NARCO
DME 195 DISTANCE MEASURING EQUIPMENT
GENERAL INDEX

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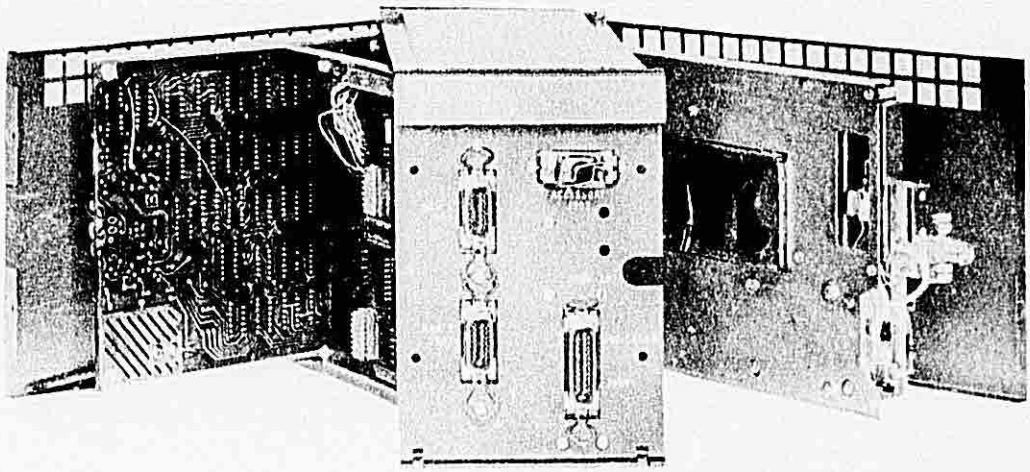
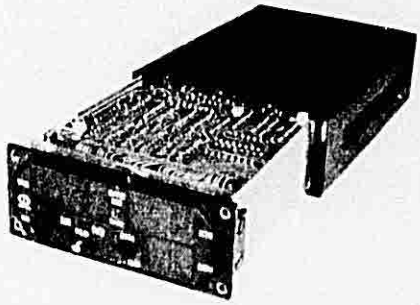
NARCO AVIONICS

DME 195





INSTALLATION MANUAL

03313-0621

November, 1976

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

ATP
RECORD OF REVISIONS

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

SERVICE

NARCO AVIONICS DIVISION OF NARCO SCIENTIFIC INDUSTRIES, Fort Washington, Pa. 19034

NARCO SERVICE BULLETIN DME-195 No. 13 August 17, 1979

TO: ALL NARCO AVIONICS CENTERS
ALL NARCO AVIONICS WHOLESALE DISTRIBUTORS

SUBJECT: SCHEMATIC UPDATE

Included with this bulletin are schematics and table of contents for the later chassis of the DME-195.

Please add these schematics to the appropriate places in your DME-195 manual and note these changes in the parts list section.

The schematics are:

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Page 6-7I	Distance Board	Chassis "D"
Page 6-12A	Velocity Board	Chassis "C"
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Page 6-22A	Smoothing Board	Chassis "D"

Very truly yours,

NARCO AVIONICS

Lew Wickman

Lew Wickman
Technical Representative

LW/pk

Attachment

1.1 GENERAL

This manual provides information pertaining to the installation and maintenance of NARCO AVIONIC's DME 195.

Section 2, Installation: provides specifications, wiring instructions, and templates along with installation mechanical drawings. (Narco has available, under separate order, all the necessary accessories required to complete an installation should the shop or aircraft require them. See Section 2.4.)

Section 3, Circuit Description: outlines the basic functions of DMEs, the main circuits of the DME 195 and then discusses in detail, the theory of each circuit and its relationship to other circuits. For those who are "light" on DME, IC operation, digital functions, etc. this section should be studied.

Section 4, Maintenance; furnishes procedures for: isolating problem areas through operation of the DME System's external controls, checking out each module for possible module replacement, and then isolating a problem down to a detail circuit or specific component.

Section 5, Replacement Parts List: supplies illustrations and related lists identifying numerous (if not all) mechanical parts of the DME. These are followed by component location drawings and a complete list of the electrical parts, by symbol number, in alpha-numeric sequence.

Section 6, Schematics, contains a schematic of each PC board along with a component location drawing to provide rapid transition from the schematic to the component.

FEATURES:

- 100% modular solid state design, a world's first in DME.
- Professional style, incandescent digital readouts with dimmer control.
- Simultaneous display of distance, velocity, and time-to-station.
- Instant station lock-on, usually less than 1 second.
- Distance accuracy $\pm$.1 nautical mile (typical) up to full range.
- Distance to 200 nm; ground speed to 400 Kts; time-to-station to 89 minutes.
- Built-in DME HOLD function.
- Compact, standard-size (3-1/2 x 1-1/4) panel Indicator.
- 200 channels, 100 watts (nominal), RNAV compatible.
- Ident level control.
- Channeled by Narco 2 out-of-5 or ARINC codes. Optional channeling code kits for other codes.
- Fast servicing with replacement of fold-out modules.
- Meets or exceeds the requirements of FAA TSO C-66a.

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2.1 INTRODUCTION

This section contains detailed instructions for the installation of the NARCO AVIONICS TSO'd DME 195 Distance Measuring Equipment System.

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

The DME System is composed of three assemblies: an instrument panel mounted Indicator; the remote, fuselage mounted Interrogator/Receiver; and a fuselage mounted Antenna.

To expedite installation, a metal template is provided to allow for either front or rear mounting of the Indicator to the instrument panel; a mounting tray is supplied for the Interrogator/Receiver Unit.

During the planning phase of the installation, the following should be kept in mind:

1. Locate the Antenna and Interrogator/Receiver as closely as possible to one another; this shortens the antenna coax cable thereby reducing signal losses and improving performance.
2. Locate the Antenna on the bottom surface of the aircraft in an area that is free of obstructions for a minimum radius of 1-1/2 feet from the Antenna; also, position the Antenna such that it is level when the aircraft is in level flight.

2.2. PRELIMINARY INSPECTION

Carefully unpack the equipment and visually inspect for damage caused by shipment.

Section 2.4 details ordering information which can be utilized as a receipt check list by referring to the appropriate DME 195 Order Number group.

2.3 SPECIFICATIONS

2.3.1 Mechanical

Size: Refer to the installation drawings.

Weight:

Interrogator/Receiver including mounting tray	7.75 Lbs. (3.52 Kgms)
Indicator	0.9 Lbs. (408 gms)
UDA-3 Antenna	0.5 Lbs. (227 gms)
Optional Cooling Kit	0.55 Lbs. (249 gms)

2.3.2 Electrical

Power requirements	13.75v/5.0 amps..... 27.5v/2.8 amps
Transmitter frequency band	1041 to 1150 MHz (paired with 108.00 to 117.95 NAV Channels)
Transmitter power	±100 watts nominal, 80 watts minimum
Transmitter frequency stability	-.01%
Number of channels	200 (includes both X and Y)
Channeling code	Standard - ARINC and Narco 2-out-of-5 Optional - Code Converter Kits permit use of ARINC and Narco codes plus King slip code or most other channeling codes
Receiver frequency	978 to 1213 MHz (Paired with 108.00 to 117.95 NAV Channels)
Receiver sensitivity	-82 dbm
Acquisition time, including channeling	1 second, nominal
Memory	6 to 8 seconds
Ident Audio Output	45 mw nominal into 300 ohms
Digital Outputs	Compatible with Narco and most other RNAV systems
Range	±0 to 199.9 nautical miles
Accuracy	-0.1 nautical mile typical, 0.2 nautical miles maximum
Ground Speed	0 to 400 knots ±5%/±1 minute
Time-to-Station	0 to 89 minutes ± 5%±1 minute

2.3.3. TSO'd Antenna

The UDA-3 Antenna meets TSO C-74 Cat. BAAAAAX Class 1 and C-66 Cat. B

2.3.4 DME 195 TSO Explanation (Meets TSO C66a)

The DME 195 Indicator is designed to be instrument panel mounted within the cabin environment of fixed and rotary wing aircraft using piston or turbine single and multi-engines. It is designed for nonpressurized aircraft operation up to 30,000 feet as well as for pressurized aircraft. This equipment requires direct current power but may be installed in aircraft that have additional on board alternating current sources.

The DME 195 Interrogator/Receiver is designed to be fuselage mounted in fixed and rotary wing aircraft using piston or turbine single and multiengines. It will operate and has been tested up to 30,000 feet for installation in nonpressurized as well as pressurized aircraft, however, it is TSO'd to 15,000 ft. This equipment requires direct current power but may be installed in aircraft that have additional on board alternating current sources.

There are twelve Environmental Test Procedures established in RTCA Document DO-138. As shown on the DME 195 TSO nameplates, the explanation of Environmental Limits for each of these categories are as follows:

DME 195 Indicator	DAPAAAXXXXXX
DME 195 Interrogator/Receiver	±A±AAAXXXXXX

2.3.4 Continued

Ambient Temperature-Altitude Criteria:	Ⓓ APAAAXXXXXX	ⓇⒻ A⅄AAAXXXXXX
Temperature Range:		
Nonoperating - LOW	-54°C (- 65°F)	-50°C (- 58°F)
- HIGH	+71°C (+160°F)	+71°C (+160°F)
Up to 30 minutes of operation	+65°C (+149°F)	+65°C (+149°F)
Continuous operation - LOW	-15°C (+ 5°F)	-46°C (- 51°F)
- HIGH	+55°C (+131°F)	+55°C (+131°F)
Altitude:		
Nonpressurized	30,000 FT	30,000 FT
Pressurized	15,000 FT	15,000 FT
Not affected by decompression to	40,000 FT	40,000 FT

Humidity: D Ⓐ PAAAXXXXXX

ⓇⒻ Ⓐ ⅄AAAXXXXXX

Standard Humidity for equipment intended for installation in Civil Aircraft.

These units have been tested under the following humidity conditions: +50°C (+122°F) at 95% RH, reduced to +38°C (+100°F) with humidity maintained as high as possible. This cycle was repeated twice for a total of 48 hours of exposure. Within 15* minutes after exposure the units were operated and met all specifications.

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

Vibration: DA ⓅAAAXXXXXX

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

ⓇA Ⓢ AAAXXXXXX

Designed for mounting anywhere in the fuselage of any fixed or rotary wing, single or multiengine piston or turbine aircraft. The maximum vibration limits are 0.10 inch double amplitude from 5 to 17 Hz. 1.5G constant acceleration from 17 to 35 Hz, 0.02 inch double amplitude from 38 Hz to 55 Hz, and 3.0G constant acceleration from 55 to 2000 Hz.

2.3.4 Continued

Audio Frequency Magnetic Field Susceptibility:* DAP (A) AAXXXXXX

$\frac{n}{D}$A$\frac{J}{S}$ (A) AAXXXXXX

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

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

Radio Frequency Susceptibility: DAPA (A) AXXXXXX

$\frac{n}{D}$A$\frac{J}{S}$A (A) AXXXXXX

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

Radio Frequency Spurious Emission: DAPAA (A) XXXXXX

$\frac{n}{D}$A$\frac{J}{S}$AA (A) XXXXXX

This equipment has been tested and does not emit radio frequency energy in excess of that specified in Category A.

Other Environmental Conditions: DAPAAA (XXXXXX)

$\frac{n}{D}$A$\frac{J}{S}$AAA (XXXXXX)

The letter "X" denotes that recognized installation practices in Civil Aircraft normally do not encounter these Environmental Conditions and are therefore not tested. These remaining six categories which are shown X'ed from Left to Right refer to: Explosion... Waterproofness...Hydraulic Fluid...Sand and Dust...Fungus...Salt Spray.

2.4 EQUIPMENT REQUIRED FOR INSTALLATION

2.4.1 System Ordering Information

DME 195 Systems are ordered by using the DME 195 Order Numbers(s) found in Table 2.1. The standard System (03313-0300) includes a sixteen foot Interconnect Cable. Interconnect Cable are available in eight and twenty-four foot lengths by ordering the DME 195 System Without Installation Material (03313-0301) together with the appropriate Installation Material number.

Individual Item Part Numbers are supplied for service replacement purposes and are not used when ordering Systems.

TABLE 2.1 DME 195 SYSTEM ORDER NUMBERS

DME 195 Order Number	List and Description of Items Supplied	Individual Item Part Numbers
03313-0300	DME 195 System With Installation Material:	
	Interrogator/Receiver Remote Unit, Indicator	
	Antenna, UDA-3.	01063-0102
	Indicator to Remote Unit Interconnect Cable (16 feet long)	90731-0116
	Remote Unit Mounting Tray.	57954-0101
	Installation Kit	03313-0500
	Installation Manual	03313-0621
	Pilot's Guide	PG-03313
03313-0301	DME 195 System Without Installation Material	
	Interrogator/Receiver Remote Unit, Indicator	
	Pilot's Guide	PG-03313
03313-0302	Installation Material (for use with 03313-0301)	
	Antenna, UDA-3.	01063-0102
	Indicator to Remote Unit Interconnect Cable (16 feet long)	90731-0116
	Remote Unit Mounting Tray.	57954-0101
	Installation Kit	03313-0500
	Installation Manual	03313-0621
03313-0303	Installation Material (For use with 03313-0301)	
	Antenna, UDA-3.	01063-0102
	Indicator to Remote Unit Interconnect Cable (8 feet long)	90731-0108
	Remote Unit Mounting Tray.	57954-0101
	Installation Kit	03313-0500
	Installation Manual	03313-0621
03313-0304	Installation Material (For use with 03313-0301)	
	Antenna, UDA-3.	01063-0102
	Indicator to Remote Unit Interconnect Cable (24 feet long)	90731-0124
	Remote Unit Mounting Tray.	57954-0101
	Installation Kit	03313-0500
	Installation Manual	03313-0621

TABLE 2.2 INSTALLATION KIT PARTS LIST 03313-0500

Description	Part Number	Quantity
Connector, BNC (P905).	41273-0002	2
Cable, Antenna, Low Loss, 8 ft. .	90072-0002	1
Connector, Channeling, 14 pin, (P901/P902).	41285-0001	2
Template, Indicator	57958-0001	1
Screw, Flat Hd, 4-40 x 3/16 (Indicator Mounting)	82884-0102	4
Insert, NAV.	04271-0002	2

2.4.2 Optional Kits Available

TABLE 2.3 OPTIONAL KITS

Kit Order Number	Description	Qty	Individual Item Part Number
90732-0108	Channeling Cable, 8 ft.		- - - - - -
90732-0116	Channeling Cable, 16 ft;		- - - - - -
90732-0124	Channeling Cable, 24 ft.		- - - - - -
03313-0502	Dealer Starter Kit		- - - - - -
03313-0504	"HOLD" Elimination Kit		- - - - - -
	Switch, Toggle	1	61497-0006
	Insert	1	55835-0002
	Modification Instruction	1	03313-0670
03313-0505	Indicator Cooling Kit		- - - - - -
	Manifold Assy	1	57799-0101
	Air Scoop	1	57798-0001
	Filter, Air (bug screen)	1	57797-0001
	Screw, Truss Hd, 6-32x3/8	6	82833-0405
	Cap	1	57814-0001
	Hose, Cooling Duct, 5/8 ID x 36" long	1	91024-0001
	Plenum	1	57971-0101
03313-0501	Code Converter Kit; King Slip and 2-out-of 5		
	ROM, MHz	1	74102-0003
	ROM, KHz	1	74102-0004
	Insert, NAV	1	04271-0003

2.4.3 Items NOT Supplied which may be needed

1. Tray mounting screws.
2. Insertion and extracting tool (Cinch), included in Dealer Starter Kit.
3. Auxiliary audio input to cabin amplifier or headphones for identification.
4. Miscellaneous connectors for channeling.
5. RNAV cable.
6. Circuit protection; 7 amp for 13.75 vdc, 5 amp for 27.5 vdc

2.5 MECHANICAL INSTALLATION

2.5.1 Interrogator/Receiver Unit (Remote Unit)

A. Locate the DME Antenna and Remote Unit as closely as possible to one another; this shortens the antenna coax cable thereby reducing signal loss and improving performance.

B. Locate the tray for the Remote Unit to provide adequate clearance for cable removal and Unit removal for service. Mount the tray with 6-32 or larger screws and related hardware. Provide a ground lug to ground the black wire in the Interconnect Cable. Obstructions that block airflow through the bottom of the tray, and out the sides should be avoided.

C. Mount the Remote Unit into the tray and tighten the lock nuts on the tray. The Remote Unit may be mounted either end first for cable convenience. The lock nuts are automatically secured by the use of a spring wisher which provides tension on the screw threads.

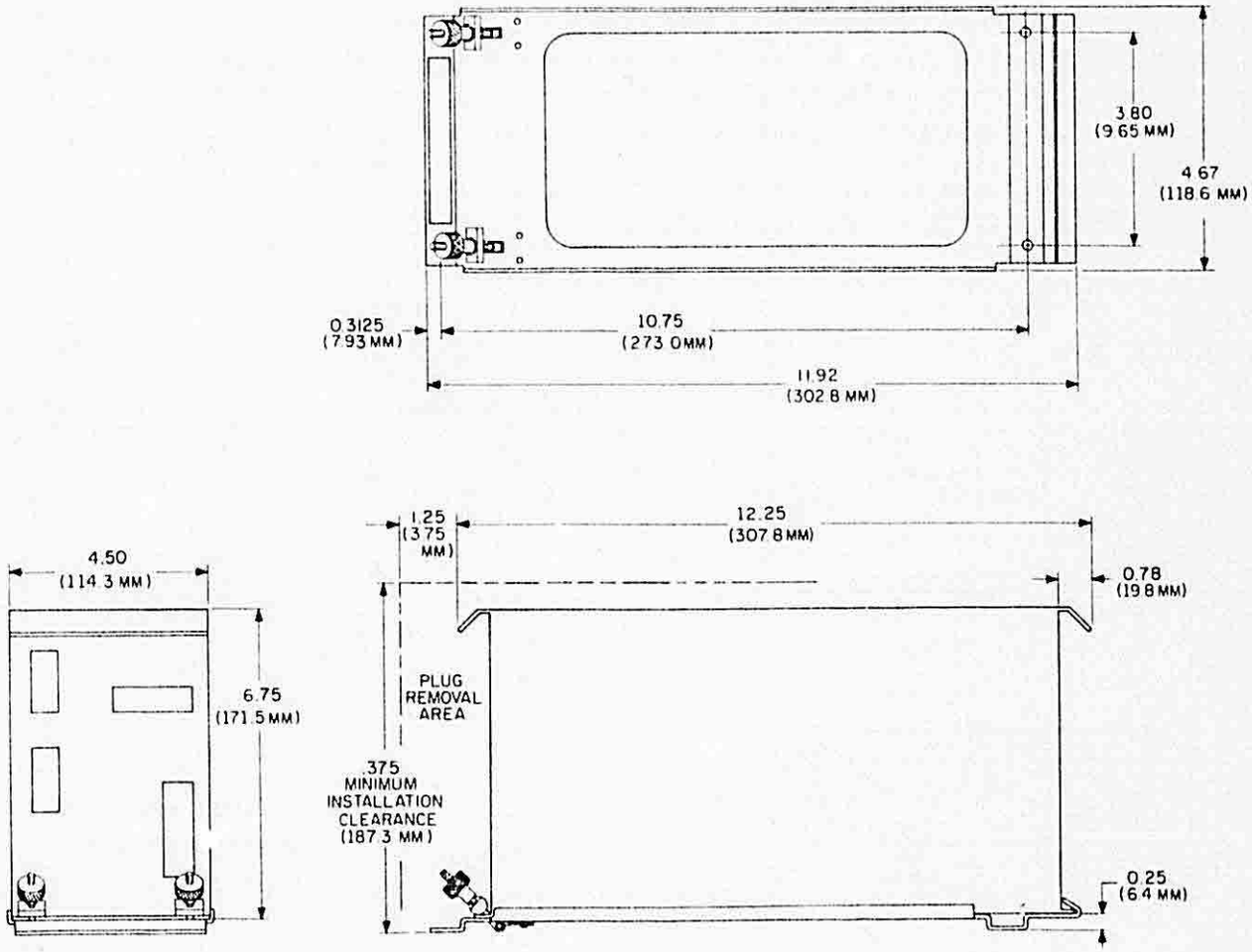


FIGURE 2-1. INTERROGATOR/RECEIVER-TRAY INSTALLATION DRAWING

SEE BLOW-UP

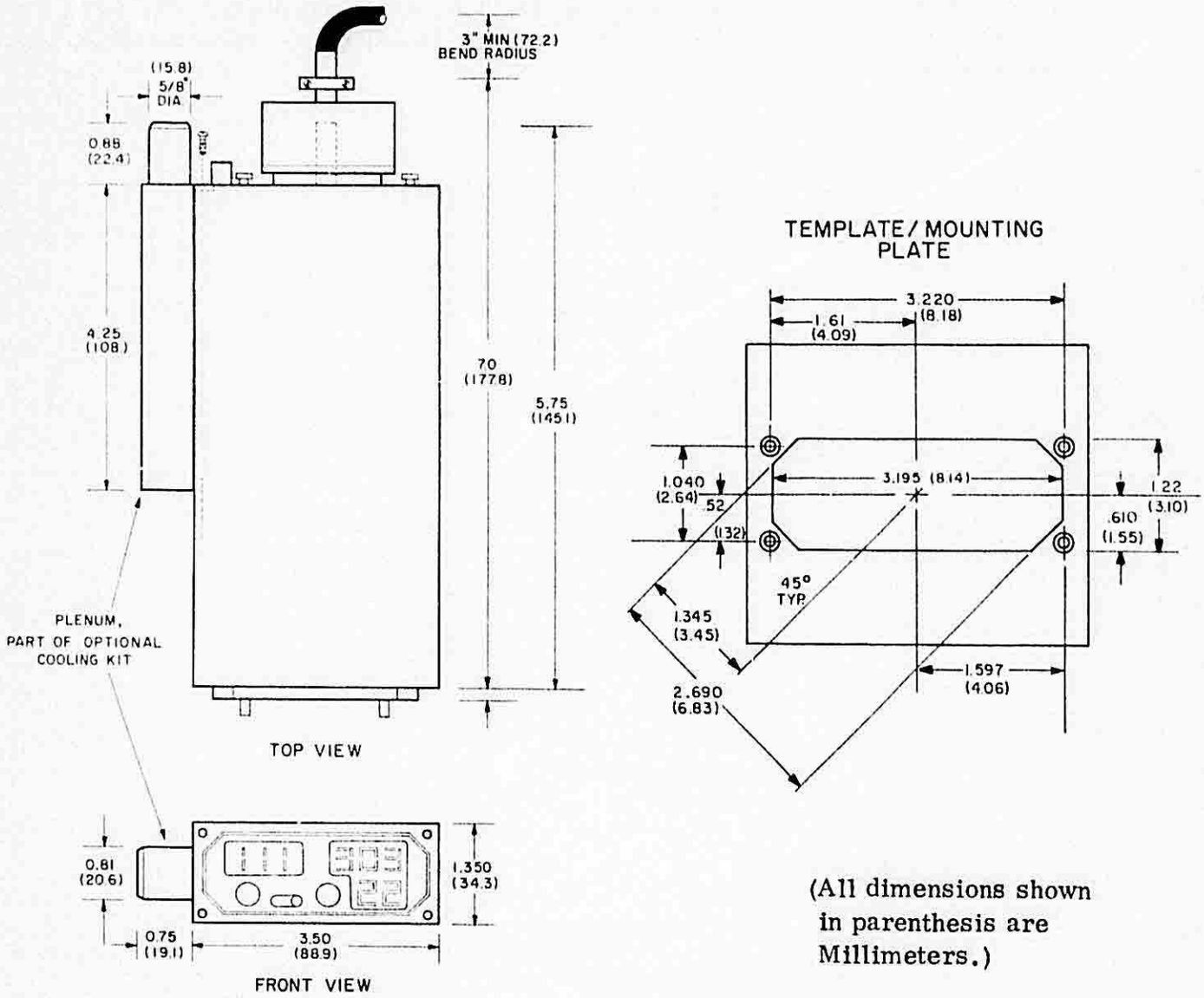
2.5.2 Indicator

The Indicator should be mounted for ease of viewing and manipulation of controls by the pilot. A metal template, 3-3/4 inches square having an octangonal cutout is supplied in the Installation Kit. See Figure 2-2. This template may be used for one of the following:

1. As a template for marking the instrument panel when the Indicator will be rear mounted directly to the instrument panel. See Subsection 2.5.2.2A.
2. As a mounting plate to allow front removal of the Indicator. See Subsection 2.5.2.2B.
3. As a mounting plate if the Indicator is to be mounted in a standard 3" instrument hole. See Subsections 2.5.2.3A and B.

NOTE

Indicator mounting screws must not penetrate the Indicator more than 1/4 inch.



(All dimensions shown in parenthesis are Millimeters.)

FIGURE 2-2. INDICATOR INSTALLATION DRAWING

SEE BLOW-UP

2.5.2.1 Indicator Cooling Kit, Optional

A cooling kit, while not required, is available for the Indicator as noted in Section 2.4. Cooling of the Indicator is normally by means of conduction, convection, and radiation. If any one of these effects is absent or restricted, the addition of a cooling kit is recommended.

If a cooling kit is part of the installation, be sure sufficient room exists for the plenum and duct hose. Generally the cooling kit will require rear mounting of the Indicator.

Installation:

Refer to Figure 2-3
This kit is similar to numerous cooling kits now in the field. Standard installation precautions should be observed, such as:

1. Scoop hole location should be approximately one foot below the unit's air intake.
2. Scoop to be positioned to "scoop" air in, flat of the "D" forward.
3. Manifold outlet ports facing upward.
4. A sealant, such as Silastic 732, be applied between skin and mounting flange of the scoop.
5. Drain hole on bottom of scoop must be clear of ALL obstructions.
6. Length of cooling duct(s) should be cut for the specific installation. Avoid dips in the line that could cause puddling in the line.
7. The plenum is attached to the RIGHT side of the Indicator (as viewed from the rear). Slip the plenum's forward lip into and under the leading vent hole in the Indicator. Position the plenum flush against the Indicator's side and secure it in place with the screw already in the rear of the Indicator. (See Indicator Installation Drawing.)

The Kit can supply ram air cooling to one or two equipments and be mounted on either side of the aircraft, forward of the instrument panel. If only one manifold port is used, cap the other.

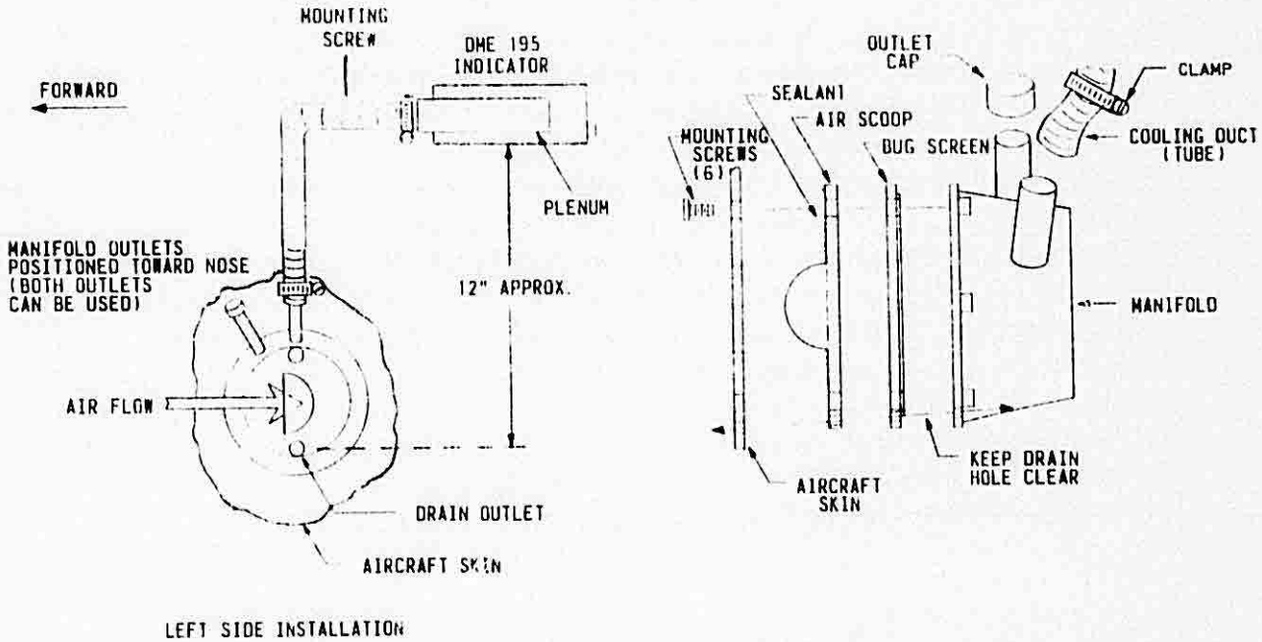
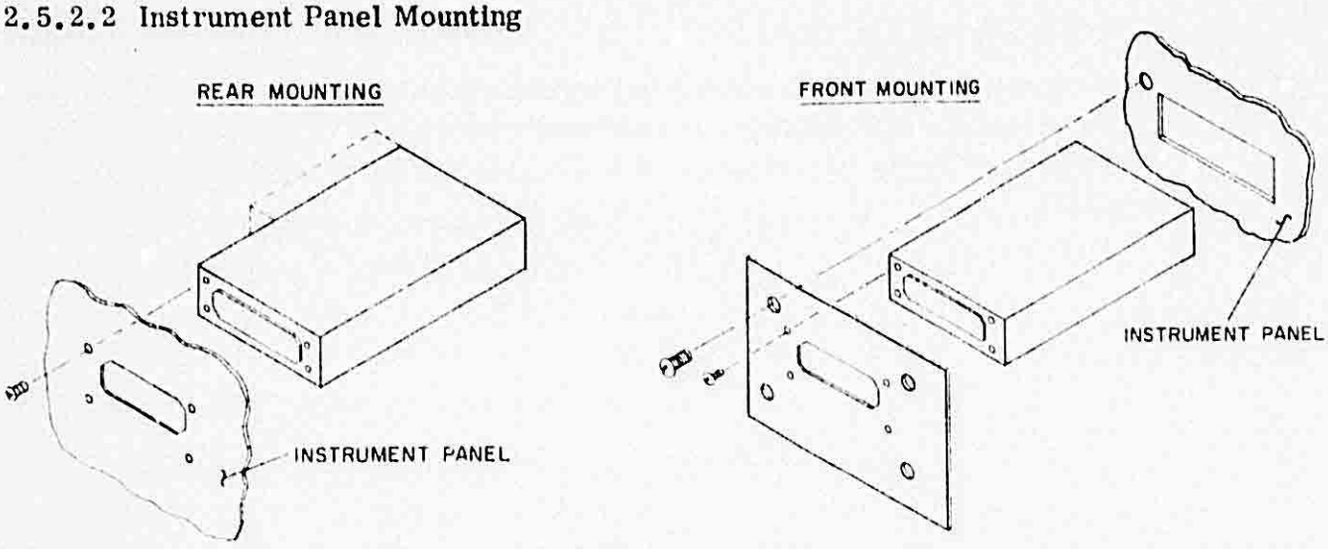


FIGURE 2-3. COOLING KIT INSTALLATION

SEE BLOW-UP

2.5.2.2 Instrument Panel Mounting



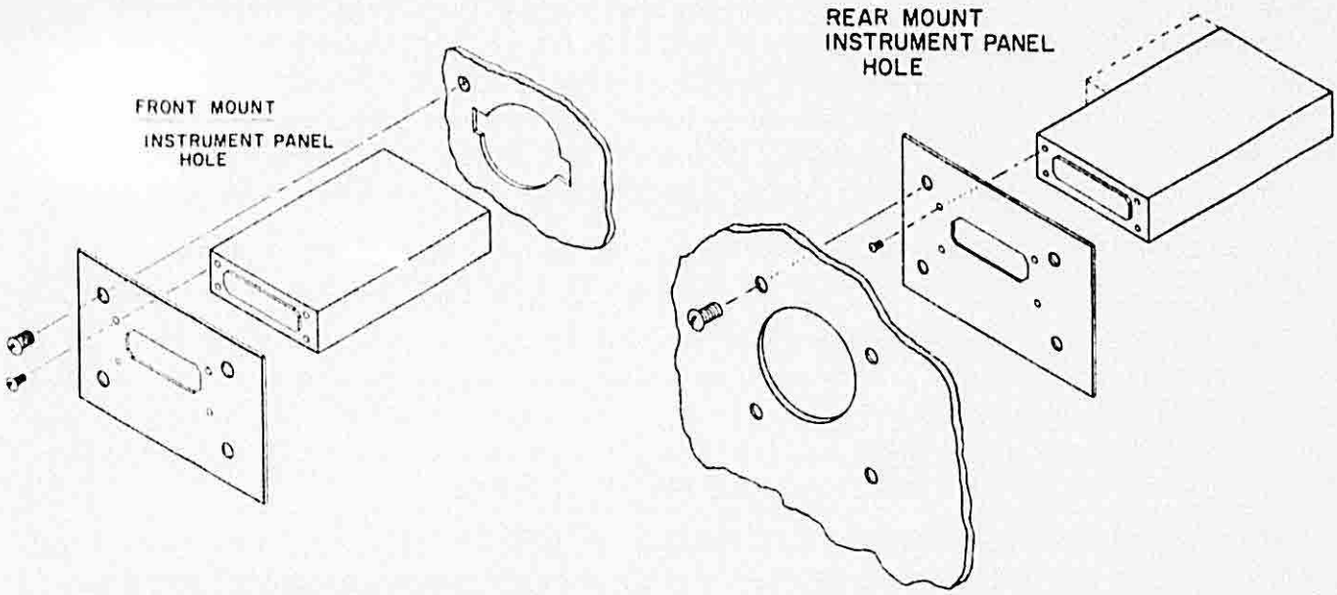
A. Rear Mounting of the Indicator

1. Using the template, scribe or mark the panel surface for the octagon shaped Indicator cutout and mounting holes.
2. Cut out the area for viewing of the Indicator's front panel.
3. Drill four .125 dia. (3.175 mm) mounting holes and countersink (82^{o}) thru .225 dia. (5.76 mm).
4. Deburr the cutout and mounting holes.
5. Mount the Indicator using the four 4-40 x 3/16 inch screws from the Installation Kit. If screws other than those supplied are used their length must be such that they will not penetrate the Indicator by more than 1/4 inch.

B. Front Mounting of the Indicator

1. Remove the Indicator's rectangular dust cover by removing two screws, at the rear of the Indicator and sliding the assembly from its dust cover.
2. Using the dust cover as a template, scribe or mark the instrument panel surface; replace the Indicator assembly in its dust cover.
3. Cut the panel opening slightly larger than the dust cover for clearance and deburr the cutout.
4. To mount the Installation Kit supplied template to the instrument panel locate four additional holes on the template; check behind the instrument panel for any potential interference; drill mounting holes in template and instrument panel.
5. Mount captive nuts in instrument panel mounting holes.
6. Mount the Indicator using the four 4-40 x 3/16 inch screws from the Installation Kit. If screws other than those supplied are used their length must be such that they will not penetrate the Indicator by more than 1/4 inch.
7. Install the Indicator and template in the instrument panel.

2.5.2.3 Instrument Hole Mounting



A. Front Mounting of the Indicator.

1. Remove the Indicator's rectangular dust cover by removing two screws, at the rear of the Indicator, and sliding the assembly from its dust cover.
2. Using the dust cover as a template enlarge the instrument hole to allow the dust cover to freely enter, deburr the cutout.
3. Replace the Indicator assembly in its dust cover.
4. Using the four 4-40 x 3/16 inch screws from the Installation Kit, assemble the template to the Indicator. If screws other than those supplied are used their length must be such that they will not penetrate the Indicator by more than 1/4 inch.
5. Slide the Indicator and template into the instrument hole and locate four mounting holes on the template and the instrument panel.
6. Remove Indicator, drill and deburr mounting holes, mount captive nuts in instrument instrument panel holes, install Indicator with template.

B. Rear Mounting of the Indicator

1. Locate the matal template to center its cutout in theinstrument hole, mark four mounting holes on the template and instrument panel.
2. Drill and deburr the mounting holes. Install all captive nuts in template mounting holes.
3. Using the four 4-40 x 3/16 inch screws from the Installation Kit, assemble the template to the Indicator. If screws other than those supplied are used their length must be such that they will not penetrate the Indicator by more than 1/4 inch.
4. Install the template and Indicator.

2.5.3 Antenna Mounting

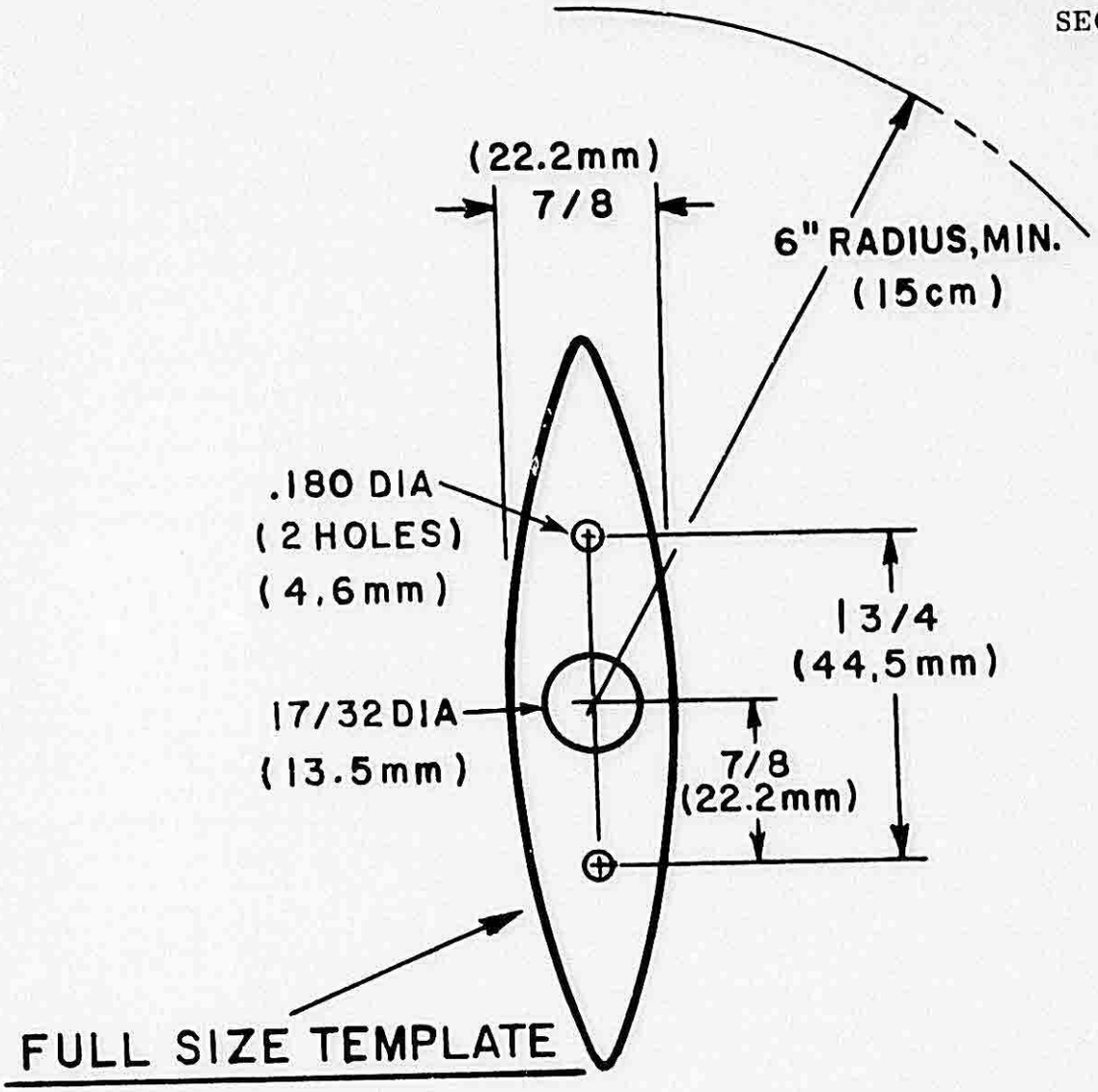
The blade antenna, type UDA-3, is used for both receiving and transmitting by the Interrogator/Receiver. This antenna should be mounted on the bottom surface of the aircraft and located so that it is in a vertical position when the aircraft is in a level flight attitude. The mounting surface should be metal, electrically grounded, and extend at least 6" in all directions from the antenna connector. (See Figure 2-4.) A three (3) foot minimum separation from other antennas, particularly transponders, must be maintained.

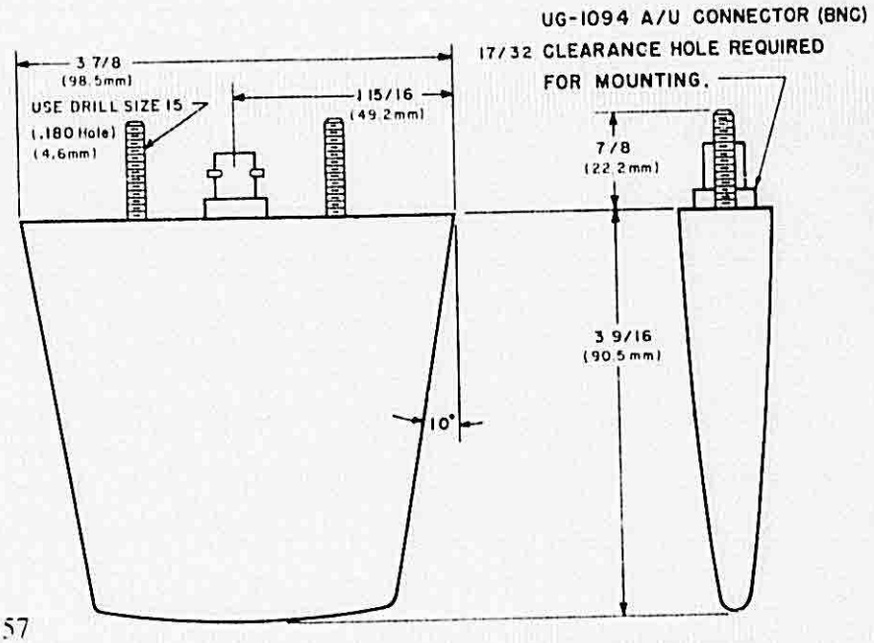
Avoid mounting the antenna near aircraft protrusions as this is likely to create radiation "shadowing" with a loss of signal strength in both transmitted and reply signals.

If this antenna is to be used on a nonmetallic aircraft skin, a ground plane at least 12" in diameter must be provided. This could be as simple as aluminum foil cemented inside a wood or fiberglass skin, or a doubler plate on a fabric-covered aircraft. Such a ground plane should be connected to the antenna mounting studs and either well insulated from, or well bonded to the airframe, to prevent erratic operation.

A doubler plate will be needed for an airworthy installation on most aircraft. Check the airworthiness regulations of the country of aircraft registry for acceptable mounting methods. Figure 2-4 is removable for a drilling template.

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





B-07362/AW557

FIGURE 2-4. UDA-3 ANTENNA INSTALLATION DRAWING

SEE BLOW-UP

2.5.3.1 Antenna Cable

A ninety-six (96) inch antenna cable comes in the Installation Kit.

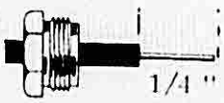
A cable run should be as direct as possible, having bend radiuses of 6 inches, minimum. In close areas, a BNC 90^{O} adapter may be utilized to clear control cables in the vicinity of the antenna.

ANTENNA CABLE LOSS SHOULD BE KEPT AS LOW AS POSSIBLE. The length and type of cable is critical as the MAXIMUM cable loss should not exceed 1-1/2 db.

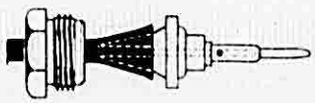
KEEP THE CABLE AS SHORT AS POSSIBLE AND CUT OFF EXCESS LENGTHS! If it is necessary to run the antenna cable some distance or should the cable be changed, refer to the following examples and take note of their limitations.

TABLE 2.4 ANTENNA CABLES

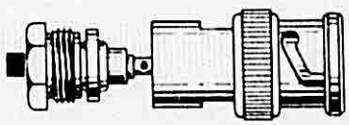
Cable type	db loss per 100 ft. @ 1000 MHz	Preferred length 1 db or less	Maximum length
RG 58 A/U	22. (.22 db per ft)	4-1/2 ft	6 ft
RG 29 /U	17. (.17 db per ft)	6 ft	8 ft
RG 54 A/U	11.5 (.115 db per ft)	8-3/4 ft	11 ft
RG 8 /U	8.5 (.085 db per ft)	11-3/4 ft	17 ft
NARCO (90072)	8.0 MAX. (.08 db per ft)	12-1/2 ft	18 ft



1. Take one clean square cut through cable insulation, braid and dielectric, exposing 1/4" of conductor. Slip nut onto cable.



2. Insert conductor into tapered, self-clamping sleeve and contact sub-assembly, force edge of sleeve between dielectric and braid until insulation rides well onto taper. Solder conductor to contact at solder hole.



3. Fit contact sub-assembly into connector body, screw nut into body, binding insulation and braid tightly against tapered sleeve ... thus forming a strong, weatherproof connection.

Courtesy of Bendix Corp.

Male and female connectors are assembled alike.

FIGURE 2-5. BNC CABLE CONNECTOR ASSEMBLY (Male/Female)

2.6 ELECTRICAL INSTALLATION

As shown in Figure 2-6, a basic DME electrical installation requires:

1. An Interconnect Cable, between the Remote Unit and the Indicator.
2. Connection to the aircraft avionics bus.
3. Wiring the DME Ident audio to the audio panel or headphone bus.
4. One or two DME channeling cables.
5. Installation of the antenna cable.

Area Navigation (RNAV) installations also require the foregoing interconnections plus wiring of the DME 195 Accessory Connector, P903.

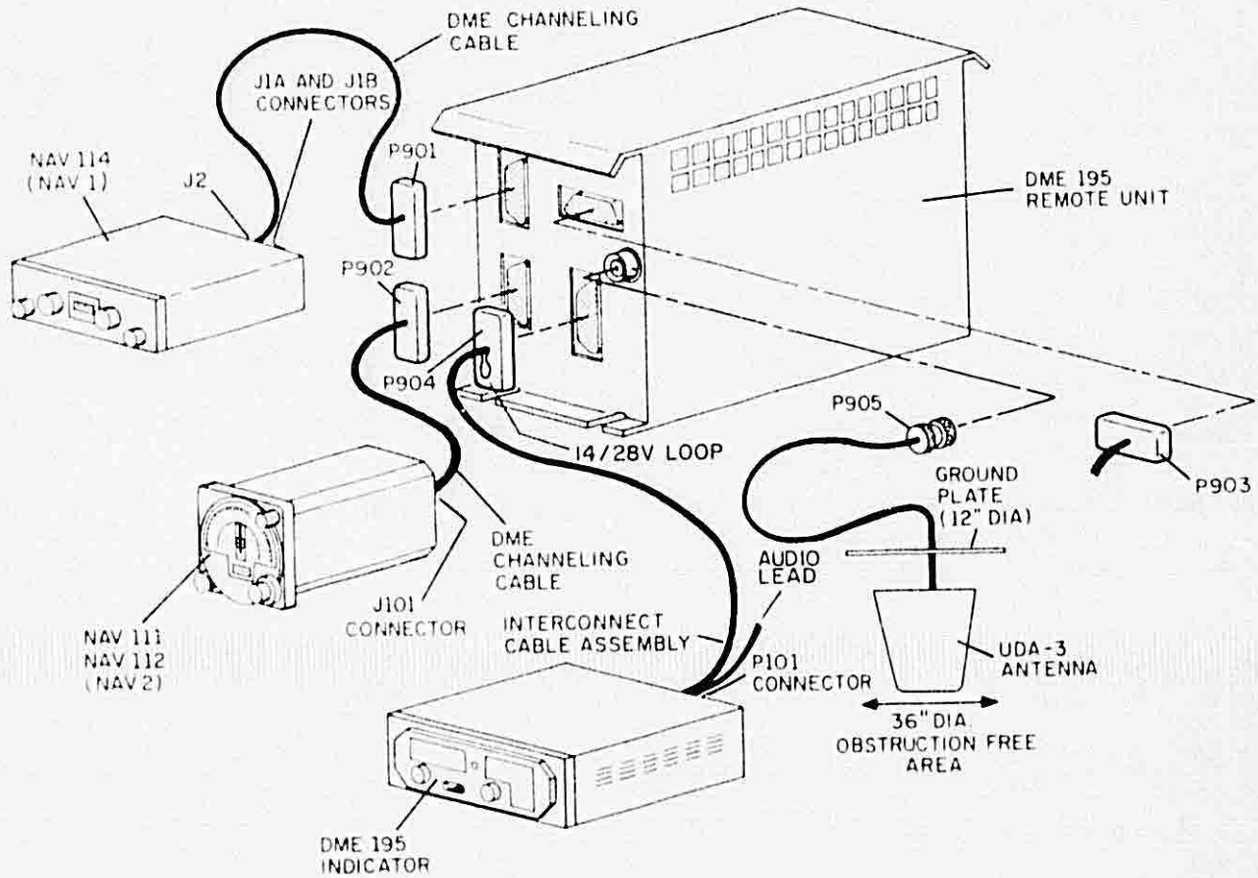


FIGURE 2-6. BASIC DME ELECTRICAL INSTALLATION

2.6.1 Definition of System Terms

Three terms used throughout Section 2.6 need brief definitions.

1. DME-STD: Consists of a DME 195 and one or two navigation (NAV) receivers for channeling. This System is detailed in Subsection 2.6.5. Refer in particular to the pictorial and wiring illustrations Figures 2-11 and 2-12.
2. NAV 1-RNAV: Consists of a DME 195, two NAV receivers with DME channeling capability, and an RNAV system. In this installation the number 1 NAV receiver (NAV 1) is part of the RNAV System. This System is detailed in Subsection 2.6.6. Refer in particular to the pictorial and wiring illustrations Figures 2-15 and 2-16.
3. NAV 2-RNAV: Same as NAV 1-RNAV except the number 2 NAV receiver (NAV 2) is part of the RNAV System. This System is detailed in Subsection 2.6.7. Refer in particular to the pictorial and wiring illustrations Figures 2-21 and 2-22.

2.6.2 Supplied and Optional Cables

2.6.2.1 Supplied Interconnect Cable (P101 and P904)

Electrical connections between the Interrogator/Receiver and the Indicator are made by the Interconnect Cable. Supplied as part of the Installation Material, this cable has several critical construction areas and therefore we recommend that the Narco constructed cable be used. Toward this end the cable is offered in three lengths to suit the majority of aircraft.

Interconnect Cable repairs will be aided by referring to Figure 2-7 and Table 2.5.

Standard DME and NAV 1-RNAV installations use the Interconnect Cable as supplied. For NAV 2-RNAV installations two connections in P101 must be reversed: a procedure is furnished in Section 2.6.7 and should be completed before the cable is installed in the aircraft.

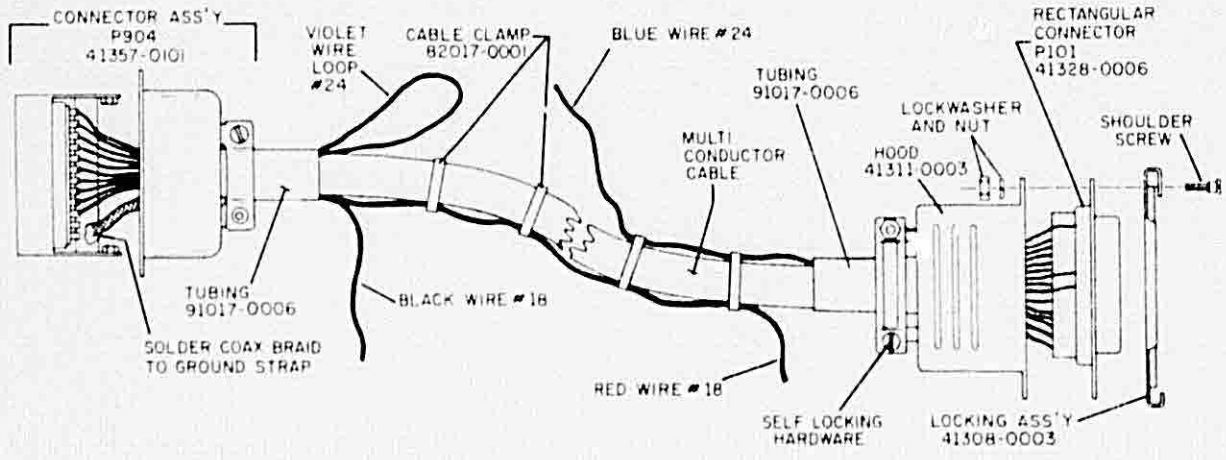


FIGURE 2-7. INTERCONNECT CABLE ASSEMBLY

TABLE 2.5 INTERCONNECT CABLE (P904/P101)

External Wires	Interconnect Cable P904 Pin #	Color	P101 Pin #	Function	Notes
	1	Black	1	Ground	Also connector shell
#18 Black	1			Unit Ground	
	2	Gray	14	Ground	Also connector shell
	3	Black Coax	17	Distance Serial Clock	Braid soldered to connector shells
	4	Red Coax	18	Distance Serial Data	Braid soldered to connector shells
	5	Brown	11	IDENT audio to Indicator	
	6	Orange	22	NAV 2 Select	NAV 2-RNAV, P101-22 and P101-10 reversed
	7	Red #20	2	+7 vdc	
	8	Blue #20	15	+7 vdc	
	9	Yellow	6	RNAV mode light	
	10	Green	9	V/T Control Head Information	
#24 Violet	11	Violet	12	DME ON-OFF	External Violet wire loop is cut for 28v installations
	12		24	Voltage Conversion	
	13	White	5	V/T Serial Data	Braid soldered to connector shells
	14	Green	7	V/T Serial Clock	Braid soldered to connector shells
	15	White/	16	Multiplex blanking	
	16	White/ Black	8	V/T function clocking	
	17	NC			
	18	White/ Red	10	NAV 1 Select	NAV 2-RNAV, P101-10 and P101-22 reversed
	19	NC			
	20	White/ Yellow	3	Hundreds distance digit	
	21	White/ Green	4	Display BAR	
	22	NC			
#18 Red	23			14/28 vdc input	
	24				
#24 Blue			23	IDENT audio output	

2.6.2.2 Optional Channeling Cables (P901 and P902)

These twelve wire cables are available in three lengths (8, 16, and 24 feet), wired to the DME's 14 pin mating connectors (P901/P902). Prior to installation the NAV receiver mating connector must be added. Within the cable are a sufficient number of wires to carry Narco, ARINC, King-slip, or most other DME channeling codes.

