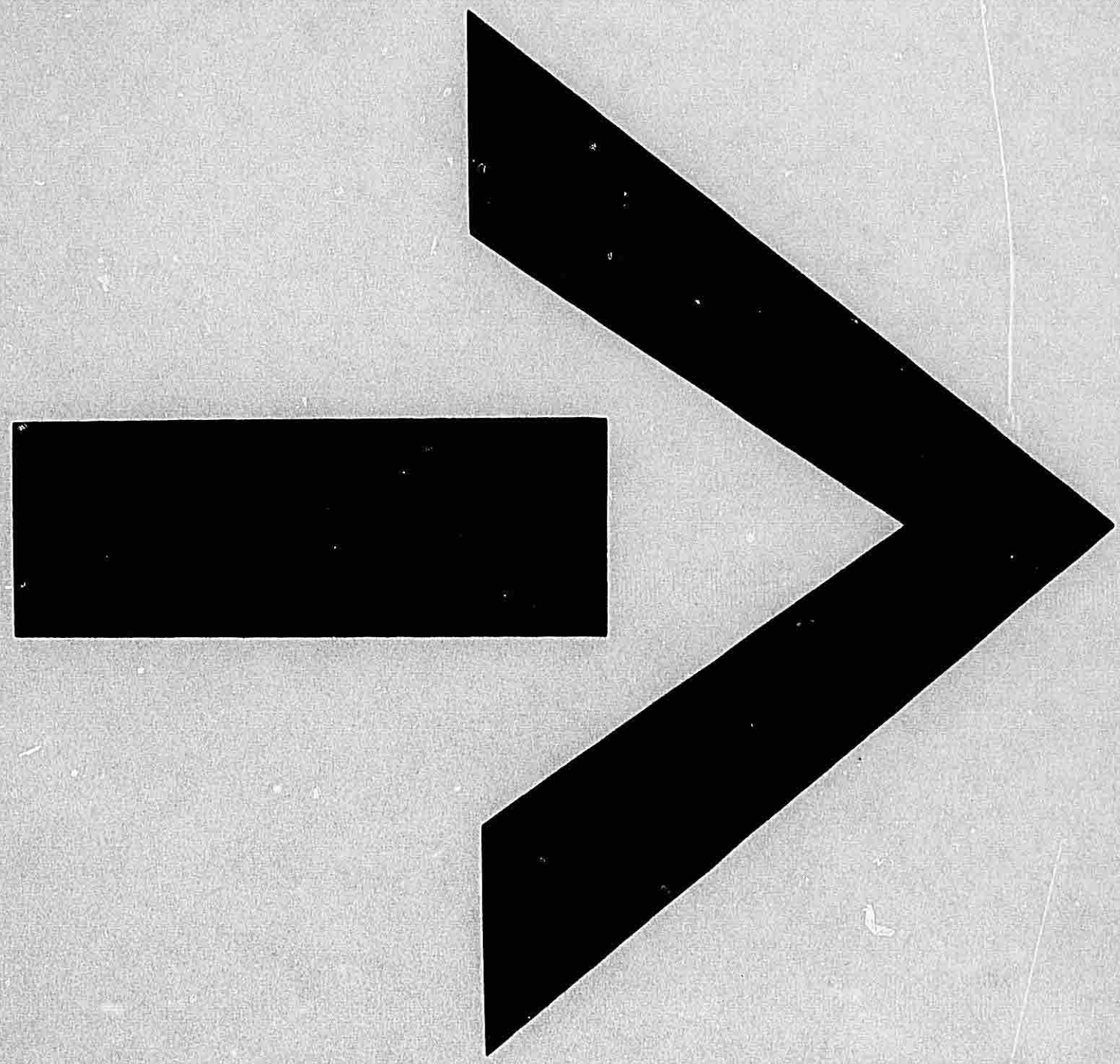
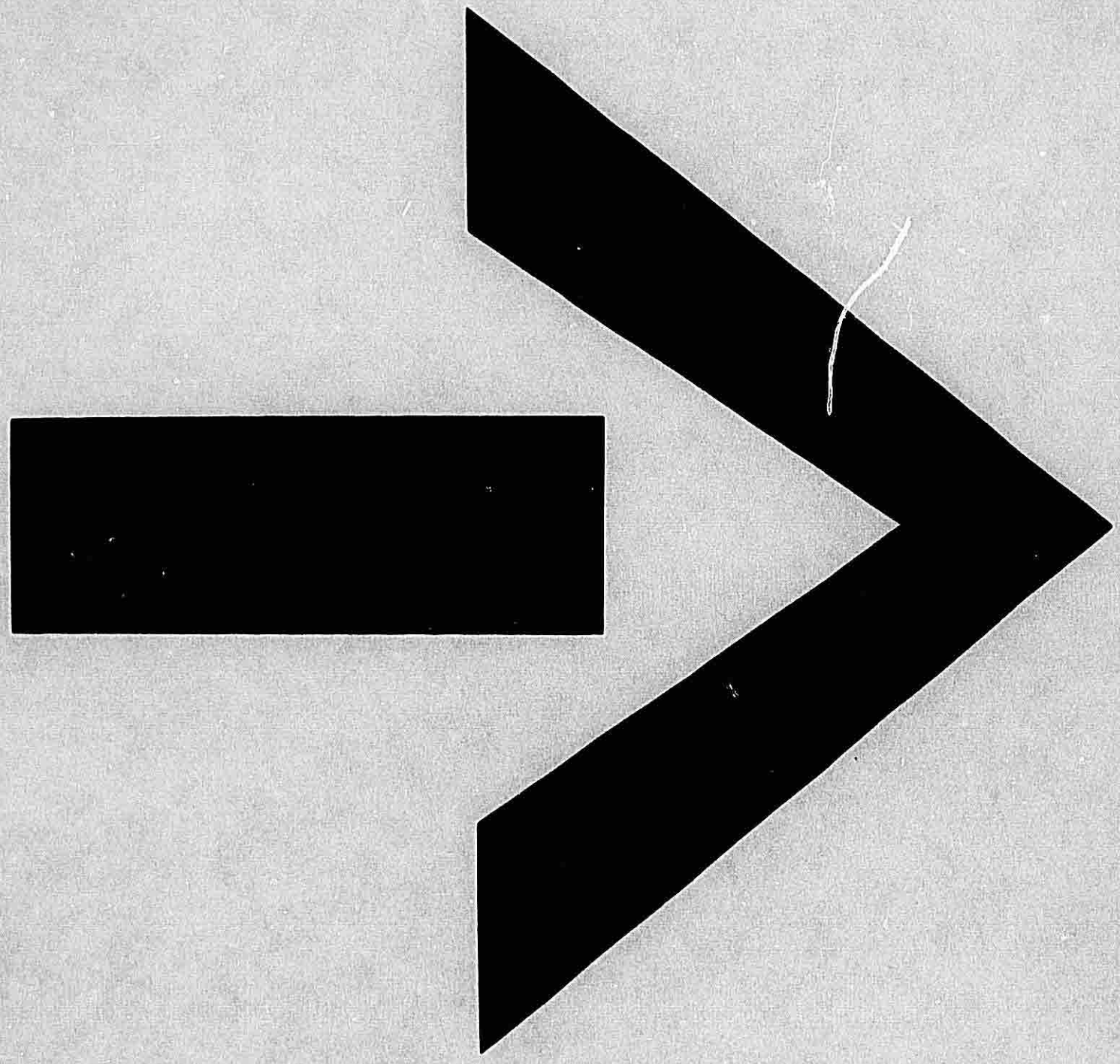


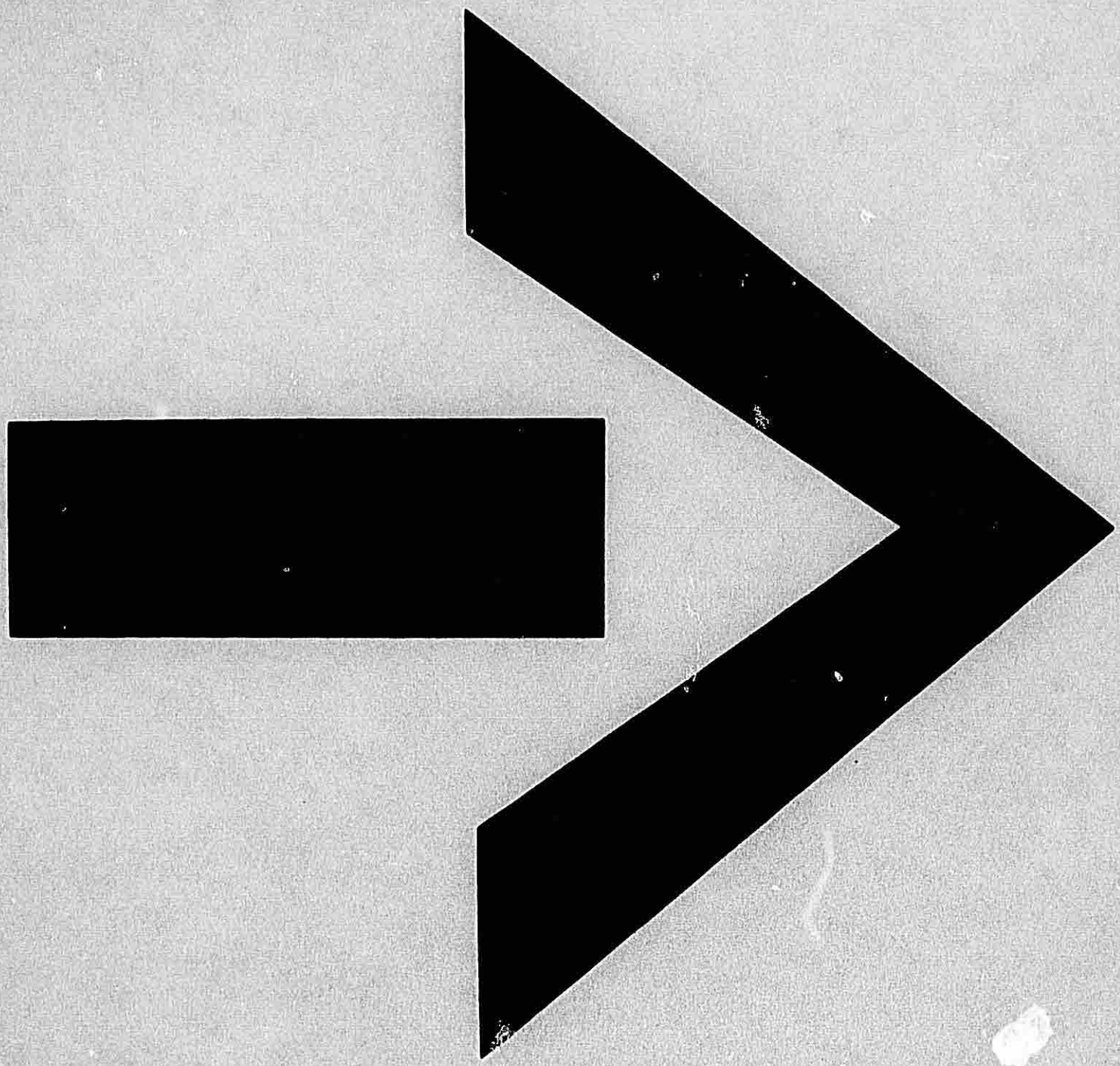
FIGURE 4-44. DIGITAL BEARING SELECTOR FLOWCHART (sheet 3 of 3)

SEE BLOW-UP









4.5.14 VOR Converter Troubleshooting

A detailed troubleshooting flowchart is given in Figure 4-45. This section will briefly discuss the type of course errors and their probable source.

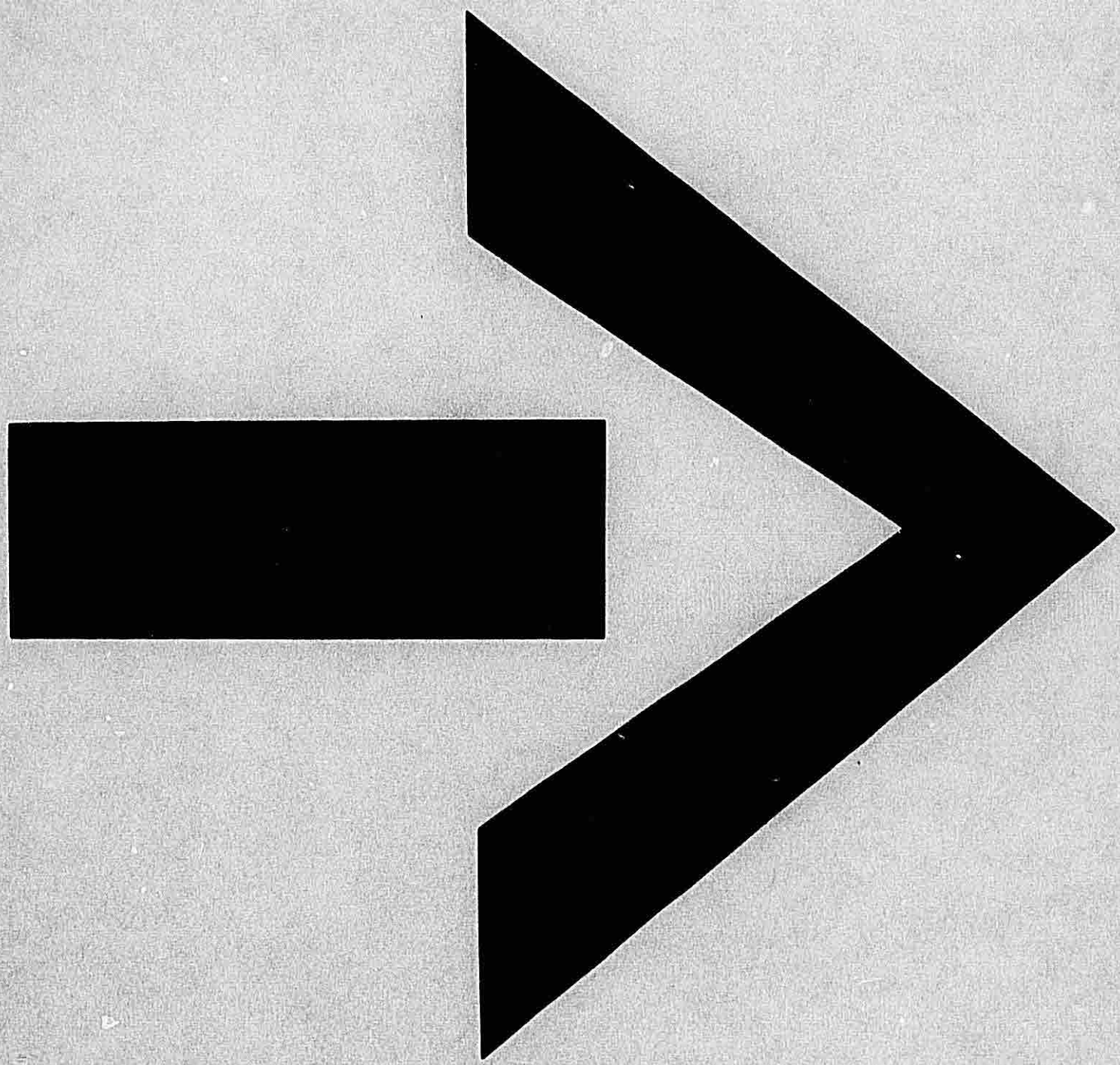
A. Cross Coupling Errors

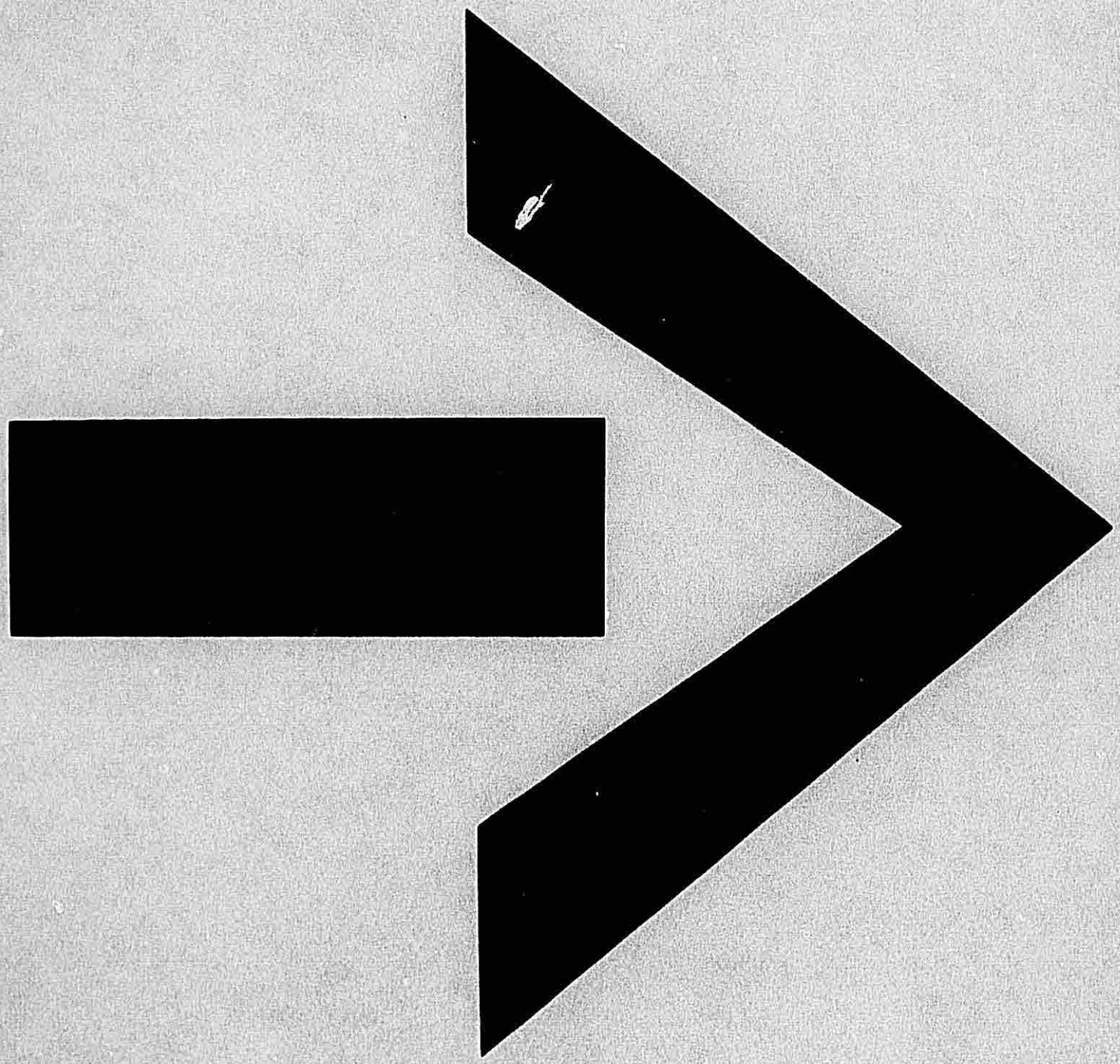
This type of error occurs when an AM signal is coupled into the FM circuits or vice versa. The cause can be attributed to printed circuit board layout and the use of dual or quad IC's in which both the AM and FM channels are present. The NAV 824/825 does not have this kind of error.

B. Reciprocal Error

A reciprocal error occurs when the 30 Hz square wave applied to the phase error detector U505A is not symmetrical. The causes could be any of the following:

1. An open in the hysterisis loop of zero crossing detector U506A. The hysterisis loop consists of C525 and R554. An open loop will cause the leading edge of the square wave at TP15 to oscillate. To check for this condition, magnify the leading edge of the square wave on a scope. There should be no multiple pertubations on the rising leading edge.
2. A defect in the 30 Hz AM filter U502D in which the output at pin 14 is not a clean sine wave but is visibly distorted. This distortion will cause a non-symmetrical square wave from U506A.
3. Distortion in the composite video from the receiver at TP24 by the untrained eye may never be noticed. To prove that the receiver is at fault, remove the anode of CR515 from the PC board. Set the detector output from the VOR generator to an ARINC level and apply this video to the cathode of CR515. Now run a reciprocal error check on the NAV 824/825 and if there is no reciprocal error, then the receiver has a problem. When the square wave at U505A is symmetrical, there is no reciprocal error in the NAV 824/825.
4. An internal defect is indicated in U506A when the offset voltage between pins 8 and 9 becomes appreciable greater than the specified 4 millivolts for a type LM339A comparator. Too large an offset voltage will cause too great an unsymmetrical square wave output and yield a reciprocal error.





4.5.14 Continued

C. Constant Offset Error

This type error is one in which all the course headings exhibit a permanent shift to either the high or low side. The following are possible causes:

1. Capacitors C512/C511 leaking.
2. L/R DC balance, R532, needs readjustment due to components ageing.
3. VOR Zero, R511, needs readjustment due to components ageing.
4. 30 Hz AM or FM bandpass filter component out of tolerance.

D. Course Hook Error

This type error is one in which, as the RF level is increased from 10 uv to 10K uv, the needle is pulled off center more than the allowed 0.5 degree. This error is generally caused by a receiver AGC problem.

E. Course Scalloping Error

This type error is similar to an actual scalloping of a VOR ground station signal, however, it is caused by slope detection of the FM signal in the receiver or a misadjusted VOR phase adjust (R520). Slope detection occurs when one of the crystal filter's pass band has shifted and the 9960 Hz is partially falling outside the center of the pass band. This gives rise to an unwanted 30 Hz component in the 9960 Hz signal. To check for this type error, delete the 30 Hz signal from the VOR generator. Short the cathode of CR507 to ground. This will permanently set TP15 high and turn on U505A. The 30 Hz FM detected signal is now directly applied to the L/R meter amplifier and the needle will be centered. Rotate the OBS through 360 degrees. The L/R needle should NOT move. If the L/R needle does move around, then there is a receiver problem. To check for a misadjusted R520, see Section 4.4 for alignment procedure.

U507 FM detector troubleshooting is found in Section 4.4.11.

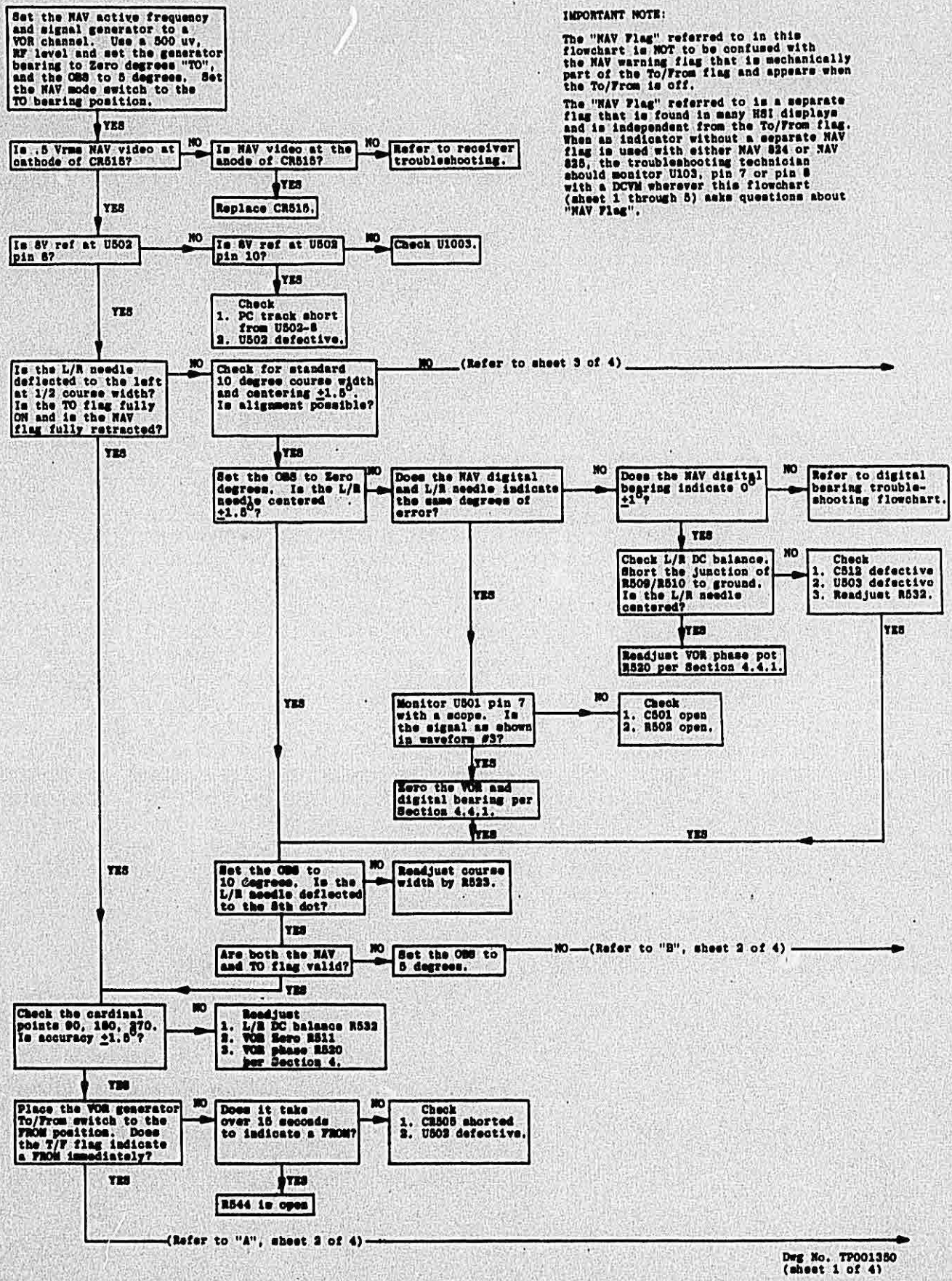


FIGURE 4-45. VOR/LOC CONVERTER FLOWCHART (sheet 1 of 4)

SEE BLOW-UP

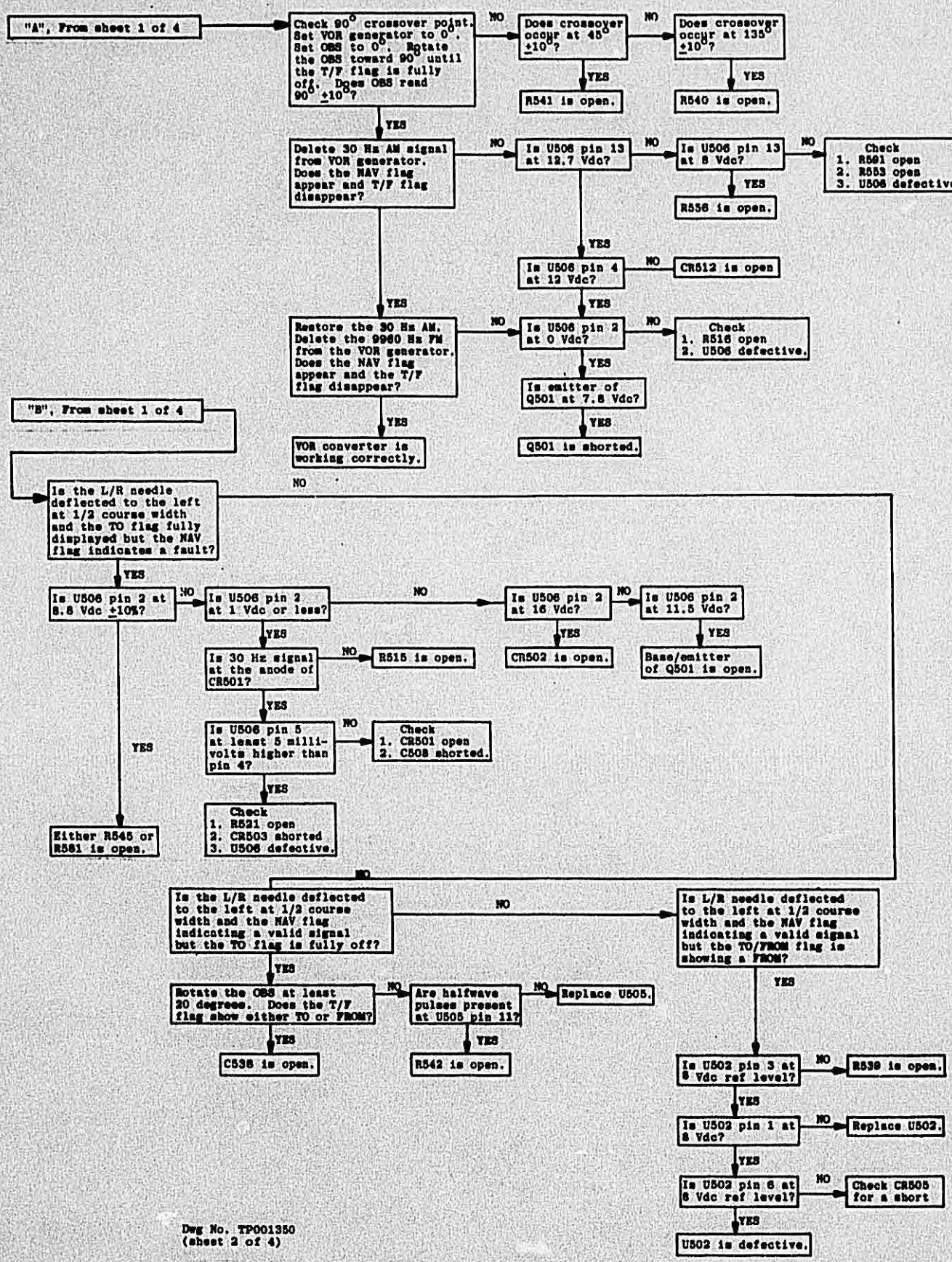


FIGURE 4-45. VOR/LOC CONVERTER FLOWCHART (sheet 2 of 4)

SEE BLOW-UP

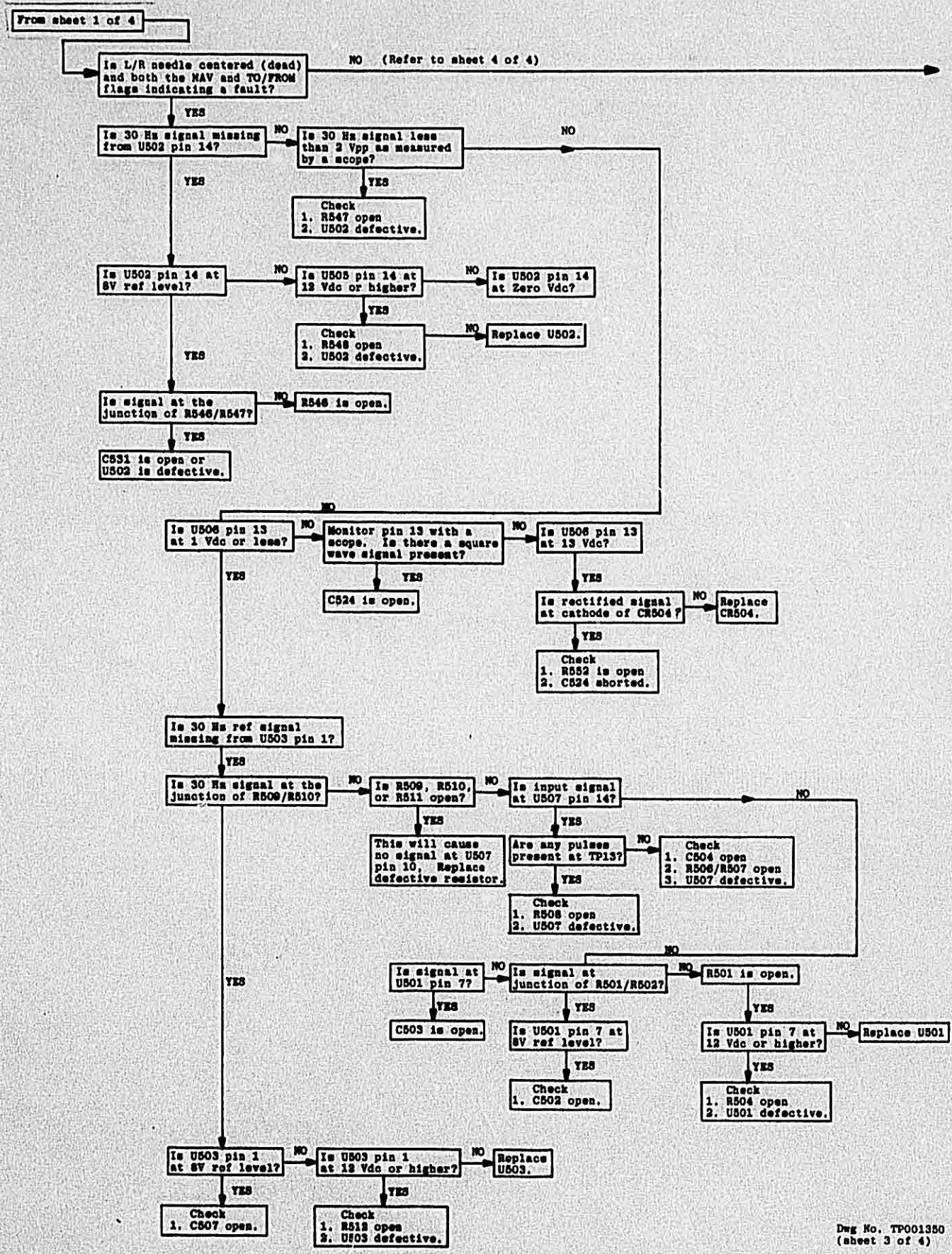


FIGURE 4-45. VOR/LOC CONVERTER FLOWCHART (sheet 3 of 4)

SEE BLOW-UP

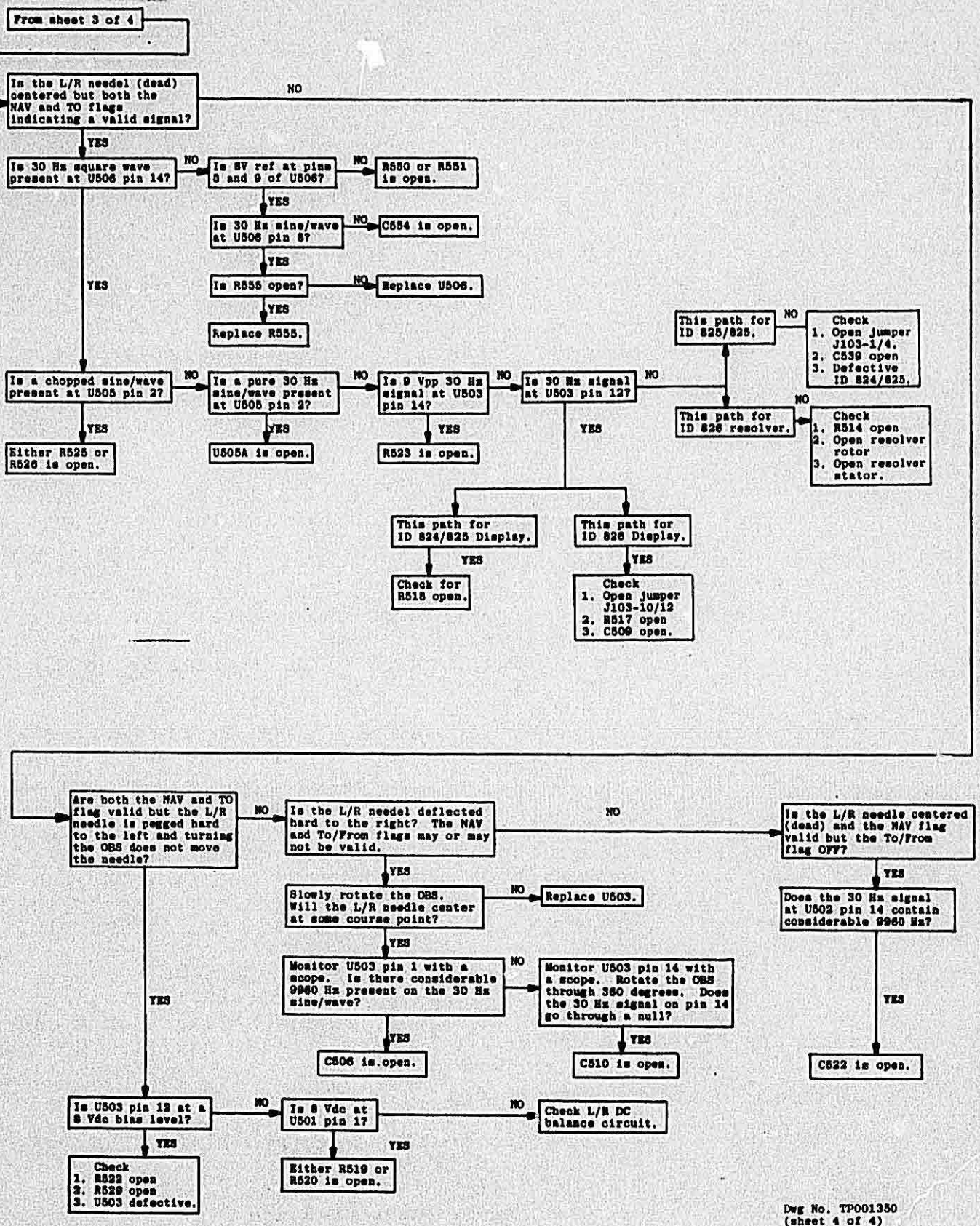


FIGURE 4-45. VOR/LOC CONVERTER FLOWCHART (sheet 4 of 4)

SEE BLOW-UP

4.5.15 ID 824/825 Test Procedure

The following test procedure is given to confirm the correct operation of the ID 824 (without glideslope) or ID 825 (with glideslope) Indicators. Connect the Indicator for bench test as shown in Figure 4-46.

A. Left/Right Meter Test

Set the resistance subtitution box to 10K ohms. Connect the negative power supply lead to P1-6 and the resistance box lead to P1-7. Slowly increase the power supply voltage until the L/R needle is deflected to the left at the fifth bar. The digital VM should read 150 millivolts ±10%. Turn the power supply voltage to zero volts. Reverse the negative and positive power supply leads. Slowly increase the power supply voltage until the L/R needle is deflected to the right at the fifth bar. The digital VM should read 150 millivolts ±10%.

B. To/From Flag Test

Set the resistance subtitution box to 2.2K ohms. Connect the negative power supply lead to P1-5 and the resistance box lead to P1-7. Slowly increase the power supply voltage until the flag gives a full FROM indication. The digital VM should read 50 millivolts ±10%. Turn the power supply voltage to zero volts and reverse the negative and positive power supply leads. Slowly increase the supply voltage until a full TO flag is indicated. The digital VM should read 50 millivolts ±10%.

C. Glideslope Up/Down Meter Test

Set the resistance subtitution box to 10K ohms. Connect the negative power supply lead to P1-8 and the resistance box lead to P1-7. Slowly increase the power supply voltage until the GS needle has deflected down to the fifth bar. The digital VM should read 160 millivolts ±10%. Turn the power supply voltage to zero volts and reverse the negative and positive power supply leads. Slowly increase the power supply voltage until the GS needle has deflected up to the fifth bar. The digital VM should read 160 millivolts ±10%.

D. Glideslope Flag Test

Set the resistance box to 10K ohms. Connect the negative power supply lead to P1-15 and the resistance box lead to P1-10. Slowly increase the power supply voltage until the GS flag has fully retracted from view. The digital VM shall read 250 millivolts ±10%.

E. Sine/Cosine Potentiometer Test

1. Open Pot test: Set an ohmmeter to the RX1000 range. Connect the ohmmeter between P1-1 and P1-2. The ohmmeter shall read 6.5K ohms ±15%.
2. Open Pot Arm Test: Set the ohmmeter to the RX1000 range. Connect the ohmmeter between P1-3 and P1-4. Rotate the OBS through 360 degrees and observe that the ohmmeter reading varies between 6.5K to 3.5K ohms ±15%.

4.5.15 Continued

3. OBS Alignment Test

Connect the Indicator for test as shown in Figure 4-47. The NAV 824/825 VOR zero point is 80 degrees. This test will confirm that the Indicator's OBS card and potentiometer are properly aligned.

Connect the positive lead of the digital VM to P1-3. Rotate the OBS course knob until the digital VM reads 854 millivolts. The Indicator OBS shall read $80^{\circ} \pm 1^{\circ}$. Connect the digital VM positive lead to P1-4. Rotate the OBS course knob until the digital VM reads 854 millivolts. The OBS shall read $80^{\circ} \pm 1^{\circ}$.

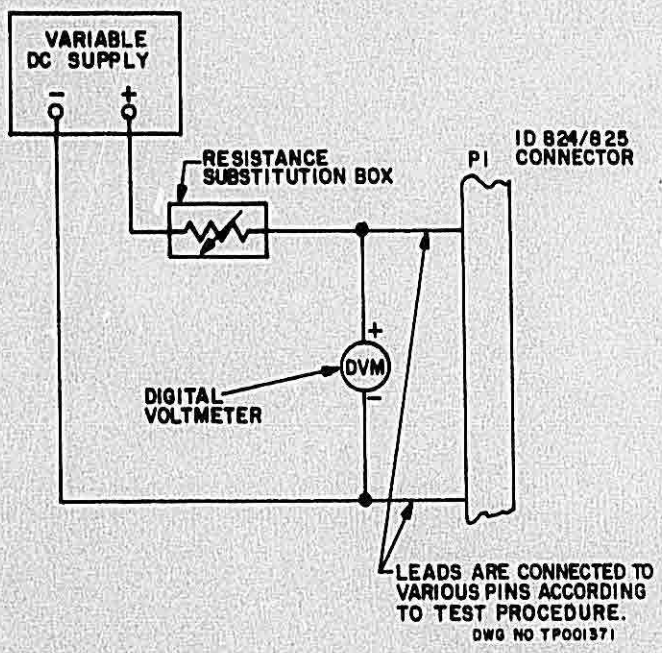


FIGURE 4-46. METERS AND FLAGS TEST SET-UP

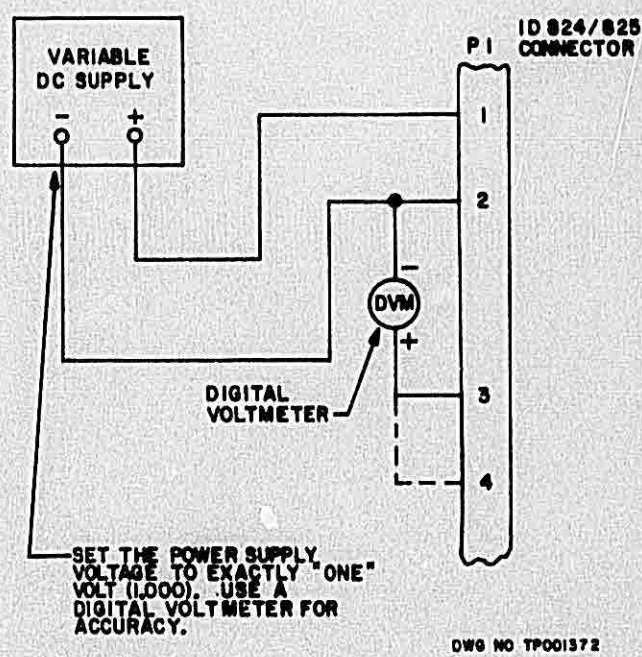
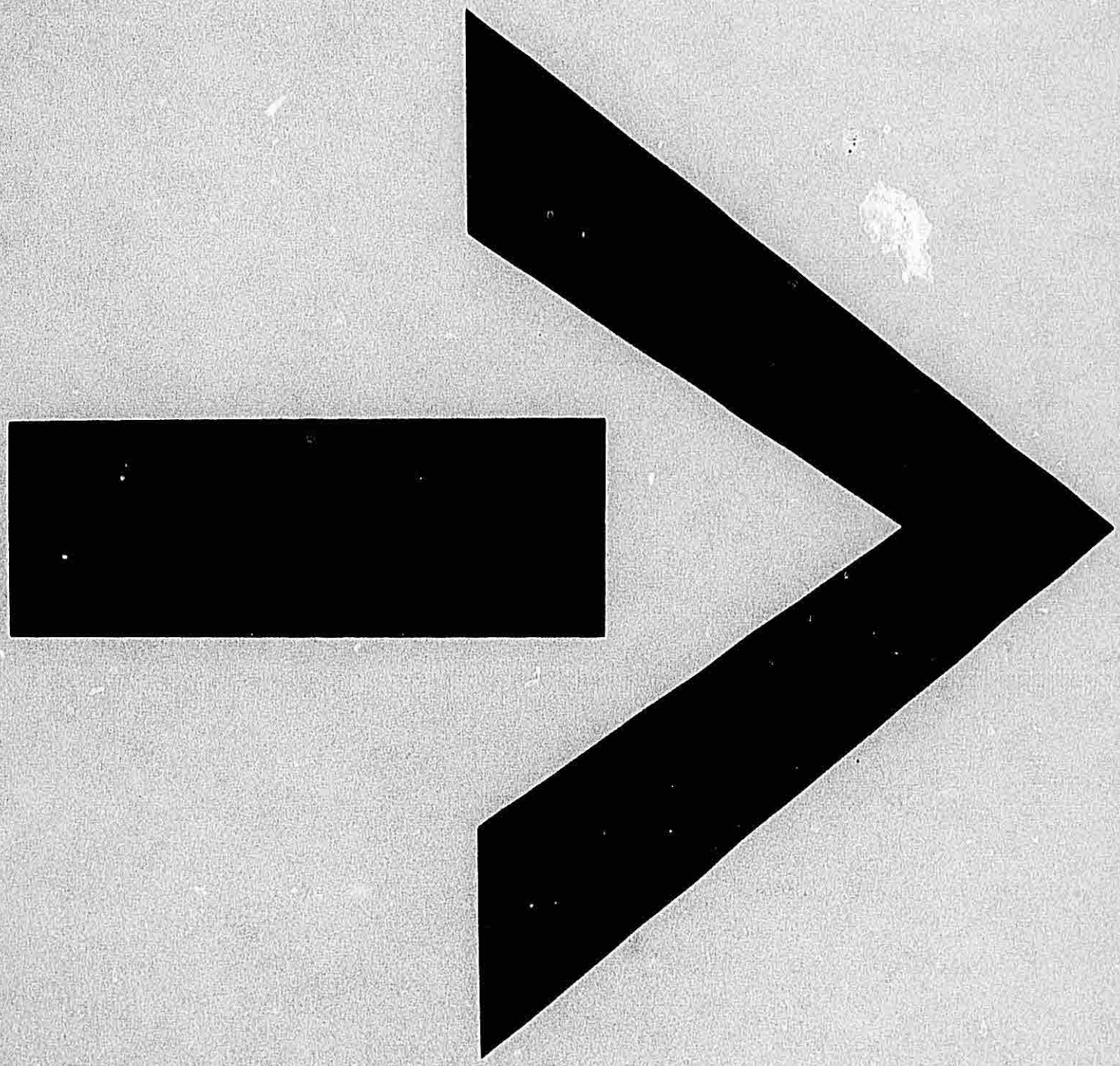


FIGURE 4-47. OBS ALIGNMENT TEST



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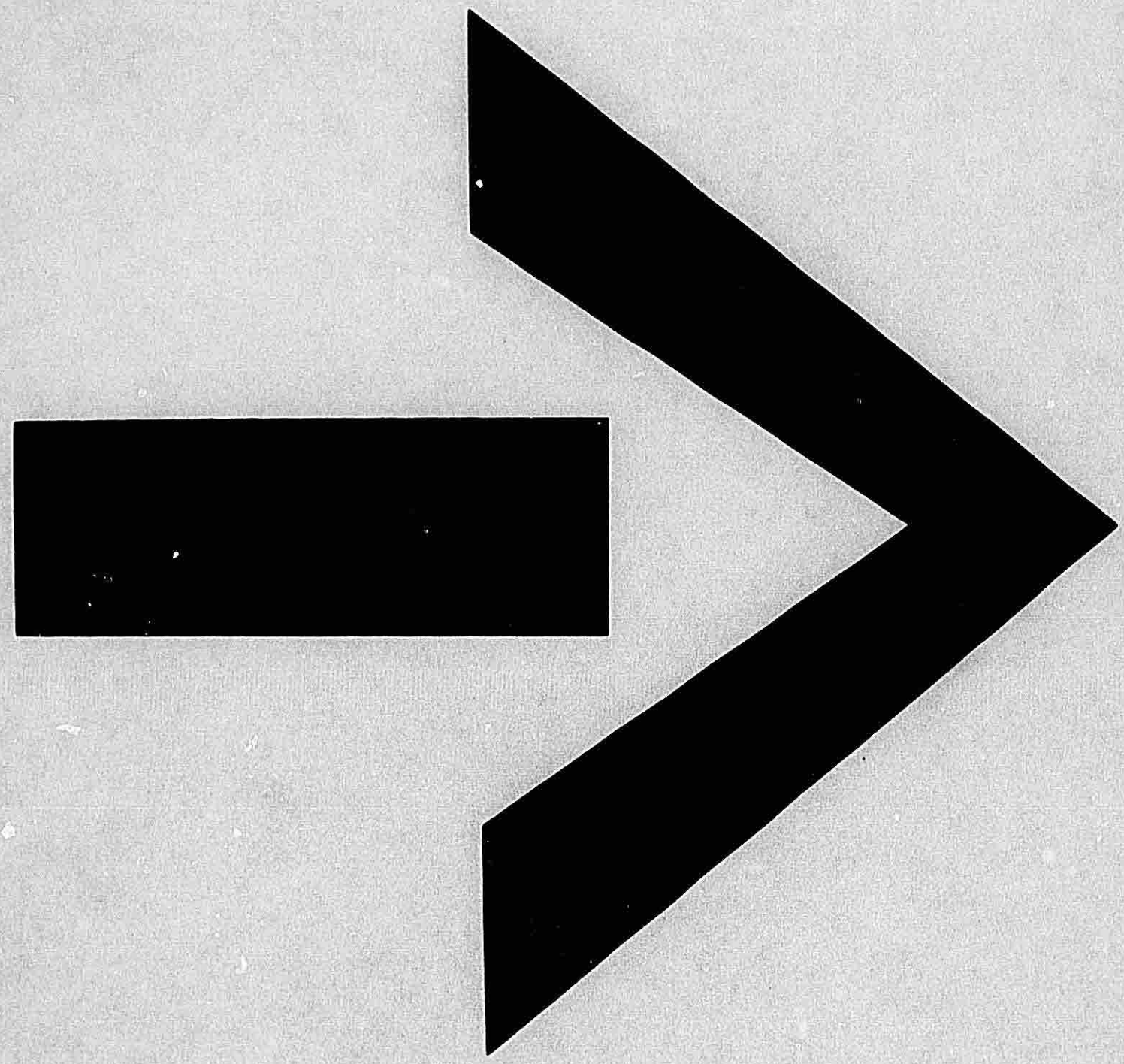
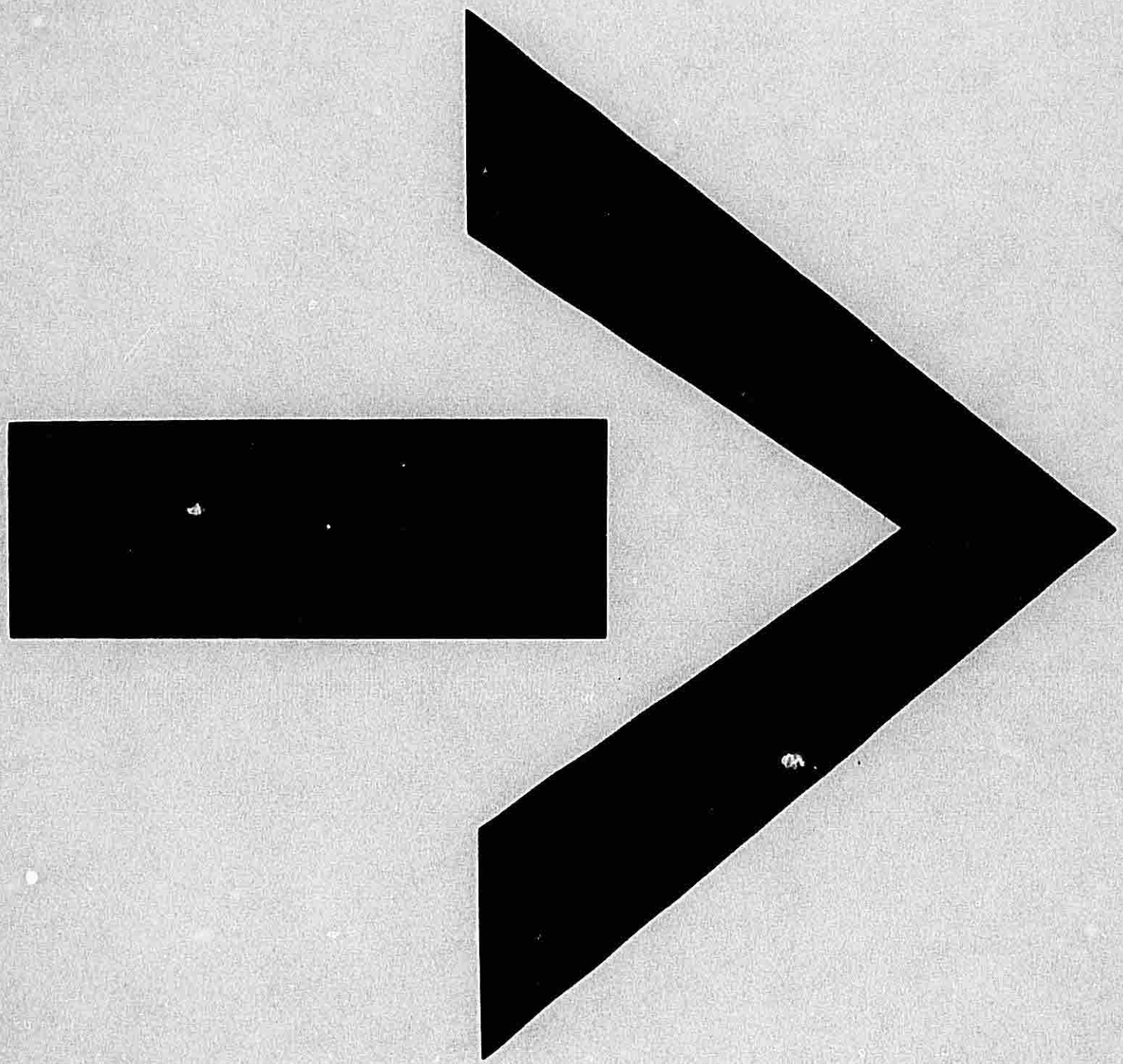
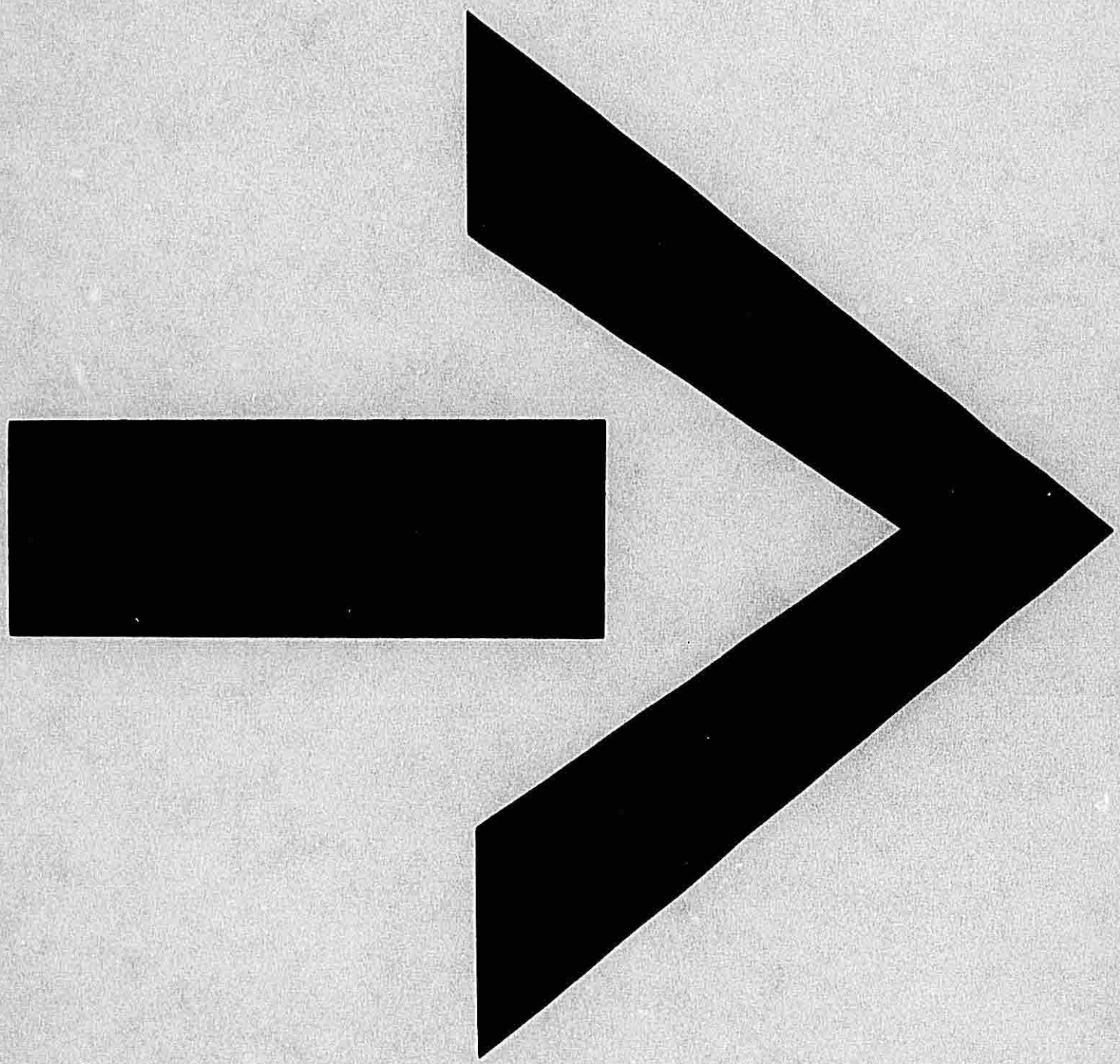






5.1 GENERAL

This Section provides simplified exploded view drawings of the NAV 824/825, the Tray Assembly, and the ID 824/825.

The lists represent a complete hypothetical mechanical disassembly of the Units. The hardware that attaches a part is listed following that part. This hardware is enclosed by the words ATTACHING PARTS and the symbol - - - - * - - - - -, designating the end of that set of attaching parts.

Where applicable, composite drawings and lists are used to identify components of two or more simular equipments. Such lists are headed with a short listing, identified as the APPLICATION CODE of the equipments being listed.

The column headed USED ON CODE will list the applicable code letter(s) of the APPLICATION CODE. This method thus identifies specific parts for specific equipments. The word ALL signifies that the part is common to all the equipments listed in the APPLICATION CODE.

Before attempting any disassembly review the exploded views, to provide foresight - disassemble only those parts required to be removed.

5.2 NAV NOTES

The NAV lists present piece parts individually. At times such individual parts are not available as they are assembled into process assemblies for future assembly. The reason for this is because, in most cases, special fixtures are required to do the job properly. When ordering any mechanical part please identify it by part number and relate it to its figure and item number.

Only those NAV electrical parts that are related to mechanical parts are listed to show their relationship, all remaining electrical parts will be found in the Electrical Parts List on the reverse side of its schematic in Section 6.

5.3 ID NOTES

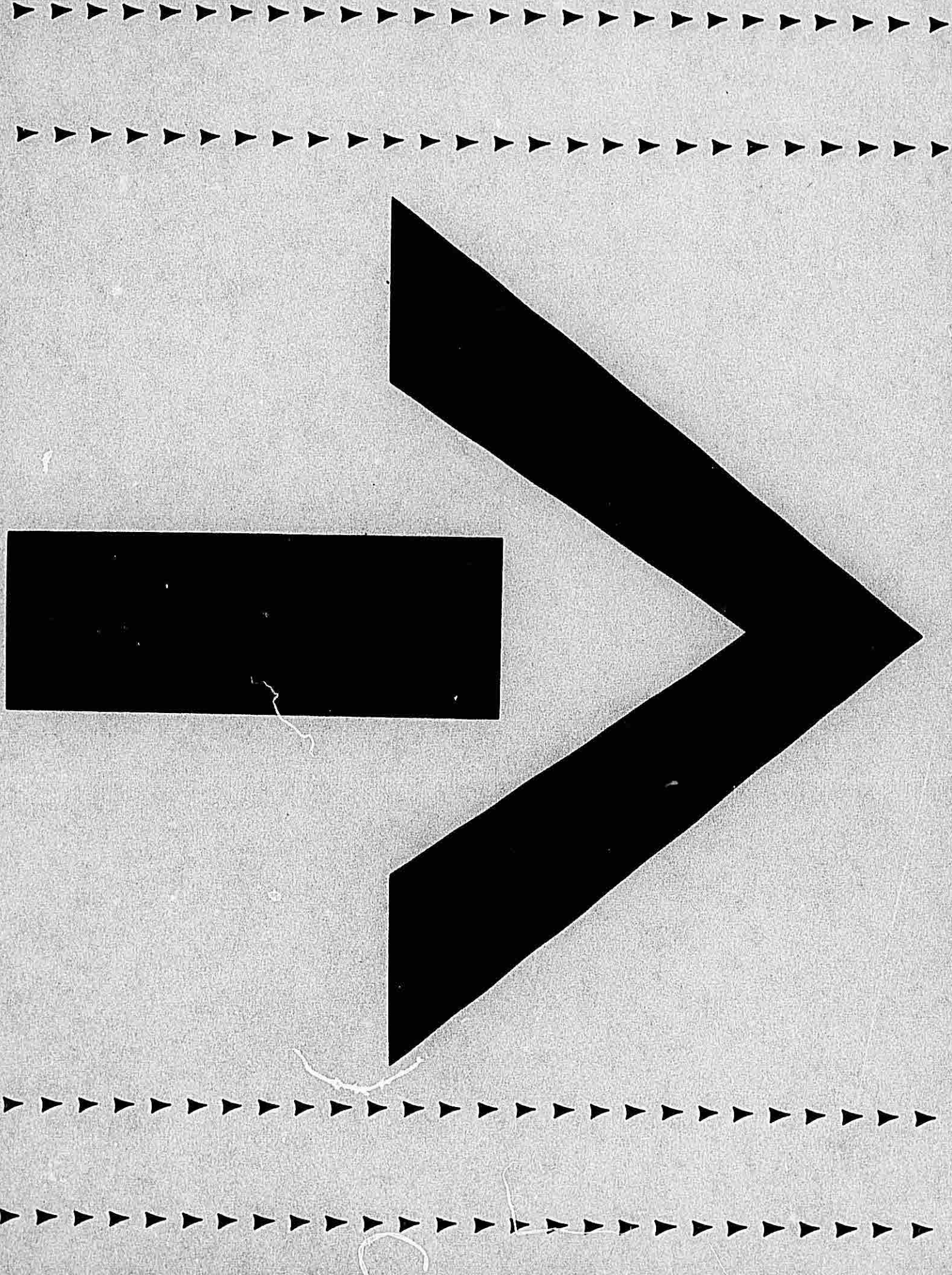
There are few designed subassemblies, however, groups of parts are assembled and joined to the chassis. The list is indexed in a disassembly sequence by parts, groups, and the parts of that group indented to the right. Such groups are not available assembled, hence the part number is listed as No Number and the quanity as non-procurable (NP).

5.4 TRAY NOTES

The list and figure is a composit that supports, the basically identical tray, for the Centerline II Avionics.

5.5 MODULES

There are no replacement modules available for either the NAVs or the IDs.



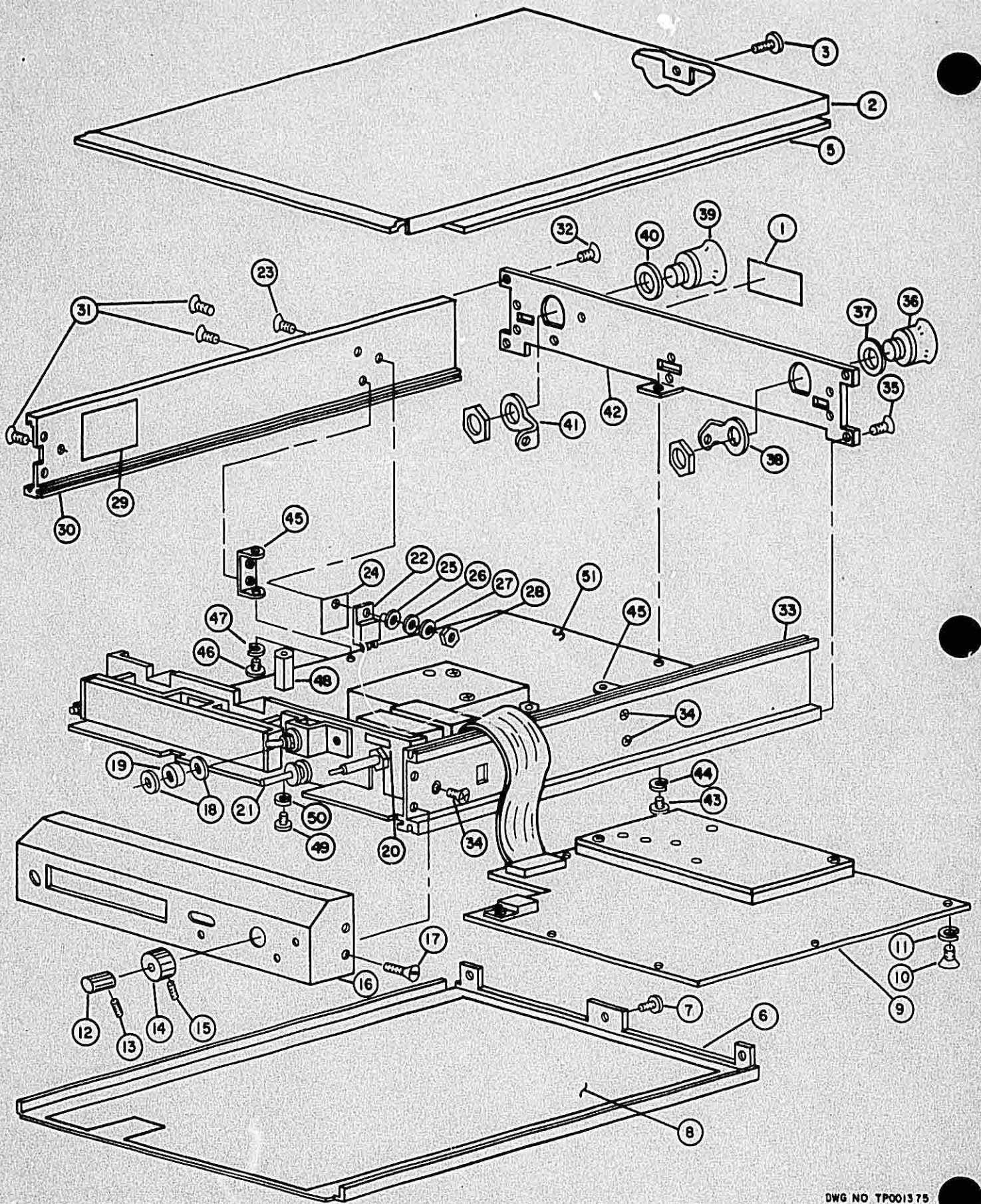


FIGURE 5-1. NAV 824/825

NAV 824/825
MECHANICAL PARTS LIST

APPLICATION CODE
A = 01382-0101 NAV 824
B = 01382-0102 NAV 825

Fig. and Index	Part Number	Symbol Number	Description	Qty	Used on Code
5.1	01382-0101		NAV 824	1	A
5.1	01382-0102		NAV 825	1	B
-1	04923-0001		LABEL, Nameplate, NAV 824	1	A
-1	04923-0002		LABEL, Nameplate, NAV 825	1	B
-2	50217-0001		COVER (Top)	1	ALL
			(ATTACHING PARTS)		
-3	82869-0701		SCREW, Taptite, Pan Hd, Phillips, 4-40 x 3/16	3	
			- - - - * - - - -		
-4	NOT USED				
-5	83039-0004		INSULATOR (Top)	1	
-6	50217-0001		COVER (Bottom)	1	
			(ATTACHING PARTS)		
-7	82869-0701		SCREW, Taptite, Pan Hd, Phillips, 4-40 x 3/16	3	
			- - - - * - - - -		
-8	83039-0003		INSULATOR (Bottom)	1	ALL
-9	01384-0101		RECEIVER BD ASSY, NAV 824 (Refer to Figure 5.2 for breakdown)	1	A
-9	01384-0102		RECEIVER BD ASSY, NAV 825 (Refer to Figure 5.2 for breakdown)	1	B
			(ATTACHING PARTS)		
-10	84536-0703		SCREW, Mach, Pan Hd, Phillips, 4-40 x 1/4	6	ALL
-11	82969-0004		WASHER, Lock, Split, No. 4	6	
			- - - - * - - - -		
-12	88237-0001		KNOB (KHz)	1	
			(ATTACHING PARTS)		
-13	82863-0722		SETSCREW, 6 Flute, 4-40 x 3/16	2	
			- - - - * - - - -		
-14	88238-0001		KNOB (MHz)	1	
			(ATTACHING PARTS)		
-15	82863-0722		SETSCREW, 6 Flute, 4-40 x 3/16	2	ALL
			- - - - * - - - -		
-16	50244-0106		TRIM PANEL ASSY (NAV 824)	1	A
-16	50244-0107		TRIM PANEL ASSY (NAV 825)	1	B
			(ATTACHING PARTS)		
-17	82402-0006		SCREW, Mach, Flat Hd, Slotted, Nylon, Black, 4-40 x 7/16	4	ALL
			- - - - * - - - -		

Fig and Index	Part Number	Symbol Number	Description	Qty	Used on Code
-18	50276-0001		SHIELD, Toggle Switch	2	All
-19	50277-0001		SUPPORT, Switch Shield	1	
-20	04931-0001		LABEL, (VOR, DIG, LOC, GS)	1	
-21	50242-0001		KNOB, (ON/OFF/VOL/IDENT)	1	
-22	75812-0004	Q602	TRANSISTOR	1	
			(ATTACHING PARTS)		
-23	82884-0504		SCREW, Mach, FH, Undercut, Phillips, 4-40 x 5/16	1	
-24	83031-0007		INSULATOR	1	
-25	81335-0012		BUSHING, Insulating	1	
-26	81307-0123		WASHER, Plain, No. 4	1	
-27	82969-0004		WASHER, Lock, Split, No. 4	1	
-28	82900-0704		NUT, Hex, 4-40	1	
			- - - - * - - - -		
-29	04023-0002		LABEL, High Voltage	1	
-30	50249-0101		PANEL ASSY, Left	1	
			(ATTACHING PARTS)		
-31	84537-0703		SCREW, Taptite, Flat Hd, Phillips, Undercut, 4-40 x 1/4	3	
-32	82869-0704		SCREW, Taptite, Flat Hd, Phillips, 4-40 x 3/8	2	
			- - - - * - - - -		
-33	50250-0101		PANEL ASSY, Right	1	
			(ATTACHING PARTS)		
-34	84537-0703		SCREW, Taptite, Flat Hd, Phillips, Undercut, 4-40 x 1/4	3	
-35	82869-0704		SCREW, Taptite, Flat Hd, Phillips, 4-40 x 3/8	2	
			- - - - * - - - -		
-36	41318-0001	J104	CONNECTOR, RF (with nut) (VOR)	1	
			(ATTACHING PARTS)		
-37	81307-0147		SPACER, .390 ID .500 OD .024 Thick	1	
-38	81737-0002		LUG, Solder	1	ALL
			- - - - * - - - -		
-39	41318-0001	J105	CONNECTOR, RF (with nut) (GS)	1	B
			(ATTACHING PARTS)		
-40	81307-0147		SPACER	1	B
-41	81737-0002		LUG, Solder	1	B
			- - - - * - - - -		
-42	50205-0003		PLATE, Rear	1	ALL
			(ATTACHING PARTS)		
-43	82860-0702		SCREW, Taptite, Pan Hd, Phillips, 4-40 x 1/4	1	
-44	82969-0004		WASHER, Lock, Split, No. 4	1	ALL

Fig and Index	Part Number	Symbol Number	Description	Qty	Used on Code
-45	50262-0101		BRACKET (Receiver Bd Support)	2	ALL
			(ATTACHING PARTS)		
-46	82869-0702		SCREW, Taptite, Pan Hd, Phillips, 4-40 x 1/4	2	
-47	82969-0004		WASHER, Lock, Split, No. 4	2	
			- - - - * - - - -		
-48	81207-0025		SPACER, Hex, 3/16 x 1 inch long	2	
			(ATTACHING PARTS)		
-49	84536-0703		SCREW, Mach, Pan Hd, Phillips, 4-40 x 1/4	2	
-50	82969-0004		WASHER, Lock, Split, No. 4	2	ALL
			- - - - * - - - -		
-51	01385-0101		MAIN PC BOARD, NAV 824 (Refer to Figure 5.3 for breakdown)	1	A
-51	01385-0102		MAIN PC BOARD, NAV 825 (Refer to Figure 5.3 for breakdown)	1	B

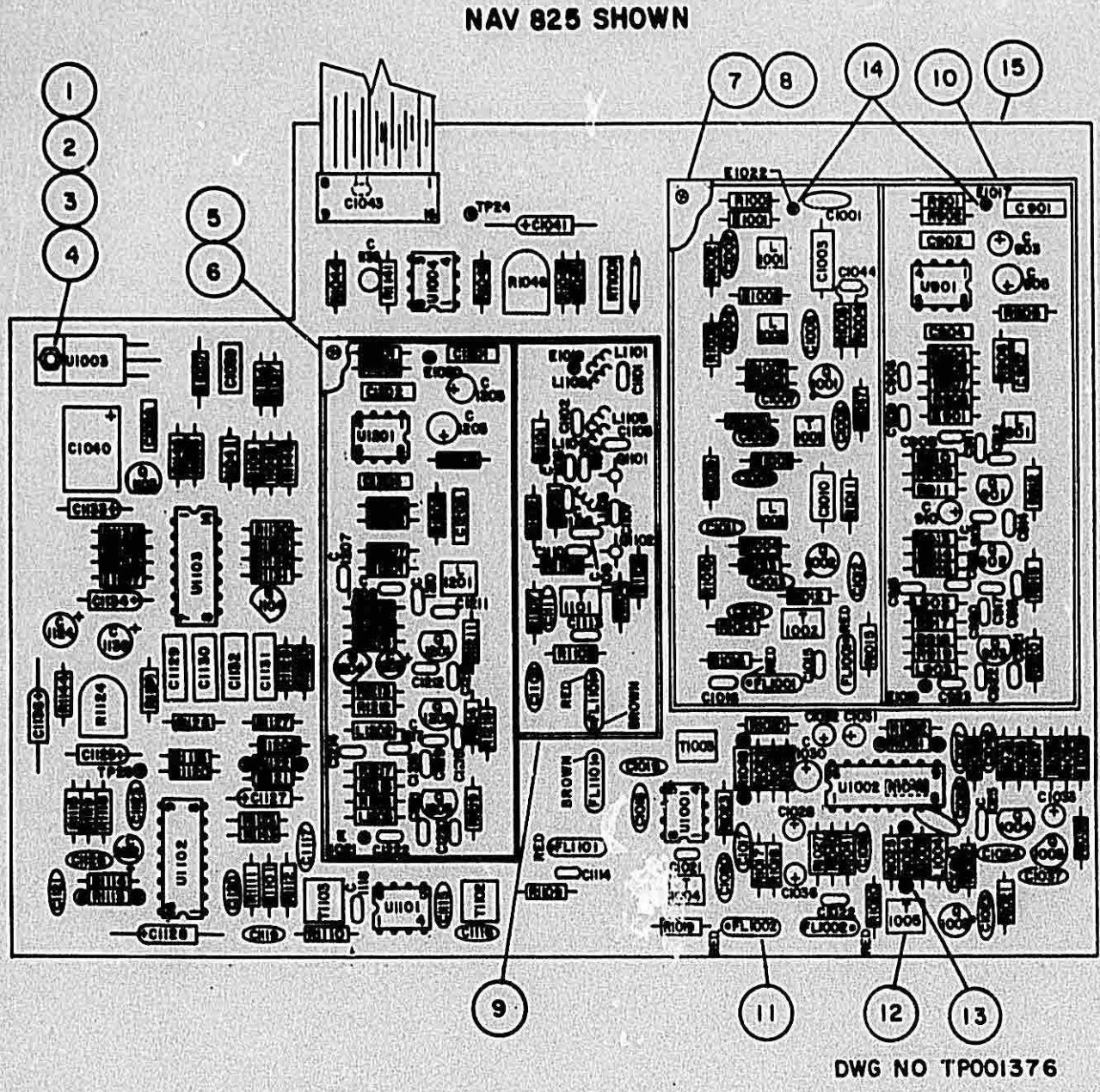


FIGURE 5-2. RECEIVER PC BOARD ASSEMBLY

SEE BLOW-UP

NAV 824/825
MECHANICAL PARTS LIST

APPLICATION CODE
A = 01384-0101 RECEIVER PC BD ASSY, NAV 824
B = 01384-0102 RECEIVER PC BD ASSY, NAV 825

Fig. and Index	Part Number	Symbol Number	Description	Qty	Used on Code
5.2	01384-0101		RECEIVER PC BD ASSY (see Figure 5.1, item 9 for next higher assembly)	REF	A
5.2	01384-0102		RECEIVER PC BD ASSY (see Figure 5.1, item 9 for next higher assembly)	REF	B
-1	74039-0001		IC, Regulator 7808	REF	All
			(ATTACHING PARTS)		
-2	84536-0704		SCREW, Mach, Pan Hd, Phillips, 4-40 x 5/16	1	
-3	81324-0004		WASHER, Lock, Split, No. 4	1	
-4	82900-0703		NUT, Hex, 4-40	1	
			- - - - * - - - -		
-5	50319-0001		COVER, VOR Front End	1	
			(ATTACHING PARTS)		
-6	84542-0702		SCREW, Taptite, Pan Hd, Phillips, 2-56 x 3/16	2	ALL
			- - - - * - - - -		
-7	50317-0001		COVER, GS Front End	1	B
			(ATTACHING PARTS)		
-8	84542-0702		SCREW, Taptite, Pan Hd, Phillips, 2-56 x 3/16	3	B
			- - - - * - - - -		
-9	50320-0001		SHIELD, VOR	1	ALL
-10	50318-0001		SHIELD, GS	1	B
-11	54559-0001		INSULATOR, Crystal Filter (FL1001/FL1002)	4	ALL
-11	54559-0001		INSULATOR, Crystal Filter (FL1101)	3	B
-12	83026-0001		INSULATOR, IF Transformer (T1002, T1003, T1004, T1005)	4	ALL
-12	83026-0001		INSULATOR, IF Transformer (T1101, T1102, T1103)	3	B
-13	81804-0104		STAND OFF, (E1019, E1020, R1024-2, R1031-2, R1048-1, R1122-2, TP24)	10	ALL
-14	81804-0104		STAND OFF, (E1022, E1017)	2	B
-15	50271-0001		PC BOARD (Less Components)	1	ALL

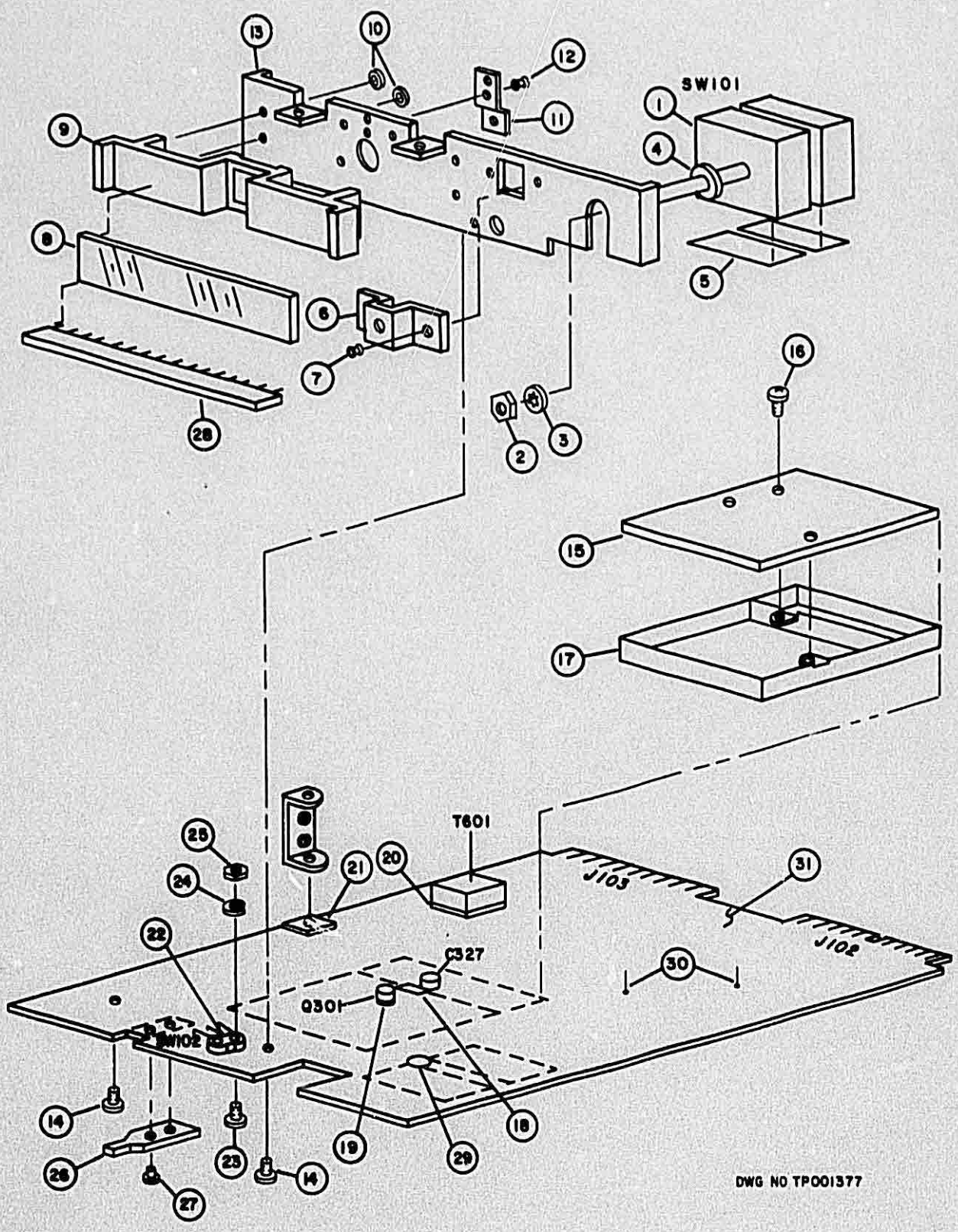


FIGURE 5-3. MAIN PC BOARD NAV 824/825

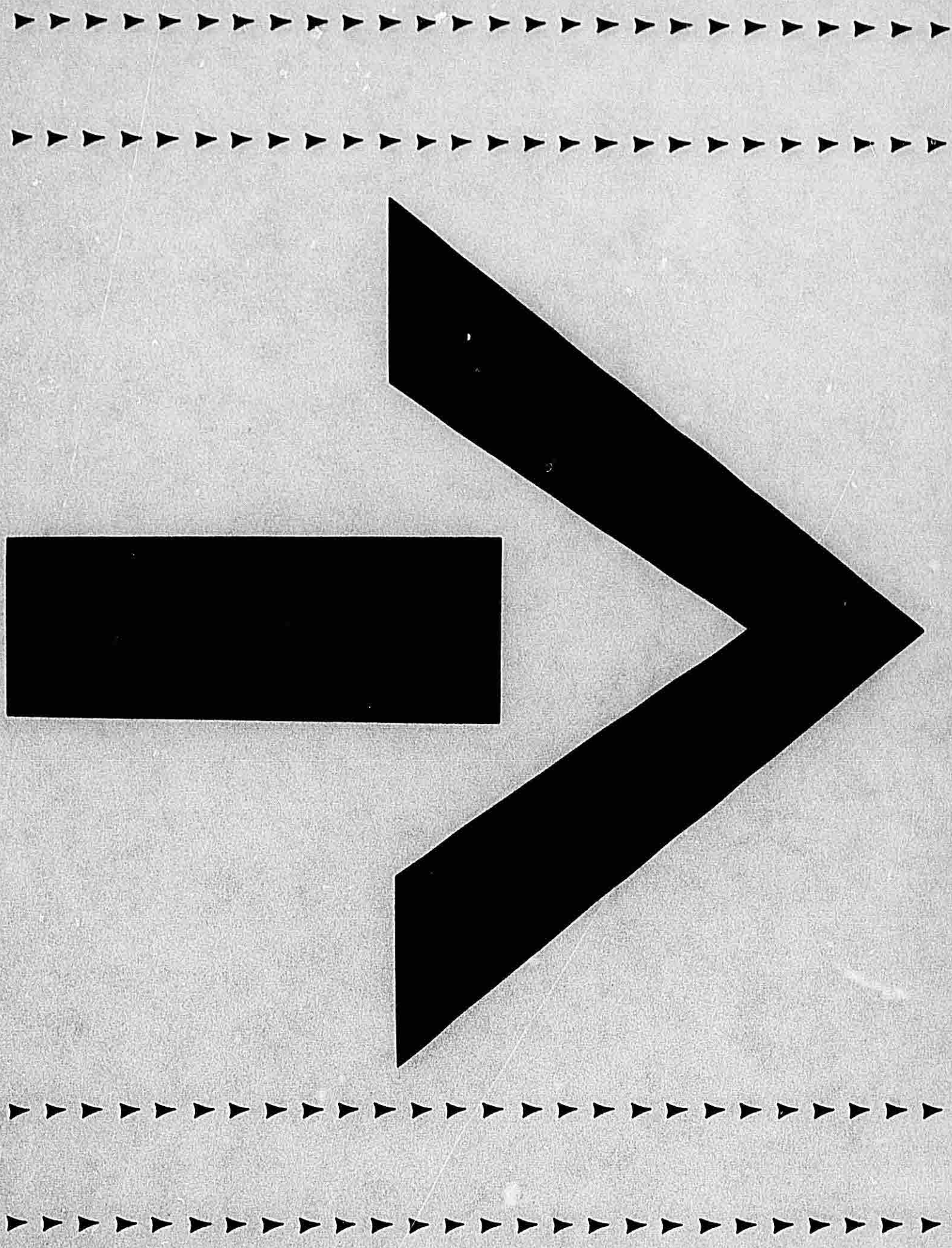
NAV 824/825
MECHANICAL PARTS LIST

APPLICATION CODE
A = 01385-0101 NAV 824 MAIN PC BD
B = 01385-0102 NAV 825 MAIN PC BD

Fig. and Index	Part Number	Symbol Number	Description	Qty	Used on Code
5.3	01385-0101		MAIN PC BD, NAV 824 (See Figure 5-1, item 51 for next higher assembly)	REF	A
5.3	01385-0102		MAIN PC BD, NAV 825 (See Figure 5-1, item 51 for next higher assembly)	REF	B
-1	61659-0001		SWITCH, Incremental (Freq)	1	ALL
			(ATTACHING PARTS)		
-2	82900-0723		NUT, Hex, S/S, 3/8-32	1	
-3	82802-0735		WASHER, Lock, Int Tooth, 3/8	1	
-4	81213-0137		SPACER, Al, .390 ID x .500 OD x .070 lg	1	
-5	99065-0004		TAPE, Double Sided	1	
			- - - - * - - - -		
-6	50216-0001		BRACKET, Switch (SW102)	1	
			(ATTACHING PARTS)		
-7	81254-0002		EYELET (SE-34)	2	
			- - - - * - - - -		
-8	50226-0001		DISPLAY, Gas Discharge	1	
-9	50223-0001		SUPPORT, Display	1	
			(ATTACHING PARTS)		
-10	81297-0011		RING, Retaining, Self-locking	8	
			- - - - * - - - -		
-11	50211-0001		SPRING, Leaf (transfer)	1	
			(ATTACHING PARTS)		
-12	81254-0001		EYELET (SE-35)	2	
			- - - - * - - - -		
-13	50219-0101		PLATE, Front	1	
			(ATTACHING PARTS)		
-14	82869-0702		SCREW, Taptite, S/S, Pan Hd, Phillips, 4-40 x 1/4	2	
			- - - - * - - - -		
-15	50321-0001		COVER	1	
			(ATTACHING PARTS)		
-16	84542-0702		SCREW, Taptite, S/S, Pan Hd, Phillips, 4 x 3/16	2	ALL
			- - - - * - - - -		

Fig. and Index	Part Number	Symbol Number	Description	Qty	Used on Code
-17	50322-0001		SHIELD, Wraparound	1	ALL
-18	83011-0038		INSULATOR 1/2 x 7/16 (Undershield between C327 and Q301)	1	
-19	83037-0004		PAD, Mounting (Q301)	1	
-20	83011-0040		INSULATOR, 3/4 x 1/2 (Under T601)	1	
-21	83032-0001		INSULATOR, 1/4 x 1/4 W/1/8 dia hole (under RC BD Bracket)	1	
-22	61556-0001	SW102	SWITCH, Momentary (Transfer)	1	
			(ATTACHING PARTS)		
-23	84533-0705		SCREW, Mach, Pan Hd, S/S, Phillips, 2-56 x 3/8	2	
-24	81324-0022		WASHER, Lock, Split, No. 2	2	
-25	82900-0701		NUT, Hex, 2-56	2	
			- - - - * - - - -		
-26	50243-0001		BUTTON, Transfer	1	
			(ATTACHING PARTS)		
-27	81257-0011		RIVET, Shoulder	2	
			- - - - * - - - -		
-28	50231-0001	J101	CONNECTOR (Display)	1	
-29	04867-0001		LABEL, Yellow 1/4" dia dot Under Frequency switch	1	
-30	81808-0104		TERMINAL, Post, Square	17	
-31	50273-0001		MAIN PC BD (Less Components)	NP	ALL

*NP = Non-procurable



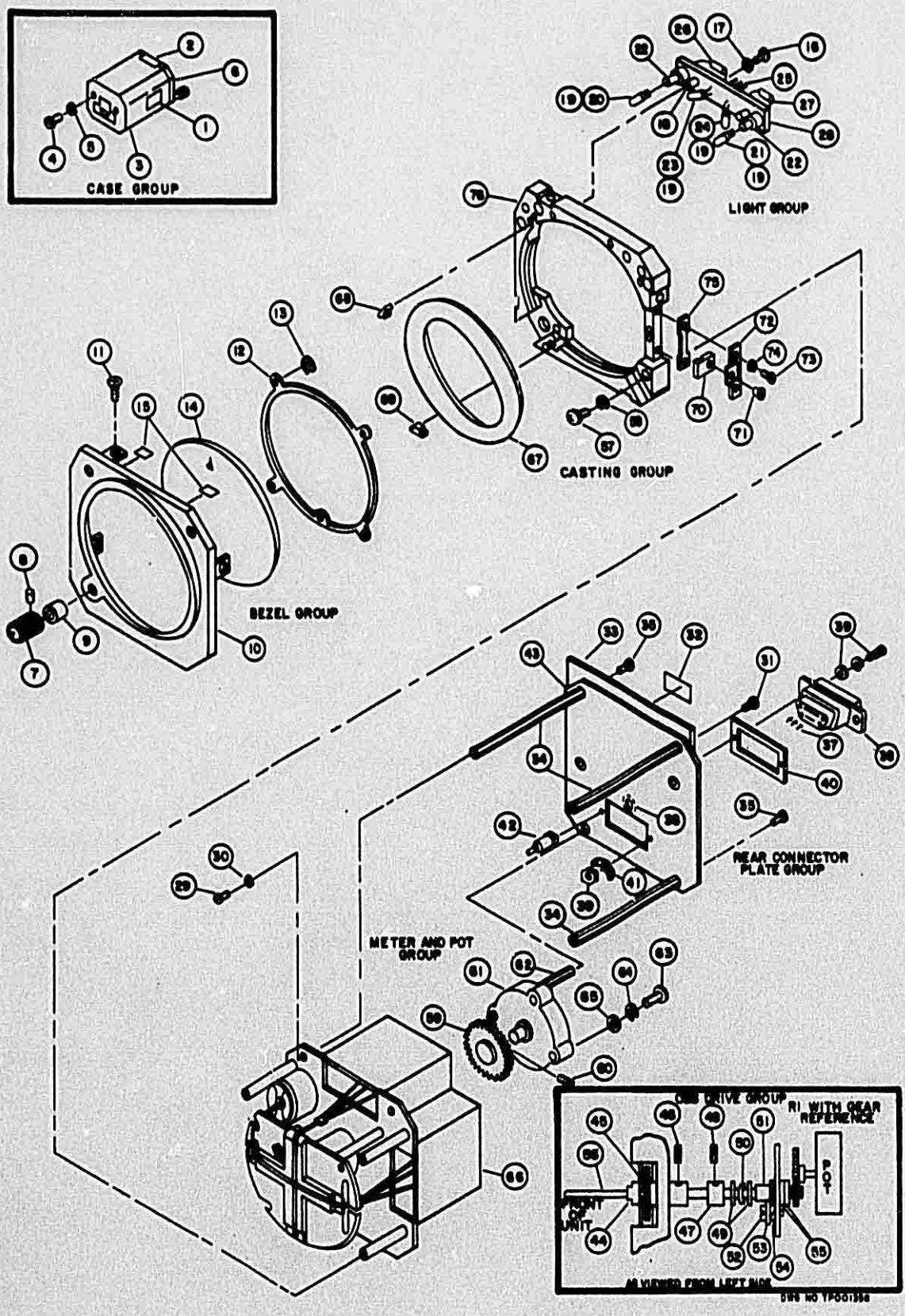


FIGURE 5-4. ID 824/825 COURSE INDICATOR

NAV 824/825
MECHANICAL PARTS LIST

APPLICATION CODE
A = 01389-0101 ID 824 COURSE INDICATOR
B = 01389-0102 ID 825 COURSE INDICATOR

Fig. and Index	Part Number	Symbol Number	Description	Qty	Used on Code
5.4	01389-0101		ID 824 COURSE INDICATOR	1	A
5.4	01389-0102		ID 825 COURSE INDICATOR	1	B
5.4	No Number		CASE GROUP	NP	ALL
-1	04928-0001		LABEL, Nameplate, ID 824	1	A
-1	04928-0002		LABEL, Nameplate, ID 825	1	B
-2	04776-0001		LABEL, Caution	1	ALL
-3	56943-0001		CASE	1	
			(ATTACHING PARTS)		
-4	84536-0702		SCREW, Mach, Pan Hd, Phillips, 4-40 x 3/16	2	
-5	82969-0004		WASHER, Lock, Split, No. 4	2	
-6	56159-0001		GASKET, Square Ring	1	
			- - - - * - - - -		
5.4	No Number		BEZEL GROUP	NP	
-7	88227-0001		KNOB, OBS	1	
			(ATTACHING PARTS)		
-8	82863-0219		SETSCREW, 6 Flutes, 4-40 x 3/32	2	
			- - - - * - - - -		
-9	88230-0003		SPACER, Knob	1	ALL
-10	56059-0013		BEZEL	1	A
-10	56059-0012		BEZEL	1	B
			(ATTACHING PARTS)		
-11	82884-0502		SCREW, Mach, Flat Hd, Phillips, 4-40 x 3/16	4	ALL
			- - - - * - - - -		
-12	56914-0001		MASK, Bezel	1	
			(ATTACHING PARTS)		
-13	81192-0014		RING, Retaining	4	
			- - - - * - - - -		
-14	50252-0002		LENS, Wedge	1	
			(ATTACHING PARTS)		
-15	99065-0008		TAPE, Double-sided	2	
			- - - - * - - - -		
5.4	No Number		LIGHT GROUP	NP	
			(ATTACHING PARTS)		
-16	84533-0706		SCREW, Mach, Fill Hd, Phillips, 2-56 x 7/16	2	
-17	81336-0002		WASHER, Insulating	2	
-18	56736-0022		SPACER, .187 OD x .187 long	2	ALL
			- - - - * - - - -		

Fig and Index	Part Number	Symbol Number	Description	Qty	Used on Code
-19	81747-0016		FILTER, Lamp, Blue	4	ALL
-20	12009-0002	DS1	LAMP, 5V	1	
-21	12009-0002	DS2	LAMP, 5V	1	
-22	12009-0001		SOCKET	2	
-23	12000-0014	DS3	LAMP, 5V	1	
-24	12000-0014	DS4	LAMP, 5V	1	
-25	81808-0106		TERMINAL	3	
-26	31149-0150	R2	RESISTOR, Carbon, Composition, 150 ohm ±5%, 1/2W	1	
-27	31149-0150	R3	RESISTOR, Carbon, Composition, 150 ohm ±5%, 1/2W	1	
-28	50282-0001		PC BOARD	1	
5.4	No Number		REAR CONNECTOR PLATE GROUP	NP	
			(ATTACHING PARTS)		
-29	84536-0704		SCREW, Mach, Pan Hd, Phillips, 4-40 x 5/16	3	
-30	82969-0004		WASHER, Lock, Split, No. 4	3	
-31	84536-0703		SCREW, Mach, Pan Hd, Phillips, 4-40 x 1/4	1	
			- - - - * - - - -		
-32	04929-0001		LABEL, Serial	1	
-33	56934-0001		GASKET, Foam	1	
-34	81207-0076		SPACER, Hex, Tapped 4-40, 2.520 lg	3	
			(ATTACHING PARTS)		
-35	84536-0703		SCREW, Mach, Pan Hd, Phillips, 4-40 x 1/4	3	
			- - - - * - - - -		
-36	04878-0001		LABEL, Disc, Mylar Alum, 1/2 OD	1	ALL
-37	41372-0008		PIN, Contact	9	A
-37	41364-0008		PIN, Contact	11	B
-38	41364-0003	P1	CONNECTOR	1	ALL
			(ATTACHING PARTS)		
-39	41308-0006		STUD, Locking (pair)	1	
-40	56975-0001		SPACER, Connector	1	
-41	81716-0002		LUG, Solder, 2 lugs	1	
-42	81423-0010	T2	TERMINAL, Standoff, Insulator	1	
			- - - - * - - - -		
-43	56916-0101		PLATE, Connector	1	ALL