TABLE 2.6 OPTIONAL CHANNELING CABLE COLOR CODE

DME 195 P901/P902	Optional Cable Color Code	NAV 111, P101 or NAV 112, P101 or NAV 114, J2 or RNAV 112, P104	DME Channel Programming	
			NARCO	ARINC
1	Brown	1	B	A MHz
2	Red	2	C	B MHz
3	Orange	3	D	C MHz
4	Yellow	4	E	D MHz
5	Green	5	A	E MHz
6	Blue	6	F	A KHz
7	Purple	7	H	B KHz
8	Gray	8	J	C KHz
9	White	9	K	D KHz
10	White/Brown	10	L	E KHz
11	White/Red	11	"Y" Channel Act.	
12	Black	12	DME Common	
13	NC			
14	NC			

2.6.3 Optional Code Converter Kits

The DME 195, as shipped, is programmed for Narco and ARINC 2-out-of-5 channel coding. Each optional Code Converter Kit permits:

1. Channeling with Narco or ARINC codes plus another channeling scheme, such as the King Radio slip code.
2. NAV 1 and NAV 2 DME channeling with a specified code other than 2-out-of-5.
3. NAV 1 and NAV 2 DME channeling with Narco or ARINC 2-out-of-5 coding (for use when updating an existing DME 195 installation which previously did not utilize 2-out-of-5 coding).

When ordering a Kit, be sure the kit name includes the coding to be processed (example: Code Converter Kit - King slip and 2-out-of-5).

Each Kit contains:

1. Two integrated circuit, pre-programmed, read only memories.
2. Two channel code identification labels to permit external identification of internal programming.

2.6.3.1 Installation and Programming Procedure

NOTE: DME-STD and NAV 1-RNAV proceed to steps B and C.
NAV 2-RNAV perform steps A, B, and C.

A. Refer to Figure 2-21.

J901 is always the RNAV system channeling connector. Since the NAV 2 channeling connector will now mate with J901, the NAV 1 legend adjacent to J901 should be covered with a "NAV 2" label from the Installation Kit. In addition the NAV 2 legend adjacent to J902 should be covered with a "NAV 1" label from the Installation Kit.

B. Read-Only-Memory Installation

1. From the Interrogator/Receiver, remove the left side panel; the panel is secured by 10 screws.
2. Pivot the Velocity Circuit Board by loosening, at the forward end of the board's mounting rails, two screws; the board pivots at the rear of the assembly (Fig. 2-8).
3. Refer to Figure 2-9 (Channel Multiplex component board) locate J201 and J202.
4. Remove the wired plugs and insert the proper Read-Only-Memory (Code Converter Converter ROM):

   DME-STD, refer to Table 2.7
   NAV 1-RNAV, refer to Table 2.7
   NAV 2-RNAV, refer to Table 2.8

   NOTE: The MHz and KHz ROMs are not interchangeable and are identified by the part number stamped on the component.

C. Channel Multiplex Programming

1. Refer to the proper Table (2.7 or 2.8) for any required channel multiplex board jumpers.
2. Close and resecure the Velocity Board and side panel.
3. Adjacent to J901 and J902 apply the channel code identification labels.

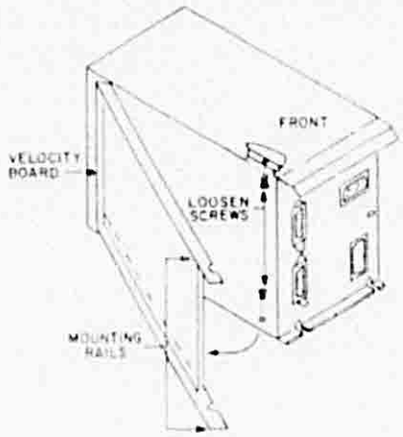


FIGURE 2-8. DME 195 VELOCITY BOARD ACCESS

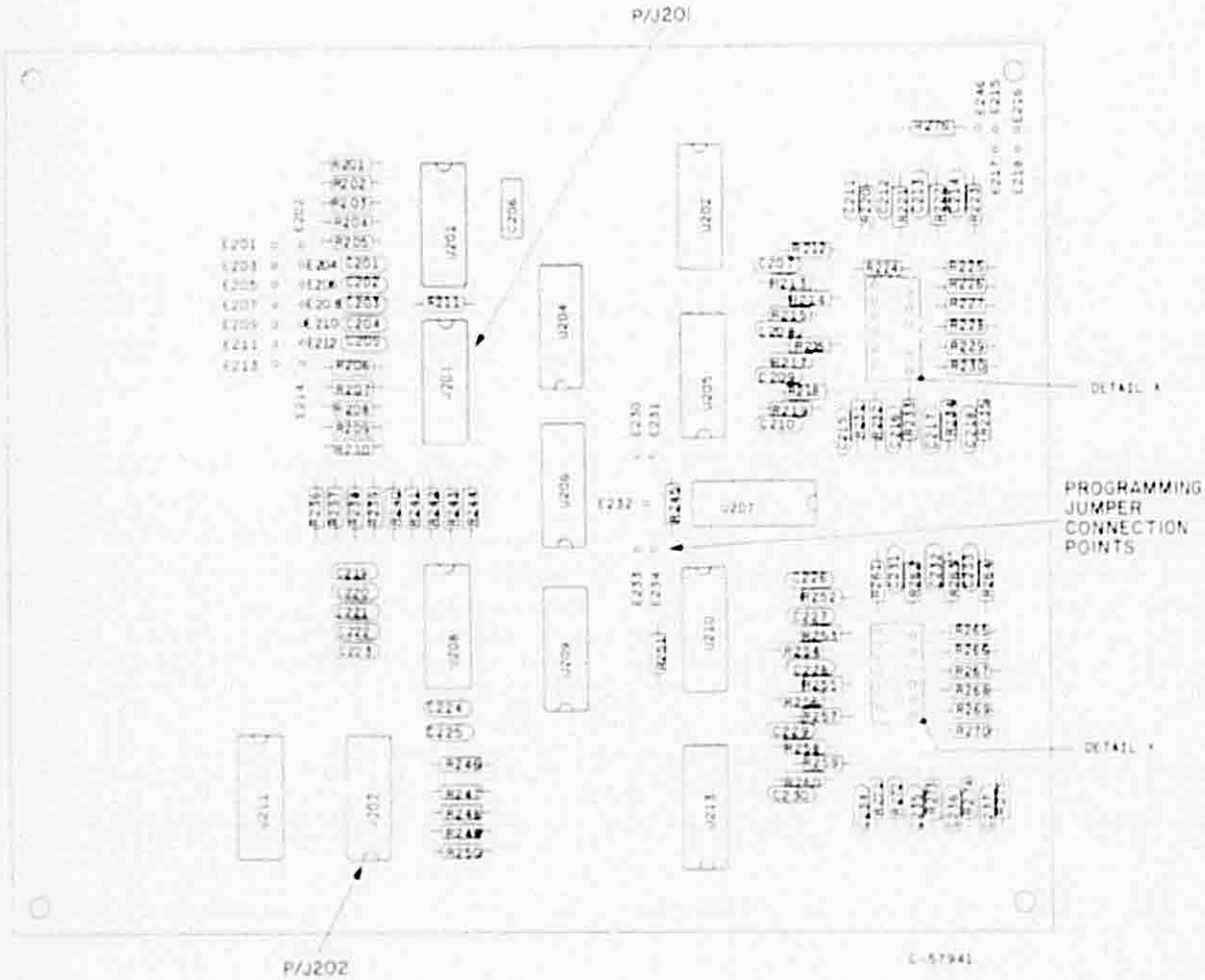
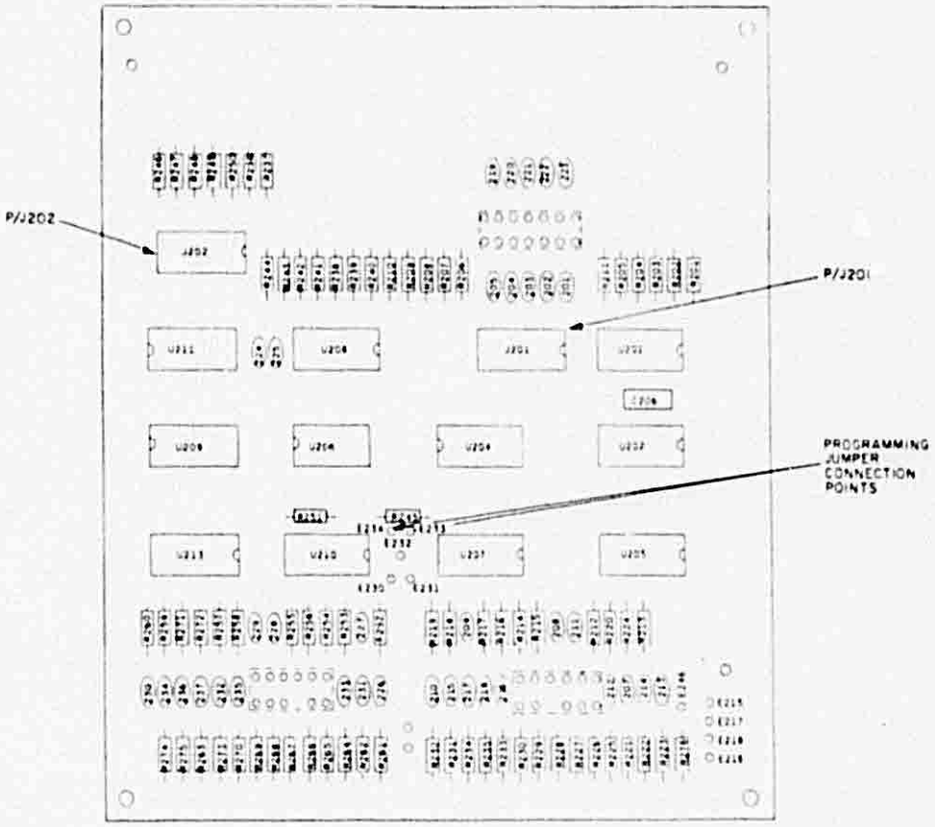


FIGURE 2-9. CHANNEL MULTIPLEX COMPONENT BOARD

SEE BLOW-UP



NOTES: This assembly is electrically identical to the assembly shown in Figure 2-9.

Refer to Tables 2.7 and 2.8 for programming instructions.

FIGURE 2-9A CHANNEL MULTIPLEX COMPONENT BOARD
LATER MODELS

SEE BLOW-UP

TABLE 2.7 DME-STD and NAV 1-RNAV JUMPER/ROM PROGRAMMING

NAV UNIT DME CHANNEL CODE	RECEIVER USED AS	JUMPER E232 TO	PROGRAM P201	PROGRAM P202
NARCO or ARINC NARCO or ARINC	NAV 1 NAV 2	Not Required (do not jumper)	Wired Plug* P/N 42077-0101	Wired Plug* P/N 42077-0101
NARCO KING	NAV 1 NAV 2	E233	ROM P/N 74102-0003	ROM P/N 74102-0004
KING NARCO	NAV 1 NAV 2	E234	ROM P/N 74102-0003	ROM P/N 74102-0004
KING KING	NAV 1 NAV 2	E230	ROM P/N 74102-0003	ROM P/N 74102-0004
NARCO or ARINC NARCO or ARINC	NAV 1 NAV 2	E231	ROM P/N 74102-0003	ROM P/N 74102-0004

*Narco installed Program,
all others, field installed.

TABLE 2.8 NAV 2-RNAV JUMPER/ROM PROGRAMMING

NAV UNIT DME CHANNEL CODE	RECEIVER USED AS	JUMPER E232 TO	PROGRAM P201	PROGRAM P202
NARCO or ARINC NARCO or ARINC	NAV 1 NAV 2	Not Required (do not jumper)	Wired Plug* P/N 42077-0101	Wired Plug* P/N 42077-0101
NARCO KING	NAV 1 NAV 2	E234	ROM P/N 74102-0003	ROM P/N 74102-0004
KING NARCO	NAV 1 NAV 2	E233	ROM P/N 74102-0003	ROM P/N 74102-0004
KING KING	NAV 1 NAV 2	E230	ROM P/N 74102-0003	ROM P/N 74102-0004
NARCO or ARINC NARCO or ARINC	NAV 1 NAV 2	E231	ROM P/N 74102-0003	ROM P/N 74102-0004

*Narco installed Program,
all others, field installed.

2.6.4 Accessory Connector (P903)

P903 is shipped with the Interrogator/Receiver and is prewired for DME-STD operation with the jumpers shown in Figure 2-12. RNAV installations require removal of the jumpers and wiring added from P903 to the RNAV computer and Standard/RNAV pushbutton switches.

NOTE:

All Interrogator/Receiver Units must have P903 properly wired and installed to operate. In RNAV systems with the RNAV computer temporarily removed or disabled, the "Standard Jumpers" (see Figure 2-12) must be installed in P903 for the DME 195 to operate.

2.6.5 DME-STD Installation Wiring

This installation is illustrated in Figures 2-11 and 2-12.

2.6.5.1 Interconnect Cable

A. Power Connections (Refer to Figure 2-10).

From P904 exit two #18 wires, one red and one black. The black wire should be kept as short as possible and is connected to a ground lug close to the Interrogator/ Receiver. The red wire carries 14 or 28 vdc A+ input and is connected to the DME circuit breaker.

A violet wire loop also exits from P904. In 28 vdc installations the loop is cut and the free ends insulated. The loop is NOT cut in 14 vdc installations.

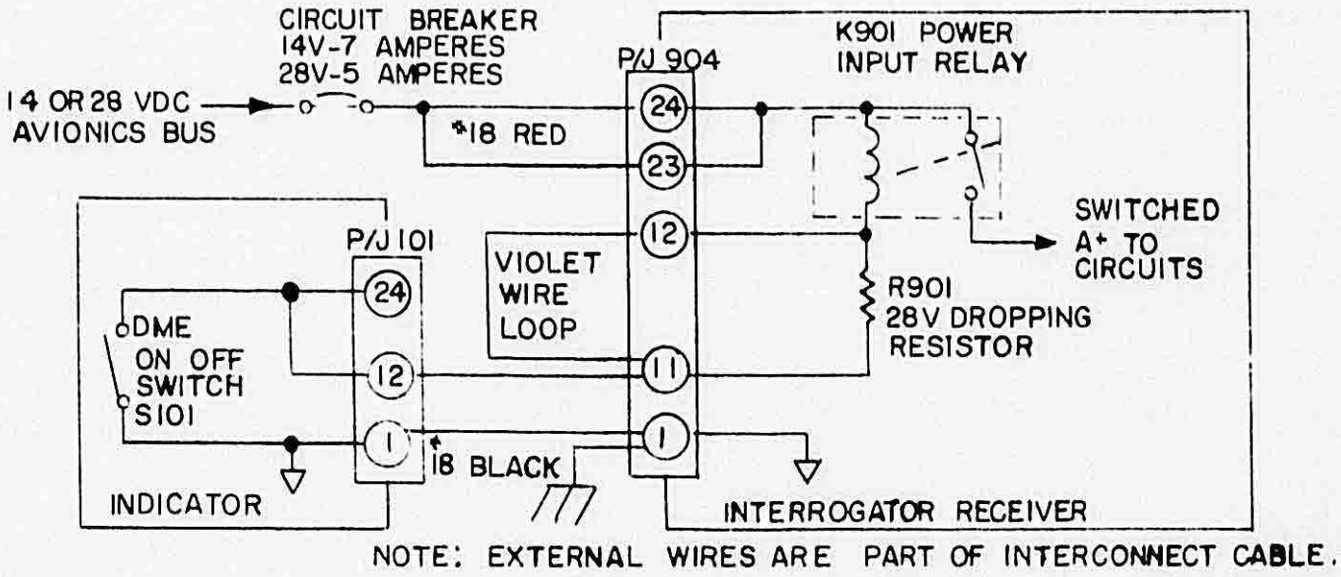


FIGURE 2-10. POWER INPUT SCHEMATIC

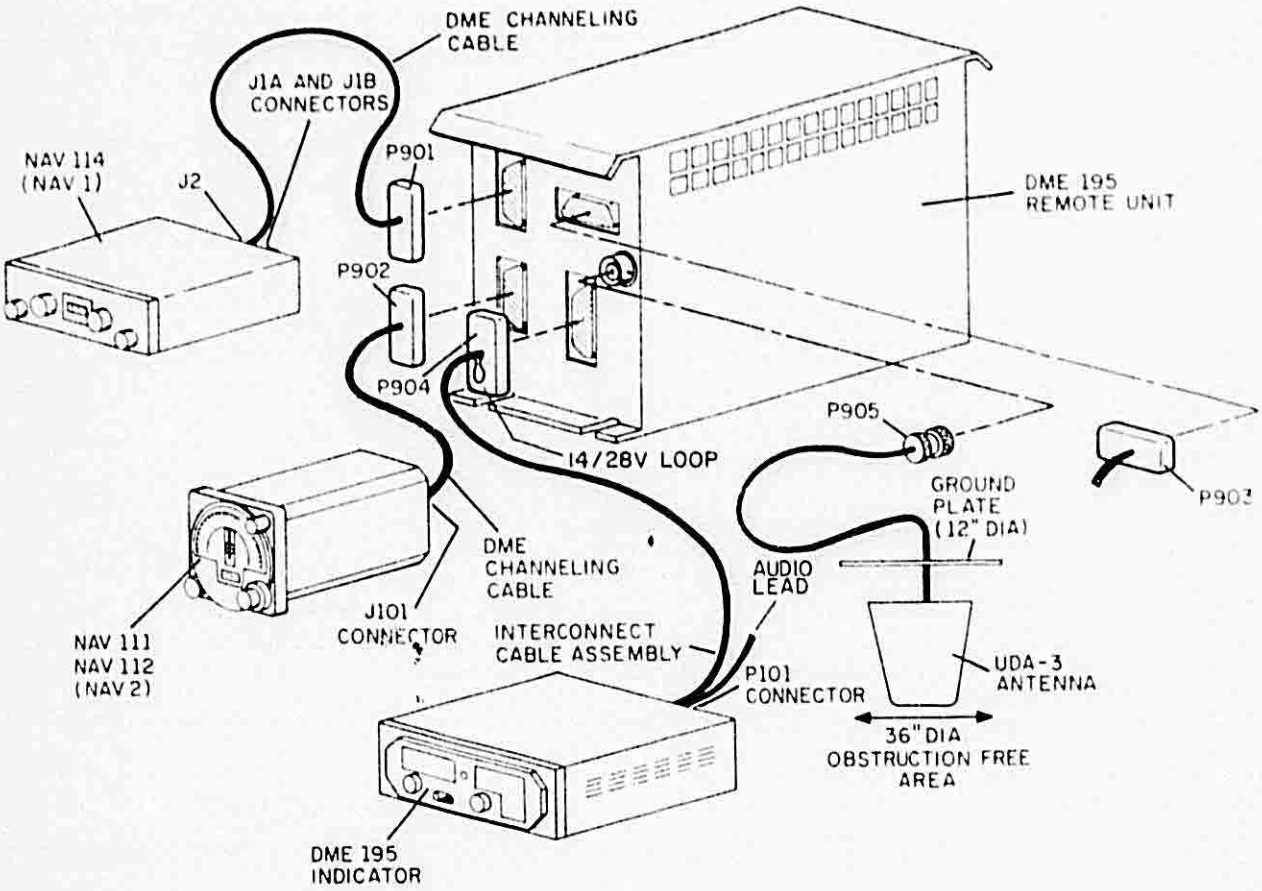
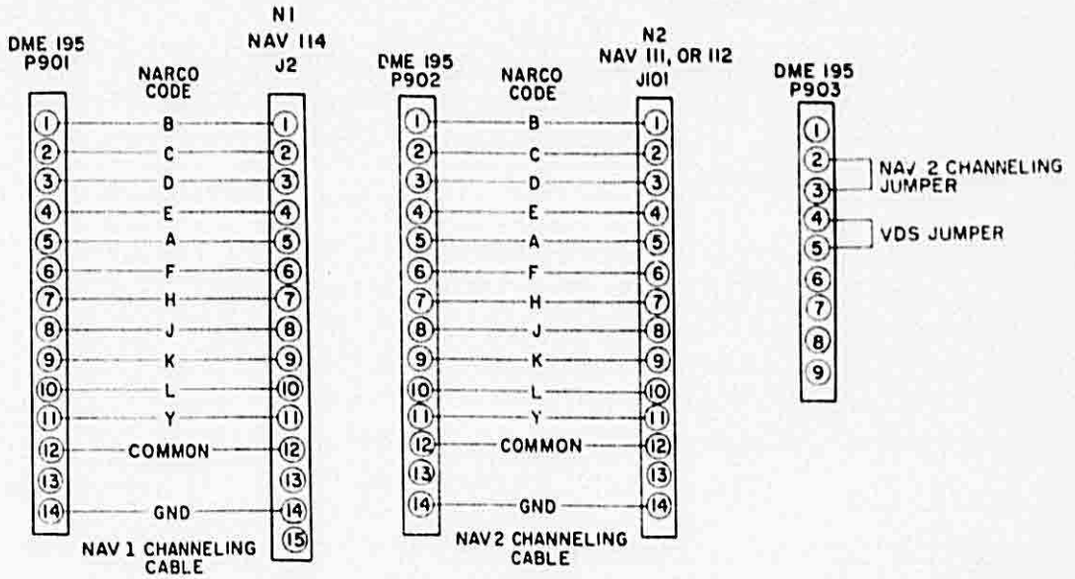


FIGURE 2-11. STANDARD DME WIRING PICTORIAL

NOTE:
1. 14 VOLT INSTALLATIONS — DO NOT CUT VIOLET WIRE LOOP
   28 VOLT INSTALLATIONS — CUT VIOLET WIRE LOOP, INSULATE FREE ENDS.
2. VEL/TTS = VELOCITY / TIME-TO-STATION
   VDS = VALID DATA STROBE



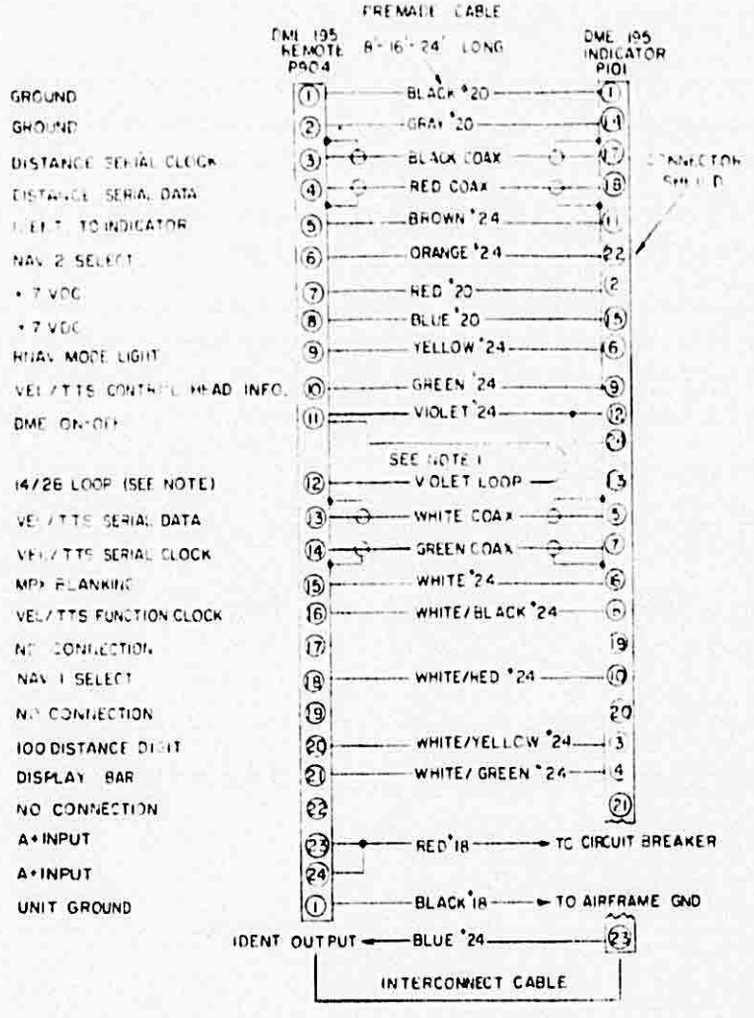


FIGURE 2-12. STANDARD DME WIRING

SEE BLOW-UP

2.6.5.1 Continued

B. Ident Audio Connections

From P101 exits a #22 blue wire which generally is connected to an audio panel's DME audio input port. Figure 2-13 illustrates the major DME 195 Ident interconn interconnections. Note that Ident audio is taken directly from the arm of the DME Ident Volume control.

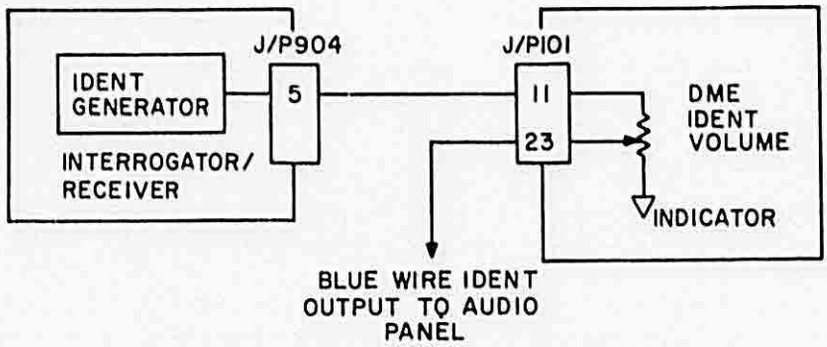


FIGURE 2-13. IDENT INTERCONNECTIONS

CP125, CP126, or CP127 Audio Panel

DME Ident may be directly connected to the selected audio panel input and the panel's input potentiometer adjusted to set the system Ident volume for a given DME volume control setting.

Paralleling DME Ident with a second audio source (Marker Beacon Receiver, NAV Receiver, etc.) should follow these general rules:

1. Paralleling DME with a high impedance (4.7K ohm or greater) source requires adding a 1500 ohm or larger, 1/4 watt resistor in series with the blue wire.
2. Paralleling DME with a low impedance (up to 4.7K ohm) source requires adding a 330 ohm or larger, 1/4 watt resistor in series with the blue wire.

VP 22 Audio Panel or Headphone Bus

When driving a headphone bus or an audio panel switching raw headphone audio, such as the VP 22 or KMA-20, add a 330 ohm or larger, 1/4 watt resistor in series with the blue Ident wire. This resistor must be added to prevent loading of the headphone bus.

2.6.5.2 Channeling Connectors (P901 and P902)

A. Channeling Codes

The DME 195, as shipped, is programmed for Narco and ARINC 2-out-of-5 channel coding. Optional Code Converter Kits and their installation are discussed in Section 2.6.3.

B. Single NAV Receiver Installations

Installations containing a single DME channeling source should either wire P901 and P902 in parallel, or install jumpers in the unused plug which will channel the DME to 108.00. In the first case, the proper channel will be selected regardless of N1 or N2 NAV Receiver Selector Switch setting. In the second case, 108.00 is a test frequency and the inadvertant selection of the jumpered plug will not result in the DME locking-on to a real but undesired, and possibly misleading, DME station.

C. P901/P902 Wiring

Refer to Table 2.9 for Narco and ARINC Programming Connections. Figure 2-12 shows the interconnections between P901/P902 and several Narco NAV receivers. Refer to Table 2.10 for King slip code programming connections.

D. Installation Kit Labels

Supplied in the Installation Kit are NAV 1 and NAV 2 stickers. They are to be applied to cable mounted connectors P901 and P902 for identification purposes.

E. Isolation and HOLD

External channeling line isolation is not required when following the wiring diagrams included in this manual. The HOLD mode requires no additional external switches or wires. If desired, the HOLD function may be eliminated by installing a two position switch; refer to Section 2.4 for HOLD Elimination Kit part number.

2.6.5.3 Accessory Connector (P903)

No additional connections to P903 are necessary since the required jumpers are installed at the factory. Figure 2-12 shows the standard DME-STD jumpers.

P903 must be installed for the DME to operate.

This completes the DME STD installation wiring.

TABLE 2.9 NARCO AND ARINC DME CHANNEL PROGRAMMING

MHz NARCO	MHz ARINC	DME 195 P901 & P902	MHz CHANNELS 108	109	110	111	112	113	114	115	116	117	Optional Channeling Cable Color Code
B	A	1	X	X		X	X						Brown
C	B	2			X	X		X	X				Red
D	C	3					X	X		X	X		Orange
F	D	4	X						X	X		X	Yellow
A	E	5		X	X						X	X	Green

KHz NARCO	KHz ARINC	DME 195 P901 & P902	KHz CHANNELS .00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95	Optional Channeling Cable Color Code
F	A	6			X	X	X	X											X	X	X	X	Blue
B	B	7	X	X	X	X			X	X	X	X											Purple
J	C	8					X	X	X	X			X	X	X	X							Gray
K	D	9									X	X	X	X			X	X	X	X			White
L	E	10	X	X											X	X	X	X			X	X	White/Brown
"Y" CHANNEL ACT.		11		Y		Y		Y		Y		Y		Y		Y		Y		Y		Y	White/Red
DME COMMON		12																					Black

NOTES:
1. "X" indicates continuity to the DME common terminal, Pin 12.
2. "Y" indicates continuity to the ground terminal.

TABLE 2.10 SLIP CODE DME CHANNEL PROGRAMMING

MHz SLIP	DME 195 P901 & P902	MHz CHANNELS 108	109	110	111	112	113	114	115	116	117	Optional Channeling Cable Color Code
M_0	5			X	X	X		X		X	X	Green
M_1	3				X	X	X		X		X	Orange
M_2	2	X				X	X	X		X		Red
M_3	1		X				X	X	X		X	Brown

KHz SLIP	DME 195 P901 & P902	KHz CHANNELS .00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95	Optional Channeling Cable Color Code
K_0	7	X	X	X	X	X	X					X	X							X	X	Purple
K_1	8	X	X	X	X	X	X	X	X					X	X							Gray
K_2	9			X	X	X	X	X	X	X	X					X	X					White
K_3	6					X	X	X	X	X	X	X	X					X	X			Blue
"Y" CHANNEL ACT.	11		Y		Y		Y		Y		Y		Y		Y		Y		Y		Y	White/Red
DME COMMON	12																					Black

NOTES:
1. "X" indicates continuity to the DME common terminal, Pin 12.
2. "Y" indicates continuity to the ground terminal.

2.6.6. NAV 1-RNAV Installation Wiring

This installation is illustrated in Figures 2-15 and 2-16.

2.6.6.1 Interconnect Cable

A. Power Connections (Refer to Figure 2-14).

From P904 exit two #18 wires, one red and one black. The black wire should be kept as short as possible and is connected to a ground lug close to the Interrogator/ Receiver. The red wire carries 14 or 28 vdc A+ input and is connected to the DME circuit breaker.

A violet wire loop also exits from P904. In 28 vdc installations the loop is cut and the free ends insulated. The loop is NOT cut in 14 vdc installations.

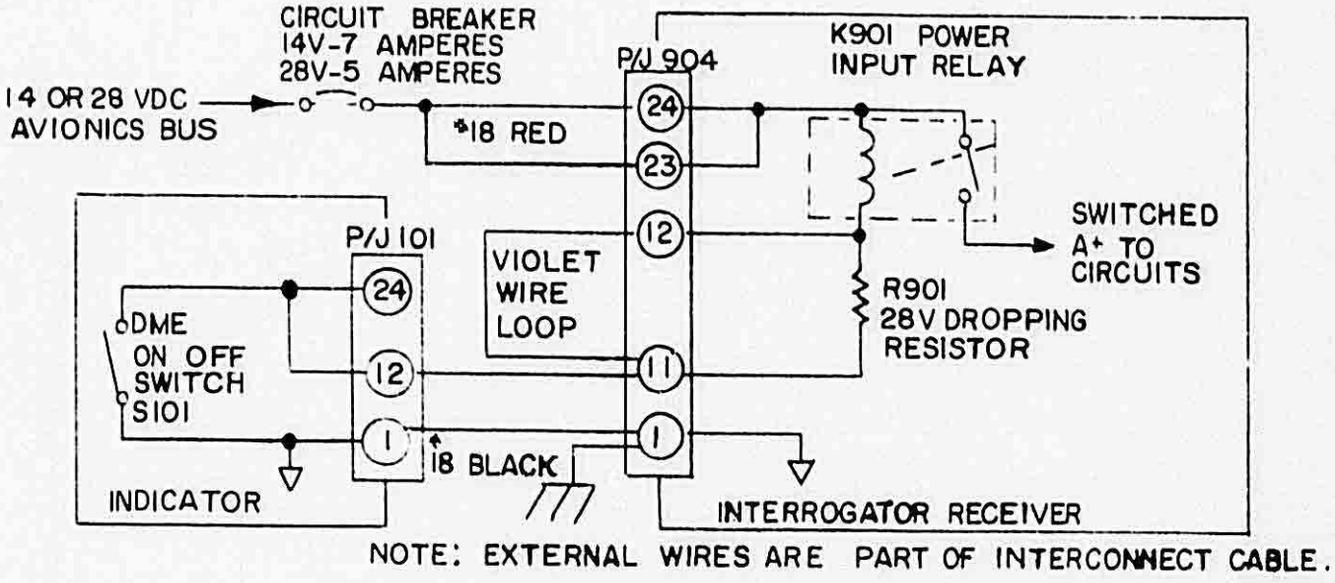


FIGURE 2-14. POWER INPUT SCHEMATIC

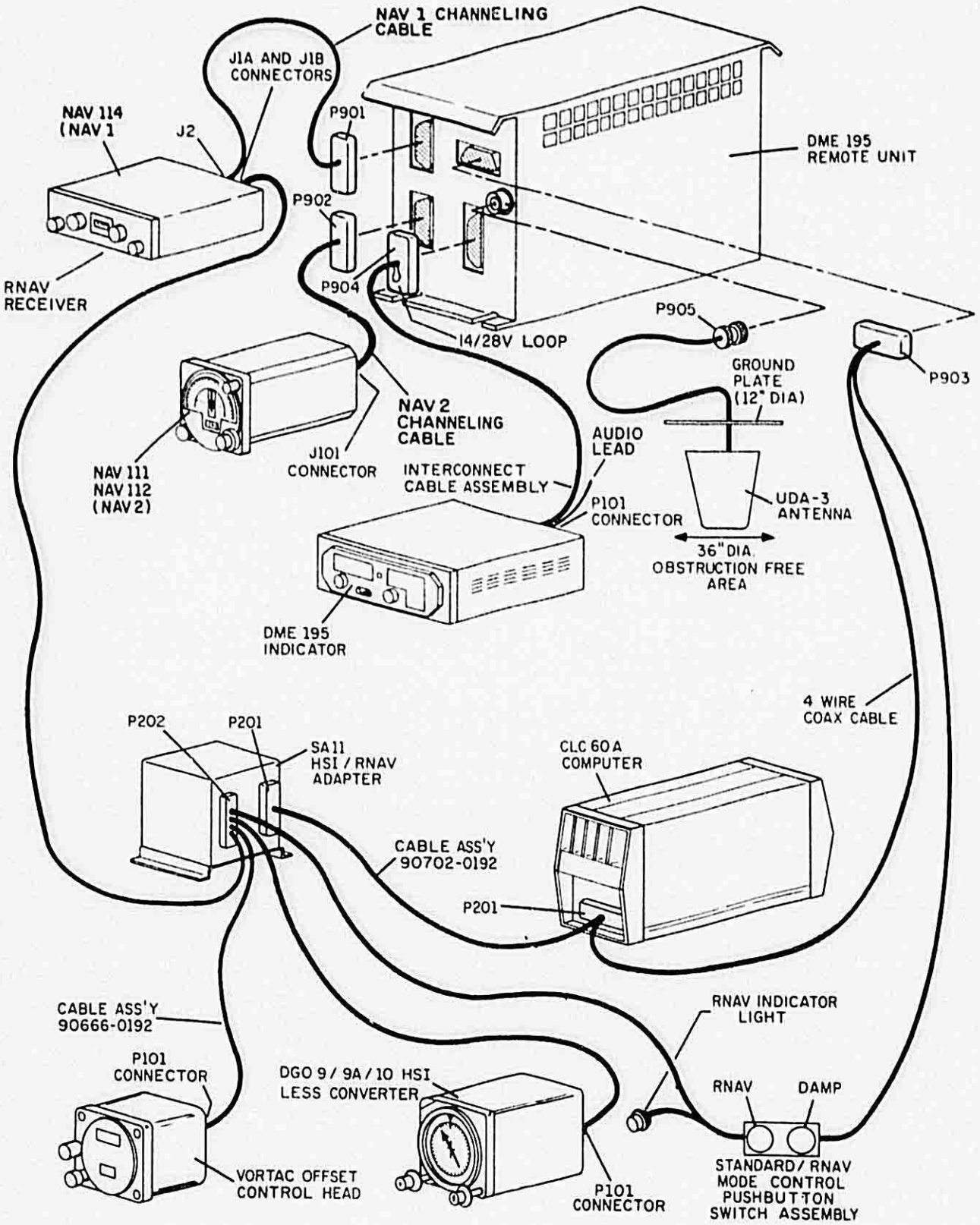


FIGURE 2-15. NAV 1-RNAV WIRING PICTORIAL

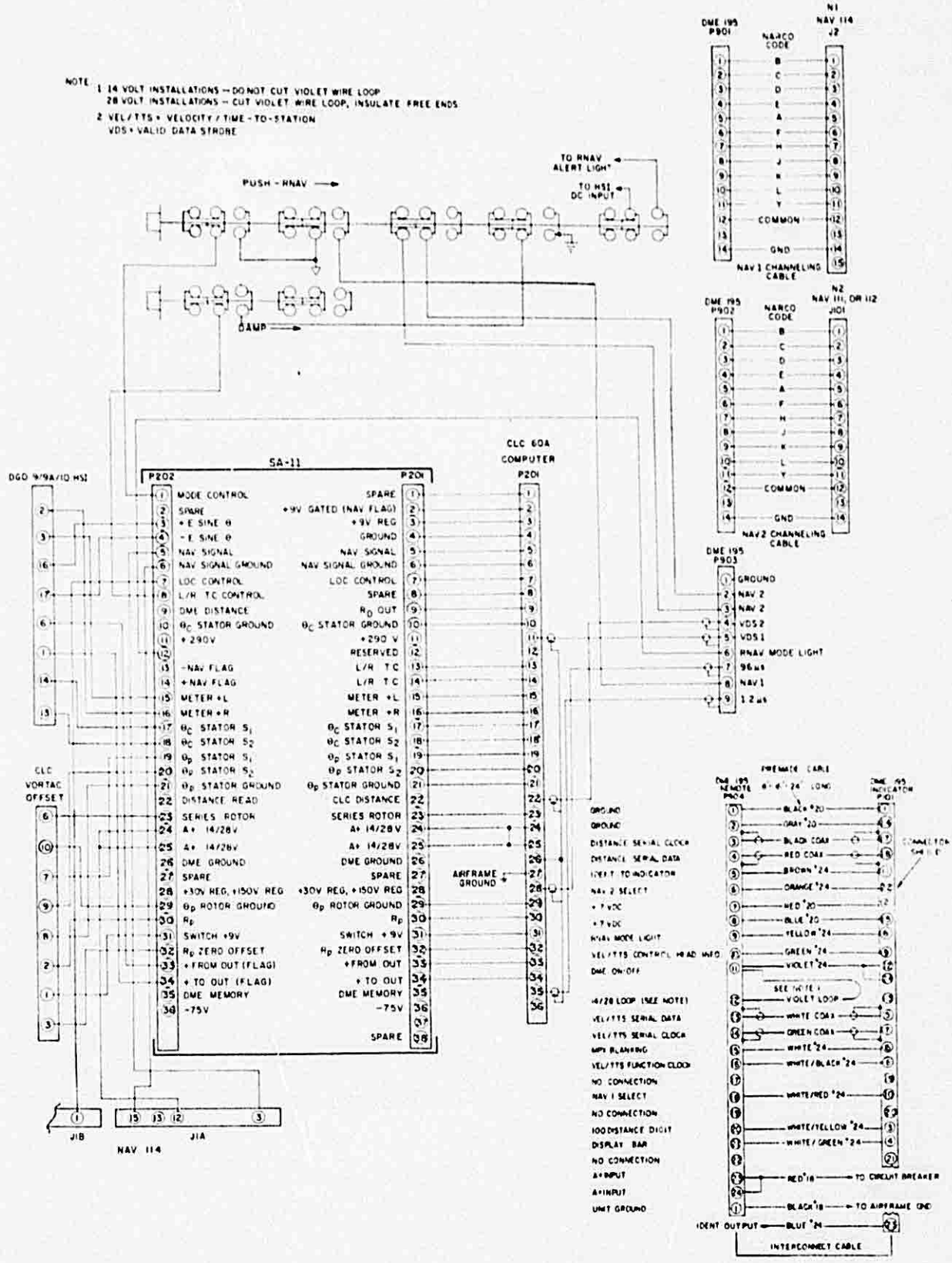


FIGURE 2-16. NAV 1-RNAV WIRING DIAGRAM

SEE BLOW-UP

2.6.6.1 Continued

B. Ident Audio Connections

From P101 exits a #22 blue wire which generally is connected to an audio panel's DME audio input port. Figure 2-17 illustrates the major DME 195 Ident interconnections. Note that Ident audio is taken directly from the arm of the volume control.

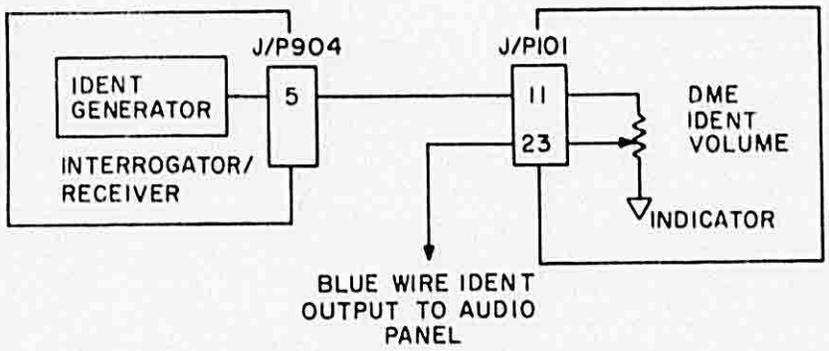


FIGURE 2-17. IDENT INTERCONNECTIONS

CP125, CP126, or CP127 Audio Panel

DME Ident may be directly connected to the selected audio panel input and the panel's input potentiometer adjusted to set the system Ident volume for a given DME volume control setting.

Paralleling DME Ident with a second audio source (Marker Beacon Receiver, NAV Receiver, etc.) should follow these general rules:

1. Paralleling DME with a high impedance (4.7K ohm or greater) source requires adding a 1500 ohm or larger, 1/4 watt resistor in series with the blue wire.
2. Paralleling DME with a low impedance (up to 4.7K ohm) source requires adding a 330 ohm or larger, 1/4 watt resistor in series with the blue wire.

VP 22 Audio Panel or Headphone Bus

When driving a headphone bus or an audio panel switching raw headphone audio, such as the VP 22 or KMA-20, add a 330 ohm or larger, 1/4 watt resistor in series with the blue Ident wire. This resistor must be added to prevent loading of the headphone bus.

2.6.6.2 Channeling Connectors (P901 and P902)

A. Channeling Codes

The DME 195, as shipped, is programmed for Narco and ARINC 2-out-of-5 channel coding. Optional Code Converter Kits and their installation are discussed in Section 2.6.3.

B. P901/P902 Wiring

Refer to Table 2.11 for Narco and ARINC Programming Connections. Figure 2-16 shows the interconnections between P901/P902 and several Narco NAV Receivers. Refer to Table 2.12 for King slip code programming connections.

C. Installation Kit Labels

Supplied in the Installation Kit are NAV 1 and NAV 2 stickers. They are to be applied to cable mounted connectors P901 and P902 for identification purposes.

D. Isolation and HOLD

External channeling line isolation is not required when following the wiring diagrams included in this manual.

The HOLD mode requires no additional external switches or wires. If desired, the HOLD function may be eliminated by installing a two position switch: refer to Section 2.4 for HOLD Elimination Kit part number.

TABLE 2.11 NARCO AND ARINC DME CHANNEL PROGRAMMING

MHz NARCO	MHz ARINC	DME 195 P901 & P902	MHz CHANNELS 108	109	110	111	112	113	114	115	116	117	Optional Channeling Cable Color Code
B	A	1	X	X		X	X						Brown
C	B	2			X	X		X	X				Red
D	C	3					X	X		X	X		Orange
F	D	4	X						X	X		X	Yellow
A	E	5		X	X						X	X	Green

KHz NARCO	KHz ARINC	DME 195 P901 & P902	KHz CHANNELS .00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95	Optional Channeling Cable Color Code
F	A	6			X	X	X	X											X	X	X	X	Blue
H	B	7	X	X	X	X			X	X	X	X											Purple
J	C	8					X	X	X	X			X	X	X	X							Gray
K	D	9									X	X	X	X			X	X	X	X			White
L	E	10	X	X											X	X	X	X			X	X	White/Brown
"Y" CHANNEL ACT.		11		Y		Y		Y		Y		Y		Y		Y		Y		Y		Y	White/Red
DME COMMON		12																					Black

NOTES:
1. "X" indicates continuity to the DME common terminal, Pin 12.
2. "Y" indicates continuity to the ground terminal.

TABLE 2.12 SLIP CODE DME CHANNEL PROGRAMMING

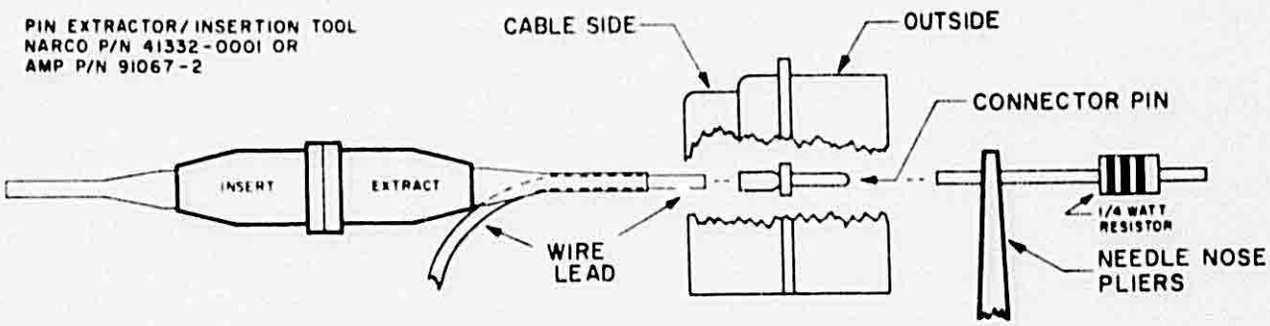
MHz SLIP	DME 195 P901 & P902	MHz CHANNELS 108	109	110	111	112	113	114	115	116	117	Optional Channeling Cable Color Code
M_0	5			X	X	X		X		X	X	Green
M_1	3				X	X	X		X		X	Orange
M_2	2	X				X	X	X		X		Red
M_3	1		X				X	X	X		X	Brown

KHz SLIP	DME 195 P901 & P902	KHz CHANNELS .00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95	Optional Channeling Cable Color Code
K_0	7	X	X	X	X	X	X					X	X							X	X	Purple
K_1	8	X	X	X	X	X	X	X	X					X	X							Gray
K_2	9			X	X	X	X	X	X	X	X					X	X					White
K_3	6					X	X	X	X	X	X	X	X					X	X			Blue
"Y" CHANNEL ACT.	11		Y		Y		Y		Y		Y		Y		Y		Y		Y		Y	White/Red
DME COMMON	12																					Black

NOTES:
1. "X" indicates continuity to the DME common terminal, Pin 12.
2. "Y" indicates continuity to the ground terminal.

2.6.6.3 RNAV Connections to Accessory Connector (P903)

The Dealer Starter Kit contains a pin extractor tool for the removal of two factory installed jumpers. (See Figure 2-18.) Once extracted these pins are discarded since additional pins are provided in the Installation Kit.



TO CHANGE OR ADD PINS TO THE CONNECTOR, THE HOOD MUST BE DISASSEMBLED FROM THE SHELL AND SLID UP THE CABLE TO ALLOW THE INSERTION/EXTRACTION TOOL TO ENTER THE SHELL.

CARE SHOULD BE TAKEN TO AVOID ANY UNNECESSARY STRAIN OR FLEXING OF THE LEADS WHILE REMOVING THE HOOD, CHANGING PINS, AND REASSEMBLY.

EXTRACTION

1. Locate wire/pin to be removed.
2. Slide EXTRACT end of tool over wire.
3. Push tool into connector (encompassing rear of pin) until a "click" is heard or felt. It may be necessary to rotate the tool to free the pin. Leave tool in this position.
4. From the outside of the connector locate the desired pin:
   a) Female Pins: insert the lead of a 1/4 watt carbon resistor into the pin, using a needle nose plier, exert force to push the pin and extractor tool from the connector. Remove the resistor lead.
   b) Male Pins: use a blunt tool, such as the needle nose pliers, butt the pliers to the pin tip or grasp the pin to push it and the extractor tool from the connector.

INSERTION

1. Locate pin position, cable side.
2. Slide INSERT end of tool over wire up to shoulder of the pin.
3. Insert pin and tool into pin position until a "click" is heard or felt.
4. Remove tool.
5. Exert a slight pull to be sure pin is locked in place.

FIGURE 2-18. CONNECTOR PIN EXTRACTION AND INSERTION

2.6.6.3 Continued

Connections to P903 are shown in Figure 2-16. Physical requirements for the coax cable connections are illustrated in Figure 2-19.

The accessory connector is wired to a CLC 60A System or to similar RNAV components. For pulse signals use 50 ohm coaxial cable (RG 178 B/U or equivalent) or the 4 coaxial cable supplied with the CLC 60A where indicated in the Interconnect Wiring Diagram. All exposed center conductors must be kept to a minimum length to prevent RF effects. Standard hook-up wire may be used on other connections.

The System is designed to indicate when RNAV operation is in use by grounding P903, Pin 6. This illuminates the RNAV indicator light and causes velocity and time-to-station to extinguish.

When RNAV is engaged, the RNAV System VOR receiver is automatically selected as the DME channeling source. This is accomplished by routing the DME's NAV Selector Switch wiring through P903 and the Mode Control Pushbutton Assembly as shown in Figures 2-15 and 2-16. By connecting the channeling ground through the accessory connector the DME 195 will be channeled by the RNAV VOR receiver in RNAV operation regardless of the position of the NAV selector switch and lights, in the DME 195 Indicator.

A 0.01 uf ceramic capacitor must be added to the DME's Distance Board. This capacitor is soldered in parallel with C321. Access to the Distance Board is by removing the right side cover, then pivoting the Receiver-Transmitter Assy out from the Unit.

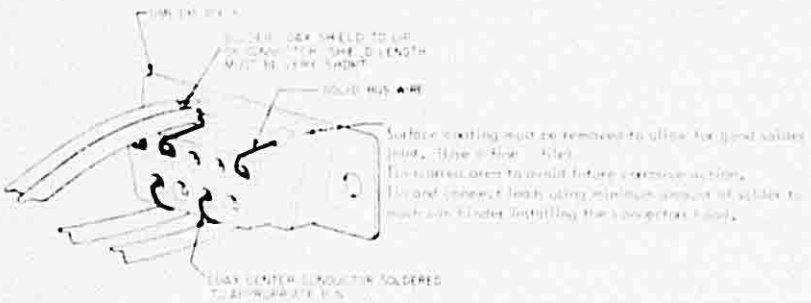


FIGURE 2-19. P903 CABLE ASSEMBLY

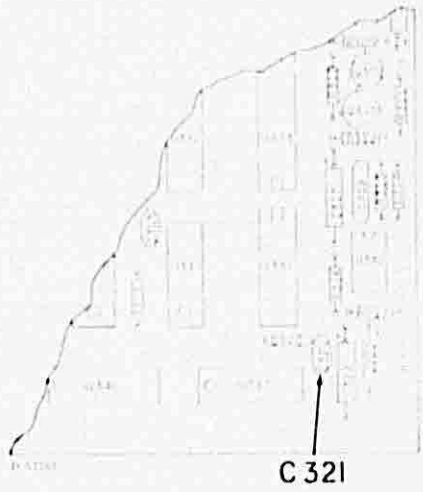


FIGURE 2-20. DISTANCE BD's C321

This completes the NAV 1-RNAV installation wiring.

SEE BLOW-UP

2.6.7 NAV 2-RNAV Installation Wiring

This type of installation requires modifying the Interconnect Cable and interchanging the channeling connectors.

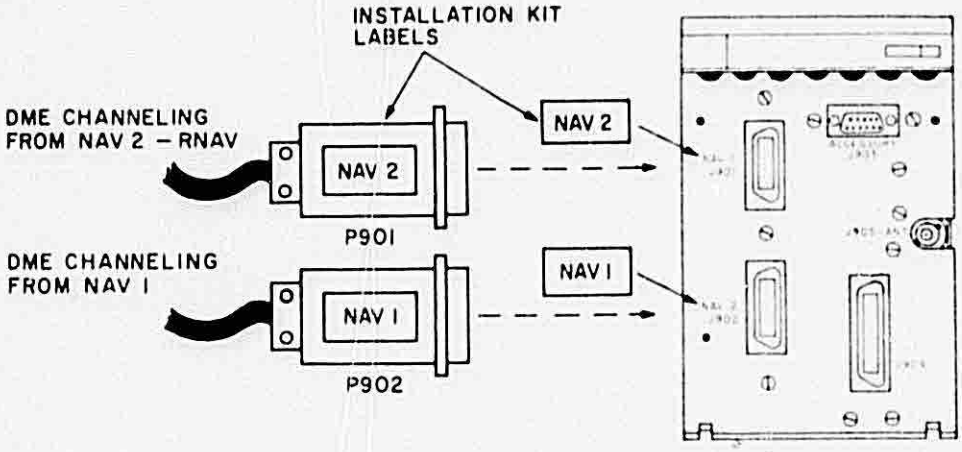
2.6.7.1 Interconnect Cable

Refer to Figures 2-21 and 2-22.

2.6.7.1.1 NAV 2-RNAV Receiver Selection

As shipped the DME 195 System is wired to automatically select the NAV 1 receiver when the RNAV mode is engaged. This System is shown in Figure 2-16. Note that when RNAV is engaged, the NAV 2 receiver cannot channel the DME 195.

RNAV Systems using the NAV 2 receiver will be accomodated with minor rewiring of P101 on the Interconnect Cable. When rewired, the NAV 2 receiver will be automatically selected when the RNAV mode is engaged. This system is shown in Figure 2-22.



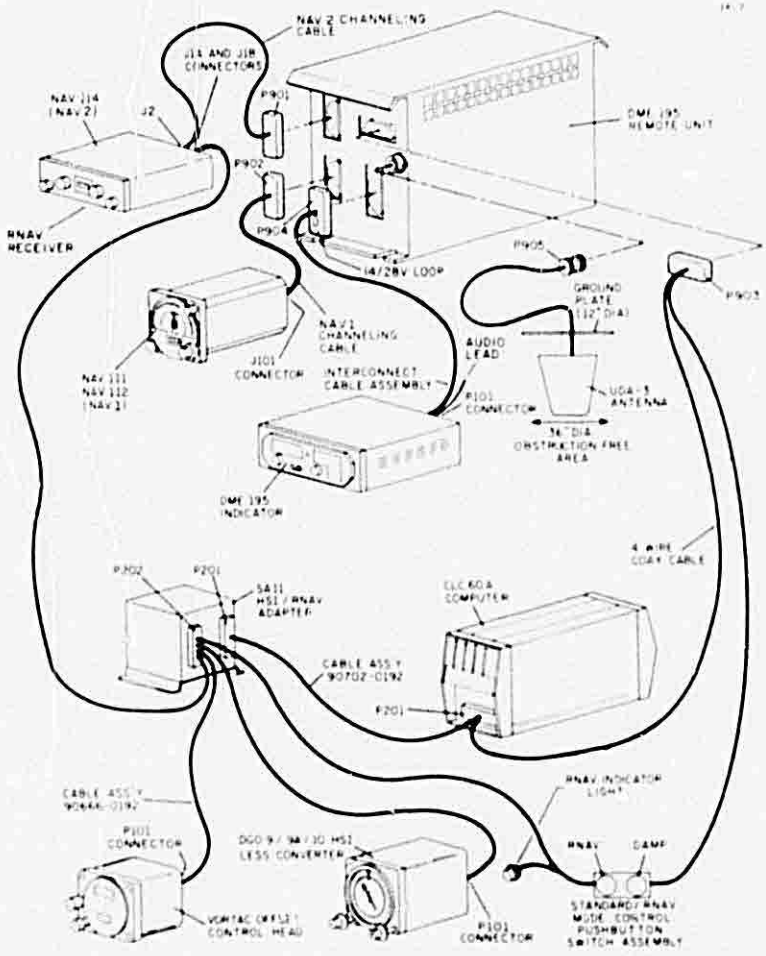


FIGURE 2-21. NAV 2-RNAV WIRING PICTORIAL

SEE BLOW-UP

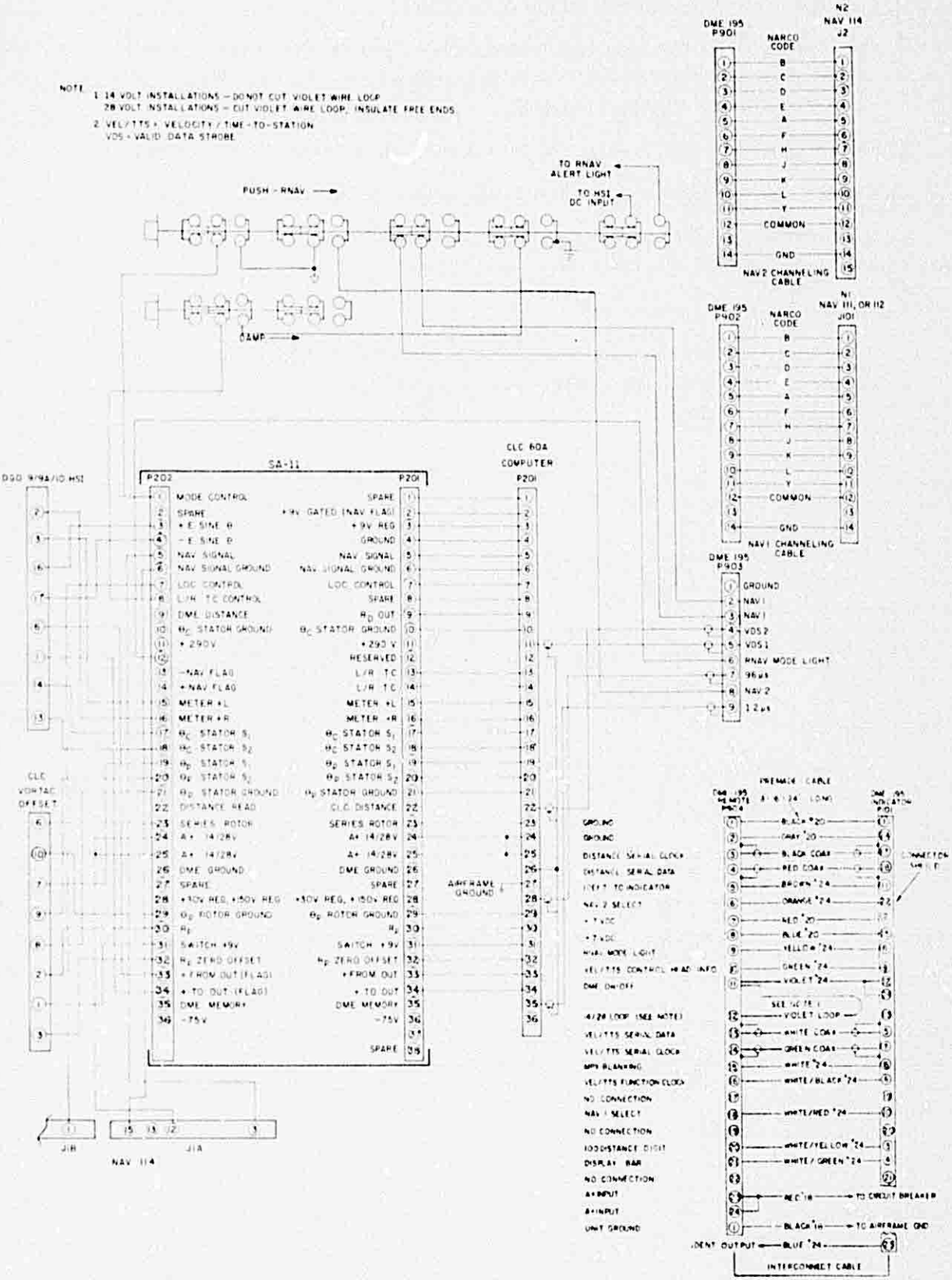


FIGURE 2-22. NAV 2-RNAV WIRING DIAGRAM

SEE BLOW-UP

2.6.7.1.2 NAV 2-RNAV Modification Procedure

1. Locate P101 on the Interconnect Cable. P101 is the brass colored 25 pin connector with the blue "Ident output" wire extending from the assembly. Figure 2-23 details the Interconnect Cable Assembly.
2. From the DME 195 Dealer Starter Kit obtain a pin extractor tool.
3. Referring to Figures 2-23 and 2-24 perform the following steps:
   a. Locate pin 10 (Red/White wire) and extract it.
   b. Locate pin 22 (Orange wire) and extract it.
4. Reverse the two wires by:
   a. Insert the Orange wire and pin into pin location 10.
   b. Insert the Red/White wire and pin into pin location 22.
5. Re-assemble P101.

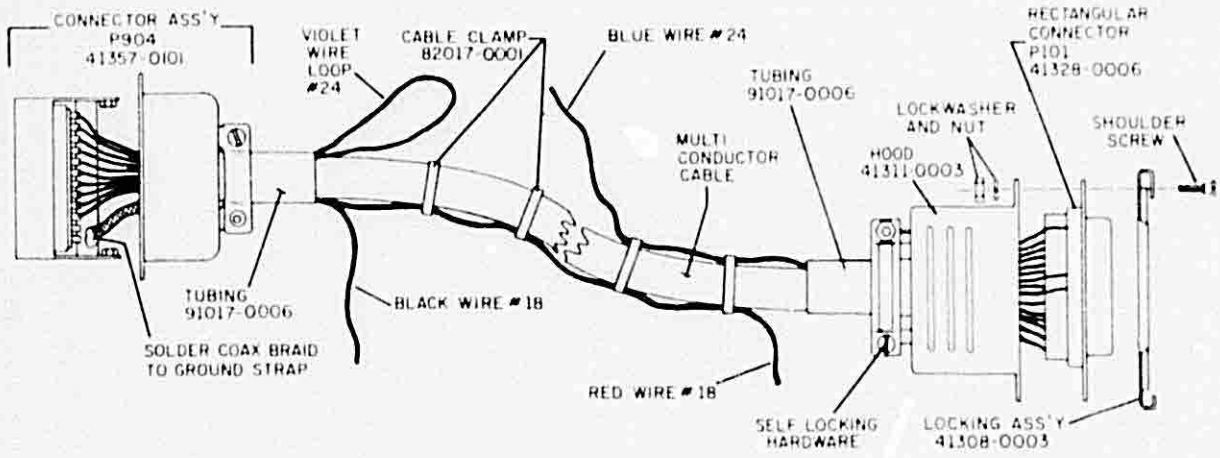
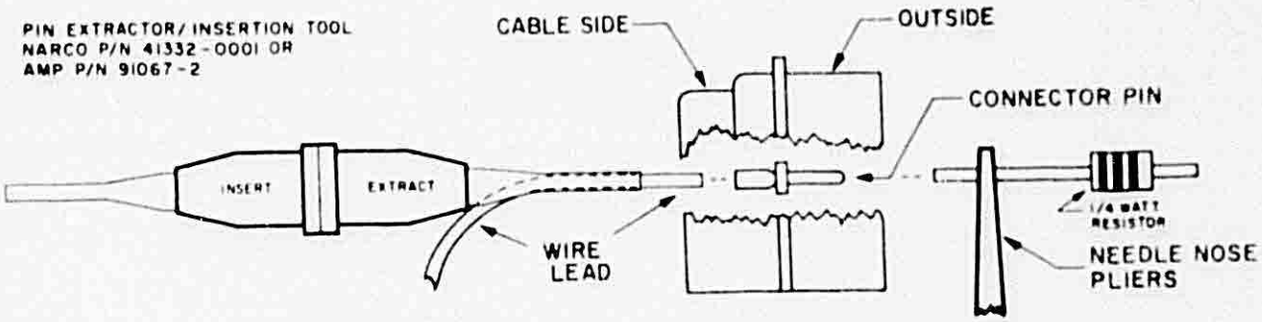


FIGURE 2-23. INTERCONNECT CABLE ASSY



TO CHANGE OR ADD PINS TO THE CONNECTOR, THE HOOD MUST BE DISASSEMBLED FROM THE SHELL AND SLID UP THE CABLE TO ALLOW THE INSERTION/EXTRACTION TOOL TO ENTER THE SHELL.

CARE SHOULD BE TAKEN TO AVOID ANY UNNECESSARY STRAIN OR FLEXING OF THE LEADS WHILE REMOVING THE HOOD, CHANGING PINS, AND REASSEMBLY.

EXTRACTION

1. Locate wire/pin to be removed.
2. Slide EXTRACT end of tool over wire.
3. Push tool into connector (encompassing rear of pin) until a "click" is heard or felt. It may be necessary to rotate the tool to free the pin. Leave tool in this position.
4. From the outside of the connector locate the desired pin:
   a) Female Pins: insert the lead of a 1/4 watt carbon resistor into the pin, using a needle nose plier, exert force to push the pin and extractor tool from the connector. Remove the resistor lead.
   b) Male Pins: use a blunt tool, such as the needle nose pliers, butt the pliers to the pin tip or grasp the pin to push it and the extractor tool from the connector.

INSERTION

1. Locate pin position, cable side.
2. Slide INSERT end of tool over wire up to shoulder of the pin.
3. Insert pin and tool into pin position until a "click" is heard or felt.
4. Remove tool.
5. Exert a slight pull to be sure pin is locked in place.

FIGURE 2-24. CONNECTOR PIN EXTRACTION AND INSERTION

2.6.7.1.3 Power and Ident Audio

A. Power Connections (Refer to Figure 2-25)

From P904, exit two #18 wires, one red and one black. The black wire should be kept as short as possible and is connected to a ground lug close to the Interrogator/ Receiver. The red wire carries 14 or 28 vdc A+ input and is connected to the DME circuit breaker.

A violet wire loop also exits from P904. In 28 vdc installations, the loop is cut and the free ends insulated. The loop is NOT cut in 14 vdc installations.

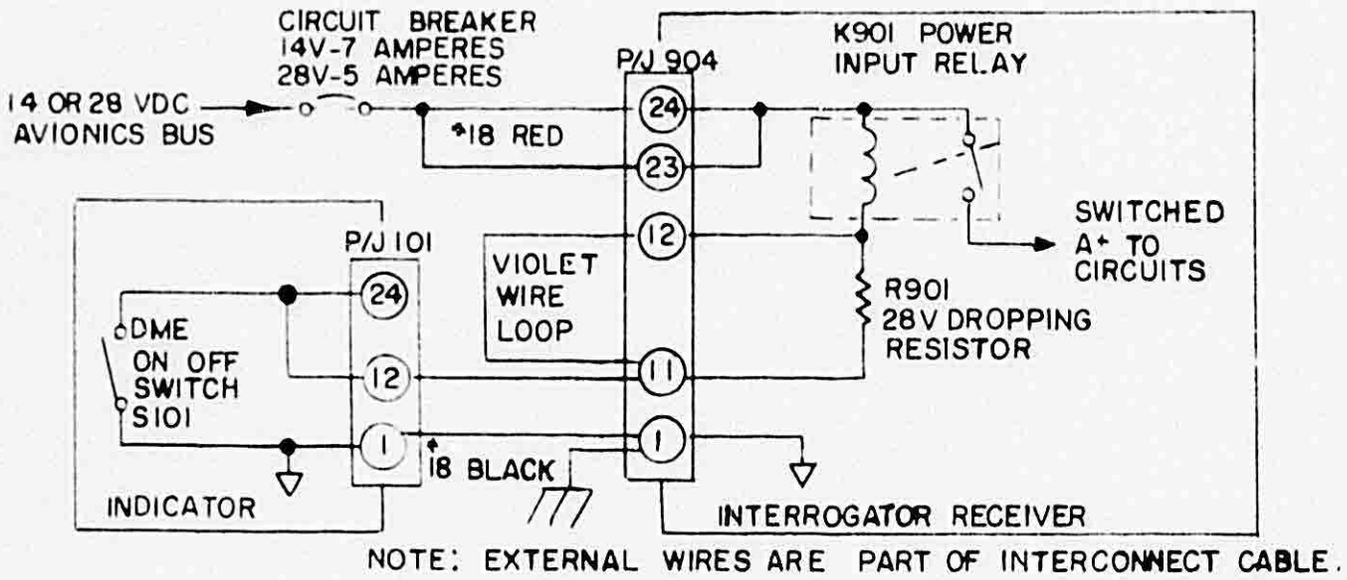


FIGURE 2-25. POWER INPUT SCHEMATIC

2.6.7.1.3 Continued

B. Ident Audio Connections

From P101 exists a #22 blue wire which generally is connected to an audio panel's DME audio input port. Figure 2-26 illustrates the major DME 195 Ident interconnections. Note that Ident audio is taken directly from the arm of the volume control.

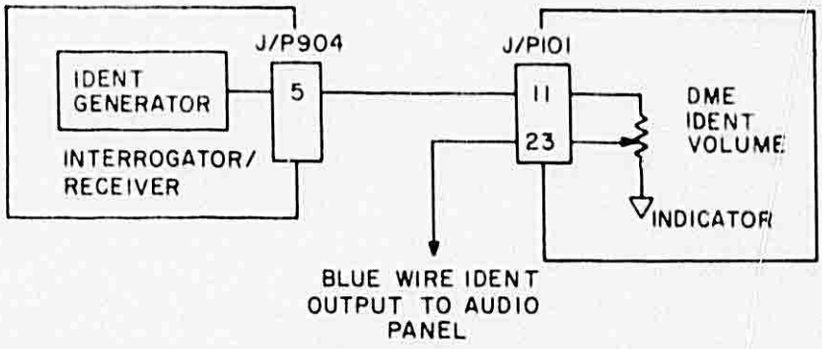


FIGURE 2-26. IDENT INTERCONNECTIONS

CP125, CP126, or CP127 Audio Panel

DME Ident may be directly connected to the selected audio panel input and the panel's input potentiometer adjusted to set the system Ident volume for a given DME volume control setting.

Paralleling DME Ident with a second audio source (Marker Beacon Receiver, NAV Receiver, etc.) should follow these general rules:

1. Paralleling DME with a high impedance (4.7K ohm or greater) source requires adding a 1500 ohm or larger, 1/4 watt resistor in series with the blue wire.
2. Paralleling DME with a low impedance (up to 4.7K ohm) source requires adding a 330 ohm or larger, 1/4 watt resistor in series with the blue wire.

VP 22 Audio Panel or Headphone Bus

When driving a headphone bus or an audio panel switching raw headphone audio, such as the VP 22 or KMA-20, add a 330 ohm or larger, 1/4 watt resistor in series with the blue Ident wire. This resistor must be added to preven loading of the headphone bus.

2.6.7.2 Channeling Connectors (P901 and P902)

Refer to Figure 2-21. J901 is always the RNAV system channeling connector. Since the NAV 2 channeling connector will now mate with J901, the NAV 1 legend adjacent to J901 should be covered with a "NAV 2" label from the Installation Kit. In addition, the NAV 2 legend adjacent to J902 should be covered with a "NAV 1" label from the Installation Kit.

A. Channeling Codes

The DME 195, as shipped, is programmed for Narco and ARINC 2-out-of-5 channel coding. Optional Code Converter Kits and their installation are discussed in Section 2.6.3.

B. P901/P902 Wiring

Refer to Table 2.13 for Narco and ARINC Programming Connections. Figure 2-22 shows the interconnections between P901/P902 and several Narco NAV receivers. Refer to Table 2.14 for King slip code programming connections.

C. Installation Kit Labels

Supplied in the Installation Kit are NAV 1 and NAV 2 stickers. They are to be applied to cable mounted connectors P901 and P902 for identification purposes.

D. Isolation and HOLD

External channeling line isolation is not required when following the wiring diagrams included in this manual.

The HOLD mode requires no additional external switches or wires. If desired, the HOLD function may be eliminated by installing a two position switch: refer to Section 2.4 for HOLD Elimination Kit part number.

TABLE 2.13 NARCO AND ARINC DME CHANNEL PROGRAMMING

MHz NARCO	MHz ARINC	DME 195 P901 & P902	MHz CHANNELS 108	109	110	111	112	113	114	115	116	117	Optional Channeling Cable Color Code
B	A	1	X	X		X	X						Brown
C	B	2			X	X		X	X				Red
D	C	3					X	X		X	X		Orange
E	D	4	X						X	X		X	Yellow
A	E	5		X	X						X	X	Green

KHz NARCO	KHz ARINC	DME 195 P901 & P902	KHz CHANNELS .00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95	Optional Channeling Cable Color Code
F	A	6			X	X	X	X											X	X	X	X	Blue
H	B	7	X	X	X	X			X	X	X	X											Purple
J	C	8					X	X	X	X			X	X	X	X							Gray
K	D	9									X	X	X	X			X	X	X	X			White
L	F	10	X	X											X	X	X	X			X	X	White/Brown
"Y" CHANNEL ACT.		11		Y		Y		Y		Y		Y		Y		Y		Y		Y		Y	White/Red
DME COMMON		12																					Black

NOTES:
1. "X" indicates continuity to the DME common terminal, Pin 12.
2. "Y" indicates continuity to the ground terminal.

TABLE 2.14 SLIP CODE DME CHANNEL PROGRAMMING

MHz SLIP	DME 195 P901 & P902	MHz CHANNELS 108	109	110	111	112	113	114	115	116	117	Optional Channeling Cable Color Code
M_0	5			X	X	X		X		X	X	Green
M_1	3				X	X	X		X		X	Orange
M_2	2	X				X	X	X		X		Red
M_3	1		X				X	X	X		X	Brown

KHz SLIP	DME 195 P901 & P902	KHz CHANNELS .00	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95	Optional Channeling Cable Color Code
K_0	7	X	X	X	X	X	X					X	X							X	X	Purple
K_1	8	X	X	X	X	X	X	X	X					X	X							Gray
K_2	9			X	X	X	X	X	X	X	X					X	X					White
K_3	6					X	X	X	X	X	X	X	X					X	X			Blue
"Y" CHANNEL ACT.	11		Y		Y		Y		Y		Y		Y		Y		Y		Y		Y	White/Red
DME COMMON	12																					Black

NOTES:
1. "X" indicates continuity to the DME common terminal, Pin 12.
2. "Y" indicates continuity to the ground terminal.

2.6.7.3 RNAV Connections to Accessory Connector (P903)

The Dealer Starter Kit contains a pin extractor tool for removal of two factory installed jumpers (see Figure 2-24). Once extracted, these pins are discarded since additional pins are provided in the Installation Kit.

Connections to P903 are shown in Figure 2-22. Physical requirements for the coax cable connections are illustrated in Figure 2-27.

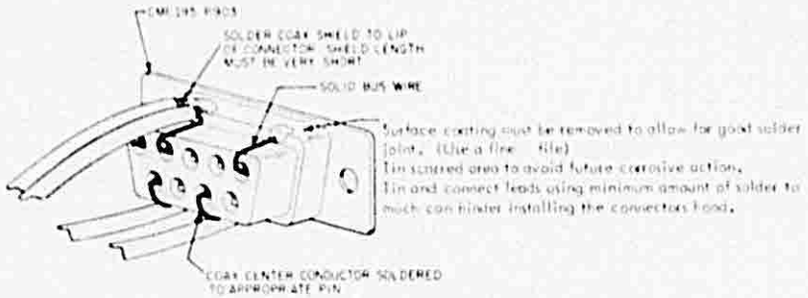


FIGURE 2-27. CABLE ASSEMBLY

The accessory connector is wired to a CLC 60A System. For pulse signals use 50 ohm coaxial cable (RG 178 B/U or equivalent) or the 4 coaxial cable supplied with the CLC 60A where indicated in the Interconnect Wiring Diagram. All exposed center conductors must be kept to a minimum length to prevent RF effects. Standard hook-up wire may be used on other connections. The System is designed to indicate when RNAV operation is in use by grounding P101, Pin 6. This illuminates the RNAV indicator light and causes velocity an and time-to-station to extinguish. By connecting the channeling ground through the acce accessory connector the DME 195 will be channeled by the RNAV VOR Receiver in RNAV operation regardless of the position of the NAV Selector Switch and lights, in the DME 195 Indicator.

A 0.01 uf ceramic capacitor must be added to the DME's Distance Board. This capacitor is soldered in parallel with C321. Access to the Distance Board is by removing the right side cover, then pivoting the Receiver-Transmitter Assy out from the Unit.

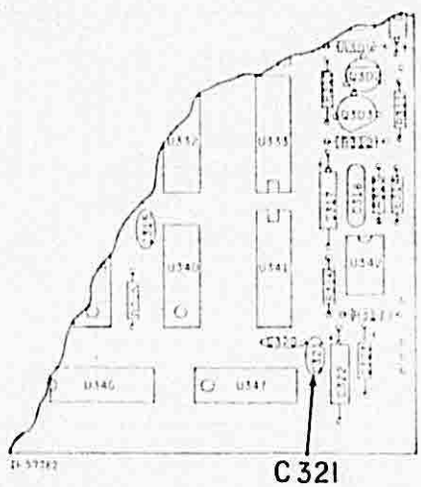


FIGURE 2-28. DISTANCE BD's C321

This completes the NAV 2-RNAV installation wiring.

SEE BLOW-UP

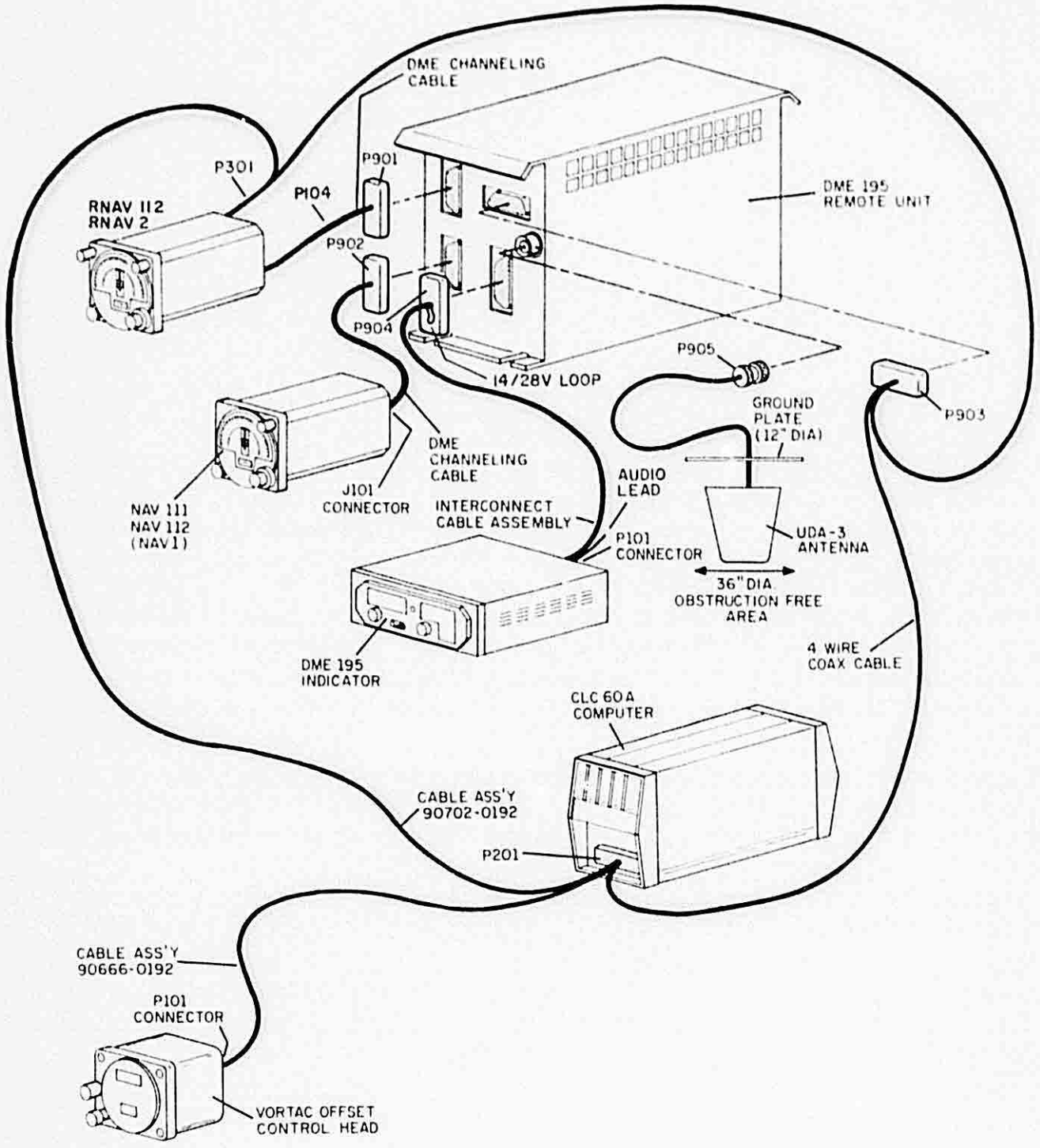
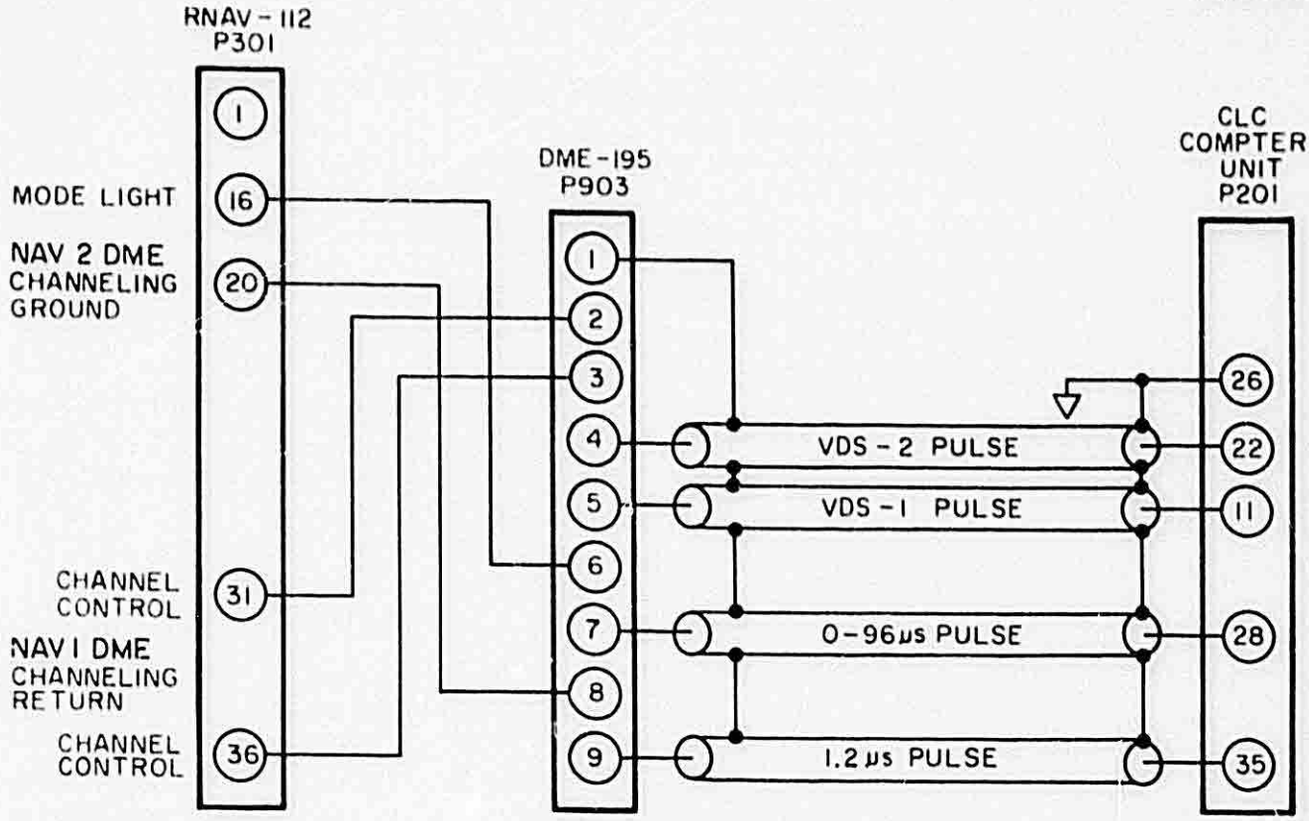
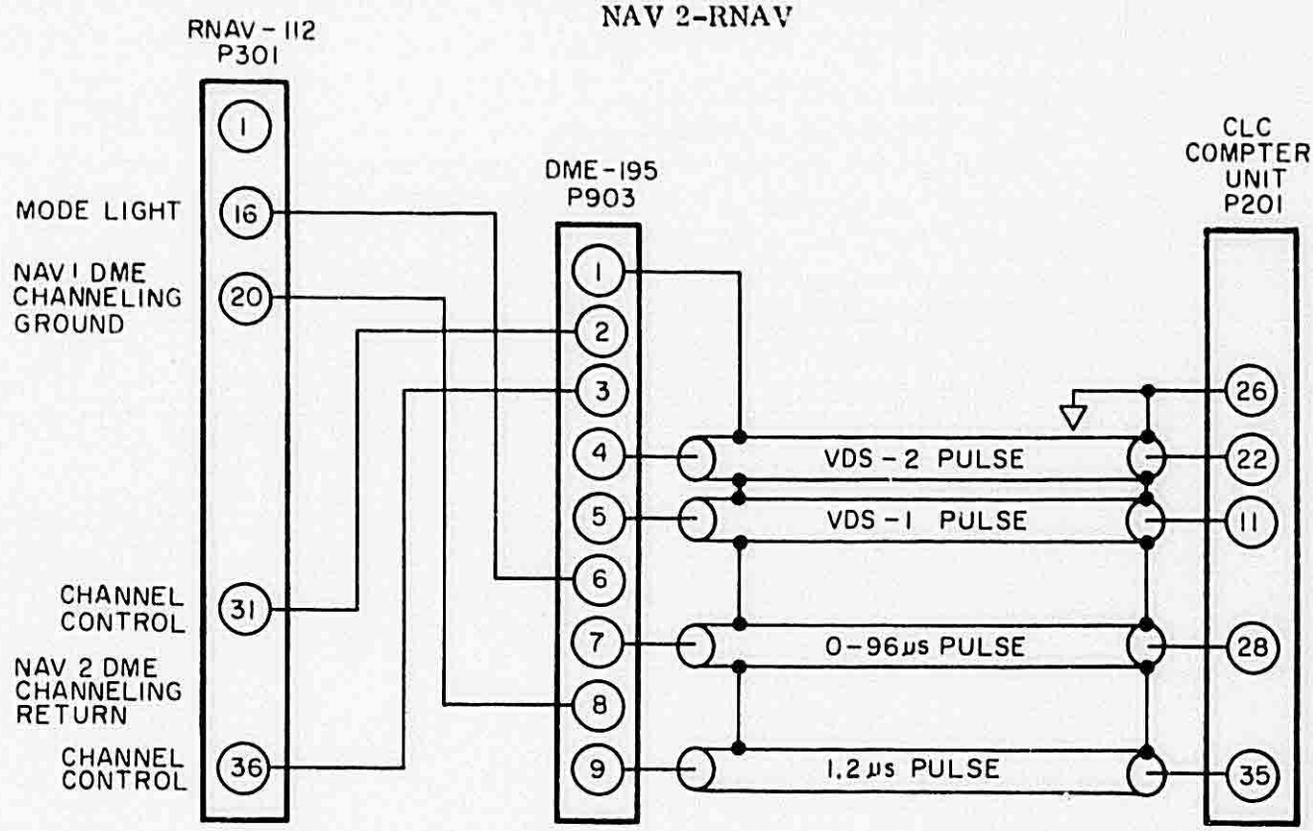


FIGURE 2-29. NAV 2-RNAV WITH RNAV 112



NAV 2-RNAV



NAV 1-RNAV

FIGURE 2-30. RNAV-112/DME-195 INTERCONNECTIONS

2.7 PREINSTALLATION BENCH TEST

2.7.1 Test Equipment Required

A. Power Supply, 5 amp.
B. Test Generator, IFR 1200Y3 or equivalent (See Note).

2.7.2 Procedure

1. Turn the DME Indicator switch to OFF.
2. Connect the DME Indicator, Remote Unit, Channeling Cables, A+ (14 or 28v).
3. Connect antenna connector to the Test Generator.
4. Set the Test Generator to 100 NM range, attenuator to -73 dbm, reply efficiency to 70% and squitter to 2700.
5. Set the Channel Selector to the desired channel and Test Generator to the same channel.
6. Energize both the generator and power supply.
7. Turn the DME 195 switch to ON.
8. Verify complete readout lamp illumination by pushing the Push-To-Test button. Readout with the button depressed should be 188.8 (Miles, 888 speed, 88 minutes).
9. With the button released, the DME 195 readout should read 100 -.2 NM.
10. Set speed to 180 knots - direction inbound.
11. Start generator tracking, read transmit power, after stabilization (about 3 minutes), read knots... readout should be within ±5% of that indicated on the generator, read time; readout should be ±1 minute of the distance at that time divided by the DME's indicated ground speed.

    Example: Generator distance..... $\frac{60}{180}$ x 60 = 20 ± 1 (the MIN readout)
    DME indicated ground speed....

    When in MIN mode, the highest TIME readout programmed is 89. Should the DME process a signal that results in a time greater than 89 MIN, the time readout extinguishes.
12. Check sensitivity for tracking in distance. Should track at -82 dbm, velocity may require -73 dbm for ground speed accuracy.
13. Check Ident operation on ALL .100 MHz at 112 MHz.
14. Check Ident on all MHz channels for lock-on and power output.
15. Check both channel selectors and hold by switching the NAV 1, HOLD, NAV 2 switch.

NOTE:
The digital system of the DME 195 operates statistically on a TACAN or DME signal. Some test generators do not accurately simulate the ground DME or TACAN signal and may not operate the DME 195 correctly. This may result in improper distance (miles) or ground speed (knots) computation. This is usually caused when squitter or countdown is not produced in a random manner.

2.8 POST INSTALLATION CHECK

Both the Ground check and Flight check are recommended after installation and major repair.

Ground:

Use a Ramp Test Signal Generator or a local station of known distance.

1. Channel to proper frequency.
2. Turn DME 195 to ON.
3. Check readout lamps by pushing the TEST button. Readout should be 188.8 miles, 888 knots, 88 minutes.
4. Release button, distance should be in agreement with that set in the generator or that of the actual station (accuracy: $\pm$.2 NM).
5. Check ground speed if using a generator.
6. Check that audio Ident tone is present.
7. Check the operation of both NAV Receivers, channeling and hold.
8. If R-NAV is installed, check its operation.

NOTE:
Do not test reduced reply efficiency as some Test Generators do not simulate actual signals and may not operate the DME 195.

Flight:

1. At 10,000 feet altitude, range 100 NM, check that there are no dropouts during a flat 360° turn.
2. At 6,000 feet altitude, range 50 NM, check that there are no dropouts during a flat 360° turn.
3. High Angle Check: While flying at an altiutde of 6,000 to 10,000 feet (above the station's elevation) and from a distance of 10 NM, track inbound to the station and then track the reciprocal course. In each pass check the accuracy at the critical points...over the station and at the 10 NM point.
4. Orbit Approach: At a distance of 10 DME miles fly an orbit for one (1) minute. there shall be no dropouts. Repeat this flight in the opposite direction.
5. Electromagnetic Compatibility: The DME should not cause the performance of other systems aboard the aircraft to be degraded nor should the DME be adversely affected by other on board equipment. This can be checked by turning such equipments ON and OFF one by one and listening and viewing the resultant action. There should be no restrictions.

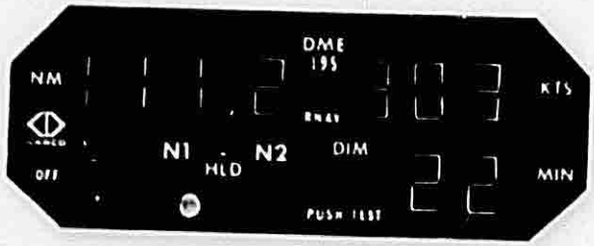


FIGURE 2-31. DME 195 INDICATOR FRONT PANEL

2.9 OPERATION

1. OFF/ON, IDENT Volume Control
   This turns the Unit ON or OFF and adjusts the identification volume to a comfortable level.

2. NAV Receiver Selector Switch
   The switch position indicates which VOR/ILS navigation receiver will channel the DME 195. A light illuminates either N1 or N2 for night operation.

   The DME hold position (HLD) will hold the channel last tuned by either NAV 1 or NAV 2 by switching the selector switch first to the desired NAV position and then into hold. This frees the navigation receiver to be used on another channel such as an ILS. When in hold the yellow announciator lamp is lit as an advisory.

   NOTE:
   If the DME is switched OFF when the NAV selector switch is in hold, when the Unit is turned ON the channel is indeterminate.

3. Dim-Push Test Switch
   This knob controls the brightness of all digits and advisory lamps, as well as the N1 and N2 lamps.

4. RNAV Indicator Light
   This is lit whenever the DME 195 is displaying RNAV distance when using a CLC-60A. When this lamp is lighted, only distance is displayed, and only the RNAV receiver will channel the DME.

5. Distance Display
   Displays distance from 0 to 199.9 NM and also displays when the DME is not locked to a station by horizontal bars.

6. Velocity Display
   Displays velocity from 10 to 400 knots. This display is extinguished when the DME is not locked on or is displaying RNAV distance.

7. Time Display
   Displays time TO or FROM a station from 0 to 89 minutes. This display is extinguished when the DME is not locked on, when it is displaying RNAV distance, or when the computed time is in excess of 89 minutes.

2.10 GOVERNMENT REQUIREMENTS

2.10.1 License Requirements

Operator:

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

Aircraft:

The DME 195 as installed in the aircraft, requires an Aircraft Radio Station License. This license is obtained by filing FCC Form 404. The DME 195 may be operated for up to 30 days without a station license, after filing the FCC Form 404 and while awaiting receipt of the station license, providing a copy of the FCC Form 404 is kept in the aircraft. However, if the aircraft has been previously licensed for a DME, resubmittal of FCC Form 404 is not required.

This equipment has been type accepted by the FCC and entered on their list of type accepted equipments as: "NARCO DME 195".

CAUTION

The UHF transmitter in this equipment is guaranteed to meet Federal Communications Commission approval only when the NARCO crystal is used. The use of other than a NARCO crystal will void manufacturers warranty.

2.10.2 Form 337 Requirements and Log Book Entry

A. Form 337
DME 195 was installed in accordance with NARCO Avionics Installation Manual 03313-0621.

In computing electrical load operating current 13.75 volts - 5 amps, 27.5 volts - 2.8 amps. Enter actual circuit protectors used.

B. Log Book
Redo the weight and balance.

Weights of DME 195:

Interrogator/Receiver including mounting tray.	7.75 Lbs. (3.52 Kgms)
Indicator	0.9 Lbs. (408 gms)
UDA-3 Antenna.	0.5 Lbs. (227 gms)
Optional Cooling Kit	0.55 Lbs. (249 gms)

CIRCUIT DESCRIPTION

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3.2	AIRBORNE DME OPERATION	3-2	1F07
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3.7.12	Clock Generator	3-61	1H24
3.7.13	Channel Multiplex	3-64	1J03
3.7.13.1	Receiver Selection	3-64	
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3.7.15	Power Supply	3-79	1J20
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3-3	DME 195 VELOCITY MODE BLOCK DIAGRAM.	3-7	1F12	
3-4	DME 195 TIME-TO-STATION MODE BLOCK DIAGRAM.	3-9	1F14	
3-5	PERIOD COUNTER	3-16	1F21	
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3-7	DME RECEIVE/TRANSMIT TIMING DIAGRAM FOR 10 MILE INTERROGATION.	3-20	1G01	
3-8	DIGITAL DISPLAY, BASIC BLOCK DIAGRAM	3-20		
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3-41	CHANNEL MULTIPLEX SWITCHING	3-66	1J05	NC J343
3-42	SYNTHESIZER BLOCK DIAGRAM	3-70	1J09	
3-43	VCO AND BUFFER AMPLIFIERS	3-71	1J10	NC J343
3-44	FREQUENCY PRESCALER	3-72	1J11	
3-45	÷ N AND ÷ 10/11 FREQUENCY DIVIDERS	3-74	1J13	NC J343
3-46	PHASE/FREQUENCY DETECTOR	3-75	1J16	
3-47	CODE CONVERTER, SCHEMATIC DIAGRAM	3-77	1J18	NC J343
3-48	POWER SUPPLY, BLOCK DIAGRAM	3-79	1J20	
3-49	POWER SUPPLY, SCHEMATIC	3-81	1J22	
3-50	VELOCITY LOCKED LOOP	3-83	1J24	NC J343
3-51	△ MILE DECODER	3-85	1K02	NC J[illegible]
3-52	FREQUENCY COMPARE AND ÷ 4096 COUNTER	3-85		
3-53	VCO SCHEMATIC	3-86	1K03	
3-54	VELOCITY AND TTS COMPUTE, BASIC BLOCK DIAGRAM	3-89	1K06	
3-55	VELOCITY AND TTS COMPUTE, DETAILED BLOCK DIAGRAM	3-90	1K07	
3-56	V/T ELECTRONIC SWITCH	3-91	1K10	
3-57	÷ 76 AND ÷ 192 COUNTER	3-92	1K11	NC J343
3-58	DELAY TIMING	3-92		
3-59	VEL/TTS COMPUTE AND SHIFT REGISTER	3-93	1K12	NC J343
3-60	SERIAL MULTIPLEX	3-95	1K14	NC J343
3-61	T COMPUTE TIME AND TTS SEQUENTIAL LOGIC	3-96	1K15	NC J343

3.1 BASIC DME GROUND/AIRBORNE OPERATION

A full cycle of DME operation includes the transmission of a radio signal from the aircraft to the ground station and reply from the ground station to the aircraft. The time required for this process is determined by the distance between the two stations. The aircraft transmits a pair of pulses at approximately 30 Hz and the signal is received at the ground station as shown in Figure 3-1. After a fixed delay, the ground station transmits the pulse pair back to its source. The airborne receiver must then confirm that the pulse pair is the result of the original transmission, measure the time taken for this round-trip radio signal, and translate the time period into the equivalent number of miles.

The airborne DME must take into consideration that the ground station is also replying to other aircraft (the ground station simulates these even when not being interrogated). The ground station also takes "time out" from replies to transmit its own identification. The airborne DME is therefore an instrument that measures the time required for a radio signal to travel from the aircraft to the ground station and return to the aircraft. The time required is a function of the distance measured in nautical miles and the delay in transmission of a reply. The radio wave requires 12.36 microseconds to travel through one nautical mile of space and return; the DME is calibrated in 0.1 mile increments (equal to 1.236 microseconds) to keep track of how many 1.236 microsecond periods have been measured and display it by an equivalent group of numbers. There is an additional delay of 50 microseconds, added to the two-way signal period, that permits the DME receiver to recover from the DME transmitter blast. This delay of 50 microseconds, before the ground station retransmits, is the same for all DME ground station transmitters. The receiver compensates for this 50 microsecond delay. The DME is capable of recognizing the correct reply, although not every interrogation gets a reply.

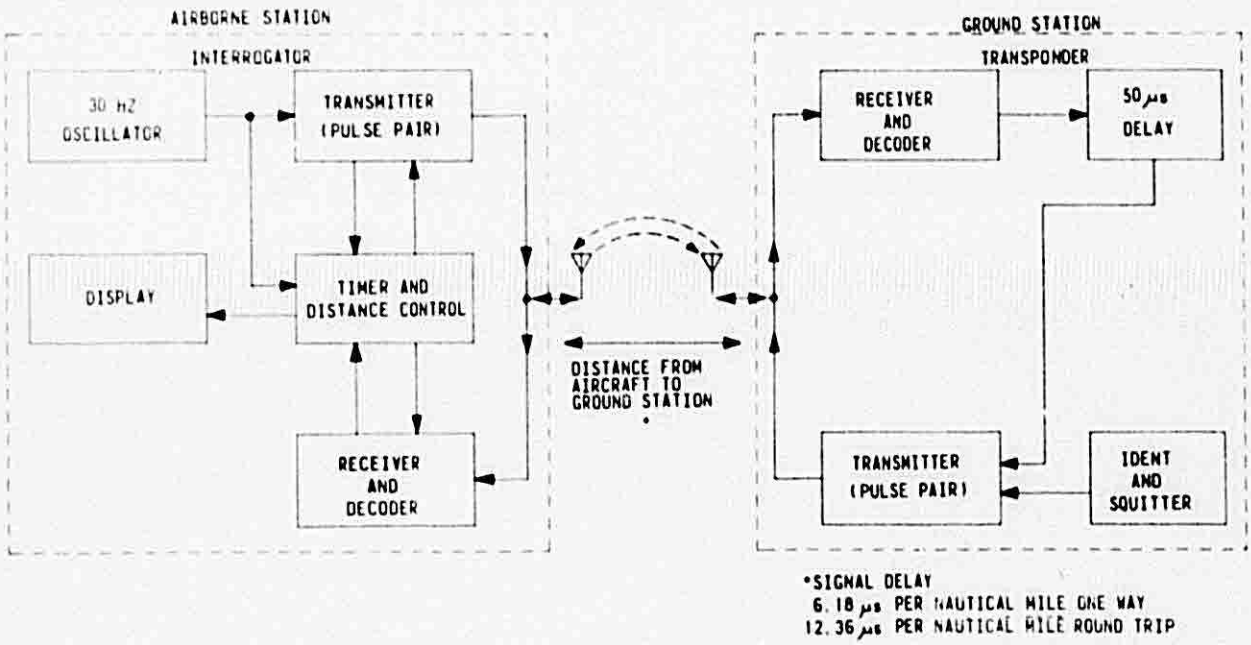


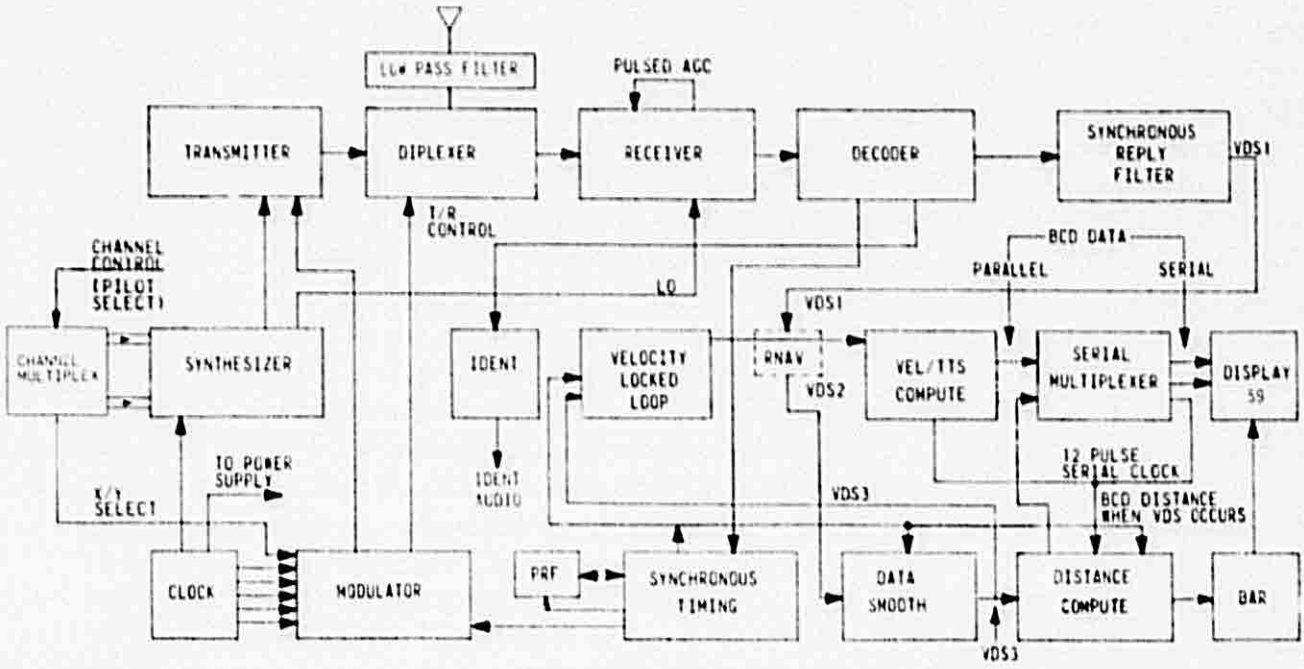
FIGURE 3-1. ELEMENTARY AIR/GROUND DME 195 SYSTEM

3.1 Continued

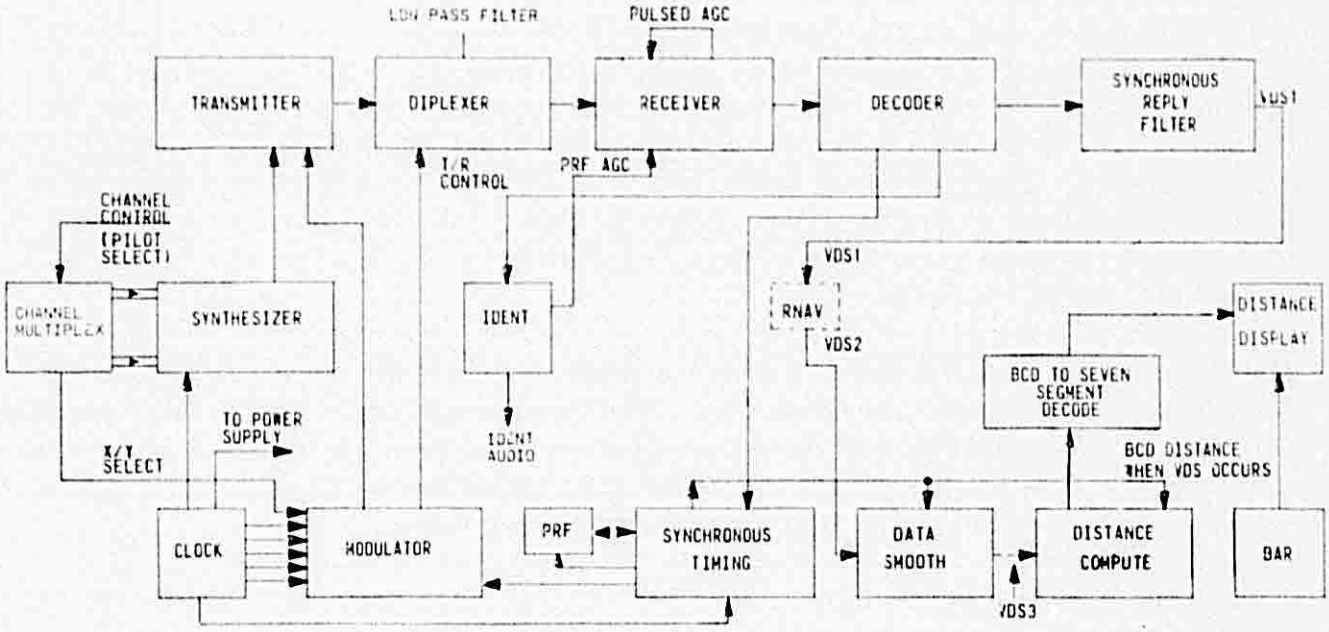
The DME ground station has three basic functions: retransmits any received signals; during off time generates squitter, which is a constant rate of reply; and generates an IDENT signal for the aircrafts' audio system. When retransmitting a pulse train of pulse pairs, this ground station reply may be in response to an interrogation from another aircraft; the DME 195, however, is able to disregard the other replies, recognize only the correct reply from the ground station and process only this signal. If the ground station transmitter is sending IDENT or squitter, or replying to interrogations from another DME, it will not reply to the DME 195's interrogations. The IDENT signal from the ground station is regularly spaced pulses (dot and dashes of Morse code) heard on the aircrafts' audio system.