Fig and Index	Part Number	Symbol Number	Description	Qty	Used on Code
5.4	No Number		OBS DRIVE GROUP	NP	ALL
-44	56907-0001		BEARING, OBS	1	
-45	56906-0101		GEAR, OBS Driver	1	
			(ATTACHING PARTS)		
-46	82863-0219		SETSCREW, 6 Flutes, 4-40 x 3/32	2	
			- - - - * - - - -		
-47	56042-0001		COLLAR	1	
			(ATTACHING PARTS)		
-48	82863-0202		SETSCREW, 4 Flutes, 2-56 x 3/32	2	
			- - - - * - - - -		
-49	81307-0138		WASHER, Flat, .128 ID x .350 OD x .030 Thick SPECIAL	2	
-50	81312-0019		WASHER, Spring, .312 x .140 x .010	1	
-51	56915-0001		BUSHING, Eccentric	1	
			(ATTACHING PARTS)		
-52	84533-0702		SCREW, Mach, Pan Hd, Phillips, 2-56 x 3/16	1	
-53	81329-0102		WASHER, Flat, .093 ID x .218 OD x .020 Thick SPECIAL	1	
-54	82969-0002		WASHER, Lock, Split, No. 2	1	
			- - - - * - - - -		
-55	81307-0138		WASHER, Flat, .128 ID x .350 OD x .030 Thich SPECIAL	2	
-56	56056-0102		GEAR AND SHAFT ASSY	1	
5.4	No Number		METERS AND POT GROUP	NP	
			(ATTACHING PARTS)		
-57	82965-0703		SCREW, Mach, Fill Hd, Phillips, 4-40 x 1/4	3	
-58	82969-0004		WASHER, Lock, Split, No. 4	3	
			- - - - * - - - -		
-59	56057-0001		GEAR, OBS Pot	1	
			(ATTACHING PARTS)		
-60	82863-0219		SETSCREW, 6 Flutes, 4-40 x 3/32	2	
			- - - - * - - - -		
-61	32068-0001	R1	POTENTIOMETER	1	
			(ATTACHING PARTS)		
-62	50278-0001		STANDOFF, Hex, External and Internal 4-40 threads	1	
-63	84536-0709		SCREW, Mach, Pan Hd, Phillips, 4-40 x 3/4	2	
-64	82969-0004		WASHER, Lock, Split, No. 4	2	
-65	81329-0104		WASHER, Flat, No. 4	2	ALL
			- - - - * - - - -		
-66	76147-0001	M1	METER, L/R	1	A
-66	76148-0001	M1	METER, L/R - GS	1	B

Fig and Index	Part Number	Symbol Number	Description	Qty	Used on Code
5.4	No Number		CASTING GROUP	NPN	ALL
-67	56911-0001		AZIMUTH CARD	1	
			(ATTACHING PARTS)		
-68	56908-0001		GUIDE, Dial (Azimuth), Fixed, Upper	1	
-69	56908-0002		GUIDE, Dial (Azimuth), Fixed, Lower	1	
			- - - - * - - - -		
-70	56909-0001		GUIDE, Dial (Azimuth), Spring Loaded	1	
			(ATTACHING PARTS)		
-71	81254-0029		EYELET	1	
			- - - - * - - - -		
-72	56910-0001		SPRING, Dial (Azimuth) Guide	1	
			(ATTACHING PARTS)		
-73	84533-0702		SCREW, Mach, Pan Hd, Phillips, 2-56 x 3/16	2	
-74	82969-0002		WASHER, Lock, Split, No. 2	2	
-75	56919-0001		SHIM	1	
			- - - - * - - - -		
-76	56025-0002		CASTING, Front	1	ALL

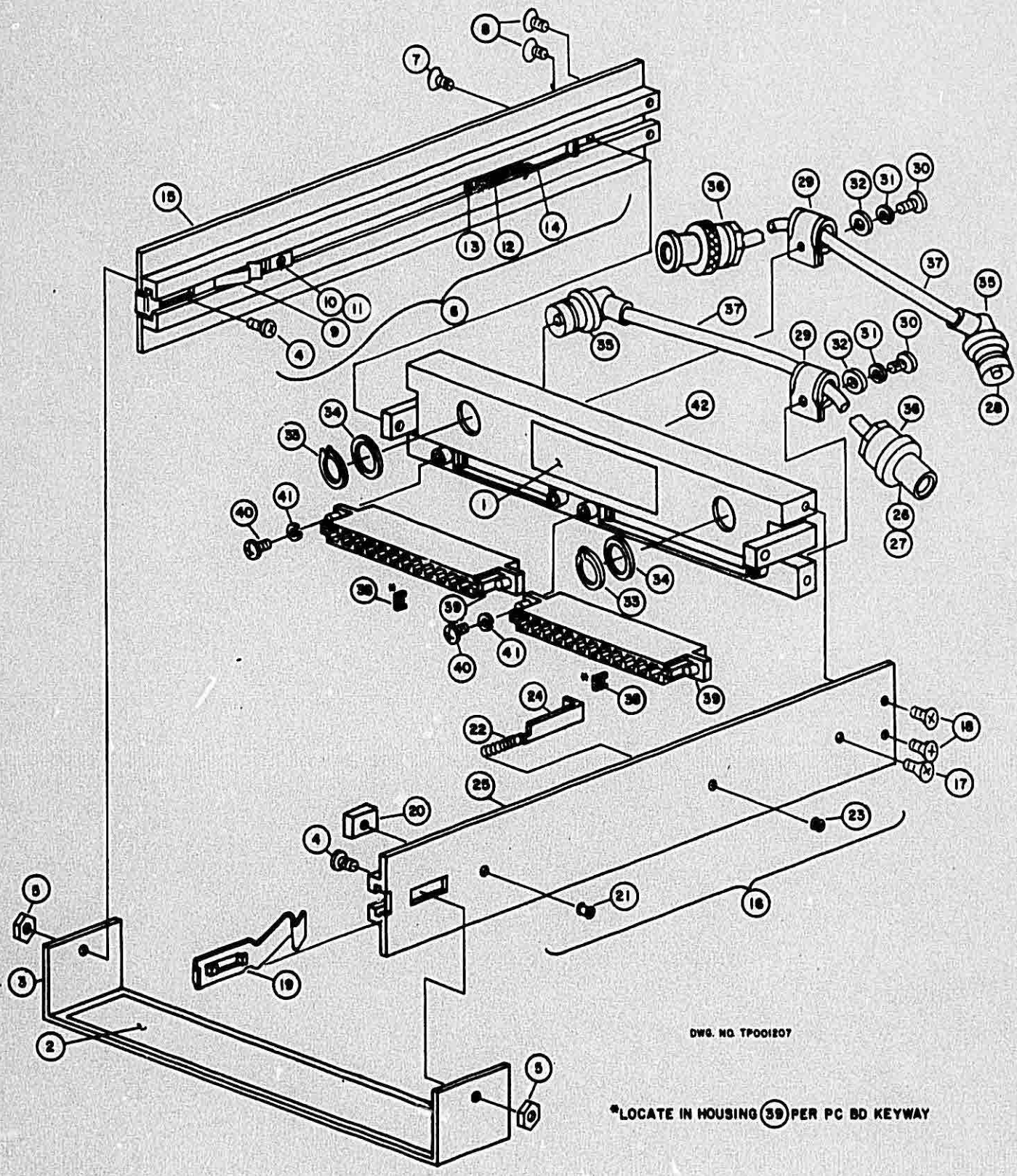


FIGURE 5-5. TRAY ASSEMBLY

MECHANICAL PARTS LIST

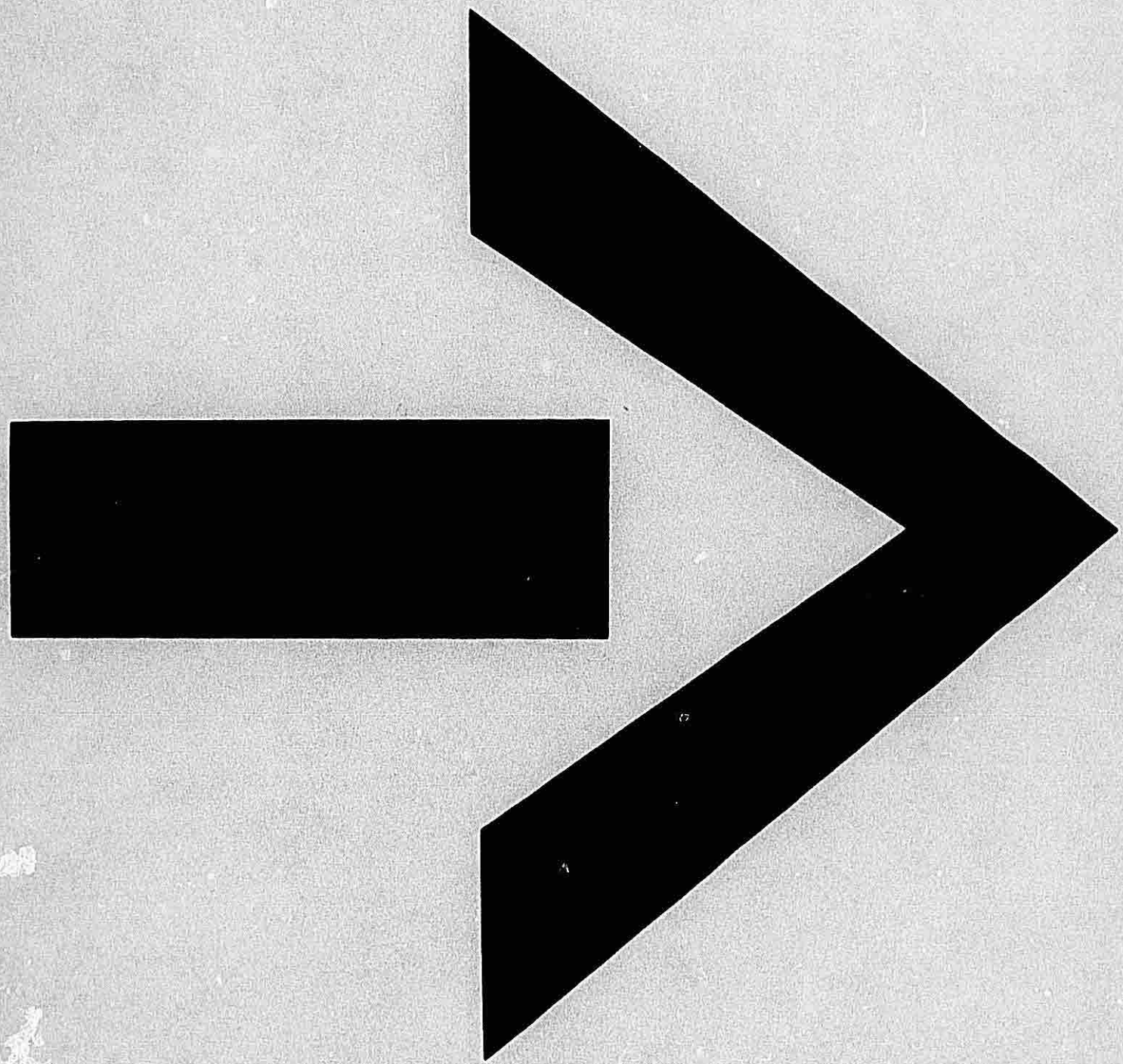
USED ON CODE
A - COM 810 TRAY ASSY
B - NAV 825 TRAY ASSY
C - DME 890 TRAY ASSY
D - NAV 824 TRAY ASSY
E - COM 811 TRAY ASSY

Fig. and Index	Part Number	Symbol Number	Description	Qty	USED ON Code
5.5	01372-0101		TRAY ASSY, COM 810	1	A
	01372-0102		TRAY ASSY, NAV 825	1	B
	01372-0103		TRAY ASSY, DME 890	1	C
	01372-0104		TRAY ASSY, NAV 824	1	D
	01372-0105		TRAY ASSY, COM 811	1	E
-1	04913-0003		LABEL, Tray	NP	A
	04913-0006		LABEL, Tray	NP	B
	04913-0001		LABEL, Tray	NP	C
	04913-0005		LABEL, Tray	NP	D
	04913-0004		LABEL, Tray	NP	E
-2	04924-0001		LABEL, Caution	1	All
-3	50045-0001		BRACKET, Shipping	1	
			(ATTACHING PARTS)		
-4	84539-0705		SCREW, Mach, Pan Hd, 6-32 X 3/8	2	
-5	82900-0009		NUT, Hex, 6-32	2	
			- - - - * - - - -		
-6	No Number		LEFT SIDE RAIL ASSY	NP	
			(ATTACHING PARTS)		
-7	82809-0703		SCREW, Mach, Flat Hd Phillips 4-40 X 1/4	1	
-8	82809-0705		SCREW, Mach, Flat Hd, Phillips 4-40 X 3/8	2	
			- - - - * - - - -		
-9	50203-0001		SPRING, Leaf	1	
-10	50253-0001		BUMPER, Tray	1	
			(ATTACHING PARTS		
-11	81254-0054		EYELET (SE-38)	1	
			- - - - * - - - -		
-12	50251-0001		SPRING, Tension	1	
			(ATTACHING PARTS)		
-13	81254-0001		EYELET (SE-34)	1	
			- - - - * - - - -		
-14	50202-0001		BRACKET, Spring	1	
-15	50204-0001		SIDE RAIL, Left	1	
-16	No Number		RIGHT SIDE RAIL ASSY	NP	
			(ATTACHING PARTS)		
-17	82809-0703		SCREW, Mach, Flat Hd, Phillips 4-40 X 1/4	1	
-18	82809-0705		SCREW, Mach, Flat Hd, Phillips 4-40 X 3/8	2	All
			- - - - * - - - -		

Fig. and Index	Part Number	Symbol Number	Description	Qty	Used on Code
-19	50203-0001		SPRING, Leaf	1	All
-20	50253-0001		BUMPER, Tray	1	
			(ATTACHING PARTS)		
-21	81254-0054		EYELET, (SE-38)	1	
			- - - - * - - - -		
-22	50251-0001		SPRING, Tension	1	
			(ATTACHING PARTS)		
-23	81254-0001		EYELET, (SE-34)	1	
			- - - - * - - - -		
-24	50202-0001		BRACKET, Spring	1	
-25	50204-0001		SIDE RAIL, Right	1	All
-26	90701-0106		CABLE ASSY, 15" long	1	ACE
-27	90701-0107		CABLE ASSY, 30" long marked "VOR"	1	BD
-28	90701-0108		CABLE ASSY, 30" long marked "Glide Slope"	1	B
			(ATTACHING PARTS)		
-29	82010-0014		CLAMP, Cable	1	ACDE
	82010-0014		CLAMP, Cable	2	B
-30	84536-0704		SCREW, Mach, Pan Hd, 4-40 X 5/16	1	ACDE
	84536-0704		SCREW, Mach, Pan Hd, 4-40 X 5/16	2	B
-31	81324-0023		WASHER, Lock, Split, No. 4	1	ACDE
	81324-0023		WASHER, Lock, Split, No. 4	2	B
-32	81329-0104		WASHER, Flat, No. 4	1	ACDE
	81329-0104		WASHER, Flat, No. 4	2	B
-33	81192-0024		RING, Retaining	1	ACDE
	81192-0024		RING, Retaining	2	B
-34	81312-0022		WASHER, Spring	1	ACDE
	81312-0022		WASHER, Spring	2	B
			- - - - * - - - -		
-35	41341-0001		CONNECTOR, Coax, BNC, Right Angle	1	All
-36	41229-0003		CONNECTOR, Coax, BNC, Male	1	ACE
-36	41152-0005		CONNECTOR, Coax, BNC, Female	1	BD
-37	90092-0001		COAX, Cable, 15" long, RG223/U	1	ACE
	90092-0001		COAX, Cable, 30" long, RG223/U	1	BD

Fig. and Index	Part Number	Symbol Number	Description	Qty	Used on Code
-38	41410-0001		KEY, Polarizing	1	ACDE
	41410-0001		KEY, Polarizing	2	B
-39	41406-0007		HOUSING, Connector, 24 pin	1	ACDE
	41406-0007		HOUSING, Connector, 24 pin	2	B
			(ATTACHING PARTS)		
-40	84536-0706		SCREW, Mach, Pan Hd, 4-40 X 7/16	2	ACDE
	84536-0706		SCREW, Mach, Pan Hd, 4-40 X 7/16	4	B
-41	81324-0003		WASHER, Lock, Split, No. 4	2	ACDE
	81324-0003		WASHER, Lock, Split, No. 4	4	B
			- - - - * - - - -		
-42	50222-0001		PLATE, Rear	1	All

*NP - Non-procureable



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6.1.2	Component Location Drawings	6-1	2F04	
6.1.3	Electrical Parts List	6-1	2F04	
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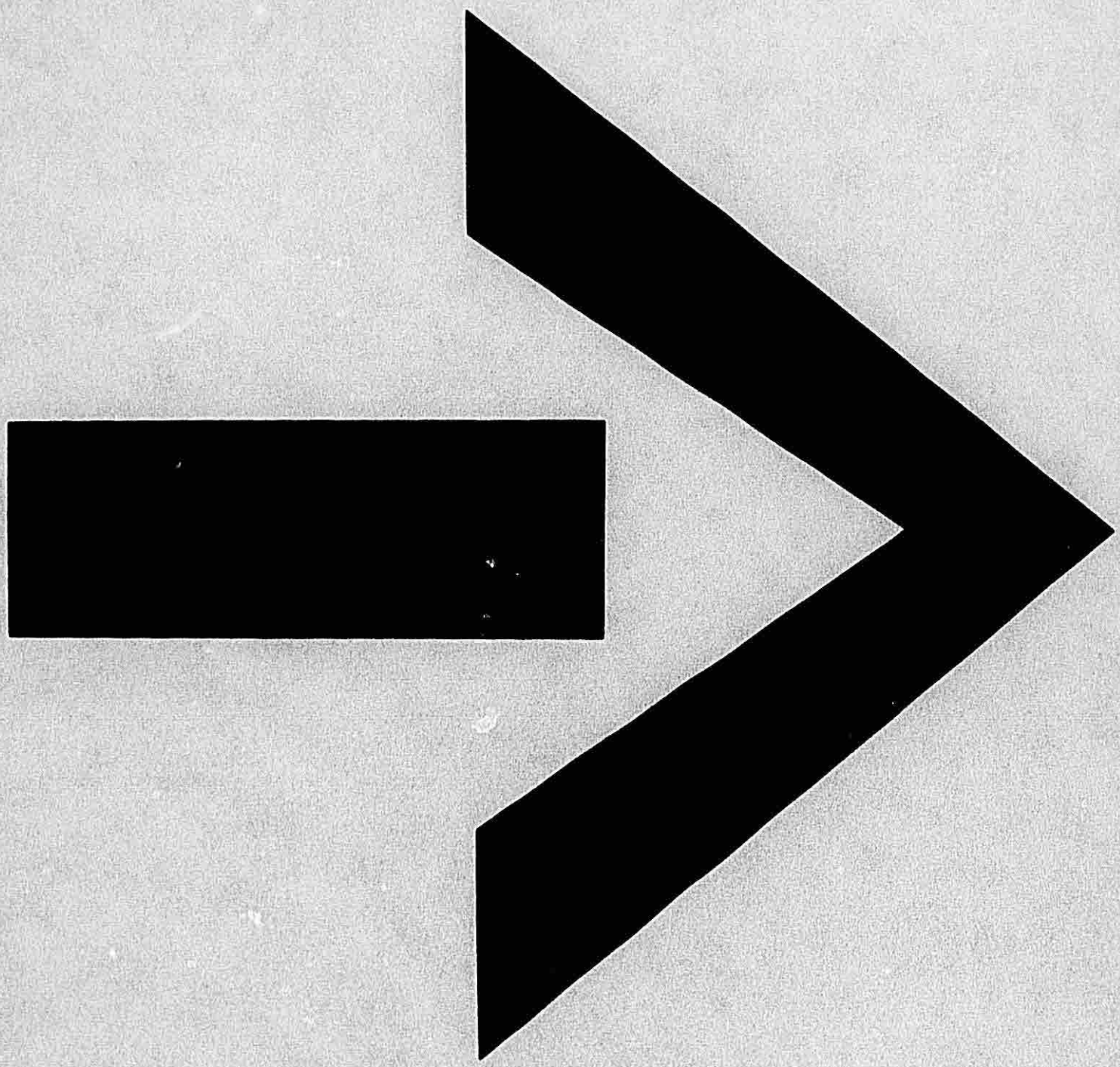


6.1 GENERAL

This Section contains a set of schematics and support information for the NAV 824 and NAV 825. Such support information comprises:

- An internal interconnect diagram
- Component location drawings with "solder track"
- Voltage test points
- Waveforms
- Electrical Parts List on the reverse side of the schematic

6.1.1 Internal Interconnect Diagram

Figure 6-1, the internal interconnect diagram shows point-to-point wiring. This figure's To/From Wiring List is a redundant list, that is, the left column contains, in alphanumeric sequence, both ends of a lead, allowing one to find the opposite end of a lead quickly. Lead functions and wire colors are given. (Note: wire colors may be changed without notice).

6.1.2 Component Location Drawings

The component drawing adjacent to its schematic is provided to give quick schematic/unit orientation. The PC runs shown are provided to aid in tracing and identifying components. Numerous waveform and voltages are shown on or about the schematic to allow quick trouble-shooting, in conjunction with the trouble isolation flowcharts of Section 4.

6.1.3 Electrical Parts List

The Electrical Parts List, formerly located in Section 5 will be found on the reverse side of its schematic. The parts listed are those parts found in the schematic.

This list contains such data as: the parts effectivity, and an Action if any, its electrical symbol number, Narco Part Number, Description, and its component assembly and schematic grid coordinates.

6.1.3.1 Using the Electrical Parts List

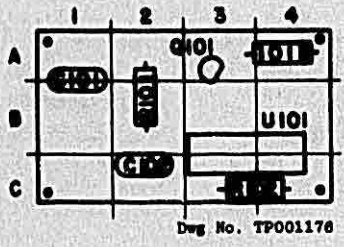
The action column identifies added, changed, and deleted parts, the effectivity column identifies the Chassis Level Configuration Code Letter used to identify when the part was effected.

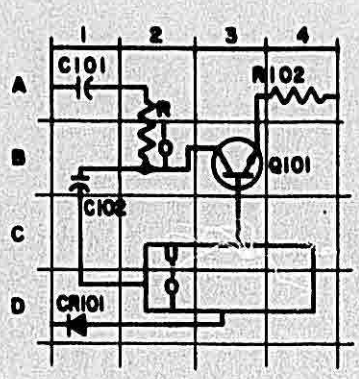
To the far right of the part number/description one will find a grid coordinate listing for that part, one set of coordinates locates that part on the component assembly drawing, the second locates the part within the schematic. Where a part, such as an IC, is broken down into several subcomponents, each component part is located for the user.

6.1.3.1 Continued

Grid coordinates are shown on both the component assembly drawing and the schematic. The grids are not, in themselves, shown to avoid clutter.

The grid coordinate identifies that grid box wherein the component's symbol letter is located as shown in the sample below.





	Component Grid	Schematic Grid
C101	A1	A1
C102	C2	C1
CR101	A4	D1
Q101	A2	B4
R101	B2	A2
R102	C3	A3
U101	B4	C2

6.2 MODIFICATION LABEL

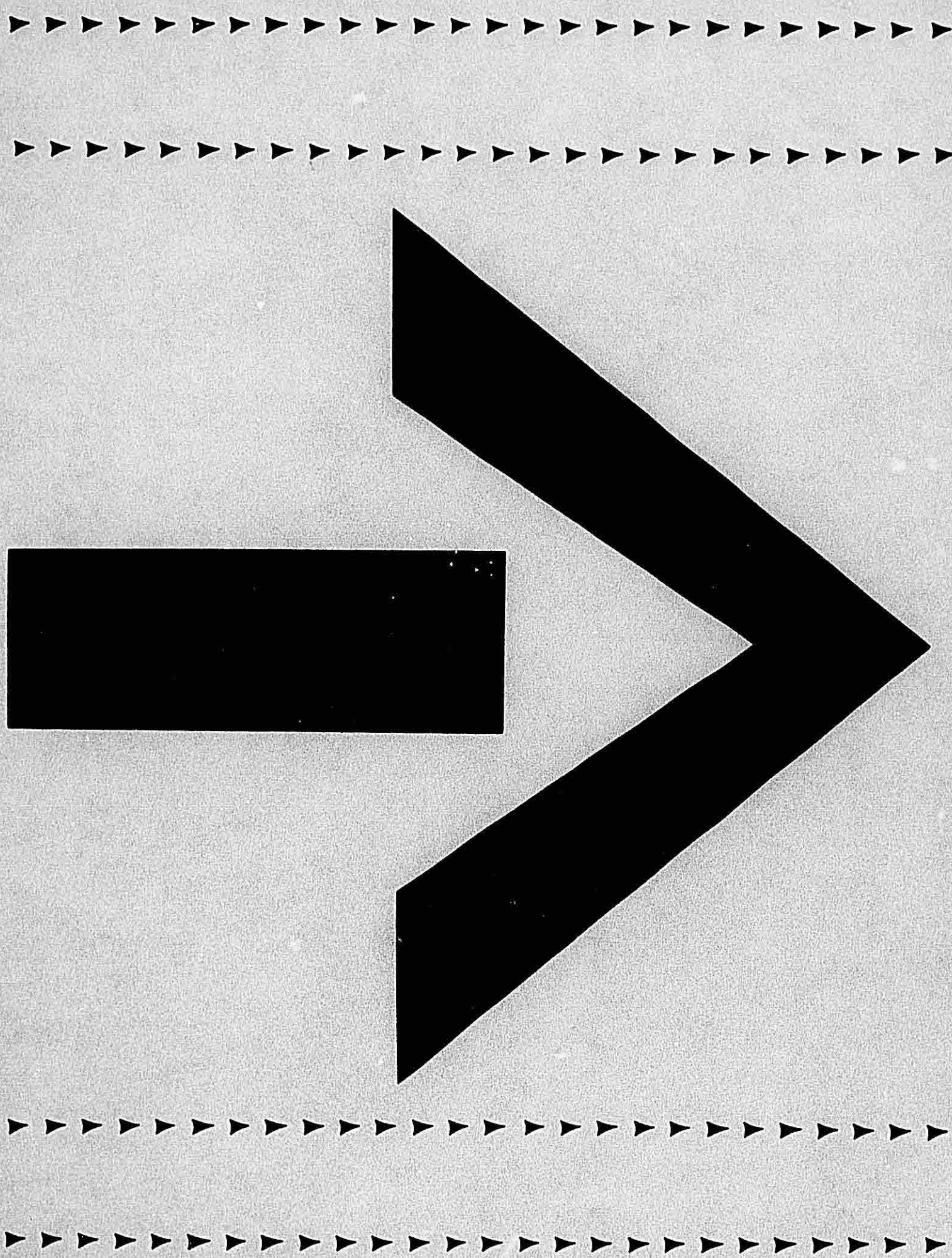
The modification label affixed to the Unit is provided to allow quick recognition of what modifications where made to that Unit, if any. Thus the block should only be filled in upon completion of a Narco Service Bulletin Modification Instruction. Fill in only that block or blocks that the Bulletin designates.

6.3 SERIAL NUMBER v/s CHASSIS LEVEL CONFIGURATION CODE

The Serial Number will be the key factor to identify Units. The Chassis Level Configuration Codes will be used when necessary to identify specific subassemblies at specific levels.

When a Unit's Chassis Code is presented as a series of letters, their arrangement reflects:

Unit	Serial No.	v/s	Chassis Codes Main PC	Receiver PC
NAV 824	10000		B	B
NAV 825	50000		B	B
ID 824/825	11000		Unit B	



TO/FROM WIRING LIST

Solder Point	Wire Color	Function	Solder Point
C114	Bus	Jumper (+5V)	C115
C115	Bus	Jumper (+5V)	C114
C509	Enamel Wire		J103-10
E101	Red	+190V	E601
E102	Bus	Transfer Ground	SW102
E103	Bus	Transfer	SW102
E104	Brown	TO	SW103
E105	Blue	FROM	SW103
E106	Red	Ground	SW103
E107	Yellow	Arm	R174
E108	Orange	Ground	R174
E109	Green	Rec Audio	R174
E109	PC Track	Rec Audio	E404
E110	Bus	Ground	R121
E111	Bus	+ Power	R121
E301	Coax Blue	NAV RF Drive	E1018
E302 (TP9)	Coax No Color	Phase Detector (NAV Synth)	E1017
E303	Coax Red	GS RF Drive	E1021
E304 (TP11)	Coax Orange	Phase Detector (GS Synth)	E1020
E401	PC Track	+16V	F601
E401	Ribbon Cable	+16V	E1001
E402	Ribbon Cable	Ground	E1002
E403	Ribbon Cable	Detector (ARINC output)	E1003
E404	PC Track	Rec Audio	E109
E404	Ribbon Cable	Rec Audio	E1004
E405	Ribbon Cable	Ground	E1005
E406	Ribbon Cable	+8V	E1006
E407	Ribbon Cable	VOR/LOC Command	E1007
E408	Ribbon Cable	+GS Flag	E1008
E409	Ribbon Cable	GS Zero	E1009
E409	PC Track	GS Zero	R1136
E410	Ribbon Cable	GS Zero	E1010
E410	PC Track	GS Zero	R1136
E411	Ribbon Cable	V Ref	E1011
E412	Ribbon Cable	GS Zero	E1012
E412	PC Track	GS Zero	R1136 Arm
E413	- - - - - -	NOT USED - - - - - -	E1013
E414	PC Track	+Up GS	E417
E414	Ribbon Cable	+Up GS	E1014
E415	Ribbon Cable	Ground	E1015
E416	Ribbon Cable	Ground	E1016
E417	Green	+Up GS	E418
E417	PC Track	+Up GS	E414
E418	Green	+Up GS	E417
E418	PC Track	+Up GS	J103-11
E601	Red	+190V	E101
E602	PC Track	14/28V input (via C610)	J102-9/K
E602	Blue	ON/OFF (14/28V input)	SW103
E603	PC Track	Switched A+	J102-11/M
E603	Red	ON/OFF Switched A+	SW103
E604	Red	ON/OFF Switched A+	SW103
E605	Orange		E606
E606	Orange		E605
E1001	Ribbon Cable	+16V	E401
E1002	Ribbon Cable	Ground	E402
E1003	Ribbon Cable	Detector (ARINC output)	E403
E1004	Ribbon Cable	Rec Audio	E404
E1005	Ribbon Cable	Ground	E405
E1006	Ribbon Cable	+8V	E406
E1007	Ribbon Cable	VOR/LOC Command	E407
E1008	Ribbon Cable	+GS Flag	E408
E1009	Ribbon Cable	GS Zero	E409
E1009	PC Track	GS Zero	R1137
E1010	Ribbon Cable	GS Zero	E410
E1010	PC Track	GS Zero	R1134
E1011	Ribbon Cable	V Ref	E411
E1012	Ribbon Cable	GS Zero	E412
E1012	PC Track	GS Zero	U1104-6
E1013	- - - - - -	NOT USED - - - - - -	E413
E1014	Ribbon Cable	+Up GS	E414
E1015	Ribbon Cable	Ground	E415
E1016	Ribbon Cable	Ground	E416
E1017	Coax No Color	Phase Detector (NAV synth)	E302 (TP9)
E1018	Coax Blue	RF Drive	E301
E1019	Coax Yellow	GS Antenna	J105
E1020	Coax Orange	Phase Detector (GS Synth)	E304 (TP11)
E1021	Coax Red	GS RF Drive	E303
E1022	Coax Green	VOR Antenna	J104
F601	PC Track	+16V	E401
J102-9/M	PC Track	14/28V input (via C610)	E602
J102-11/M	PC Track	Switched A+	E603
J103-10	Enamel Wire		C509
J103-11	PC Track	+Up GS	E418
J103-M	Enamel Wire		R523
J104	Coax Green	VOR Antenna	E1022
J105	Coax Yellow	GS Antenna	E1019
R121	Bus	Ground	E110
R121	Bus	+ Power	E111
R174	Yellow	Arm	E107
R174	Orange	Ground	E108
R174	Green	Rec Audio	E109
R174	PC Track	Vol Control	E404
R523	Enamel Wire		J103-M
R1029	Bus	Jumper +8V	R1033
R1033	Bus	Jumper +8V	R1029
R1134	PC Track	GS Zero	E1010
R1136	PC Track	GS Zero	E410
R1136 Arm	PC Track	GS Zero	E412
R1136	PC Track	GS Zero	E409
R1137	PC Track	GS Zero	E1009
SW102	Bus	Transfer Ground	E102
SW102	Bus	Transfer	E103
SW103	Brown	TO	E104
SW103	Blue	FROM	E105
SW103	Red	Ground	E106
SW103	Blue	ON/OFF 14/28V input	E602
SW103	Red	ON/OFF Switched A+	E603
SW103	Bus	ON/OFF	E604
TP3	Bus	Active Entry Jumper (if used)	TP4
TP4	Bus	Active Entry Jumper (if used)	TP3
TP9 (E302)	Coax No Color	Phase Detector (NAV Synth)	E1017
TP11 (E304)	Coax Orange	Phase Detector (GS Synth)	E1020
U1104-6	PC Track	GS Zero	E1012

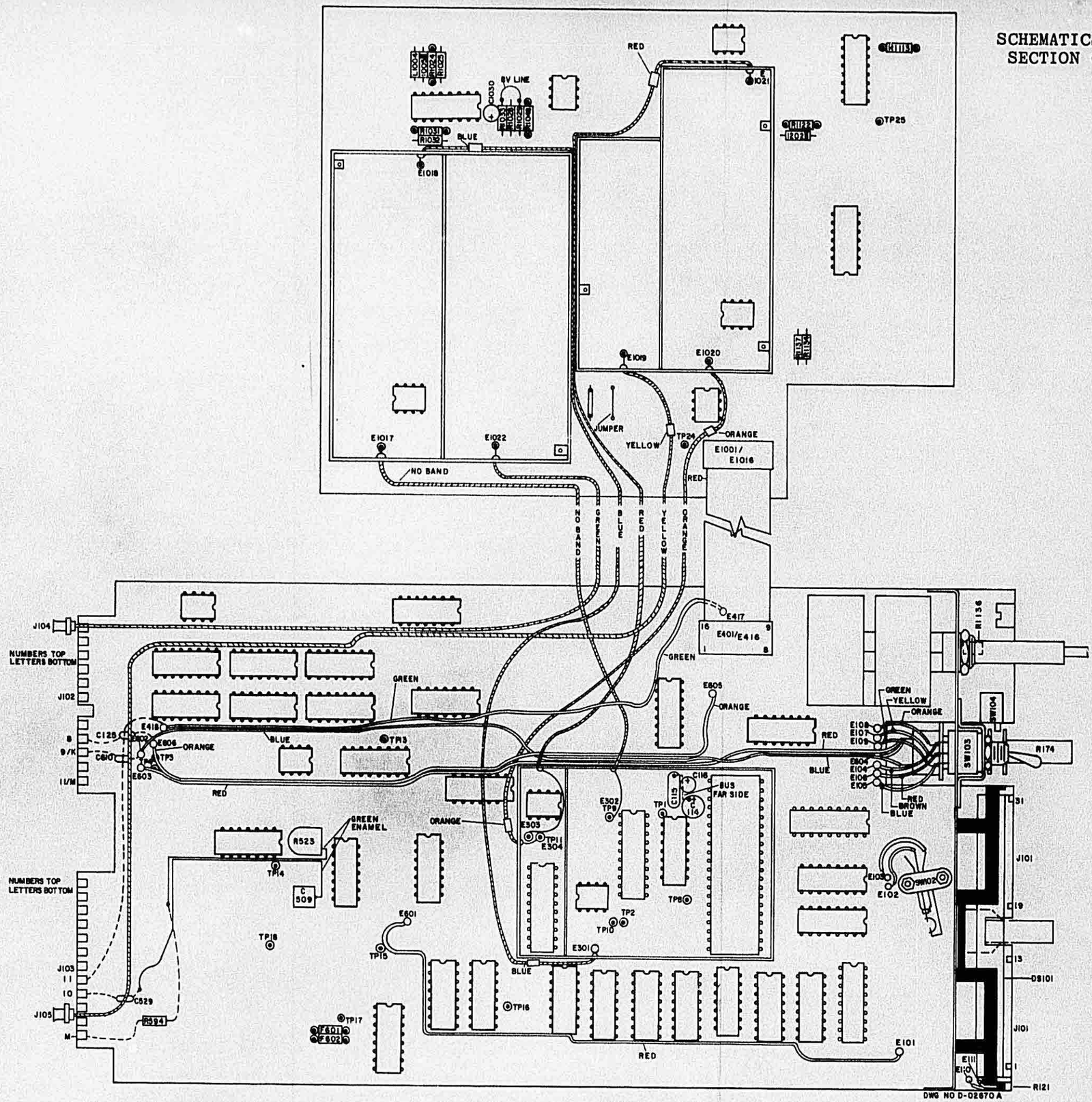
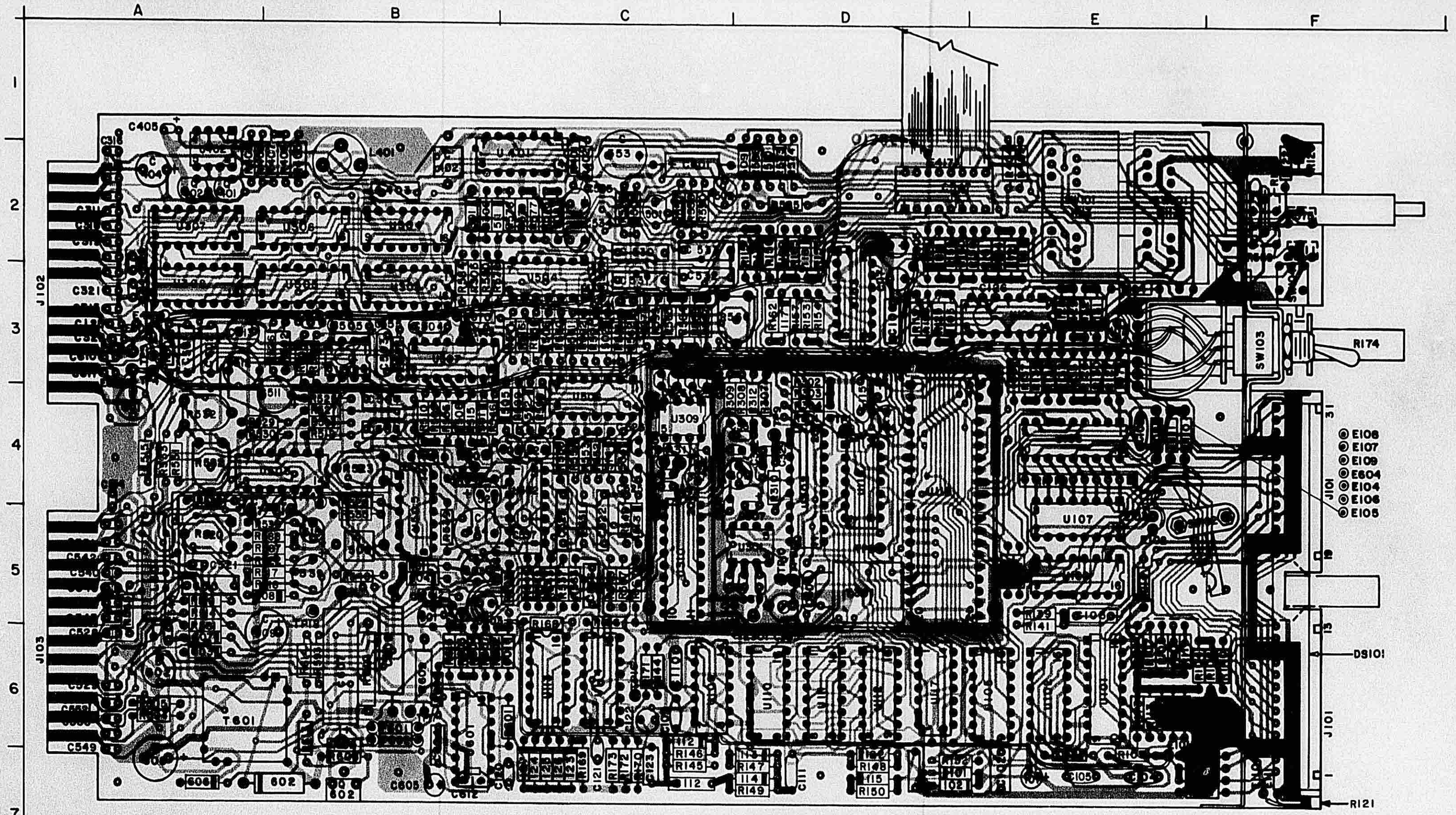


FIGURE 6-1. INTERNAL INTERCONNECT WIRING DIAGRAM AND TO/FROM LIST

SEE BLOW-UP

SEE BLOW-UP



NOTES:

1. ▭ INDICATES DIODE, CR OMITTED FOR CLARITY. BAR INDICATES CATHODE END.

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.

Dwg. No. D-50266-G

FIGURE 6-2. NAV 824/825 MAIN BOARD (sheet 1 of 2)

6-6 (NAV 825 SHOWN)

(6-5 Blank)

SEE BLOW-UP

SEE BLOW-UP

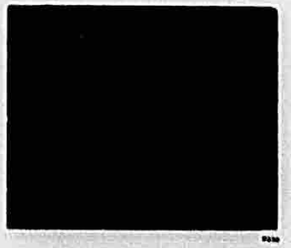
(25)

TP13 FM Detector

X10 Probe
DC Coupled
Internal Positive Sync

Standard Omni Signal
Zero Heading

GND



(26)

GND U502-14 AC Coupled
TP15 DC Coupled

X10 Probe
Internal Positive Sync

Standard Omni Signal
Zero Heading

GND

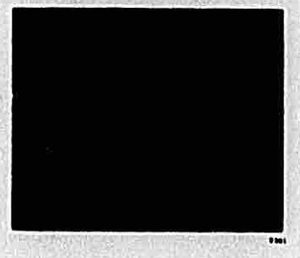
(27)

TP16

X10 Probe
DC Coupled
Internal Positive Sync

Standard Omni Signal

GND



(28)

TP14

X10 Probe
DC Coupled
Internal Positive Sync

Standard Omni Signal

GND

(29)

U505-2 and TP15

X10 Probe
GND DC Coupled
Internal Positive Sync

Standard Omni Signal

GND

(30)

TP15 and U502-1

X10 Probe
GND DC Coupled
Internal Positive Sync

Standard Omni Signal

GND

(31)

GND U504-14 and U504-8

X10 Probe
AC Coupled
Internal Positive Sync

Frequency 110.50 MHz

Standard Localizer Signal
On Course Ø ddm

(32)

GND CR509 Cathode and CR510 Anode

X10 Probe
AC Coupled
Internal Positive Sync

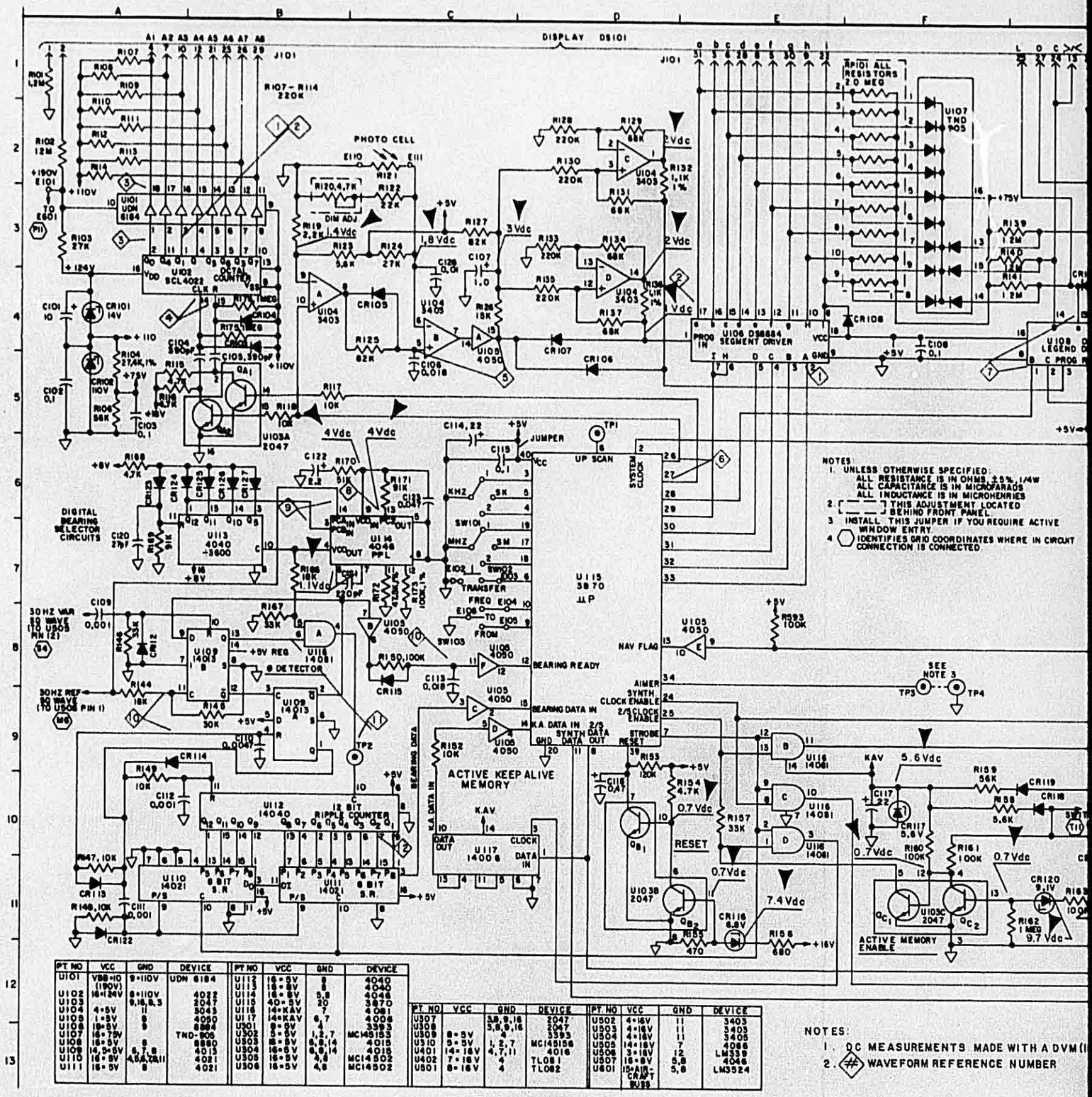
GND Standard Localizer Signal
On Course Ø ddm

(33)

U505-3

X10 Probe
GND AC Coupled
Internal Positive Sync

Standard Localizer Signal
On Course Ø ddm



PT NO	VCC	GND	DEVICE
U101	VBB=10 (190V)	9=110V	UDN 6184
U102	16=12V	8=110V	4022
U103		9,16,8,3	2047
U104	4=5V	11	3403
U105	1=5V	8	4050
U106	18=5V	9	8884
U107	16=75V		TND-905
U108	16=5V	8	8880
U109	14,9=5V	6,7,8	4013
U110	16=5V	4,6,7,8,11	4021
U111	16=5V	8	4021
U112	16=5V	8	4040
U113	16=5V	8	4040
U114	16=5V	5,8	4046
U115	40=5V	20	3870
U116	14=KAV	7	4081
U117	14=KAV	6,7	4006
U301	8=5V	4	3393
U302	5=5V	1,2,7	MC145153
U303	16=5V	8,8,14	4015
U304	16=5V	8,8,14	4015
U305	16=5V	4,8	MC14502
U306	16=5V	4,8	MC14502
U307		3,8,9,16	2047
U308		3,8,9,16	2047
U309	8=5V	4	3393
U310	5=5V	1, 2, 7	MC145156
U401	14=16V	4,7,11	4016
U402	7=16V	4	TL081
U501	8=16V	4	TL082
U502	4=16V	11	3403
U503	4=16V	11	3403
U504	4=16V	11	3403
U505	14=16V	7	4066
U506	3=16V	12	LM339
U507	16=8V	5,8	4046
U601	15=AIRCRAFT BUSS	5,8	LM3524

NOTES:
1. DC MEASUREMENTS MADE WITH A DVM (I
2. (#) WAVEFORM REFERENCE NUMBER

FIGURE 6-2. NAV 824/825 MAIN BOARD (sheet 2 of 2)
(NAV 825 SHOWN)

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01385-0101G

Action: original, added, changed, deleted. / Chassis Level Code / Symbol Number	Part Number	Description	Grid Coordinates Schematic	Component Assy
		CAPACITOR		
o A C101	21567-0016	Electrolytic, 10 uF +20%, 25V	E7	A4
o A C102	23113-0112	Met. Polyester, .1 uF ±10%, 250V	E7	A5
o A C103	23113-0112	Met. Polyester, .1 uF ±10%, 250V	E5	A5
o A C104	24049-0391	Dipped Mica, 390 pF ±5%, 500V	E7	A4
o A C105	24049-0391	Dipped Mica, 390 pF ±5%, 500V	E7	B5
o A C106	23107-0016	Poly Film, .018 uF ±5%, 100V	D3	C5
o A C107	21567-0014	Electrolytic, 1.0 uF +10%, 50V	E3	C3
o A C108	24515-0001	Ceramic Disc, .1 uF +80/-20%, 10V	E4	F4
o A C109	21291-0021	Ceramic Disc, .001 uF +20%, 500V	C6	A7
o A C110	23107-0009	Poly Film, .0047 uF ±5%, 100V	C6	B9
o A C111	23107-0001	Poly Film, .001 uF ±5%, 100V	C7	A11
o A C112	23107-0001	Poly Film, .001 uF ±5%, 100V	C7	A10
o A C113	23107-0016	Poly Film, .018 uF ±5%, 100V	C7	C8
o A C114	21564-0034	Tantalum, 22 uF +20%, 15V	D4	C5
o A C115	24515-0001	Ceramic, .1 uF +80/-20%, 10V	D4	C6
o A C116	21564-0157	Tantalum, .47 uF ±10%, 35V	D4	D10
o A C117	21564-0034	Tantalum, 22 uF +20%, 15V	D3	F10
o A C118	21564-0146	Tantalum, 10 uF ±10%, 20V	D2	G11
o A C120	24052-0270	Dipped Mica, 27 pF ±5%, 500V	B7	A7
o A C121	24052-0221	Dipped Mica, 220 pF ±5%, 300V	C7	B7
o A C122	21564-0028	Tantalum, 2.2 uF +20%, 15V	C6	B6
o A C123	23107-0121	Poly Film, .047 uF ±10%, 100V	C7	C6
o A C125	24551-0002	Ceramic, 470 pF ±20%, 50V	A3	N11
o A C126	21291-0030	Ceramic, .01 uF ±20%, 50V	E3	C3
o A C301	24551-0003	Ceramic, .001 uF +100/-0%, 50V	D5	H11
o A C302	24551-0003	Ceramic, .001 uF +100/-0%, 50V	D4	H10
o A C303	24550-2103	Ceramic, .01 uF ±10%, 100V	C5	H12
o A C304	24550-2103	Ceramic, .01 uF ±10%, 100V	D5	H12
o A C305	22057-0004	Trimmer 5-30 pF, 100V	D5	J10
o A C306	24052-0101	Dipped Mica, 100 pF ±5%, 300V	D5	J10
o A C307	21564-0034	Tantalum, 22 uF +20%, 15V	D5	K12
o A C308	24550-2103	Ceramic, .01 uF ±10%, 100V	C4	K12
o A C309	24550-2103	Ceramic, .01 uF ±10%, 100V	B3	L9
o A C310	24551-0002	Ceramic, 470 pF ±20%, 50V	A2	L11
o A C311	24551-0002	Ceramic, 470 pF ±20%, 50V	A2	L11
o A C312	24551-0002	Ceramic, 470 pF ±20%, 50V	A2	L11
o A C313	24551-0002	Ceramic, 470 pF ±20%, 50V	A3	L12
o A C314	24551-0002	Ceramic, 470 pF ±20%, 50V	A3	L12
o A C315	24551-0002	Ceramic, 470 pF ±20%, 50V	A3	L12
o A C316	24551-0002	Ceramic, 470 pF ±20%, 50V	A1	M12
o A C317	24551-0002	Ceramic, 470 pF ±20%, 50V	A2	K11
o A C318	24551-0002	Ceramic, 470 pF ±20%, 50V	A2	K11
o A C319	24551-0002	Ceramic, 470 pF ±20%, 50V	A2	K11
o A C320	24551-0002	Ceramic, 470 pF ±20%, 50V	A3	K12
o A C321	24551-0002	Ceramic, 470 pF ±20%, 50V	A3	K12
o A C322	24551-0002	Ceramic, 470 pF ±20%, 50V	A3	K12
o A C323	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C4	H7
o A C324	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C4	H7
o A C325	24550-2103	Ceramic, .01 uF ±10%, 100V	C4	H8
o A C326	24550-2103	Ceramic, .01 uF ±10%, 100V	C4	H8
o A C327	21564-0034	Tantalum, 22 uF ±20%, 15V	C4	K8
o A C328	24550-2103	Ceramic, .01 uF ±10%, 100V	C4	K9
o A C329	24551-0002	Ceramic, 470 pF ±20%, 50V	D4	K11
o A C330	24551-0002	Ceramic, 470 pF ±20%, 50V	C5	K8
o A C331	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C5	G7
o A C332	24052-0101	Dipped Mica, 100 pF ±5%, 300V	D4	H10
o A C401	21555-0026	Tantalum, 10 uF ±20%, 20V	C2	P9
o A C402	23113-0005	Met. Polyester, 1.0 uF ±5%, 100V	B2	R8
o A C403	23107-0129	Mylar, .22 uF ±10%, 63V	B2	S8
o A C404	21567-0021	Electrolytic, 150 uF +75/-10%, 50V	A2	T9
o A C405	21564-0057	Tantalum, .47 uF ±20%, 35V	A1	S9

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01385-0101G

Action: original, added, changed, deleted. / Chassis Level Code / Symbol Number	Part Number	Description	Grid Coordinates Schematic	Component Assy
		CAPACITOR		
o A C501	23109-5103	Poly Film, .01 uF ±5%, 100V	A3	H1
o A C502	23109-5103	Poly Film, .01 uF ±5%, 100V	A3	H1
o A C503	23107-0013	Poly Film, .01 uF ±5%, 100V	B3	J1
o A C504	23107-0005	Poly Film, .0022 uF ±5%, 100V	B3	J2
o A C505	23107-0005	Poly Film, .0022 uF ±5%, 100V	B3	K2
o A C506	23109-2104	Poly Film, .1 uF ±2.5%, 100V	B4	K1
o A C507	23109-2104	Poly Film, .1 uF ±2.5%, 100V	B4	K1
o A C508	21564-0059	Tantalum, 1 uF ±20%, 35V	C4	M2
o A C509	23113-0005	Met. Polyester, 1.0 uF ±5%, 100V	B5	S1
o A C510	23109-5223	Poly Film, .022 uF ±5%, 100V	A5	P3
o A C511	21564-0037	Tantalum, 68 uF ±20%, 15V	A4	R2
o A C512	21564-0036	Tantalum, 47 uF ±20%, 15V	A3	R2
o A C513	21564-0033	Tantalum, 15 uF ±20%, 15V	A3	S2
o A C514	24551-0002	Ceramic, 470 pF ±20%, 50V	A4	T1
o A C515	21564-0033	Tantalum, 15 uF ±20%, 15V	B5	S3
o A C516	21564-0131	Tantalum, 6.8 uF ±10%, 15V	B4	T3
o A C517	21564-0140	Tantalum, 1 uF ±10%, 20V	A4	T3
o A C518	24551-0002	Ceramic, 470 pF ±20%, 50V	A5	T3
o A C519	24551-0002	Ceramic, 470 pF ±20%, 50V	A6	T3
o A C520	21564-0034	Tantalum, 22 uF ±20%, 15V	C5	T4
o A C521	24551-0002	Ceramic, 470 pF ±20%, 50V	A5	T1
o A C522	23109-2104	Poly Film, .1 uF ±2.5%, 100V	C5	K2
o A C523	23109-2104	Poly Film, .1 uF ±2.5%, 100V	C5	K3
o A C524	21564-0059	Tantalum, 1 uF ±20%, 35V	C4	L4
o A C525	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C4	L3
o A C526	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C4	M4
o A C527	23109-5334	Poly Film, .33 uF ±5%, 50V	D2	L4
o A C528	24551-0002	Ceramic, 470 pF ±20%, 50V	A6	T6
o A C529	24551-0002	Ceramic, 470 pF ±20%, 50V	A6	T6
o A C530	23109-2104	Poly Film, .1 uF ±2.5%, 100V	C2	H3
o A C531	23109-2104	Poly Film, .1 uF ±2.5%, 100V	C3	H3
o A C532	23109-2154	Poly Film, .15 uF ±2.5%, 50V	C3	H5
o A C533	23109-2154	Poly Film, .15 uF ±2.5%, 50V	C2	H6
o A C534	21564-0059	Tantalum, 1 uF ±20%, 35V	C2	J3
o A C535	21564-0059	Tantalum, 1 uF ±20%, 35V	C2	J6
o A C536	23107-0031	Poly Film, .33 uF ±5%, 63V	C5	N7
o A C537	21564-0033	Tantalum, 15 uF ±20%, 15V	A6	P7
o A C538	23107-0027	Poly Film, .15 uF ±5%, 100V	B5	R5
o A C539	21564-0036	Tantalum, 47 uF ±20%, 15V	B5	T1
o A C540	24551-0002	Ceramic, 470 pF ±20%, 50V	A5	T5
o A C541	24556-0224	Ceramic, .22 uF ±20%, 25V	C3	M5
o A C542	24551-0002	Ceramic, 470 pF ±20%, 50V	A5	S1
o A C543	24551-0002	Ceramic, 470 pF ±20%, 50V	A5	T5
o A C544	24551-0002	Ceramic, 470 pF ±20%, 50V	A5	T4
o A C545	24551-0002	Ceramic, 470 pF ±20%, 50V	A5	T6
o A C546	24551-0002	Ceramic, 470 pF ±20%, 50V	A5	T1
o A C548	24551-0002	Ceramic, 470 pF ±20%, 50V	A6	T2
o A C549	24551-0002	Ceramic, 470 pF ±20%, 50V	A6	T7
o A C550	24551-0002	Ceramic, 470 pF ±20%, 50V	A6	T7
o A C551	24551-0002	Ceramic, 470 pF ±20%, 50V	A5	T8
o A C552	24551-0002	Ceramic, 470 pF ±20%, 50V	B5	T2
o A C553	21564-0036	Tantalum, 47 uF ±20%, 15V	C1	M4
o A C554	21564-0036	Tantalum, 47 uF ±20%, 15V	B4	L3
o A C601	21567-0009	Electrolytic, 100 uF +75/-10%, 50V	A4	T11
o A C602	21567-0009	Electrolytic, 100 uF +75/-10%, 50V	A6	T11
o A C603	21567-0017	Electrolytic, 47 uF +20%, 10V	B5	T12
o A C604	23107-0117	Poly Film, .022 uF ±10%, 100V	B5	S12
o A C605	21567-0010	Electrolytic, 3.3 uF ±20%, 25V	B7	R12
o A C606	21554-0070	Electrolytic, 2.0 uF +50/-10%, 250V	B6	P11
o A C607	21554-0071	Electrolytic, 500 uF +75/-10%, 16V	B6	P11
o A C608	21567-0023	Electrolytic, 330 uF +75/-10%, 35V	A7	P11
o A C609	21567-0023	Electrolytic, 330 uF +75/-10%, 35V	B5	P11
o A C610	24551-0002	Ceramic, 470 pF ±20%, 50V	A3	T11
o A C611	24551-0002	Ceramic, 470 pF ±20%, 50V	A3	T11
o A C612	24551-0002	Ceramic, 470 pF ±20%, 50V	B7	S12

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01385-0101G

Action: original, added, changed, deleted. / Chassis Level Code / Symbol Number	Part Number	Description	Grid Coordinates Schematic	Component Assy
		DIODE		
o A CR101	75027-0014	Zener, 14V ±5%, 1N4108	C7	A4
o A CR102	75025-0028	Zener, 110V ±5%, 1N5272B	C7	A5
o A CR103	75028-0001	Silicon, 1N4149	E6	B4
o A CR104	75028-0001	Silicon, 1N4149	E6	B4
o A CR105	75028-0001	Silicon, 1N4149	D3	C4
o A CR106	75028-0001	Silicon, 1N4149	E3	D4
o A CR107	75028-0001	Silicon, 1N4149	E3	D4
o A CR108	75062-0005	Silicon, 1N4005	E4	F4
o A CR109	75028-0001	Silicon, 1N4149	D2	G10
o A CR110	75216-0003	Silicon, FAST RECOVERY	E4	G4
o A CR111	75216-0003	Silicon, FAST RECOVERY	E4	G4
o A CR112	75028-0001	Silicon, 1N4149	C6	A8
o A CR113	75028-0001	Silicon, 1N4149	C6	A11
o A CR114	75028-0001	Silicon, 1N4149	C7	A9
o A CR115	75028-0001	Silicon, 1N4149	C7	C9
o A CR116	75025-0025	Zener, 6.8V ±5%, 1N4736A	D2	E11
o A CR117	75027-0004	Zener, 5.6V ±5%, 1N752A	D3	F10
o A CR118	75028-0001	Silicon, 1N4149	E2	G10
o A CR119	75028-0001	Silicon, 1N4149	D2	G10
o A CR120	75025-0007	Zener, 9.1V ±5%, 1N4739A	D2	G11
o A CR121	75028-0001	Silicon, 1N4149	E2	G11
o A CR122	75028-0001	Silicon, 1N4149	C6	A11
o A CR123	75028-0001	Silicon, 1N4149	C7	A6
o A CR124	75028-0001	Silicon, 1N4149	C7	A6
o A CR125	75028-0001	Silicon, 1N4149	C7	B6
o A CR126	75018-0001	Silicon, 1N4149	C7	B6
o A CR127	75028-0001	Silicon, 1N4149	C7	B6
o A CR301	75062-0005	Silicon, 1N4005	B2	M11
o A CR501	75028-0001	Silicon, 1N4149	B4	M2
o A CR502	75028-0001	Silicon, 1N4149	C3	N3
o A CR503	75028-0001	Silicon, 1N4149	C2	N3
o A CR504	75028-0001	Silicon, 1N4149	C4	L4
o A CR505	75028-0001	Silicon, 1N4149	C4	P6
o A CR506	75028-0001	Silicon, 1N4149	C3	K4
o A CR507	75036-0003	Silicon, Multi-Pellet	C3	L2
o A CR508	75028-0001	Silicon, 1N4149	C2	J3
o A CR509	75028-0001	Silicon, 1N4149	D2	J3
o A CR510	75028-0001	Silicon, 1N4149	D2	J5
o A CR511	75028-0001	Silicon, 1N4149	B2	J5
o A CR512	75028-0001	Silicon, 1N4149	C4	M4
o A CR513	75028-0001	Silicon, 1N4149	C5	N7
o A CR514	75028-0001	Silicon, 1N4149	C4	N6
o A CR515	75028-0001	Silicon, 1N4149	A4	N8
o A CR601	75028-0001	Silicon, 1N4149	C6	T13
o A CR602	75220-3610	Zener, 36V	B7	S11
o A CR603	75062-0007	Silicon, 1N4007	A6	P10
o A CR604	75036-0001	Multi-Pellet	B5	P10
o A CR605	75216-0003	Silicon, FAST RECOVERY	A6	P11
o A CR606	75224-0001	Rectifier, Hot Carrier 1N5817	A7	P11
o A CR607	75025-0000	Zener, 18V ±5%, 1N4746A	A6	N11
o A CR608	75025-0015	Zener, 6.2V ±5%, 1N4735A	A5	N12
o A DS101	50226-0001	DISPLAY, Gas Discharge		D1
		FUSE		
o A F601	66516-0010	Sub miniature, Axial Leads 1/2 Amp	B6	P11
o A F602	66516-0010	Sub miniature, Axial Leads 1/2 Amp	B6	P12
		CONNECTOR		
o A J101	50231-0001	Display, 31 contacts	F6	B1
o A J102		Rear Connectors Part of Main PC Board	A3	M13
o A J103		Rear Connectors Part of Main PC Board	A6	U1
		INDUCTOR		
o A L401	11488-0003	Adjustable (IDENT)	B2	R7
o A L601	11487-0001	Choke, Filter (Input)	A5	T10

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01385-0101G

Action: original, added, changed, deleted. / Chassis Level Code / Symbol Number	Part Number	Description	Grid Coordinates Schematic	Component Assy
		TRANSISTOR		
o A Q301	75661-0002	FET	D4	H10
o A Q401	75658-0003	NPN 92PU01A	A2	S7
o A Q402	75658-0004	PNP, 92PI51A	A2	T8
o A Q501	75561-0036	Silicon, NPN, 2N4124	C2	N3
o A Q502	75561-0036	Silicon, NPN, 2N4124	C2	N4
o A Q601	75688-0003	Audio Power, NPN, 2N6718	B5	R11
o A Q602	75812-0004	Silicon, Power NPN, D44H8	B7	R12
o A Q603	75676-0003	High Voltage PNP, MPSA92	B5	P10
		RESISTOR		
o A R101	31218-0125	Carbon Film, 1.2 Meg ±5%, 1/4W	E7	A1
o A R102	31218-0125	Carbon Film, 1.2 Meg ±5%, 1/4W	E7	A2
o A R103	31218-0273	Carbon Film, 27K ±5%, 1/4W	E6	A3
o A R104	31199-0343	Precision Film, 27.4K ±1%, 1/4W	E6	A5
o A R106	31218-0563	Carbon Film, 56K ±5%, 1/4W	F6	A5
o A R107	31218-0224	Carbon Film, 220K ±5%, 1/4W	E6	A1
o A R108	31218-0224	Carbon Film, 220K ±5%, 1/4W	E6	A1
o A R109	31218-0224	Carbon Film, 220K ±5%, 1/4W	E6	A1
o A R110	31218-0224	Carbon Film, 220K ±5%, 1/4W	E6	A1
o A R111	31218-0224	Carbon Film, 220K ±5%, 1/4W	E6	A2
o A R112	31218-0224	Carbon Film, 220K ±5%, 1/4W	E6	A2
o A R113	31218-0224	Carbon Film, 220K ±5%, 1/4W	E6	A2
o A R114	31218-0224	Carbon Film, 220K ±5%, 1/4W	E5	A2
o A R115	31218-0472	Carbon Film, 4.7K ±5%, 1/4W	D2	A5
o A R116	31218-0472	Carbon Film, 4.7K ±5%, 1/4W	D2	A5
o A R117	31218-0103	Carbon Film, 10K ±10%, 1/4W	E5	B5
o A R118	31218-0103	Carbon Film, 10K ±10%, 1/4W	E5	B5
o A R119	31218-0222	Carbon Film, 2.2K ±5%, 1/4W	D3	B3
o A R120	32054-0003	Variable Trimmer, 4.7K	F2	B2
o A R121	31217-0001	Photocell	F7	C2
o A R122	31218-0223	Carbon Film, 22K ±5%, 1/4W	F2	C3
o A R123	31218-0562	Carbon Film, 5.6K ±5%, 1/4W	D3	B3
o A R124	31218-0273	Carbon Film, 27K ±5%, 1/4W	E3	C3
o A R125	31218-0823	Carbon Film, 82K ±5%, 1/4W	D3	C4
o A R126	31218-0153	Carbon Film, 15K ±5%, 1/4W	E3	C4
o A R127	31218-0823	Carbon Film, 82K ±5%, 1/4W	E3	C3
o A R128	31218-0224	Carbon Film, 220K ±5%, 1/4W	E3	D2
o A R129	31218-0683	Carbon Film, 68K ±5%, 1/4W	E3	D2
o A R130	31218-0224	Carbon Film, 220K ±5%, 1/4W	E3	D2
o A R131	31218-0683	Carbon Film, 68K ±5%, 1/4W	E3	D3
o A R132	31199-0205	Precision Film, 1.1K ±1%, 1/4W	E3	D2
o A R133	31218-0224	Carbon Film, 220K ±5%, 1/4W	E3	D3
o A R134	31218-0683	Carbon Film, 68K ±5%, 1/4W	E3	D3
o A R135	31218-0224	Carbon Film, 220K ±5%, 1/4W	E3	D4
o A R136	31199-0205	Precision Film, 1.1K ±1%, 1/4W	E3	D4
o A R137	31218-0683	Carbon Film, 68K ±5%, 1/4W	E3	D4
o A R139	31218-0125	Carbon Film, 1.2 Meg ±5%, 1/4W	E5	F3
o A R140	31218-0125	Carbon Film, 1.2 Meg ±5%, 1/4W	F6	F3
o A R141	31218-0125	Carbon Film, 1.2 Meg ±5%, 1/4W	E5	F4
o A R142	31218-0125	Carbon Film, 1.2 Meg ±5%, 1/4W	E7	G1
o A R143	31218-0125	Carbon Film, 1.2 Meg ±5%, 1/4W	E7	G1
o A R144	31218-0183	Carbon Film, 18K ±5%, 1/4W	C6	A8
o A R145	31218-0303	Carbon Film, 30K ±5%, 1/4W	C7	B9
o A R146	31218-0333	Carbon Film, 33K ±5%, 1/4W	C6	A8
o A R147	31218-0103	Carbon Film, 10K ±5%, 1/4W	C7	A11
o A R148	31218-0103	Carbon Film, 10K ±5%, 1/4W	D7	A9
o A R149	31218-0103	Carbon Film, 10K ±5%, 1/4W	C7	A9
o A R150	31218-0104	Carbon Film, 100K ±5%, 1/4W	C7	C8
o A R152	31218-0103	Carbon Film, 10K ±5%, 1/4W	D6	C9
o A R153	31218-0124	Carbon Film, 120K ±5%, 1/4W	D3	D9
o A R154	31218-0472	Carbon Film, 4.7K ±5%, 1/4W	D2	D10
o A R155	31218-0471	Carbon Film, 470 ±5%, 1/4W	D2	E11
o A R156	31218-0681	Carbon Film, 680 ±5%, 1/4W	D2	E11
o A R157	31218-0333	Carbon Film, 33K ±5%, 1/4W	D3	E10
o A R158	31218-0562	Carbon Film, 5.6K ±5%, 1/4W	E2	F10
o A R159	31218-0563	Carbon Film, 56K ±5%, 1/4W	D2	F9
o A R160	31218-0104	Carbon Film, 100K ±5%, 1/4W	D2	F10
o A R161	31218-0104	Carbon Film, 100K ±5%, 1/4W	E1	F10

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01385-0101G

Action	Chassis Level Code	Symbol Number	Part Number	Description	Grid Coordinates Schematic	Grid Coordinates Component Assy
				RESISTOR		
o	A	R162	31218-0105	Carbon Film, 1 Meg ±5%, 1/4W	D3	G11
o	A	R163	31218-0104	Carbon Film, 100K ±5%, 1/4W	D2	G11
o	A	R164	31218-0333	Carbon Film, 33K ±5%, 1/4W	E2	G11
o	A	R166	31218-0183	Carbon Film, 18K ±5%, 1/4W	C5	B7
o	A	R167	31218-0333	Carbon Film, 33K ±5%, 1/4W	C5	B8
o	A	R168	31218-0472	Carbon Film, 4.7K ±5%, 1/4W	C5	A6
o	A	R169	31218-0913	Carbon Film, 91K ±5%, 1/4W	C7	A7
o	A	R170	31218-0513	Carbon Film, 51K ±5%, 1/4W	C7	B6
o	A	R171	31218-0913	Carbon Film, 91K ±5%, 1/4W	C6	C6
o	A	R172	31199-0366	Precision Film, 47.5K ±1%, 1/4W	C7	C7
o	A	R173	31199-0401	Precision Film, 100K ±1%, 1/4W	C7	C7
o	A	R174	32070-0005	Variable, 1K, w/SPST Switch	F3	P10
o	A	R175	31218-0105	Carbon Film, 1 Meg ±5%, 1/4W	E6	B4
o	A	R176	31218-0105	Carbon Film, 1 Meg ±5%, 1/4W	E6	B4
o	A	R301	31218-0471	Carbon Film, 470 ±5%, 1/4W	D5	J10
o	A	R302	31218-0123	Carbon Film, 12K ±5%, 1/4W	D3	J12
o	A	R303	31218-0123	Carbon Film, 12K ±5%, 1/4W	D4	J12
o	A	R304	31218-0123	Carbon Film, 12K ±5%, 1/4W	D4	K12
o	A	R305	31218-0103	Carbon Film, 10K ±5%, 1/4W	B3	M10
o	A	R306	31218-0473	Carbon Film, 47K ±5%, 1/4W	B2	M11
o	A	R307	31218-0123	Carbon Film, 12K ±5%, 1/4W	D4	J9
o	A	R308	31218-0123	Carbon Film, 12K ±5%, 1/4W	D4	J9
o	A	R309	31218-0123	Carbon Film, 12K ±5%, 1/4W	C4	K8
o	A	R310	31218-0101	Carbon Film, 100 ±5%, 1/4W	D4	K11
o	A	R311	31218-0101	Carbon Film, 100 ±5%, 1/4W	C4	K8
o	A	R312	31218-0471	Carbon Film, 470 ±5%, 1/4W	D4	H10
o	A	R401	31218-0102	Carbon Film, 1K ±5%, 1/4W	C2	R9
o	A	R402	31218-0104	Carbon Film, 100K ±5%, 1/4W	C2	R8
o	A	R403	31218-0103	Carbon Film, 10K ±5%, 1/4W	C2	R9
o	A	R404	31218-0103	Carbon Film, 10K ±5%, 1/4W	C2	S8
o	A	R405	31218-0271	Carbon Film, 270 ±5%, 1/4W	B2	S7
o	A	R406	31218-0223	Carbon Film, 22K ±5%, 1/4W	B2	S8
o	A	R407	31218-0474	Carbon Film, 470K ±5%, 1/4W	B2	S7
o	A	R408	31218-0473	Carbon Film, 47K ±5%, 1/4W	A2	S9
o	A	R409	31218-0102	Carbon Film, 1K ±5%, 1/4W	A2	S8
o	A	R501	31218-0472	Carbon Film, 4.7K ±5%, 1/4W	A3	H1
o	A	R502	31199-0089	Precision Film, 82.5 ±1%, 1/4W	B3	H2
o	A	R503	31218-0333	Carbon Film, 33K ±5%, 1/4W	B3	H2
o	A	R504	31199-0349	Precision Film, 31.6K ±1%, 1/4W	B3	H1
o	A	R505	31218-0154	Carbon Film, 150K ±5%, 1/4W	B4	J2
o	A	R506	31218-0753	Carbon Film, 75K ±5%, 1/4W	B4	J2
o	A	R507	32054-0011	Variable Trimmer, 100K	B4	K2
o	A	R508	31218-0154	Carbon Film, 150K ±5%, 1/4W	B3	J2
o	A	R509	31218-0333	Carbon Film, 33K ±5%, 1/4W	B4	K1
o	A	R510	31199-0278	Precision Film, 6.34K ±1%, 1/4W	B4	K1
o	A	R511	32091-0105	Variable, 2K	F2	K2
o	A	R512	31199-0465	Precision Film, 464K ±1%, 1/4W	B4	K1
o	A	R513	31218-0474	Carbon Film, 470K ±5%, 1/4W	B4	K2
o	A	R514	31218-0122	Carbon Film, 1.2K ±5%, 1/4W	A5	L1
o	A	R515	31218-0473	Carbon Film, 47K ±5%, 1/4W	B4	M2
o	A	R516	31218-0105	Carbon Film, 1 Meg ±5%, 1/4W	C3	M2
o	A	R517	31218-0333	Carbon Film, 33K ±5%, 1/4W	A5	R1
o	A	R518	31199-0465	Precision Film, 464K ±1%, 1/4W	A5	R1
o	A	R519	31199-0433	Precision Film, 215K ±1%, 1/4W	A5	N3
o	A	R520	32054-0006	Variable Trimmer, 47K	A5	N2
o	A	R521	31218-0473	Carbon Film, 47K ±5%, 1/4W	C3	N2
o	A	R522	31199-0465	Precision Film 464K ±1%, 1/4W	A5	P1
o	A	R523	32054-0012	Variable Trimmer, 100K	B4	P2
o	A	R524	31218-0124	Carbon Film, 120K ±5%, 1/4W	C2	N3
o	A	R525	31218-0103	Carbon Film, 10K ±5%, 1/4W	B4	R2
o	A	R526	31218-0223	Carbon Film, 22K ±5%, 1/4W	B3	R2
o	A	R527	31199-0359	Precision Film, 40.2K ±1%, 1/4W	B4	R3
o	A	R528	31199-0434	Precision Film, 221K ±1%, 1/4W	B4	S3
o	A	R529	31218-0513	Carbon Film, 51K ±5%, 1/4W	A4	S2
o	A	R530	31218-0513	Carbon Film, 51K ±5%, 1/4W	A4	S2
o	A	R531	31218-0222	Carbon Film, 2.2K ±5%, 1/4W	A4	S5
o	A	R532	32054-0002	Variable, 470	A4	R6
o	A	R533	31218-0222	Carbon Film, 2.2K ±5%, 1/4W	A4	S6

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01385-0101G

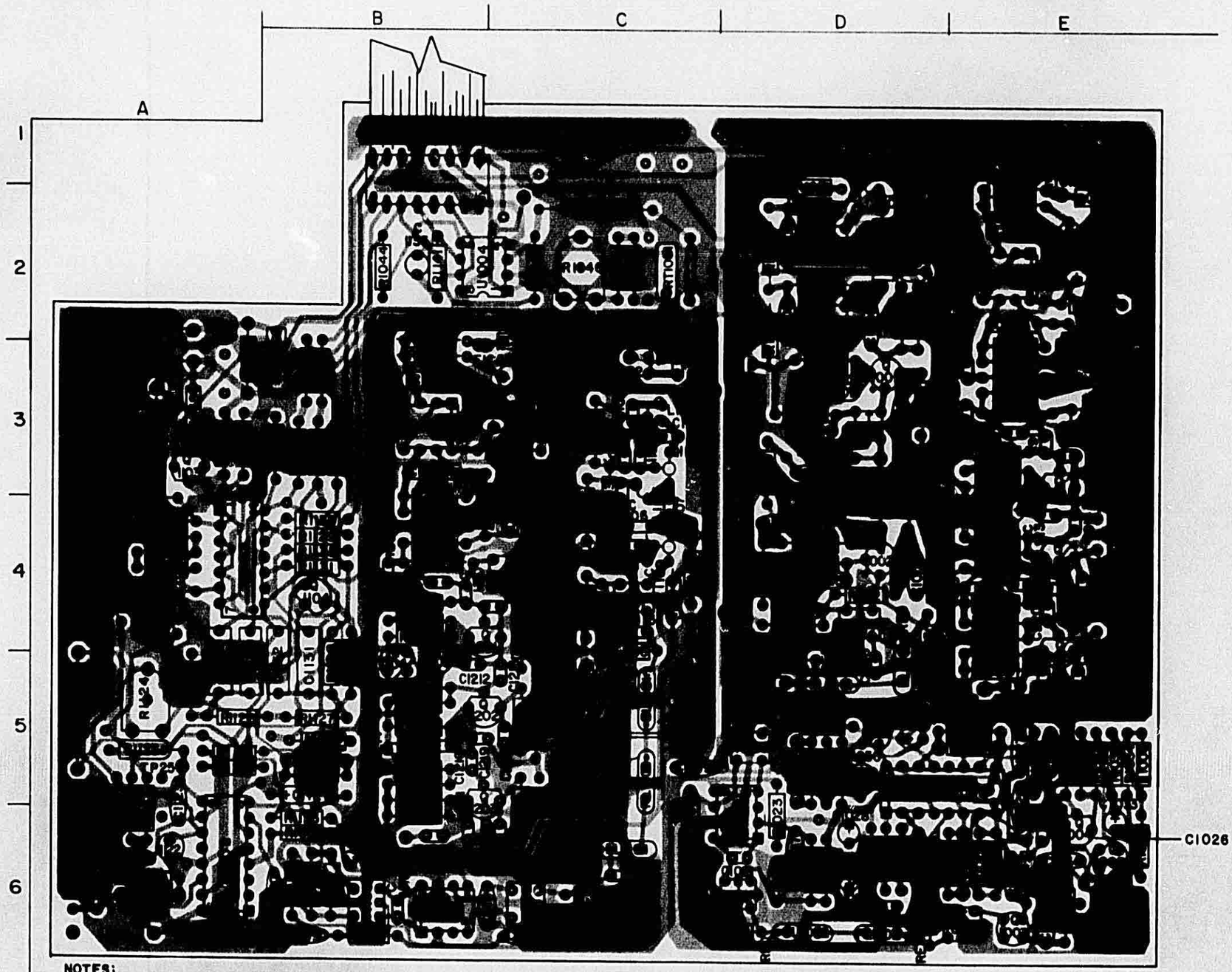
Action	Chassis Level Code	Symbol Number	Part Number	Description	Grid Coordinates Schematic	Grid Coordinates Component Assy
				RESISTOR		
o	A	R535	31199-0418	Precision Film, 150K ±1%, 1/4W	B5	S3
o	A	R536	31199-0312	Precision Film, 13K ±1%, 1/4W	A5	S3
o	A	R537	31199-0442	Precision Film, 267K ±1%, 1/4W	C5	T2
o	A	R538	31218-0274	Carbon Film, 270K ±5%, 1/4W	A4	T3
o	A	R539	31199-0354	Precision Film, 36.7K ±1%, 1/4W	B4	R4
o	A	R540	31199-0385	Precision Film, 75K ±1%, 1/4W	B5	R4
o	A	R541	31199-0385	Precision Film, 75K ±1%, 1/4W	B4	R4
o	A	R542	31218-0623	Carbon Film, 62K ±5%, 1/4W	B5	S4
o	A	R543	31218-0682	Carbon Film, 6.8K ±5%, 1/4W	B5	T5
o	A	R544	31218-0682	Carbon Film, 6.8K ±5%, 1/4W	B5	T4
o	A	R545	31218-0223	Carbon Film, 22K ±5%, 1/4W	A5	S6
o	A	R546	31218-0683	Carbon Film, 68K ±5%, 1/4W	B4	K2
o	A	R547	31199-0288	Precision Film, 8.06K ±1%, 1/4W	C5	K3
o	A	R548	31199-0458	Precision Film, 392K ±1%, 1/4W	C5	K2
o	A	R549	31218-0394	Carbon Film, 390K ±5%, 1/4W	C5	K3
o	A	R550	31218-0123	Carbon Film, 12K ±5%, 1/4W	C4	L2
o	A	R551	31218-0123	Carbon Film, 12K ±5%, 1/4W	C5	L3
o	A	R552	31218-0183	Carbon Film, 18K ±5%, 1/4W	C4	L4
o	A	R553	31218-0105	Carbon Film, 1 Meg ±5%, 1/4W	C4	L4
o	A	R554	31218-0224	Carbon Film, 220K ±5%, 1/4W	C4	L3
o	A	R555	31218-0472	Carbon Film, 4.7K ±5%, 1/4W	C4	L2
o	A	R556	31218-0332	Carbon Film, 3.3K ±5%, 1/4W	C3	L4
o	A	R557	31218-0473	Carbon Film, 47K ±5%, 1/4W	C2	N5
o	A	R558	31218-0332	Carbon Film, 3.3K ±5%, 1/4W	C2	N4
o	A	R559	32091-0108	Variable, 20K	F2	M3
o	A	R560	31218-0224	Carbon Film, 220K ±5%, 1/4W	C3	M4
o	A	R561	31218-0123	Carbon Film, 12K ±5%, 1/4W	C3	M5
o	A	R562	31218-0473	Carbon Film, 47K ±5%, 1/4W	C3	N4
o	A	R563	31218-0333	Carbon Film, 33K ±5%, 1/4W	C5	N3
o	A	R564	31199-0241	Precision Film, 2.61K ±1%, 1/4W	C3	H3
o	A	R565	31199-0268	Precision Film, 4.99K ±1%, 1/4W	C3	H4
o	A	R566	32054-0004	Variable Trimmer, 4.7K	C3	H4
o	A	R567	31199-0274	Precision Film, 5.76K ±1%, 1/4W	C3	H5
o	A	R568	31199-0246	Precision Film, 2.94K ±1%, 1/4W	C3	H5
o	A	R569	31199-0378	Precision Film, 63.4K ±1%, 1/4W	C3	H3
o	A	R570	31218-0623	Carbon Film, 62K ±5%, 1/4W	B3	H4
o	A	R571	31218-0683	Carbon Film, 68K ±5%, 1/4W	C3	H4
o	A	R572	31199-0381	Precision Film, 68.1K ±1%, 1/4W	B3	H5
o	A	R573	31218-0473	Carbon Film, 47K ±5%, 1/4W	D2	J3
o	A	R574	31218-0473	Carbon Film, 47K ±5%, 1/4W	D2	J5
o	A	R575	32091-0108	Variable, 20K	F2	J4
o	A	R576	31218-0103	Carbon Film, 10K ±5%, 1/4W	C2	J3
o	A	R577	31218-0105	Carbon Film, 1 Meg ±5%, 1/4W	C2	J3
o	A	R578	31218-0103	Carbon Film, 10K ±5%, 1/4W	C2	J5
o	A	R579	31218-0105	Carbon Film, 1 Meg ±5%, 1/4W	C2	J6
o	A	R580	31218-0753	Carbon Film, 75K ±5%, 1/4W	B3	K3
o	A	R581	31218-0223	Carbon Film, 22K ±5%, 1/4W	A5	S6
o	A	R582	32054-0002	Variable Trimmer, 470	A4	S5
o	A	R584	31218-0223	Carbon Film, 22K ±5%, 1/4W	B3	T7
o	A	R585	31218-0123	Carbon Film, 12K ±5%, 1/4W	D2	M4
o	A	R586	31218-0222	Carbon Film, 2.2K ±5%, 1/4W	D2	L2
o	A	R587	31218-0220	Carbon Film, 22 ±5%, 1/4W	A5	S5
o	A	R588	31218-0220	Carbon Film, 22 ±5%, 1/4W	A5	S6
o	A	R589	31218-0105	Carbon Film, 1 Meg ±5%, 1/4W	C4	L4
o	A	R590	31218-0683	Carbon Film, 68K ±5%, 1/4W	C2	K6
o	A	R591	31218-0183	Carbon Film, 18K ±5%, 1/4W	C3	L3
o	A	R592	31218-0183	Carbon Film, 18K ±5%, 1/4W	C3	M3
o	A	R593	31218-0104	Carbon Film, 100K ±5%, 1/4W	C3	E8
o	A	R594	31218-0470	Carbon Film, 47K ±5%, 1/4W	A6	S1
o	A	R595	31218-0123	Carbon Film, 12K ±5%, 1/4W	C3	M4
o	A	R601	31218-0101	Carbon Film, 100 ±5%, 1/4W	C6	S11
o	A	R602	31218-0392	Carbon Film, 3.9K ±5%, 1/4W	B6	T11
o	A	R603	31218-0392	Carbon Film, 3.9K ±5%, 1/4W	C5	T11
o	A	R604	31199-0259	Precision Film, 4.02K ±1%, 1/4W	B6	T12
o	A	R605	31199-0259	Precision Film, 4.02K ±1%, 1/4W	B6	T12
o	A	R606	31218-0272	Carbon Film, 2.7K ±5%, 1/4W	B6	S12
o	A	R607	31218-0471	Carbon Film, 470 ±5%, 1/4W	B6	R11
o	A	R608	31218-0150	Carbon Film, 15 ±5%, 1/4W	B7	R12
o	A	R609	31149-0120	Carbon, 12 ±5%, 1/2W	B6	R11
o	A	R610	31230-0002	Beryllium Oxide, 105 ±3%, 2W	B6	R12

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01385-0101G

Action	Chassis Level Code	Symbol Number	Part Number	Description	Grid Coordinates Schematic	Grid Coordinates Component Assy
				RESISTOR		
o	A	R611	31218-0270	Carbon Film, 27 ±5%, 1/4W	B5	P10
o	A	R612	31218-0224	Carbon Film, 220K ±5%, 1/4W	B5	P11
o	A	R613	31218-0124	Carbon Film, 120K ±5%, 1/4W	B6	P12
o	A	R614	31199-0259	Precision Film, 4.02K ±1%, 1/4W	B6	P11
o	A	R615	31199-0259	Precision Film, 4.02K ±1%, 1/4W	B6	P12
o	A	R1136	32091-0108	Variable, 20K	F2	N8
o	A	RP101	30002-0001	S.I.P. 2 Meg	E4	N1
				SWITCH		
o	A	SW101	61659-0001	Incremental Frequency	E2	C7
o	A	SW102	61556-0001	Snap Action, SPDT (XFR)	E2	C7
o	A	SW103	61497-0009	Toggle SPDT, (Freq-To-From)	F3	C8
o	A	SW104	61646-0001	SPDT, Slide, Right Angle	F3	P9
o	A	T601	11937-0001	TRANSFORMER, DC to DC Converter	A6	R10
				IC		
o	A	U101	74216-0001	UDN6184A	E6	A3
o	A	U102	74226-0001	4022	E6	A4
o	A	U103	74223-0001	ULN2047A	D3	
o	A	U103A				B6
o	A	U103B				D11
o	A	U104	74105-0001	3403	E3	
o	A	U104A				B4
o	A	U104B				C4
o	A	U104C				D2
o	A	U104D				D4
o	A	U105	74110-0002	4050	E6	
o	A	U105A				C4
o	A	U105B				C8
o	A	U105C				C9
o	A	U105D				C9
o	A	U105E				E8
o	A	U105F				C8
o	A	U106	74231-0001	DS8884A	E4	E4
o	A	U107	74220-0001	TND905	E5	F2
o	A	U108	74222-0001	DS8880	E5	G4
o	A	U109	74086-0001	4013	C6	
o	A	U109A				B9
o	A	U109B				B8
o	A	U110	74169-0001	MC14021BCP	D6	A11
o	A	U111	74169-0001	MC14021BCP	D6	B11
o	A	U112	74171-0001	MC14040B	D6	B10
o	A	U113	74171-0001	MC14040B	C6	B7
o	A	U114	74119-0001	4046	C6	C7
o	A	U115	74240-0001	MK3870 (Microprocessor)	D4	D7
o	A	U116	74091-0001	4081B	D4	
o	A	U116A				B8
o	A	U116B				E9
o	A	U116C				E10
o	A	U116D				E10
o	A	U117	74172-0001	MC14006B	D6	C10
o	A	U301	74221-0001	MC3393F	D5	H11
o	A	U302	74228-0001	MC1451/6	D4	J11
o	A	U303	74116-0001	4015	B3	L8
o	A	U304	74116-0001	4015	B2	M8
o	A	U305	74101-0001	MC14502	B3	K10
o	A	U306	74101-0001	MC14502	B2	L10
o	A	U307	74223-0001	ULN2047A	A2	L10
o	A	U308	74223-0001	ULN2047A	A3	L10
o	A	U309	74221-0001	MC3303P	C4	H8
o	A	U310	74228-0001	MC145156	C5	J8

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01385-0101G

Action	Chassis Level Code	Symbol Number	Part Number	Description	Grid Coordinates Schematic	Grid Coordinates Component Assy
				IC		
o	A	U401	74072-0002	CD4066	C2	
o	A	U401A				R9
o	A	U401B				R9
o	A	U401C				R9
o	A	U401D				S9
o	A	U402	74229-0001	TL081CP	A2	
o	A	U402A				S8
o	A	U501	74230-0001	TL082CP	B3	
o	A	U501A				R5
o	A	U501B				H2
o	A	U502	74105-0001	3403	C5	
o	A	U502A				R4
o	A	U502B				T5
o	A	U502C				P6
o	A	U502D				L2
o	A	U503	74105-0001	3403	B4	
o	A	U503A				S2
o	A	U503B				L2
o	A	U503C				P2
o	A	U503D				T3
o	A	U504	74232-0001	MC3405	C3	
o	A	U504A				J3
o	A	U504B				J5
o	A	U504C				H4
o	A	U504D				H5
o	A	U505	74072-0002	CD4066	B5	
o	A	U505A				R2
o	A	U505B				R4
o	A	U505C				R2
o	A	U505D				S5
o	A	U506	74092-0001	339	C4	
o	A	U506A				L2
o	A	U506B				L4
o	A	U506C				M5
o	A	U506D				N2
o	A	U507	74119-0001	4046	B3	J2
o	A	U601	74225-0001	LM3524	B7	S11
				CRYSTAL		
o	A	Y301	72041-0001	3.200 MHz	D5	S11



NOTES:
1. ▭ INDICATES DIODE, CR OMITTED FOR CLARITY. BAR INDICATES CATHODE END.

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.

Dwg. No. C-50269-C

FIGURE 6-3. NAV 824/825 RECEIVER (sheet 1 of 2)
(NAV 825 SHOWN)

SEE BLOW-UP

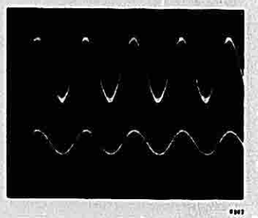
◇34

GND

TP24 and U1002-9

X10 Probe
AC Coupled
Internal Positive Probe

GND Frequency 115.50 MHz
500 uv RF Level
Standard Omni Signal

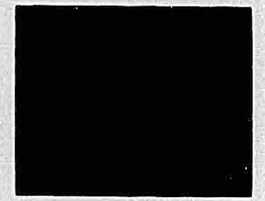


◇35

Q1004 Base and CR1006 Cathode

X10 Probe
AC Coupled
GND Internal Positive Sync

1020 Hz IDENT at 30% Mod
30 Hz and 9960 Hz Signals
GND turned OFF



◇36

U1102-9 and U1102-15

X10 Probe
GND AC Coupled
Internal Positive Sync

110.30 MHz Active Frequency
GND 500 uv RF Level

◇37

E1104

X10 Probe
DC Coupled
Internal Positive Sync

Frequency 115.50 MHz
Modulation: 1020 Hz only
30% Amplitude

GND

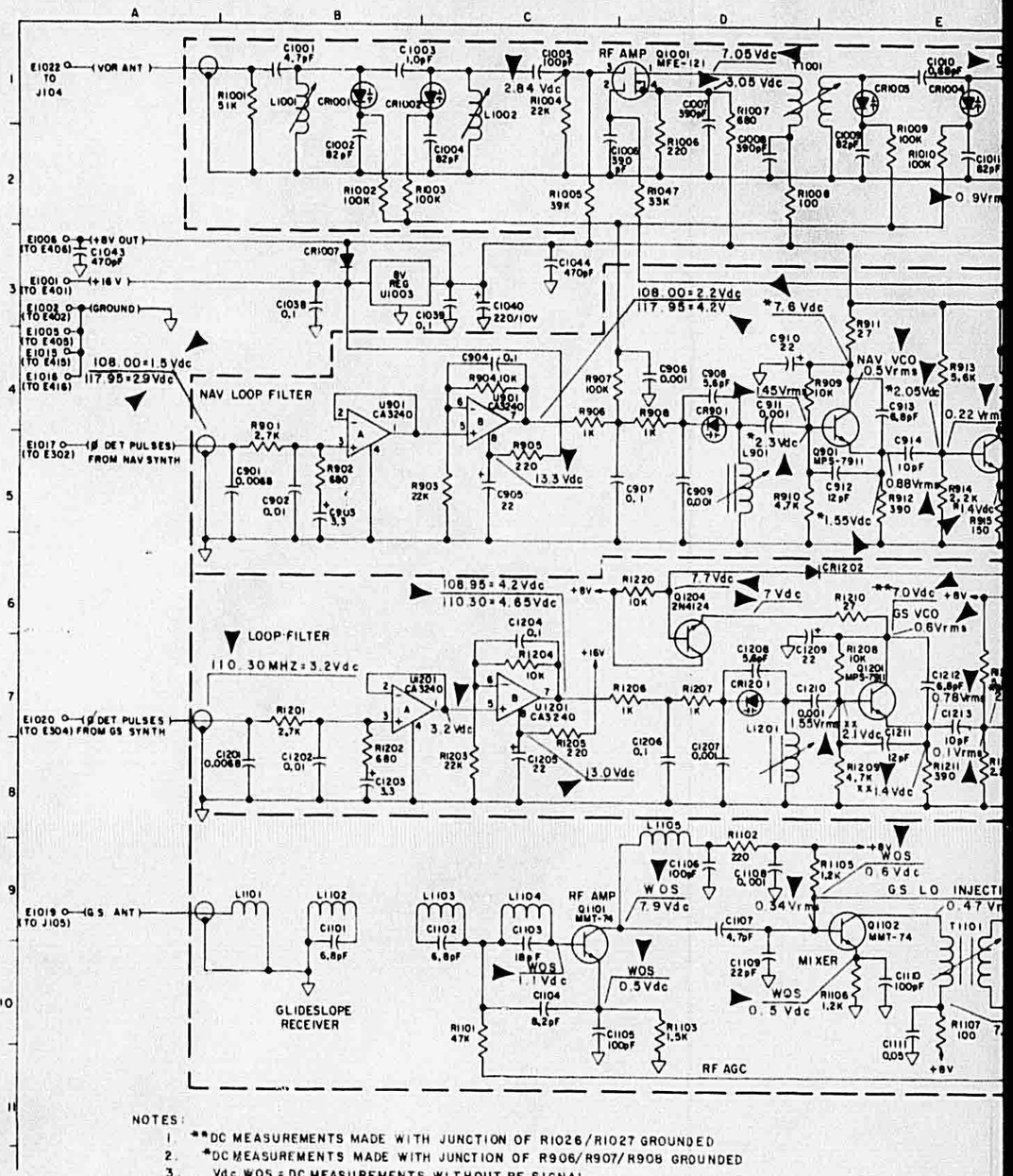
◇38

GND

TP24 and U1002-9

X10 Probe
AC Coupled
Internal Positive Sync

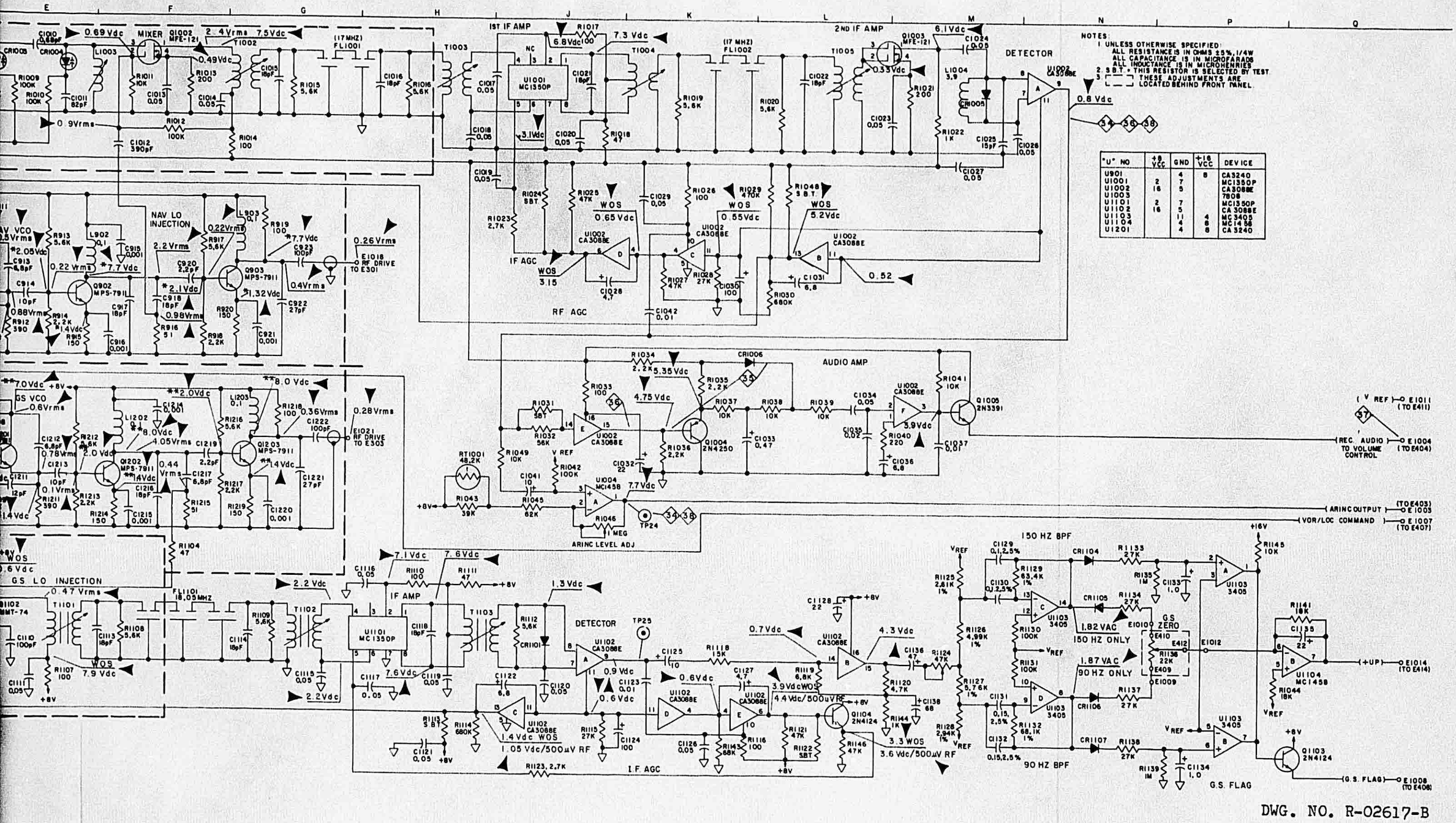
Frequency 110.50 MHz
GND 500 uv
Standard Localizer Signal
on Center



NOTES:

1. **DC MEASUREMENTS MADE WITH JUNCTION OF R1026/R1027 GROUNDED
2. *DC MEASUREMENTS MADE WITH JUNCTION OF R906/R907/R908 GROUNDED
3. Vdc WOS = DC MEASUREMENTS WITHOUT RF SIGNAL
4. Vrms MEASUREMENTS MADE WITH A RCA SENIOR VOLT OHYMST USING A RCA WG 3014 CRYSTAL DIODE PROBE.
   NAV SYNTH Vrms MEASUREMENTS MADE AT 108.00 MHZ.
   GS SYNTH Vrms MEASUREMENTS MADE AT 108.95 MHZ.
5. ◇# WAVEFORM NUMBER.