3.2 AIRBORNE DME OPERATION

The DME transmitter operates within the frequency range of 1041 through 1150 MHz and the receiver frequencies 978 through 1213 MHz; transmit and receive frequencies on any given channel are offset by 63 MHz, which is the receiver IF frequency. These operating frequencies are paired to operate with the associated OMNI channel as shown in Table 3.1. The DME channel is selected by the setting of the DME channel selector switch; VOR channels 108.00 through 117.95 MHz are indicated since they are paired directly with the DME ground station located at a VORTAC or VOR ground station. The channel select controls are connected directly to the frequency synthesizer as shown in Figure 3-2; synthesizer operating frequency is 1/3 the transmitter output frequency. The pulse repetition frequency (PRF) source is the timer that turns ON the transmitter at time-to-station (TTS) mode. Since the basic distance mode is similar to velocity or TTS, the distance mode will be described followed by the circuit differences in the other modes using Figure 3-2 as a guide for the distance description, Figure 3-3 for velocity, and 3-4 for TTS.



A. Distance, Velocity, and Time-to-Station Configuration



B. Distance Only Configuration

FIGURE 3-2. DME 195 FUNCTIONAL BLOCK DIAGRAM

3.3 OPERATION FOR DISTANCE (Miles) DETERMINATION

3.3.1 Transmit/Receive

The transmitter is turned ON as follows: the Synchronous Timing section generates pairs of pulses separated by 12 or 36 microseconds when gated at a rate of approximately 28 Hz by the PRF source, the pairs of pulses turn ON the Modulator and RF Transmitter. The low level section of the Transmitter operates continuously. The pulse pair from the Modulator, which turn ON the high power final stages, also enables the Diplexer. The Diplexer connects either the receiver or transmitter to a single antenna and protects the receiver from damage due to overload when the transmitter operates.

The RF output from the antenna is pairs of pulses of RF energy at a selected frequency between 1041 and 1150 MHz. The pulses are 3.5 microseconds wide with 12 microseconds spacing on 0.10 MHz (X channels), 36 microseconds on 0.05 MHz (Y channels); the pulse pairs are repeated at a 28 Hz rate. Channel frequencies are summarized in Table 3.2.

Approximately 50 microseconds, equal to the ground station's fixed delay, after the first pulse from the modulator turns ON the transmitter, the clock starts to feed 1.236 microsecond clock pulses to the Synchronous Timing's ÷2000 Digital counter. The 1.236 microsecond period is the time required for the transmitted signal to travel 0.1 nautical mile and return. During the period that the Receiver is awaiting a reply from the ground station, the ÷ 2000 Counter is measuring the time interval as it is being loaded with a train of clock pulses, one pulse for each 0.1 nautical mile to the ground station.

With the modulator pulse removed from the Diplexer, the Receiver awaits the pulse pair reply from the ground station. The Synthesizer, which operates a 1/3 the transmitted frequency, also serves as the local oscillator of the Receiver. If the selected channel is 108.00, the transmit frequency is 1041 MHz, the synthesizer output 347 MHz, and the receiver frequency 978 MHz. The received pulse pair (978 MHz) and synthesizer frequency (347 MHz) are combined in the mixer section of the Receiver. The third harmonic of the Synthesizer (3 x 347 = 1041 MHz) heterodyning with the received frequency provides a difference frequency of 63 MHz (1041 -978 = 63 MHz). This IF (intermediate frequency), is amplified, detected and converted to logic levels fed to the Decoder and Synchronous Reply Filter (SYNC) sections.

The Decoder confirms that the pulses of the received pulse pair are separated by the desired interval (12 or 36 microseconds). The Synchronous Reply Filter then compares the received decoded pulse with the decoded pulse stored from a previous interrogation; if occurring at a synchronous rate this output then becomes the valid data strobe (VDS) 1 pulse (pulse time equivalent to DME distance to ground station).

When using an area navigation computer (R-NAV), the VDS1 pulse time may be altered by inserting distance to a phantom station. Regardless of change, this output now becomes VDS2. If an R-NAV is not used, a jumper (at P901, Pins 10-11) serves as a substitute.

3.3.1 Continued

The VDS2 data may exist for approximately 50% of the interrogations. The VDS2 data is further filtered by the Data Smooth circuit and is now referred to as VDS3. Although the VDS3 data represents a smaller percentage of the interrogations, it is of much more value since it does not jump back and forth. This is important in the velocity mode where changes are measured as distance vs time. The VDS3 data is the strobe input to the Distance Compute.

Fifty microseconds after the start of the transmitted pulse pair, the Synchronous Timing's ÷ 2000 Counter is started. This Counter continues for its full 2000 count of 0.1 mile intervals (200 nautical miles) with the parallel output changing in accordance with the binary coded decimal (BCD) progression. Since the output of the ÷ 2000 Counter is connected to the Distance Compute, the arrival of the VDS3 transfers the condition of the Counter to the 13 bit storage register of the Distance Compute. This operation does not in any way affect the 2000 count cycle of the 2000 Counter; only the instantaneous condition of the Counter is sampled and stored.

The BCD distance encoded in the 13 lines is decoded by a BCD-to-7-Segment Decoder and used to light up the Display Distance on the front panel. If there is no valid data strobe for 10 seconds, the front panel Bar display is lit in place of the numerical display. This tells the pilot that there is no accurate or useful information received by the DME 195. To prevent erratic display of numbers, turn-on or channel change also activates the Bar display.

3.4 OPERATION FOR VELOCITY (Knots) DETERMINATION

In the velocity mode, the DME continues to operate as in the distance mode, however, velocity information is displayed. The basic distance information is differentiated against time in increments of 0.1 mile time intervals and displayed on the front panel as nautical miles per hours.

3.4.1 Velocity, Locked Loop

(Refer to Figure 3-3)

The overall distance information, from the Synchronous Timing ÷2000 Counter, is clocked into the 0.1 mile Latch by a VDS3 pulse. The distance is in 4-bit, BCD format. The Δ Mile Decoder then adds the current distance, in the Latch, to the BCD distance stored in the 0.1 Mile Memory from the previous velocity computation. An output pulse is generated by the Δ Mile Decoder for each tenth mile crossing (i.e. each tenth mile difference between Latch and Memory distances).

The Distance one shot is clocked by each Decoder output pulse to drive the non-inverting input of the Comparison Integrator. To the inverting input of the Comparison Integrator, through the VCO one shot, is applied the counted down, by ÷4096, VCO output.

A Low Pass Filter then converts the Integrator's output to a dc voltage to bias the VCO current source. The sense of the Integrator is such as to cause the VCO frequency to increase or decrease until the VCO one shot is firing the same number of times as the 0.1 mile data changes. The overall VCO circuit, therefore, is an oscillator whose frequency is controlled by a correction voltage obtained through a feedback loop.

In this VCO feedback loop, the VCO output pulse rate is 16 times greater than the pulse rate to the ÷999 Counter. When this Counter is gated ON for 1.4 second intervals, the VCO output (divided by a factor of 4096) makes the pulse rate into the comparison integrator equal to the distance change.

The VCO output is divided by a factor of ÷16 to remove jitter from the velocity display. The ÷16 frequency divider output is then gated into the ÷999 Counter. The Counter Gate remains open for a given time (approximately 1.4 seconds). At the end of this period the Gate is closed, the number of counts in the ÷999 Counter is strobed into latches, the Counter is reset to its 000 condition, and the Gate is reset to allow pulses into the ÷999 Counter once more. The count stored in the latches is changed from BCD data to the form used in the 7-Segment Display by the same process described in Section 3.3 for the distance (MILES) display.

3.4.1 Continued

The velocity (KNOTS) display is updated every 1.4 seconds by repeating this cycle of gating, counting, and latch into the display. The velocity is then indicated directly in nautical miles per hour. An example would be if the aircraft is traveling at 100 miles per hour, the 0.1 mile average change occurs at 3.6 second intervals. Since the VCO output into the integrating comparator is divided by a factor of 4096, during a 3.6 second period, the VCO output is 4096 pulses or 1137.8 pulses per second (pps). The 1137.8 pps signal is then divided-by-16 to obtain a counted down rate of 71.11 pps. This rate of pulses is counted for approximately 1.4 seconds; 100 counts will enter the counter during this period and the display will indicate 100 knots, the ground speed of the aircraft. It can be seen that the velocity of the DME is always with reference to the ground station location; therefore, the display only represents ground speed when the aircraft is heading directly to or from the ground station.

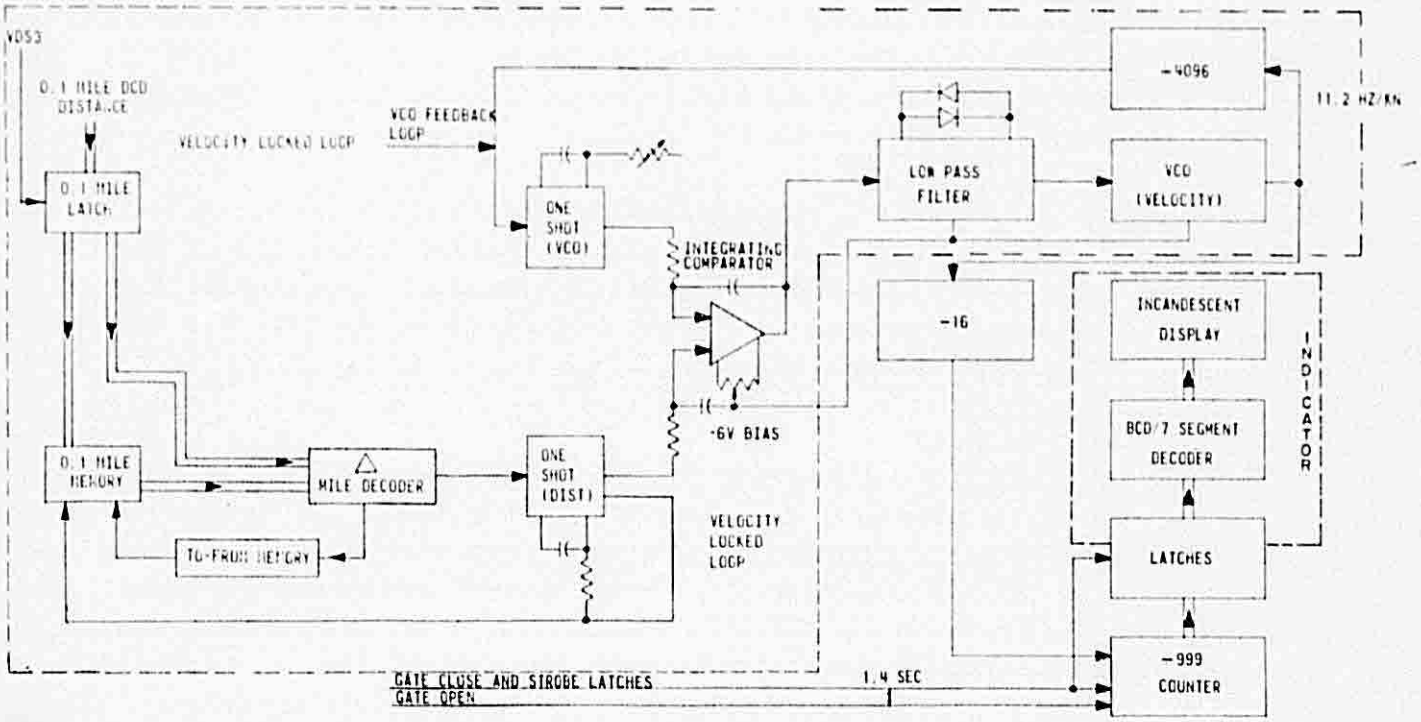


FIGURE 3-3. DME 195 VELOCITY MODE BLOCK DIAGRAM

3.5 OPERATION FOR TIME-TO-STATION (Min) DETERMINATION

Time-To-Station (TTS) provides a digital display of the number of minutes flying time required to arrive at the DME ground station. This display is accurate only when flying TO the station.

The computation of time is made by calculating $T = \frac{\text{DISTANCE}}{\text{VELOCITY}}$; distance is the same quantity previously obtained and velocity (VEL) the same quantity obtained in the velocity computation. The TTS computations are made at approximately 15 second intervals; since the digital display is in minutes, the display is updated during any one of approximately four times during each minute. During the TTS computations, the distance circuits are operating, storing updated distance information to the Data Shift Register. Refer to Figure 3-4 for the block diagram.

The TTS computation is started with coincidence of three conditions; (1) 15 second timing interval is completed; (2) 0-200 mile counting interval is completed; and (3) VDS3 pulse present during the 0-200 mile epic. The occurrence of these three events provides an enable output from the TTS Compute Gate and an inhibit to the PRF Generator. The TTS Gate is enabled, and the velocity VCO starts clocking the 1000 bit Data Shift Register. In addition, the Counter Gate is enabled and the ÷ 76 Counter output is gated into the VEL/TTS ÷ 999 Counter.

At this point, the relationship between velocity and distance is time; an example of the relationship at 100 knots is given below. The VCO frequency at 100 knots $= \frac{4096}{\text{time to travel 0.1 mile}}$ $= \frac{4096}{3.6} = 1137.78$ pulses per second. If the distance is 100 miles from the ground station, the distance pulse is in the 500 bit position of the 1000 bit Shift Register which is part of the Synchronous Reply Filter (mid-position in this 200 mile register). Therefore it would take 500 clock pulses from the velocity VCO to shift this serial data out of the Register; the period required is 0.43945 second.

While the velocity VCO pulses are clocking the Data Shift Register, 96 microsecond pulses (from the clock) are fed to the ÷ 76 Counter and gated into the VEL/TTS ÷ 999 Counter. The 96 microsecond clock pulses, divided by 76 provides 135.281 pps into the Counter. During the 0.43945 second required to clock the data pulse from the Data Shift Register, the VEL/TTS ÷ 999 Counter counts 60 pulses, which is equal to 60 minutes (TIME-TO-STATION).

The data pulse shifted out of the Data Shift Register is ORed into the Timing Delay where the following occurs: (1) a strobe is fed to the VEL/TTS ÷ 999 Counter Latch and the count of 60 is transferred from the Counter to the latches; (2) the Multiplex output sends 12 clock pulses to the Latch and this parallel data is clocked serially into the Display Latches; and (3) a reset pulse is then fed to the VEL/TTS ÷ 999 Counter. If clock pulses are gated into this register until the count exceeds 89 and no strobe is present, the time is greater than the TTS display capability. The next clock pulse provides a Counter output that is ORed into the Time Delay. The resulting strobe provides a BAR'ed TTS Display; this is considered a flag and indicates an invalid display.

3.5 Continued

During the 12 pulse output from the Multiplex circuit, an inhibit is fed to the BCD/7 Segment Decoder. After the BCD display data is stored in the Display Latch, the inhibit is removed; the number of minutes to be displayed, in BCD format, is then decoded and displayed.

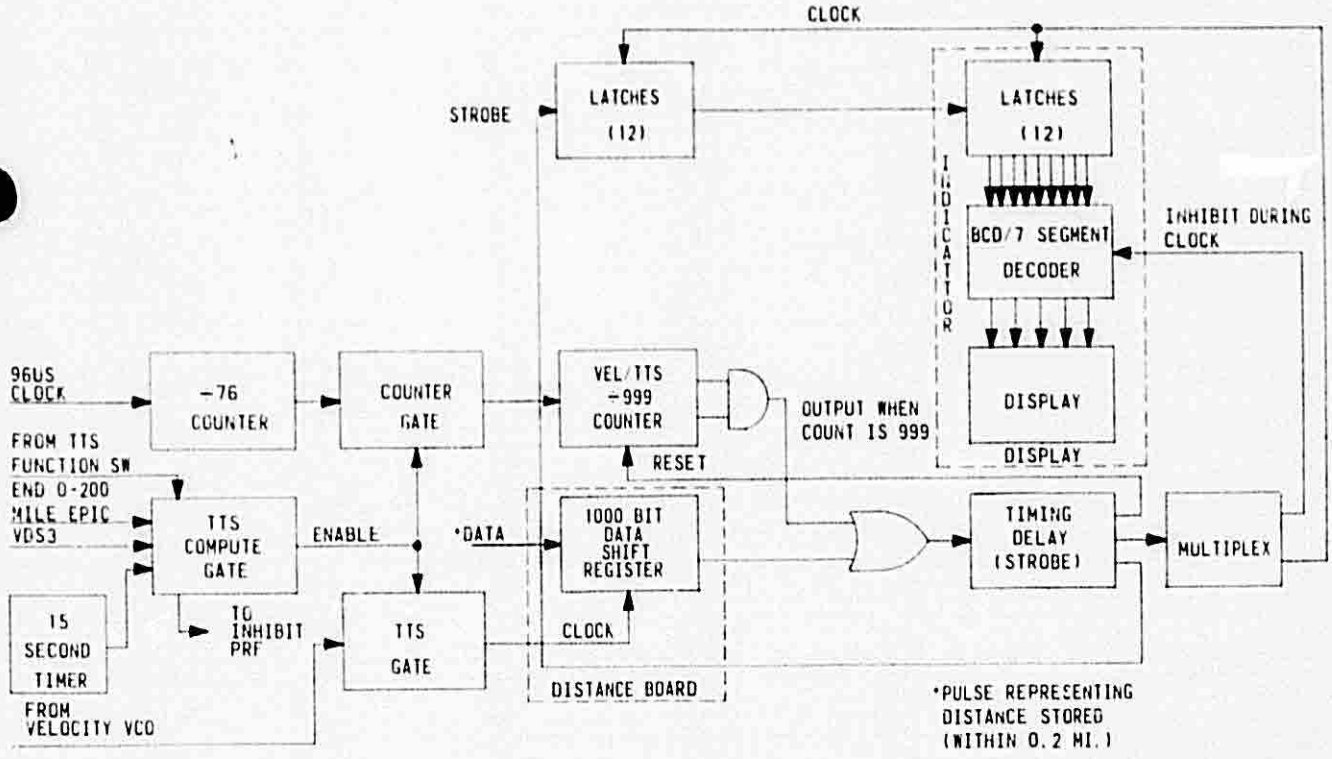


FIGURE 3-4. DME 195 TIME-TO-STATION MODE BLOCK DIAGRAM

TABLE 3.1 VOR/DME CHANNEL PAIRING AND OPERATING FREQUENCIES

Channel No.	VHF Channel (MHz)	Airborne Interrogating Frequency (MHz)	VCO Frequency (MHz)	Airbone Interrogating Pulse Code (usecs)	Ground Reply Frequency (MHz)	Ground Reply Pulse Spacing (usec)
+ 17X	108.00	1041	347.00	12	978	12
17Y	108.05	1041	347.00	36	1104	30
18X	108.10	1042	347.33	12	979	12
18Y	108.15	1042	347.33	36	1105	30
19X	108.20	1043	347.66	12	980	12
19Y	108.25	1043	347.66	36	1106	30
20X	108.30	1044	348.00	12	981	12
20Y	108.35	1044	348.00	36	1107	30
21X	108.40	1045	348.33	12	982	12
21Y	108.45	1045	348.33	36	1108	30
22X	108.50	1046	348.66	12	983	12
22Y	108.55	1046	348.66	36	1109	30
23X	108.60	1047	349.00	12	984	12
23Y	108.65	1047	349.00	36	1110	30
24X	108.70	1048	349.33	12	985	12
24Y	108.75	1048	349.33	36	1111	30
25X	108.80	1049	349.66	12	986	12
25Y	108.85	1049	349.66	36	1112	30
26X	108.90	1050	350.00	12	987	12
26Y	108.95	1050	350.00	36	1113	30
27X	109.00	1051	350.33	12	988	12
27Y	109.05	1051	350.33	36	1114	30
28X	109.10	1052	350.66	12	989	12
28Y	109.15	1052	350.66	36	1115	30
29X	109.20	1053	351.00	12	990	12
29Y	109.25	1053	351.00	36	1116	30
30X	109.30	1054	351.33	12	991	12
30Y	109.35	1054	351.33	36	1117	30
31X	109.40	1055	351.66	12	992	12
31Y	109.45	1055	351.66	36	1118	30
32X	109.50	1056	352.00	12	993	12
32Y	109.55	1056	352.00	36	1119	30
33X	109.60	1057	352.33	12	994	12
33Y	109.65	1057	352.33	36	1120	30
34X	109.70	1058	352.66	12	995	12
34Y	109.75	1058	352.66	36	1121	30
35X	109.80	1059	353.00	12	996	12
35Y	109.85	1059	353.00	36	1122	30
36X	109.90	1060	353.33	12	997	12
36Y	109.95	1060	353.33	36	1123	30
37X	110.00	1061	353.66	12	998	12
37Y	110.05	1061	353.66	36	1124	30
38X	110.10	1062	354.00	12	999	12
38Y	110.15	1062	354.00	36	1125	30
39X	110.20	1063	353.33	12	1000	12
39Y	110.25	1063	354.33	36	1126	30

TABLE 3.1 Continued

Channel No.	VHF Channel (MHz)	Airborne Interrogating Frequency (MHz)	VCO Frequency (MHz)	Airbone Interrogating Pulse Code (usecs)	Ground Reply Frequency (MHz)	Ground Reply Pulse Spacking (usecs)
40X	110.30	1064	354.66	12	1001	12
40Y	110.35	1064	354.66	36	1127	30
41X	110.40	1065	355.00	12	1002	12
41Y	110.45	1065	355.00	36	1128	30
42X	110.50	1066	355.33	12	1033	12
42Y	110.55	1066	355.33	36	1129	30
43X	110.60	1067	355.66	12	1004	12
43Y	110.65	1067	355.66	36	1130	30
44X	110.70	1068	356.00	12	1005	12
44Y	110.75	1068	356.00	36	1131	30
45X	110.80	1069	356.33	12	1006	12
45Y	110.85	1069	356.33	36	1132	30
46X	110.90	1070	356.66	12	1007	12
46Y	110.95	1070	356.66	36	1133	30
47X	111.00	1071	357.00	12	1008	12
47Y	111.05	1071	357.00	36	1134	30
48X	111.10	1072	357.33	12	1009	12
48Y	111.15	1072	357.33	36	1135	30
49X	111.20	1073	357.66	12	1010	12
49Y	111.25	1073	357.66	36	1136	30
50X	111.30	1074	358.00	12	1011	12
50Y	111.35	1074	358.00	36	1137	30
51X	111.40	1075	358.33	12	1012	12
51Y	111.45	1075	358.33	36	1138	30
52X	111.50	1076	358.66	12	1013	12
52Y	111.55	1076	358.66	36	1139	30
53X	111.60	1077	359.00	12	1014	12
53Y	111.65	1077	359.00	36	1140	30
54X	111.70	1078	359.33	12	1015	12
54Y	111.75	1078	359.33	36	1141	30
55X	111.80	1079	359.66	12	1016	12
55Y	111.85	1079	359.66	36	1142	30
56X	111.90	1080	360.00	12	1017	12
56Y	111.95	1080	360.00	36	1143	30
57X	112.00	1081	360.33	12	1018	12
57Y	112.05	1081	360.33	36	1144	30
58X	112.10	1082	360.66	12	1019	12
58Y	112.15	1082	360.66	36	1145	30
59X	112.20	1083	361.00	12	1020	12
59Y	112.25	1083	361.00	36	1146	30
70X	112.30	1094	364.66	12	1157	12
**70Y	112.35	1094	364.66	36	1031	30
71X	112.40	1095	365.00	12	1158	12
**71Y	112.45	1095	365.00	36	1032	30
72X	112.50	1096	365.33	12	1159	12
**72Y	112.55	1096	365.33	36	1033	30
73X	112.60	1097	365.66	12	1160	12
**73Y	112.65	1097	365.66	36	1034	30
74X	112.70	1098	366.00	12	1161	12
**74Y	112.75	1098	366.00	36	1035	30
75X	112.80	1099	366.33	12	1162	12
**75Y	112.85	1099	366.33	36	1036	30
76X	112.90	1100	366.66	12	1163	12
**76Y	112.95	1100	366.66	36	1037	30
77X	113.00	1101	367.00	12	1164	12
**77Y	113.05	1101	367.00	36	1038	30

Table 3.1 Continued

Channel No.	VHF Channel (MHz)	Airborne Interrogating Frequency (MHz)	VCO Frequency (MHz)	Airborne Interrogating Pulse Code (usecs)	Ground Reply Frequency (MHz)	Ground Reply Pulse Code (usecs)
78X	113.10	1102	367.33	12	1165	12
**78Y	113.15	1102	367.33	36	1039	30
79X	113.20	1103	367.66	12	1166	12
**79Y	113.25	1103	367.66	36	1040	30
80X	113.30	1104	368.00	12	1167	12
80Y	113.35	1104	368.00	36	1041	30
81X	113.40	1105	368.33	12	1168	12
81Y	113.45	1105	368.33	36	1042	30
82X	113.50	1106	368.66	12	1169	12
82Y	113.55	1106	368.66	36	1043	30
83X	113.60	1107	369.00	12	1170	12
83Y	113.65	1107	369.00	36	1044	30
84X	113.70	1108	369.33	12	1171	12
84Y	113.75	1108	369.33	36	1045	30
85X	113.80	1109	369.66	12	1172	12
85Y	113.85	1109	369.66	36	1046	30
86X	113.90	1110	370.00	12	1173	12
86Y	113.95	1110	370.00	36	1047	30
87X	114.00	1111	370.33	12	1174	12
87Y	114.05	1111	370.33	36	1048	30
88X	114.10	1112	370.66	12	1175	12
88Y	114.15	1112	370.66	36	1049	30
89X	114.20	1113	371.00	12	1176	12
89Y	114.25	1113	371.00	36	1050	30
90X	114.30	1114	371.33	12	1177	12
90Y	114.35	1114	371.33	36	1051	30
91X	114.40	1115	371.66	12	1178	12
91Y	114.45	1115	371.66	36	1052	30
92X	114.50	1116	372.00	12	1179	12
92Y	114.55	1116	372.00	36	1053	30
93X	114.60	1117	372.33	12	1180	12
93Y	114.65	1117	372.33	36	1054	30
94X	114.70	1118	372.66	12	1181	12
94Y	114.75	1118	372.66	36	1055	30
95X	114.80	1119	373.00	12	1182	12
95Y	114.85	1119	373.00	36	1056	30
96X	114.90	1120	373.33	12	1183	12
96Y	114.95	1120	373.33	36	1057	30
97X	115.00	1121	373.66	12	1184	12
97Y	115.05	1121	373.66	36	1058	30
98X	115.10	1122	374.00	12	1185	12
98Y	115.15	1122	374.00	36	1059	30
99X	115.20	1123	374.33	12	1186	12
99Y	115.25	1123	374.33	36	1060	30
100X	115.30	1124	374.66	12	1187	12
100Y	115.35	1124	374.66	36	1061	30
101X	115.40	1125	375.00	12	1188	12
101Y	115.45	1125	375.00	36	1062	30
102X	115.50	1126	375.33	12	1189	12
102Y	115.55	1126	375.33	36	1063	30
103X	115.60	1127	375.66	12	1190	12
103Y	115.65	1127	375.66	36	1064	30
104X	115.70	1128	376.00	12	1191	12
104Y	115.75	1128	376.00	36	1065	30
105X	115.80	1129	376.33	12	1192	12
105Y	115.85	1129	376.33	36	1066	30

Table 3.1 Continued

Channel No.	VHF Channel (MHz)	Airborne Interrogating Frequency (MHz)	VCO Frequency (MHz)	Airborne Interrogating Pulse Code (usecs)	Ground Reply Frequency (MHz)	Ground Reply Pulse Spacing (usecs)
106X	115.90	1130	376.66	12	1193	12
106Y	115.95	1130	376.66	36	1067	30
107X	116.00	1131	377.00	12	1194	12
107Y	116.05	1131	377.00	36	1068	30
108X	116.10	1132	377.33	12	1195	12
108Y	116.15	1132	377.33	36	1069	30
109X	116.20	1133	377.66	12	1196	12
109Y	116.25	1133	377.66	36	1070	30
110X	116.30	1134	378.00	12	1197	12
110Y	116.35	1134	378.00	36	1071	30
111X	116.40	1135	378.33	12	1198	12
111Y	116.45	1135	378.33	36	1072	30
112X	116.50	1136	378.66	12	1199	12
112Y	116.55	1136	378.66	36	1073	30
113X	116.60	1137	379.00	12	1200	12
113Y	116.65	1137	379.00	36	1074	30
114X	116.70	1138	379.33	12	1201	12
114Y	116.75	1138	379.33	36	1075	30
115X	116.80	1139	379.66	12	1202	12
115Y	116.85	1139	379.66	36	1076	30
116X	116.90	1140	380.00	12	1203	12
116Y	116.95	1140	380.00	36	1077	30
117X	117.00	1141	380.33	12	1204	12
117Y	117.05	1141	380.33	36	1078	30
118X	117.10	1142	380.66	12	1205	12
118Y	117.15	1142	380.66	36	1079	30
119X	117.20	1143	381.00	12	1206	12
119Y	117.25	1143	381.00	36	1080	30
120X	117.30	1144	381.33	12	1207	12
120Y	117.35	1144	381.33	36	1081	30
121X	117.40	1145	381.66	12	1208	12
121Y	117.45	1145	381.66	36	1082	30
122X	117.50	1146	382.00	12	1209	12
122Y	117.55	1146	382.00	36	1083	30
123X	117.60	1147	382.33	12	1210	12
123Y	117.65	1147	382.33	36	1084	30
124X	117.70	1148	382.66	12	1211	12
**124Y	117.75	1148	382.66	36	1085	30
125X	117.80	1149	383.00	12	1212	12
**125Y	117.85	1149	383.00	36	1086	30
126X	117.90	1150	383.33	12	1213	12
**126Y	117.95	1150	383.33	36	1087	30

TABLE 3.2 X/Y MODES, FREQUENCY CORRELATION SUMMARY

VHF Channel Number	Frequency (MHz)	DME Operation		LO Frequency 3 x Synth. freq.
		Receive	Transmit	
108.0 TO 112.2 (0.1 MHz)	978 TO 1020	X		Above receiver frequency (receiver freq. +63
108.0 TO 112.2	1041 TO 1083		X	
112.3 TO 117.9 (0.1 MHz)	1094 TO 1150		X	Below receiver frequency (receiver freq. -63
112.3 TO 117.9	1157 TO 1213	X		
108.05 TO 112.25 (0.05 MHz)	1041 TO 1083		Y	Below receiver frequency (receiver freq. -63)
113.35 TO 117.55	1104 TO 1146	Y		
112.35 TO 117.95 (0.05 MHz)	1094 TO 1150		Y	Above receiver frequency (receiver freq.+63)
112.35 TO 117.95	1031 TO 1087	Y		

Spacing between pulse pairs X = 12 microsec (0.1 MHz Channels) _____ Both
Y = 36 microsec (0.05 MHz Channels) _____ Air to Ground
Y = 30 microsec (0.05 MHz Channels) _____ Ground to Air

3.6 OVERALL CIRCUIT DESCRIPTION

3.6.1 Digital Display

This circuit description covers the Synchronous Timing BCD ÷2000 Counter and associated components necessary to display the distance (MILES), on the front panel display. The basic Decade Counter, including the Latch, Decoder, and 7-Segment Display will be grouped together for the purpose of simplifying the overall count/display circuit operation. Subsequent subsections separate these components and describe their operation in conjunction with other circuits.

Since the front panel display includes four digits and the extreme left number never increases beyond "1", the maximum count is 1999. The decimal point location changes this to 199.9; this display is the result of a ÷2000 Decade Counter. The display capability is considered to be 200 miles. For the purpose of simplification, only one decade of this Counter will be described along with the method of starting and stopping the Counter and display of the associated digits; refer to Figures 3-5 and 3-6.

During actual operation, the display is in increments of 0.1 mile; the time required for a radio signal to travel from the aircraft to the ground station 0.1 mile distant and back is 1.236 microseconds. Normally, the Counter counts increments of 1.236 microseconds obtained from the crystal controlled clock; however, to simplify this description, we will assume a count period of 1.0 microseconds.

The basic single Decade Counter shown in Figure 3-5 is started and stopped by the Gate Control. The Gate Control output enables the Clock Gate and connects 1 MHz pulses (1-microsecond period) from the crystal controlled clock into the Counter. The single Decade Counter consists of four flip-flops (FF) in series, capable of ten counts, with an output line from the output of each of the four FFs; the Decade Counter output is in a binary coded decimal (BCD) format. Each of the four BCD output lines is capable of indicating the logic state of its associated FF, a "1" (high) or a "0" (low). The high state has a voltage level of 3 volts and the low state has a voltage level of 0.5 volts. The condition of each output line of the Counter is shown in waveforms C, D, E, and F of Figure 3-6. At the tenth count of the Decade Counter, the output now becomes the stop input to the Gate Control and the Clock Gate turns OFF the clock pulses to the Counter.

To satisfy these operating conditions, let us now apply the DME control signals to a single typical Decade Counter stage. With all four FFs in their zero state (all four output lines low) the 1 microsecond pulses are gated into the first FF. The first FF changes state for each input pulse however it passes each alternate pulse (i.e.; ÷2) into the second FF (waveform C). As the count advances, the second FF passes each alternate pulse to the third FF (waveform D). The third and fourth FFs (waveforms E and F) operate in a similar fashion with one exception; the frequency and period of the two waveforms are identical, however, the phasing differs. The four output lines show the condition of each FF in the Counter. As the clock pulses are loaded into the Counter the count progresses in a ÷2 binary sequence as shown in the timing diagram of Figure 3-6 and Table 3.3.

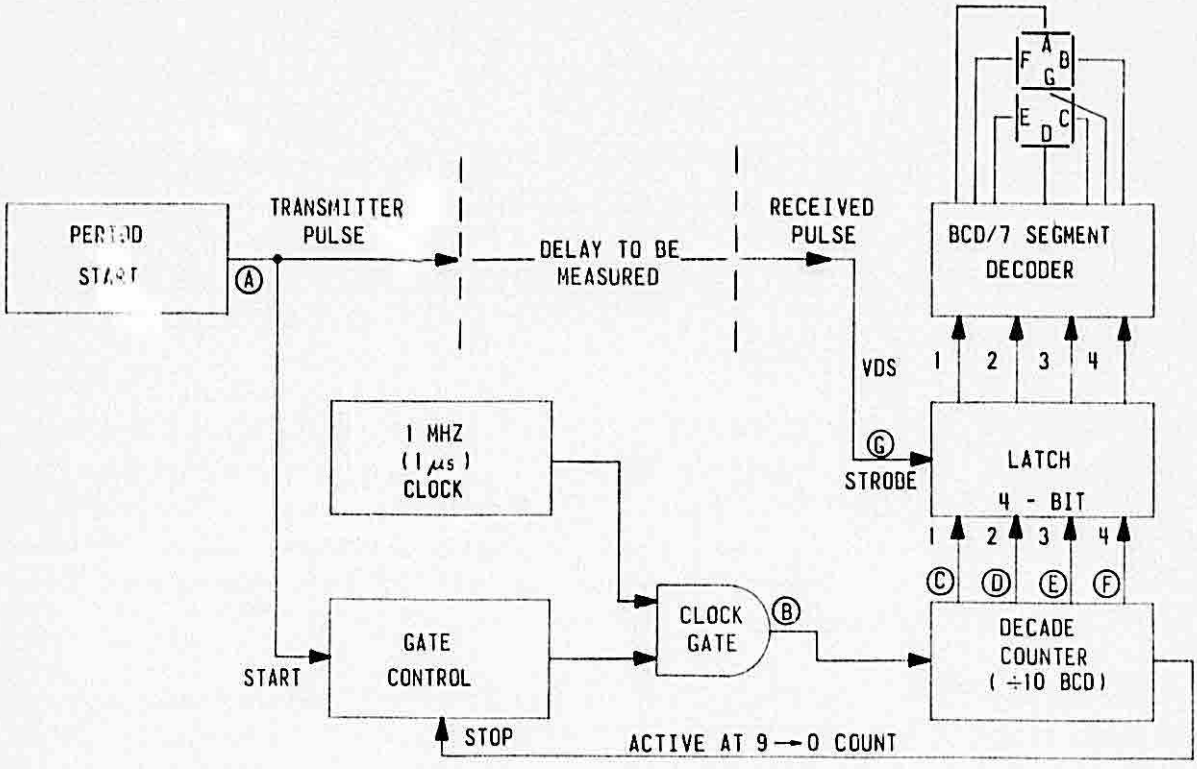


FIGURE 3-5. PERIOD COUNTER

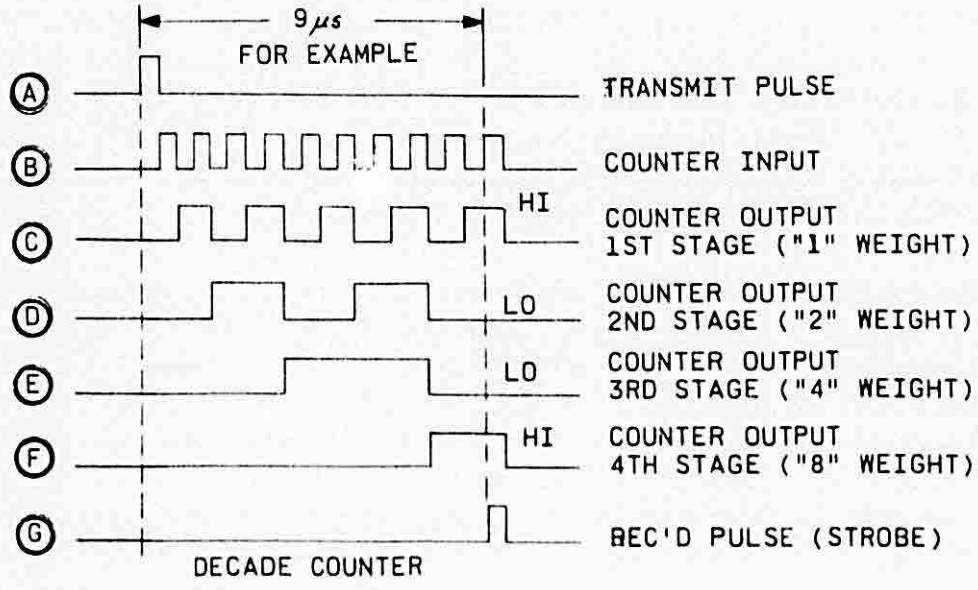


FIGURE 3-6. DECADE COUNTER, TIMING DIAGRAM

TABLE 3.3 BCD OUTPUT OF DECADE COUNTER

Count	BCD Output			
	FF1	FF2	FF3	FF4
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

TABLE 3.4 BCD/7 SEGMENT DECODER OPERATING CONDITIONS FOR BCD COUNT OF "9"

INPUT FOR "9" (LATCH OUTPUT)		OUTPUT FOR "9" (DECODER OUT TO DISPLAY)	
BCD Digit	State	Segment	Condition
1st	High (1)	A	Lit (Lo)
2nd	Low (0)	B	Lit (Lo)
3rd	Low (0)	C	Lit (Lo)
4th	High (1)	D	Off (Hi)
		E	Off (Hi)
		F	Lit (Lo)
		G	Lit (Lo)

3.6.1 Continued

Upon reaching the count of 9, the first FF is high, second FF low, third FF low, and fourth FF high. If we assign a binary weight of 1 to the first FF, 2 to the second FF, 4 to the third FF, and 8 to the fourth FF, it may be seen that the sum of the binary weights becomes 9. If the Counter would stop at this time it would be in the 9 state. However, we do not want to stop the Counter, only read what is in it at this instant in time. The Counter would then run to its full capacity of 10 and then turn itself back to the initial state of low on all four output lines.

If, at the count of 9 a strobe pulse is fed into the 4-Bit Latch, as shown in Figure 3-5, the data (1 or 0) at the latch inputs will be transferred to the latch outputs and stored until the next strobe pulse occurs. Under these conditions, the Counter can continue running until it shuts itself OFF with no effect upon the count stored in the Latch. The BCD count of 9 is 1 0 0 1 as shown in Table 3.4.

The Latch outputs are connected to the BCD to 7-Segment Decoder inputs. The Decoder is a static device that converts the data encoded in the four BCD lines into the appropriate 7 output lines to drive a 7-Segment Incandescent Display. In this case, the figure "9" will be displayed when the A, B, C, F, and G segments are lit; refer to Figure 3-5. During this display time the Counter continues, with no effect upon the display, and resets itself when it reaches the full count.

To expand this for the ÷2000 counter, the output from this Decade Counter at the count of 10 (previously used for reset) is fed to another decade counter that is identical with the first decade. Since there is a single input to the second decade for each 10 counts (10 usec) of the first decade, to load the second decade with 10 counts it is necessary to feed 100 counts (100 usec) into the first decade.

A third decade in this counter chain would require 10 pulses from the second decade. Since it requires 100 counts into the first decade to load up the second decade, 1000 counts (1000 usec) would be required to load up the third decade. A flip-flip, which is a ÷2 counter, is now used to extend the counter from ÷1000 to the new configuration of ÷2000. The first, second, and third decades have a latch and decoder associated with each 7-segment display; the fourth display, however, has a FF functioning as a latch to turn ON the 1000 as required. The full counter output in BCD form appears on 13 lines to the latch and decoder/display. With an understanding of the operation of the ÷2000 counter and digital display let us now fit this into the overall picture of one cycle of DME operation.

In the description given here, the clock pulse period is 1.236 microseconds for 0.1 mile round trip time (to and from the ground station). Since there is a delay of 50 microseconds at the ground station (between receipt and reply of a pulse pair), the airborne DME must insert a delay of 50 microseconds before starting the interval Counter. The timing diagram, Figure 3-7, and the block diagram, Figure 3-8, show the sequence of transmitter/receiver operation at a distance of 10 miles from the ground station. The sequence starts at T_0 when the PRF output (waveform A) goes low and the modulator generates a pulse pair to turn ON the transmitter (waveform B).

3.6.1 Continued

Following the 50 microsecond delay, 1.236 microsecond clock pulses (800 KHz) are gated into the ÷2000 Counter (200 mile) as shown in waveform C. The Counter changes the clock intervals into the equivalent distance since each clock pulse is the equivalent of 0.1 mile distance. The ÷2000 Counter represents 200 miles since the increments of measurement are each 0.1 miles.

The Counter has a capacity of 2000 counts which is obtained by the use of 3 Decade Counters and one flip-flop as shown in Figure 3-8A. Each decade is ÷10; when placed in series, it becomes ÷100 (from U327), ÷1000 (from U318), and ÷2000 (from U309A). Each decade has a four bit output plus one output from the FF; this constitutes a 13 bit system.

The pulse pair received from the ground station (waveform E) requires 123.6 microseconds for travel to and from the ground station. Therefore, during this interval, 100 1.236 microsecond clock pulses (waveform C) have been fed into the ÷2000 Counter. The first (units) decade changes state 100 times, passing 10 counts to the second (tens) decade. The tens decade changes state 10 times, passing one count to the third (hundreds) decade. The condition of the Counter is a one in the hundreds decade and zeros in the ten and unit decade; the full count is 100.

Upon receipt of the pulse pair from the receiver, a valid data strobe (VDS) is generated as shown in waveform F. The VDS pulse into the Latch samples the BCD output of the ÷2000 Counter and stores it in the 12 Bit Latch (U334, U326, and U317); the 13th bit is hard wired into the display through U308B, and U312D. Strobing of the Latch has no effect upon the ÷2000 Counter operation. The 1.236 microsecond pulses continue from the clock; therefore the ÷2000 Counter continues operation until the full count is reached and it turns itself OFF. The 2000 count interval provides the capability of a 200 mile readout and is referred to as the 0-200 mile epic or period, used in other sections of the DME.

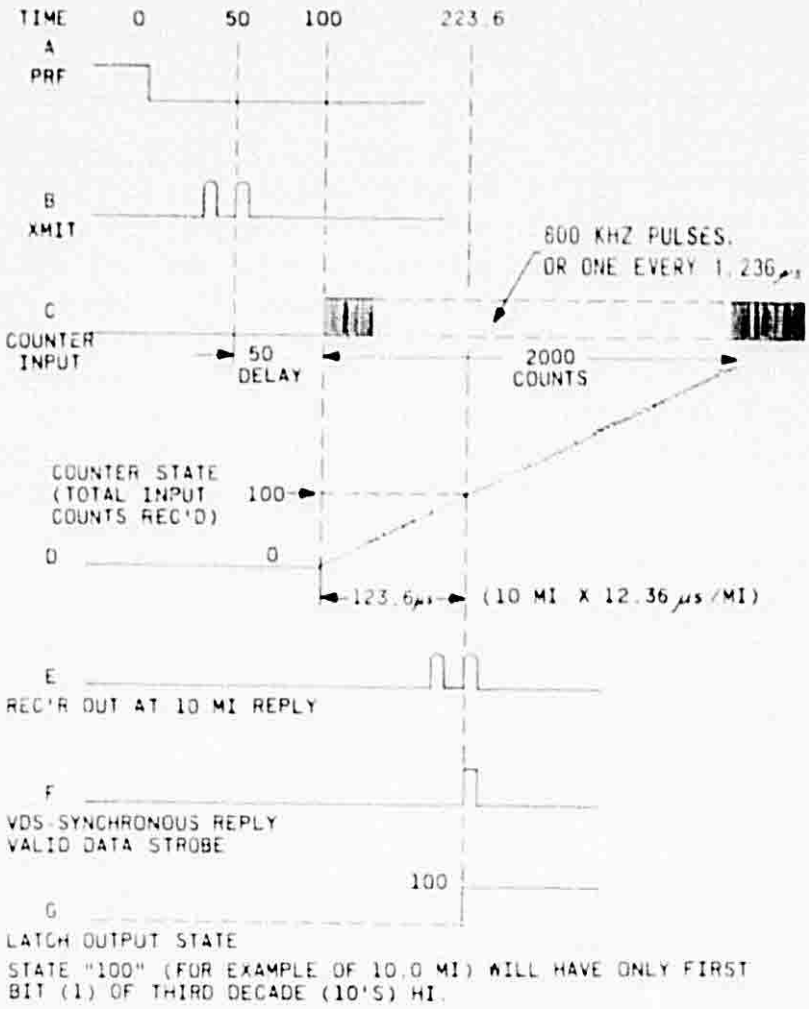


FIGURE 3-7. DME RECEIVE/TRANSMIT TIMING DIAGRAM FOR 10 MILE INTERROGATION

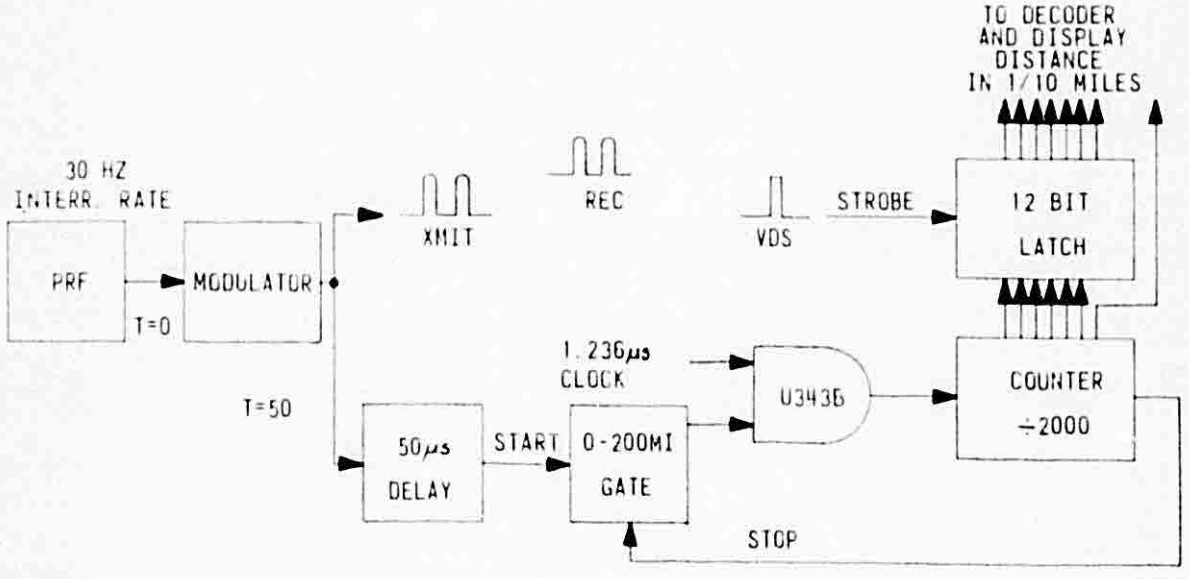


FIGURE 3-8. DIGITAL DISPLAY, BASIC BLOCK DIAGRAM

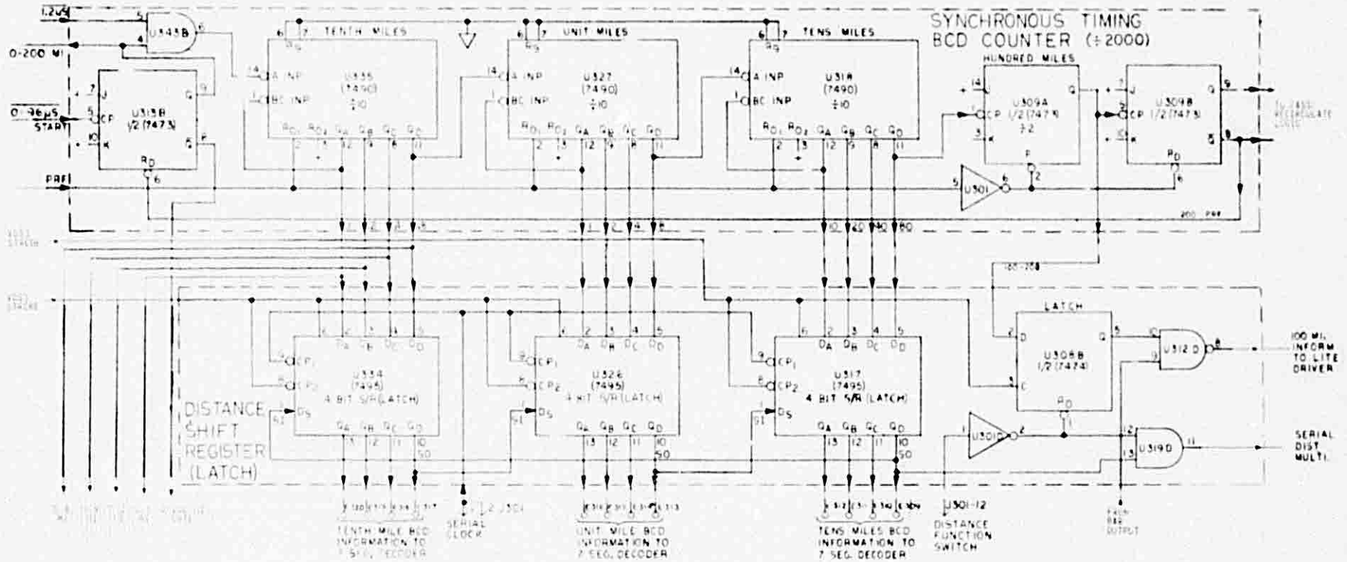


FIGURE 3-8A. 0-200 MILE COUNTER AND DISTANCE SHIFT REGISTER

SEE BLOW-UP

3.6.2 Shift Register

The shift register is used for transferring digital information and/or converting digital data from serial to parallel or parallel to serial form. The shift register comprises a group of flip-flops (FFs) connected in series, one FF for each bit in the register. The intercopnections are from the FF output to the next input in this series circuit; clock inputs, however, are connected in parallel to simultaneously clock all FFs. Refer to Figure 3-9.

If a high is loaded into the first FF and a clock pulse applied, this high will be transferred to the second FF. The second clock pulse will transfer this high to the third FF; simultaneously, the second FF will revert to whatever was in the first FF. Since each FF output is connected to the next FF's inputs, each FF is preset by this conditioning and the FF is changed to the appropriate state when a clock pulse is applied (i.e. FF1 output presets FF2 input; FF2 output presets FF3 input; etc.). In this manner, the shift register progressively moves the digital bits (highs and lows) from FF to FF in accordance with the number of clock pulses applied. This is referred to as serial mode.

An example would be operation of a typical 10 bit shift register comprising 10 FFs. If a high is introduced into the shift register input, it will be seen at the output after 10 shift pulses. This serial mode input and serial mode output is frequently used.

A second mode of operation is to load data in serial form and take it out in parallel form. An example would be operation of the four bit shift register shown in Figure 3-9. The four bits of data are loaded into the registers in serial form upon the application of four clock pulses. At this time the output of each FF will be loaded with one bit of this four bit data group. The shift register output can now be read in parallel form by simultaneously checking the state of each FF in the register.

A third mode of operation is to load data into the shift register in parallel form and take it out in serial form. The data is loaded in parallel form by presetting one bit of data into each FF of the register. Data can be introduced, on some shift registers, by using a command which will take information that is at the input terminals and preset it into the FFs. This is a latch function that can be provided by a parallel input shift register.

This equipment uses all modes; inputs can be serial or parallel and outputs can be in serial or parallel form.

DATA IN = 1010

CLOCK PULSE	FF1	FF2	FF3	FF4
#1	0	0	0	0
#2	1	0	0	0
#3	0	1	0	0
#4	1	0	1	0

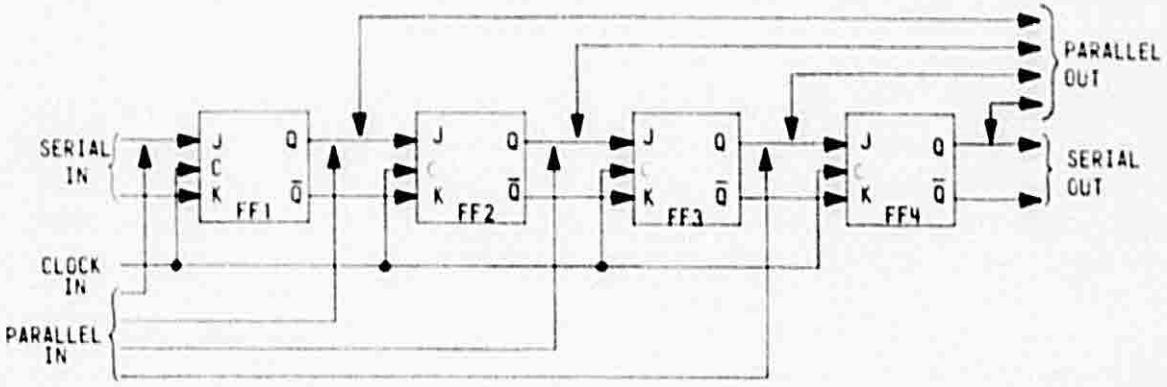


FIGURE 3-9. TYPICAL 4-BIT SHIFT REGISTER, BLOCK DIAGRAM

3.7 DETAILED CIRCUIT DESCRIPTION

3.7.1 PRF Generator and Synchronous Timing Encode

The PRF Generator provides a basic 28 Hz timing cycle to start the transmitter and distance sequence of the DME. The PRF Generator output, in conjunction with crystal controlled clock pulses, is used to generate a precisely timed pair of modulation pulses that turn ON the transmitter and initiate the distance circuitry. Refer to Figure 3-10.

3.7.1.1 PRF Generator

The PRF Generator operates only when reset by the Jitter Delay FF output. The Jitter Delay FF is toggled by decoded receiver data, this operation is at a random rate since the decoder output also includes noise. This semi random interval is set at 28 Hz by the PRF generator and will not exceed 30 Hz. This random starting point of the synchronous timing constitutes jitter and is used to ensure that interrogations from the DME will not be synchronous with any other DME within range and result in false replies from the ground station.

Since the jitter affects the instant of start of the modulation pulse pair, and a transmit/receive cycle is completed before transmission of the next pulse pair, the internal timing circuits do not see this jitter. The jitter is only evident when viewing the output of the PRF generator or synchronous timing encode circuit with reference to real time; synchronizing with the PRF output displays a steady signal on an oscilloscope for any one PRF.

The PRF timer (U316) is reset when the $\overline{Q}$ output of the jitter delay FF U302A-13 provides a logic "0" to U316-2. The 28 Hz timing interval is controlled by R308 and C308. The timer output is inverted by U314A and constitutes one input (pin 10) into two-input AND gate U305A. The AND gate is inhibited by a logic "0" at pin 9 during TTS computations; the gate is enabled, by a logic "1" at pin 9, in the distance and velocity modes and in TTS when not computing.

3.7.1.2 Synchronous Timing Encode

Jitter Delay FF U302 is enabled by a logic high from the PRF output at the end of the 28 Hz time interval and the next decoded video is used as a clock at pin 1. The $\overline{Q}$ output from pin 13 U302A then resets the PRF timer, resets the 1,236 microsecond clock chain, and arms the encode and delay gate control FF (U302B). U302B then provides an output coincident with the next negative-going edge of the 96 microsecond clock pulse at U302B-5.

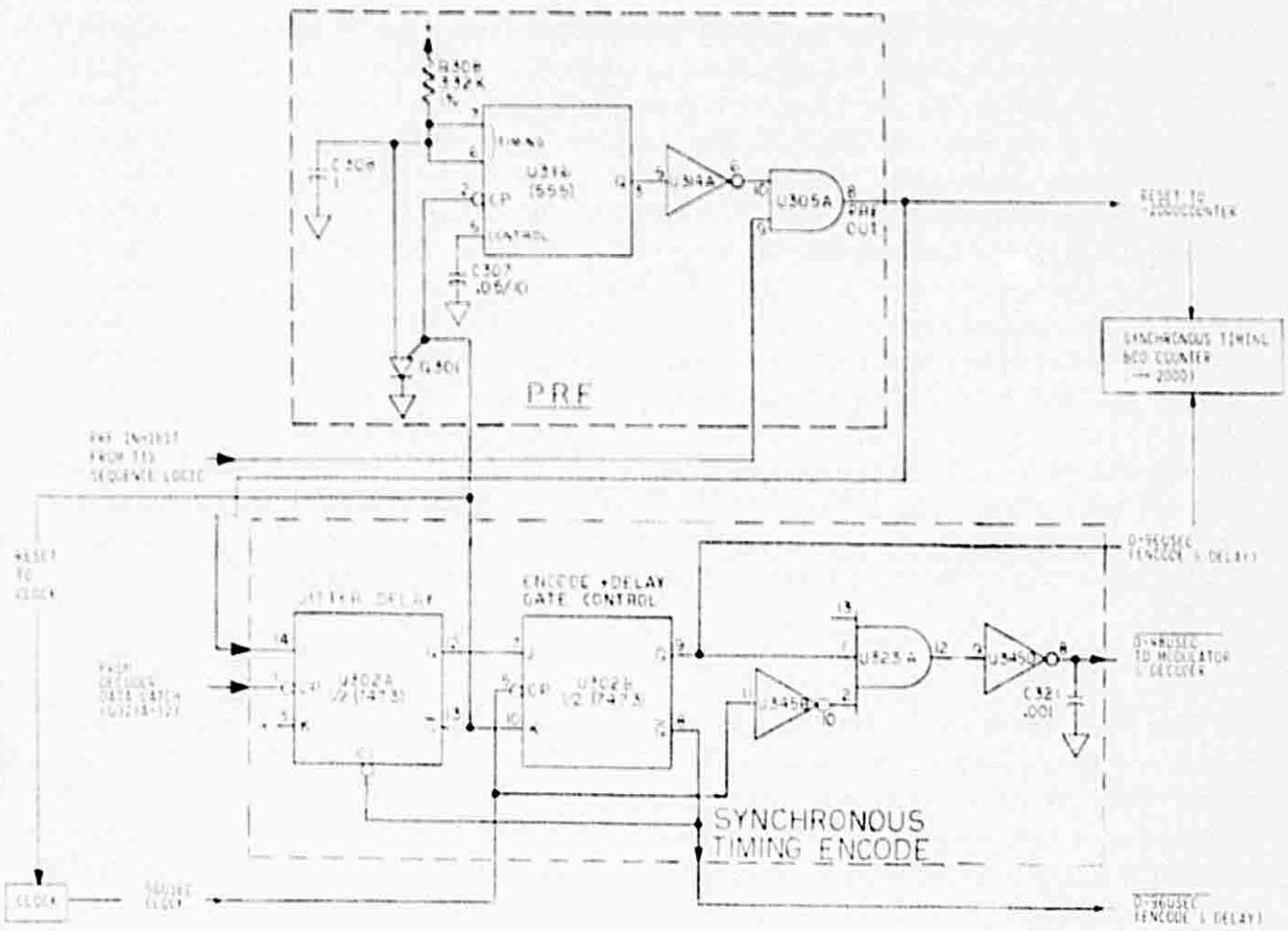


FIGURE 3-10. PRF AND SYNCHRONOUS TIMING ENCODE SCHEMATIC DIAGRAM

3.7.1.2 Continued

Encoding for the transmitter modulation takes place during the 96 microsecond interval. Chronologic order of events during this time period is as follows: two 96 microsecond wide gate pulses (encode and delay) are generated, the positive-going from U302B-9 and the negative-going from U302B-8; during the first 48 microseconds all modulator encoding takes place and the Decoder is inhibited so that it will not cut back Receiver gain during the transmit period. The $\overline{0\text{-}48}$ microsecond pulse at U345D-8 serves as the modulator enable to U341-7 and the Decoder inhibit to U315-1, U324-16, and U333-16; at the end of the 0-48 microsecond period U345D-8 goes high to generate a Dead Time interval simulating the ground station Dead Time. The negative-going encode and delay pulses from U302B-8 are fed to the RNAV to be used as a start pulse and the positive-going pulse from U302B-9 are fed to the 2-State Counter (U302B-9) of the Pass/Recirculate Logic.

Upon receipt of the next 96 microsecond clock pulse, the encode and delay gate control FF is set back to its relaxed state and the $\overline{Q}$ output from pin 8 resets U302A. The negative transition of the Q output (pin 9) from U302B is used to start the 0-200 mile epic by clocking U313B in the Synchronous Timing BCD Counter ($\div$ 2000).

3.7.2 Modulator

The Modulator turns on the transmitter when so directed by the Synchronous Timing Encode section described in subsection 3.7.1.2. The Modulator is separated into an encoder section and a modulation driver/shaper section as shown in Figure 3-11. The encoder generates two pulse trains to control the output of the modulation driver/shaper. The modulation driver/shaper receives +60 volts from the power supply; when pulses from the encoder, +33 and +51 volt pulse pairs activate the transmitter.

3.7.2.1 Encoder

The encoder has inputs comprising 3, 6, 12, 24, and 48-microsecond crystal controlled pulse trains from the Clock generator, plus the X/Y input from the Channel Multiplex via the Synthesizer. When enabled by the Synchronous Timing Encode section, the modulator encoder generates pairs of pulses that have the pulse width and pulse spacing crystal controlled; the X/Y control selects a crystal controlled pulse spacing of (X) 12 or (Y) 36-microseconds.

The encoder pulse spacing is controlled by U341, the 8-input Multiplex shown in Figure 3-12. For 12 microsecond pulse spacing, pins 13 and 15 are enabled (logic high). This will decode the binary states of 4 and 6. When input lines at pins 11, 10, and 9 are addressed with this binary code and the strobe line is activated (pin 7 logic low), output frequencies are 12, 24, and 48 microseconds wide, the two output pulse will be 6-microseconds wide.

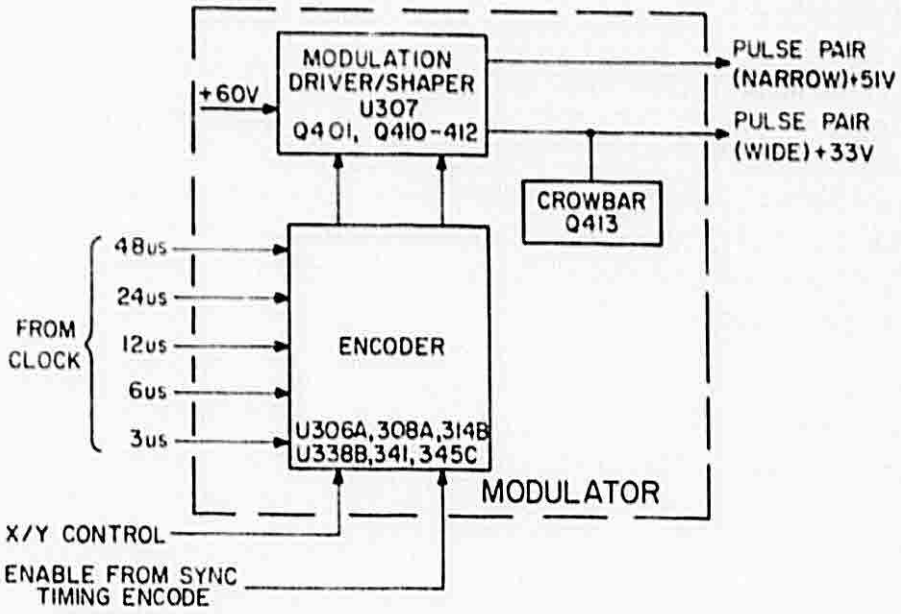


FIGURE 3-11. MODULATOR, BLOCK DIAGRAM

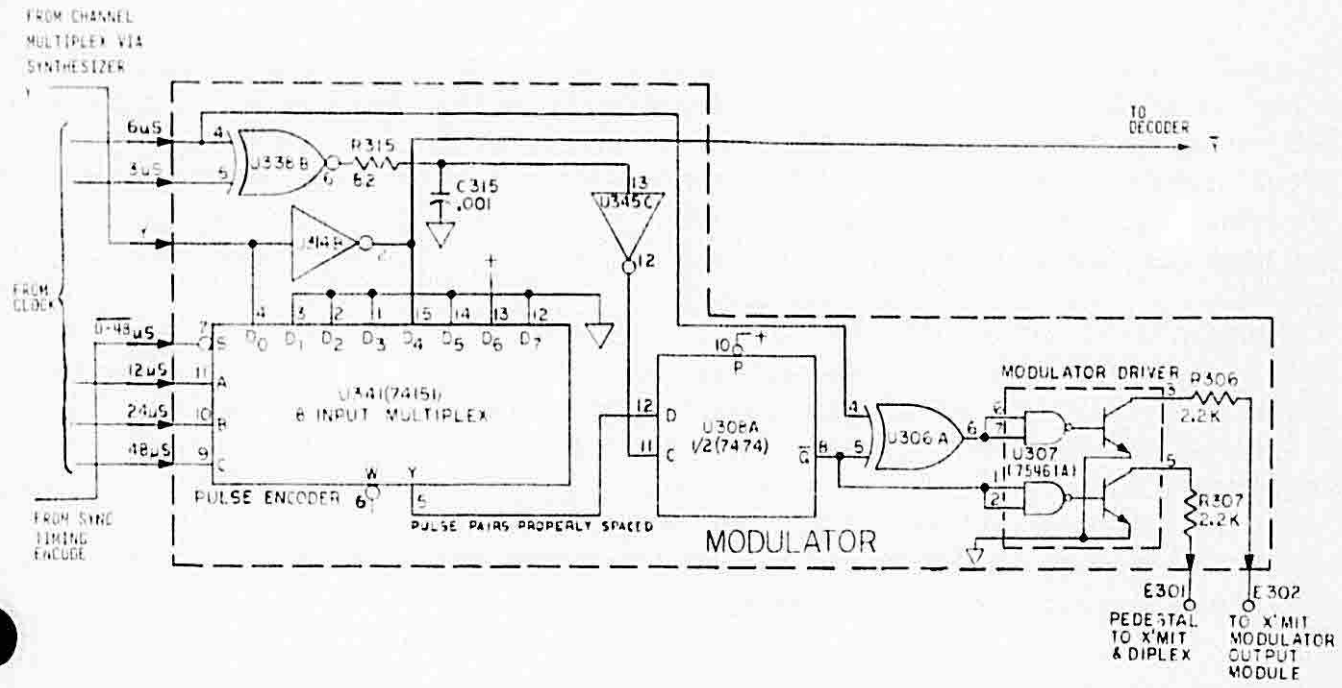


FIGURE 3-12. MODULATOR ENCODER, SCHEMATIC DIAGRAM

SEE BLOW-UP

3.7.2.1 Continued

The 6-microsecond wide pulses are then delayed 4.5-microseconds by FF U308A. The delay is obtained by clocking the FF with a 6-microsecond clock shifted 90° by exclusive OR U338B and inverted by U345C. [The result, as shown in Figure 3-13, is a pair of 6-microsecond wide pulses centered about the 3-microsecond negative half of the 6-microsecond clock.] This inverted output is used to enable modulator driver U307-2, which acts as an interface between TTL levels and the high voltage levels to drive the transmitter power supply.

The inverted output from U308A-8 ($\overline{Q}$) is then exclusive ORed with the 6-microsecond clock. The negative-going 3-microsecond output is used to drive U307-6 and -7, the second half of the modulator driver. This process is repeated every time the strobe port (U341-7) is enabled by a logic low. The strobe, from U345D-8, is controlled by the Synchronous Timing Encode section and occurs at a 28 Hz rate.

In the Y mode, the spacing between pulses of the pulse pair is 36-microseconds. The only change at U341 is that pin 4 is selected (instead of pin 15 for X); therefore, a binary "0" is used to select the P1 position instead of a binary "1". The P1 position, with respect to P2, will move four more binary positions (4 x 6-microseconds = 24 microseconds) and the new spacing is now 36-microseconds. The timing relationship is shown in Figure 3-14.

3.7.2.2 Modulator Driver Shaper

The modulator driver/shaper comprises two pulse driver-modulator stages and their associated pulse shaping and protective circuitry. Their function is to permit the DC voltage across the energy storage capacitors to be applied to the transmitter in the form of short pulses when so directed by the pulse pairs from the encoder.

The pedestal modulator produces a 33-volt pulse pair, each with a nominal pulse width of 8-microseconds. These pulses are used to modulate Q603 and Q604 in the Transmitter, and the low level driver stages in the power amplifier module of the Transmitter. The output modulator produces a 51 volt pulse pair, each with a nominal pulse width of 3.5 microseconds. These narrow pulses are timed to occur during the pedestal pulse, and are used to modulate the high level stages in the power amplifier (PA) module.

The protective circuitry consists of appropriately placed zener diodes whose function is to voltage level the pulses, and to prevent transients from being applied to the transmitter. Redundant zener diodes are used for increased reliability. A "crowbar" circuit is used in the pedestal modulator to protect the transmitter in the event of "long pulsing". Should the pedestal modulator remain on for more than 100 microseconds (approximately), which could occur due to component failure, the silicon controlled rectifier (SCR) which is connected across the energy storage capacitor would fire, discharging the capacitor, thus removing the voltage from the transmitter.

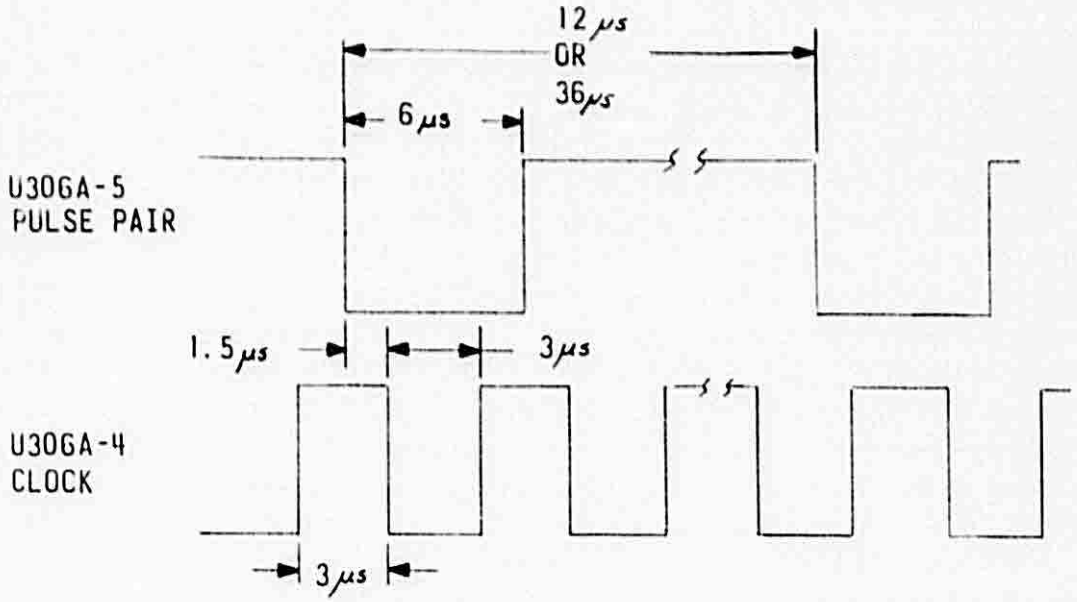


FIGURE 3-13. 6-MICROSECOND PEDESTAL PULSE

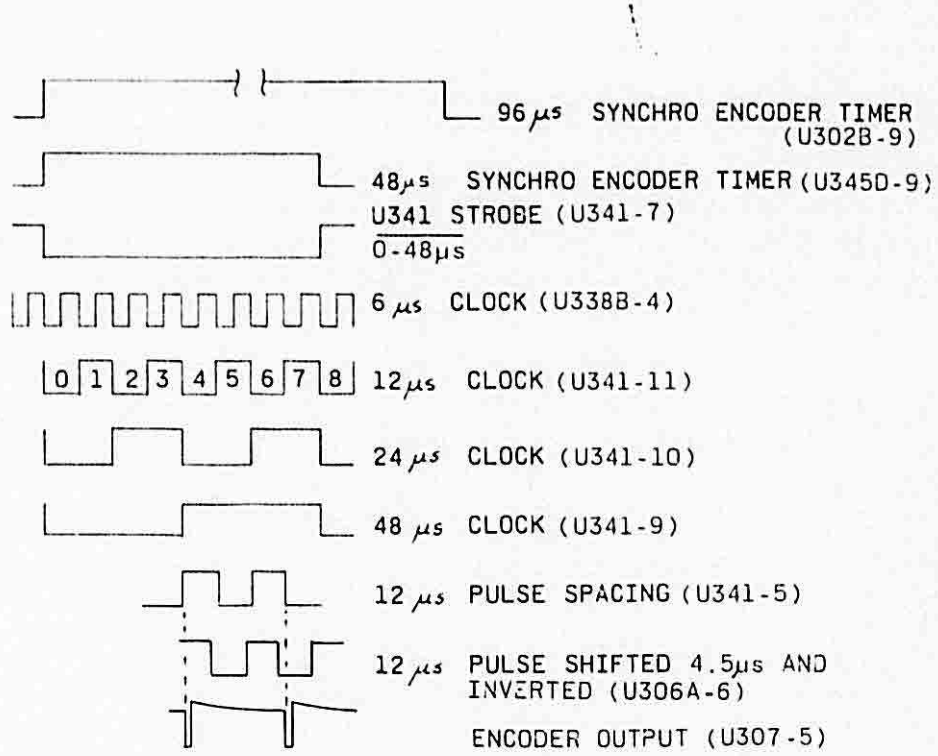


FIGURE 3-14. ENCODE CLOCK PULSE TIMING DIAGRAM

3.7.2.3 Pedestal Modulator

The negative going 6 microsecond signal from the modulator driver (U307-5) is applied to the base of Q411, where it is amplified and inverted as shown in Figure 3-15. The signal is then shaped by R416, R418, L411, and C413 and applied to the base of Q412, a high current Darlington emitter follower. This amplifier acts as a switch between energy storage capacitor C414 and the transmitter. In addition to the transmitter, resistor R415 provides a constant resistance load for Q412. The energy storage capacitor C414, is charged from the 60 volt power supply through current limiting diode CR411. This diode limits the charging time of C414 in the event of circuit malfunction (i.e., shorted Q412, firing of the SCR, etc.). A 36 volt zener diode (CR412) limits the maximum voltage across energy storage capacitor C414. A 33 volt zener diode limits the voltage applied to the transmitter. The RC network, consisting of R415 and C412, senses the pulse duration of the 33 volt pedestal pulse. Should the modulator "long pulse", the voltage across C412, after being voltage divided by R419, R420, and RT410, is applied to the gate of Q413. This turns ON Q413, which discharges energy storage capacitor C414, preventing damage to the transmitter. Thermistor RT410 compensates for the temperature characteristics of Q413. Resistor R421 discharges energy storage capacitors C414 and C401 (in the high voltage modulator) when the equipment is turned OFF.

3.7.2.4 Output Modulator

A pair of negative-going 3 microsecond wide pulses from the modulator driver (U307-3) are applied to the base of Q410, where they are amplified and inverted as shown in Figure 3-16. This signal is shaped to provide the required modulating pulse for the power amplifier module. The shaping is performed by L410, C410, R411, R402, L401, and C402. The signal is then applied to the base of high current Darlington emitter follower Q401. In addition to the transmitter, resistor R401 provides a constant load for Q401. Zener diode CR413 limits the voltage across energy storage capacitor C401, to 56 volts. A 51 volt zener on the emitter of Q401 limits the voltage of the pulses applied to the PA module. Protection of the PA module in the event of failure of this diode is assured by an additional 51 volt zener diode (CR401) on the base of Q401.

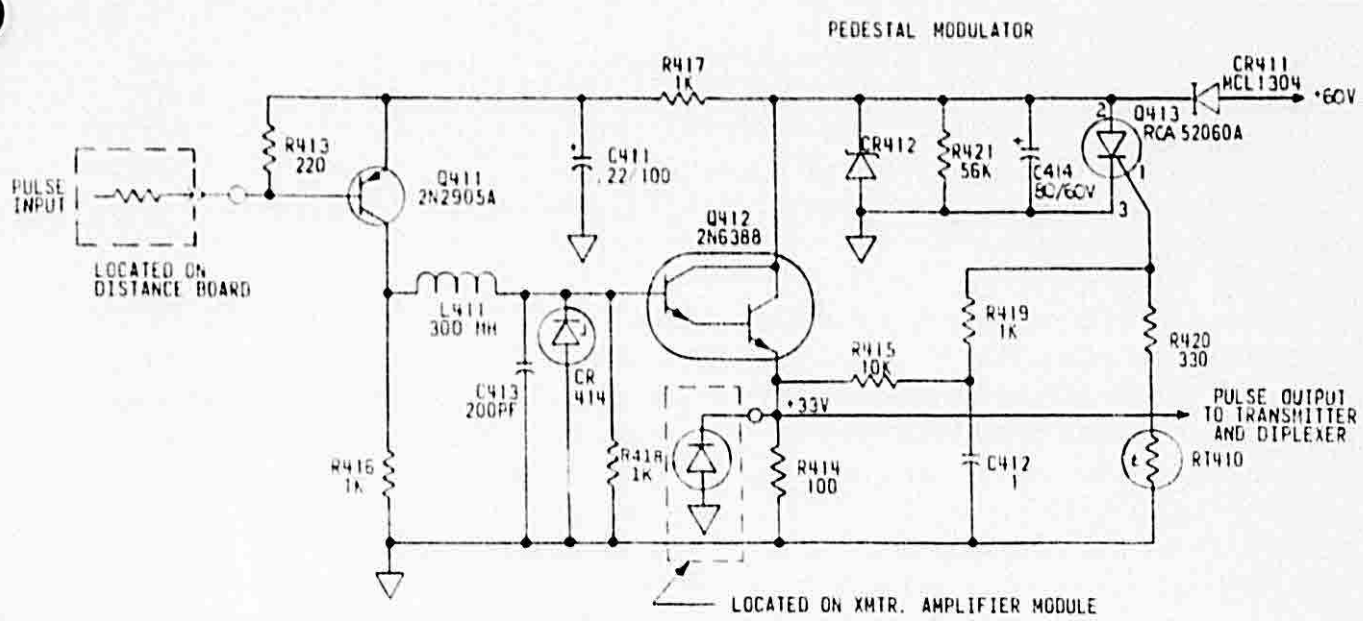


FIGURE 3-15. PEDESTAL MODULATOR, SCHEMATIC DIAGRAM

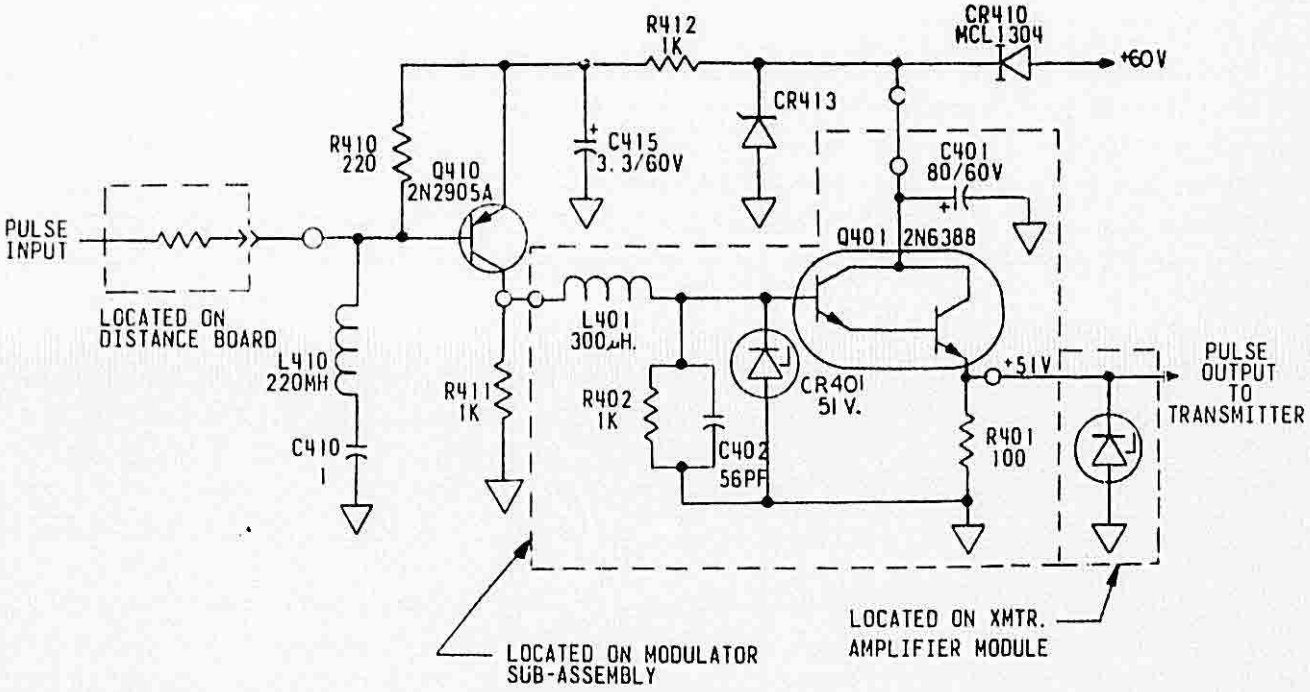


FIGURE 3-16. OUTPUT MODULATOR

3.7.3 Transmitter

The Transmitter amplifies the RF excitation from the Synthesizer and triples its frequency when pulsed by the Modulator. The transmitter comprises three basic functional areas as shown in Figure 3-17; low level RF amplifier, step recovery diode (SRD) frequency tripler, and the RF power amplifier module. When provided with excitation of 0.5 milliwatt at 360 MHz, the transmitter output to the Diplexer is 100 watts minimum at 1080 MHz.

NOTE:

The input frequency range is from 347.0 through 383.3 MHz and output from 1041 to 1150 MHz; however, to simplify this description, the input and output frequencies will be referred to as 360 and 1080 MHz respectively.

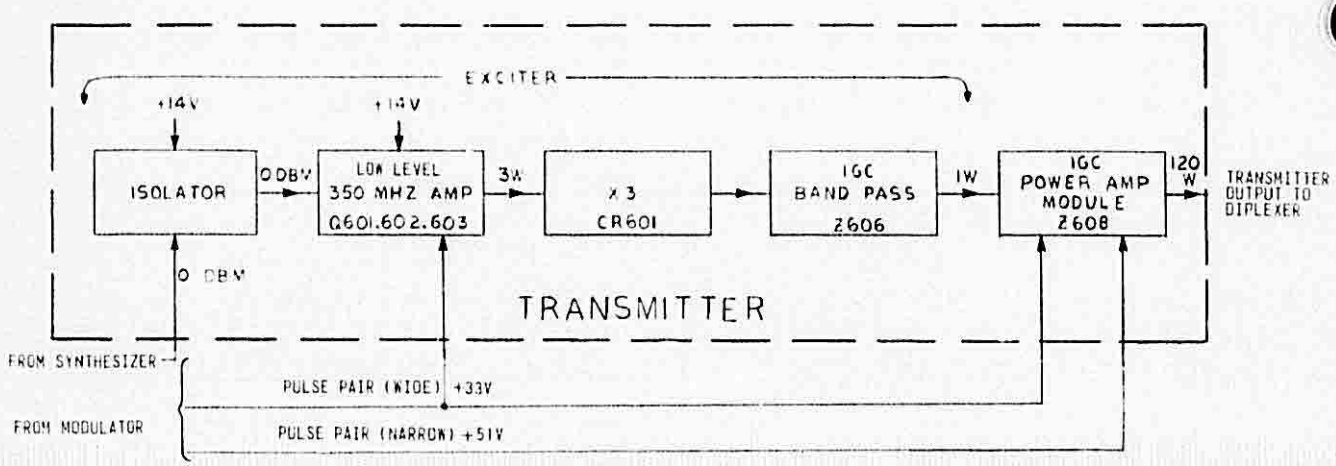


FIGURE 3-17. RF TRANSMITTER, FUNCTIONAL BLOCK DIAGRAM

3.7.3.1 Low Level RF Amplifier

The low level RF amplifier is a four transistor RF amplifier that provides 3-watts of drive to the SRD (Figure 3-18). A 10 db resistive attenuator (R601, R602, R603) provides isolation for the Synthesizer and an impedance matching network (L601, C601) provides impedance matching to the input stage, Q601. Interstage coupling between the four RF amplifiers is similar, therefore only one will be described as typical.

The Q601 output is coupled to the Q602 input through a broad band impedance matching band pass filter comprising L602, C603, C605, and L603. Functionally, the Q602/Q603 and Q603/Q604 coupling are identical to the above. The output of Q604, which comprises L608, C617, C618, and C609 provides impedance matching to the SRD.

Separate decoupling circuits are used in each stage. The Q601 and Q602 stages utilize C602 and C607 for RF bypass and a combination of Z601, Z602, and C606 for decoupling from the +14 vdc power supply. The Q603 and Q604 amplifiers utilize similar circuitry for RF return and decoupling from the +33 volt pedestal modulator.

The first three stages receive base bias through voltage dividers (i.e. Q601 uses R604 and R605), operating as Class A amplifiers. With no dc bias, Q604, however, operates as a Class C amplifier. Upon application of a 33 volt pulse, both Q603 and Q604 are turned ON for the pulse duration and RF is applied to CR601, the SRD frequency tripler. On an overall basis, 360 MHz RF is continuously applied to the Q603 input; when the 33 volt pulse train is applied, the RF is gated on and this output is applied to the power amplifier module.

3.7.3.2 Frequency Tripler (Step Recovery Diode)

The frequency tripler is a passive device that increases the frequency of the pulsed RF output of Q604 from 360 MHz to the new frequency of 1080 MHz that is supplied to the RF power amplifier. The frequency tripler input is 3 watts at 360 MHz; the output from the bandpass filter is 1.0 watt at 1080 MHz. The frequency tripler description of operation that follows includes the output circuit of Q604 (4th RF amplifier) referring to it as the frequency tripler input.

The frequency tripler comprises an SRD and a bandpass filter (BPF) tuned to 1095 $\pm$ 70 MHz. As shown in Figure 3-19, the combination of L608, C617, C618, and L609 match the impedance of RF amplifier Q604 to the SRD input. The BPF (Z606) is a microstrip filter with a 2 db attenuator built into the output circuit for isolation from RF power amplifier module Z608.

When the +33 volt pulse turns ON the low level RF amplifier for 8-microseconds, a pulse of 360 MHz RF is applied to the frequency tripler input, which is tuned to 360 MHz. The SRD generates many harmonics of this frequency; however, the BPF is tuned to 1095 MHz, the third harmonic. The BPF attenuates those harmonics above and below the third harmonic. Therefore, the power amplifier module input has a relatively high level third harmonic with the frequencies above and below at relatively low levels.

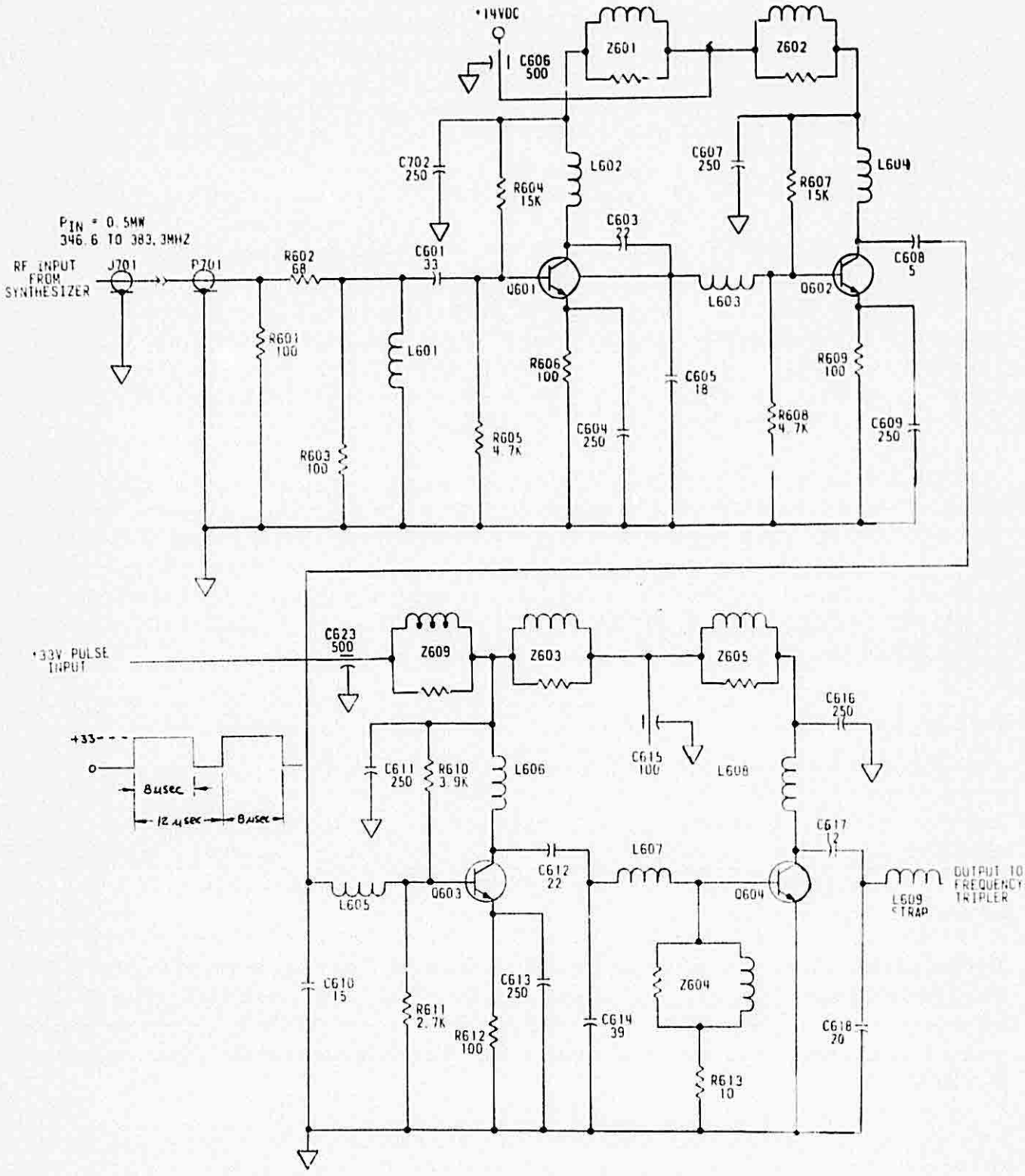


FIGURE 3-18. LOW LEVEL RF AMPLIFIER SCHEMATIC

3.7.3.3 Power Amplifier Module

The power amplifier module (Z608) is a single sealed module that provides a minimum of 100 watts to the antenna when driven by 0.6 watt. The module is a four transistor RF amplifier operating within the 1041 to 1150 MHz range. The two low level stages utilize conventional interstage coupling; the two final power amplifiers are coupled together and to the output through hybrid networks. The output is internally protected from damage due to large changes in load impedance.

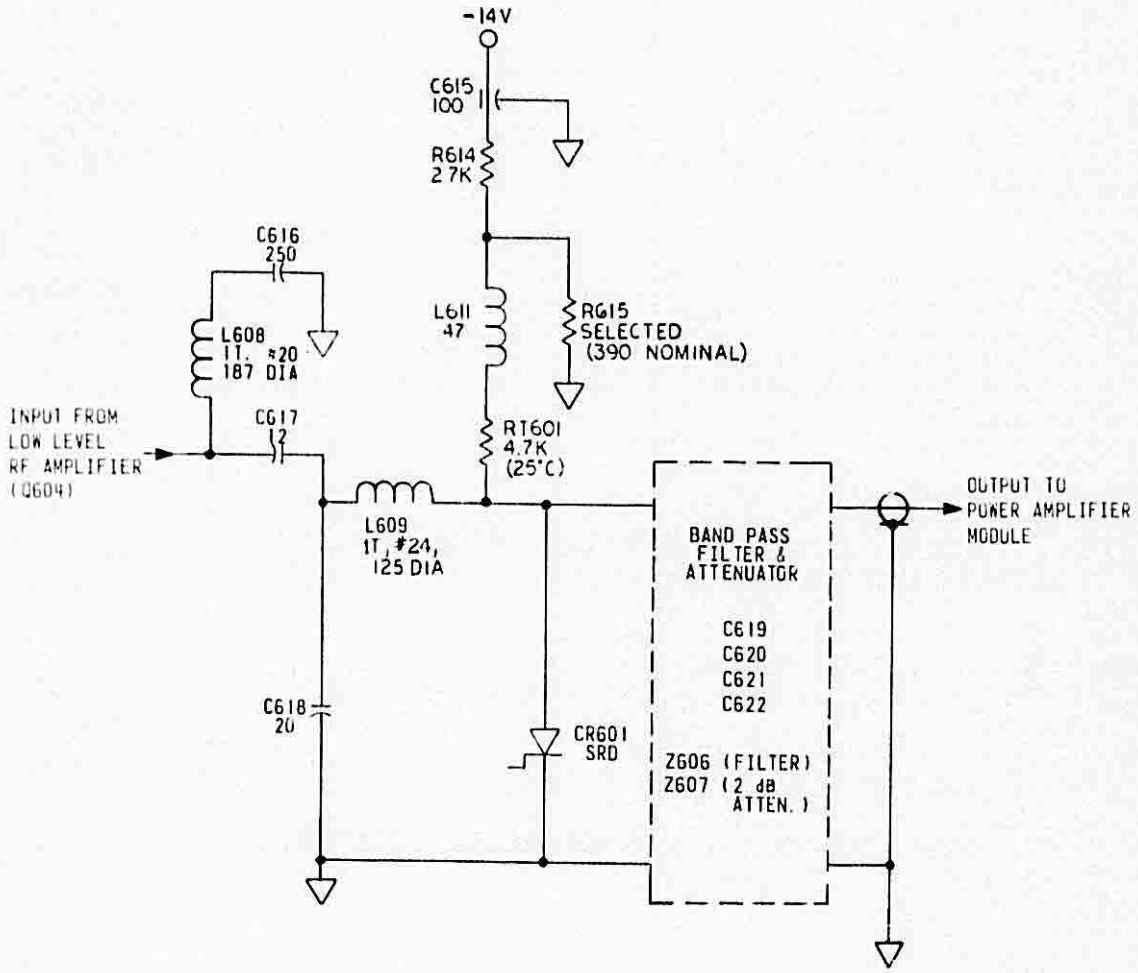


FIGURE 3-19. FREQUENCY TRIPLER

3.7.3.3 Continued

The power amplifier module is gated ON by the +33 volt and +51 volt pulses as shown in Figure 3-20. The high level transistors are gated ON by the +51 volt pulse; the modulator supplies both pulse pairs. The high and low level pulses occur at the same pulse recurrence rate, however there is delay before the start of the +51 volt high level pulse. The sequence of operation is as follows: the +33 volt pulse turns ON the low level RF and a few microseconds later the high power final amplifier is turned ON by the +51 volt pulse.

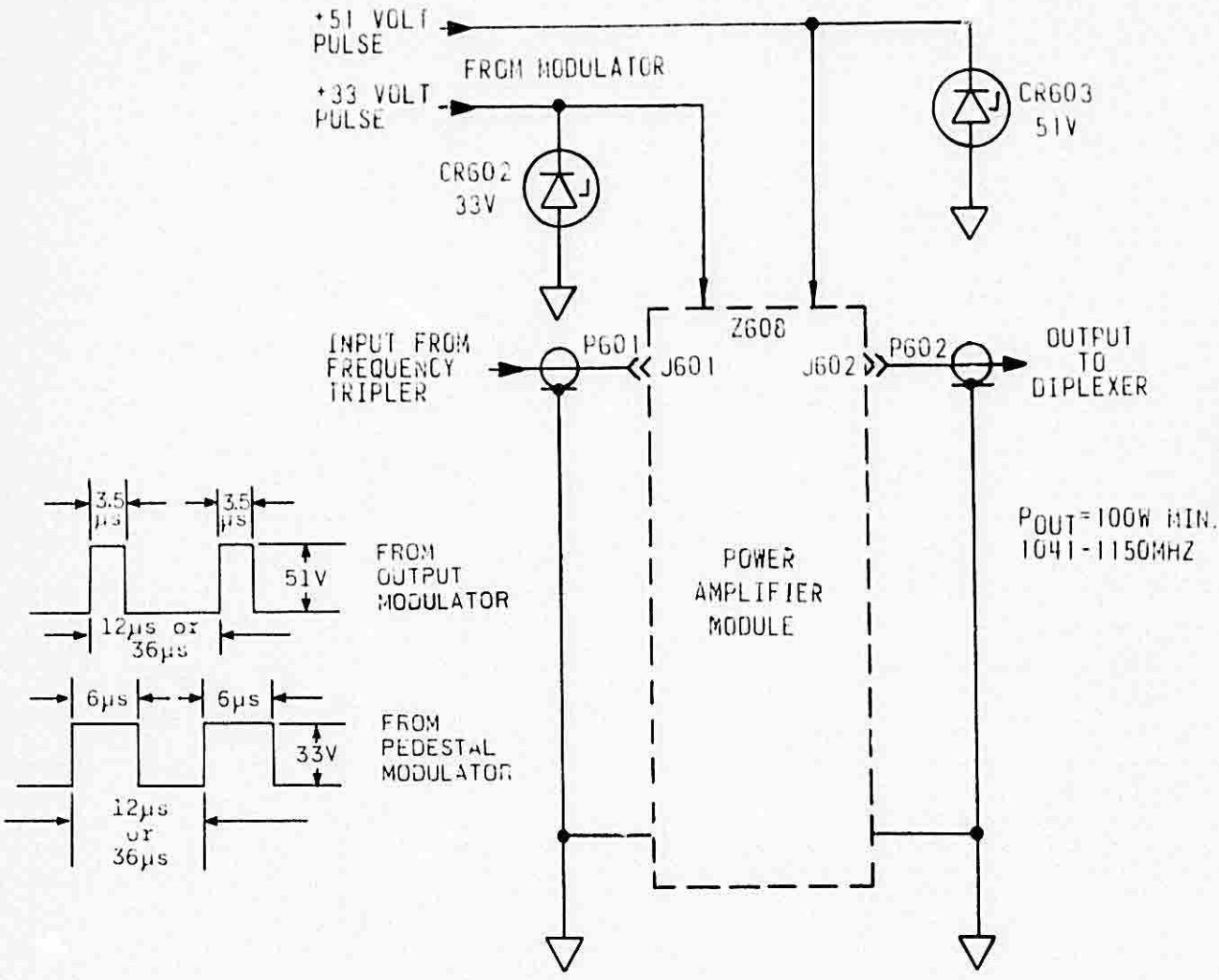


FIGURE 3-20. RF POWER AMPLIFIER MODULE

3.7.4 Diplexer, RF Receiver, and AGC Circuits

3.7.4.1 General

Shown in Figure 3-21 are the receiver circuits in block diagram form. RF energy from the antenna is filtered by the low pass filter and routed to the preselector by the Diplexer. Preselector output energy is mixed with the local oscillator signal, from the synthesizer, in the double balanced mixer producing a 63 MHz IF signal. Amplified by the 63 MHz IF Amplifier the signal is then detected by the video detector. Detected video pulses are amplified and clipped to drive TTL circuits in the Decoder.

The Decoder delays the video data for 12 microseconds on X channels or 30 microseconds on Y channels. Properly spaced pulse pairs will result in delayed data from the Decoder, and TTL Driver data, arriving coincidently at the AND gate inputs. A pulse output from the AND gate will then enable the sample and hold AGC to sample the video amplifiers pulse amplitude and produce an AGC voltage for the 63 MHz IF circuits.

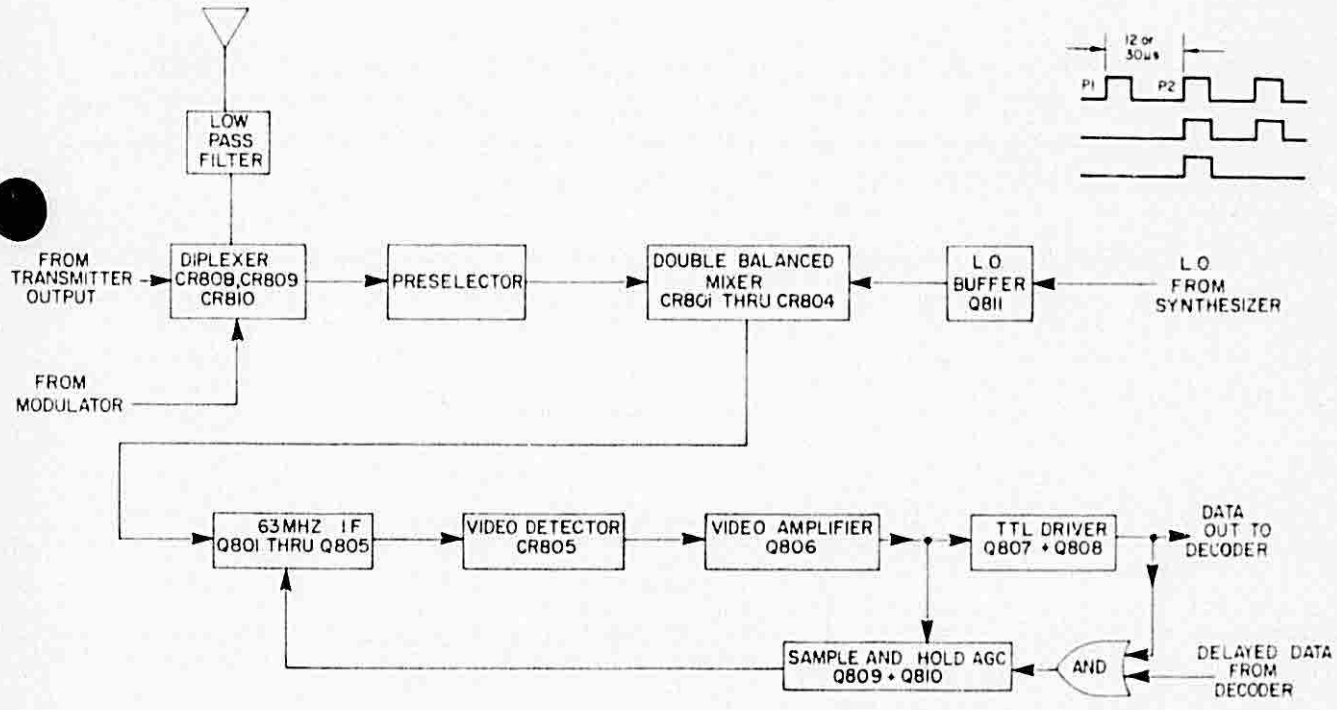


FIGURE 3-21. RF RECEIVER, BLOCK DIAGRAM

3.7.4.2 Low Pass Filter

RF energy above 1500 MHz is attenuated by a passive, seven element, low pass filter. The filter therefore attenuates harmonics from the DME transmitter as well as received RF above the DME frequency band.

3.7.4.3 Diplexer and Preselector

The Diplexer alternately connects the antenna, through the low pass filter, to the receiver or the transmitter as directed by the 33 volt modulator pedestal pulse. In the transmit mode the positive going pedestal pulse will forward bias PIN diodes CR809 and CR810. Diode CR810 connects the transmitter output, through C838, to the low pass filter while CR809 provides a short circuit resulting in over 20 db of isolation between transmitter and receiver.

While in the receive mode the negative going back swing of the pedestal pulse reverse biases CR809 and CR810. The preselector is then connected to the low pass filter and antenna.

The preselector is a bandpass filter, the purpose of which is to attenuate interfering signals lying outside the 978 - 1213 MHz tuning range of the receiver. It consists of five shorted, quarter wave, side coupled resonators; plus a hairpin loop and a sixth quarter wave resonator to provide input and output coupling respectively.

The rods are positioned and cemented in place to provide the best response. Alignment of the preselector should not be attempted without the necessary test equipment and test fixtures.

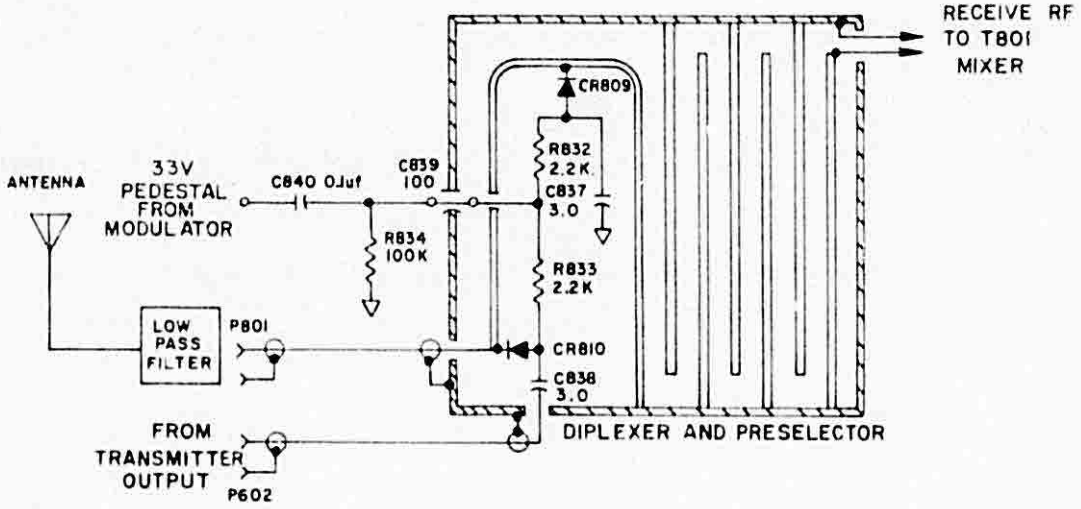


FIGURE 3-22. DIPLEXER AND PRESELECTOR

3.7.4.4 Balanced Mixer

The local oscillator (LO) injection, which is 1/3 the frequency of the transmitter, is coupled into buffer amplifier Q811 of the receiver through balun T803 as shown in Figure 3 Rec 3. The buffer output is coupled into the balanced mixer through balun T802 and the received signal from the preselector is coupled in through balun T801. Mixing occurs in diodes CR801 through CR804 where the two frequencies are heterodyned; the beat of the third harmonic of the synthesizer frequency with the received frequency provides a difference frequency of 63 MHz. Transformer coupling is used to couple the IF signal from the mixer. The leads of the mixer diodes are the transformer primary with toroid L801 the secondary. Capacitors C801 and C802 resonate L801 to 63 MHz and connect the 63 MHz signal into the IF Amplifiers.