SEE BLOW-UP



DWG. NO. R-02617-B

FIGURE 6-3. NAV 824/825 RECEIVER (sheet 2 of 2)
(NAV 825 SHOWN)

SEE BLOW-UP

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01384-0101/0102G

Action: original, added, changed, deleted. / Chassis Level Code / Symbol Number	Part Number	Description	Grid Coordinates Schematic	Component Assy
CAPACITOR				
o A C901	23107-0111	Poly Film, .0068 uF ±10%, 100V	E2	B5
o A C902	23107-0113	Poly Film, .01 uF ±10%, 100V	E2	B5
o A C903	21564-0029	Tantalum, 3.3 uF ±20%, 15V	E2	B5
o A C904	23107-0125	Poly Film, .1 uF ±10%, 100V	E2	C4
o A C905	21564-0034	Tantalum, 22 uF ±20%, 15V	E2	C5
o A C906	24551-0003	Ceramic, .001 uF +100/-0%, 50V	E3	D4
o A C907	23107-0125	Poly Film, .1 uF ±10%, 100V	E3	D5
o A C908	24552-1589	Ceramic, 5.6 pF ±.5 pF, 50V, NPO	E3	D4
o A C909	24551-0003	Ceramic, .001 uF,+100/-0%, 50V	E3	D5
o A C910	21564-0034	Tantalum, 22 uF ±20%, 15V	E4	D4
o A C911	24551-0003	Ceramic, .001 uF +100/-0%, 50V	E3	D4
o A C912	24552-1120	Ceramic, 12 pF ±10%, 50V, NPO	E3	E5
o A C913	24552-1689	Ceramic, 6.8 pF ±.5 pF, 50V, NPO	E4	E4
o A C914	24552-1100	Ceramic, 10 pF ±10%, 50V, NPO	E4	E4
o A C915	24551-0003	Ceramic, .001 uF +100/-0%, 50V	E4	F4
o A C916	24551-0003	Ceramic, .001 uF +100/-0%, 50V	E4	F5
o A C917	24552-1180	Ceramic, 18 pF ±10%, 50V, NPO	E4	F5
o A C918	24552-1180	Ceramic, 18 pF ±10%, 50V, NPO	E4	F5
o A C920	24552-1229	Ceramic, 2.2 pF ±.5 pF, 50V, NPO	E4	F4
o A C921	24551-0003	Ceramic, .001 uF +100/-0%, 50V	E5	G5
o A C922	24552-1270	Ceramic, 27 pF ±10%, 50V, NPO	E5	G5
o A C923	24551-0001	Ceramic, 100 pF ±20%, 50V	E5	G4
o A C1001	24516-0479	Ceramic Disc, 4.7 pF ±.5 pF, 500V	D1	B1
o A C1002	24552-1820	Ceramic, 82 pF ±10%, 50V, NPO	D2	B2
o A C1003	24509-0109	Ceramic, 1 pF ±5%, 500V	D2	B1
o A C1004	24552-1820	Ceramic, 82 pF ±10%, 50V, NPO	D2	C2
o A C1005	21201-0027	Ceramic Disc, 100 pF ±10%, 500V	D2	C1
o A C1006	21291-0031	Ceramic Disc, 390 pF ±10%, 500V	D3	C2
o A C1007	21291-0031	Ceramic Disc, 390 pF ±10%, 500V	D3	D1
o A C1008	21291-0031	Ceramic Disc, 390 pF ±10%, 500V	D3	D2
o A C1009	24552-1820	Ceramic, 82 pF ±10%, 50V, NPO	D3	E2
o A C1010	24509-0688	Ceramic, .68 pF ±5%, 500V	D4	E1
o A C1011	24552-1820	Ceramic, 82 pF ±10%, 50V, NPO	D4	E2
o A C1012	21291-0031	Ceramic Disc, 390 pF ±10%, 500V	D4	F2
o A C1013	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	D4	F2
o A C1014	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	D4	F2
o A C1015	24552-7180	Ceramic, 18 pF ±10%, 50V, NPO	D5	G1
o A C1016	24552-7180	Ceramic, 18 pF ±10%, 50V, NPO	D5	H1
o A C1017	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	D6	H1
o A C1018	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	C6	H2
o A C1019	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	C5	H3
o A C1020	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	D6	J2
o A C1021	24552-7180	Ceramic, 18 pF ±10%, 50V, NPO	D6	J1
o A C1022	24552-7180	Ceramic, 18 pF ±10%, 50V, NPO	D6	L1
o A C1023	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	E6	L2
o A C1024	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	E6	M1
o A C1025	24052-0150	Dipped Mica, 15 pF ±1 pF, 500V	E5	M2
o A C1026	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	E6	M2
o A C1027	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	E5	M3
o A C1028	21564-0102	Tantalum, 4.7 uF ±10%, 6V	D6	J4
o A C1029	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	E6	K3
o A C1030	21564-0038	Tantalum, 100 pF ±20%, 15V	D5	K4
o A C1031	21564-0103	Tantalum, 6.8 uF ±10%, 6V	D5	L4
o A C1032	21564-0120	Tantalum, 22 uF ±10%, 10V	D5	J7
o A C1033	21564-0157	Tantalum, .47 uF ±10%, 35V	E5	L7
o A C1034	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	E6	L6
o A C1035	24515-0010	Ceramic Disc, .02 uF -20%, 50V	D6	L6
o A C1036	21564-0103	Tantalum, 6.8 uF ±10%, 6V	D6	M7
o A C1037	21291-0030	Ceramic Disc, .01 uF -20%, 50V	E6	M7
o A C1038	23107-0125	Poly Film, .1 uF ±10%, 100V	A3	B3
o A C1039	23107-0125	Poly Film, .1 uF ±10%, 100V	B3	B3
o A C1040	21564-0026	Tantalum, 220 uF ±20%, 10V	A3	C3
o A C1041	21568-0061	Tantalum, 10 uF ±10%, 15V	C2	J7
o A C1042	21291-0030	Ceramic Disc, .01 uF -20%, 50V	E5	K5
o A C1043	24551-0002	Ceramic 470 uF ±20%, 50V	B1	A3
o A C1044	24551-0002	Ceramic 470 uF ±20%, 50V	B2	C3

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01384-0101/0102G

Action: original, added, changed, deleted. / Chassis Level Code / Symbol Number	Part Number	Description	Grid Coordinates Schematic	Component Assy
CAPACITOR				
o A C1101	24552-1689	Ceramic, 6.8 pF ±.5 pF, 50V, NPO	C3	B9
o A C1102	24552-1689	Ceramic, 6.8 pF ±.5 pF, 50V, NPO	C3	C9
o A C1103	24552-7180	Ceramic, 18 pF ±10%, 50V, NPO	C3	C9
o A C1104	24552-1829	Ceramic, 8.2 pF ±.5 pF, 50V, NPO	C3	C10
o A C1105	24551-0001	Ceramic, 100 pF ±20%, 50V	C3	C10
o A C1106	24551-0001	Ceramic, 100 pF ±20%, 50V	C4	D9
o A C1107	24552-1479	Ceramic, 4.7 pF ±.5 pF, 50V, NPO	C4	D9
o A C1108	21291-0019	Ceramic Disc, .001 uF -10%, 500V	C5	D9
o A C1109	24052-0220	Dipped Mica, 22 pF ±5%, 500V	C4	D10
o A C1110	24551-0001	Ceramic, 100 pF -20%, 50V	C4	E10
o A C1111	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	C4	E10
o A C1113	24552-7180	Ceramic, 18 pF ±.5 pF, 50V, N750	C4	F10
o A C1114	24552-7180	Ceramic, 18 pF ±.5 pF, 50V, N750	C6	G10
o A C1115	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	C6	G10
o A C1116	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	C6	G9
o A C1117	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	B6	H10
o A C1118	24552-7180	Ceramic, 18 pF ±.5 pF, 50V, N750	B6	H9
o A C1119	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	B6	H10
o A C1120	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	B6	J10
o A C1121	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	A6	H11
o A C1122	21564-0103	Tantalum, 6.8 uF ±10%, 6V	A6	J10
o A C1123	21291-0030	Ceramic Disc, .01 uF -10%, 50V	A6	J10
o A C1124	21564-0124	Tantalum, 100 uF -10%, 10V	A4	K11
o A C1125	21568-0032	Tantalum, 10 uF ±10%, 10V	A5	K10
o A C1126	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	A6	K11
o A C1127	21568-0005	Tantalum, 4.7 uF ±10%, 6V	B5	K10
o A C1128	21568-0036	Tantalum, 22 uF ±10%, 10V	A6	L9
o A C1129	23109-2104	Poly Film, .1 uF ±2.5%, 100V	A5	M8
o A C1130	23109-2104	Poly Film, .1 uF ±2.5%, 100V	A5	M9
o A C1131	23109-2154	Poly Film, .15 uF ±2.5%, 50V	B5	M10
o A C1132	23109-2154	Poly Film, .15 uF ±2.5%, 50V	B5	M11
o A C1133	21568-0109	Tantalum, 1.0 uF ±10%, 35V	A4	P9
o A C1134	21568-0109	Tantalum, 1.0 uF ±10%, 35V	A4	P11
o A C1135	21564-0034	Tantalum, 22 uF ±20%, 15V	B2	Q9
o A C1136	21568-0040	Tantalum, 47 uF ±10%, 10V	A5	M10
o A C1138	21564-0037	Tantalum, 68 uF ±20%, 15V	A4	M10
o A C1201	23107-0111	Poly Film, .0068 uF ±10%, 100V	C2	B8
o A C1202	23107-0113	Poly Film, .01 uF ±10%, 100V	B3	B8
o A C1203	21564-0029	Tantalum, 3.3 uF ±20%, 15V	C3	B8
o A C1204	23107-0125	Poly Film, .1 uF ±10%, 100V	B3	C8
o A C1205	21564-0034	Tantalum, 22 uF ±20%, 15V	C3	C8
o A C1206	23107-0125	Poly Film, .1 uF ±10%, 100V	C4	D7
o A C1207	24551-0003	Ceramic, .001 uF +100/-0%, 50V	B4	D8
o A C1208	24552-1569	Ceramic, 5.6 pF ±0.5 pF, 50V, NPO	B4	D7
o A C1209	21564-0034	Tantalum, 22 uF ±20%, 15V	B4	D7
o A C1210	24551-0003	Ceramic, .001 uF +100/-0%, 50V	B4	D7
o A C1211	24552-1120	Ceramic, 12 pF ±10%, 50V, NPO	C4	E7
o A C1212	24552-1689	Ceramic, 6.8 pF ±.5 pF, 50V, NPO	B5	E7
o A C1213	24552-1100	Ceramic, 10 pF ±10%, 50V, NPO	C5	E7
o A C1214	24551-0003	Ceramic, .001 uF +100/-0%, 50V	B5	F6
o A C1215	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C5	F8
o A C1216	24552-1180	Ceramic, 18 pF ±10%, 50V, NPO	B5	F7
o A C1217	24552-1180	Ceramic, 18 pF ±10%, 50V, NPO	B5	F7
o A C1219	24552-1229	Ceramic, 2.2 pF ±.5 pF, 50V, NPO	B5	F7
o A C1220	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C6	G8
o A C1221	24552-1270	Ceramic, 27 pF ±10%, 50V, NPO	B6	G7
o A C1222	24551-0001	Ceramic, 100 pF -20%, 50V	B6	G6

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01384-0101/0102G

Action: original, added, changed, deleted. / Chassis Level Code / Symbol Number	Part Number	Description	Grid Coordinates Schematic	Component Assy
DIODE				
o A CR001	75037-0002	Varactor	E3	D4
o A CR1001	75037-0001	Varactor	D2	B1
o A CR1002	75037-0001	Varactor	D2	B1
o A CR1003	75037-0001	Varactor	D3	E1
o A CR1004	75037-0001	Varactor	D4	E1
o A CR1005	75034-0001	Hot Carrier, FH 1100	E6	M2
o A CR1006	75028-0001	Silicon, 1N4149	E5	K5
o A CR1007	75062-0005	Silicon, 1N4005	A3	B3
o A CR1101	75034-0001	Hot Carrier, FH 1100	B6	J10
o A CR1104	75028-0001	Silicon, 1N4149	B3	N8
o A CR1105	75028-0001	Silicon, 1N4149	B3	N9
o A CR1106	75028-0001	Silicon, 1N4149	B3	N11
o A CR1107	75028-0001	Silicon, 1N4149	A4	N11
o A CR1201	75037-0002	Varactor	B4	D7
o A CR1202	75028-0001	Silicon, 1N4149	B5	E8
CRYSTAL FILTER				
o A FL1001	43210-0001	4 Pole, 17 MHz	D5	G1
o A FL1002	43210-0001	4 Pole, 17 MHz	D6	K1
o A FL1101	43211-0001	6 Pole, 18.05 MHz	C5	E9
INDUCTOR				
o A L901	11938-0003	Coil, RF, Variable, (VCO)	E3	D5
o A L902	11485-0001	Choke, RF .1 uH	E4	E4
o A L903	11485-0001	Choke, RF .1 uH	E5	G3
o A L1001	11938-0002	Coil, RF, Variable	D2	B1
o A L1002	11938-0002	Coil, RF, Variable	D2	C1
o A L1003	11938-0002	Coil, RF, Variable	D4	E1
o A L1004	11485-0020	Choke, RF, 3.9 uH	E6	M1
o A L1101	11713-0021	Coil, RF, (Increment), 1-1/2 Turns	C2	B9
o A L1102	11713-0015	Coil, RF, (Increment), 4-1/2 Turns	C3	H9
o A L1103	11713-0015	Coil, RF, (Increment), 4-1/2 Turns	C3	C9
o A L1104	11713-0021	Coil, RF, (Increment), 1-1/2 Turns	C3	C9
o A L1105	11713-0019	Coil, RF, (Increment), 5-1/2 Turns	C4	D8
o A L1201	11938-0003	Coil, RF, Variable	C4	D7
o A L1202	11485-0001	Choke, RF, .1 uH	B5	F6
o A L1203	11485-0001	Choke, RF, .1 uH	B6	G6
TRANSISTOR				
o A Q901	75592-0001	Silicon, NPN, SPS 7911	E3	E5
o A Q902	75592-0001	Silicon, NPN, SPS 7911	E4	E5
o A Q903	75592-0001	Silicon, NPN, SPS 7911	E4	G4
o A Q1001	75611-0002	FET	D3	D1
o A Q1002	75611-0002	FET	D4	F1
o A Q1003	75611-0002	FET	E6	M1
o A Q1004	75565-0003	Silicon, PNP, 2N4250	E6	K7
o A Q1005	75550-0002	Silicon, NPN, 2N3391	E6	M6
o A Q1101	75629-0001	RF, NPN, MMT-74	C3	C9
o A Q1102	75629-0001	RF, NPN, MMT-74	C4	E9
o A Q1103	75561-0036	Silicon, NPN, 2N4124	A3	Q11
o A Q1104	75561-0036	Silicon, NPN, 2N4124	B4	L11
o A Q1201	75592-0001	Silicon, NPN, SPS 7911	B4	E7
o A Q1202	75592-0001	Silicon, NPN, SPS 7911	B5	F7
o A Q1203	75592-0001	Silicon, NPN, SPS 7911	B5	G7
o A Q1204	75561-0036	Silicon, NPN, 2N4124	B4	D6

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01384-0101/0102G

Action: original, added, changed, deleted. / Chassis Level Code / Symbol Number	Part Number	Description	Grid Coordinates Schematic	Component Assy
RESISTOR				
o A R901	31218-0272	Carbon Film, 2.7K ±5%, 1/4W	E1	B4
o A R902	31218-0681	Carbon Film, 680 ±5%, 1/4W	E2	B5
o A R903	31218-0223	Carbon Film, 22K ±5%, 1/4W	E3	B5
o A R904	31218-0103	Carbon Film, 10K ±5%, 1/4W	E2	C4
o A R905	31218-0221	Carbon Film, 220 ±5%, 1/4W	E2	C5
o A R906	31218-0102	Carbon Film, 1K ±5%, 1/4W	E3	C4
o A R907	31218-0104	Carbon Film, 100K ±5%, 1/4W	E3	C4
o A R908	31218-0102	Carbon Film, 1K ±5%, 1/4W	E3	D4
o A R909	31218-0103	Carbon Film, 10K ±5%, 1/4W	E3	E4
o A R910	31218-0472	Carbon Film, 4.7K ±5%, 1/4W	E3	D5
o A R911	31218-0270	Carbon Film, 27 ±5%, 1/4W	E3	E3
o A R912	31218-0391	Carbon Film, 390 ±5%, 1/4W	E3	E5
o A R913	31218-0562	Carbon Film, 5.6K ±5%, 1/4W	E4	E4
o A R914	31218-0222	Carbon Film, 2.2K ±5%, 1/4W	E4	E5
o A R915	31218-0151	Carbon Film, 150 ±5%, 1/4W	E4	E5
o A R916	31218-0510	Carbon Film, 51 ±5%, 1/4W	E4	F5
o A R917	31218-0562	Carbon Film, 5.6K ±5%, 1/4W	E4	F4
o A R918	31218-0222	Carbon Film, 2.2K ±5%, 1/4W	E4	F5
o A R919	31218-0101	Carbon Film, 100 ±5%, 1/4W	E4	G4
o A R920	31218-0151	Carbon Film, 150 ±5%, 1/4W	E5	F5
o A R1001	31218-0513	Carbon Film, 51K ±5%, 1/4W	D1	A1
o A R1002	31218-0104	Carbon Film, 100K ±5%, 1/4W	D2	B2
o A R1003	31218-0104	Carbon Film, 100K ±5%, 1/4W	D2	B2
o A R1004	31218-0223	Carbon Film, 22K ±5%, 1/4W	D2	C1
o A R1005	31218-0393	Carbon Film, 39K ±5%, 1/4W	D2	C2
o A R1006	31218-0221	Carbon Film, 220 ±5%, 1/4W	D3	D2
o A R1007	31218-0681	Carbon Film, 680 ±5%, 1/4W	D3	D1
o A R1008	31218-0101	Carbon Film, 100 ±5%, 1/4W	D3	D2
o A R1009	31218-0104	Carbon Film, 100K ±5%, 1/4W	D3	E1
o A R1010	31218-0104	Carbon Film, 100K ±5%, 1/4W	D4	E2
o A R1011	31218-0103	Carbon Film, 10K ±5%, 1/4W	D4	F1
o A R1012	31218-0104	Carbon Film, 100K ±5%, 1/4W	D4	F2
o A R1013	31218-0201	Carbon Film, 200 ±5%, 1/4W	D4	F1
o A R1014	31218-0101	Carbon Film, 100 ±5%, 1/4W	D4	G2
o A R1015	31218-0562	Carbon Film, 5.6K ±5%, 1/4W	D5	G1
o A R1016	31218-0562	Carbon Film, 5.6K ±5%, 1/4W	D5	H1
o A R1017	31218-0101	Carbon Film, 100 ±5%, 1/4W	D6	J1
o A R1018	31218-0470	Carbon Film, 47 ±5%, 1/4W	D6	J2
o A R1019	31218-0562	Carbon Film, 5.6K ±5%, 1/4W	D6	K2
o A R1020	31218-0562	Carbon Film, 5.6K ±5%, 1/4W	D6	L2
o A R1021	31218-0201	Carbon Film, 200 ±5%, 1/4W	E6	M1
o A R1022	31218-0102	Carbon Film, 1K ±5%, 1/4W	E6	M2
o A R1023	31218-0272	Carbon Film, 2.7K ±5%, 1/4W	D6	H3
o A R1024	31218-SEL	Carbon Film, SELECT BY TEST	E6	J3
o A R1025	31218-0473	Carbon Film, 47K ±5%, 1/4W	E6	J3
o A R1026	31218-0101	Carbon Film, 100 ±5%, 1/4W	E5	K3
o A R1027	31218-0473	Carbon Film, 47K ±5%, 1/4W	D6	K4
o A R1028	31218-0273	Carbon Film, 27K ±5%, 1/4W	D5	K4
o A R1029	31218-0474	Carbon Film, 470K ±5%, 1/4W	D5	K3
o A R1030	31218-0684	Carbon Film, 680K ±5%, 1/4W	D5	K4
o A R1031	31218-SEL	Carbon Film, SELECT BY TEST	E5	J6
o A R1032	31218-0563	Carbon Film, 56K ±5%, 1/4W	E5	J7
o A R1033	31218-0101	Carbon Film, 100 ±5%, 1/4W	D5	J6
o A R1034	31218-0222	Carbon Film, 2.2K ±5%, 1/4W	E5	K5
o A R1035	31218-0222	Carbon Film, 2.2K ±5%, 1/4W	E5	K6
o A R1036	31218-0222	Carbon Film, 2.2K ±5%, 1/4W	E5	K7
o A R1037	31218-0103	Carbon Film, 10K ±5%, 1/4W	E5	K6
o A R1038	31218-0103	Carbon Film, 10K ±5%, 1/4W	E5	L6
o A R1039	31218-0103	Carbon Film, 10K ±5%, 1/4W	E6	L6
o A R1040	31218-0221	Carbon Film, 220 ±5%, 1/4W	D6	M7
o A R1041	31218-0103	Carbon Film, 10K ±5%, 1/4W	D6	M8
o A R1042	31218-0104	Carbon Film, 100K ±5%, 1/4W	C2	J7
o A R1043	31218-0683	Carbon Film, 68K ±5%, 1/4W	C2	H8
o A R1044	31218-	Film, 18K ±5%, 1/4W	B2	P10
o A R1045	31218-0473	Carbon Film, 47K ±5%, 1/4W	C2	J8
o A R1046	32054-0020	Variable, 1 Meg	C2	J8
o A R1047	31218-0333	Carbon Film, 33K ±5%, 1/4W	B3	D2
o A R1048	31218-SEL	Carbon Film, SELECT BY TEST	B5	L3
o A R1049	31218-0103	Carbon Film, 10K ±5%, 1/4W	C2	J7

NAV 824/
ELECTRICAL PA
LIST NO. 01384-

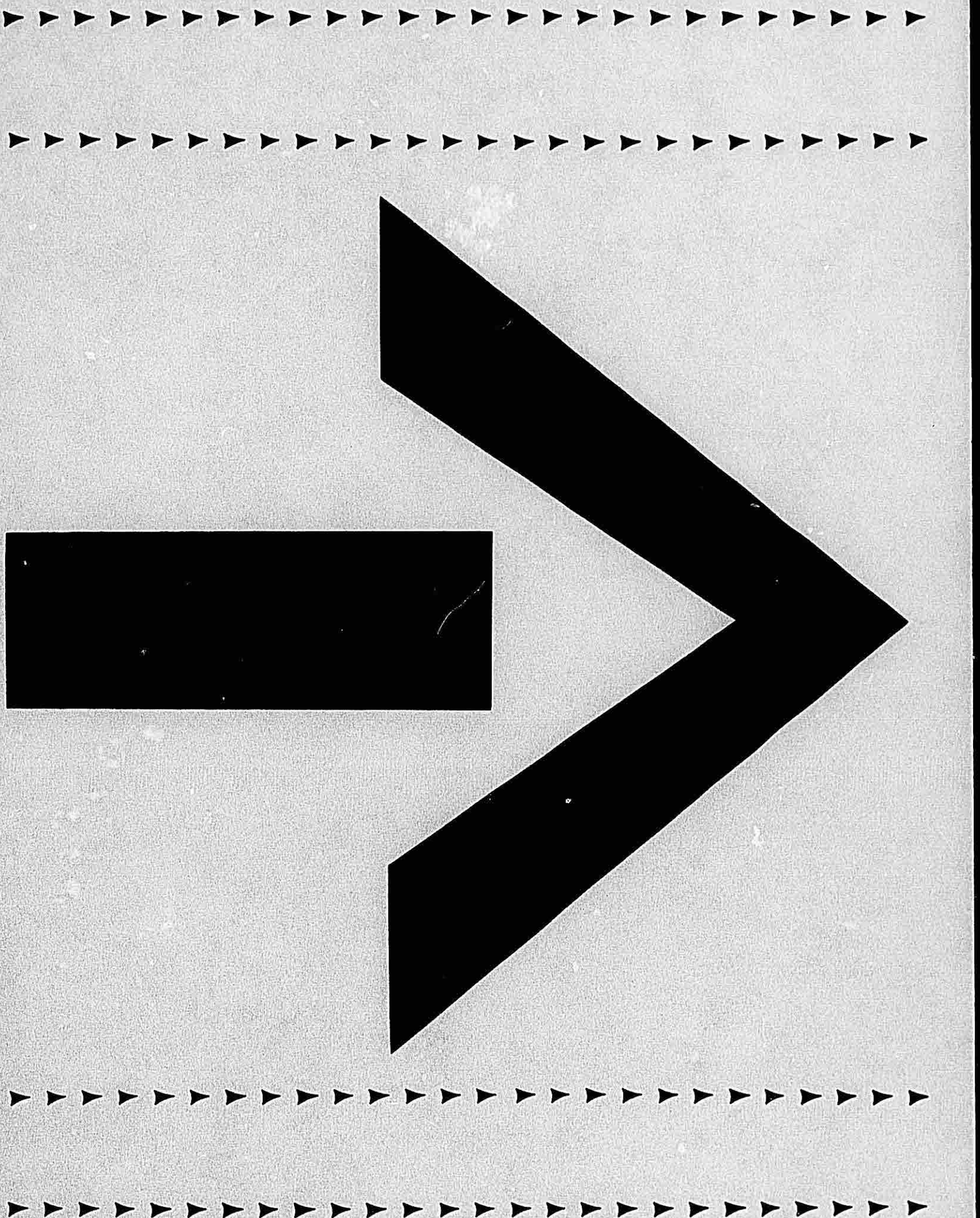
Action: original, added, changed, / Chassis Level Code / Symbol Number	Part Number	De	Component Assy
RE			
o A R1101	31218-0473	Carbon Film,	
o A R1102	31218-0221	Carbon Film,	
o A R1103	31218-0152	Carbon Film,	
o A R1104	31218-0201	Carbon Film,	
o A R1105	31218-0122	Carbon Film,	
o A R1106	31218-0122	Carbon Film,	
o A R1107	31218-0101	Carbon Film,	
o A R1108	31218-0562	Carbon Film,	
o A R1109	31218-0562	Carbon Film,	
o A R1110	31218-0101	Carbon Film,	
o A R1111	31218-0470	Carbon Film,	
o A R1112	31218-0562	Carbon Film,	
o A R1113	31218-SEL	Carbon Film,	
o A R1114	31218-0684	Carbon Film,	
o A R1115	31218-0273	Carbon Film,	
o A R1116	31218-0101	Carbon Film,	
o A R1118	31218-0153	Carbon Film,	
o A R1119	31218-0682	Carbon Film,	
o A R1120	31218-0472	Carbon Film,	
o A R1121	31218-0473	Carbon Film,	
o A R1122	31218-SEL	Carbon Film,	
o A R1123	31218-0272	Carbon Film,	
o A R1124	32054-0004	Variable, Tr	
o A R1125	31199-0241	Precision Fi	
o A R1126	31199-0268	Precision Fi	
o A R1127	31199-0274	Precision Fi	
o A R1128	31199-0246	Precision Fi	
o A R1129	31199-0378	Precision Fi	
o A R1130	31218-0104	Carbon Film,	
o A R1131	31218-0104	Carbon Film,	
o A R1132	31199-0381	Precision Fi	
o A R1133	31218-0273	Carbon Film,	
o A R1134	31218-0273	Carbon Film,	
o A R1135	31218-0105	Carbon Film,	
o A R1137	31218-0273	Carbon Film,	
o A R1138	31218-0273	Carbon Film,	
o A R1139	31218-0105	Carbon Film,	
o A R1141	31218-0183	Carbon Film,	
o A R1143	31218-0683	Carbon Film,	
o A R1144	31218-0102	Carbon Film,	
o A R1145	31218-0103	Carbon Film,	
o A R1146	31218-0473	Carbon Film,	
o A R1201	31218-0272	Carbon Film,	
o A R1202	31218-0681	Carbon Film,	
o A R1203	31218-0223	Carbon Film,	
o A R1204	31218-0103	Carbon Film,	
o A R1205	31218-0221	Carbon Film,	
o A R1206	31218-0102	Carbon Film,	
o A R1207	31218-0102	Carbon Film,	
o A R1208	31218-0103	Carbon Film,	
o A R1209	31218-0472	Carbon Film,	
o A R1210	31218-0270	Carbon Film,	
o A R1211	31218-0391	Carbon Film,	
o A R1212	31218-0562	Carbon Film,	
o A R1213	31218-0222	Carbon Film,	
o A R1214	31218-0151	Carbon Film,	
o A R1215	31218-0510	Carbon Film,	
o A R1216	31218-0562	Carbon Film,	
o A R1217	31218-0222	Carbon Film,	
o A R1218	31218-0101	Carbon Film,	
o A R1219	31218-0151	Carbon Film,	
o A R1220	31218-0103	Carbon Film,	
o A RT1001	31205-0003	Thermistor,	

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01384-0101/0102G

al, added, changed, deleted. Code per	Part Number	Description	Grid Coordinates Schematic	Component Assy
		RESISTOR		
18-0473		Carbon Film, 47K ±5%, 1/4W	C3	C10
18-0221		Carbon Film, 110 ±5%, 1/4W	C4	D8
18-0152		Carbon Film, 1.5K ±5%, 1/4W	C4	D10
18-0201		Carbon Film, 200 ±5%, 1/4W	C4	F8
18-0122		Carbon Film, 1.2K ±5%, 1/4W	C4	E9
18-0122		Carbon Film, 1.2K ±5%, 1/4W	C4	E10
18-0101		Carbon Film, 100 ±5%, 1/4W	C4	E10
18-0562		Carbon Film, 5.6K ±5%, 1/4W	C4	F10
18-0562		Carbon Film, 5.6K ±5%, 1/4W	C6	G9
18-0101		Carbon Film, 100 ±5%, 1/4W	B6	H9
18-0470		Carbon Film, 47 ±5%, 1/4W	B6	H9
18-0562		Carbon Film, 5.6K ±5%, 1/4W	B6	J9
18-SEL		Carbon Film, SELECT BY TEST	A6	H11
18-0684		Carbon Film, 680K ±5%, 1/4W	A6	H11
18-0273		Carbon Film, 27K ±5%, 1/4W	A6	J11
18-0101		Carbon Film, 100 ±5%, 1/4W	A5	K11
18-0153		Carbon Film, 15K ±5%, 1/4W	A6	K10
18-0682		Carbon Film, 6.8K ±5%, 1/4W	A6	L10
18-0472		Carbon Film, 4.7K ±5%, 1/4W	A5	M10
18-0473		Carbon Film, 47K ±5%, 1/4W	B5	L11
18-SEL		Carbon Film, SELECT BY TEST	B5	L11
18-0272		Carbon Film, 2.7K ±5%, 1/4W	B6	J11
54-0004		Variable, Trimmer, 4.7K	A5	M10
99-0241		Precision Film, 2.61K ±1%, 1/4W	A5	M9
99-0268		Precision Film, 4.99K ±1%, 1/4W	A5	M9
99-0274		Precision Film, 5.76K ±1%, 1/4W	B5	M10
99-0246		Precision Film, 2.94K ±1%, 1/4W	B5	M11
99-0378		Precision Film, 63.4K ±1%, 1/4W	B4	N9
18-0104		Carbon Film, 100K ±5%, 1/4W	B4	N9
18-0104		Carbon Film, 100K ±5%, 1/4W	B4	N10
99-0381		Precision Film, 68.1K ±1%, 1/4W	B4	N11
18-0273		Carbon Film, 27K ±5%, 1/4W	A3	N8
18-0273		Carbon Film, 27K ±5%, 1/4W	B3	N9
18-0105		Carbon Film, 1 MeG ±5%, 1/4W	A4	N9
18-0273		Carbon Film, 27K ±5%, 1/4W	B3	N10
18-0273		Carbon Film, 27K ±5%, 1/4W	A4	N11
18-0105		Carbon Film, 1 MeG ±5%, 1/4W	A4	N11
18-0183		Carbon Film, 18K ±5%, 1/4W	B2	Q9
18-0683		Carbon Film, 68K ±5%, 1/4W	B6	K11
18-0102		Carbon Film, 1K ±5%, 1/4W	A5	M11
18-0103		Carbon Film, 10K ±5%, 1/4W	A3	P8
18-0473		Carbon Film, 47K ±5%, 1/4W	B3	L11
18-0272		Carbon Film, 2.7K ±5%, 1/4W	B2	B7
18-0681		Carbon Film, 680 ±5%, 1/4W	B3	B8
18-0223		Carbon Film, 22K ±5%, 1/4W	B4	C8
18-0103		Carbon Film, 10K ±5%, 1/4W	B3	C7
18-0221		Carbon Film, 220 ±5%, 1/4W	C3	C7
18-0102		Carbon Film, 1K ±5%, 1/4W	B4	D7
18-0102		Carbon Film, 1K ±5%, 1/4W	B4	D7
18-0103		Carbon Film, 10K ±5%, 1/4W	B4	E7
18-0472		Carbon Film, 4.7K ±5%, 1/4W	B4	E8
18-0270		Carbon Film, 27 ±5%, 1/4W	B4	E6
18-0391		Carbon Film, 390 ±5%, 1/4W	C4	E8
18-0562		Carbon Film, 5.6K ±5%, 1/4W	B5	E7
18-0222		Carbon Film, 2.2K ±5%, 1/4W	B5	E8
18-0151		Carbon Film, 150 ±5%, 1/4W	C5	E8
18-0510		Carbon Film, 51 ±5%, 1/4W	C5	F8
18-0562		Carbon Film, 5.6K ±5%, 1/4W	B5	F6
18-0222		Carbon Film, 2.2K ±5%, 1/4W	B5	F7
18-0101		Carbon Film, 100 ±5%, 1/4W	B5	G6
18-0151		Carbon Film, 150 ±5%, 1/4W	C6	G8
18-0103		Carbon Film, 10K ±5%, 1/4W	B5	D6
95-0003		Thermistor, 46.2K	C2	H7

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01384-0101/0102G

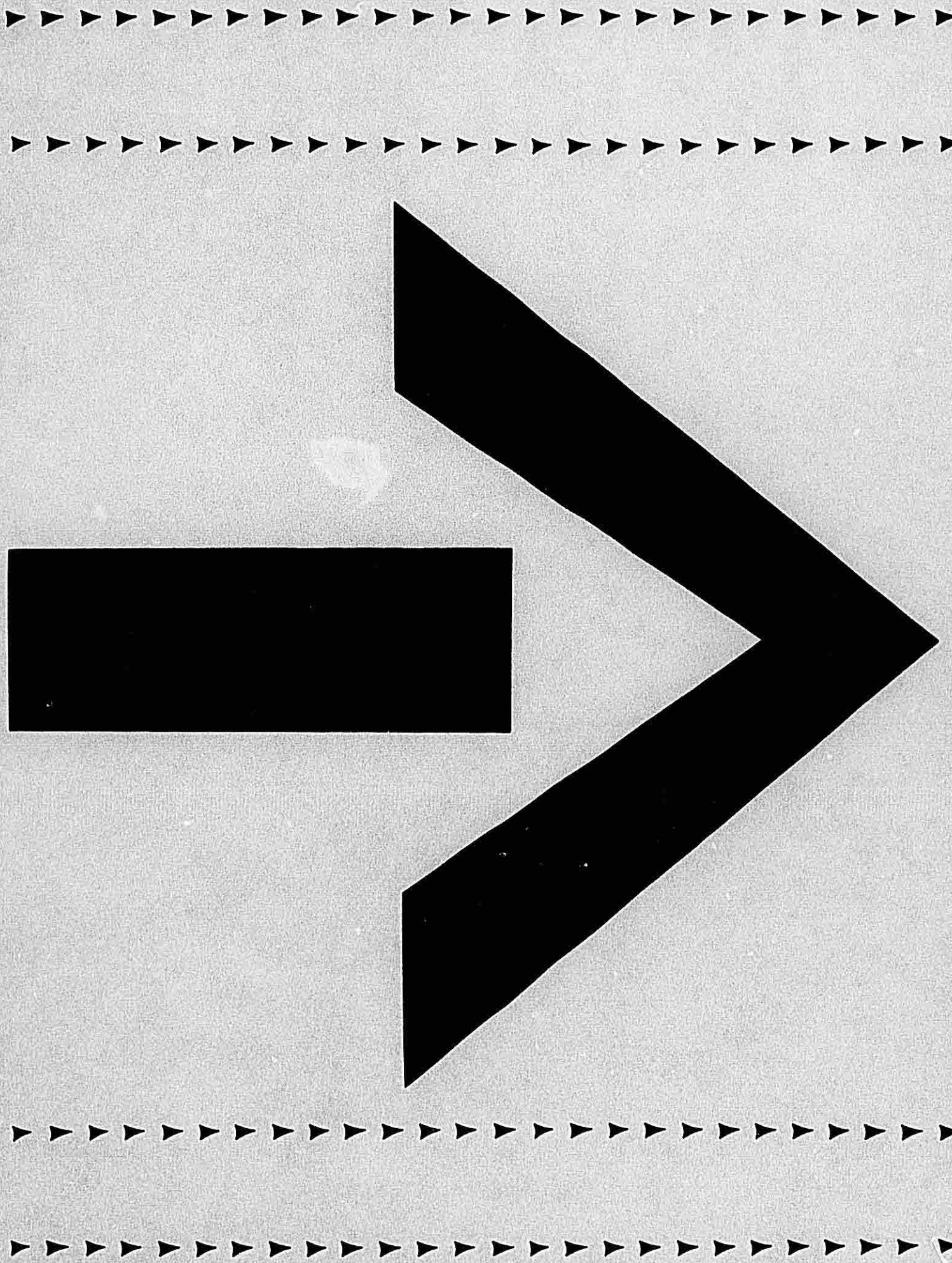
Action: original, added, changed, deleted. Chassis Level Code Symbol Number	Part Number	Description	Grid Coordinates Schematic	Component Assy
		TRANSFORMER		
o A T1001	11846-0001	Variable, RF	D3	D1
o A T1002	11881-0001	Variable, IF	D4	G1
o A T1003	11881-0001	Variable, IF	D5	H1
o A T1004	11881-0002	Variable, IF	D6	K1
o A T1005	11881-0001	Variable, IF	E6	L1
o A T1101	11881-0001	Variable, IF	C4	E9
o A T1102	11881-0001	Variable, IF	C6	H9
o A T1103	11881-0002	Variable, IF	B6	H9
		IC		
o A U901	74211-0001	CA3240	E2	
o A U901A				B4
o A U901B				C4
o A U1001	74028-0001	MC1350P	D6	J1
o A U1002	74099-0001	CA3088E	D5	
o A U1002A				N1
o A U1002B				L4
o A U1002C				K4
o A U1002D				J4
o A U1002E				J7
o A U1002F				M6
o A U1003	74039-0001	7808 (Regulator)	A3	B3
o A U1004	74103-0001	MC1458C	B2	J7
o A U1101	74028-0001	MC1350P	B6	H10
o A U1102	74099-0001	CA3088E	A6	
o A U1102A				J10
o A U1102B				L10
o A U1102C				J11
o A U1102D				K10
o A U1102E				K10
o A U1103	74232-0001	MC3405	A4	
o A U1103A				P9
o A U1103B				P11
o A U1103C				N9
o A U1103D				N11
o A U1201	74211-0001	CA3240	B3	
o A U1201A				B7
o A U1201B				C7



NAV 824/825
AND
ID 824/825
PARTS PRICE LIST

July 1981

NOTE: Part numbers identified will be included in next update of Parts Price Catalog and will be maintained therein.



PART NUMBER	DESCRIPTION	AON
01372-0102	Tray, NAV-825	65.00
01372-0104	Tray, NAV-824	65.00
03115-0500	Installation Kit, NAV-824	35.00
03115-0501	Installation Kit, NAV-825	35.00
03115-0600	NAV-824/825 Maintenance Manual	30.00
03749-0500	Installation Kit, ID-824/825	35.00
04023-0002	Label	.52
04776-0001	Label	.68
04867-0001	Label	.02
04878-0001	Label	.30
04913-0001	Label	1.29
04913-0003	Label	1.21
04913-0004	Label	1.21
04913-0005	Label	1.21
04913-0006	Label	1.21
04923-0001	Label	1.90
04923-0002	Label	1.90
04924-0001	Label	.25
04928-0001	Label	1.40
04928-0002	Label	1.40
04931-0001	Label	.20
11485-0001	Inductor	1.55
11485-0020	Inductor	1.72
11487-0001	Inductor	3.52
11488-0003	Inductor	5.30
11713-0015	Inductor	.14
11713-0019	Inductor	.13
11713-0021	Inductor	.15
11846-0001	Transformer	2.16
11881-0001	Transformer	2.40
11881-0002	Transformer	2.40
11937-0001	Transformer	20.25
11938-0002	Inductor	5.00
11938-0003	Inductor	8.01
12000-0014	Lamp	2.95
12009-0001	Socket	5.17
12009-0002	Lamp	5.00
21291-0019	Capacitor	.20
21291-0021	Capacitor	.19
21291-0027	Capacitor	.21
21291-0030	Capacitor	.35
21291-0031	Capacitor	.22
21554-0070	Capacitor	2.54
21554-0071	Capacitor	3.60

PART NUMBER	DESCRIPTION	AON
21555-0026	Capacitor	3.50
21564-0026	Capacitor	14.10
21564-0028	Capacitor	1.70
21564-0029	Capacitor	1.70
21564-0033	Capacitor	3.20
21564-0034	Capacitor	3.20
21564-0036	Capacitor	10.20
21564-0037	Capacitor	3.00
21564-0038	Capacitor	16.60
21564-0057	Capacitor	1.70
21564-0059	Capacitor	1.70
21564-0102	Capacitor	1.62
21564-0103	Capacitor	1.62
21564-0120	Capacitor	3.20
21564-0124	Capacitor	10.30
21564-0131	Capacitor	1.34
21564-0140	Capacitor	1.75
21564-0146	Capacitor	3.30
21564-0157	Capacitor	1.70
21567-0009	Capacitor	1.62
21567-0010	Capacitor	1.07
21567-0014	Capacitor	1.18
21567-0016	Capacitor	1.19
21567-0017	Capacitor	1.19
21567-0021	Capacitor	2.41
21567-0023	Capacitor	2.50
21568-0005	Capacitor	2.12
21568-0032	Capacitor	2.12
21568-0036	Capacitor	4.50
21568-0040	Capacitor	6.10
21568-0061	Capacitor	4.50
21568-0109	Capacitor	2.12
22057-0004	Capacitor	4.60
23107-0001	Capacitor	1.04
23107-0005	Capacitor	.80
23107-0009	Capacitor	.80
23107-0013	Capacitor	1.04
23107-0016	Capacitor	.50
23107-0027	Capacitor	1.60
23107-0031	Capacitor	2.15
23107-0111	Capacitor	.66
23107-0113	Capacitor	1.09
23107-0117	Capacitor	.90

PART NUMBER	DESCRIPTION	AON
23107-0121	Capacitor	1.08
23107-0125	Capacitor	.86
23107-0129	Capacitor	1.51
23109-2104	Capacitor	2.08
23109-2154	Capacitor	4.20
23109-5103	Capacitor	1.66
23109-5223	Capacitor	1.49
23109-5334	Capacitor	2.36
23113-0005	Capacitor	5.76
23113-0112	Capacitor	1.60
24049-0391	Capacitor	1.51
24052-0101	Capacitor	1.02
24052-0150	Capacitor	1.12
24052-0220	Capacitor	1.12
24052-0221	Capacitor	1.66
24052-0270	Capacitor	1.31
24509-0109	Capacitor	.45
24509-0688	Capacitor	.49
24515-0001	Capacitor	.55
24515-0005	Capacitor	.36
24515-0010	Capacitor	.49
24516-0120	Capacitor	.14
24516-0479	Capacitor	.30
24550-2103	Capacitor	1.50
24551-0001	Capacitor	.28
24551-0002	Capacitor	.28
24551-0003	Capacitor	.28
24552-1100	Capacitor	.38
24552-1120	Capacitor	.39
24552-1180	Capacitor	.39
24552-1229	Capacitor	.39
24552-1270	Capacitor	.48
24552-1479	Capacitor	.39
24552-1569	Capacitor	.39
24552-1689	Capacitor	.40
24552-1820	Capacitor	.64
24552-1829	Capacitor	.39
24552-7180	Capacitor	.38
24556-0224	Capacitor	1.55
30002-0001	Resistor	4.27
31149-0120	Resistor	.10
31149-0150	Resistor	.15
31199-0089	Resistor	.76

PART NUMBER	DESCRIPTION	AON
31199-0205	Resistor	.34
31199-0241	Resistor	.40
31199-0246	Resistor	.63
31199-0259	Resistor	.34
31199-0268	Resistor	.50
31199-0274	Resistor	.63
31199-0278	Resistor	.34
31199-0288	Resistor	.63
31199-0312	Resistor	.63
31199-0343	Resistor	.57
31199-0349	Resistor	.57
31199-0354	Resistor	.65
31199-0359	Resistor	.34
31199-0366	Resistor	.87
31199-0378	Resistor	.57
31199-0381	Resistor	.36
31199-0385	Resistor	.87
31199-0401	Resistor	.34
31199-0418	Resistor	.63
31199-0433	Resistor	.57
31199-0434	Resistor	1.12
31199-0442	Resistor	.57
31199-0458	Resistor	.36
31199-0465	Resistor	.34
31205-0003	Resistor	5.80
31217-0001	Resistor	10.00
31218-0101	Resistor	.08
31218-0102	Resistor	.08
31218-0103	Resistor	.08
31218-0104	Resistor	.08
31218-0105	Resistor	.08
31218-0122	Resistor	.08
31218-0123	Resistor	.08
31218-0124	Resistor	.08
31218 0125	Resistor	.08
31218-0150	Resistor	.08
31218-0151	Resistor	.08
31218-0152	Resistor	.08
31218-0153	Resistor	.12
31218-0154	Resistor	.12
31218-0183	Resistor	.12
31218-0201	Resistor	.12
31218-0220	Resistor	.12
31218-0221	Resistor	.12

PART NUMBER	DESCRIPTION	AON
31218-0222	Resistor	.12
31218-0223	Resistor	.12
31218-0224	Resistor	.12
31218-0270	Resistor	.12
31218-0271	Resistor	.12
31218-0272	Resistor	.12
31218-0273	Resistor	.12
31218-0274	Resistor	.12
31218-0303	Resistor	.12
31218-0332	Resistor	.12
31218-0333	Resistor	.12
31218-0391	Resistor	.12
31218-0392	Resistor	.12
31218-0393	Resistor	.12
31218-0394	Resistor	.12
31218-0470	Resistor	.12
31218-0471	Resistor	.12
31218-0472	Resistor	.12
31218-0473	Resistor	.12
31218-0474	Resistor	.12
31218-0753	Resistor	.12
31218-0823	Resistor	.12
31218-0913	Resistor	.12
31218-0510	Resistor	.12
31218-0513	Resistor	.12
31218-0562	Resistor	.12
31218-0563	Resistor	.12
31218-0623	Resistor	.12
31218-0681	Resistor	.12
31218-0682	Resistor	.12
31218-0683	Resistor	.12
31218-0684	Resistor	.12
31230-0002	Resistor	4.80
32054-0002	Resistor	1.30
32054-0003	Resistor	1.30
32054-0004	Resistor	1.30
32054-0006	Resistor	1.12
32054-0011	Resistor	1.30
32054-0012	Resistor	1.30
32054-0020	Resistor	1.30
32068-0001	Potentiometer	64.23
32070-0005	Resistor	14.97
32091-0105	Resistor	12.65
32091-0108	Resistor	12.80

PART NUMBER	DESCRIPTION	AON
41152-0005	Connector	9.74
41229-0003	Connector	13.40
41308-0006	Stud	4.54
41318-0001	Connector	8.90
41341-0001	Connector	15.52
41364-0003	Connector	5.50
41364-0008	Pin	6.05
41372-0008	Pin	1.00
41406-0007	Housing	3.18
41410-0001	Key	.13
43210-0001	Crystal Filter	29.75
43211-0001	Crystal Filter	79.10
50045-0001	Bracket	2.00
50202-0001	Bracket	1.49
50203-0001	Spring	1.91
50204-0001	Side Rail	9.00
50205-0003	Plate	6.26
50211-0001	Spring	1.08
50216-0001	Bracket	2.50
50217-0001	Cover	8.96
50219-0101	Plate	7.40
50222-0001	Plate	17.25
50223-0001	Support	3.25
*50226-0001	Display	60.00
50231-0001	Connector	24.75
50242-0001	Knob	1.30
50243-0001	Button	2.56
50244-0106	Trim Panel Assy.	18.06
50244-0107	Trim Panel Assy.	18.06
50249-0101	Panel Assy., Left	10.63
50250-0101	Panel Assy., Right	10.63
50251-0001	Spring	1.92
50252-0002	Lens	15.20
50253-0001	Bumper	.57
50262 0101	Bracket	2.70
50271-0001	PC Board	69.72
50273-0001	Main PC Board	87.80
50276-0001	Shield	.50
50277-0001	Support	.23
50278-0001	Standoff	3.97
50282-0001	PC Board	9.20
50317-0001	Cover	9.00
50318-0001	Shield	11.00
50319-0001	Cover	5.85

*See Note on Page 10

PART NUMBER	DESCRIPTION	AON
50320-0001	Shield	12.75
50321-0001	Cover	4.75
50322-0001	Shield	10.20
54559-0001	Insulator	.38
56025-0002	Casting	21.50
56042-0001	Collar	1.80
56056-0102	Gear & Shaft Assy.	15.51
56057-0001	Gear	10.08
56059-0012	Bezel	38.03
56059-0013	Bezel	38.03
56159-0001	Gasket	1.34
56736-0022	Spacer	1.51
56906-0101	Gear	12.12
56907-0001	Bearing	1.51
56908-0001	Guide	1.89
56908-0002	Guide	1.89
56909-0001	Guide	2.21
56910-0001	Spring	1.40
56911-0001	Azimuth Card	8.00
56914-0001	Mask	7.00
56915-0001	Bushing	9.35
56916-0101	Plate	8.55
56919-0001	Shim	.60
56934-0001	Gasket	2.17
56943-0001	Case	39.30
56975-0001	Spacer	1.60
61497-0009	Switch	10.20
61556-0001	Switch	4.70
61646-0001	Switch	12.10
61659-0001	Switch	59.00
66516-0010	Fuse	3.13
72041-0001	Crystal	23.10
74028-0001	IC	4.78
74039-0001	IC	7.65
74072-0002	IC	2.90
74086-0001	IC	3.10
74091-0001	IC	2.20
74092-0001	IC	4.25
74099-0001	IC	8.95
74101-0001	IC	4.70
74103-0001	IC	3.52
74105-0001	IC	5.80
74110-0002	IC	3.00

PART NUMBER	DESCRIPTION	AON
74116-0001	IC	6.46
74119-0001	IC	7.50
74169-0001	IC	5.72
74171-0001	IC	5.70
74172-0001	IC	6.58
74211-0001	IC	6.58
*74240-0001	Microprocessor	77.00
74216-0001	IC	12.60
74220-0001	IC	9.86
74221-0001	IC	13.52
74222-0001	IC	8.44
74223-0001	IC	5.31
74225-0001	IC	20.63
74226-0001	IC	4.90
74228-0001	IC	28.80
74229-0001	IC	2.75
74230-0001	IC	5.75
74231-0001	IC	12.96
74232-0001	IC	9.50
75025-0007	Diode	.90
75025-0009	Diode	.90
75025-0015	Diode	1.10
75025-0025	Diode	.90
75025-0028	Diode	2.10
75027-0004	Diode	.90
75027-0014	Diode	6.00
75028-0001	Diode	.18
75034-0001	Diode	2.30
75036-0001	Diode	2.30
75036-0003	Diode	5.54
75037-0002	Diode	4.00
75062-0005	Diode	.72
75216-0003	Diode	2.90
75220-3610	Diode	4.95
75224-0001	Diode	5.22
75550-0002	Transistor	.75
75561-0036	Transistor	.80
75565-0003	Transistor	.75
75592-0001	Transistor	3.00
75611-0002	Transistor	4.30
75629-0001	Transistor	7.43
75658-0003	Transistor	3.15
75658-0004	Transistor	1.75
75676-0003	Transistor	3.40

*See Note on Page 10

PART NUMBER	DESCRIPTION	AON
75688-0003	Transistor	2.80
75812-0004	Transistor	9.78
76147-0001	Meter	172.80
76148-0001	Meter	268.80
81192-0014	Ring	.14
81192-0024	Ring	.35
81207-0025	Spacer	2.58
81207-0076	Spacer	2.68
81213-0137	Spacer	.75
81254-0001	Eyelet	.10
81254-0002	Eyelet	.10
81254-0029	Eyelet	.08
81254-0054	Eyelet	.13
81257-0011	Rivet	.18
81297-0011	Ring	.10
81307-0123	Washer	.21
81307-0138	Washer	.25
81307-0147	Spacer	.20
81312-0019	Washer	.54
81312-0022	Washer	.50
81324-0003	Washer	.14
81324-0004	Washer	.10
81324-0022	Washer	.10
81324-0023	Washer	.01
81329-0102	Washer	.10
81329-0104	Washer	.02
81335-0012	Bushing	.35
81336-0002	Washer	.21
81423-0010	Terminal	2.84
81716-0002	Lug	.21
81737-0002	Lug	.30
81747-0016	Filter	2.52
81808-0104	Terminal	.20
81808-0106	Terminal	.76
82010-0014	Clamp	1.32
82402-0006	Screw	.17
82802-0735	Washer	.22
82809-0703	Screw	.11
82809-0705	Screw	.11
82863-0202	Screw	.50
82863-0219	Setscrew	.27
82869-0701	Screw	.30

PART NUMBER	DESCRIPTION	AON
82869-0702	Screw	.20
82869-0704	Screw	.60
82884-0502	Screw	.09
82884-0504	Screw	.18
82900-0009	Nut	.05
82900-0701	Nut	.10
82900-0703	Nut	.10
82900-0704	Nut	.13
82900-0723	Nut	.69
82965-0703	Screw	.17
82969-0002	Washer	.03
82969-0004	Washer	.13
83011-0038	Insulator	.97
83011-0040	Insulator	.84
83026-0001	Insulator	.32
83031-0007	Insulator	.91
83032-0001	Insulator	.40
83037-0004	Pad	.26
83039-0003	Insulator	7.90
84533-0702	Screw	.11
84533-0705	Screw	.10
84533-0706	Screw	.12
84536-0702	Screw	.11
84536-0703	Screw	.11
84536-0704	Screw	.11
84536-0706	Screw	.11
84536-0709	Screw	.13
84537-0703	Screw	.20
84539-0705	Screw	.11
84542-0702	Screw	.32
88227-0001	Knob	6.17
88230-0003	Spacer	3.52
88237-0001	Knob	8.65
88238-0001	Knob	9.53
90092-0001	Coax Cable	1.51
90701-0106	Cable Assy.	30.00
90701-0107	Cable Assy.	30.00
90701-0108	Cable Assy.	30.00
99065-0004	Tape	.20
99065-0008	Tape	.10

*During the warranty period, these items will be available as replacements directly from Narco; i.e., they will not be reimbursed at list. Defective part must be returned to Narco Avionics for failure analysis.

NARCO AVIONICS ID-824/825/826

MODIFICATION INSTRUCTION 03749-0670

KIT NO: 03749-0502

PARTS SUPPLIED:

1. Modification Instruction.....P/N 03749-0670
2. Magnetic Shield.....P/N 50547-0001

PURPOSE: To reduce the magnetic interference between the Indicator and the aircraft's wet compass when they are mounted closer than 0.3 meters (11.8 inches) to each other.

GENERAL: When planning the installation, give careful consideration to the idea of moving the aircraft's wet compass to prevent any magnetic interference. Some installations may require that both the compass be moved and a magnetic shield installed on the Indicator. The application of one (1) sheet of magnetic shield to the Indicator will permit the Indicator to be moved to within 9 inches of the compass. If the Indicator must be moved closer, then additional sheets of magnetic shield must be added to the Indicator to build up the shield thickness. It is advisable not to mount the Indicator any closer than 6 inches to the compass because too many sheets of magnetic shield would have to be added.

PROCEDURE:

> **CAUTION**
> DO NOT repeatedly bend or flex the magnetic shield as this will destroy the magnetic shielding property of the metal.

The magnetic shield is supplied with a double faced pressure sensitive tape installed on one surface with a release coated protective liner. The dimensions of the shield are 4 inches wide by 15 inches long.

1. Remove the protective liner from the tape side of the shield.
2. Place the 4 inch wide edge of the shield (tape side down) across the top of the Indicator case, front to back.
3. Carefully wrap the shield around the circumference of the Indicator. There is enough material for the finishing edge to overlap the starting edge.
4. Figure 1 illustrates a correctly installed magnetic shield.

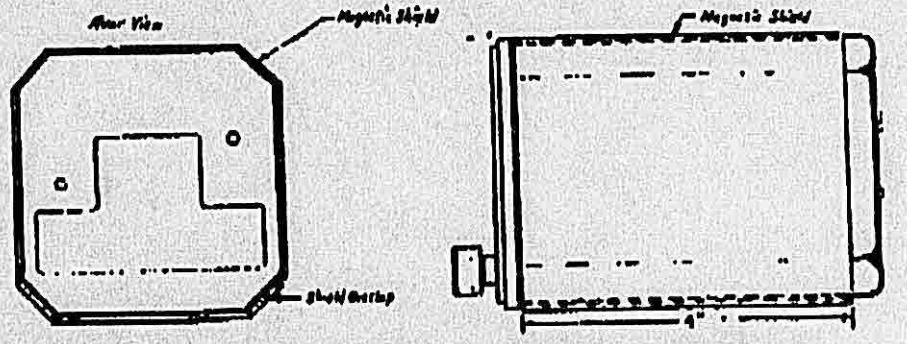


FIGURE 1. INDICATOR WITH MAGNETIC SHIELD INSTALLED

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. ....

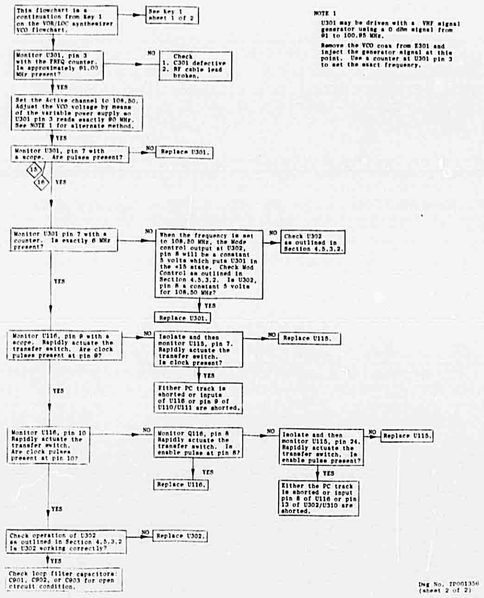


FIGURE 4-21. NAV SYNTHESIZER FLOWCHART (sheet 2 of 2)

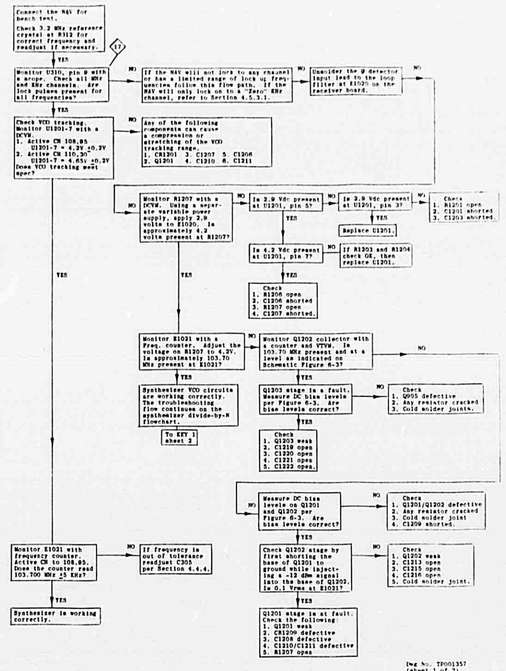


FIGURE 4-22. GLIDESLOPE SYNTHESIZER FLOWCHART (sheet 1 of 2)

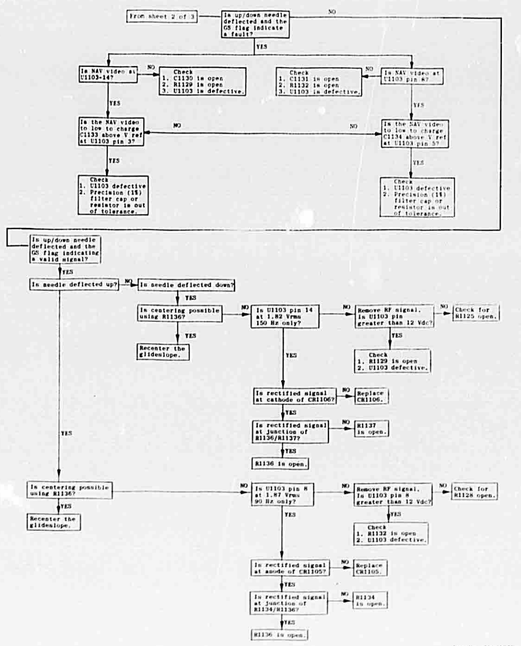


FIGURE 4-23. GLIDESLOPE CONVERTER FLOWCHART (sheet 3 of 3)

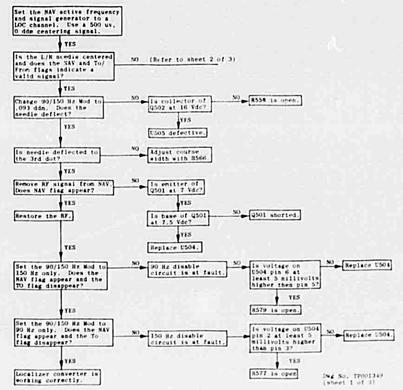


FIGURE 4-24. LOCALIZER CONVERTER FLOWCHART (sheet 1 of 3)

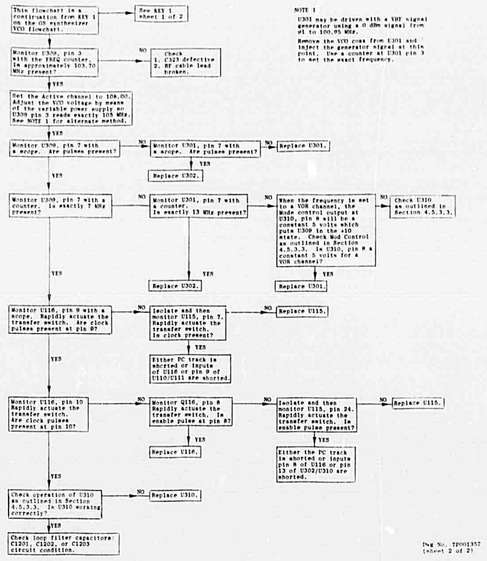


FIGURE 4-22. GLIDESLOPE SYNTHESIZER FLOWCHART (sheet 2 of 2)

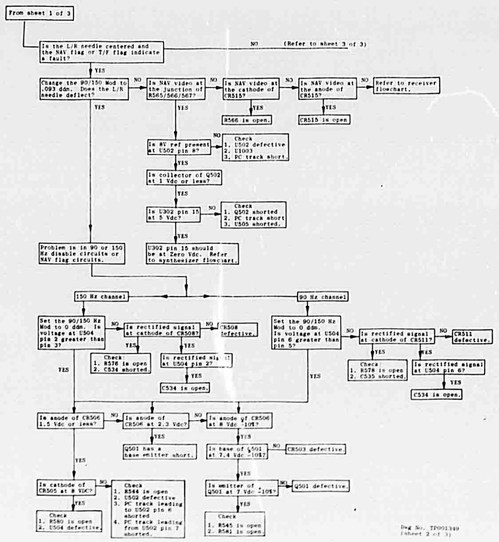


FIGURE 4-24. LOCALIZER CONVERTER FLOWCHART (sheet 2 of 3)

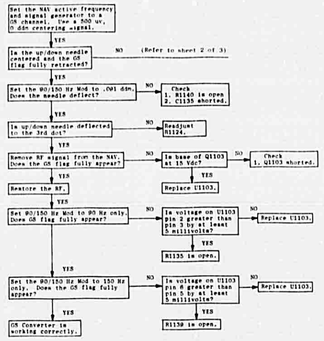


FIGURE 4-23. GLIDESLOPE CONVERTER FLOWCHART (sheet 1 of 3)

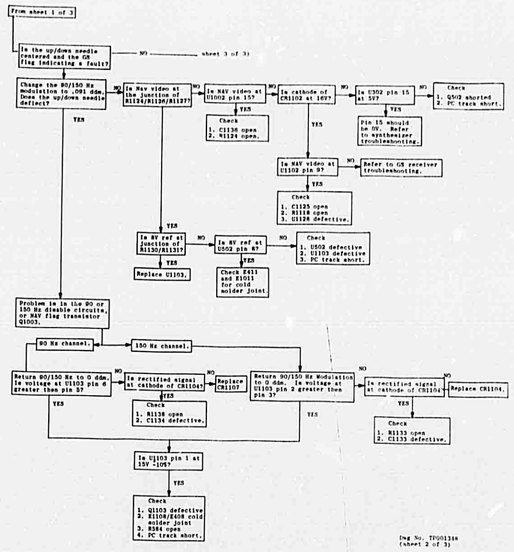


FIGURE 4-23. GLIDESLOPE CONVERTER FLOWCHART (sheet 2 of 3)

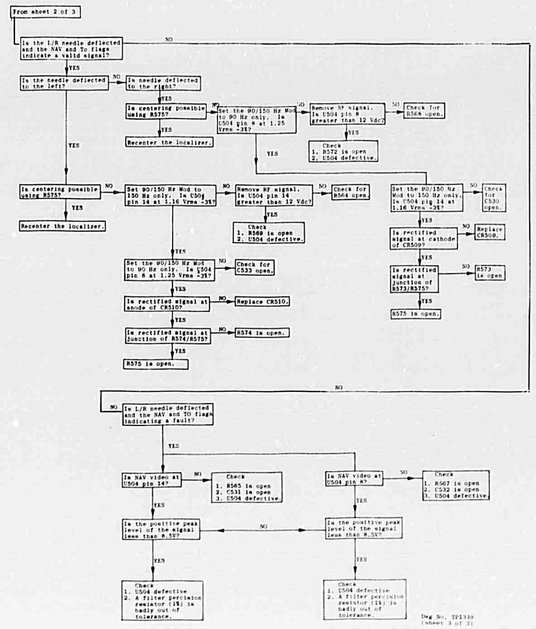


FIGURE 4-24. LOCALIZER CONVERTER FLOWCHART (sheet 3 of 3)

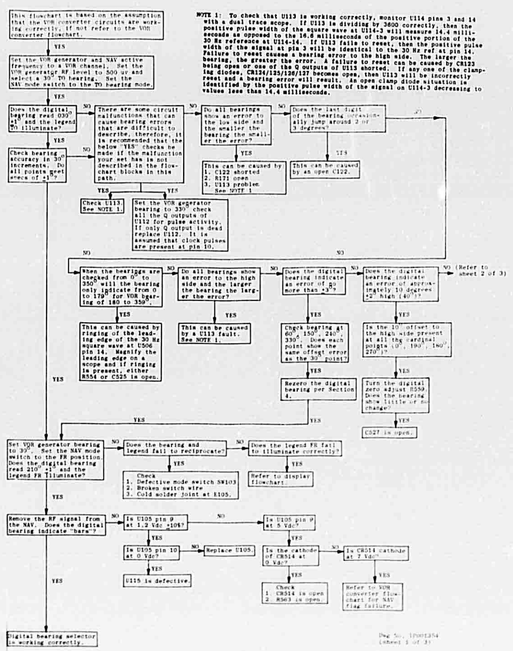


FIGURE 4-44. DIGITAL BEARING SELECTOR FLOWCHART (sheet 1 of 3)

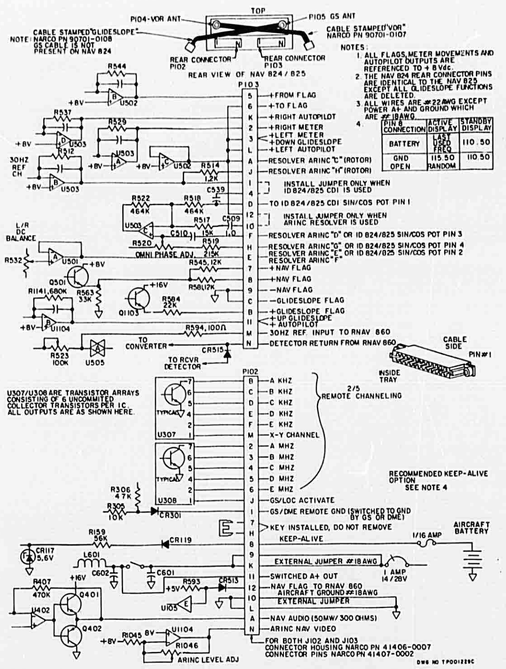


FIGURE 2-6. INTERCONNECT WIRING, NAV 824/825

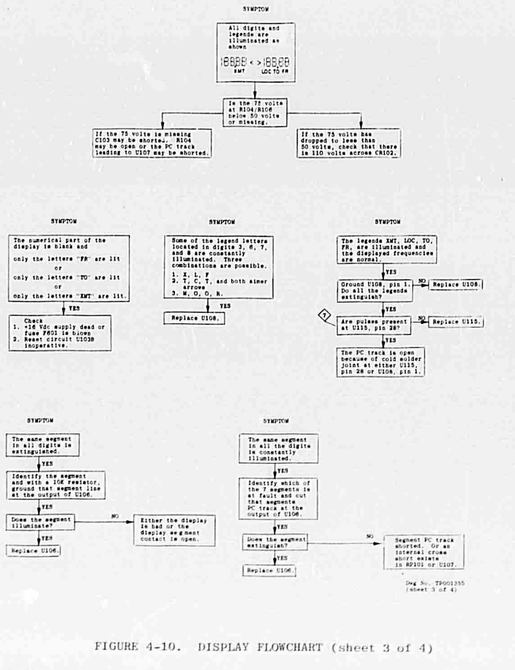


FIGURE 4-10. DISPLAY FLOWCHART (sheet 3 of 4)

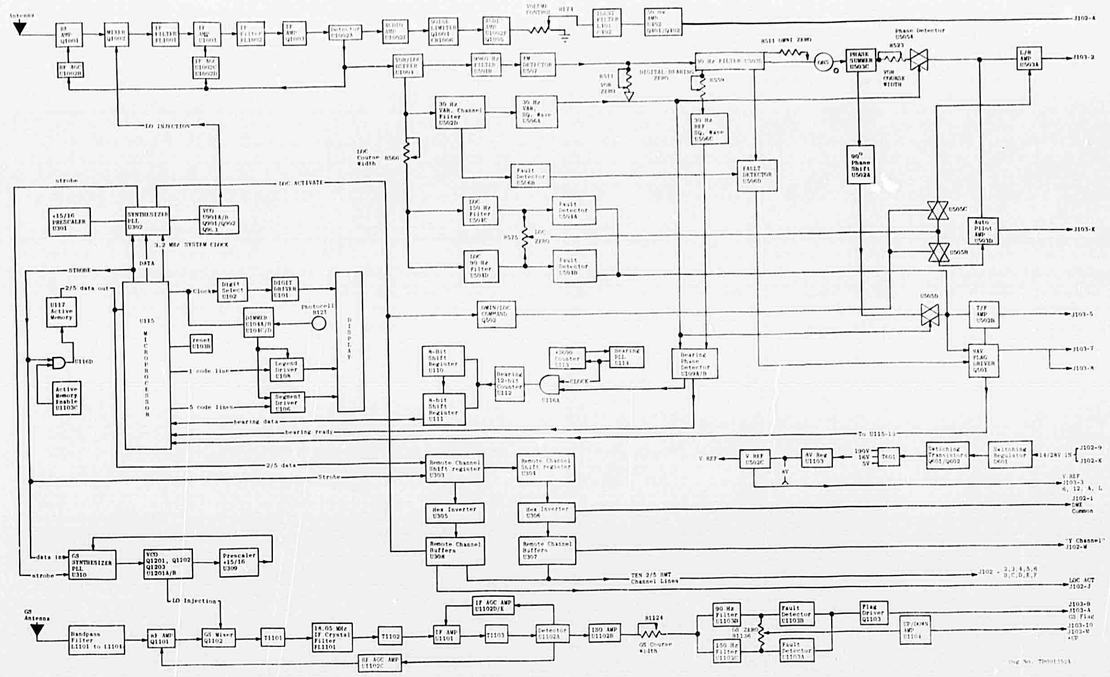


FIGURE 3-1. NAV 824/825 BLOCK DIAGRAM

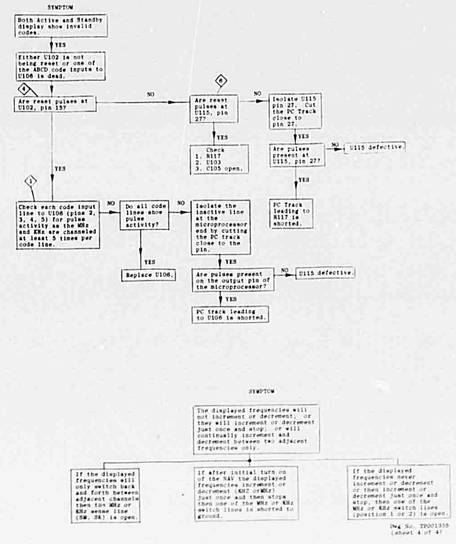


FIGURE 4-10. DISPLAY FLOWCHART (sheet 4 of 4)

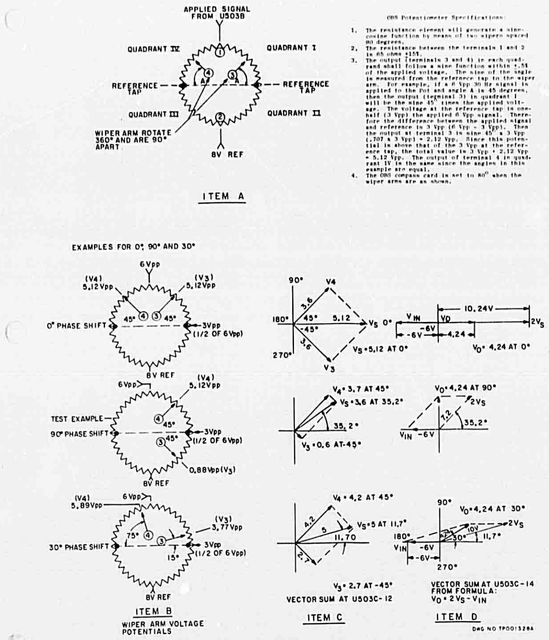


FIGURE 3-22. SINE/COSINE POTENTIOMETER PHASE SHIFT ANALYSIS

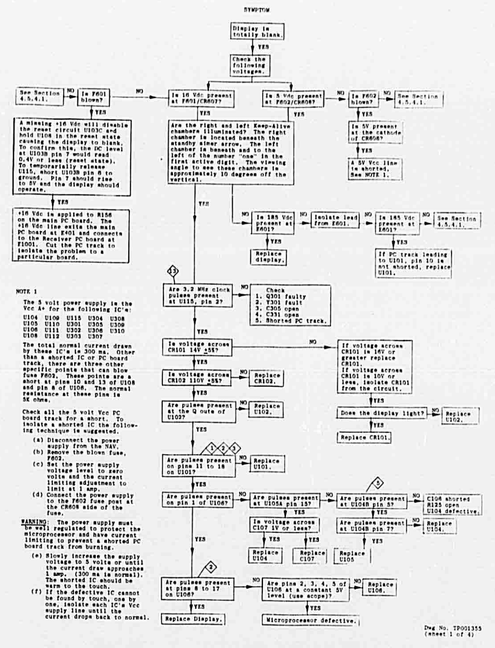


FIGURE 4-10. DISPLAY FLOWCHART (sheet 1 of 4)

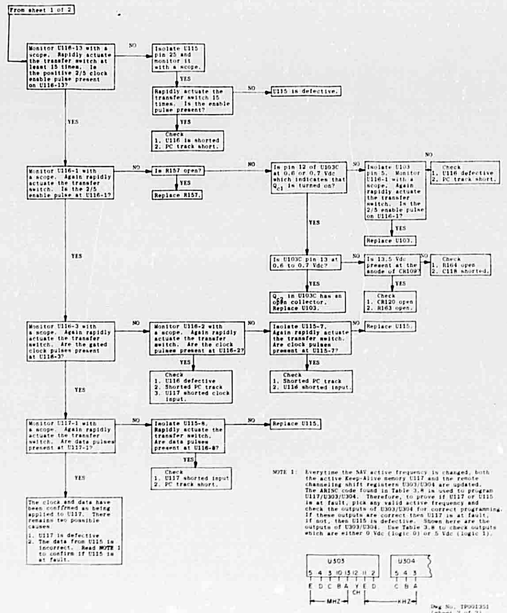


FIGURE 4-11. ACTIVE KEET-ALIVE MEMORY FLOWCHART (sheet 2 of 2)

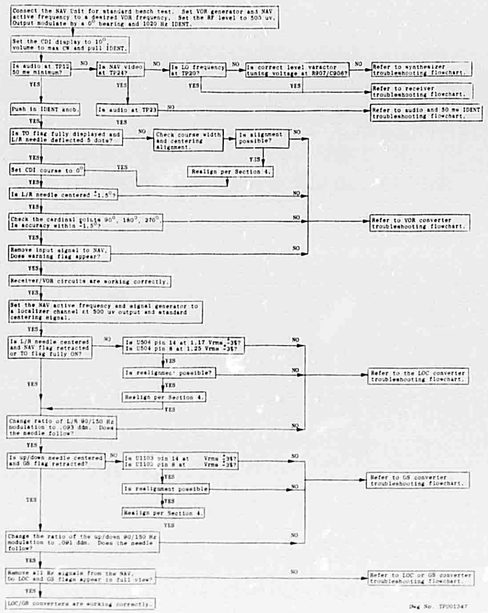


FIGURE 4-19. RECEIVER AND VOR CONVERTER FLOWCHART

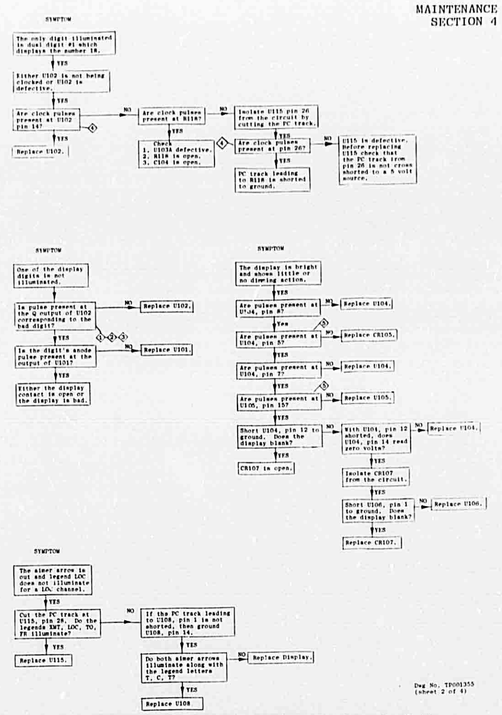


FIGURE 4-10. DISPLAY FLOWCHART (sheet 2 of 4)

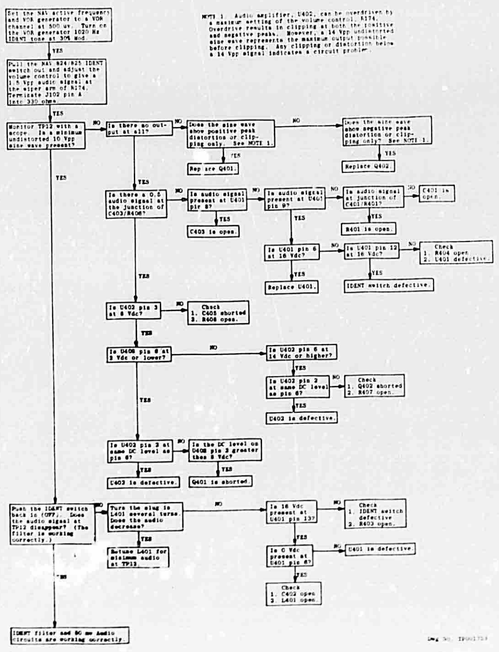


FIGURE 4-20. IDENT AND 50 mw AUDIO FLOWCHART

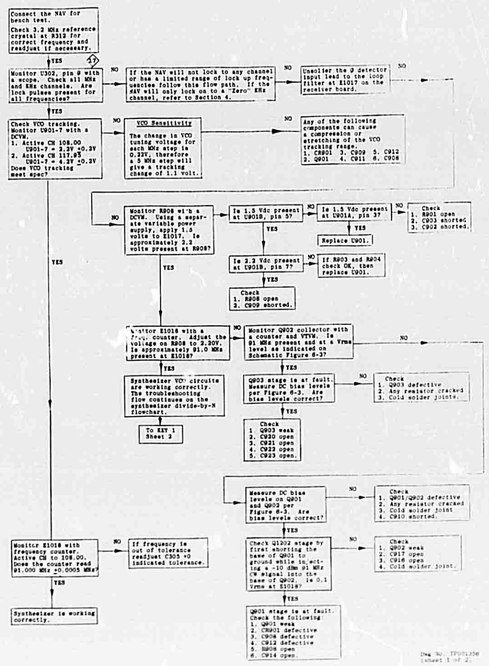


FIGURE 4-21. NAV SYNTHESIZER FLOWCHART (sheet 1 of 2)

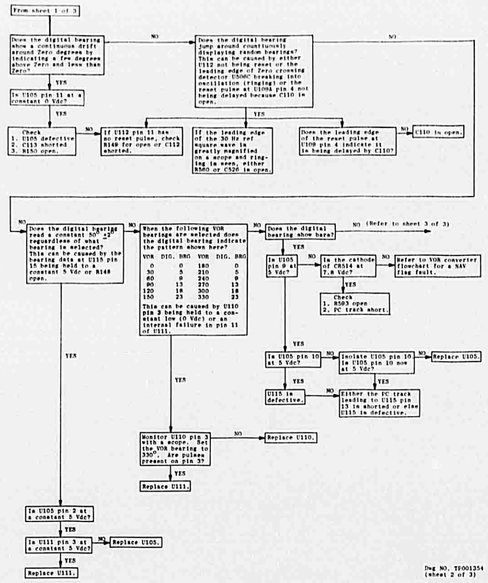


FIGURE 4-44. DIGITAL BEARING SELECTOR FLOWCHART (sheet 2 of 3)

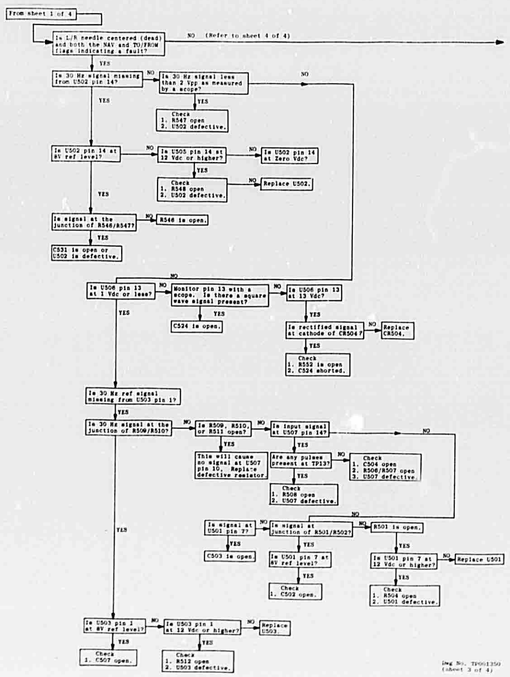


FIGURE 4-45. VOR/LOC CONVERTER FLOWCHART (sheet 3 of 4)

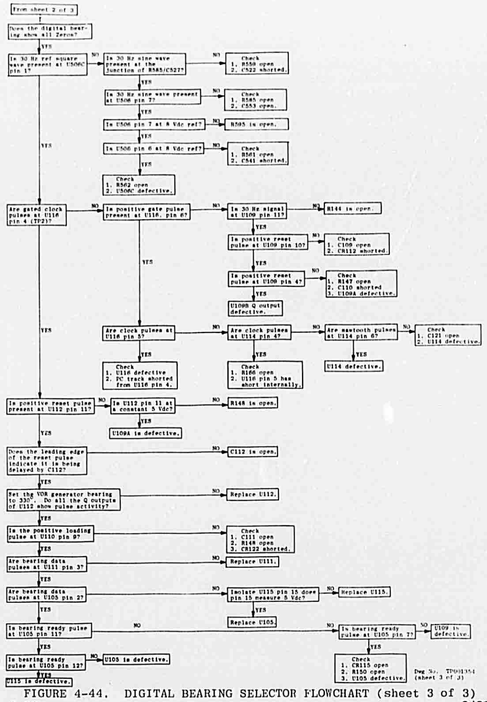


FIGURE 4-44. DIGITAL BEARING SELECTOR FLOWCHART (sheet 3 of 3)

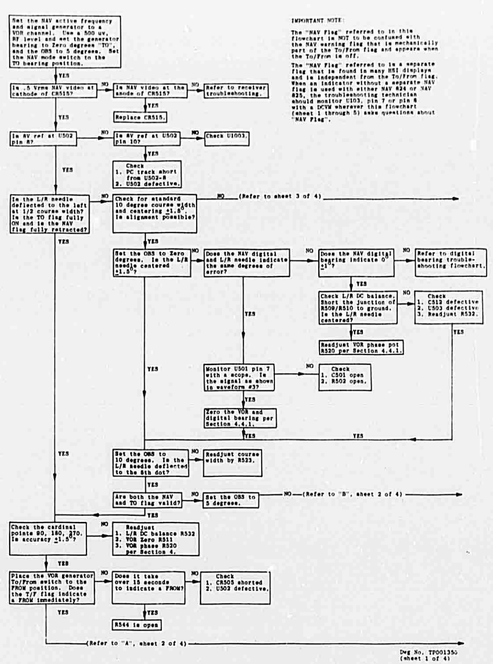


FIGURE 4-45. VOR/LOC CONVERTER FLOWCHART (sheet 1 of 4)

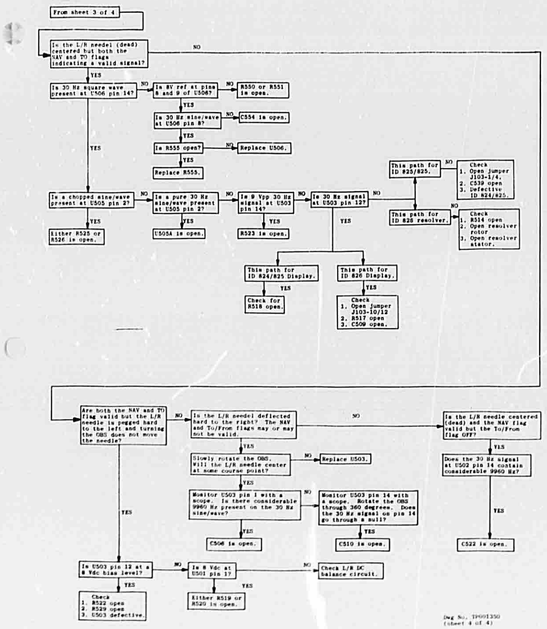


FIGURE 4-45. VOR/LOC CONVERTER FLOWCHART (sheet 4 of 4)

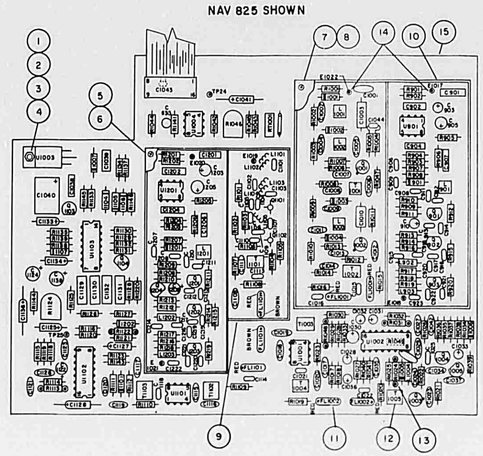


FIGURE 5-2. RECEIVER PC BOARD ASSEMBLY

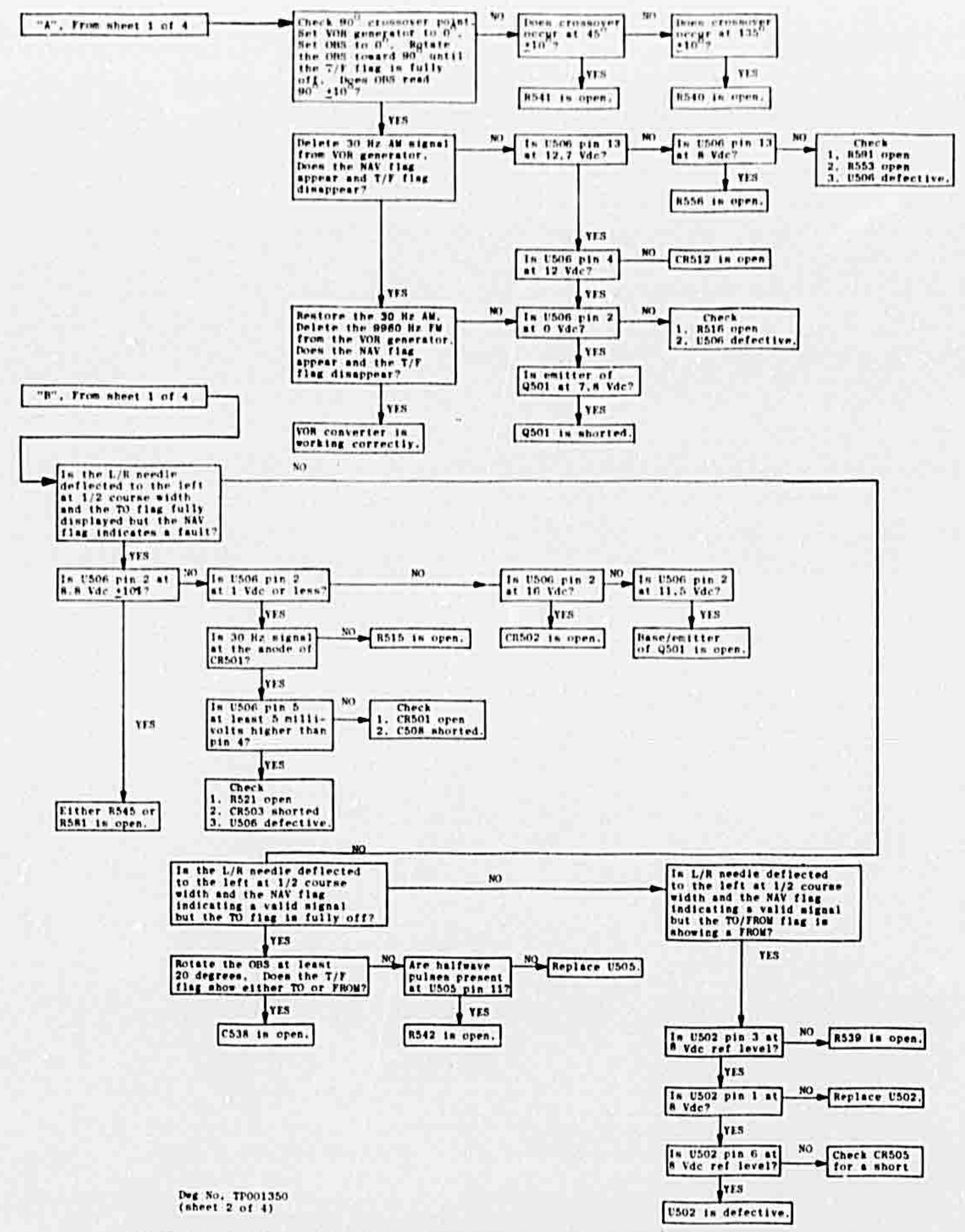


FIGURE 4-45. VOR/LOC CONVERTER FLOWCHART (sheet 2 of 4)

TO/FROM WIRING LIST

Solder Point	Wire Color	Function	Solder Point
C114	Bus	Jumper (+5V)	C115
C115	Bus	Jumper (+5V)	C114
C309	Enamel Wire		J103-10
E101	Red	+190V	E601
E102	Bus	Transfer Ground	SW102
E103	Bus	Transfer	SW102
E104	Brown	TO	SW103
E105	Blue	FROM	SW103
E106	Red	Ground	SW103
E107	Yellow	Arm	R174
E108	Orange	Ground	R174
E109	Green	Rec Audio	R174
E109	PC Track	Rec Audio	E404
E110	Bus	Ground	R121
E111	Bus	+ Power	R121
E301	Coax Blue	NAV RF Drive	E1018
E302 (TP9)	Coax No Color	Phase Detector (NAV Synth)	E1017
E303	Coax Red	GS RF Drive	E1021
E304 (TP11)	Coax Orange	Phase Detector (GS Synth)	E1020
E401	PC Track	+16V	F601
E401	Ribbon Cable	+16V	E1001
E402	Ribbon Cable	Ground	E1002
E403	Ribbon Cable	Detector (ARINC output)	E1003
E404	PC Track	Rec Audio	E109
E404	Ribbon Cable	Rec Audio	E1004
E405	Ribbon Cable	Ground	E1005
E406	Ribbon Cable	+8V	E1006
E407	Ribbon Cable	VOR/LOC Command	E1007
E408	Ribbon Cable	+GS Flag	E1008
E409	Ribbon Cable	GS Zero	E1009
E409	PC Track	GS Zero	R1136
E410	Ribbon Cable	GS Zero	E1010
E410	PC Track	GS Zero	R1136
E411	Ribbon Cable	V Ref	E1011
E412	Ribbon Cable	GS Zero	E1012
E412	PC Track	GS Zero	R1136 Arm
E413	- - - - - - -	NOT USED - - - - - -	E1013
E414	PC Track	+Up GS	E417
E414	Ribbon Cable	+Up GS	E1014
E415	Ribbon Cable	Ground	E1015
E416	Ribbon Cable	Ground	E1016
E417	Green	+Up GS	E418
E417	PC Track	+Up GS	E414
E418	Green	+Up GS	E417
E418	PC Track	+Up GS	J103-11
E601	Red	+190V	E101
E602	PC Track	14/28V Input (via C610)	J102-9/K
E602	Blue	ON/OFF (14/28V input)	SW103
E603	PC Track	Switched A+	J102-11/M
E603	Red	ON/OFF Switched A+	SW103
E604	Red	ON/OFF Switched A+	SW103
E605	Orange		E606
E606	Orange		E605
E1001	Ribbon Cable	+16V	E401
E1002	Ribbon Cable	Ground	E402
E1003	Ribbon Cable	Detector (ARINC output)	E403
E1004	Ribbon Cable	Rec Audio	E404
E1005	Ribbon Cable	Ground	E405
E1006	Ribbon Cable	+8V	E406
E1007	Ribbon Cable	VOR/LOC Command	E407
E1008	Ribbon Cable	+GS Flag	E408
E1009	Ribbon Cable	GS Zero	E409
E1009	PC Track	GS Zero	R1137
E1010	Ribbon Cable	GS Zero	E410
E1010	PC Track	GS Zero	R1134
E1011	Ribbon Cable	V Ref	E411
E1012	Ribbon Cable	GS Zero	E412
E1012	PC Track	GS Zero	U1104-6
E1013	- - - - - - -	NOT USED - - - - - -	E413
E1014	Ribbon Cable	+Up GS	E414
E1015	Ribbon Cable	Ground	E415
E1016	Ribbon Cable	Ground	E416
E1017	Coax No Color	Phase Detector (NAV synth)	E302 (TP9)
E1018	Coax Blue	RF Drive	E301
E1019	Coax Yellow	GS Antenna	J105
E1020	Coax Orange	Phase Detector (GS Synth)	E304 (TP11)
E1021	Coax Red	GS RF Drive	E303
E1022	Coax Green	VOR Antenna	J104
F601	PC Track	+16V	E401
J102-9/K	PC Track	14/28V Input (via C610)	E602
J102-11/M	PC Track	Switched A+	E603
J103-10	Enamel Wire		C309
J103-11	PC Track	+Up GS	E418
J103-M	Enamel Wire		R523
J104	Coax Green	VOR Antenna	E1022
J105	Coax Yellow	GS Antenna	E1019
R121	Bus	Ground	E110
R121	Bus	+ Power	E111
R174	Yellow	Arm	E107
R174	Orange	Ground	E108
R174	Green	Rec Audio	E109
R174	PC Track	Vol Control	E404
R523	Enamel Wire		J103-M
R1029	Bus	Jumper +8V	R1033
R1033	Bus	Jumper +8V	R1029
R1134	PC Track	GS Zero	E1010
R1136	PC Track	GS Zero	E410
R1136 Arm	PC Track	GS Zero	E412
R1136	PC Track	GS Zero	E409
R1137	PC Track	GS Zero	E1009
SW102	Bus	Transfer Ground	E102
SW102	Bus	Transfer	E103
SW103	Brown	TO	E104
SW103	Blue	FROM	E105
SW103	Red	Ground	E106
SW103	Blue	ON/OFF 14/28V Input	E602
SW103	Red	ON/OFF Switched A+	E603
SW103	Bus	ON/OFF	E604
TP3	Bus	Active Entry Jumper (if used)	TP4
TP4	Bus	Active Entry Jumper (if used)	TP3
TP9 (E302)	Coax No Color	Phase Detector (NAV Synth)	E1017
TP11 (E304)	Coax Orange	Phase Detector (GS Synth)	E1020
U1104-6	PC Track	GS Zero	E1012