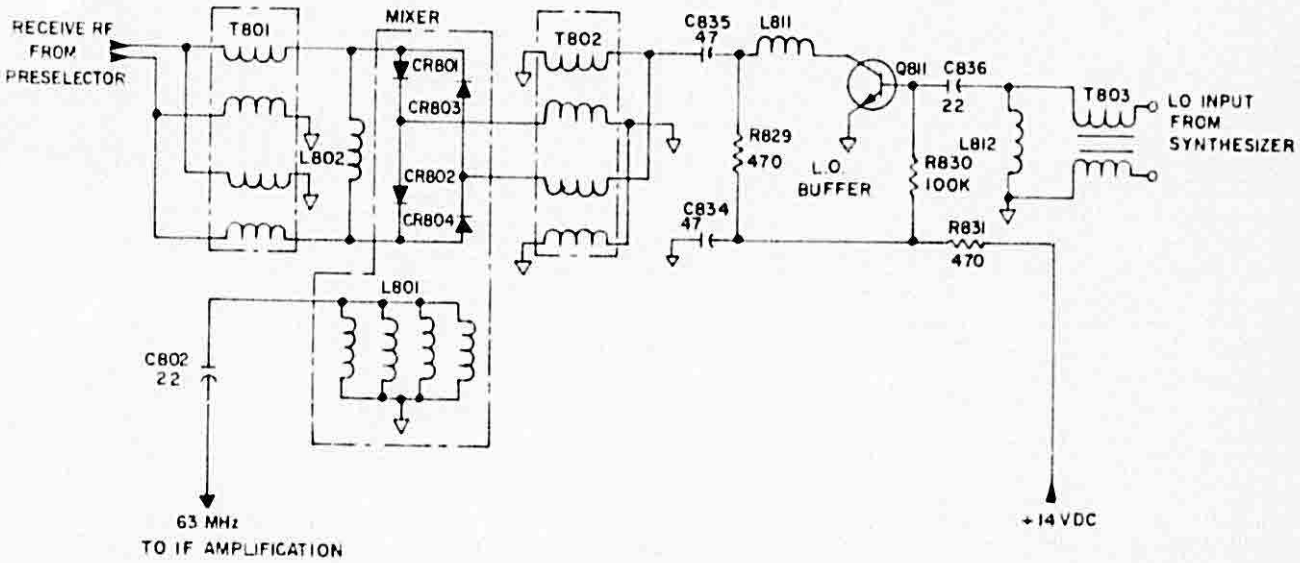


FIGURE 3-23. BALANCED MIXER

3.7.4.5 IF Amplifiers and Detector

The five stage, Q801 thru Q805, IF amplifier is tuned to 63 MHz by three double tuned interstage networks and a single tuned coil, L810. Capacitive coupling is used between each of the elements. Video detection is performed by diode CR805.

AGC voltage is applied to each of the IF transistors. These transistors are selected for dc beta with IF gain being proportional to the operating current.

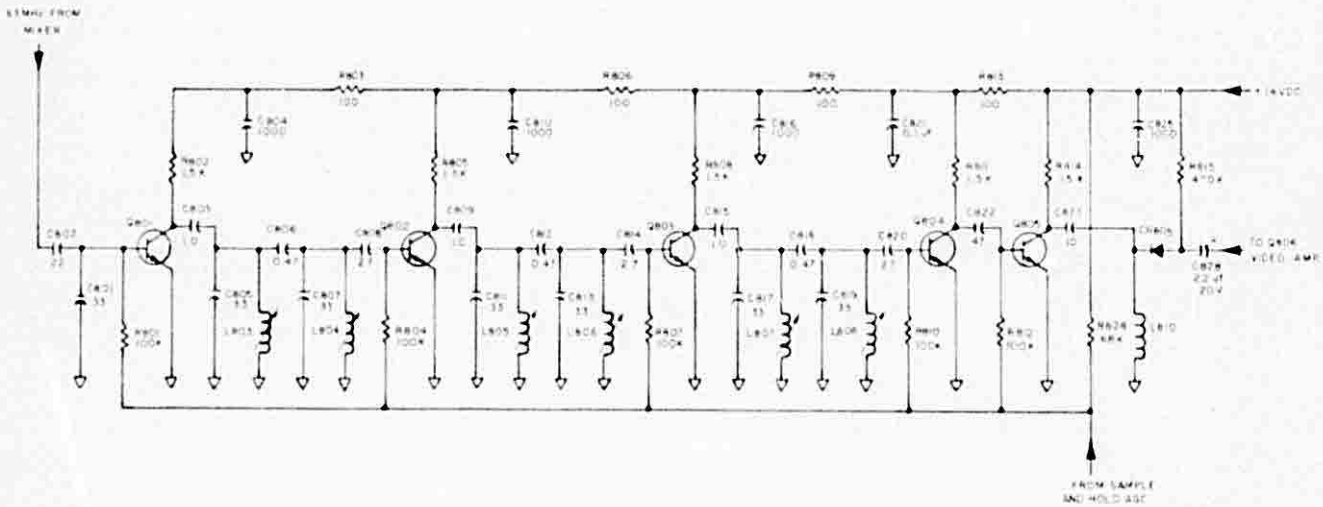


FIGURE 3-24. IF AMPLIFICATION AND DETECTION

SEE BLOW-UP

3.7.4.6 Video Amplifier and TTL Driver

The video amplifier, Q806, exhibits a gain of approximately 200 increasing the detected video pulse amplitude to about 1 volt peak to peak. When the output pulse from Q806 exceeds the base-emitter voltage of Q807, about 0.6 volt, the TTL Drivers (Q807 and Q808) will provide a gain of approximately 30. The output from the TTL Driver is a squared, positive going, volt peak to peak pulse.

Extra length pulses are shortened by C830 and R824. R824 also provides the current sink required by the decoders TTL circuits.

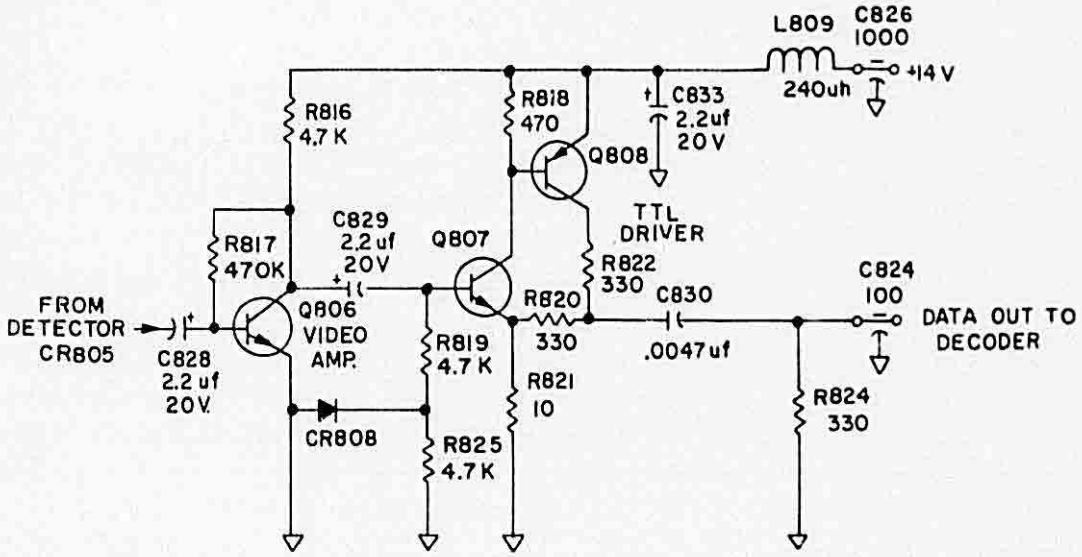


FIGURE 3-25. VIDEO AMPLIFIER AND TTL DRIVER

3.7.4.7 Sample and Hold AGC

The Sample and Hold AGC controls the IF gain to produce uniform amplitude pulses at the output of the video amplifier. In addition, only properly spaced pulses will enable AGC action.

Proper pulse spacing is determined by a diode AND gate consisting of CR806 and CR807. TTL driver output pulses are applied to CR806 and the Decoder. The Decoder will delay the TTL data for 12us on X channels or 30us on Y channels. Delayed data from the Decoder is applied to CR807. If properly spaced, the P2 pulse from the TTL Driver will occur coincident with the delayed P1 pulse from the Decoder causing Q809 to conduct. The video level of the video amplifiers P2 pulse is then sampled and stored on Q810 and C832. If the amplitude of the video pulse is higher than the desired value, established by the base emitter voltage of Q810, Q810 will conduct and pull down the AGC line to reduce the IF gain.

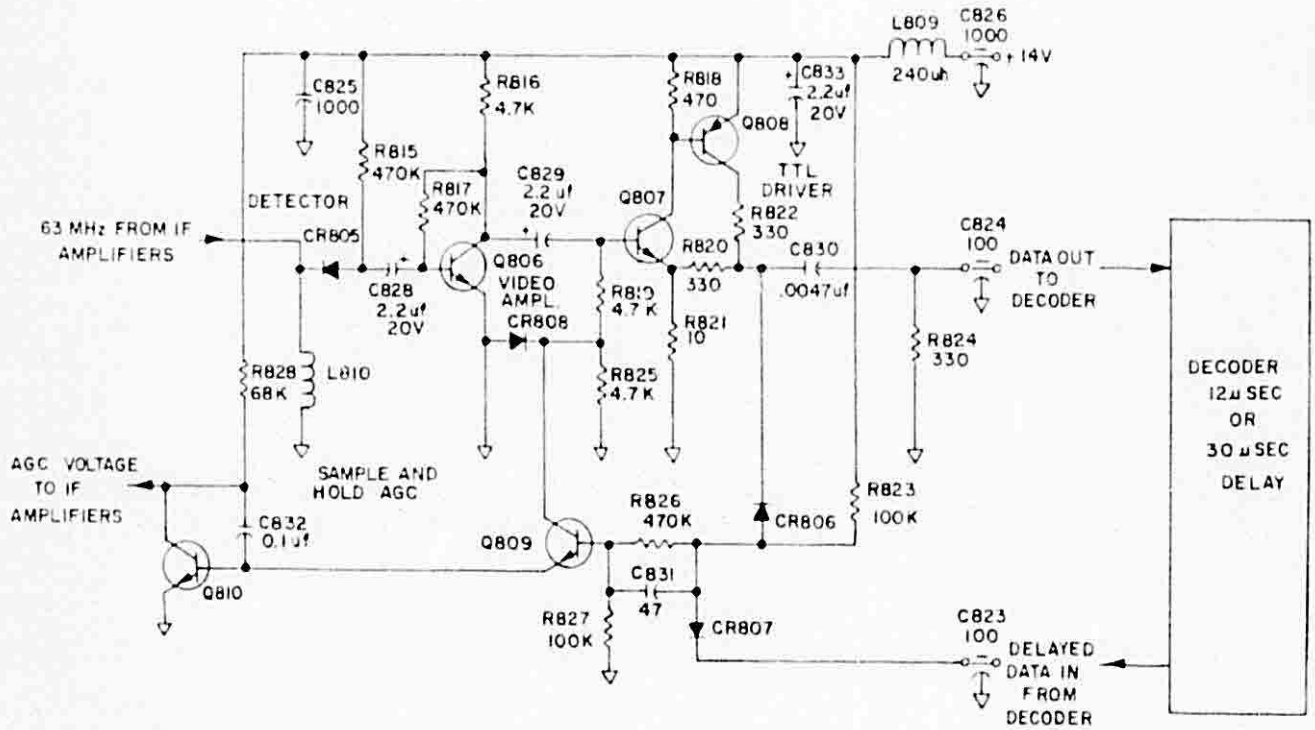


FIGURE 3-26. SAMPLE AND HOLD AGC

3.7.5 Decoder

3.7.5.1 General

The purpose of the Decoder is to examine received signals for proper pulse spacing (i.e. either 12 or 30 microseconds). Incorrectly spaced pulse pairs are rejected while correctly spaced pulse pairs are accepted and routed to the IDENT Generator, receiver pulse AGC and Synchronous Reply Filter. Random noise pulses and squitter will produce Decoder output pulses, however, since these pulses do not occur in synchronism with the DME's internal timing (PRF) they will be rejected by the Synchronous Reply Filter.

3.7.5.2 Theory

The Decoder comprises a delay line (shift register) and gates for recognition of X or Y mode of operation (zero or 50 KHz channel selection) as shown in Figure 3-27. The shift register functions as a digital delay line operating in a serial in/serial out mode with clock pulses shifting data at a 1.236 microsecond rate. Data from the TTL output of the receiver is applied to the shift register. If this data is high at the instant that the 1.236 microsecond clock goes low, it will be loaded into the following stage of the shift register.

This shift register is tapped at 10 bits and 25 bits. Since the shift register is clocked at a 1.236 microsecond rate, 10 bits represents a delay of 12.4 microseconds; 25 bits represents a delay of 30.8 microseconds. Pilot selection of "zero KHz" (X) enables the 10 bit tap from U305C; "50 KHz" (Y) selection enables the 25 bit output from U305D.

The shift register is contained in three packages as shown in Figure 3-27A. Data enters U315A, is delayed for 8 bits, and enters U324, where the 10 bit delay is tapped off at its second stage. After three additional delay stages within U324, data enters U315B (8 bit delay) and then enters U333; the output is then taken after four bits of delay. The output tap, taken from the fourth stage of U333, therefore has a total delay of 25 bits.

When the X or Y is selected, delayed data is AND'ed with the direct data in U305B; positive decoded data is present at its output. Input data in the form of single pulses (noise) or incorrect pulse spacing (Y or X is selected, etc.) do not pass the Decoder. In like fashion, U312B NANDs the delayed and direct data to produce negative-going decoded data.

Positive decoded data from U305B exits to the receiver's sample-and-hold AGC system; AGC action is applied to only properly spaced pulse pairs.

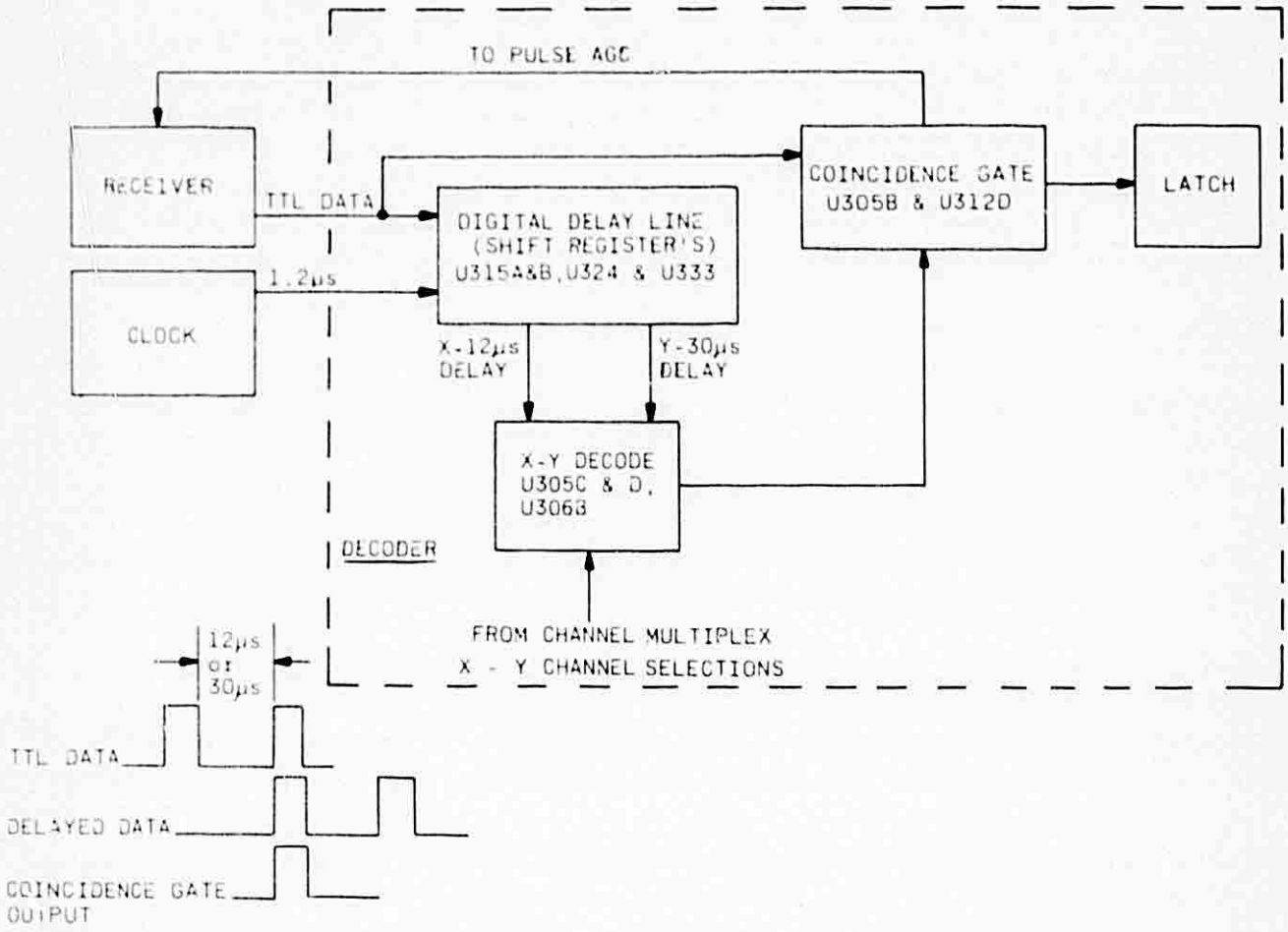


FIGURE 3-27. DECODER BLOCK DIAGRAM

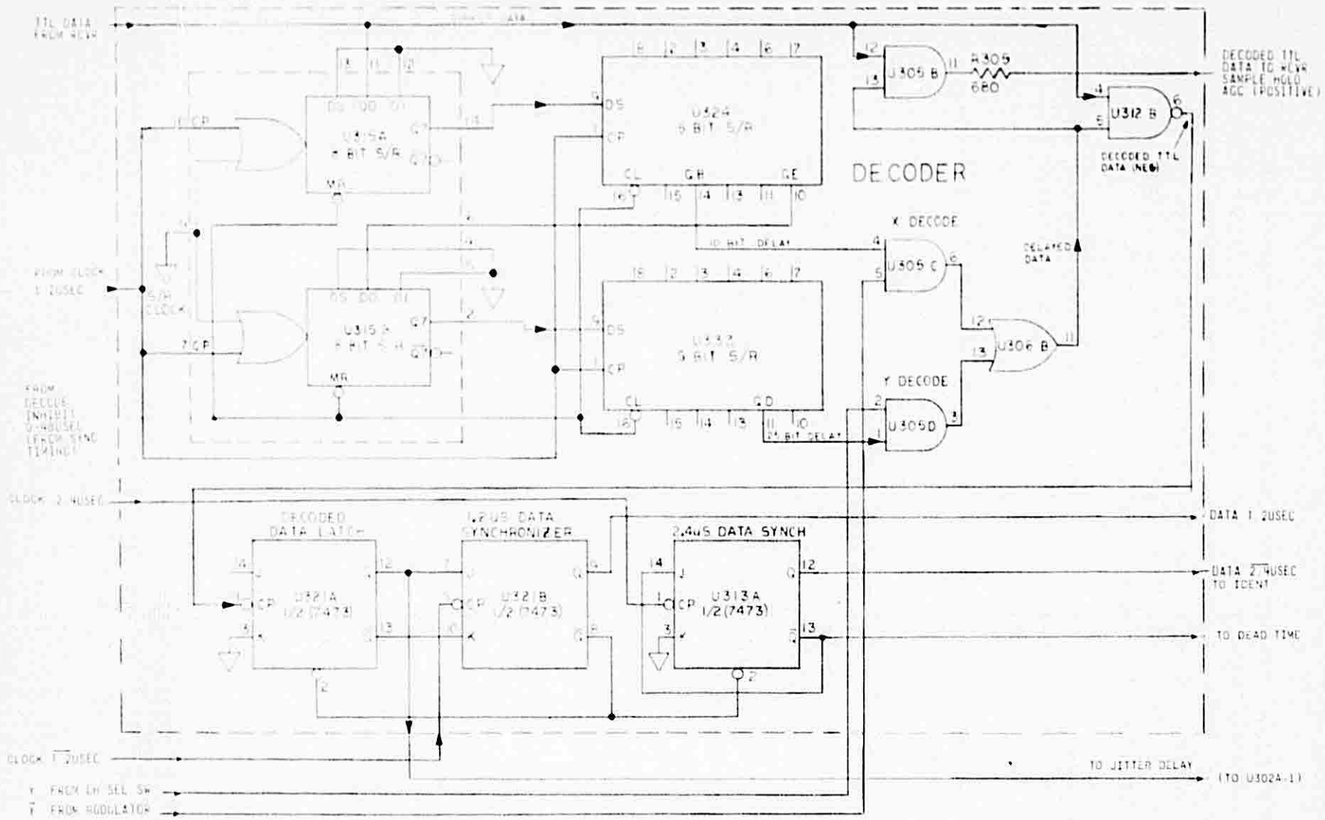


FIGURE 3-27A. DECODER, SCHEMATIC DIAGRAM

3.7.5.2 Continued

The negative-going decoded data from NAND gate U312B causes the U321A to latch or change its state on the negative going edge of the pulse. This in turn allows the next clock pulse to toggle JK U321B. Upon toggling, U321B resets JK U321A. At this point, U321B is high for only one clock period and represents information or data synchronized to the 1.236 microsecond clock. In a similar fashion, JK U313A uses this input information to create data that is two clock pulses wide, or 2.4 microseconds.

The 2.4 microsecond data output of JK U313A inputs the IDENT generator (U342) and the Dead Time/echo suppress gates (U330C) within the Synchronous Reply Filter, which "snorts" to 0.2 mile resolution.

The 1.2 microsecond data output of JK U321B is also applied to the Synchronous Reply Filter, and represents data of 0.1 mile resolution.

3.7.6 Synchronous Reply Filter

The Synchronous Reply Filter ensures that the pulse pairs received and processed occur in synchronism with the pulse pairs transmitted. Although pairs of pulses are transmitted, this circuit processes single pulses that are representative of correctly spaced pulse pairs. The Decoder, which is ahead of this circuit, examines the pulse pairs for proper spacing between P1 and P2 and eliminates P1 if the interval between pulses is correct. Therefore, the Synchronous Reply Filter checks for coincidence between P2 of the transmitted pulse pair and P2 of the next received pulse pair; if synchronism occurs within the internal timing, these pulses are selected. The Synchronous Reply Filter output is then the VDS1 strobe. Refer to Figures 3-28 and 3-29 for the block diagrams and Figure 3-30 for the schematic.

The Synchronous Reply Filter is composed of the following circuits:

1. Dead Time - purpose of which is to prevent the DME 195 from synchronizing to reflected replies.

2. Pass/Recirculate Logic - in the "pass" mode decoded data is entered into the Data Shift Register. The "recirculate" mode permits comparing of current or updated decoded data to that stored in the Data Shift Register.

   During high countdown situations the 3 State Counter (stuff) will reinsert stored data into the Data Shift Register. The effect is that of a short term memory providing a stable display.

3. Data Shift Register - stores data from the Pass/Recirculate Logic during the "pass" mode. In the "recirculate" mode the data is serially shifted out and compared to current data by the Logic.

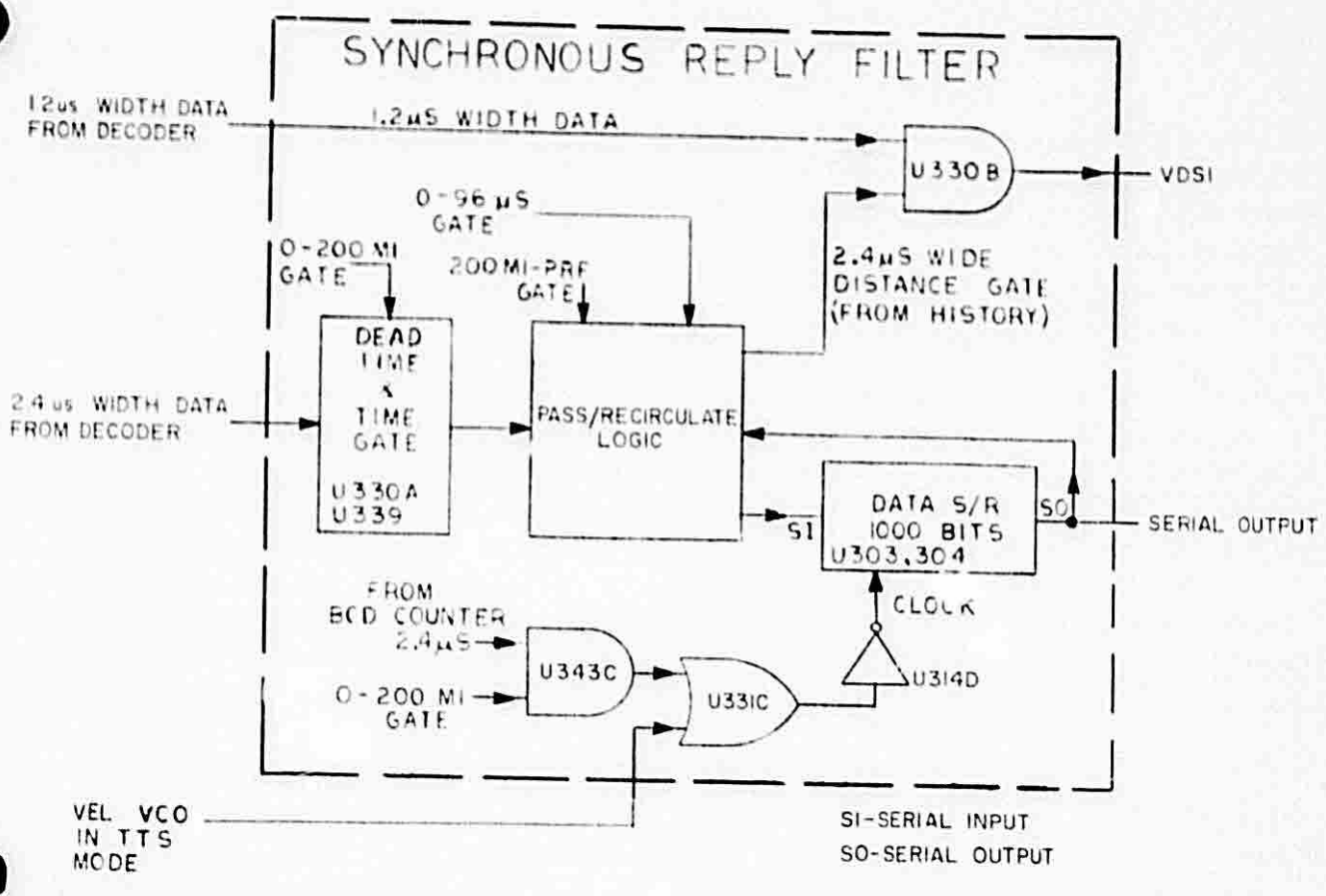


FIGURE 3-28. SYNCHRONOUS REPLY FILTER, BASIC BLOCK DIAGRAM

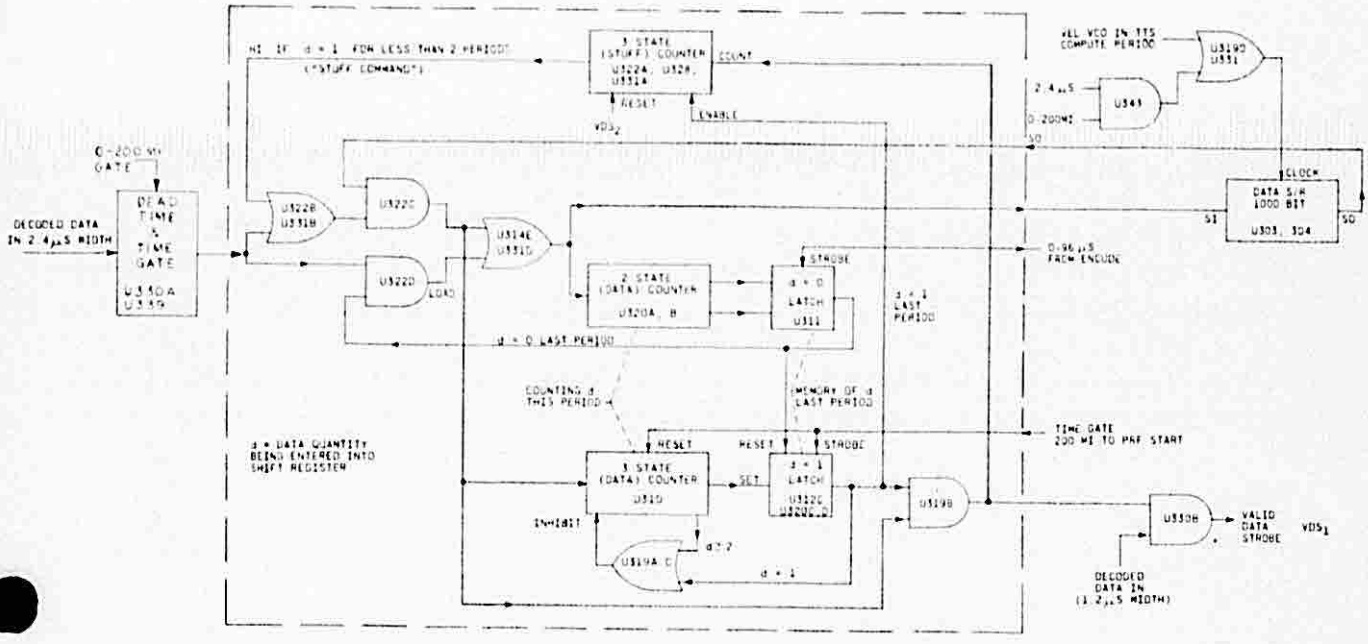


FIGURE 3-29. SYNCHRONOUS REPLY FILTER, DETAILED BLOCK DIAGRAM

SEE BLOW-UP

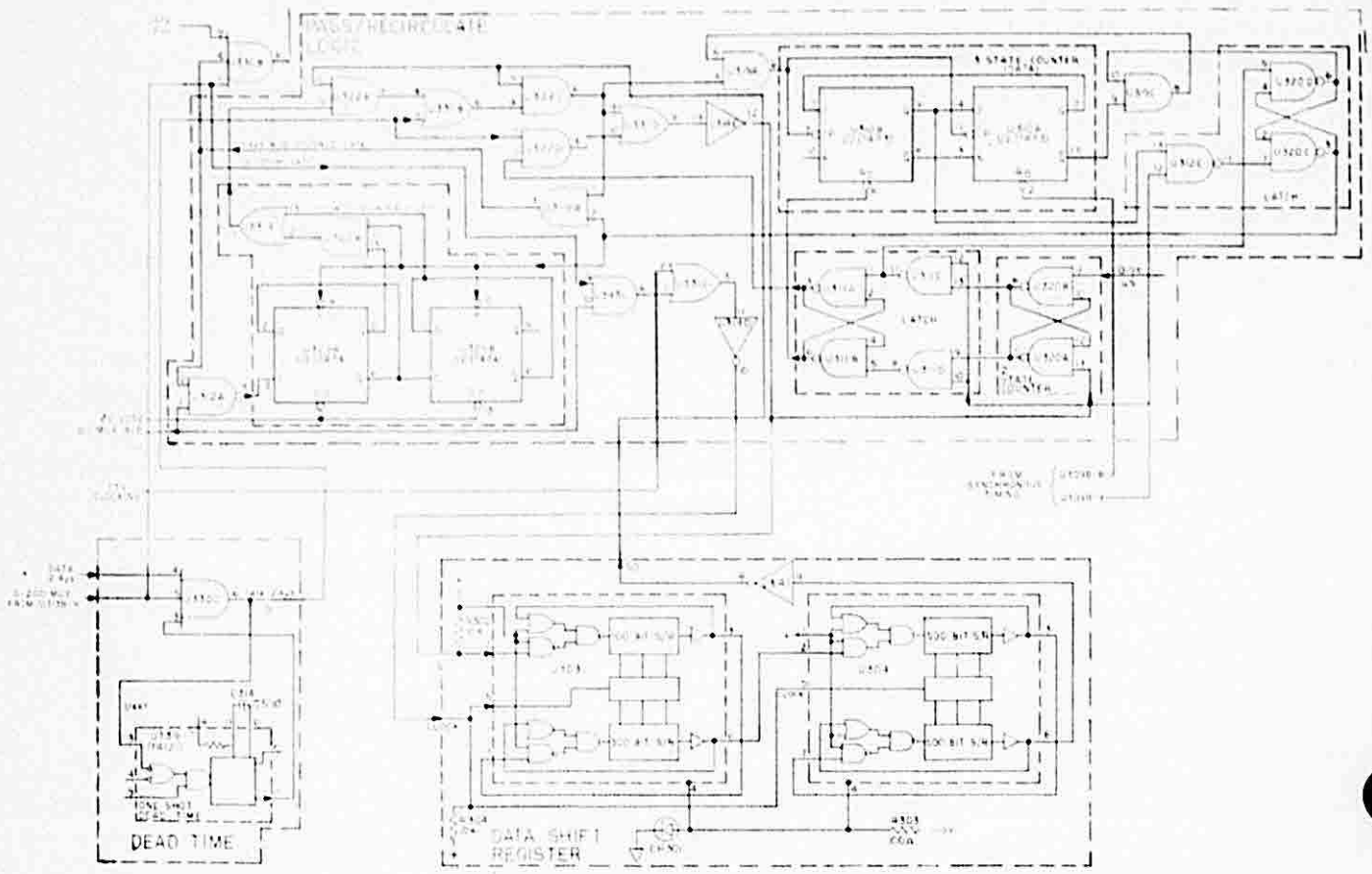


FIGURE 3-30. SYNCHRONOUS REPLY FILTER SCHEMATIC

SEE BLOW-UP

3.7.6 Synchronous Reply Filter, Continued

Because the Synchronous Reply Filter (SRF) looks for synchronous replies for only during the 0-200 mile gate, a large portion of the received replies are disregarded. The 0-200 mile gate is begun when the 0-96us encode pulse (from U302B in the Synchronous Timing Encode) goes low clocking flip-flop U313B (in the Synchronous Timing ÷2000-BCD Counter). U313B's output is then the 0-200 mile gate. This output enables AND gate U343B to permit clocking U335, of the ÷2000 Counter, by the $\overline{1.2us}$ clock.

The same 1.2us clock pulses serve to clock the Data Shift Register as follows: the Q_A output of the 0.1 mile counter (U335-12) is gated through AND gate U343C when the gate is enabled by the 0-200 mile gate at pin 9; the output from U343C-8 is connected to OR gate U331C and inverted by U314D; the clock pulses are then used to clock U303 and U304, the 1000 bit Data Shift Register. Since the Q_A output of U335 is the 1.2 microsecond clock divided by two, the output is a 2.4 microsecond clock. Therefore, 1000 2-4 microsecond clock pulses will occur during the 0-200 mile gate and the Data Shift Register will be clocked through its complete 1000 bits for each PRF period. Any decoded data appearing at the serial input (U303-2) will be stored at that bit position to a resolution of 0.2 mile.

The 0-200 mile gate pulse is also used as an enable to pin 5 of U330C, the three-input AND gate in the Dead Time circuit. The remaining two inputs are the 2.4 microsecond data pulse from the Decoder (U313A-13) at pin 4 and the $\overline{Q}$ output of the Dead Time one-shot (U339-1) at pin 3. The U330C output (pin 6) is the data source path for the Data Shift Register. Using the 0-200 mile gate as an enable, the only data used in the Synchronous Filter is data occurring during this interval. Since the 0-200 mile gate pulse is approximately 2.5 milliseconds out of approximately 33 milliseconds, 90% of the decoded data is filtered or removed.

The Dead Time one-shot, U339, serves to reduce the possibility of synchronizing the DME to a reflection path. U339 is toggled, at pin 3, by the negative-going edge of the data pulse from U330C-6; the $\overline{Q}$ output from pin 1 is connected to U330C-3, which inhibits passing another pulse for approximately 60 microseconds.

The data pulses from U330C-6 are connected to AND gate U322D-1 and OR gate U331B-5. These two gates constitute the Pass/Recirculate Logic inputs. If there are no data pulses in the Data Shift Register, the Latch (U311A, B, C, D) will be in the pass condition with U311A-3 at a logic "1" with the start of the 0-200 gate pulse. In this condition, U322D is enabled and all 2.4 microsecond data pulses occurring within the 0-200 gate period will be stored in the Data Shift Register. The path of these pulses is through AND gate U322D, OR gate U331D, and inverted by U314E for storage.

3.7.6 Synchronous Reply Filter, Continued

The U314F inverter output also provides the input to the 2-State Counter (U320A, B) for any pulses entered for storage during the 0-200 gate pulse. The 2-State Counter has a logic "1" at U320A-11 at the end of the 0-200 mile count, thereby enabling NAND gate U311D and inhibiting NAND gate U311C. The end-of-epic pulse (0-200) from FF U309B-9 (in Synchronous Timing BCD Counter circuit) will set the Pass/Recirculate Latch so that NAND gate U311B-6 output is a logic "1" and U311A-3 output a logic "0". This condition inhibits the pass gate (U322D) and no data pulses can enter the Data Shift Register; the logic "1" from U311B-6 enables the 3-State Counter (data) at FF U310B-6.

The 2-State Counter is reset by the $\overline{0\text{-}96}$ microsecond pulse at U320B-9 that occurs before the start of the 0-200 mile gate pulse. Therefore, if all pulses are removed from the Data Shift Register, the Latch would be put back in the pass condition for loading with all pulses received during the next 0-200 mile epic.

With the Pass/Recirculate Logic in the recirculate condition, during the 0-200 gate pulse, the path of the data pulses is through OR gate U331B to pin 4 of AND gate U322C; the other input to U322C is the Data Shift Register output (from inverter U314F). Therefore, in the recirculate condition, the only pulses reloaded in the Data Shift Register are those having coincidence with pulses that are already stored in the Shift Register. Using this technique, all non-coincident pulses are rejected.

With the 3-State Counter (data) enabled (U310A, B) it counts the number of pulses that are in the Data Shift Register during each epic. The clock input to the Counter is obtained from 2-input AND gate U319A; the input to pin 4 of U319A is from coincidence gate U322C and the pin 5 input is from Latch U319C-8. Let us assume that the Latch output (U319C-8) provides a logic "1" enable to U319A-5. Under these conditions, every coincident pulse will clock the 3-State Counter. The first pulse will cause U310B to change state and the Q output from pin 9 will be a logic "1"; U310A does not change state with this first pulse. If there are two coincident pulses, the second pulse will cause U310A to change state and the Q output from pin 12 is a logic "1"; the $\overline{Q}$ output from pin 13 is a logic "0". The logic "0" input to pin 9 of U319C causes this AND gate output to go to a logic "0". This inhibits the 3-State Counter from any further counting by inhibiting the clock path through U319A. The only information the logic requires is that there is more than one pulse in the Shift Register; the absolute number is unimportant. It should be noted that at the end of the two pulses, U310B is back to the same state: Q = logic "0". At the end of the 0-200 mile gate, U310A is reset and the Counter is enabled for the next period.

The preceding process is repeated until there is only one pulse in the Data Shift Register. This is noted by U310B being in the Q = logic "1" state at the end of the 0-200 mile epic. When this occurs, U312C-13 is enabled by the Q output of FF U310B and pin 12 enabled by the end-of-epic pulse from the Q output of FF U309B (in Synchronous Timing BCD Counter circuit). This coincidence causes NAND gate U312C-11 to go to a logic "0"; Latch U320C and D now go to the state where U320C-3 output is a logic "1" and U320D-6 output is a logic "0". The logic "0" from U320D inhibits the data pulses from clocking the 3-State Counter and the system is locked in this mode for the next PRF period.

3.7.6 Synchronous Reply Filter, Continued

The logic "1" output from the Latch (U320C-3) serves as an enable for two circuits: the 3-State (stuff) Counter, comprising U329A and B; and the one-and-only-one gate, AND gate U319B-2. If, a coincidence occurs during the next PRF period, the coincidence pulse from AND gate U322C-6 is passed through AND gate U319B and becomes an input to pin 11 of AND gate U330B. The other inputs to U330B are the 0-200 mile gate pulse (pin 10) and the 1.2 microsecond data pulse (pin 9). The output of this gate then becomes VDS1 to the resolution of 0.1 mile.

The stuff counters purpose is to enhance the system's ability to LOCK in a high countdown situation by providing an alternate path for restoring the pulse in the Data Shift Register. When enabled, the stuff counter, U329, allows reinsertion of the data pulse into the Data Shift Register. Reinsertion is through OR gate U331B-6 only if pin 4 is held at a logic "1" for 3 PRF periods after the first coincidence following enabling of the stuff counter; the logic "1" is the result of coincidence being present.

If a VDS2 is present during the three PRF periods, the stuff counter is reset to allow three more possibilities. If, at the end of the three PRF periods there is no coincidence (VDS2), the Counter will not reinsert and the system will revert to the pass mode.

3.7.7 Data Smooth

The Data Smooth section serves as distance validation logic in the reduction of jitter and elimination of erroneous locks. If three successive VDS2 strobes occur at the same 0.1 mile point (odd or even), a VDS3 strobe is generated.

The 0.1 and 0.2 mile counter outputs (U335QA and QB) constitute the inputs to the memory Latches U337A and U337B. The two Latches are alternately strobed through U344A and U344D by the output of the phase splitter (U343A, U344B, U344C). Refer to Figure 3-31 for the block diagram and Figure 3-32 for the schematic. The Latch outputs are fed to exclusive OR gates U338C, U338D, and AND gate U328A for comparison. If the two outputs are coincident for three consecutive VDS2 strobes (and every alternate one thereafter), the phase (ϕ) 2 VDS2 is enabled by the 2-State Counter U336A and becomes VDS3. The VDS3 output strobes the distance Shift Register Latches, velocity tenth mile distance Latches, bar circuit, and the TTS sequencer logic. Due to the number of loads driven by this VDS3 strobe, two parallel gates (U328B, C) provide the drive.

If the memory Latch outputs are not the same, the comparator outputs (ANDed in U328A) are used to reset the 2-State Counter at U336A-2. The purpose of the phase splitter is to obtain two 400 microsecond pulses; the first strobes the memory and the second is the VDS3 pulse. Using this technique, comparison and strobing can be accomplished by the same VDS2 pulse.

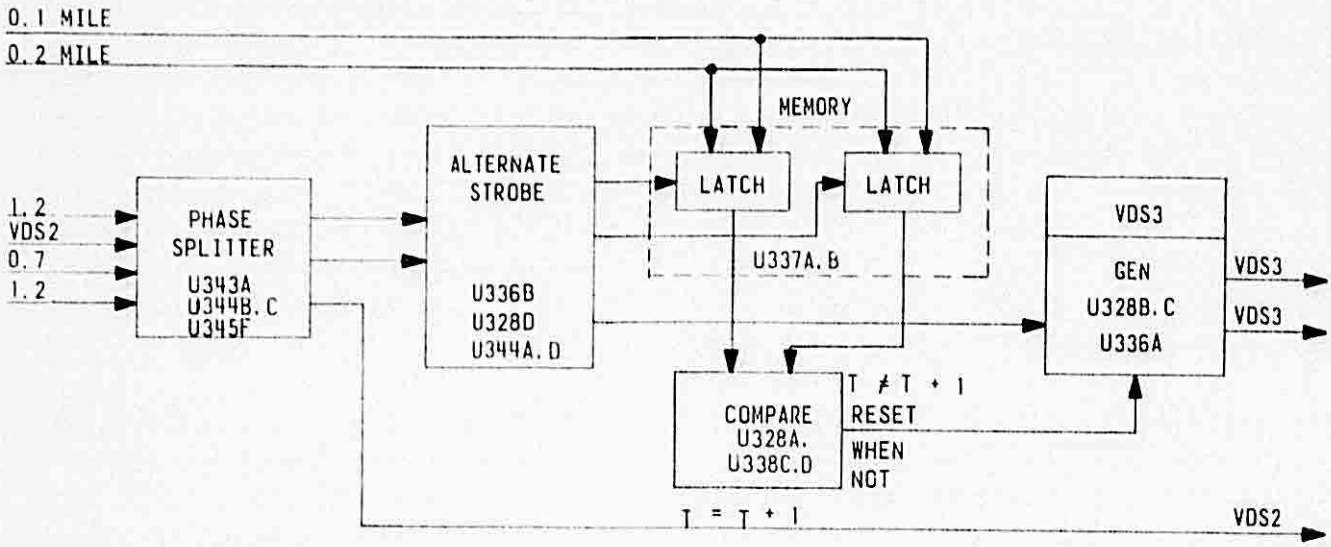


FIGURE 3-31. DATA SMOOTH, BLOCK DIAGRAM

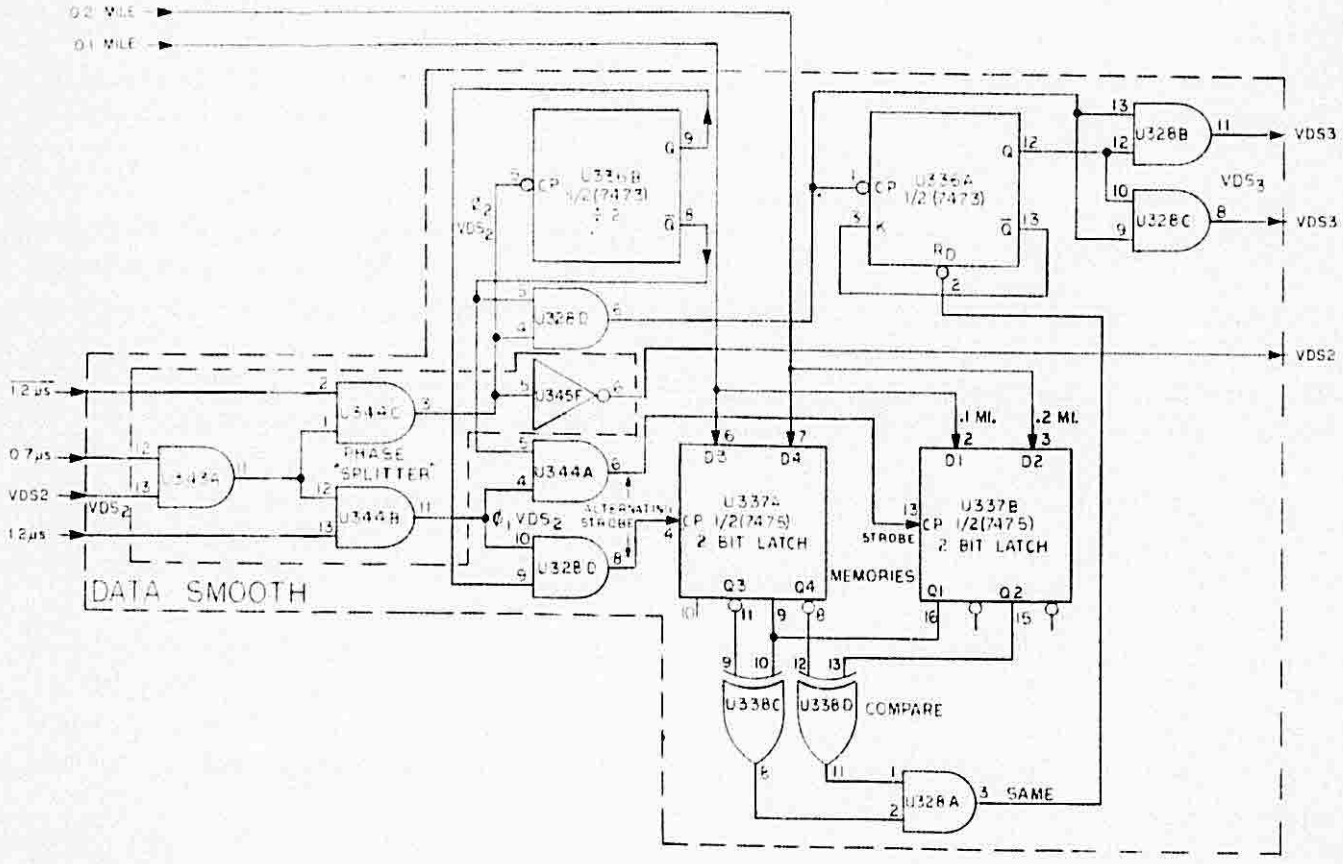


FIGURE 3-32. DATA SMOOTH, SCHEMATIC DIAGRAM

SEE BLOW-UP

3.7.8 Synchronous Timing ÷2000 Counter (0-200 MI)

The Synchronous Timing ÷ 2000 Counter is the chain which starts after the transmitter has emitted to the ground station; refer to Figure 3-33. The negative going edge of the 0-96 microsecond pulse into FF 313B provides a logic "1" from the Q output that enables AND gate U343B (pin 4). Since this gate is enabled, 1.2 microsecond clock pulses are gated into the U335-14, the first decade of the ÷ 2000 Counter. The Counter comprises three decades (U335, U327, U318) for the one-tenth units, units, and ten units, and a single flip-flop (U309A) for the hundred miles. The basic Counter has a full count capability of 2000; at the end of this period the Counter output from U309A toggles FF U309B to reset U313B and stop the count.

Each of the three decades has four BCD output lines to provide parallel inputs to the Distance Shift Register; the fourth digit is hand wired to the display through FF 308B and NAND gate U312D. The sequence is as follows: (a) the count starts when the 0-96 microsecond pulse goes low; (b) Counter is clocked by 1.2 microsecond clock pulses until VDS3 is received; (c) VDS3, if present, will Latch the instantaneous condition of the ÷ 2000 Counter into the Distance Shift Register, loading in parallel form (see subsection 3.3.1 for explanation of overall distance operation); (d) the ÷2000 Counter continues uninterrupted until it reaches 2000 and shuts itself OFF. The Q output of U309B tells the Pass/Recirculate Logic that the ÷ 2000 period is completed; (e) the next positive going PRF pulse from U305A resets the Q outputs of U335, U327, U318, and U309 to a logic low.

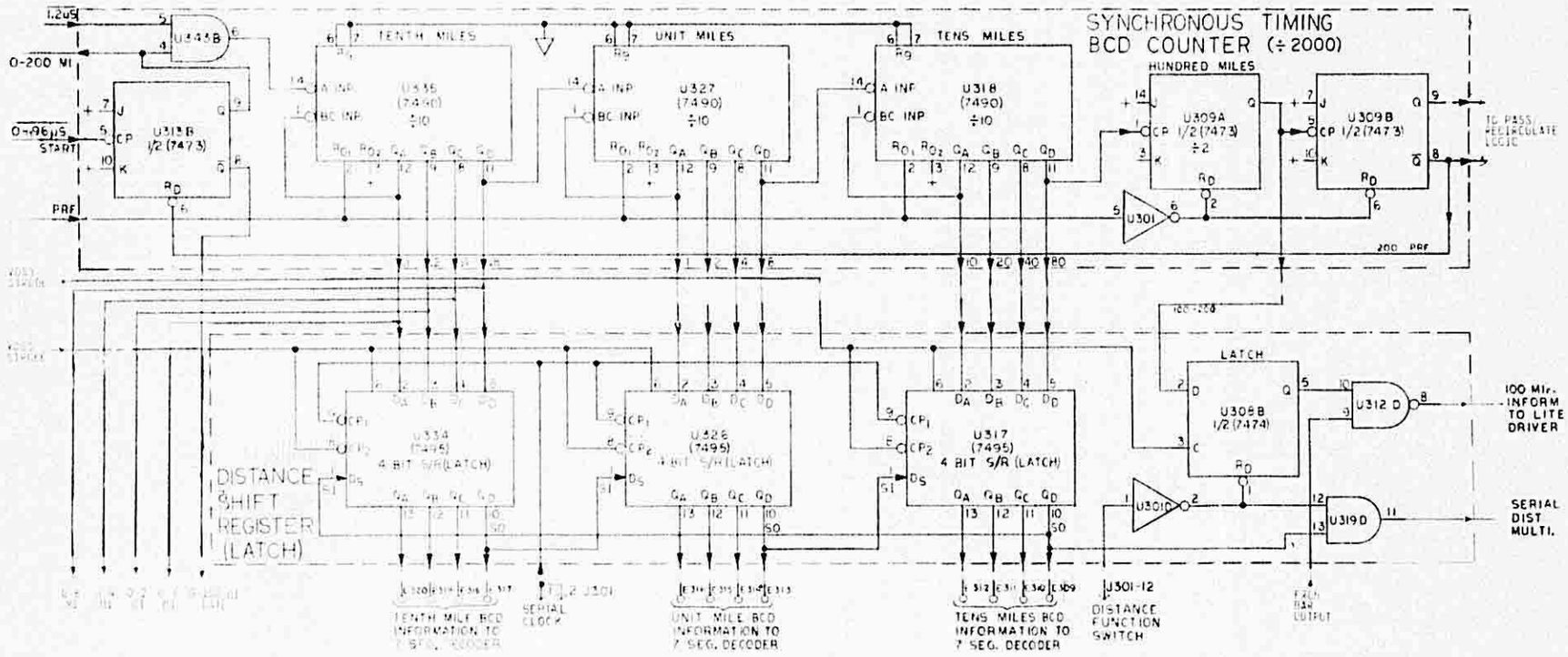


FIGURE 3-33. 0-200 MILE COUNTER AND DISTANCE SHIFT REGISTER

SEE BLOW-UP

3.7.9 Indicator

3.7.9.1 General

A simultaneous display of distance, velocity and time-to-station is provided by the indicator. In addition the indicator's N1-N2-HLD switch selects the DME channeling source or places the channel Multiplex and Synthesizer circuits in a HOLD condition. The HOLD function allows the DME to continue operating on a selected channel while the Nav receivers are set to new channels.

Illumination of all nine, incandescent, seven segment, numerical displays are activated by a PUSH TEST function. Eight of the displays will indicate "8", to check all segments, while the hundreds digit of the distance display will indicate "1"; since "1" is the maximum count for this digit. To indicate an invalid display, such as loss of receive signal or insufficient data for an accurate display, a lighted bar will show in the tenths, units, and tens distance displays. The distance hundreds digit plus the velocity and time-to-station displays will remain blank. If only the time-to-station display shows blank it is likely that the 89 minute capability of the DME 195 has been exceeded.