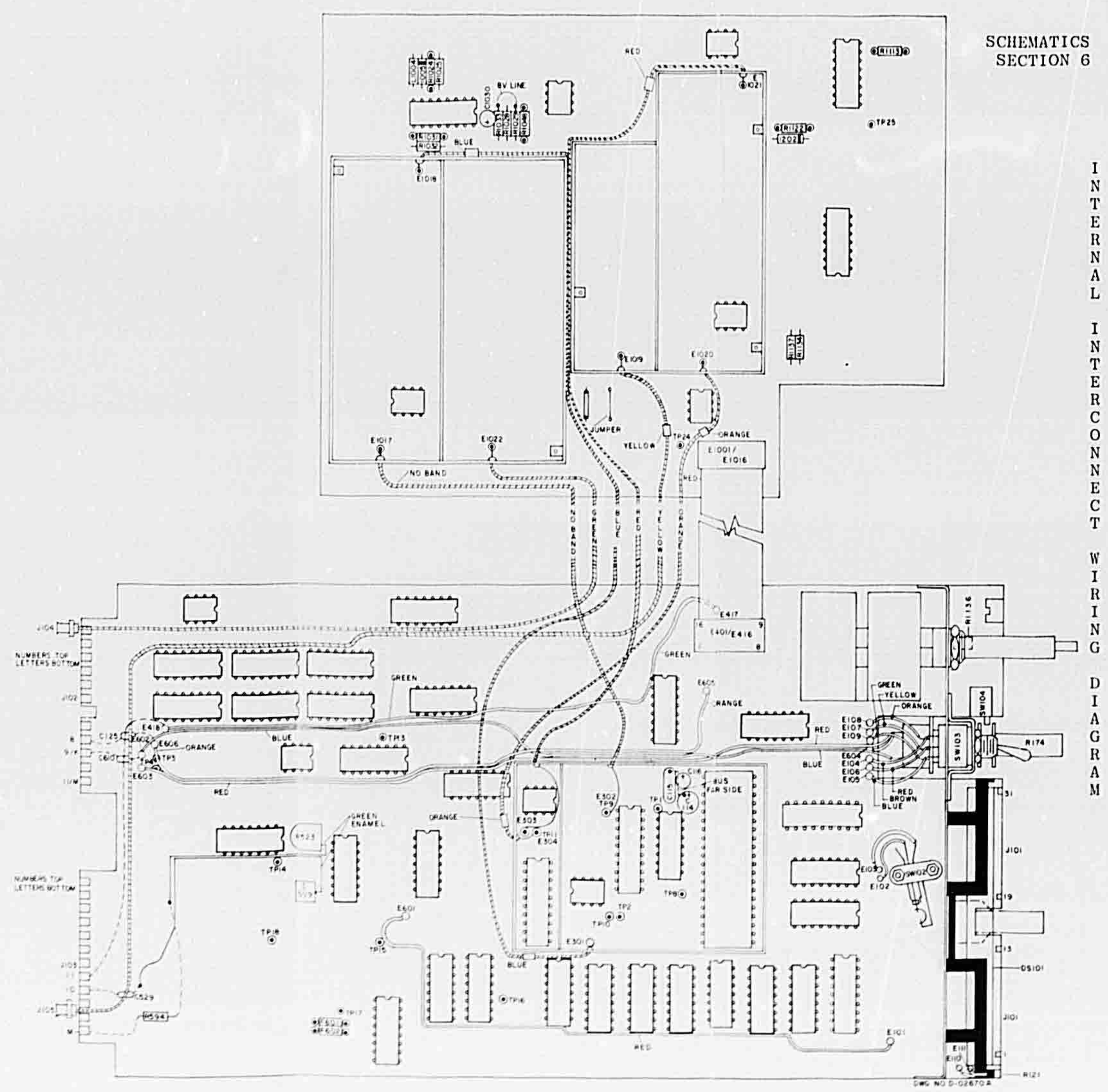
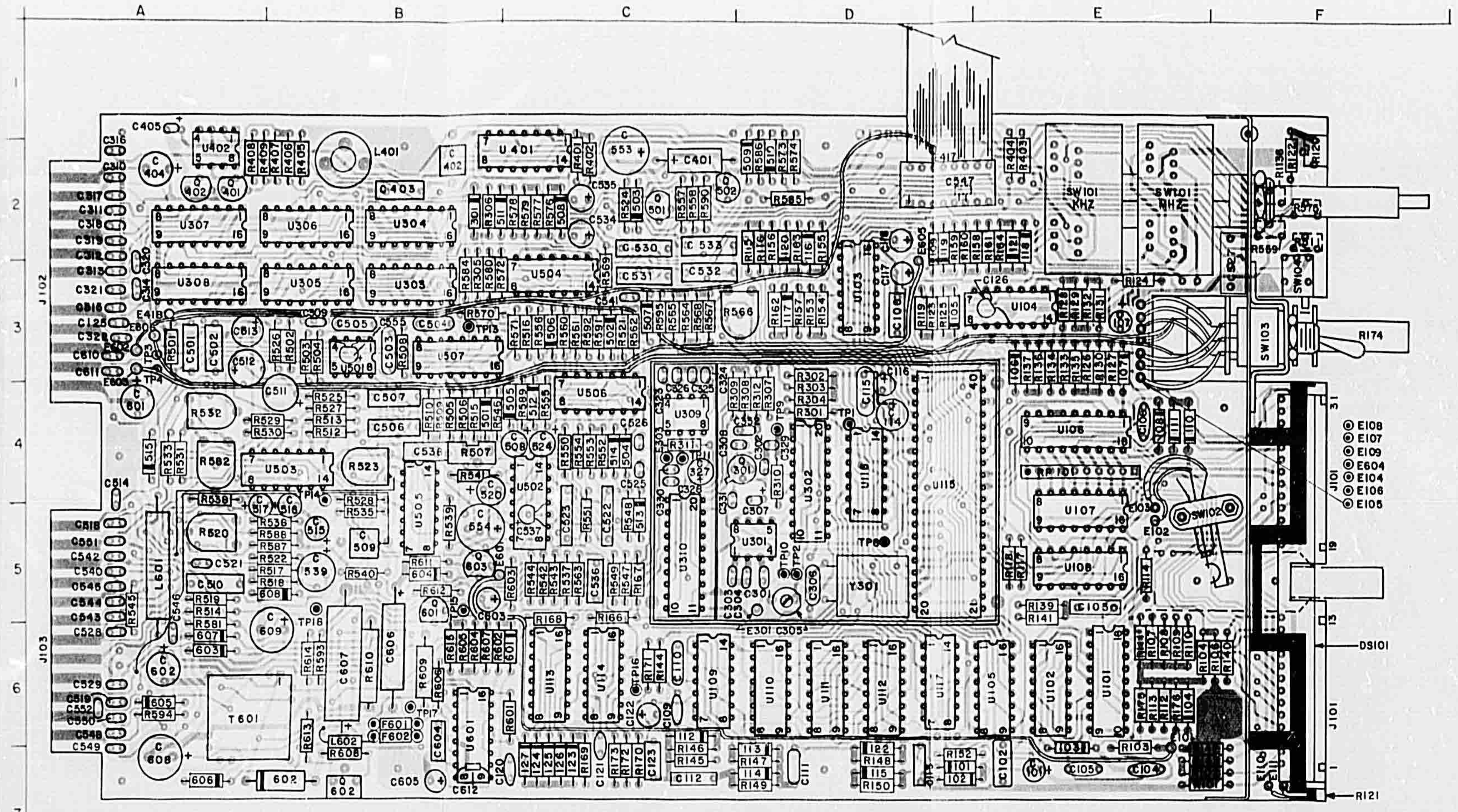


FIGURE 6-1. INTERNAL INTERCONNECT WIRING DIAGRAM AND TO/FROM LIST

INTERNAL INTERCONNECT WIRING DIAGRAM



NOTES:

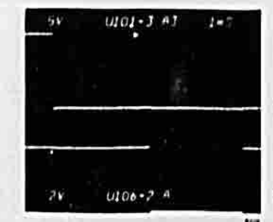
1. ▭ INDICATES DIODE, CR OMITTED FOR CLARITY. BAR INDICATES CATHODE END.

Solder runs shown in GREY are those on the "BOTTOM" (non-component) side of the board.

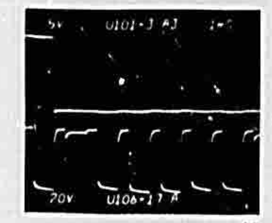
Solder runs shown in PINK are those on the "TOP" (component) side of the board.

Dwg. No. D-50266-G

FIGURE 6-2. NAV 824/825 MAIN BOARD (sheet 1 of 2)
(NAV 825 SHOWN)

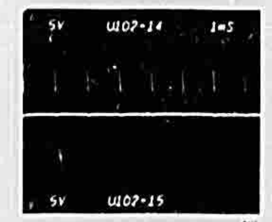


1. U101-3, Anode 3 AC Coupled
U106-2, A DC Coupled
X10 Probe
Internal Positive Sync
Segment Drivers
115.50 MHz - Active
110.50 MHz - Standby

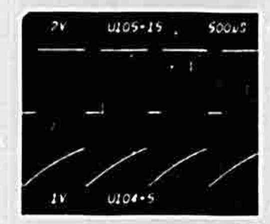


2. U101-3 A3 and U106-17A
X10 Probe
DC Coupled
Internal Positive Sync
115.50 MHz - Active
110.50 MHz - Standby

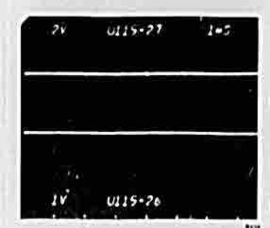
3. U102-2 and U101-18
X10 Probe
DC Coupled
External Positive Sync
A1 Anode Drive



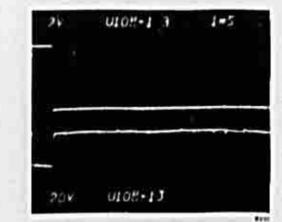
4. U102-14 and U102-15
X10 Probe
AC Coupled
Internal Positive Sync
* +106 Volts Above Ground



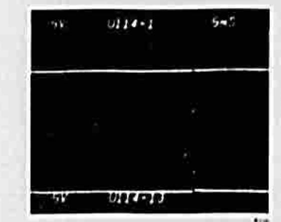
5. U105-15 and U104-5
X10 Probe
DC Coupled
Internal Positive Sync
Display A+ Average Room Light



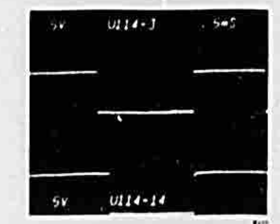
6. U115-27 Reset
U115-26 Clock
X10 Probe
DC Coupled
Internal Positive Sync



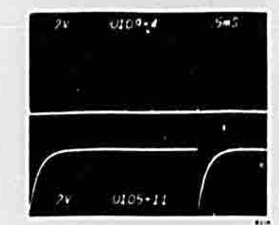
7. U108-18 and U108-13
X10 Probe
DC Coupled
Internal Positive Sync
110.50 MHz Active
Standby Loc



8. U114-1 and U114-13
X10 Probe
DC Coupled
Internal Positive Sync

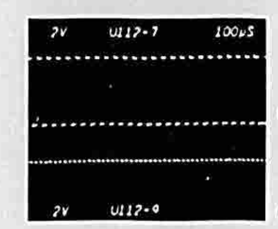


9. U114-3 and U114-14
X10 Probe
DC Coupled
Internal Positive Sync

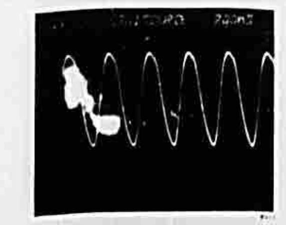


10. U109-4 and U105-11
X10 Probe
DC Coupled
Internal Positive Sync

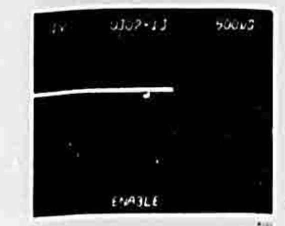
11. TP12 and U116-6
X10 Probe
AC Coupled
Internal Positive Sync
VOR Generator bearing
Set to One Degree



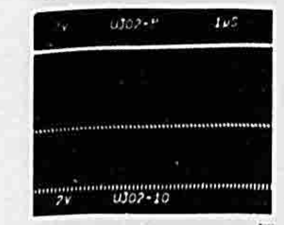
12. U112-7 and U112-9
X10 Probe
DC Coupled
Internal Positive Sync
10° Bearing



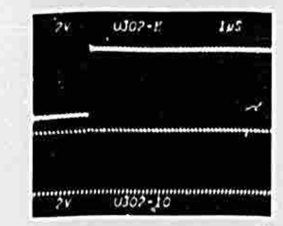
13. Q301 Source
X10 Probe
AC Coupled
Internal Positive Sync



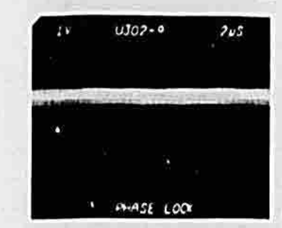
14. U302-13
X10 Probe
DC Coupled
Internal Positive Sync
Synthesizer Enable Gate



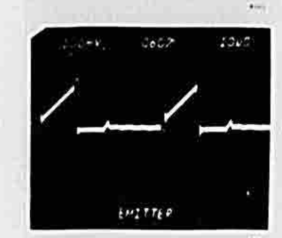
15. U302-8 Mode Control
U302-10 F_{in}
X10 Probe
DC Coupled
Internal Positive Sync
110.50 Active Frequency



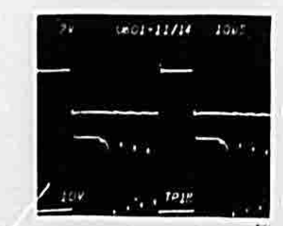
16. U302-8 Mod Control
U302-10 F_{in}
X10 Probe
DC Coupled
Internal Negative Sync
112.95 Active Frequency



17. U302-9
X10 Probe
DC Coupled
Internal Negative Sync
Phase Lock Indicator



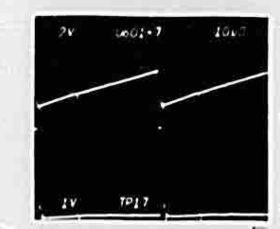
18. Q602 Emitter
X10 Probe
DC Coupled
Internal Positive Sync
Power Supply



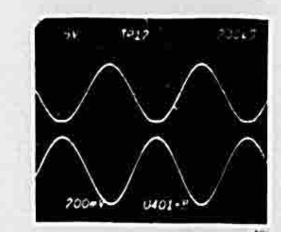
19. U601-11/14 and TP18
X10 Probe
DC Coupled
Internal Positive Sync
Power Supply

20. CR606 Anode and CR605 Anode
X10 Probe
DC Coupled
Internal Positive
Power Supply

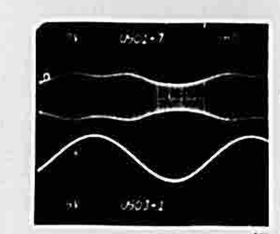
21. CR603 Anode
X10 Probe
DC Coupled
Internal Positive
Power Supply



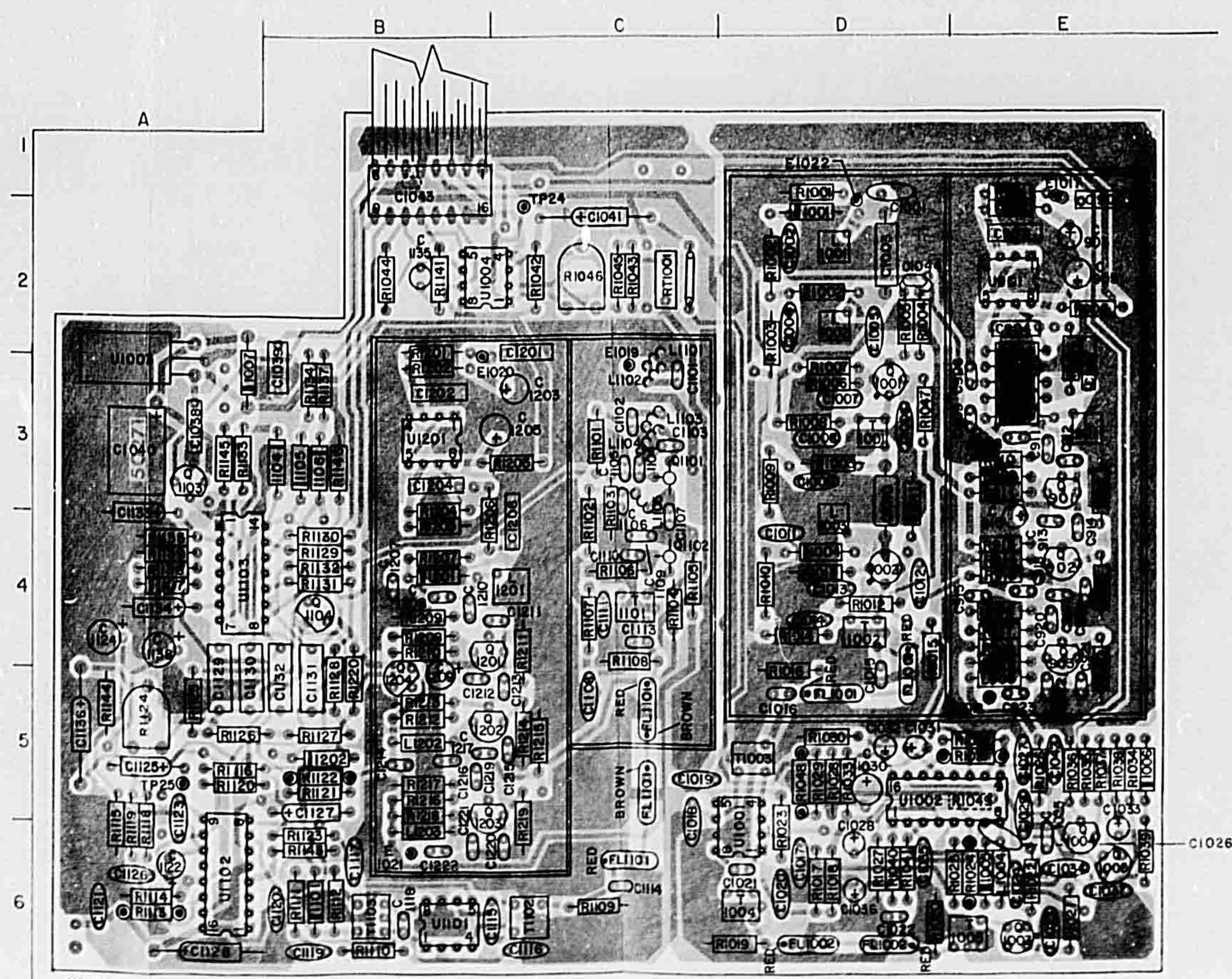
22. U601-7 and TP17
X10 Probe
DC Coupled
Internal Positive Sync
Power Supply



23. TP12 and U401-8
X10 Probe
AC Coupled
Internal Positive Sync
Frequency 115.50 MHz
30 Hz and 9960 Hz Deleted
1020 Hz Mod Only
30% Amplitude
IDENT MODE, 50 mw output
Across 300 ohms



24. U501 AC Coupled
U503-1 DC Coupled
X10 Probe
Internal Positive Sync
Standard Omni Signal
Zero Heading



NOTES:

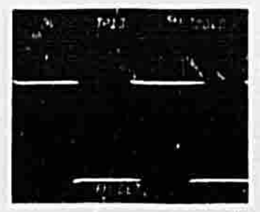
1. ▭ INDICATES DIODE, CR OMITTED FOR CLARITY. BAR INDICATES CATHODE END.

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.

Dwg. No. C-50269-C

FIGURE 6-3. NAV 824/825 RECEIVER (sheet 1 of 2)
(NAV 825 SHOWN)



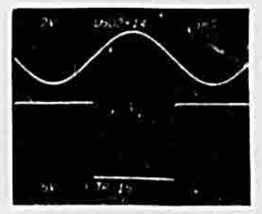
21

TP13 FM Detector

X10 Probe
DC Coupled
Internal Positive Sync

Standard Omni Signal
Zero Heading

GND



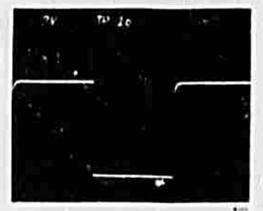
26

U502-14 AC Coupled
TP15 DC Coupled

X10 Probe
Internal Positive Sync

Standard Omni Signal
Zero Heading

GND



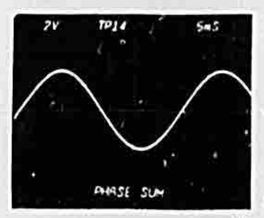
27

TP16

X10 Probe
DC Coupled
Internal Positive Sync

Standard Omni Signal

GND



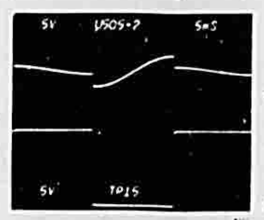
28

TP14

X10 Probe
DC Coupled
Internal Positive Sync

Standard Omni Signal

GND



29

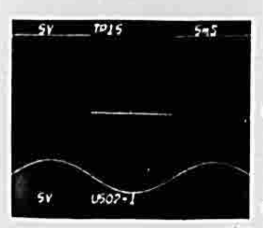
U505-2 and TP15

GND

X10 Probe
DC Coupled
Internal Positive Sync

Standard Omni Signal

GND



30

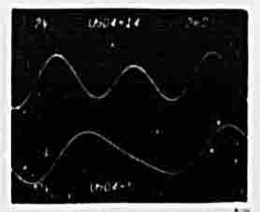
TP15 and U502-1

GND

X10 Probe
DC Coupled
Internal Positive Sync

Standard Omni Signal

GND



31

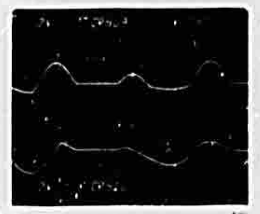
GND

U504-14 and U504-8

X10 Probe
AC Coupled
Internal Positive Sync

Frequency 110.50 MHz

Standard Localizer Signal
On Course Ø ddm



32

CR509 Cathode and CR510 Anode

GND

X10 Probe
AC Coupled
Internal Positive Sync

GND

Standard Localizer Signal
On Course Ø ddm

33

U505-3

GND

X10 Probe
AC Coupled
Internal Positive Sync

Standard Localizer Signal
On Course Ø ddm

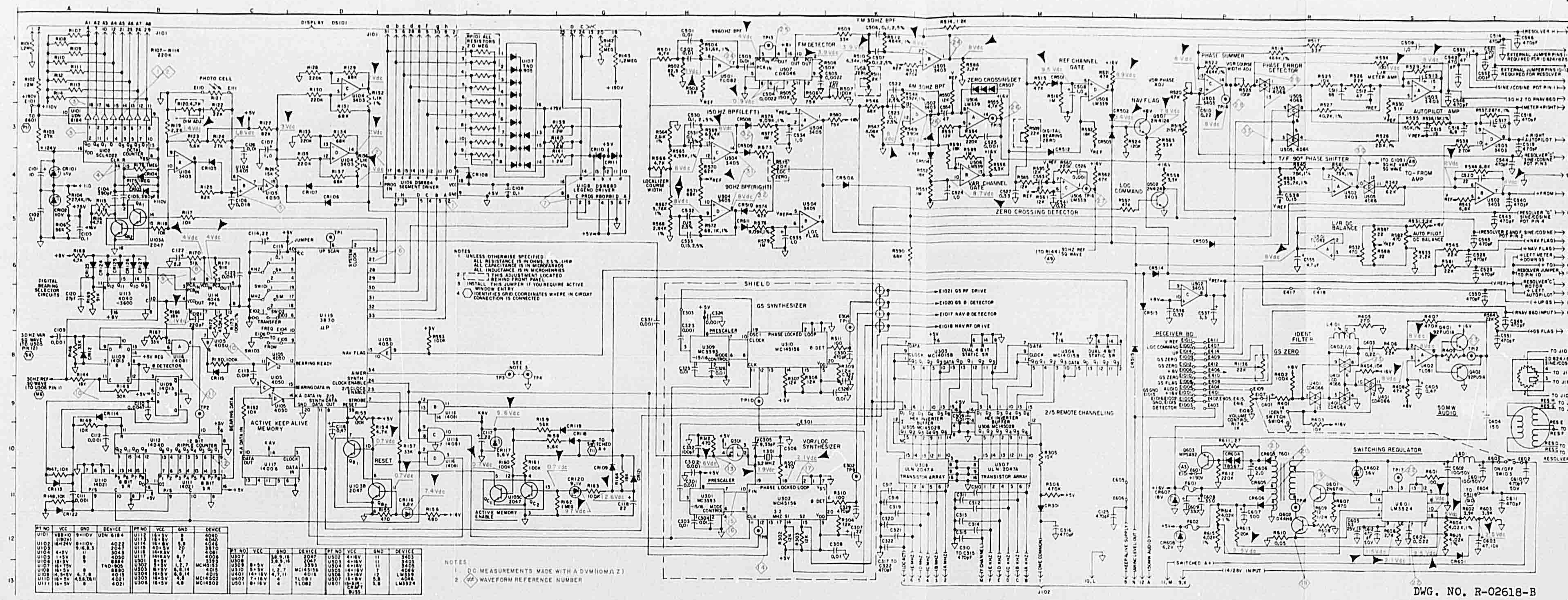


FIGURE 6-2. NAV 824/825 MAIN BOARD (sheet 2 of 2)
(NAV 825 SHOWN)

100's/
600's

M
A
I
N

B
O
A
R
D

34

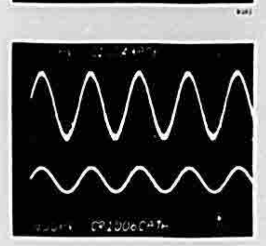
TP24 and U1002-9

GND

X10 Probe
AC Coupled
Internal Positive Probe

GND

Frequency 115.50 MHz
500 uv RF Level
Standard Omni Signal



35

Q1004 Base and CR1006 Cathode

X10 Probe
AC Coupled
GND Internal Positive Sync

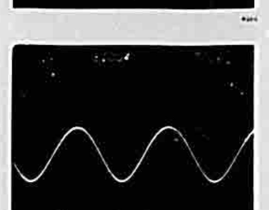
1020 Hz IDENT at 30% Mod
30 Hz and 9960 Hz Signals
GND turned OFF

36

U1102-9 and U1102-15

X10 Probe
GND AC Coupled
Internal Positive Sync

110.30 MHz Active Frequency
GND 500 uv RF Level



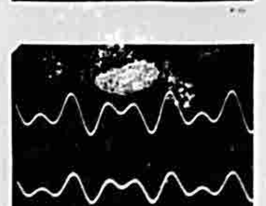
37

E1104

X10 Probe
DC Coupled
Internal Positive Sync

Frequency 115.50 MHz
Modulation: 1020 Hz only
30% Amplitude

GND



38

TP24 and U1002-9

GND

X10 Probe
AC Coupled
Internal Positive Sync

GND

Frequency 110.50 MHz
500 uv
Standard Localizer Signal
on Center

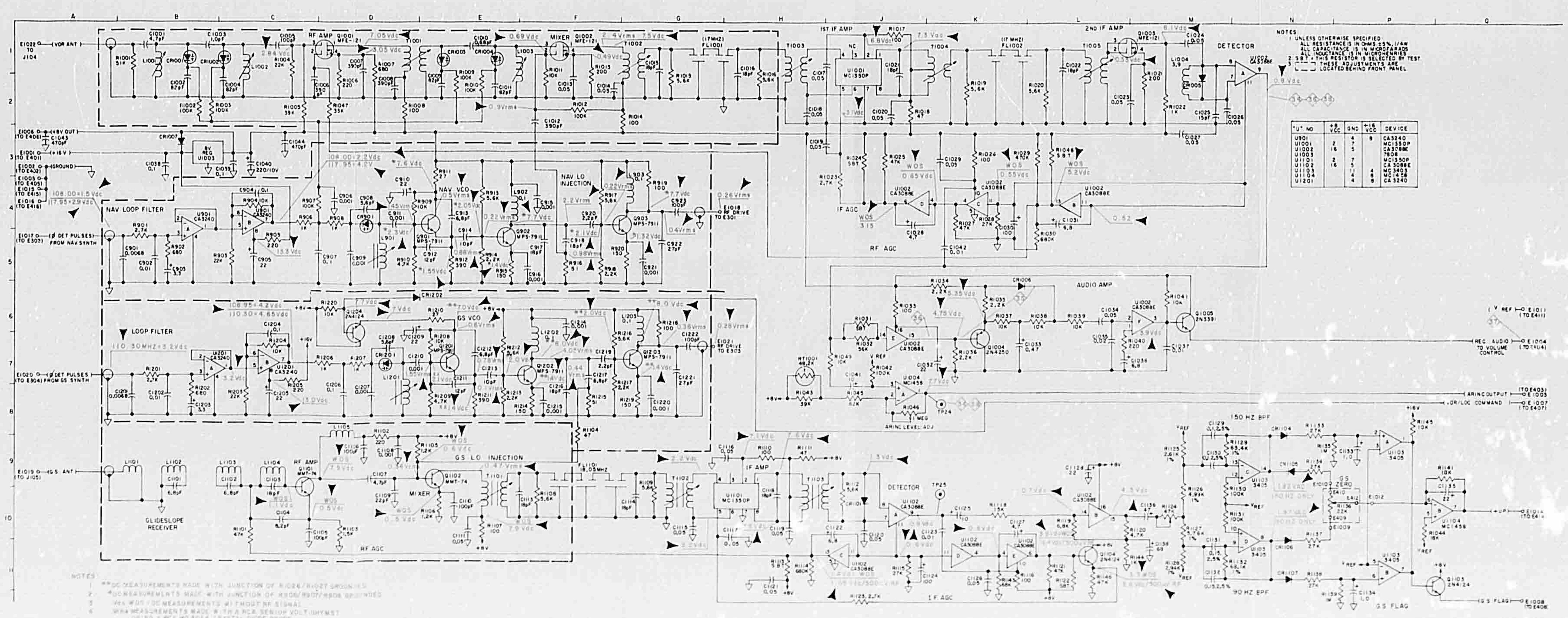


FIGURE 6-3. NAV 824/825 RECEIVER (sheet 2 of 2)
(NAV 825 SHOWN)

900's/
1200's

R
E
C
E
I
V
E
R

NAV 824/825
ELECTRICAL PARTS LIST
LIST NO. 01385-0101G

Action: original, added, changed, deleted. / Chassis Level Code / Symbol Number — Grid Coordinates: Schematic, Component Assy

CAPACITOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A C101	21567-0016	Electrolytic, 10 uF +20%, 25V	E7	A4
o A C102	23113-0112	Met. Polyester, .1 uF +10%, 250V	E7	A5
o A C103	23113-0112	Met. Polyester, .1 uF +10%, 250V	E5	A5
o A C104	24040-0391	Dipped Mica, 390 pF +5%, 500V	E7	A4
o A C105	24040-0391	Dipped Mica, 390 pF +5%, 500V	E7	B5
o A C106	23107-0016	Poly Film, .018 uF +5%, 100V	D3	C5
o A C107	21567-0014	Electrolytic, 1.0 uF +10%, 50V	E3	C3
o A C108	24515-0001	Ceramic Disc, .1 uF +80/-20%, 10V	E4	T4
o A C109	21291-0021	Ceramic Disc, .001 uF +20%, 500V	C6	A7
o A C110	23107-0009	Poly Film, .0047 uF +5%, 100V	C6	B9
o A C111	23107-0001	Poly Film, .001 uF +5%, 100V	C7	A11
o A C112	23107-0001	Poly Film, .001 uF +5%, 100V	C7	A10
o A C113	23107-0016	Poly Film, .018 uF +5%, 100V	C7	C8
o A C114	21564-0034	Tantalum, 22 uF +20%, 15V	D4	C5
o A C115	24515-0001	Ceramic, .1 uF +80/-20%, 10V	D4	C6
o A C116	21564-0157	Tantalum, .47 uF +10%, 35V	D4	D10
o A C117	21564-0034	Tantalum, 22 uF +20%, 15V	D3	F10
o A C118	21564-0146	Tantalum, 10 uF +10%, 20V	D2	G11
o A C120	24052-0270	Dipped Mica, 27 pF +5%, 500V	B7	A7
o A C121	24052-0221	Dipped Mica, 220 pF +5%, 300V	C7	B7
o A C122	21564-0028	Tantalum, 2.2 uF +20%, 15V	C6	B6
o A C123	23107-0121	Poly Film, .047 uF +10%, 100V	C7	C6
o A C125	24551-0002	Ceramic, 470 pF +20%, 50V	A3	N11
o A C126	21291-0030	Ceramic, .01 uF +20%, 50V	E3	C3
o A C301	24551-0003	Ceramic, .001 uF +100/-0%, 50V	D5	H11
o A C302	24551-0003	Ceramic, .001 uF +100/-0%, 50V	D4	H10
o A C303	24550-2103	Ceramic, .01 uF +10%, 100V	C5	H12
o A C304	24550-2103	Ceramic, .01 uF +10%, 100V	D5	H12
o A C305	22057-0004	Trimmer 5-30 pF, 100V	D5	J10
o A C306	24052-0101	Dipped Mica, 100 pF +5%, 300V	D5	J10
o A C307	21564-0034	Tantalum, 22 uF +20%, 15V	D5	K12
o A C308	24550-2103	Ceramic, .01 uF +10%, 100V	C4	K12
o A C309	24550-2103	Ceramic, .01 uF +10%, 100V	B3	L9
o A C310	24551-0002	Ceramic, 470 pF +20%, 50V	A2	L11
o A C311	24551-0002	Ceramic, 470 pF +20%, 50V	A2	L11
o A C312	24551-0002	Ceramic, 470 pF +20%, 50V	A2	L11
o A C313	24551-0002	Ceramic, 470 pF +20%, 50V	A3	L12
o A C314	24551-0002	Ceramic, 470 pF +20%, 50V	A3	L12
o A C315	24551-0002	Ceramic, 470 pF +20%, 50V	A3	L12
o A C316	24551-0002	Ceramic, 470 pF +20%, 50V	A1	M12
o A C317	24551-0002	Ceramic, 470 pF +20%, 50V	A2	K11
o A C318	24551-0002	Ceramic, 470 pF +20%, 50V	A2	K11
o A C319	24551-0002	Ceramic, 470 pF +20%, 50V	A2	K11
o A C320	24551-0002	Ceramic, 470 pF +20%, 50V	A3	K12
o A C321	24551-0002	Ceramic, 470 pF +20%, 50V	A3	K12
o A C322	24551-0002	Ceramic, 470 pF +20%, 50V	A3	K12
o A C323	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C4	H7
o A C324	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C4	H7
o A C325	24550-2103	Ceramic, .01 uF +10%, 100V	C4	H8
o A C326	24550-2103	Ceramic, .01 uF +10%, 100V	C4	H8
o A C327	21564-0034	Tantalum, 22 uF +20%, 15V	C4	K8
o A C328	24550-2103	Ceramic, .01 uF +10%, 100V	C4	K9
o A C329	24551-0002	Ceramic, 470 pF +20%, 50V	D4	K11
o A C330	24551-0002	Ceramic, 470 pF +20%, 50V	C5	K8
o A C331	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C5	G7
o A C332	24052-0101	Dipped Mica, 100 pF +5%, 300V	D4	H10
o A C401	21555-0026	Tantalum, 10 uF +20%, 20V	C2	P9
o A C402	23113-0005	Met. Polyester, 1.0 uF +5%, 100V	B2	R8
o A C403	23107-0129	Mylar, .22 uF +10%, 63V	B2	S8
o A C404	21567-0021	Electrolytic, 150 uF +75/-10%, 50V	A2	T9
o A C405	21564-0057	Tantalum, .47 uF +20%, 35V	A1	S9

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CAPACITOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A C501	23109-5103	Poly Film, .01 uF +5%, 100V	A3	H1
o A C502	23109-5103	Poly Film, .01 uF +5%, 100V	A3	H1
o A C503	23107-0013	Poly Film, .01 uF +5%, 100V	B3	J1
o A C504	23107-0005	Poly Film, .0022 uF +5%, 100V	B3	J2
o A C505	23107-0005	Poly Film, .0022 uF +5%, 100V	B3	K2
o A C506	23109-2104	Poly Film, .1 uF +2.5%, 100V	B4	K1
o A C507	23109-2104	Poly Film, .1 uF +2.5%, 100V	B4	K1
o A C508	21564-0059	Tantalum, 1 uF +20%, 35V	C4	M2
o A C509	23113-0005	Met. Polyester, 1.0 uF +5%, 100V	B5	S1
o A C510	23109-5223	Poly Film, .022 uF +5%, 100V	A5	P3
o A C511	21564-0037	Tantalum, 68 uF +20%, 15V	A4	R2
o A C512	21564-0036	Tantalum, 47 uF +20%, 15V	A3	R2
o A C513	21564-0033	Tantalum, 15 uF +20%, 15V	A3	S2
o A C514	24551-0002	Ceramic, 470 pF +20%, 50V	A4	T1
o A C515	21564-0033	Tantalum, 15 uF +20%, 15V	B5	S3
o A C516	21564-0131	Tantalum, 6.8 uF +10%, 15V	B4	T3
o A C517	21564-0140	Tantalum, 1 uF +10%, 20V	A4	T3
o A C518	24551-0002	Ceramic, 470 pF +20%, 50V	A5	T3
o A C519	24551-0002	Ceramic, 470 pF +20%, 50V	A6	T3
o A C520	21564-0034	Tantalum, 22 uF +20%, 15V	C5	T4
o A C521	24551-0002	Ceramic, 470 pF +20%, 50V	A5	T1
o A C522	23109-2104	Poly Film, .1 uF +2.5%, 100V	C5	K2
o A C523	23109-2104	Poly Film, .1 uF +2.5%, 100V	C5	K3
o A C524	21564-0059	Tantalum, 1 uF +20%, 35V	C4	L4
o A C525	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C4	L3
o A C526	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C4	M4
o A C527	23109-5334	Poly Film, .33 uF +5%, 50V	D2	L4
o A C528	24551-0002	Ceramic, 470 pF +20%, 50V	A6	T6
o A C529	24551-0002	Ceramic, 470 pF +20%, 50V	A6	T6
o A C530	23109-2104	Poly Film, .1 uF +2.5%, 100V	C2	H3
o A C531	23109-2104	Poly Film, .1 uF +2.5%, 100V	C3	H3
o A C532	23109-2154	Poly Film, .15 uF +2.5%, 50V	C3	H5
o A C533	23109-2154	Poly Film, .15 uF +2.5%, 50V	C2	H6
o A C534	21564-0059	Tantalum, 1 uF +20%, 35V	C2	J3
o A C535	21564-0059	Tantalum, 1 uF +20%, 35V	C2	J6
o A C536	23107-0031	Poly Film, .33 uF +5%, 63V	C5	N7
o A C537	21564-0033	Tantalum, 15 uF +20%, 15V	A6	P7
o A C538	23107-0027	Poly Film, .15 uF +5%, 100V	B5	R5
o A C539	21564-0036	Tantalum, 47 uF +20%, 15V	B5	T1
o A C540	24551-0002	Ceramic, 470 pF +20%, 50V	A5	T5
o A C541	24556-0224	Ceramic, .22 uF +20%, 25V	C3	M5
o A C542	24551-0002	Ceramic, 470 pF +20%, 50V	A5	S1
o A C543	24551-0002	Ceramic, 470 pF +20%, 50V	A5	T5
o A C544	24551-0002	Ceramic, 470 pF +20%, 50V	A5	T4
o A C545	24551-0002	Ceramic, 470 pF +20%, 50V	A5	T6
o A C546	24551-0002	Ceramic, 470 pF +20%, 50V	A5	T1
o A C548	24551-0002	Ceramic, 470 pF +20%, 50V	A6	T2
o A C549	24551-0002	Ceramic, 470 pF +20%, 50V	A6	T7
o A C550	24551-0002	Ceramic, 470 pF +20%, 50V	A6	T7
o A C551	24551-0002	Ceramic, 470 pF +20%, 50V	A5	T8
o A C552	24551-0002	Ceramic, 470 pF +20%, 50V	B5	T2
o A C553	21564-0036	Tantalum, 47 uF +20%, 15V	C1	M4
o A C554	21564-0036	Tantalum, 47 uF +20%, 15V	B4	L3
o A C601	21567-0009	Electrolytic, 100 uF +75/-10%, 50V	A4	T11
o A C602	21567-0009	Electrolytic, 100 uF +75/-10%, 50V	A6	T11
o A C603	21567-0017	Electrolytic, 47 uF +20%, 10V	B5	T12
o A C604	23107-0117	Poly Film, .022 uF +10%, 100V	B5	S12
o A C605	21567-0010	Electrolytic, 3.3 uF +20%, 25V	B7	R12
o A C606	21554-0070	Electrolytic, 2.0 uF +50/-10%, 250V	B6	P11
o A C607	21554-0071	Electrolytic, 500 uF +75/-10%, 16V	B6	P11
o A C608	21567-0023	Electrolytic, 330 uF +75/-10%, 35V	A7	P11
o A C609	21567-0023	Electrolytic, 330 uF +75/-10%, 35V	B5	P11
o A C610	24551-0002	Ceramic, 470 pF +20%, 50V	A3	T11
o A C611	24551-0002	Ceramic, 470 pF +20%, 50V	A3	T11
o A C612	24551-0002	Ceramic, 470 pF +20%, 50V	B7	S12

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DIODE

Symbol	Part Number	Description	Comp. Assy	Schematic
o A CR101	75027-0014	Zener, 14V +5%, 1N4108	C7	A4
o A CR102	75025-0028	Zener, 110V +5%, 1N5272B	C7	A5
o A CR103	75028-0001	Silicon, 1N4149	E6	B4
o A CR104	75028-0001	Silicon, 1N4149	E6	B4
o A CR105	75028-0001	Silicon, 1N4149	D3	C4
o A CR106	75028-0001	Silicon, 1N4149	E3	D4
o A CR107	75028-0001	Silicon, 1N4149	E3	D4
o A CR108	75062-0005	Silicon, 1N4005	E4	F4
o A CR109	75028-0001	Silicon, 1N4149	D2	G10
o A CR110	75216-0003	Silicon, FAST RECOVERY	E4	G4
o A CR111	75216-0003	Silicon, FAST RECOVERY	E4	G4
o A CR112	75028-0001	Silicon, 1N4149	C6	A8
o A CR113	75028-0001	Silicon, 1N4149	C6	A11
o A CR114	75028-0001	Silicon, 1N4149	C7	A9
o A CR115	75028-0001	Silicon, 1N4149	C7	C9
o A CR116	75025-0025	Zener, 6.8V +5%, 1N4736A	D2	E11
o A CR117	75027-0004	Zener, 5.6V +5%, 1N752A	D3	F10
o A CR118	75028-0001	Silicon, 1N4149	E2	G10
o A CR119	75028-0001	Silicon, 1N4149	D2	G10
o A CR120	75025-0007	Zener, 9.1V +5%, 1N4739A	D2	G11
o A CR121	75028-0001	Silicon, 1N4149	E2	G11
o A CR122	75028-0001	Silicon, 1N4149	C6	A11
o A CR123	75028-0001	Silicon, 1N4149	C7	A6
o A CR124	75028-0001	Silicon, 1N4149	C7	A6
o A CR125	75028-0001	Silicon, 1N4149	C7	B6
o A CR126	75018-0001	Silicon, 1N4149	C7	B6
o A CR127	75028-0001	Silicon, 1N4149	C7	B6
o A CR301	75062-0005	Silicon, 1N4005	B2	M11
o A CR501	75028-0001	Silicon, 1N4149	B4	M2
o A CR502	75028-0001	Silicon, 1N4149	C3	N3
o A CR503	75028-0001	Silicon, 1N4149	C2	N3
o A CR504	75028-0001	Silicon, 1N4149	C4	L4
o A CR505	75028-0001	Silicon, 1N4149	C4	P6
o A CR506	75028-0001	Silicon, 1N4149	C3	K4
o A CR507	75036-0003	Silicon, Multi-Pellet	C3	L2
o A CR508	75028-0001	Silicon, 1N4149	C2	J3
o A CR509	75028-0001	Silicon, 1N4149	D2	J3
o A CR510	75028-0001	Silicon, 1N4149	D2	J5
o A CR511	75028-0001	Silicon, 1N4149	B2	J5
o A CR512	75028-0001	Silicon, 1N4149	C4	M4
o A CR513	75028-0001	Silicon, 1N4149	C5	N7
o A CR514	75028-0001	Silicon, 1N4149	C4	N6
o A CR515	75028-0001	Silicon, 1N4149	A4	N8
o A CR601	75028-0001	Silicon, 1N4149	C6	T13
o A CR602	75220-3610	Zener, 36V	B7	S11
o A CR603	75062-0007	Silicon, 1N4007	A6	P10
o A CR604	75036-0001	Multi-Pellet	B5	P10
o A CR605	75216-0003	Silicon, FAST RECOVERY	A6	P11
o A CR606	75224-0001	Rectifier, Hot Carrier 1N5817	A7	P11
o A CR607	75025-0009	Zener, 18V +5%, 1N4746A	A6	N11
o A CR608	75025-0015	Zener, 6.2V +5%, 1N4735A	A5	N12
o A DS101	50226-0001	DISPLAY, Gas Discharge		D1

FUSE

Symbol	Part Number	Description	Comp. Assy	Schematic
o A F601	66516-0010	Sub miniature, Axial Leads 1/2 Amp	B6	P11
o A F602	66516-0010	Sub miniature, Axial Leads 1/2 Amp	B6	P12

CONNECTOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A J101	50231-0001	Display, 31 contacts	F6	B1
o A J102		Rear Connectors Part of Main PC Board	A3	M13
o A J103		Rear Connectors Part of Main PC Board	A6	U1

INDUCTOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A L401	11488-0003	Adjustable (IDENT)	B2	R7
o A L601	11487-0001	Choke, Filter (Input)	A5	T10

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TRANSISTOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A Q301	75661-0002	FET	D4	H10
o A Q401	75658-0003	NPN 92PU01A	A2	S7
o A Q402	75658-0004	PNP, 92P151A	A2	T8
o A Q501	75561-0036	Silicon, NPN, 2N4124	C2	N3
o A Q502	75561-0036	Silicon, NPN, 2N4124	C2	N4
o A Q601	75688-0003	Audio Power, NPN, 2N6718	B5	R11
o A Q602	75812-0004	Silicon, Power NPN, D44H8	B7	R12
o A Q603	75676-0003	High Voltage PNP, MPSA92	B5	P10

RESISTOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A R101	31218-0125	Carbon Film, 1.2 Meg +5%, 1/4W	E7	A1
o A R102	31218-0125	Carbon Film, 1.2 Meg +5%, 1/4W	E7	A2
o A R103	31218-0273	Carbon Film, 27K +5%, 1/4W	E6	A3
o A R104	31199-0343	Precision Film, 27.4K +1%, 1/4W	E6	A5
o A R106	31218-0563	Carbon Film, 56K +5%, 1/4W	F6	A5
o A R107	31218-0224	Carbon Film, 220K +5%, 1/4W	E6	A1
o A R108	31218-0224	Carbon Film, 220K +5%, 1/4W	E6	A1
o A R109	31218-0224	Carbon Film, 220K +5%, 1/4W	E6	A1
o A R110	31218-0224	Carbon Film, 220K +5%, 1/4W	E6	A1
o A R111	31218-0224	Carbon Film, 220K +5%, 1/4W	E6	A2
o A R112	31218-0224	Carbon Film, 220K +5%, 1/4W	E6	A2
o A R113	31218-0224	Carbon Film, 220K +5%, 1/4W	E6	A2
o A R114	31218-0224	Carbon Film, 220K +5%, 1/4W	E5	A2
o A R115	31218-0472	Carbon Film, 4.7K +5%, 1/4W	D2	A5
o A R116	31218-0472	Carbon Film, 4.7K +5%, 1/4W	D2	A5
o A R117	31218-0103	Carbon Film, 10K +10%, 1/4W	E5	B5
o A R118	31218-0103	Carbon Film, 10K +10%, 1/4W	E5	B5
o A R119	31218-0222	Carbon Film, 2.2K +5%, 1/4W	D3	B3
o A R120	32054-0003	Variable Trimmer, 4.7K	F2	B2
o A R121	31217-0001	Photocell	F7	C2
o A R122	31218-0223	Carbon Film, 22K +5%, 1/4W	F2	C3
o A R123	31218-0562	Carbon Film, 5.6K +5%, 1/4W	D3	B3
o A R124	31218-0273	Carbon Film, 27K +5%, 1/4W	E3	C3
o A R125	31218-0823	Carbon Film, 82K +5%, 1/4W	D3	C4
o A R126	31218-0153	Carbon Film, 15K +5%, 1/4W	E3	C4
o A R127	31218-0823	Carbon Film, 82K +5%, 1/4W	E3	C3
o A R128	31218-0224	Carbon Film, 220K +5%, 1/4W	E3	D2
o A R129	31218-0683	Carbon Film, 68K +5%, 1/4W	E3	D2
o A R130	31218-0224	Carbon Film, 220K +5%, 1/4W	E3	D2
o A R131	31218-0683	Carbon Film, 68K +5%, 1/4W	E3	D3
o A R132	31199-0205	Precision Film, 1.1K +1%, 1/4W	E3	D2
o A R133	31218-0224	Carbon Film, 220K +5%, 1/4W	E3	D3
o A R134	31218-0683	Carbon Film, 68K +5%, 1/4W	E3	D3
o A R135	31218-0224	Carbon Film, 220K +5%, 1/4W	E3	D4
o A R136	31199-0205	Precision Film, 1.1K +1%, 1/4W	E3	D4
o A R137	31218-0683	Carbon Film, 68K +5%, 1/4W	E3	D4
o A R139	31218-0125	Carbon Film, 1.2 Meg +5%, 1/4W	E5	F3
o A R140	31218-0125	Carbon Film, 1.2 Meg +5%, 1/4W	F6	F3
o A R141	31218-0125	Carbon Film, 1.2 Meg +5%, 1/4W	E5	F4
o A R142	31218-0125	Carbon Film, 1.2 Meg +5%, 1/4W	E7	G1
o A R143	31218-0125	Carbon Film, 1.2 Meg +5%, 1/4W	E7	G1
o A R144	31218-0183	Carbon Film, 18K +5%, 1/4W	C6	A8
o A R145	31218-0303	Carbon Film, 30K +5%, 1/4W	C7	B9
o A R146	31218-0333	Carbon Film, 33K +5%, 1/4W	C6	A8
o A R147	31218-0103	Carbon Film, 10K +5%, 1/4W	C7	A11
o A R148	31218-0103	Carbon Film, 10K +5%, 1/4W	D7	A9
o A R149	31218-0103	Carbon Film, 10K +5%, 1/4W	C7	A9
o A R150	31218-0104	Carbon Film, 100K +5%, 1/4W	C7	C8
o A R152	31218-0103	Carbon Film, 10K +5%, 1/4W	D6	C9
o A R153	31218-0124	Carbon Film, 120K +5%, 1/4W	D3	D9
o A R154	31218-0472	Carbon Film, 4.7K +5%, 1/4W	D2	D10
o A R155	31218-0471	Carbon Film, 470 +5%, 1/4W	D2	E11
o A R156	31218-0681	Carbon Film, 680 +5%, 1/4W	D2	E11
o A R157	31218-0333	Carbon Film, 33K +5%, 1/4W	D3	E10
o A R158	31218-0562	Carbon Film, 5.6K +5%, 1/4W	E2	F10
o A R159	31218-0563	Carbon Film, 56K +5%, 1/4W	D2	F9
o A R160	31218-0104	Carbon Film, 100K +5%, 1/4W	D2	F10
o A R161	31218-0104	Carbon Film, 100K +5%, 1/4W	E1	F10

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Symbol	Part Number	Description	Comp. Assy	Schematic
o A R162	31218-0105	Carbon Film, 1 Meg +5%, 1/4W	D3	G11
o A R163	31218-0104	Carbon Film, 100K +5%, 1/4W	D2	G11
o A R164	31218-0333	Carbon Film, 33K +5%, 1/4W	E2	G11
o A R166	31218-0183	Carbon Film, 18K +5%, 1/4W	C5	B7
o A R167	31218-0333	Carbon Film, 33K +5%, 1/4W	C5	B8
o A R168	31218-0472	Carbon Film, 4.7K +5%, 1/4W	C5	A6
o A R169	31218-0913	Carbon Film, 91K +5%, 1/4W	C7	A7
o A R170	31218-0513	Carbon Film, 51K +5%, 1/4W	C7	B6
o A R171	31218-0913	Carbon Film, 91K +5%, 1/4W	C6	C6
o A R172	31199-0366	Precision Film, 47.5K +1%, 1/4W	C7	C7
o A R173	31199-0401	Precision Film, 100K +1%, 1/4W	C7	C7
o A R174	32070-0005	Variable, 1K, w/SPST Switch	F3	P10
o A R175	31218-0105	Carbon Film, 1 Meg +5%, 1/4W	E6	B4
o A R176	31218-0105	Carbon Film, 1 Meg +5%, 1/4W	E6	B4
o A R301	31218-0471	Carbon Film, 470 +5%, 1/4W	D5	J10
o A R302	31218-0123	Carbon Film, 12K +5%, 1/4W	D3	J12
o A R303	31218-0123	Carbon Film, 12K +5%, 1/4W	D4	J12
o A R304	31218-0123	Carbon Film, 12K +5%, 1/4W	D4	K12
o A R305	31218-0103	Carbon Film, 10K +5%, 1/4W	B3	M10
o A R306	31218-0473	Carbon Film, 47K +5%, 1/4W	B2	M11
o A R307	31218-0123	Carbon Film, 12K +5%, 1/4W	D4	J9
o A R308	31218-0123	Carbon Film, 12K +5%, 1/4W	D4	J9
o A R309	31218-0123	Carbon Film, 12K +5%, 1/4W	C4	K8
o A R310	31218-0101	Carbon Film, 100 +5%, 1/4W	D4	K11
o A R311	31218-0101	Carbon Film, 100 +5%, 1/4W	C4	K8
o A R312	31218-0471	Carbon Film, 470 +5%, 1/4W	D4	H10
o A R401	31218-0102	Carbon Film, 1K +5%, 1/4W	C2	R9
o A R402	31218-0104	Carbon Film, 100K +5%, 1/4W	C2	R8
o A R403	31218-0103	Carbon Film, 10K +5%, 1/4W	C2	R9
o A R404	31218-0103	Carbon Film, 10K +5%, 1/4W	C2	S8
o A R405	31218-0271	Carbon Film, 270 +5%, 1/4W	B2	S7
o A R406	31218-0223	Carbon Film, 22K +5%, 1/4W	B2	S8
o A R407	31218-0474	Carbon Film, 470K +5%, 1/4W	B2	S7
o A R408	31218-0473	Carbon Film, 47K +5%, 1/4W	A2	S9
o A R409	31218-0102	Carbon Film, 1K +5%, 1/4W	A2	S8
o A R501	31218-0472	Carbon Film, 4.7K +5%, 1/4W	A3	H1
o A R502	31199-0089	Precision Film, 82.5 +1%, 1/4W	B3	H2
o A R503	31218-0333	Carbon Film, 33K +5%, 1/4W	B3	H2
o A R504	31199-0349	Precision Film, 31.6K +1%, 1/4W	B3	H1
o A R505	31218-0154	Carbon Film, 150K +5%, 1/4W	B4	J2
o A R506	31218-0753	Carbon Film, 75K +5%, 1/4W	B4	J2
o A R507	32054-0011	Variable Trimmer, 100K	B4	K2
o A R508	31218-0154	Carbon Film, 150K +5%, 1/4W	B3	J2
o A R509	31218-0333	Carbon Film, 33K +5%, 1/4W	B4	K1
o A R510	31199-0278	Precision Film, 6.34K +1%, 1/4W	B4	K1
o A R511	32091-0105	Variable, 2K	F2	K2
o A R512	31199-0465	Precision Film, 464K +1%, 1/4W	B4	K1
o A R513	31218-0474	Carbon Film, 470K +5%, 1/4W	B4	K2
o A R514	31218-0122	Carbon Film, 1.2K +5%, 1/4W	A5	L1
o A R515	31218-0473	Carbon Film, 47K +5%, 1/4W	B4	M2
o A R516	31218-0105	Carbon Film, 1 Meg +5%, 1/4W	C3	M2
o A R517	31218-0333	Carbon Film, 33K +5%, 1/4W	A5	R1
o A R518	31199-0465	Precision Film, 464K +1%, 1/4W	A5	R1
o A R519	31199-0433	Precision Film, 215K +1%, 1/4W	A5	N3
o A R520	32054-0006	Variable Trimmer, 47K	A5	N2
o A R521	31218-0473	Carbon Film, 47K +5%, 1/4W	C3	N2
o A R522	31199-0465	Precision Film 464K +1%, 1/4W	A5	P1
o A R523	32054-0012	Variable Trimmer, 100K	B4	P2
o A R524	31218-0124	Carbon Film, 120K +5%, 1/4W	C2	N3
o A R525	31218-0103	Carbon Film, 10K +5%, 1/4W	B4	R2
o A R526	31218-0223	Carbon Film, 22K +5%, 1/4W	B3	R2
o A R527	31199-0359	Precision Film, 40.2K +1%, 1/4W	B4	R3
o A R528	31199-0434	Precision Film, 221K +1%, 1/4W	B4	S3
o A R529	31218-0513	Carbon Film, 51K +5%, 1/4W	A4	S2
o A R530	31218-0513	Carbon Film, 51K +5%, 1/4W	A4	S2
o A R531	31218-0222	Carbon Film, 2.2K +5%, 1/4W	A4	S5
o A R532	32054-0002	Variable, 470	A4	R6
o A R533	31218-0222	Carbon Film, 2.2K +5%, 1/4W	A4	S6

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LIST NO. 01385-0101G

RESISTOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A R535	31199-0418	Precision Film, 150K +1%, 1/4W	B5	S3
o A R536	31199-0312	Precision Film, 13K +1%, 1/4W	A5	S3
o A R537	31199-0442	Precision Film, 267K +1%, 1/4W	C5	T2
o A R538	31218-0274	Carbon Film, 270K +5%, 1/4W	A4	T3
o A R539	31199-0354	Precision Film, 35.7K +1%, 1/4W	B4	R4
o A R540	31199-0385	Precision Film, 75K +1%, 1/4W	B5	R4
o A R541	31199-0385	Precision Film, 75K +1%, 1/4W	B4	R4
o A R542	31218-0623	Carbon Film, 62K +5%, 1/4W	B5	S4
o A R543	31218-0682	Carbon Film, 6.8K +5%, 1/4W	B5	T5
o A R544	31218-0682	Carbon Film, 6.8K +5%, 1/4W	B5	T4
o A R545	31218-0223	Carbon Film, 22K +5%, 1/4W	A5	S6
o A R546	31218-0683	Carbon Film, 68K +5%, 1/4W	B4	K2
o A R547	31199-0288	Precision Film, 8.06K +1%, 1/4W	C5	K3
o A R548	31199-0458	Precision Film, 392K +1%, 1/4W	C5	K2
o A R549	31218-0394	Carbon Film, 390K +5%, 1/4W	C5	K3
o A R550	31218-0123	Carbon Film, 12K +5%, 1/4W	C4	L2
o A R551	31218-0123	Carbon Film, 12K +5%, 1/4W	C5	L3
o A R552	31218-0183	Carbon Film, 18K +5%, 1/4W	C4	L4
o A R553	31218-0105	Carbon Film, 1 Meg +5%, 1/4W	C4	L4
o A R554	31218-0224	Carbon Film, 220K +5%, 1/4W	C4	L3
o A R555	31218-0472	Carbon Film, 4.7K +5%, 1/4W	C4	L2
o A R556	31218-0332	Carbon Film, 3.3K +5%, 1/4W	C3	L4
o A R557	31218-0473	Carbon Film, 47K +5%, 1/4W	C2	N5
o A R558	31218-0332	Carbon Film, 3.3K +5%, 1/4W	C2	N4
o A R559	32091-0108	Variable, 20K	F2	M3
o A R560	31218-0224	Carbon Film, 220K +5%, 1/4W	C3	M4
o A R561	31218-0123	Carbon Film, 12K +5%, 1/4W	C3	M5
o A R562	31218-0473	Carbon Film, 47K +5%, 1/4W	C3	N4
o A R563	31218-0333	Carbon Film, 33K +5%, 1/4W	C5	N3
o A R564	31199-0241	Precision Film, 2.61K +1%, 1/4W	C3	H3
o A R565	31199-0268	Precision Film, 4.99K +1%, 1/4W	C3	H4
o A R566	32054-0004	Variable Trimmer, 4.7K	C3	H4
o A R567	31199-0274	Precision Film, 5.76K +1%, 1/4W	C3	H5
o A R568	31199-0246	Precision Film, 2.94K +1%, 1/4W	C3	H5
o A R569	31199-0378	Precision Film, 63.4K +1%, 1/4W	C3	H3
o A R570	31218-0623	Carbon Film, 62K +5%, 1/4W	B3	H4
o A R571	31218-0683	Carbon Film, 68K +5%, 1/4W	C3	H4
o A R572	31199-0381	Precision Film, 68.1K +1%, 1/4W	B3	H5
o A R573	31218-0473	Carbon Film, 47K +5%, 1/4W	D2	J3
o A R574	31218-0473	Carbon Film, 47K +5%, 1/4W	D2	J5
o A R575	32091-0108	Variable, 20K	F2	J4
o A R576	31218-0103	Carbon Film, 10K +5%, 1/4W	C2	J3
o A R577	31218-0105	Carbon Film, 1 Meg +5%, 1/4W	C2	J3
o A R578	31218-0103	Carbon Film, 10K +5%, 1/4W	C2	J5
o A R579	31218-0105	Carbon Film, 1 Meg +5%, 1/4W	C2	J6
o A R580	31218-0753	Carbon Film, 75K +5%, 1/4W	B3	K3
o A R581	31218-0223	Carbon Film, 22K +5%, 1/4W	A5	S6
o A R582	32054-0002	Variable Trimmer, 470	A4	S5
o A R584	31218-0223	Carbon Film, 22K +5%, 1/4W	B3	T7
o A R585	31218-0123	Carbon Film, 12K +5%, 1/4W	D2	M4
o A R586	31218-0222	Carbon Film, 2.2K +5%, 1/4W	D2	L2
o A R587	31218-0220	Carbon Film, 22 +5%, 1/4W	A5	S5
o A R588	31218-0220	Carbon Film, 22 +5%, 1/4W	A5	S6
o A R589	31218-0105	Carbon Film, 1 Meg +5%, 1/4W	C4	L4
o A R590	31218-0683	Carbon Film, 68K +5%, 1/4W	C2	K6
o A R591	31218-0183	Carbon Film, 18K +5%, 1/4W	C3	L3
o A R592	31218-0183	Carbon Film, 18K +5%, 1/4W	C3	M3
o A R593	31218-0104	Carbon Film, 100K +5%, 1/4W	C3	E8
o A R594	31218-0470	Carbon Film, 47K +5%, 1/4W	A6	S1
o A R595	31218-0123	Carbon Film, 12K +5%, 1/4W	C3	M4
o A R601	31218-0101	Carbon Film, 100 +5%, 1/4W	C6	S11
o A R602	31218-0392	Carbon Film, 3.9K +5%, 1/4W	B6	T11
o A R603	31218-0392	Carbon Film, 3.9K +5%, 1/4W	C5	T11
o A R604	31199-0259	Precision Film, 4.02K +1%, 1/4W	B6	T12
o A R605	31199-0259	Precision Film, 4.02K +1%, 1/4W	B6	T12
o A R606	31218-0272	Carbon Film, 2.7K +5%, 1/4W	B6	S12
o A R607	31218-0471	Carbon Film, 470 +5%, 1/4W	B6	R11
o A R608	31218-0150	Carbon Film, 15 +5%, 1/4W	B7	R12
o A R609	31149-0120	Carbon, 12 +5%, 1/2W	B6	R11
o A R610	31230-0002	Beryllium Oxide, 105 +3%, 2W	B6	R12

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RESISTOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A R611	31218-0270	Carbon Film, 27 +5%, 1/4W	B5	P10
o A R612	31218-0224	Carbon Film, 220K +5%, 1/4W	B5	P11
o A R613	31218-0124	Carbon Film, 120K +5%, 1/4W	B6	P12
o A R614	31199-0259	Precision Film, 4.02K +1%, 1/4W	B6	P11
o A R615	31199-0259	Precision Film, 4.02K +1%, 1/4W	B6	P12
o A R1136	32091-0108	Variable, 20K	F2	P8
o A RP101	30002-0001	S.I.P. 2 Meg	E4	F1

SWITCH

Symbol	Part Number	Description	Comp. Assy	Schematic
o A SW101	61659-0001	Incremental Frequency	E2	C7
o A SW102	61556-0001	Snap Action, SPDT (XFR)	E2	C7
o A SW103	61497-0009	Toggle SPDT, (Freq-To-From)	F3	C8
o A SW104	61646-0001	SPDT, Slide, Right Angle	F3	P9
o A T601	11937-0001	TRANSFORMER, DC to DC Converter	A6	R10

IC

Symbol	Part Number	Description	Comp. Assy	Schematic
o A U101	74216-0001	UDN6184A	E6	A3
o A U102	74226-0001	4022	E6	A4
o A U103	74223-0001	ULN2047A	D3	
o A U103A				B6
o A U103B				D11
o A U104	74105-0001	3403	E3	
o A U104A				B4
o A U104B				C4
o A U104C				D2
o A U104D				D4
o A U105	74110-0002	4050	E6	
o A U105A				C4
o A U105B				C8
o A U105C				C9
o A U105D				C9
o A U105E				E8
o A U105F				C8
o A U106	74231-0001	DS8884A	E4	E4
o A U107	74220-0001	TND905	E5	F2
o A U108	74222-0001	DS8880	E5	G4
o A U109	74086-0001	4013	C6	
o A U109A				B9
o A U109B				B8
o A U110	74169-0001	MC14021BCP	D6	A11
o A U111	74169-0001	MC14021BCP	D6	B11
o A U112	74171-0001	MC14040B	D6	B10
o A U113	74171-0001	MC14040B	C6	B7
o A U114	74119-0001	4046	C6	C7
o A U115	74240-0001	MK3870 (Microprocessor)	D4	D7
o A U116	74091-0001	4081B	D4	
o A U116A				B8
o A U116B				E9
o A U116C				E10
o A U116D				E10
o A U117	74172-0001	MC14006B	D6	C10
o A U301	74221-0001	MC3393P	D5	H11
o A U302	74228-0001	MC145156	D4	J11
o A U303	74116-0001	4015	B3	L8
o A U304	74116-0001	4015	B2	M8
o A U305	74101-0001	MC14502	B3	K10
o A U306	74101-0001	MC14502	B2	L10
o A U307	74223-0001	ULN2047A	A2	L10
o A U308	74223-0001	ULN2047A	A3	L10
o A U309	74221-0001	MC3303P	C4	H8
o A U310	74228-0001	MC145156	C5	J8

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IC

Symbol	Part Number	Description	Comp. Assy	Schematic
o A U401	74072-0002	CD4066	C2	
o A U401A				R9
o A U401B				R9
o A U401C				R9
o A U401D				S9
o A U402	74229-0001	TL081CP	A2	
o A U402A				S8
o A U501	74230-0001	TL082CP	B3	
o A U501A				R5
o A U501B				H2
o A U502	74105-0001	3403	C5	
o A U502A				R4
o A U502B				T5
o A U502C				P6
o A U502D				L2
o A U503	74105-0001	3403	B4	
o A U503A				S2
o A U503B				L2
o A U503C				P2
o A U503D				T3
o A U504	74232-0001	MC3405	C3	
o A U504A				J3
o A U504B				J5
o A U504C				H4
o A U504D				H5
o A U505	74072-0002	CD4066	B5	
o A U505A				R2
o A U505B				R4
o A U505C				R2
o A U505D				S5
o A U506	74092-0001	339	C4	
o A U506A				L2
o A U506B				L4
o A U506C				M5
o A U506D				N2
o A U507	74119-0001	4046	B3	J2
o A U601	74225-0001	LM3524	B7	S11

CRYSTAL

Symbol	Part Number	Description	Comp. Assy	Schematic
o A Y301	72041-0001	3.200 MHz	D5	S11

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ELECTRICAL PARTS LIST
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CAPACITOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A C901	23107-0111	Poly Film, .0068 uF +10%, 100V	E2	B5
o A C902	23107-0113	Poly Film, .01 uF +10%, 100V	E2	B5
o A C903	21564-0029	Tantalum, 3.3 uF +20%, 15V	E2	B5
o A C904	23107-0125	Poly Film, .1 uF +10%, 100V	E2	C4
o A C905	21564-0034	Tantalum, 22 uF +20%, 15V	E2	C5
o A C906	24551-0003	Ceramic, .001 uF +100/-0%, 50V	E3	D4
o A C907	23107-0125	Poly Film, .1 uF +10%, 100V	E3	D5
o A C908	24552-1569	Ceramic, 5.6 pF +.5 pF, 50V, NPO	E3	D4
o A C909	24551-0003	Ceramic, .001 uF +100/-0%, 50V	E3	D5
o A C910	21564-0034	Tantalum, 22 uF +20%, 15V	E4	D4
o A C911	24551-0003	Ceramic, .001 uF +100/-0%, 50V	E3	D4
o A C912	24552-1120	Ceramic, 12 pF +10%, 50V, NPO	E3	[illegible]
o A C913	24552-1689	Ceramic, 6.8 pF +.5 pF, 50V, NPO	E4	E4
o A C914	24552-1100	Ceramic, 10 pF +10%, 50V, NPO	E4	E4
o A C915	24551-0003	Ceramic, .001 uF +100/-0%, 50V	E4	F4
o A C916	24551-0003	Ceramic, .001 uF +100/-0%, 50V	E4	F5
o A C917	24552-1180	Ceramic, 18 pF +10%, 50V, NPO	E4	F5
o A C918	24552-1180	Ceramic, 18 pF +10%, 50V, NPO	E4	F5
o A C920	24552-1229	Ceramic, 2.2 pF +.5 pF, 50V, NPO	E4	F4
o A C921	24551-0003	Ceramic, .001 uF +100/-0%, 50V	E5	G5
o A C922	24552-1270	Ceramic, 27 pF +10%, 50V, NPO	E5	G5
o A C923	24551-0001	Ceramic, 100 pF +20%, 50V	E5	G4
o A C1001	24516-0479	Ceramic Disc, 4.7 pF +.5 pF, 500V	D1	H1
o A C1002	24552-1820	Ceramic, 82 pF +10%, 50V, NPO	D2	H2
o A C1003	24509-0109	Ceramic, 1 pF +5%, 500V	D2	H1
o A C1004	24552-1820	Ceramic, 82 pF +10%, 50V, NPO	D2	C2
o A C1005	21291-0027	Ceramic Disc, 100 pF +10%, 500V	D2	C1
o A C1006	21291-0031	Ceramic Disc, 390 pF +10%, 500V	D3	C2
o A C1007	21291-0031	Ceramic Disc, 390 pF +10%, 500V	D3	D1
o A C1008	21291-0031	Ceramic Disc, 390 pF +10%, 500V	D3	D2
o A C1009	24552-1820	Ceramic, 82 pF +10%, 50V, NPO	D3	E2
o A C1010	24509-0688	Ceramic, .68 pF +5%, 500V	D4	E1
o A C1011	24552-1820	Ceramic, 82 pF +10%, 50V, NPO	D4	E2
o A C1012	21291-0031	Ceramic Disc, 390 pF +10%, 500V	D4	F2
o A C1013	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	D4	F2
o A C1014	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	D4	F2
o A C1015	24552-7180	Ceramic, 18 pF +10%, 50V, NPO	D5	G1
o A C1016	24552-7180	Ceramic, 18 pF +10%, 50V, NPO	D5	H1
o A C1017	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	D6	H1
o A C1018	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	C6	H2
o A C1019	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	C5	H2
o A C1020	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	D6	J2
o A C1021	24552-7180	Ceramic, 18 pF +10%, 50V, NPO	D6	J1
o A C1022	24552-7180	Ceramic, 18 pF +10%, 50V, NPO	D6	L1
o A C1023	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	E6	L2
o A C1024	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	E6	M1
o A C1025	24052-0150	Dipped Mica, 15 pF +1 pF, 500V	E5	M2
o A C1026	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	E6	M2
o A C1027	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	D5	M3
o A C1028	21564-0109	Tantalum, 4.7 uF +10%, 6V	D6	J4
o A C1029	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	E6	E3
o A C1030	21564-0038	Tantalum, 100 uF +20%, 15V	D5	F4
o A C1031	21564-0100	Tantalum, 6.8 uF +10%, 6V	D5	L4
o A C1032	21564-0126	Tantalum, 22 uF +10%, 10V	D5	J7
o A C1033	21564-0157	Tantalum, .47 uF +10%, 35V	E5	E7
o A C1034	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	E6	L6
o A C1035	24515-0010	Ceramic Disc, .02 uF +20%, 50V	D6	L6
o A C1036	21564-0100	Tantalum, 6.8 uF +10%, 6V	D6	M7
o A C1037	21291-0030	Ceramic Disc, .01 uF +20%, 50V	E6	M7
o A C1038	23107-0125	Poly Film, .1 uF +10%, 100V	E2	[illegible]
o A C1039	23107-0125	Poly Film, .1 uF +10%, 100V	E3	E3
o A C1040	21564-0026	Tantalum, 220 uF +20%, 10V	A3	C3
o A C1041	21564-0061	Tantalum, 10 uF +10%, 15V	C2	J7
o A C1042	21291-0030	Ceramic Disc, .01 uF +20%, 50V	E5	K5
o A C1043	24551-0002	Ceramic 470 uF +20%, 50V	B1	A3
o A C1044	24551-0002	Ceramic 470 uF +20%, 50V	B2	C3

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CAPACITOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A C1101	24552-1689	Ceramic, 6.8 pF +.5 pF, 50V, NPO	C3	B9
o A C1102	24552-1689	Ceramic, 6.8 pF +.5 pF, 50V, NPO	C3	C9
o A C1103	24552-7180	Ceramic, 18 pF +10%, 50V, NPO	C3	C9
o A C1104	24552-1829	Ceramic, 8.2 pF +.5 pF, 50V, NPO	C3	C10
o A C1105	24551-0001	Ceramic, 100 pF +20%, 50V	C3	C10
o A C1106	24551-0001	Ceramic, 100 pF +20%, 50V	C4	D9
o A C1107	24552-1479	Ceramic, 4.7 pF +.5 pF, 50V, NPO	C4	D9
o A C1108	21291-0019	Ceramic Disc, .001 uF +10%, 500V	C5	D9
o A C1109	24052-0220	Dipped Mica, 22 pF +5%, 500V	C4	D10
o A C1110	24551-0001	Ceramic, 100 pF +20%, 50V	C4	E10
o A C1111	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	C4	E10
o A C1113	24552-7180	Ceramic, 18 pF +.5 pF, 50V, N750	C4	F10
o A C1114	24552-7180	Ceramic, 18 pF +.5 pF, 50V, N750	C6	G10
o A C1115	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	C6	G10
o A C1116	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	C6	G9
o A C1117	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	B6	H10
o A C1118	24552-7180	Ceramic, 18 pF +.5 pF, 50V, N750	B6	H9
o A C1119	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	B6	H10
o A C1120	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	B6	J10
o A C1121	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	A6	H11
o A C1122	21564-0100	Tantalum, 6.8 uF +10%, 6V	A6	J10
o A C1123	21291-0030	Ceramic Disc, .01 uF +10%, 50V	A6	J10
o A C1124	21564-0124	Tantalum, 100 uF +10%, 10V	A4	K11
o A C1125	21568-0032	Tantalum, 10 uF +10%, 10V	A5	K10
o A C1126	24515-0005	Ceramic Disc, .05 uF +80/-20%, 10V	A6	K11
o A C1127	21568-0001	Tantalum, 4.7 uF +10%, 6V	B5	K10
o A C1128	21568-0036	Tantalum, 22 uF +10%, 10V	A6	L8
o A C1129	23109-2104	Poly Film, .1 uF +2.5%, 100V	A5	M8
o A C1130	23109-2104	Poly Film, .1 uF +2.5%, 100V	A5	M9
o A C1131	23109-2154	Poly Film, .15 uF +2.5%, 50V	B5	M10
o A C1132	23109-2154	Poly Film, .15 uF +2.5%, 50V	B1	M11
o A C1133	21568-0106	Tantalum, 1.0 uF +10%, 35V	A4	P9
o A C1134	21568-0106	Tantalum, 1.0 uF +10%, 35V	A4	P11
o A C1135	21564-0034	Tantalum, 22 uF +20%, 15V	B2	Q9
o A C1136	21568-0046	Tantalum, 47 uF +10%, 10V	A5	N10
o A C1138	21564-0037	Tantalum, 68 uF +10%, 15V	A4	[illegible]
o A C1201	23107-0111	Poly Film, .0068 uF +10%, 100V	C2	[illegible]
o A C1202	23107-0113	Poly Film, .01 uF +10%, 100V	B3	[illegible]
o A C1203	21564-0029	Tantalum, 3.3 uF +20%, 15V	C3	B8
o A C1204	23107-0125	Poly Film, .1 uF +10%, 100V	D3	C8
o A C1205	21564-0034	Tantalum, 22 uF +20%, 15V	C3	C8
o A C1206	23107-0125	Poly Film, .1 uF +10%, 100V	C3	[illegible]
o A C1207	24551-0003	Ceramic, .001 uF +100/-0%, 50V	B4	D8
o A C1208	24552-1569	Ceramic, 5.6 pF +.5 pF, 50V, NPO	B4	D7
o A C1209	21564-0034	Tantalum, 22 uF +20%, 15V	B4	D7
o A C1210	24551-0003	Ceramic, .001 uF +100/-0%, 50V	B4	D7
o A C1211	24552-1120	Ceramic, 12 pF +10%, 50V, NPO	C4	E7
o A C1212	24552-1689	Ceramic, 6.8 pF +.5 pF, 50V, NPO	B3	F7
o A C1213	24552-1100	Ceramic, 10 pF +10%, 50V, NPO	C3	E7
o A C1214	24551-0003	Ceramic, .001 uF +100/-0%, 50V	B2	F6
o A C1215	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C3	F6
o A C1216	24552-1180	Ceramic, 18 pF +10%, 50V, NPO	B5	F7
o A C1217	24552-1180	Ceramic, 18 pF +10%, 50V, NPO	B5	F7
o A C1219	24552-1229	Ceramic, 2.2 pF +.5 pF, 50V, NPO	B5	F7
o A C1220	24551-0003	Ceramic, .001 uF +100/-0%, 50V	C6	G6
o A C1221	24552-1270	Ceramic, 27 pF +10%, 50V, NPO	B6	G7
o A C1222	24551-0001	Ceramic, 100 pF +20%, 50V	B6	G6

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DIODE

Symbol	Part Number	Description	Comp. Assy	Schematic
o A CR901	75037-0002	Varactor	E3	D4
o A CR1001	75037-0001	Varactor	D2	B1
o A CR1002	75037-0001	Varactor	D2	C1
o A CR1003	75037-0001	Varactor	D3	F1
o A CR1004	75037-0001	Varactor	D4	L1
o A CR1005	75034-0001	Hot Carrier, FH 1100	E6	K2
o A CR1006	75028-0001	Silicon, 1N4149	E5	L3
o A CR1007	75062-0005	Silicon, 1N4005	A3	D3
o A CR1101	75034-0001	Hot Carrier, FH 1100	B6	J10
o A CR1104	75028-0001	Silicon, 1N4149	B3	[illegible]
o A CR1105	75028-0001	Silicon, 1N4149	B3	[illegible]
o A CR1106	75028-0001	Silicon, 1N4149	B3	[illegible]
o A CR1107	75028-0001	Silicon, 1N4149	A4	[illegible]
o A CR1201	75037-0002	Varactor	B4	[illegible]
o A CR1202	75028-0001	Silicon, 1N4149	B3	[illegible]

CRYSTAL FILTER

Symbol	Part Number	Description	Comp. Assy	Schematic
o A FL1001	43210-0001	4 Pole, 17 MHz	[illegible]	G1
o A FL1002	43210-0001	4 Pole, 17 MHz	[illegible]	K1
o A FL1101	43211-0001	6 Pole, 16.05 MHz	C5	[illegible]

INDUCTOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A L901	11938-0003	Coil, RF, Variable, (VCO)	E3	[illegible]
o A L902	11485-0001	Choke, RF .1 uH	E3	[illegible]
o A L903	11485-0001	Choke, RF .1 uH	E5	G3
o A L1001	11938-0002	Coil, RF, Variable	D2	F1
o A L1002	11938-0002	Coil, RF, Variable	D3	C1
o A L1003	11938-0002	Coil, RF, Variable	D4	J1
o A L1004	11485-0020	Choke, RF, 3.9 uH	E6	K1
o A L1101	11713-0022	Coil, RF, (Increment), 1-1/2 Turns	C3	[illegible]
o A L1102	11713-0015	Coil, RF, (Increment), 3-1/2 Turns	C3	[illegible]
o A L1103	11713-0013	Coil, RF, (Increment), 4-1/2 Turns	C3	[illegible]
o A L1104	11713-0021	Coil, RF, (Increment), 1-1/2 Turns	[illegible]	[illegible]
o A L1105	11713-0152	Coil, RF, (Increment), 5-1/2 Turns	[illegible]	[illegible]
o A L1201	11938-0003	Coil, RF, Variable	[illegible]	[illegible]
o A L1202	11485-0001	Choke, RF, .1 uH	[illegible]	[illegible]
o A L1203	11485-0002	Choke, RF, .1 uH	[illegible]	[illegible]

TRANSISTOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A Q901	[illegible]	Silicon, NPN, [illegible]	[illegible]	[illegible]
o A Q902	[illegible]	Silicon, NPN, [illegible]	[illegible]	[illegible]
o A Q903	[illegible]	Silicon, NPN, [illegible]	[illegible]	[illegible]
o A Q1001	[illegible]	FET	[illegible]	[illegible]
o A Q1002	[illegible]	FET	[illegible]	[illegible]
o A Q1003	[illegible]	FET	[illegible]	[illegible]
o A Q1004	[illegible]	Silicon, PNP, [illegible]	[illegible]	[illegible]
o A Q1005	[illegible]	Silicon, NPN, [illegible]	[illegible]	[illegible]
o A Q1101	[illegible]	RF, NPN, MRF-[illegible]	[illegible]	[illegible]
o A Q1102	[illegible]	RF, NPN, MRF-[illegible]	[illegible]	[illegible]
o A Q1103	[illegible]	Silicon, NPN, 2N4124	[illegible]	[illegible]
o A Q1104	[illegible]	Silicon, NPN, 2N4124	[illegible]	[illegible]
o A Q1201	[illegible]	Silicon, NPN, [illegible]	[illegible]	[illegible]
o A Q1202	[illegible]	Silicon, NPN, [illegible]	[illegible]	[illegible]
o A Q1203	[illegible]	Silicon, NPN, [illegible]	[illegible]	[illegible]
o A Q1204	[illegible]	Silicon, NPN, 2N4124	[illegible]	[illegible]

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RESISTOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A R901	31218-0272	Carbon Film, 2.7K +5%, 1/4W	E1	B4
o A R902	31218-0681	Carbon Film, 680 +5%, 1/4W	E2	B5
o A R903	31218-0223	Carbon Film, 22K +5%, 1/4W	E2	B5
o A R904	31218-0103	Carbon Film, 10K +5%, 1/4W	E2	C4
o A R905	31218-0221	Carbon Film, 220 +5%, 1/4W	E2	C5
o A R906	31218-0102	Carbon Film, 1K +5%, 1/4W	E3	C4
o A R907	31218-0104	Carbon Film, 100K +5%, 1/4W	E3	C4
o A R908	31218-0102	Carbon Film, 1K +5%, 1/4W	E2	D4
o A R909	31218-0103	Carbon Film, 10K +5%, 1/4W	E2	E4
o A R910	31218-0472	Carbon Film, 4.7K +5%, 1/4W	E3	D5
o A R911	31218-0270	Carbon Film, 27 +5%, 1/4W	E3	E5
o A R912	31218-0391	Carbon Film, 390 +5%, 1/4W	E3	E5
o A R913	31218-0562	Carbon Film, 5.6K +5%, 1/4W	E1	E4
o A R914	31218-0222	Carbon Film, 2.2K +5%, 1/4W	E4	E5
o A R915	31218-0151	Carbon Film, 150 +5%, 1/4W	E3	E5
o A R916	31218-0510	Carbon Film, 51 +5%, 1/4W	E4	F5
o A R917	31218-0562	Carbon Film, 5.6K +5%, 1/4W	E4	F4
o A R918	31218-0222	Carbon Film, 2.2K +5%, 1/4W	E4	F5
o A R919	31218-0101	Carbon Film, 100 +5%, 1/4W	E4	G4
o A R920	31218-0151	Carbon Film, 150 +5%, 1/4W	E5	F5
o A R1001	31218-0513	Carbon Film, 51K +5%, 1/4W	D1	A1
o A R1002	31218-0104	Carbon Film, 100K +5%, 1/4W	D2	B2
o A R1003	31218-0104	Carbon Film, 100K +5%, 1/4W	D2	B2
o A R1004	31218-0223	Carbon Film, 22K +5%, 1/4W	D2	C1
o A R1005	31218-0303	Carbon Film, 30K +5%, 1/4W	D2	C2
o A R1006	31218-0221	Carbon Film, 220 +5%, 1/4W	D3	D2
o A R1007	31218-[illegible]	Carbon Film, 680 +5%, 1/4W	D3	D1
o A R1008	31218-[illegible]	Carbon Film, 100 +5%, 1/4W	D3	D2
o A R1009	31218-0104	Carbon Film, 100K +5%, 1/4W	D3	E1
o A R1010	31218-01[illegible]	Carbon Film, 100K +5%, 1/4W	D4	E2
o A R1011	31218-0103	Carbon Film, 10K +5%, 1/4W	D4	F1
o A R1012	31218-0104	Carbon Film, 100K +5%, 1/4W	D4	F2
o A R1013	31218-0201	Carbon Film, 200 +5%, 1/4W	D4	F1
o A R1014	31218-0101	Carbon Film, 100 +5%, 1/4W	D4	G2
o A R1015	31218-0562	Carbon Film, 5.6K +5%, 1/4W	D5	G1
o A R1016	31218-0562	Carbon Film, 5.6K +5%, 1/4W	D5	H1
o A R1017	31218-0101	Carbon Film, 100 +5%, 1/4W	D6	J1
o A R1018	31218-0470	Carbon Film, 47 +5%, 1/4W	D6	J2
o A R1019	31218-0562	Carbon Film, 5.6K +5%, 1/4W	D6	K2
o A R1020	31218-0562	Carbon Film, 5.6K +5%, 1/4W	D6	L2
o A R1021	31218-0201	Carbon Film, 200 +5%, 1/4W	E6	M1
o A R1022	31218-0102	Carbon Film, 1K +5%, 1/4W	E6	M2
o A R1023	31218-0272	Carbon Film, 2.7K +5%, 1/4W	E6	K3
o A R1024	31218-SEL	Carbon Film, SELECT BY TEST	E6	J3
o A R1025	31218-0473	Carbon Film, 47K +5%, 1/4W	E6	J3
o A R1026	31218-0151	Carbon Film, 150 +5%, 1/4W	E5	E3
o A R1027	31218-0473	Carbon Film, 47K +5%, 1/4W	D6	K4
o A R1028	31218-0273	Carbon Film, 27K +5%, 1/4W	D3	K4
o A R1029	31218-0474	Carbon Film, 470K +5%, 1/4W	D5	K3
o A R1030	31218-0684	Carbon Film, 680K +5%, 1/4W	E5	K4
o A R1031	31218-SEL	Carbon Film, SELECT BY TEST	E5	J6
o A R1032	31218-0562	Carbon Film, 5.6K +5%, 1/4W	E5	J7
o A R1033	31218-0101	Carbon Film, 100 +5%, 1/4W	D5	J6
o A R1034	31218-0222	Carbon Film, 2.2K +5%, 1/4W	E5	K5
o A R1035	31218-0222	Carbon Film, 2.2K +5%, 1/4W	E5	K6
o A R1036	31218-0222	Carbon Film, 2.2K +5%, 1/4W	E5	K7
o A R1037	31218-0103	Carbon Film, 10K +5%, 1/4W	E5	L6
o A R1038	31218-0103	Carbon Film, 10K +5%, 1/4W	E5	L6
o A R1039	31218-0103	Carbon Film, 10K +5%, 1/4W	E6	L6
o A R1040	31218-0224	Carbon Film, 220K +5%, 1/4W	D6	M7
o A R1041	31218-0103	Carbon Film, 10K +5%, 1/4W	[illegible]	[illegible]
o A R1042	31218-0104	Carbon Film, 100K +5%, 1/4W	C2	J7
o A R1043	31218-0681	Carbon Film, 680 +5%, 1/4W	[illegible]	[illegible]
o A R1044	31218-[illegible]	Carbon Film, 100 +5%, 1/4W	E2	E10
o A R1045	31218-0473	Carbon Film, 47K +5%, 1/4W	E3	[illegible]
o A R1046	32054-0020	Variable, 1 Meg	[illegible]	[illegible]
o A R1047	31218-0203	Carbon Film, 20K +5%, 1/4W	[illegible]	[illegible]
o A R1048	31218-SEL	Carbon Film, SELECT BY TEST	[illegible]	L1
o A R1049	31218-0203	Carbon Film, 20K +5%, 1/4W	E2	F7

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RESISTOR

Symbol	Part Number	Description	Comp. Assy	Schematic
o A R1101	31218-0473	Carbon Film, 47K +5%, 1/4W	C3	C10
o A R1102	31218-0221	Carbon Film, 110 +5%, 1/4W	C4	D8
o A R1103	31218-0152	Carbon Film, 1.5K +5%, 1/4W	C4	D10
o A R1104	31218-0201	Carbon Film, 200 +5%, 1/4W	C4	F8
o A R1105	31218-0122	Carbon Film, 1.2K +5%, 1/4W	C4	E9
o A R1106	31218-0122	Carbon Film, 1.2K +5%, 1/4W	C4	E10
o A R1107	31218-0101	Carbon Film, 100 +5%, 1/4W	C4	E10
o A R1108	31218-0562	Carbon Film, 5.6K +5%, 1/4W	C4	F10
o A R1109	31218-0562	Carbon Film, 5.6K +5%, 1/4W	C6	G9
o A R1110	31218-0101	Carbon Film, 100 +5%, 1/4W	B6	H9
o A R1111	31218-0470	Carbon Film, 47 +5%, 1/4W	B6	H9
o A R1112	31218-0562	Carbon Film, 5.6K +5%, 1/4W	B6	J9
o A R1113	31218-SEL	Carbon Film, SELECT BY TEST	A6	H11
o A R1114	31218-0684	Carbon Film, 680K +5%, 1/4W	A6	H11
o A R1115	31218-0273	Carbon Film, 27K +5%, 1/4W	A6	J11
o A R1116	31218-0101	Carbon Film, 100 +5%, 1/4W	A5	K11
o A R1117	31218-0153	Carbon Film, 15K +5%, 1/4W	A6	K10
o A R1118	31218-0682	Carbon Film, 6.8K +5%, 1/4W	A6	L10
o A R1120	31218-0472	Carbon Film, 4.7K +5%, 1/4W	A5	M10
o A R1121	31218-0473	Carbon Film, 47K +5%, 1/4W	B5	L11
o A R1122	31218-SEL	Carbon Film, SELECT BY TEST	B5	L11
o A R1123	31218-0272	Carbon Film, 2.7K +5%, 1/4W	B6	J11
o A R1124	32054-0004	Variable, Trimmer, 4.7K	A5	M10
o A R1125	31199-0241	Precision Film, 2.61K +1%, 1/4W	A5	M9
o A R1126	31199-0268	Precision Film, 4.99K +1%, 1/4W	A5	M9
o A R1127	31199-0274	Precision Film, 5.76K +1%, 1/4W	B5	M10
o A R1128	31199-0246	Precision Film, 2.94K +1%, 1/4W	B5	M11
o A R1129	31199-0378	Precision Film, 63.4K +1%, 1/4W	B4	N9
o A R1130	31218-0104	Carbon Film, 100K +5%, 1/4W	B4	N9
o A R1131	31218-0104	Carbon Film, 100K +5%, 1/4W	B4	N10
o A R1132	31199-0381	Precision Film, 68.1K +1%, 1/4W	B4	N11
o A R1133	31218-0273	Carbon Film, 27K +5%, 1/4W	A3	N8
o A R1134	31218-0273	Carbon Film, 27K +5%, 1/4W	B3	N9
o A R1135	31218-0105	Carbon Film, 1 Meg +5%, 1/4W	A4	N8
o A R1137	31218-0273	Carbon Film, 27K +5%, 1/4W	B3	N10
o A R1138	31218-0273	Carbon Film, 27K +5%, 1/4W	A4	N11
o A R1139	31218-0105	Carbon Film, 1 Meg +5%, 1/4W	A4	N11
o A R1141	31218-0183	Carbon Film, 18K +5%, 1/4W	B2	Q9
o A R1143	31218-0683	Carbon Film, 68K +5%, 1/4W	A5	K11
o A R1144	31218-0102	Carbon Film, 1K +5%, 1/4W	A5	M11
o A R1145	31218-0103	Carbon Film, 10K +5%, 1/4W	A3	P8
o A R1146	31218-0473	Carbon Film, 47K +5%, 1/4W	B3	L11
o A R1201	31218-0272	Carbon Film, 2.7K +5%, 1/4W	B2	B7
o A R1202	31218-0681	Carbon Film, 680 +5%, 1/4W	B3	B8
o A R1203	31218-0223	Carbon Film, 22K +5%, 1/4W	B4	C8
o A R1204	31218-0103	Carbon Film, 10K +5%, 1/4W	B3	C7
o A R1205	31218-0221	Carbon Film, 220 +5%, 1/4W	C3	C7
o A R1206	31218-0102	Carbon Film, 1K +5%, 1/4W	B4	D7
o A R1207	31218-0102	Carbon Film, 1K +5%, 1/4W	B4	D7
o A R1208	31218-0104	Carbon Film, 10K +5%, 1/4W	B4	E7
o A R1209	31218-0472	Carbon Film, 4.7K +5%, 1/4W	B4	E8
o A R1210	31218-0270	Carbon Film, 27 +5%, 1/4W	B4	E6
o A R1211	31218-0391	Carbon Film, 390 +5%, 1/4W	C4	E8
o A R1212	31218-0562	Carbon Film, 5.6K +5%, 1/4W	B5	E7
o A R1213	31218-0222	Carbon Film, 2.2K +5%, 1/4W	B5	E8
o A R1214	31218-0151	Carbon Film, 150 +5%, 1/4W	C5	E8
o A R1215	31218-0510	Carbon Film, 51 +5%, 1/4W	C5	F8
o A R1216	31218-0562	Carbon Film, 5.6K +5%, 1/4W	B5	F6
o A R1217	31218-0222	Carbon Film, 2.2K +5%, 1/4W	A5	F7
o A R1218	31218-0101	Carbon Film, 100 +5%, 1/4W	B5	G6
o A R1219	31218-0151	Carbon Film, 150 +5%, 1/4W	C6	G6
o A R1220	31218-0103	Carbon Film, 10K +5%, 1/4W	B5	G6
o A RT1001	31205-0003	Thermistor, 4.2K	C2	H7

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TRANSFORMER

Symbol	Part Number	Description	Comp. Assy	Schematic
o A T1001	11846-0001	Variable, RF	D3	D1
o A T1002	11881-0001	Variable, IF	D4	G1
o A T1003	11881-0001	Variable, IF	D5	H1
o A T1004	11881-0002	Variable, IF	D6	K1
o A T1005	11881-0001	Variable, IF	E6	L1
o A T1101	11881-0001	Variable, IF	C4	K9
o A T1102	11881-0001	Variable, IF	C6	H9
o A T1103	11881-0002	Variable, IF	B6	H9

IC

Symbol	Part Number	Description	Comp. Assy	Schematic
o A U901	74211-0001	CA3240	E2	
o A U901A				B4
o A U901B				C4
o A U1001	74028-0001	MC1350P	D6	J1
o A U1002	74099-0001	CA3088E	D5	
o A U1002A				N1
o A U1002B				L4
o A U1002C				K4
o A U1002D				J4
o A U1002E				J7
o A U1002F				M6
o A U1003	74039-0001	7808 (Regulator)	A3	H3
o A U1004	74103-0001	MC1458C	B2	J7
o A U1101	74028-0001	MC1350P	B6	H10
o A U1102	74099-0001	CA3088E	A6	
o A U1102A				J10
o A U1102B				L10
o A U1102C				J11
o A U1102D				K10
o A U1102F				K10
o A U1103	74232-0001	MC3405	A4	
o A U1103A				P9
o A U1103B				P11
o A U1103C				N9
o A U1103D				N11
o A U1201	74211-0001	CA3240	B3	
o A U1201A				B7
o A U1201B				C7