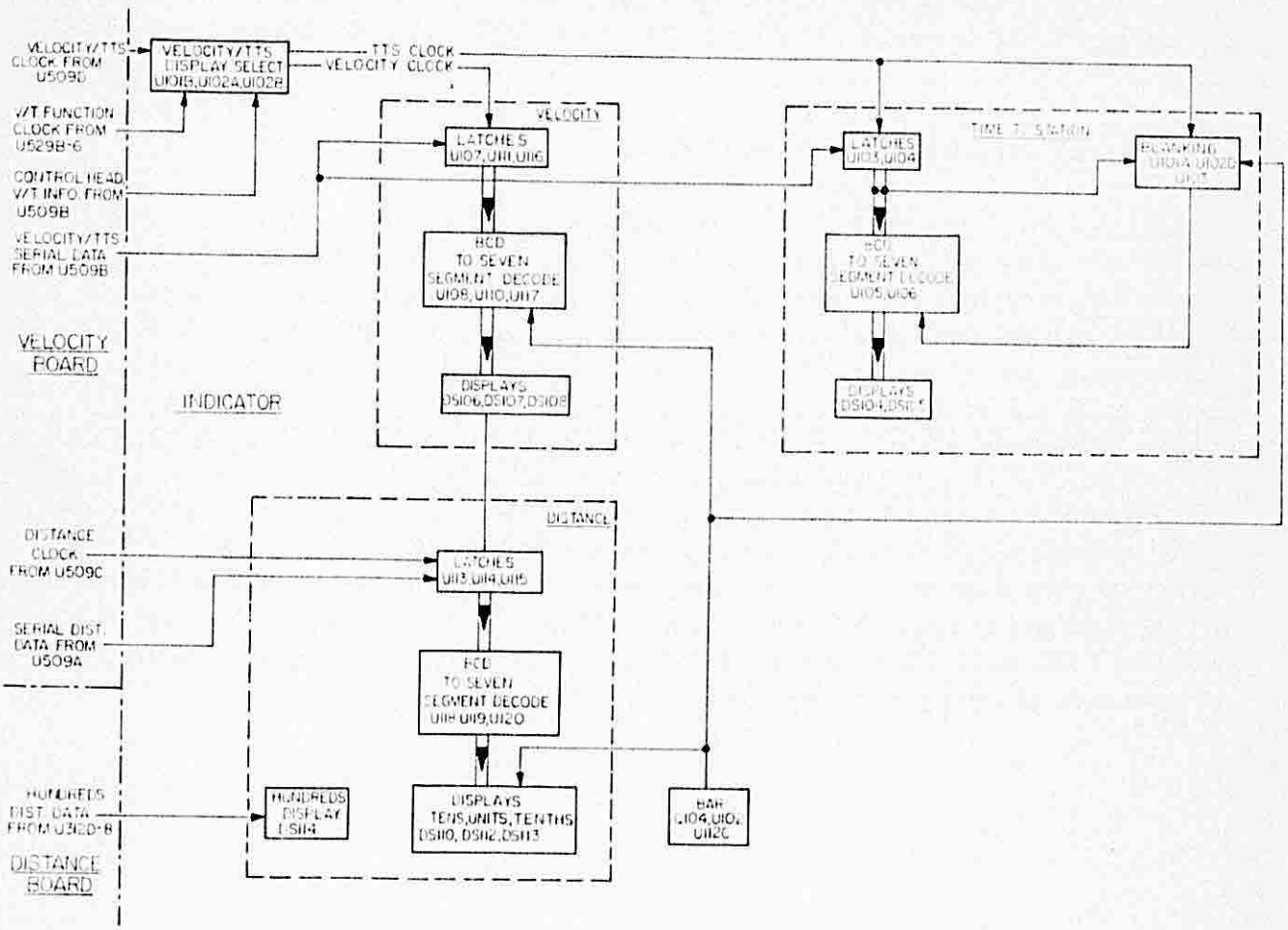


FIGURE 3-34. INDICATOR, DISPLAY BLOCK DIAGRAM

SEE BLOW-UP

3.7.9.2 Display Circuits

(Refer to Figure 3-34)

A. Distance Mode

In this mode the "distance serial" portion of the Serial Multiplex directs clock pulses to serially remove the BCD distance data stored in the Distance Shift Register (÷ 2000 Counter). Routed through buffer U509A, located on the velocity board, the distance data is clocked into the Indicator's distance latches then to BCD-to-Seven Segment Decoders to drive the displays.

Distance circuitry determines the aircraft's distance from the VORTAC being interrogated and stores this information, in BCD format, in the Distance Shift Register. Thirteen bits of data are required from the Register for a display of distance. Twelve data bits (units, ones, and tens) are serially removed from U334, U326, and U317 by a twelve pulse serial clock as directed by the Serial Multiplex. This serial clock, thru buffer U509C, also clocks the Indicator's distance Latches (U113, U114, and U115) to enter these twelve bits of BCD data. BCD to Seven Segment Decoders U118, U119, and U120 then drive displays DS110, DS112, and D113. The thirteenth bit is the hundreds data and is handwired from U312D-8 to U112C, to directly drive the hundred mile display, DS114.

B. Velocity and Time-To-Station Modes

In these modes the velocity or time-to-station BCD data stored in the V/T Shift Register is serially removed by the twelve pulse clock as directed by the Serial Multiplex. Routed through gates U520A and U509B the data is applied simultaneously to the velocity Latches (U107, U111 and U116) and time-to-station Latches (U103 and U104). Whether the data entered into the velocity or TTS Latches is determined by the VEL/TTS display select. The display select is clocked by the "V/T serial" portion of the Serial Multiplex. Timer U533, "T compact time", provides the data input logic to the display select. A logic "1" from U533-3 to U101B-12 enables gate U102A, allowing the "V/T clock" to clock the velocity Latches and enter the serial data. Decoders U108, U110 and U117 provide the BCD to Seven Segment conversion for displays DS106, DS107 and DS108. A time-to-station period is indicated by a logic "0" from U533-3. When clocked by U529B-5 the $\overline{Q}$ output of U101B becomes a logic "1" enabling gate U102B. V/T clock pulses will now clock TTS Latches U103 and U104 to enter the TTS data. U105 and U106 connect the BCD data to Seven Segment format for displays DS104 and DS105.

3.7.9.2 Display Circuits, Continued

C. Display Bar, MPX Blanking, and Push Test

Each of these functions may be reduced to the need to apply a logic "0" to the BI/RBO or LT terminals of the BCD to Seven Segment Decoders. A logic "0" at an LT terminal, generated by closing PUSH TEST switch S103, forces Decoder outputs a thru g low illuminating all display segments. DS114, the distance hundreds display, indicates "1" since CR105 effectively grounds only pins 8 and 5.

A logic "0" applied to a Decoders BI/RBO terminal, whether caused by the MPX Blanking going low or the BAR going low or by the RNAV indicator line going low, forces the Decoders a thru g outputs to a logic high extinguishing the displays. Distance displays DS110, DS112 and DS113 however will show a lighted bar due to buffers U112D, E and F applying the logic "0", at the BI/RBO inputs, to pin 6 of each of these displays.

D. Excessive TTS Bar

Exceeding the 89 minute capability of the TTS circuits is indicated by U104-10 going high. When clocked by the V/T clock U101A's $\overline{Q}$ output goes low, saturating Q103. Since the collector of Q103 is low the output of AND gate U102D goes low barring displays DS104 and DS105.

3.7.10 BAR Function

The BAR circuits monitor operation of the DME and prevent the display of invalid numerical data. Bar circuits are located on the Distance, Velocity, Channel Multiplex, Synthesizer, and Indicator Assemblies.

A Bar'd display is observed as the extinguishing of the velocity and time-to-station displays with the distance displays showing only an illuminated horizontal bar. Note, however, that the distance display's hundreds digit will not bar.

The following conditions will cause a bar display:

A. a channel change
B. loss of receive data
C. Failure within the DME distance data
D. turning ON the DME

To permit the simultaneous display of distance, velocity, and time-to-station, the inputs to the function change circuit (U503C + U541C) are hard wired to ground. Therefore the output logic from these gates remains at a logic 1 and does not change as the DME performs in the three modes. The logic 1 from U541C-8 to U528B's clear (R_D) input holds AND gate U540A-2 at a logic 1. A positive going VDS3 pulse will pass through U540A, be inverted by U314C, discharging C309 through programmable unijunction transistor (PUT) Q302. As long as VDS3 pulses are present the timer output will remain high. If VDS3 pulses are lost for between 8 and 12 seconds, the period determined by R309 and C309, the timer output at pin 3 will go low to bar the displays. The timer output also disables NAND gate U312D to blank the distance displays hundreds digit.

When power is first applied to the DME, a network consisting of R321 and C317 produces a momentary logic low at pin 3 of AND gate U323B. This logic forces the timer to bar the display for at least 8 to 12 seconds or until a VDS3 pulse arrives. When a channel change is made a positive going pulse is generated at U201-15 on the channel multiplex board. The pulse is shaped by synthesizer component C701 for MHz/KHz changes or R706, C702, and CR701 for 50 KHz changes and applied to the base of Q303. Turned OFF by the positive going pulse Q303's collector voltage appears as a logic 0 at pin 4 of U323B which resets the timer to bar the display.

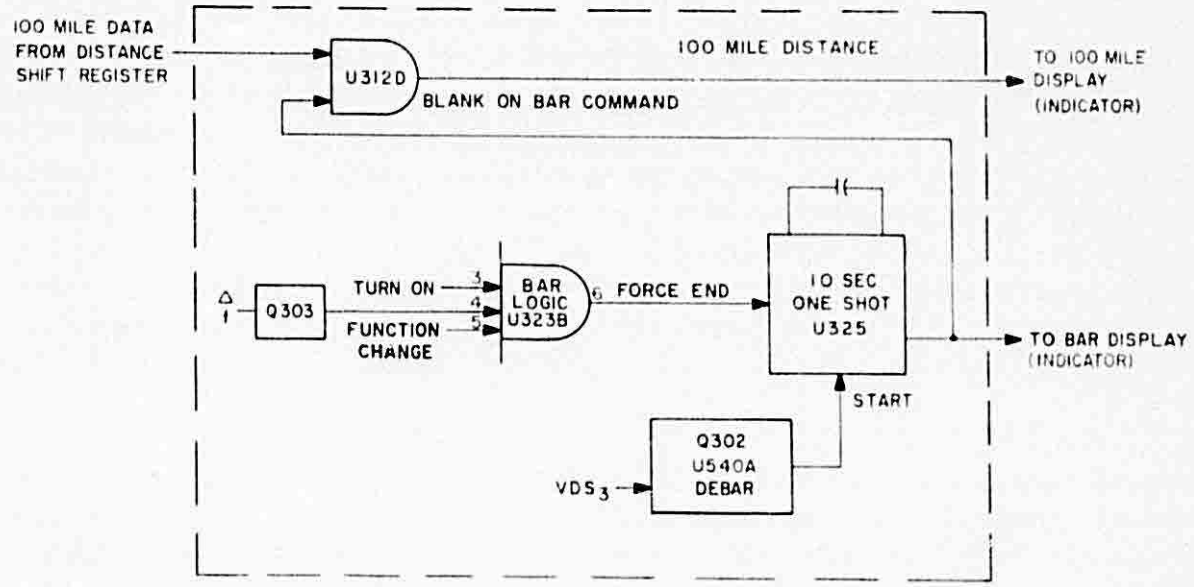


FIGURE 3-35. BAR FUNCTION, BLOCK DIAGRAM

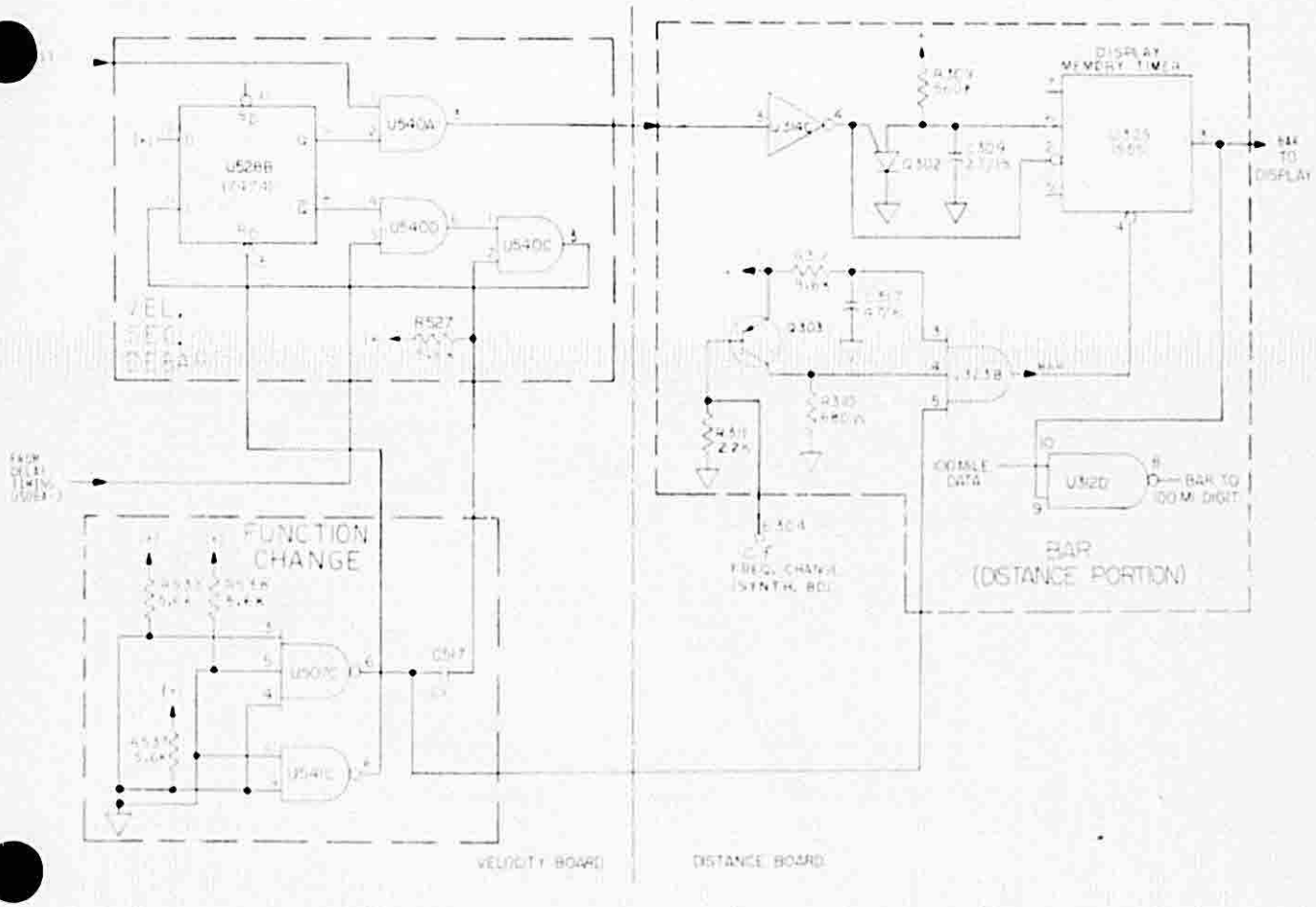


FIGURE 3-36. BAR FUNCTION, SCHEMATIC

SEE BLOW-UP

3.7.11 IDENT Generator

The Ident generator is toggled by the signal obtained from the Decoder output; this can be noise, squitter or Ident. The Ident signal is a morse code identification of the ground station at approximately 1350 Hz; actually, a REGULAR PRF of 2700 Hz (1350 double pulses). When not transmitting Ident, the ground station transmits squitter, a RANDOM PRF of approximately 2700 Hz.

The Ident generator (U342) is a timer, operating as a one-shot multivibrator as shown in Figure 3-37. When the timer is triggered at a regular rate, the output is approximately a 50-50 duty cycle 1350 Hz square wave, as determined by the time constant of R313 and C318.

The trigger input from U313A is negative decoded data comprising 2700 squitter pulses per second. Since the pulses are random, the IDENT output sound is similar to noise. However, when IDENT is being transmitted, the sound of the 1350 PPS tone resembles the output of a tone generator. The tone quality of this output from pin 3 is further improved by a low pass filter comprising R317 and C323. The signal is then AC coupled to the Ident control through C322. The ident control is connected to the Ident output from the DME.

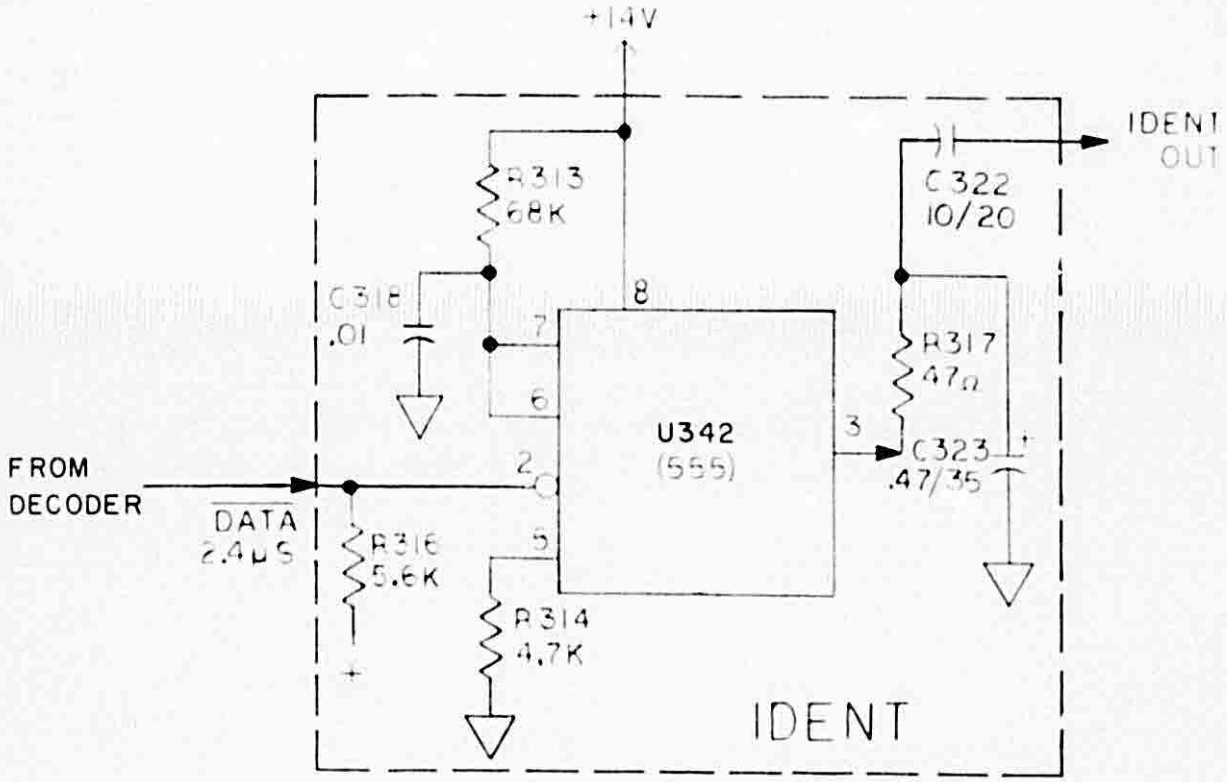


FIGURE 3-37. IDENT GENERATOR, SCHEMATIC DIAGRAM

3.7.12 Clock Generator

The Clock Generator provides timing pulses to all synchronous circuits of the DME. The Clock Generator comprises a crystal controlled 5.667 MHz oscillator driving two separate chains of digital frequency Counters as shown in Figure 3-38. One path has a constant division of the 5.667 MHz (1765 nanoseconds) by a factor of 7 for 0.1 mile clock pulses and an additional $\div 2$ for 2.4 microsecond clock pulses: the circuit is enabled at the start of each epic. The other path has a $\div 17$ for 3 microsecond clock pulses, followed by a series of five $\div 2$ binaries to produce 6, 12, 24, 48 and 96 microsecond pulses from the Clock Generator. These basic clock pulses are then routed to the appropriate circuits as required.

In the following description, frequencies are noted; however, the pulse periods ($\text{usecs} = \frac{1}{f_{\text{MHz}}}$) are given on the basis of the interval between pulses (i.e. frequency of 1 MHz = 1-microsecond period for leading edge to leading edge of adjacent pulses). The pulse period is much easier to read and check from the calibrated time base of an oscilloscope. All numbers used have been rounded off to three decimal places. Refer to Figure 3-39 for schematic.

The crystal oscillator comprises three inverters within U301. The first stage (U301A) utilizes R301 to set the operating range in its linear region. The second stage (U301B) serves as in inverter; its output, through crystal Y301 and capacitor C301 provides the positive feedback necessary to sustain oscillation at the crystal frequency. The third inverter (U301C) shapes the crystal output into logic levels to drive the two divider chains.

The $\div 14$ divider chain comprises a basic $\div 16$ frequency divider (U346) and various gates for reset to a $\div 14$ Counter and recognition of other ratios of division. The Counter outputs (Q0, Q1, Q2, Q3) are connected to U330A and U345A for reset. This basic $\div 16$ Counter is changed to a $\div 14$ Counter in the following sequence: following preset to one, the Counter advances from one to 14 (first stage low and last 3 stages high); the reset gate U330A is enabled and the level inverted by U345A to preset enable the Counter. The next count causes them to be preset to state one, producing a net of 14 counts for each operation of the gate. Appropriate taps on the $\div 14$ Counter provide the 1.2 and 2.4 microsecond clocks used in the distance logic.

3.7.12 Clock Generator, Continued

This clock chain is reset at the start of each PRF Generator cycle, by U302A, to reduce clock jitter from one interrogation to the next.

The use of exclusive OR U338A provides a relatively unsymmetrical square wave from the Counter whose average period varies between 0.4 and 0.7 microseconds. This is used for time shifting pulses in the Data Smoothing circuit.

The second divider chain comprises a ÷ 17 and four ÷ 2 frequency dividers. The ÷ 17 frequency divider includes flip-flops in U340A, U332B, and gate U323A. The 176 nanosecond pulses from the crystal oscillator clocks the first flip-flop (U340A); U340B is also clocked, but this JK flip-flop will not toggle until the clear input is reset by gate U323A. This ÷2 output (U340A) in turn feeds a three stage divider (U332B), which has a normal count capability of 8. The combined count of U340A and U332B would normally be ÷ 16. When U332B's last 3 stages are high, gate U323A is enabled and permits U340B to be toggled. This in turn inhibits the ÷ 2, U304A, and it does not operate for one count, referred to as pulse swallowing. The Counter output is one pulse for 17 pulses from the crystal oscillator and represents a 3 microsecond period. This 3 microsecond clock is applied to the ÷ 2 Counter of U332A producing a symmetrical 6 microsecond clock. The 6 microsecond clock is applied to U347, the ÷ 16 Counter with taps between stages to provide 12, 24, 48 and 96 microseconds respectively.

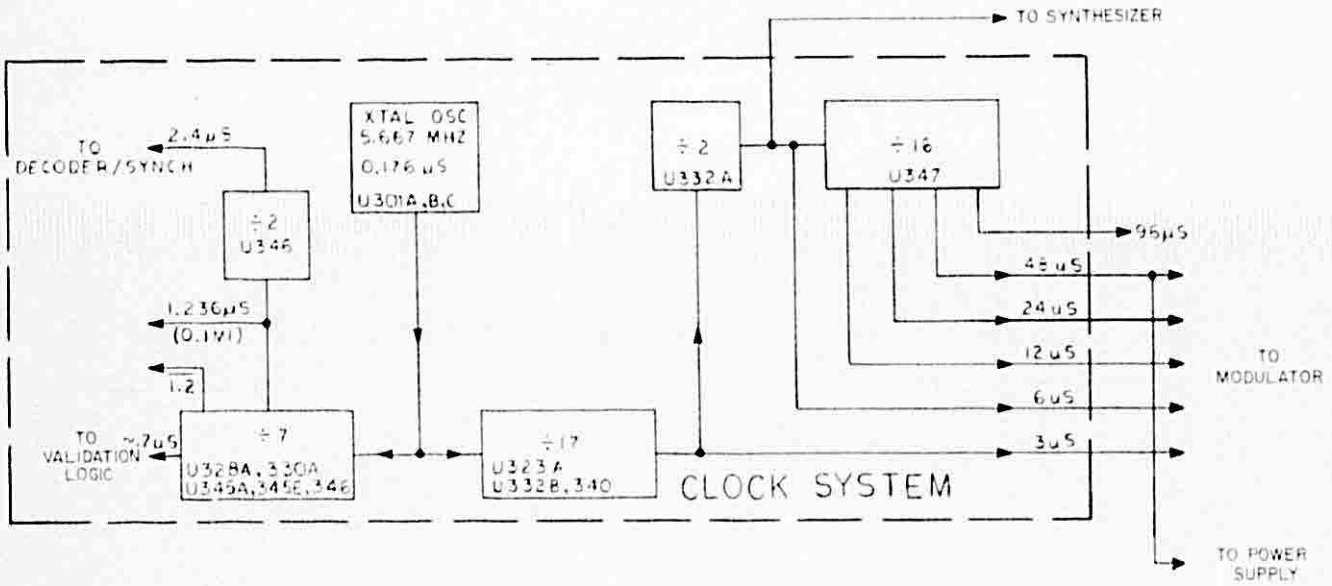


FIGURE 3-38. CLOCK GENERATOR, BLOCK DIAGRAM

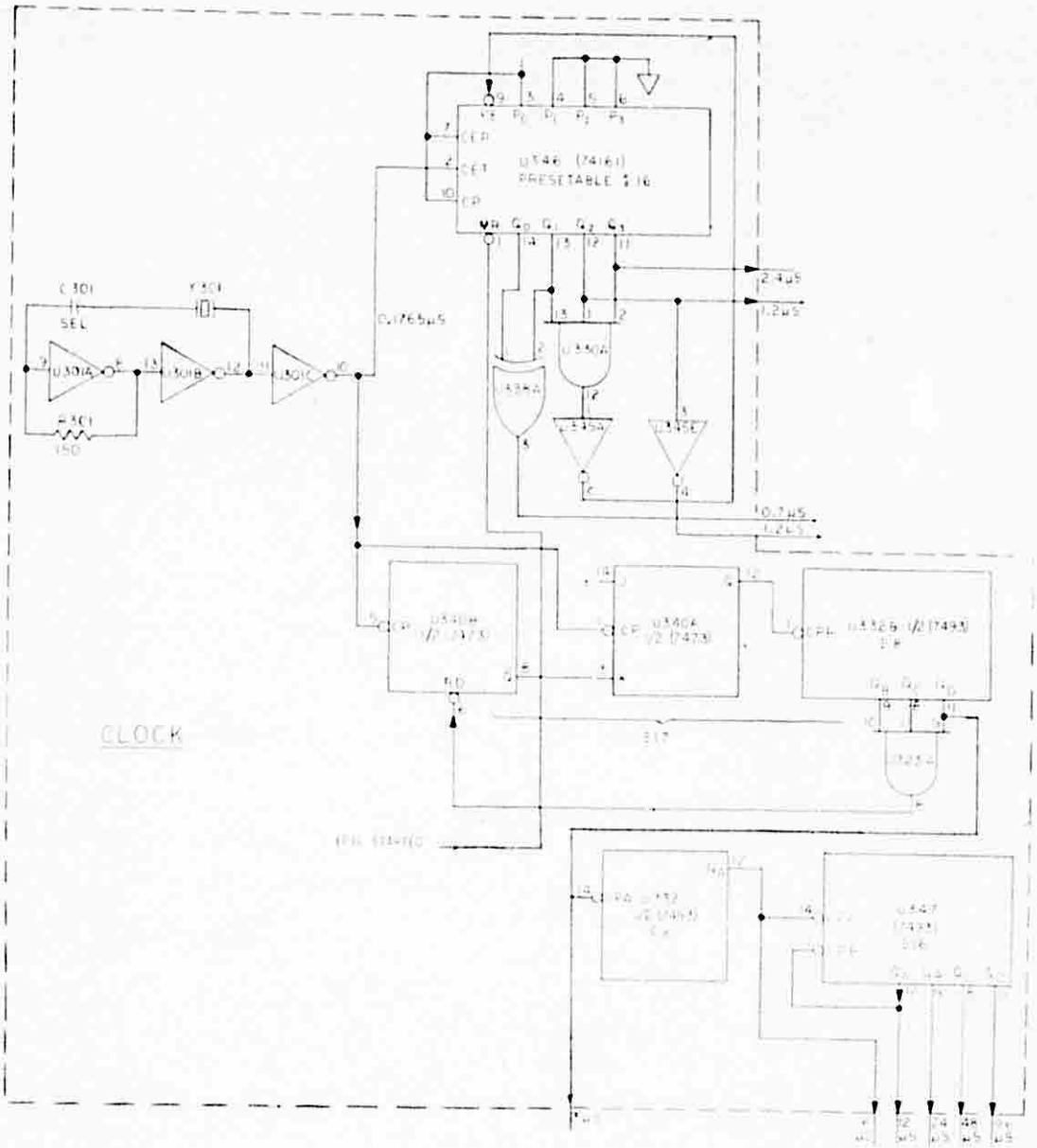


FIGURE 3-39. CLOCK GENERATOR, SCHEMATIC

SEE BLOW-UP

3.7.13 Channel Multiplex

3.7.13.1 Receiver Selection

The DME 195 may be channeled from either of two separate sources, usually Navigation Receivers. In addition a HOLD mode is provided to store the channeling data in use while allowing the Nav Receiver to be set to the next frequency.

Figure 3-40 shows in block diagram form the synthesizer frequency selection. S102 is located on the Indicator front panel and tells the channel Multiplex to accept the Nav 1 or Nav 2 channeling data or, in the HOLD mode, to store the channeling data now in use and lock out any new data. Selection of Nav 1 or Nav 2, with S102, will void the HOLD and allow entry of new selected channel data.

As shipped the channel Multiplex is programmed for the standard Narco 2-out-of-5 DME channeling code. Programming may be changed to permit the DME 195 to be channeled by other than Narco Nav receivers. Pre programmed read-only memories (ROMs) are available to replace the standard programming.

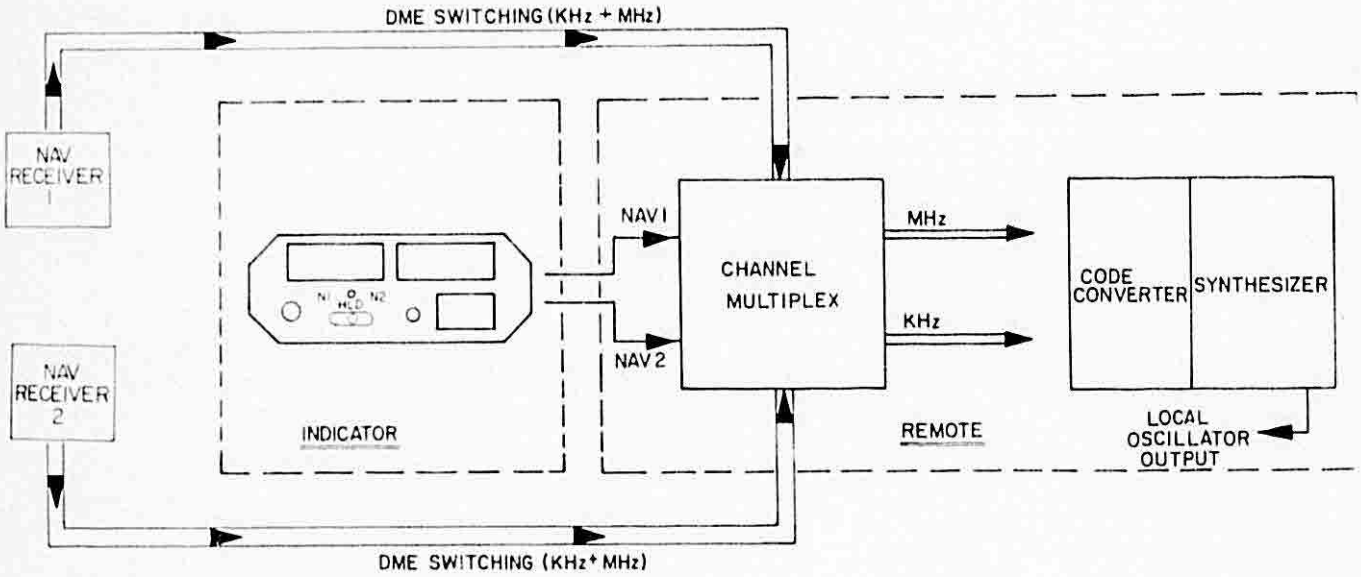


FIGURE 3-40. CHANNEL MULTIPLEX, BLOCK DIAGRAM

3.7.13.1 Receiver Selection, Continued

Before channeling the DME on the test bench refer to the NAV/DME Channel Code (programming) label on the connector end bell of the Remote Unit. The absence of a label indicates standard Narco 2-out-of-5 programming; when present the label will indicate the necessary channeling code for the NAV 1 and NAV 2 inputs.

Referring to Figure 3-41, let's assume two Narco navigation receivers are connected to supply DME channel data and that S102 is in the NAV 1 position; NAV 1 will therefore be providing the DME channeling data.

With NAV 1 selected, S102 provides a logic low to the 1 input and a logic high to the $\overline{2}$ input. The $\overline{2}$ logic high is inverted by U207B, then inverted again by U205A, providing a logic high at pin 14. This logic high is applied to the "disable" terminals (pin 4) of U210 and U213. Ideitified as three state, strobed hex inverter/buffers, the application of a logic high to the disable port isolates the output from the input preventing the transfer of NAV 2 MHz and KHz channeling data.

Entry of NAV 1 data is enabled by the logic low at the disable ports of U205 and U202. This logic low is caused by the disabling of U210 and U213 and the existence of pull down resistors R245 and R251. NAV 1 MHz data at the $\overline{A1}$ thru $\overline{F1}$ inputs will be inverted by U205; NAV 1 KHz data at $\overline{F1}$ thru $\overline{L1}$ inputs will be inverted by U202 with Y channel data entered at the 50 KHz 1 input and inverted by U202A.

Inverted $\overline{A}$ thru $\overline{D}$ MHz data is entered into U204, a four bit bistable latch, by the logic high from exclusive OR gate, U206A. With S102 in either a NAV 1 or NAV 2 position one of the inputs to U206A will be at a logic high to enable entry of channeling data. (In the HOLD mode both $\overline{1}$ and $\overline{2}$ inputs will be at a logic high forcing U206A-6 low, disabling Latches U204, U209, and U211, retainging or storing the channeling data previously entered.) The remaining MHz data bit, F1, is entered into Latch U209 by a logic high from exclusive OR gates U206B and U206C. These gates also enable entry of the inverted $\overline{F1}$ thru K1 data into Latch U211 and the inverted $\overline{L1}$ data into Latch U209. Inverted 50 $\overline{KH1}$ data is entered into Latch U209 thru exclusive OR gate U206D. Note that this data bit is Exclusive OR'd with a logic low supplied thru P212-1 jumpered to P212-15.

Channeling data stored in Latches U204, U209, and U211 is then available at the MHz and KHz output thru jumper programmers P201 and P202 as seen in the overall schematic in Section 6.

When two Narco receivers are used as the channeling sources U207C and connections E230 thru E234 serve no purpose.

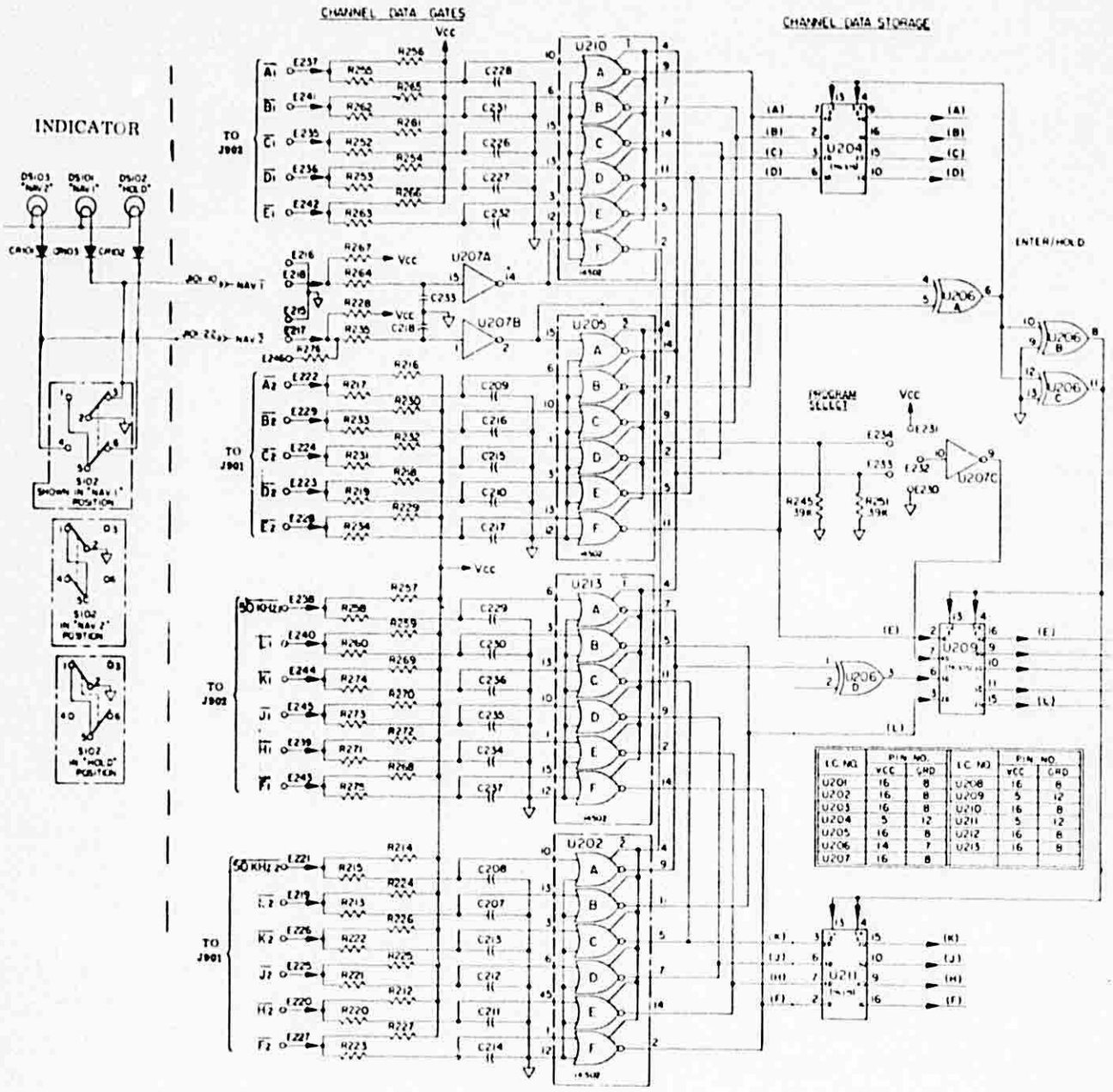


FIGURE 3-41. CHANNEL MULTIPLEX SWITCHING

SEE BLOW-UP

3.7.13.2 BAR

A channel change is detected by triple gate devices U201 and U208. Each of the NAND gate inputs are connected to either VCC or pull up resistor/capacitor networks. U201 and U208 then detect a change in the MHz or KHz output line states causing U201-15 to go high, for a period determined by C206/R211, causing the Indicator display to BAR.

Programming For Other Than Narco Receivers

The DME 195 may be channeled by receivers other than those produced by Narco. An option, consisting of two pre-programmed read only memories (ROMs), permits other than Narco manufactured Nav receivers to channel the DME 195. The optional ROMs also allow installations using Narco and non-Narco receivers as channeling sources. Table 3.5 shows various combinations of Narco, non-Narco, and ARINC channeling sources and where required, the ROMs. In addition the table illustrates the single additional jumper required when a non-Narco channeling source is used.

The ROMs are pre-programmed to decode two DME channeling codes; one Narco 2-out-of-5 code and one other code, such as the King slip code. Code selection, for a given installation, is by means of a logic "1" or "0" at pin 10 of each ROM (P201, P202). (Tables 3.6 thru 3.9 provide the input and output codes.) This logic is determined by the jumpering of E232 to either ground, VCC, or either of the inverter/buffer disable buses. U207C inverts the selected logic and applies it to Latch U209. The logic is entered when the Latch is enabled by a logic 1 at pins 13 and 4 and applied to pin 10 of both ROMs.

TABLE 3.5 JUMPER/ROM PROGRAMMING

NAV UNIT DME CHANNEL CODE	USED AS	JUMPER E232 TO:	USE ROM P201	USE ROM P202
NARCO ARINC NARCO ARINC	NAV 1 NAV 2	Not Required (do not jumper)	Standard (installed)	Standard (installed)
NARCO KING	NAV 1 NAV 2	E234	74102 -3 ROM	74102 -4 ROM
KING NARCO	NAV 1 NAV 2	E233	74102 -3 ROM	74102 -4 ROM
KING KING	NAV 1 NAV 2	E230	74102 -3 ROM	74102 -4 ROM

TABLE 3.6 NARCO KHz, PROM LOGIC STATES

		INPUTS						OUTPUTS							
		A_4	A_3	A_2	A_1	A_0	E	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
MHz Frequency	PIN	14	13	12	11	10	15	9	7	6	5	4	3	2	1
108		0	0	0	1	0	0	1	1	1	0	0	0	0	0
109		1	0	0	1	0	0	1	0	1	0	0	1	0	0
110		1	0	1	0	0	0	1	0	0	1	0	1	0	0
111		0	0	1	1	0	0	1	0	1	1	0	0	0	0
112		0	1	0	1	0	0	1	0	1	0	1	0	0	0
113		0	1	1	0	0	0	1	0	0	1	1	0	0	0
114		0	0	1	0	0	0	1	1	0	1	0	0	0	0
115		0	1	0	0	0	0	1	1	0	0	1	0	0	0
116		1	1	0	0	0	0	1	0	0	0	1	1	0	0
117		1	0	0	0	0	0	1	1	0	0	0	1	0	0
Narco Code		A	D	C	B	—	-	E	B	C	D	A	-	-	-

TABLE 3.7 NARCO MHz, PROM LOGIC STATES

		INPUTS						OUTPUTS							
		A_4	A_3	A_2	A_1	A_0	E	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
KHz Frequency	PIN	14	13	12	11	10	15	9	7	6	5	4	3	2	1
.0		1	0	0	0	0	0	1	1	0	0	0	1	0	0
.1		1	0	0	1	0	0	1	0	1	0	0	1	0	0
.2		1	1	0	0	0	0	1	0	0	0	1	1	0	0
.3		1	0	1	0	0	0	1	0	0	1	0	1	0	0
.4		0	1	1	0	0	0	1	0	0	1	1	0	0	0
.5		0	1	0	0	0	0	1	1	0	0	1	0	0	0
.6		0	1	0	0	0	0	1	1	0	0	1	0	0	0
.7		0	0	1	0	0	0	1	1	0	1	0	0	0	0
.8		0	0	1	1	0	0	1	0	1	1	0	0	0	0
.9		0	0	0	1	0	0	1	1	1	0	0	0	0	0
Narco Code		H	J	K	F	-	-	L	F	K	J	H	-	-	-

TABLE 3.8 KING TO NARCO KHz, PROM LOGIC STATES

	INPUTS						OUTPUTS							
	A_4	A_3	A_2	A_1	A_0	E	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
KHz Frequency	PIN 14	13	12	11	10	15	9	7	6	5	4	3	2	1
.0	1	1	0	0	1	0	1	1	0	0	0	1	0	0
.1	1	1	1	0	1	0	1	0	1	0	0	1	0	0
.2	1	1	1	1	1	0	1	0	1	0	1	0	0	0
.3	0	1	1	1	1	0	1	0	0	0	1	1	0	0
.4	0	0	1	1	1	0	1	0	0	1	0	1	0	0
.5	1	0	0	1	1	0	1	0	0	1	1	0	0	0
.6	0	1	0	0	1	0	1	1	0	0	1	0	0	0
.7	0	0	1	0	1	0	1	1	0	1	0	0	0	0
.8	0	0	0	1	1	0	1	0	1	1	0	0	0	0
.9	1	0	0	0	1	0	1	1	1	0	0	0	0	0
King Code	K_0	K_1	K_2	K_3	-	-	-	-	-	-	-	-	-	-
Narco Code	H	J	K	F	-	-	L	F	K	J	H	-	-	-

TABLE 3.9 KING TO NARCO MHz, PROM LOGIC STATES

	INPUTS						OUTPUTS							
	A_4	A_3	A_2	A_1	A_0	E	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
MHz Frequency	PIN 14	13	12	11	10	15	9	7	6	5	4	3	2	1
108	0	0	1	0	1	0	1	1	1	0	0	0	0	0
109	0	0	0	1	1	0	1	0	1	0	0	1	0	0
110	1	0	0	0	1	0	1	0	0	1	0	1	0	0
111	1	1	0	0	1	0	1	0	1	1	0	0	0	0
112	1	1	1	0	1	0	1	0	1	0	1	0	0	0
113	0	1	1	1	1	0	1	0	0	1	1	0	0	0
114	1	0	1	1	1	0	1	1	0	1	0	0	0	0
115	0	1	0	1	1	0	1	1	0	0	1	0	0	0
116	1	0	1	0	1	0	1	0	0	0	1	1	0	0
117	1	1	0	1	1	0	1	1	0	0	0	1	0	0
King Code	M_0	M_1	M_2	M_3	-	-	-	-	-	-	-	-	-	-
Narco Code	A	D	C	B	-	-	E	B	C	D	A	-	-	-

3.7.14 Frequency Synthesizer Description

The frequency synthesizer serves as the RF exciter for the transmitter as well as the local oscillator (LO) for the superheterodyne receiver. The synthesizer operates from 347.00 to 383.33 MHz, which is 1/3 of the transmitter's frequency range of 1041 through 1150 MHz.

The basic frequency of this ÷N synthesizer is controlled by the 6-microsecond reference pulses from the Clock Generator; the output frequency, however, is selected by the pilot when he sets a Nav receiver channel selector to the desired channel as shown in Figure 3-41. The calibrations of this channel selector are 108.00 through 117.95, which are the VHF frequencies of the paired VOR/DME channels. The actual paired DME transmit frequencies are 1041 through 1150 MHz. Table 3.1 provides all paired frequency versus VCO frequency information.

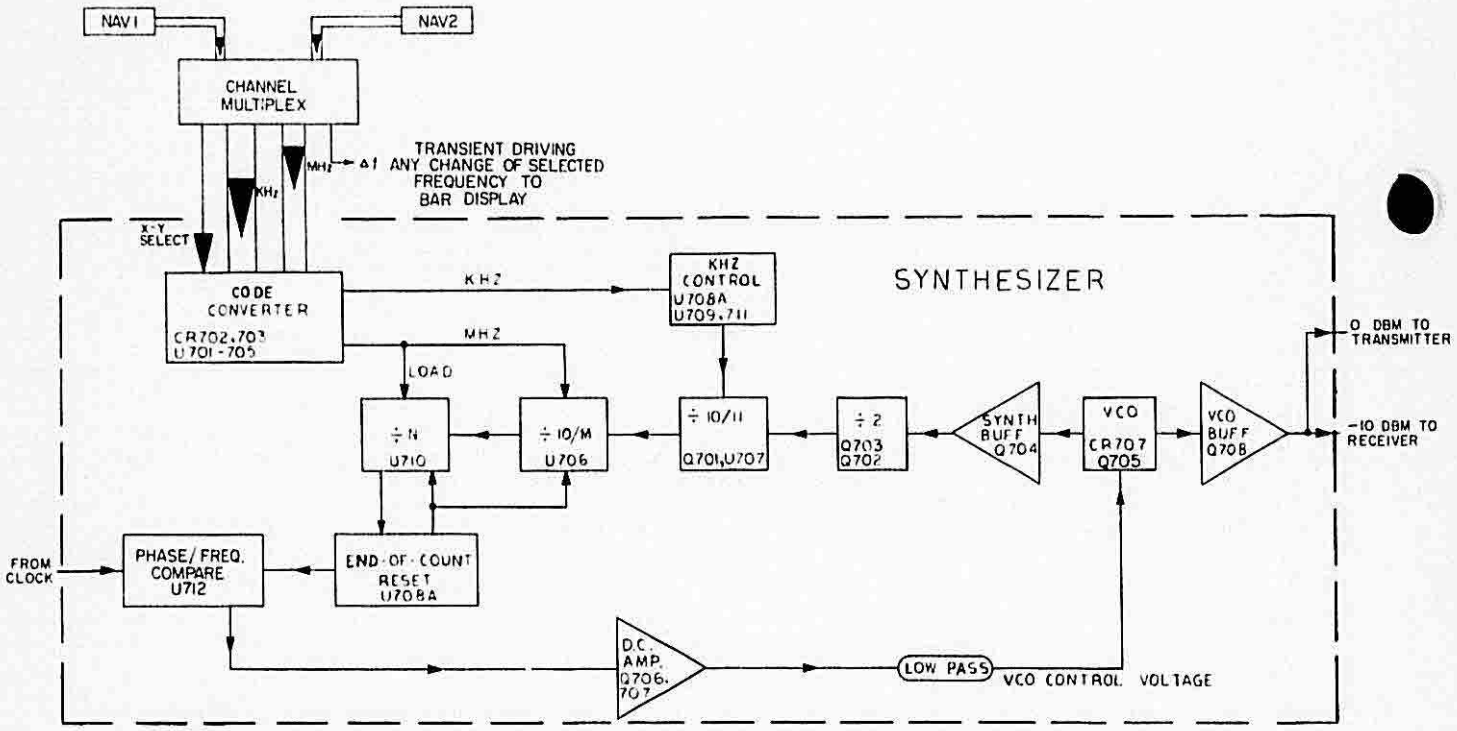


FIGURE 3-42. SYNTHESIZER BLOCK DIAGRAM

SEE BLOW-UP

3.7.14 Frequency Synthesizer Description, Continued

The basic synthesizer signal generator is Q705, the voltage controlled oscillator (VCO) shown in Figure 3-43. When the pilot sets his frequency controls, the synthesizer logic produces a VCO control voltage that sets the VCO to the required operating frequency for that channel. The control voltage applied to the VCO determines the effective capacitance of voltage variable capacitor CR707. This capacitor and C717 are series connected across L704 to form a tank circuit, which determines the frequency of the VCO. The following describes synthesizer operation when channel 26 (VOR 108.9 MHz, the transmitter 1050 MHz, and synthesizer 350 MHz) is selected.

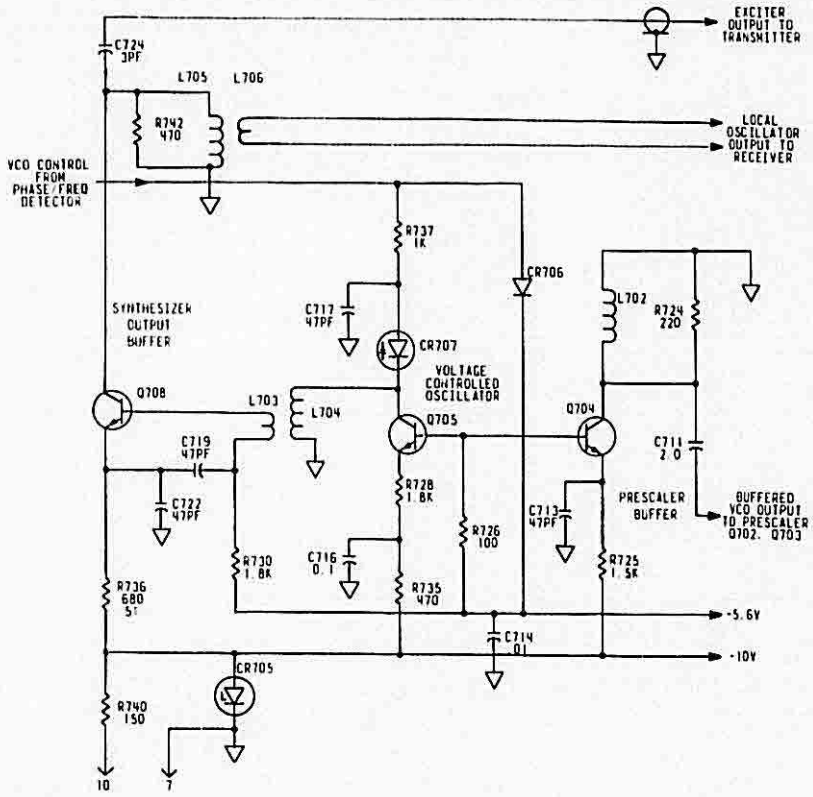


FIGURE 3-43. VCO AND BUFFER AMPLIFIERS

SEE BLOW-UP

3.7.14 Frequency Synthesizer Description, Continued

Refer to Figure 3-44.

The VCO is locked at 350 MHz, 1/3 the transmitted frequency, by the VCO control voltage (-7 to -9V typical) obtained from the logic. The 350 MHz frequency is connected through buffer Q704 to the ÷2 prescaler. The prescaler is a transformer coupled multivibrator comprising Q702, Q703, and T701. With the 350 MHz input the prescaler output is 175 MHz. The 175 MHz is further divided by 10 or 11 in prescaler U707. The U707 frequency division of ÷10 or ÷11 is determined by the U711 output applied to the U707 (PE) input port. This function is controlled by the KHz frequency selection by the pilot (1 MHz steps at DME output).

The output of the ÷10/11 prescaler, approximately 17.5 MHz in the example given, is applied to divide-by-N Counter U706 and U710 (Figure 3-45). The front panel MHz frequency selection (10 MHz steps at DME transmit output) alters the value of N; 95 for the example given.

The ÷ N Counter output, at U708A, is the output of the VCO divided by a constant. The constant comprises a combination of MHz and KHz information as selected by the pilot. This frequency is applied to phase/frequency detector U712 (Figure 3-46). In addition, the 6 microsecond clock is also applied to U712. If any difference in frequency exists (out-of-lock mode), the comparison of this 6 microsecond clock against the divided down VCO frequency produces an error signal. The error signal is amplified by a DC amplifier (Q707, Q706) and filtered by low pass filter R734 and C718 to control the frequency of the VCO. This closed loop causes the output of U708A (in-lock mode) to be a 6 microsecond repetitious waveform into the phase/frequency detector.

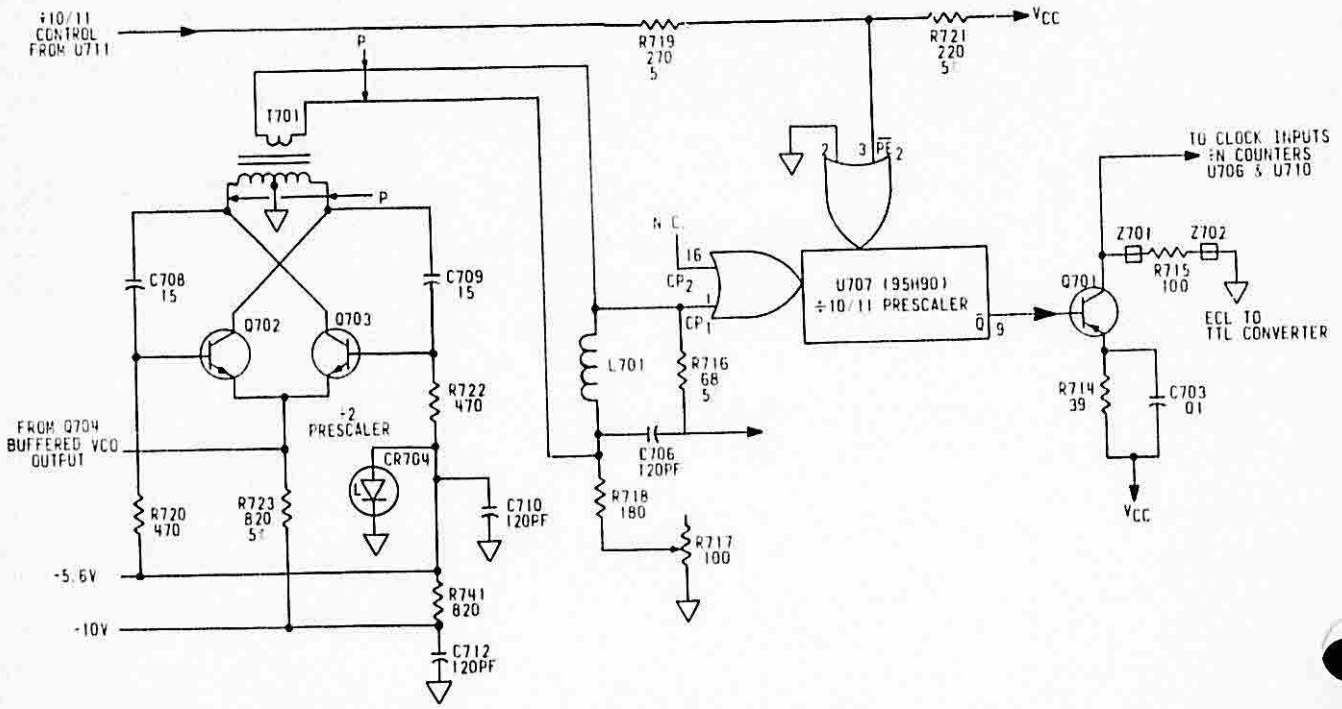


FIGURE 3-44. FREQUENCY PRESCALER

SEE BLOW-UP

3.7.14 Frequency Synthesizer Description, Continued

Within the VCO, the error output of the phase/frequency comparator is applied to voltage variable capacitance diode CR707 to control the frequency of VCO Q705.

Referring to Figure 3-43 the VCO has two output paths.

The first path from the VCO is through L703, L704 and buffer Q708. The direct high level output is through C724 to serve as excitation of approximately 1 milliwatt (0 dbm) into the transmitter. Receiver injection is from transformer L705/L706 as a floating balanced type signal; when terminated by a 50 ohm load at the receiver, this output level (local oscillator injection) is approximately -6 dbm.

The second path from the BCO is through prescaler buffer Q704, which isolates the ÷2 prescaler from the VCO. Referring to Figure 3-43, transistors Q702 and Q703 constitute a fixed ÷2 prescaler, as previously described, to divide the VCO frequency (approximately 350 MHz) down to the approximately 175 MHz frequency necessary to drive the ÷10/11 VHF prescaler. The Q702/Q703 circuit operates as an active divider that will free-run at some frequency near the center of the band; however, it is locked into a ÷2 mode by the VCO injection from Q704.

Divide by 10/11 prescaler U707 is an emitter coupled logic (ECL) device that does not operate at the normal TTL levels of +0.5/3 volts. This prescaler operates at a level determined by voltage divider, R716, R718, and variable resistor R717; R717 must be very carefully set for the proper operating point of the prescaler to center the primary or VHF input signal. In addition, the ÷10/11 control of U707 (pin 3) is set by the level obtained from voltage divider R719 and R721. The prescaler output, in the form of an ECL swing of 0.5 volt, must be amplified and its level shifted to make it compatible with TTL logic. This is the function of Q701, which has output levels of 0.5 to 3 volts.

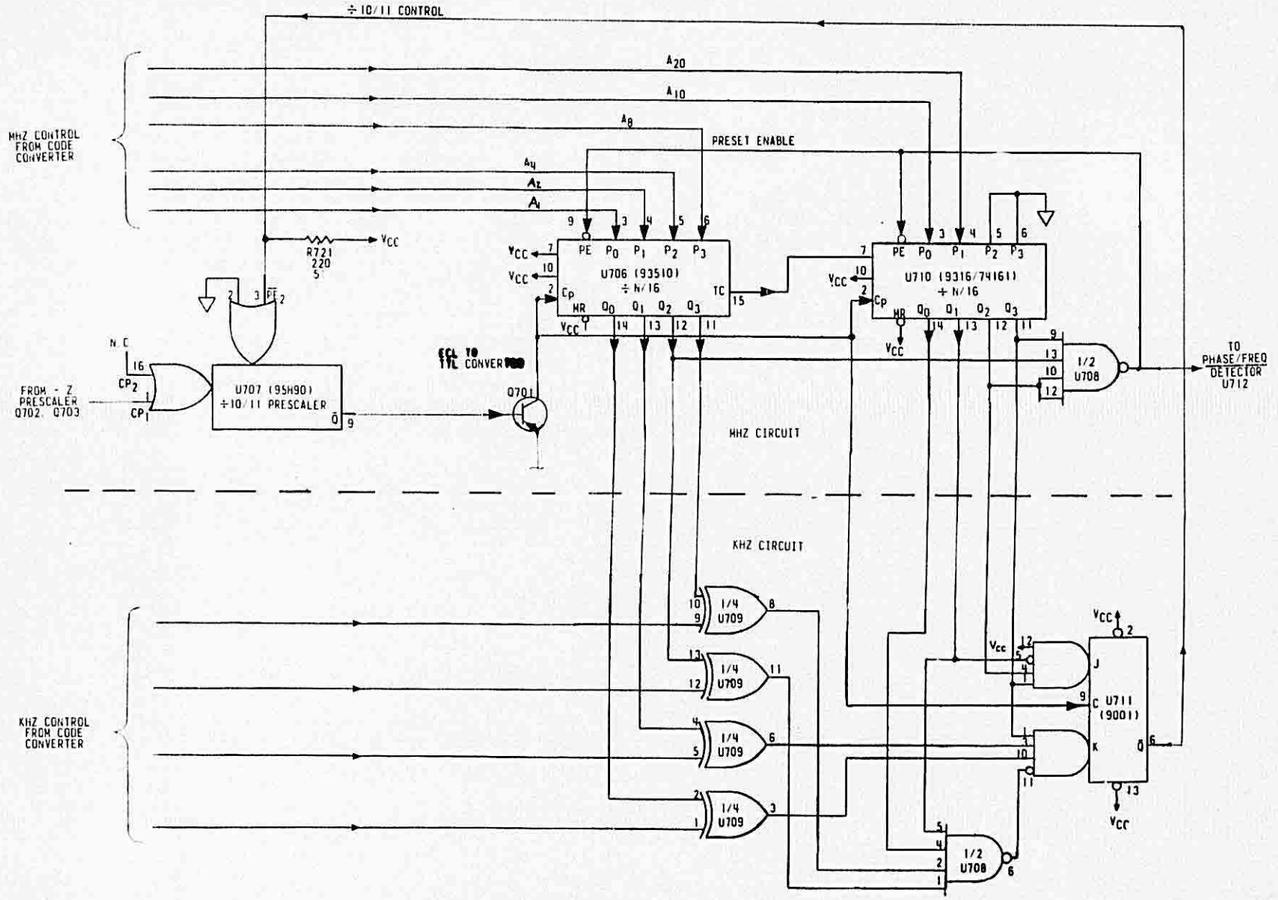


FIGURE 3-45. ÷ N AND ÷10 FREQUENCY DIVIDERS

SEE BLOW-UP

3.7.14 Frequency Synthesizer Description, Continued

Referring to Figure 3-44 the ÷10/11 prescaler output is connected through Q701 to the ÷ N Counters (U706, U710) for MHz and KHz control of these circuits. MHz control is through U706, U710, and U708A; KHz control is through U709, U708B, U711 and feedback to U707 to control its ÷10/11 function.

The outputs of ÷N Counters U706 and U710 are connected to U708A to recognize the unique conditions of the third stage of U706 and the third and fourth stages of U710 being high; U708A is then enabled and its output (preset enable) causes the state of preset of U706 and U710 permitting A1 through A20 (P_0 through P_3 of each Counter) to be loaded in. The preset conditions loaded into the Counters consist of DC levels that are the equivalent of a unique binary count set up by the external channeling. As the counted down VCO output from Q701 is applied to U706 and U710, these Counters start counting from the preset condition and run out to their fixed terminal count as determined by the gating described. Depending upon DC states enabled by external MHz channeling, the total count of the two Counters can be varied by varying this active counting interval.

The terminal count recognized by gate U708A causes proper MHz and KHz load status to be established. Code converter logic provides that P0 of U706 represents 10 channel steps (i.e. referred to a VHF channeling indication of 1 MHz steps or 10 MHz at DME transmit final frequency). The remaining U706 inputs are identified as follows: P1 (A2 line) is in 20 channel steps, P2 (A4 line) is in 40 channel steps, P3 (A8 line) is in 80 channel steps. The U710 inputs are identified as follows: P0 (A10 line) is in 100 channel steps, P1 (A20 line) is in 200 channel steps.

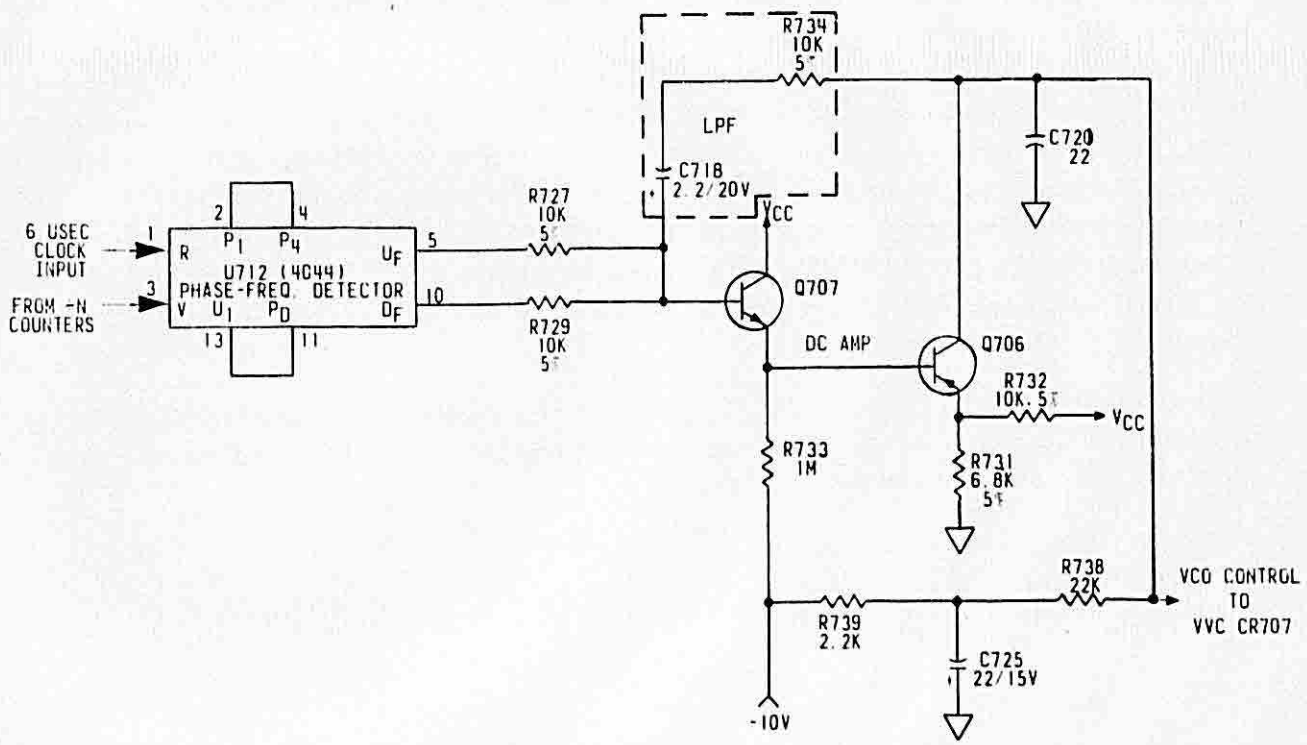


FIGURE 3-46. PHASE/FREQUENCY DETECTOR

3.7.14 Frequency Synthesizer Description, Continued

Within the counts that U706/U710 are making for MHz information, U711 flip-flop (FF) is started and stopped. The count at which this FF is put into the active state is established by the condition of the KHz control line through gate U708B and exclusive OR gates U709A thru D. This sets the K terminal active; the next pulse causes U711 to carry and put it into the ÷11 mode. It remains in this ÷11 mode until the J terminal gate is satisfied, which occurs when the third and fourth FFs of U710 are high and first FF is low.

The ÷ 10/11 prescaler (U707) is then caused to divide by 11 for anywhere from one to 11 counts from its own output. This is referred to as pulse swallowing and represents one channel steps for each state introduced into the U709 comparison system. The inputs through U709 are KHz information in BCD form; inputs to U708, U706, and U710 are in 10 MHz (channel) steps in BCD form.

The channel multiplex output is not in BCD form; additionally, there is a transmitter output frequency of 11 MHz (11 channels) jump between 112.2 and 112.3 MHz. A code converter, located between the channel multiplex and the MHz/KHz input terminals to the synthesizer, serves to change the multiplex outputs to the required BCD format. Refer to Figure 3-47 for code converter schematic.

The five MHz input lines of P701 (designed A through E) are converted by multiplexer U701 and gates U704 and U705 to produce the required MHz conversion to A1 through A20. The conversion code is shown in Table 3.10.

In similar fashion, the five KHz input lines of P701 (designated F through L) are converted by multiplexers U702 and U703, and a portion of U705 to produce B1 through B8, the required KHz channeling information.

The DC input states to DC output states as tabulated in Table 3.10 relates the input frequency selection to the required output code for that frequency. Note that selection of a 50 KHz channel by the pilot does not change the frequency of the synthesizer. The only thing changed is the pulse spacings on transmit and receive and the RF carrier frequency received from the ground station. Received frequency is 63 MHz above the transmitter for 50 KHz channels and 63 MHz below for regular channels in the low band (below 112.2); above 112.3, the opposite occurs.

Series regulator U713 changes the +7 volts into the synthesizer board to the +5 volts required for the synthesizer and channel multiplex circuits. The synthesizer draws approximately 0.4 ampere at +5 volts.

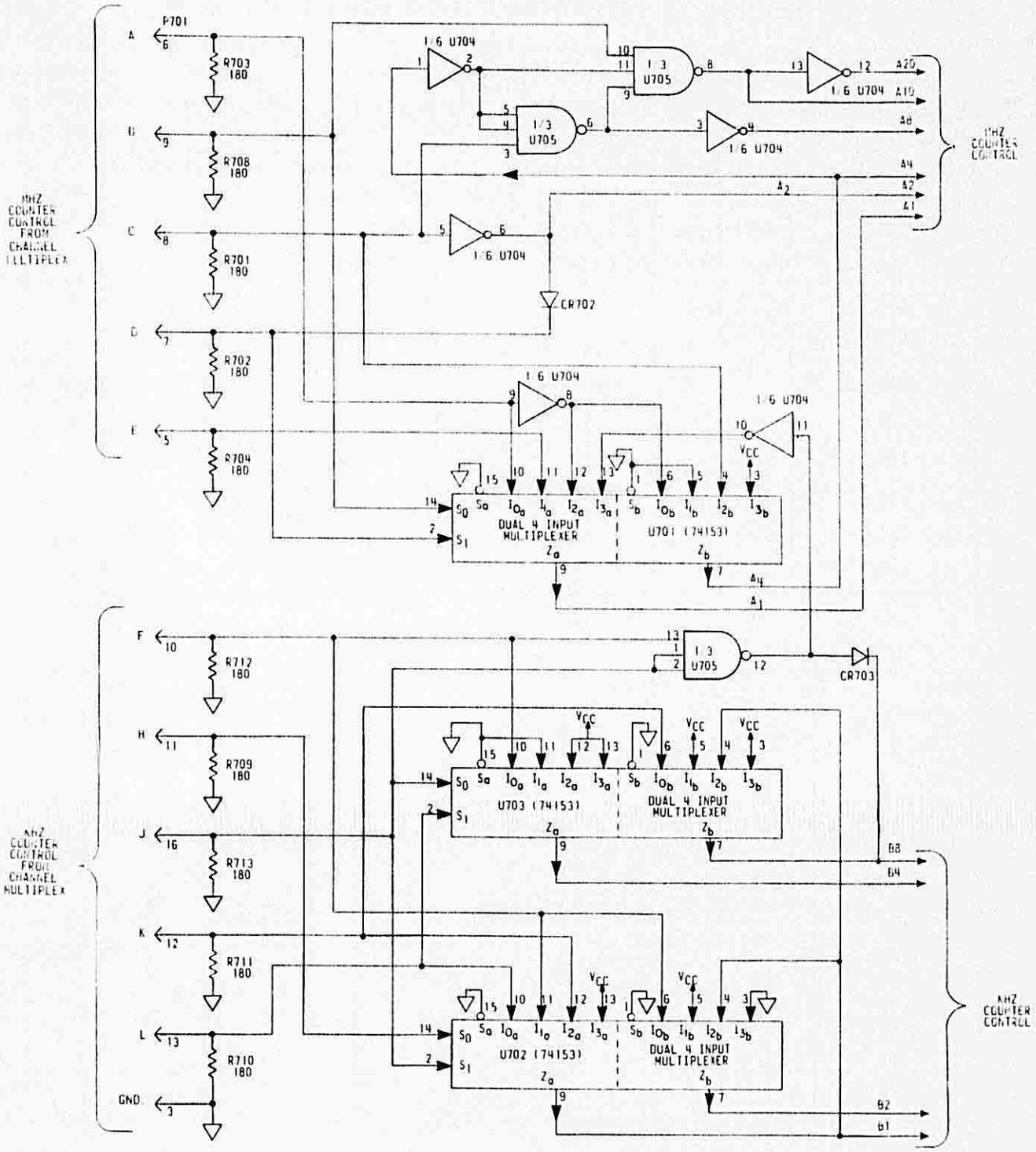


FIGURE 3-47. CODE CONVERTER, SCHEMATIC DIAGRAM

SEE BLOW-UP

TABLE 3.10 CODE CONVERTERS FREQUENCY CODE

MHz

Letter Code / P701	INPUT CODE					OUTPUT CODE					
	A 6	B 9	C 8	D 7	E 5	A20	A10	A8	A4	A2	A1
108		X			X	X					X
109	X	X				X					
110	X		X				X	X			X
111		X	X				X	X			
112 (.0-.2)		X		X			X		X	X	X
112 (.3-.9)		X		X			X		X	X	
113			X	X			X		X		X
114			X		X		X		X		
115				X	X		X			X	X
116	X			X			X			X	
117	X				X		X				X

KHz

Letter Code / P701	INPUT CODE						OUTPUT CODE					
	F 10	H 11	J 16	K 12	L 13				B8	B4	B2	B1
.0		X			X					X	X	
.1	X	X								X	X	X
.2	X		X						X			
.3		X	X						X			X
.4		X		X					X		X	
.5			X	X					X		X	X
.6			X		X				X	X		
.7				X	X				X	X		X
.8	X			X					X	X	X	
.9	X				X				X	X	X	X

X = active "high" except remote switch
where X equals active low.

3.7.15 Power Supply

The power supply section comprises a switching regulator, DC/DC converter, and a +5 volt IC regulator as shown in Figure 3-48 block diagram and Figure 3-49 schematic. The input voltage, 14 or 28 VDC, is connected to the switching regulator which supplies a highly regulated, low ripple, 7 VDC. The +7 volts powers the DC/DC converter and a +5 volt regulator on each of four PC boards; distance, belocity, display, and synthesizer. The DC/DC converter provides the following voltages: +14 VDC to the receiver, IDENT function, frequency channeling, and low level stages of the transmitter; -15 VDC to the distance and synthesizer boards; and +60 VDC to the transmitter modulator.

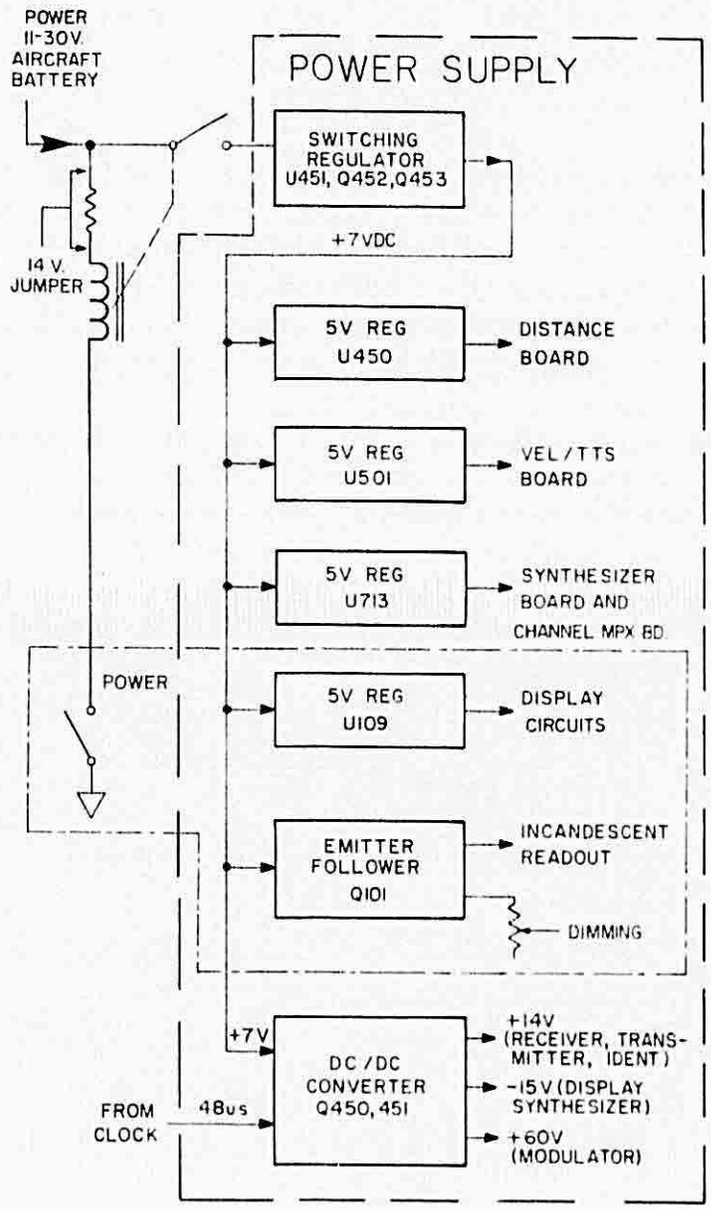


FIGURE 3-48. POWER SUPPLY, BLOCK DIAGRAM

3.7.15.1 Switching Regulator

The switching regulator provides the basic +7 VDC to the DME with input voltages of +11 to +30 volts as shown in the schematic diagram, Figure 3-49. The circuit comprises a series switch (Q453, Q452), storage coil (L450), and a voltage regulator (U451). Although the schematic is similar to a series regulator, operation is different since Q452 operates as a series switch rather than a series pass transistor. Basic operation is controlled by the voltage regulator. If a difference of potential is sensed when the output voltage is compared with an internal reference voltage, a control voltage is fed from the regulator to the series switch. The control voltage initiates oscillation; during off-time of this oscillator the storage coil has energy stored in it, during on-time the energy is transferred to the capacitor for storage.

Diode CR455 conducts for ground return during this transfer of energy. The overall operation of coil, capacitor, and diode serves to maintain a constant output voltage.

The voltage divider, comprising R454 and R456, provides the voltage set input to the voltage regulator. This sample of the output voltage is compared with the internal zener reference and the difference voltage amplified by a differential amplifier in U451. The differential amplifier loop gain controls the ripple content of the output voltage. The value of the feedback resistor (R458) for this amplifier is selected to provide maximum stability of the loop, which is maximum gain with minimum noise and ripple.

When the output voltage is correct, there is no difference voltage to amplify, therefore Q452 conducts and current flows through storage coil L450. A decrease in output voltage changes the voltage set into the voltage regulator. This imbalance of the regulator provides an oscillating control voltage to Q453 which turns OFF Q452 and the emitter is at near-ground potential (through CR455 to ground). If there is a change in voltage since the last cycle, this voltage from L450 is now transferred to capacitor C453. This is a nonsymmetric square wave that is repeated while the oscillator operates.

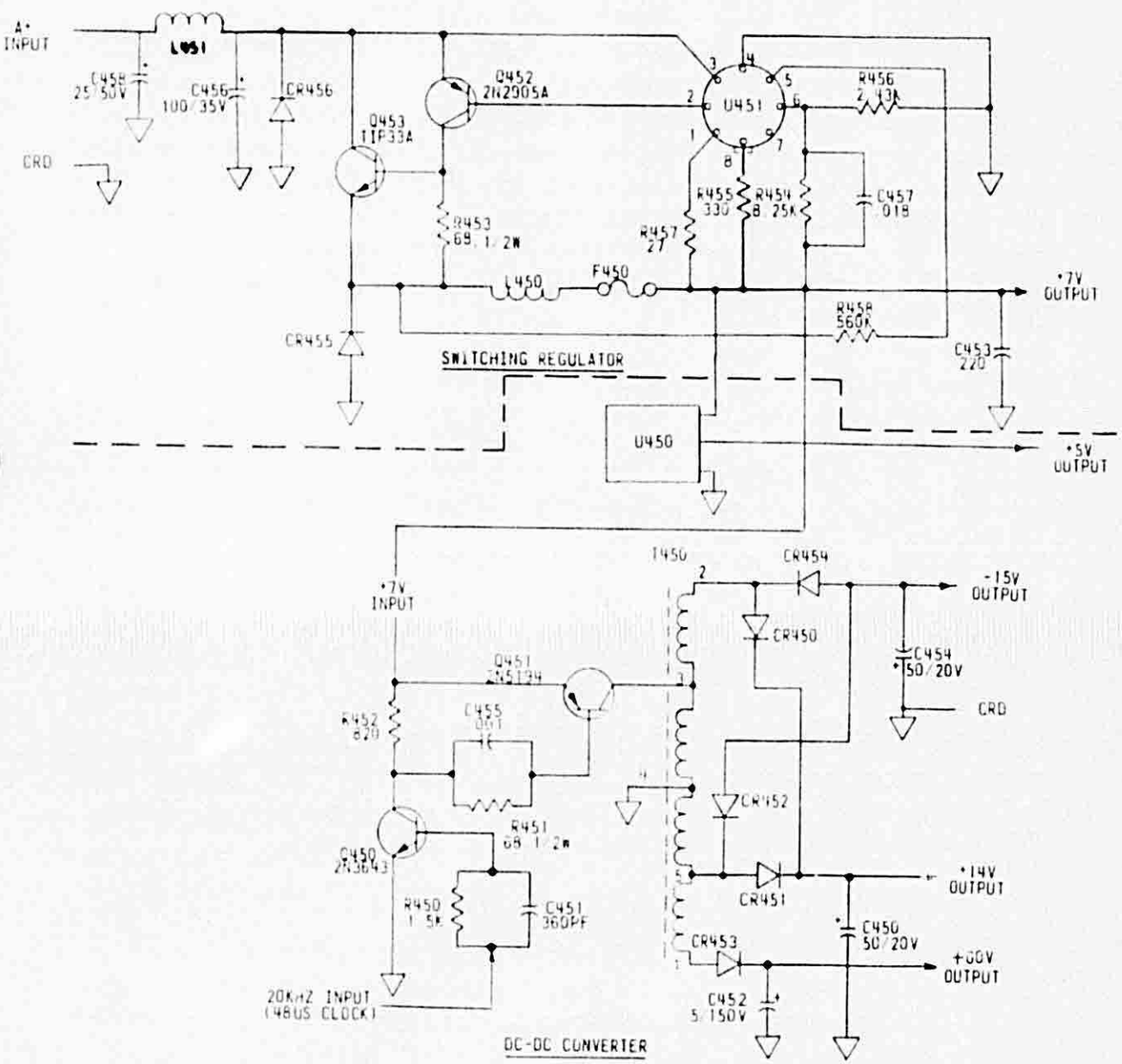


FIGURE 3-49. POWER SUPPLY, SCHEMATIC

3.7.15.2 DC/DC Converter

The DC/DC Converter increases the +7 VDC to +14, -15, and +60 volts as shown in Figure 3-49. The converter comprises an electronic switch (DC to AC converter), transformer (AC to AC converter), and a rectifier (AC to DC converter). The 20 KHz clock changes the +7 VDC to a 20 KHz (48 microsecond) square wave. The transformer provides voltage step-up of the 20 KHz input. The rectifiers provide full wave rectification for the +14 and -15 volts and half wave rectification for the +60 volts outputs.

Transistors Q450 and Q451 are connected into an electronic switch configuration. When the 48 microsecond (20 KHz) switching signal is positive, NPN transistor Q450 saturates and effectively connects the base of Q451 to ground. The negative potential at the base of this PNP transistor saturates it and thereby connects _7 volts to transformer T450. During the second half of the input pulse cycle, this negative input to the base of Q450 turns OFF the transistor and the collector returns to +7 volts. The +7 volts at the Q451 base turns OFF the transistor and the +7 volts is effectively disconnected from the transformer. The result is an AC voltage (7 volt, 20 KHz square wave) fed to the transformer.

The transformer output is a higher voltage AC, the magnitude determined by the transformer turns ratio. The transformer output is rectified by full wave rectifier CR454 and CR452 for the -15 volt output, full wave rectifier CR450 and CR451 for the -15 volt output, full wave rectifier CR450 and CR451 for the +14 volt output, and half wave rectifier CR453 for the +60 volt output. Filter capacitors are connected to each DC output.

3.7.16 Velocity Locked Loop

Refer to Figures 3-50, 3-51, 3-52, and Table 3.11.

Tenth mile BCD data, from the Synchronous Timing's U335 Counter, is entered into the tenth mile latch, U515, by a VDS3 pulse. Tenth mile memory, U516, contains tenth mile distance from the previous update. Thus, the latch contains current of "new) distance while the memory contains previous or "old" distance data.

"New" distance data and "old" distance data are added in U525, a full adder. The output states of U525 are decoded by gates U524B, U524C, U524D, U535A, U535B, U537A and U537B.

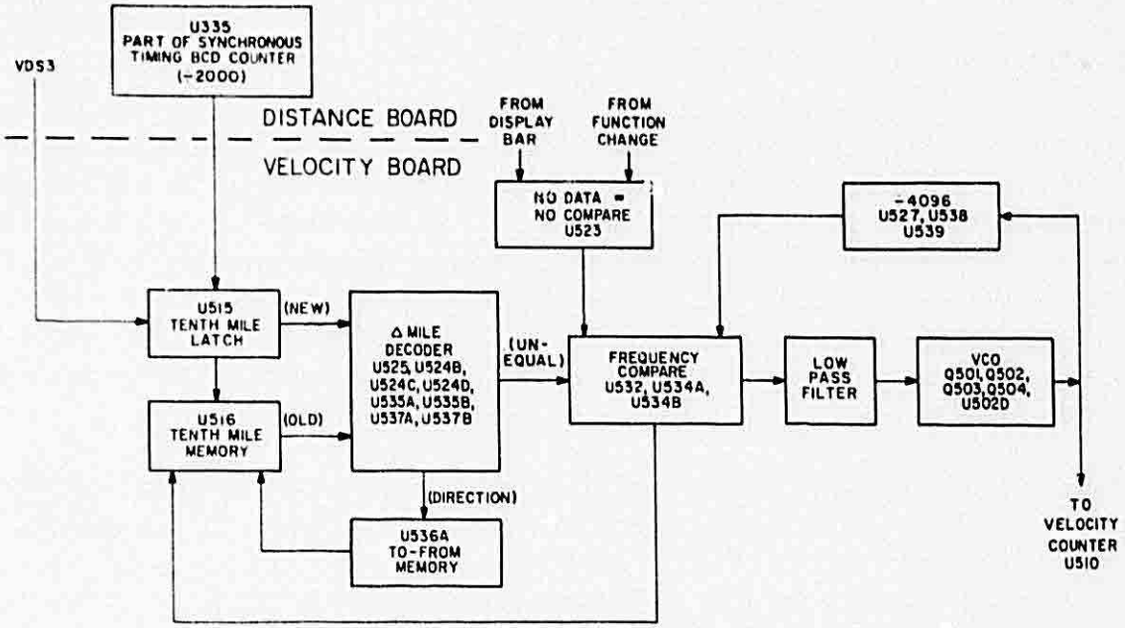


FIGURE 3-50. VELOCITY LOCKED LOOP

3.7.16 Velocity Locked Loop, Continued

If distances stored in the latch and memory are different, a logic 1 will occur at U537A-3; Table 3.11 provides the ΔMile Decoder logic states. NAND gate U537D is enabled by the logic 1 from U537A and the logic 1 from the $\overline{Q}$ output of U534B, to clock U534B. U534B is a one shot multivibrator with its period determined by C512 and R521. When clocked, its $\overline{Q}$ output goes low inhibiting gate U537D for one period. The Q output of U534B hoes high clocking the tenth mile memory, U516. U516 is a four bit, up-down counter, the direction of counting dependent upon the logic level at its pin 5. Pin 5 is connected to the to-from memory, U536A, which remembers the direction in which the aircraft was flying. When clocked U516 will change one count, up or down (if pin 5 is low it counts up, if high it counts down). The ΔMile Decoder will again add the latch and tenth mile memory distances and if unequal will again fire U534B to clock U516.

This cycle continues until the BCD distances in U515 and U516 differ by 0.1 mile. If the direction of flight agrees with that stored in the to-from memory the previously described cycle will continue until latch and memory distances are equal; velocity may then be computed. If however the direction of flight does NOT agree with that stored in the to-from memory a shift pulse is generated at U535B-10, and a direction logic change occurs at U524B-6. The shift pulse clocks U536A to enter the new direction; refer to Table 3.11; the $\overline{Q}$ output state of U536A changes to direct U516 to count in the opposite direction. The shift pulse also clocks U536B, the serial converter. A change in direction is detected by the serial converter enabling NAND gate U537C. U537C's output goes low resetting U534B and entering the new tenth mile latch data into the tenth mile memory by addressing U516's $\overline{PE}$ port.

At this point the to-from memory is in the proper state for the direction of flight and velocity may be computed.

SEE BLOW-UP

3.7.16 Velocity Locked Loop, Continued

The frequency compare, shown in Figure 3-52, section comprises one-shot multivibrators U534A, U534B, and operational amplifier U532. The two one-shots are set to have the same time period by adjusting R515. The Q outputs of both one-shots are the inputs to amplifier U532. The output from the one-shot representing distance change, U534B, is fed to the non-inverting port (+) and the one-shot representing VCO, U534A, is connected to the inverting port. Each input is integrated by a low-pass filter; (R523/C507 and R526/C508). Resistors R524 and R522 serve as pull-up resistors for the outputs and ensure that the resting voltage of the Q output is Vcc.

If the timing of the one-shot is set properly, and both one-shots are being toggled the same number of times, both inputs to amplifier U532 are at the same voltage; therefore, the output will remain constant. The preceding is a frequency lock condition where the phase relationship between one-shot firings is ignored by the loop. If the distance one-shot is toggled more frequently than the VCO one-shot (indicating an increase in speed), the non-inverting input voltage will become more negative than the inverting input. The output will now become more negative, thereby increasing the VCO frequency until the two amplifier input voltages are equal. The converse is true for a decrease in speed.

The reset input of the VCO one-shot is latched by the $\overline{Q}$ output of U523. Data inputs to U523 are from the display bar, function change bar, and Δ Mile Decoder. The loss of distance information will cause U523 to reset U534A inhibiting velocity computation until distance data is reacquired.

The operational amplifier output (U532) is then filtered by a two-mode low pass filter. When operating in the lock condition, the amplifier output is a stable DC with only the ripple due to operation of the one-shots. The ripple is filtered by the low-pass filter R518/C509. In the event of a large change in speed, the amplifier's output voltage will change in the direction to correct the loop error. If this change is in excess of the optimum value, one of the two diodes (determined by the direction of change) will be biased on and R517 connected in parallel with R518. This decrease of resistance reduces the time constant of the low-pass filter, which allows the loop to change to its new lock condition in a shorter time.

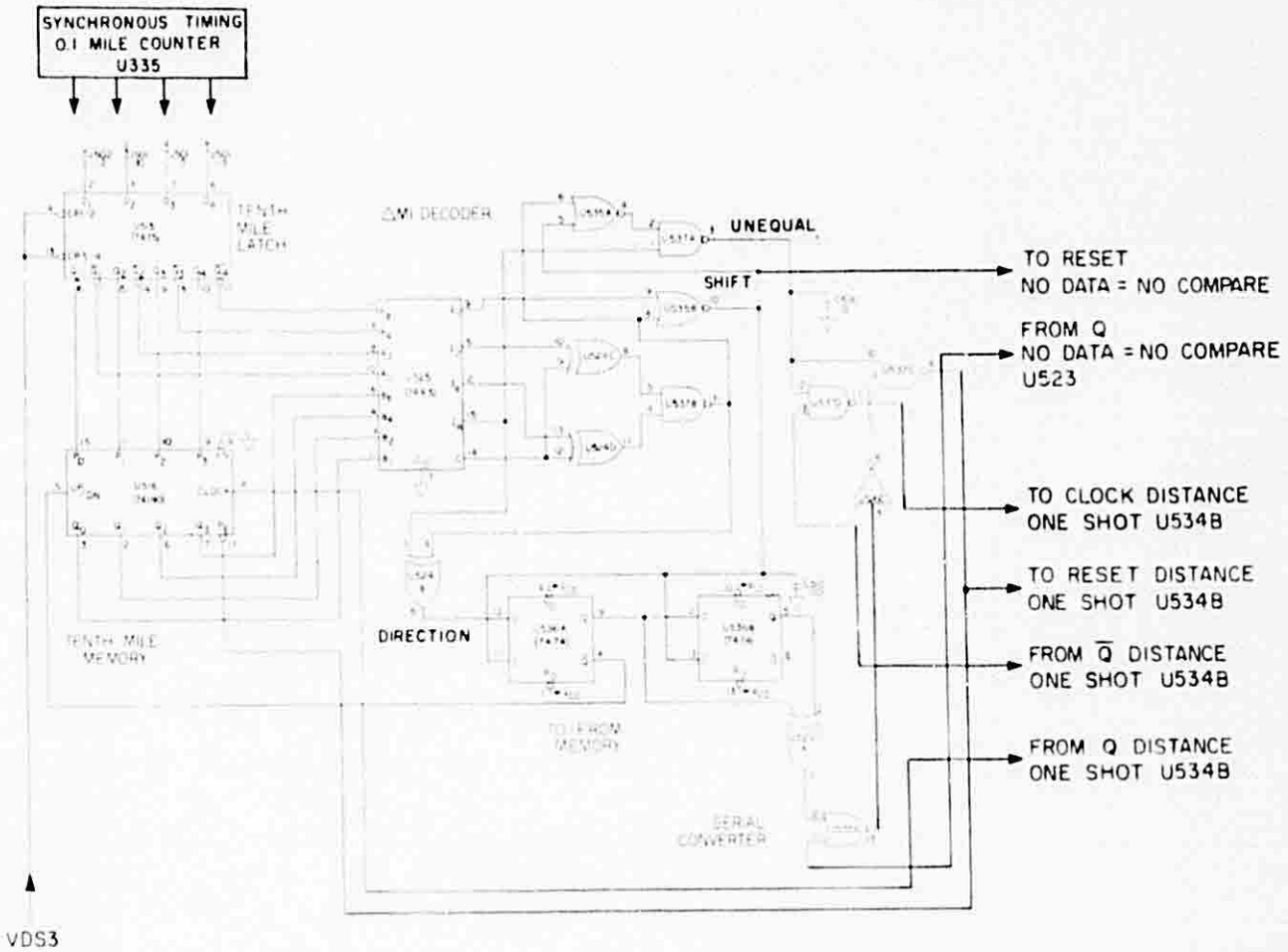


FIGURE 3-51. Δ MILE DECODER

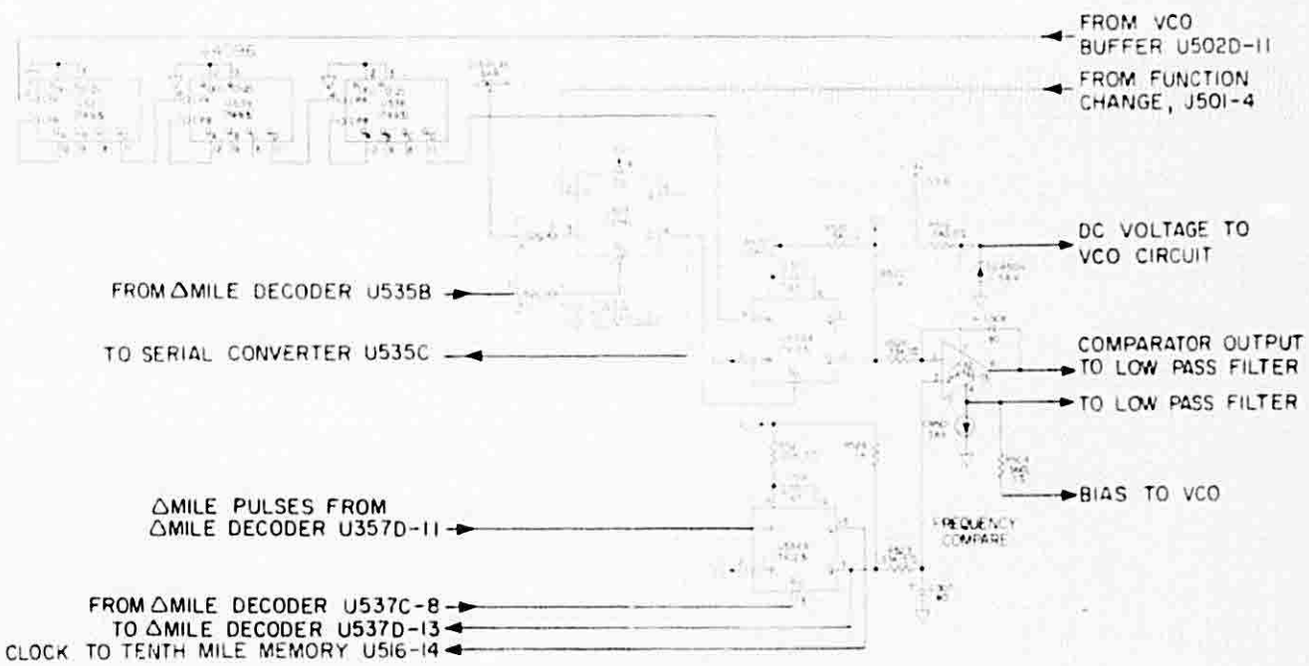


FIGURE 3-52. FREQUENCY COMPARE AND ÷ 4096 COUNTER

SEE BLOW-UP

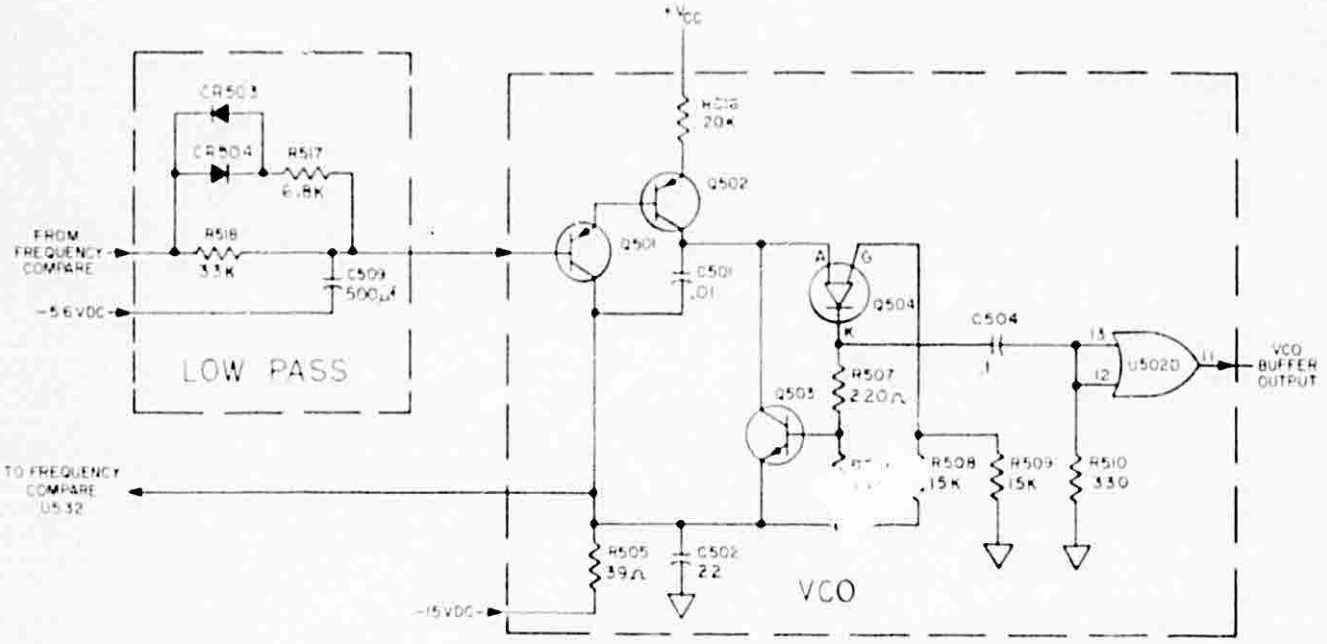


FIGURE 3-53. VCO SCHEMATIC

3.7.16 Velocity Locked Loop, Continued

As shown in Figure 3-53, the VCO section comprises a current source (Q501, Q502, R516) which is driven by the output of the low-pass filter. The current source provides the current necessary to charge VCO timing capacitor C501. The capacitor charges to the Vp voltage of the programmable unijunction transistor (PUT) Q504; upon reaching this voltage the Q504 turns ON, discharging the capacitor through R506/R507. The voltage developed across R506 turns ON Q503, which rapidly discharges C501, thereby improving the VCO's dynamic range. The positive-going voltage spike from R507 is coupled through C504 to OR gate U502D. The gate serves as a buffer to drive the TTL loads.

TABLE 3.11 Δ MILE DECODE LOGIC STATES

U525 Input Δ Mile	INTERMEDIATE POINTS						OUTPUT COMMANDS		
	U525					U537B	U535	U537A	U524B
	Σ 1	Σ 2	Σ 4	Σ 8	C		shift	not equal	direction
See Note	pin 9	6	2	15	14	6	10	3	6
+.9/-.1	0	1	1	0	0	0	1	1	0 (down)
	0	0	0	0	1	0	1	1	0 (down)
+.8/-.2	1	1	1	0	0	0	0	1	X
	1	0	0	0	1	0	0	1	X
+.7/-.3	0	0	0	1	0	1	0	1	X
	0	1	0	0	1	1	0	1	X
+.6/-.4	1	0	0	1	0	1	0	1	X
	1	1	0	0	1	1	0	1	X
+.5/-.5	0	1	0	1	0	1	0	1	X
	0	0	1	0	1	1	0	1	X
+.4/-.6	1	1	0	1	0	1	0	1	X
	1	0	1	0	1	1	0	1	X
+.3/-.7	0	0	1	1	0	1	0	1	X
	0	1	1	0	1	1	0	1	X
+.2/-.8	1	0	1	1	0	1	0	1	X
	1	1	1	0	1	1	0	1	X
+.1/-.9	0	1	1	1	0	0	1	1	1 (up)
	0	0	0	1	1	0	1	1	1 (up)
equal	1	1	1	1	0	0	0	0	X

1 = hi

0 = lo

X = don't care

NOTE

This column represents the difference in 0.1 mile distances stored in latch and tenth mile memory. Since the velocity circuit tracks only tenth mile data it cannot differentiate between 1.4 miles, 25.4 miles or 173.4 miles. For example, assume the aircraft is flying at a distance of 100.4 miles; the next tenth mile data into the latch however is 0.7. Did the distance increase by +0.3 to 100.7 miles decrease by -0.7 to 99.7 miles? For this situation one of the logic states on the +0.3/-0.7 line will exist; which one of the two will be determined by the absolute miles in the latch and memory. Note however that the output commands are the same for either logic series.

3.7.16.1 Velocity and TTS Compute

Velocity and Time-to-Station computations are based on distance information. In the velocity mode, distance information is differentiated against time in increments of 0.1 mile intervals and displayed as nautical miles per hour. Time-to-Station is determined by dividing distance by velocity and displaying the resultant in minutes. Figure 3-54 shows a basic block diagram, Figure 3-55 the detailed block diagram of the Velocity and TTS Compute circuit.

A. Velocity Mode

In the velocity mode, the VCO output from buffer U502D (Figure 3-54) is divided by 16 in U510. The divided output is then gated through U504D, which is enabled (at pin 13) when the velocity mode is selected through U519C and U504A. The VEL/TTS Counter is now allowed to count the VCO/16 pulses.

At the same time, U506C-10 is enabled and the output of the ÷76 and ÷192 Counters (Figure 3-55) is allowed to ripple through U512B. At the end of the count (approximately 1.4 second), the negative-going transition clocks U505A, which sets the condition on U505A and enables U506A. With U506A enabled, the 96 (Figure 3-56) microsecond clock output going positive generates a positive pulse that strobes the Counters (U542, U530, U521) BCD information into the Latches (U543, U531, U522). The negative transition of this pulse then clocks U505B through U512A, causing U505B to change state.

The $\overline{Q}$ output of U505B (pin 13) going low resets U505A and also causes the output of U541A to go high. This high resets Counters U542, U530, U521 to zero and enables U506B; the next 96 microsecond clock will cause U505B to go back to its normal state. The logic high $\overline{Q}$ output of U505B clocks the VEL/TTS serial multiplex; refer to Subsection 3.7.16.2 for the description of Multiplex operation.

B. Time-to-Station

When the TTS mode is enabled the U519B output becomes a logic "1". This then sets the conditions for U518B such that when clear terminal pin 13 is released (the 15 second timer reaching its end state) the next VDS3 pulse will cause U518B to change state. When pin 9 (Q output) goes to a logic "1" and applies it to U503B-10, the output tells the TTS compute logic that a valid distance has been stored in the 1000 bit Shift Register during this epic.

Since the timer period ending was a necessary condition for the release of clear terminal, the logic low at U533-3 causes a logic high at U526E. Now, at the end of the 0-200 mile epic, U503B-9 goes to a logic "1", providing a logic "1" on the three inputs; output pin 6 provides a logic "0".

3.7.16.1 Velocity and TTS Compute, Continued

The logic "0" at U305A on the distance board serves to inhibit PRF; when inverted by U519A, this output starts a TTS computation. The computation is inhibited when a logic "1" enable is applied to U504C-10, which allows the VCO to clock the 1000 bit Shift Register through U331C and U314D. In addition: U504B-5 is enabled and the output of the ÷76 Counter is fed to the input of the VEL/TTS Counters; U506D-12 is enabled to signify the end of computation by clocking out the pulse in the 1000 bit Shift Register input to U502A-2. An OR function of the preceding conditions is, if the VEL/TTS Counter has more than 89 minutes (counts; it is then detected by U520C, causing U505A and B to go through the same sequence as already described for velocity. At the end of multiplexing, the 15 second timer is restarted by a negative pulse from U517C.

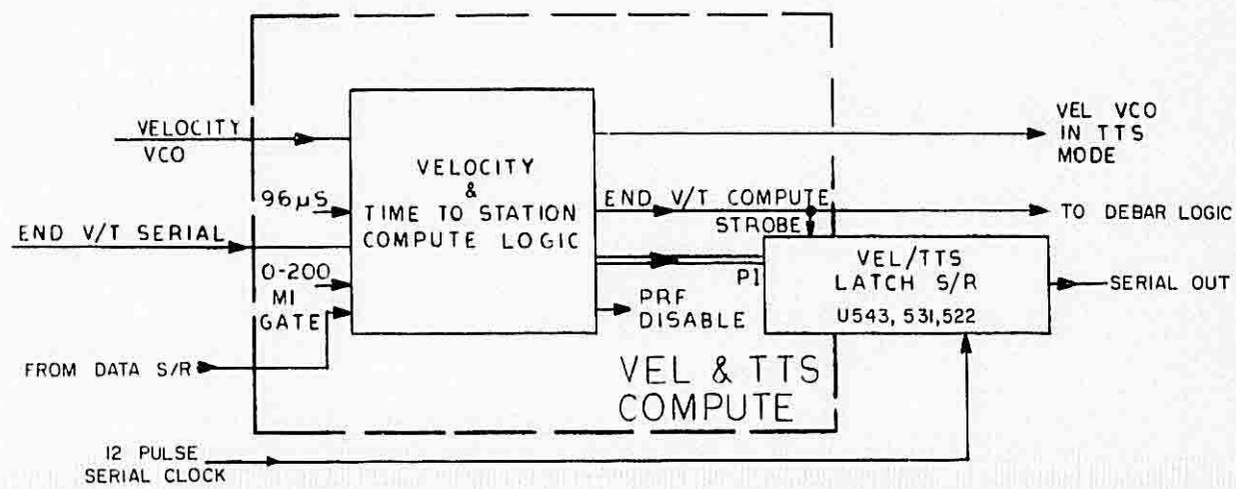


FIGURE 3.54. VELOCITY AND TTS COMPUTE, BASIC BLOCK DIAGRAM

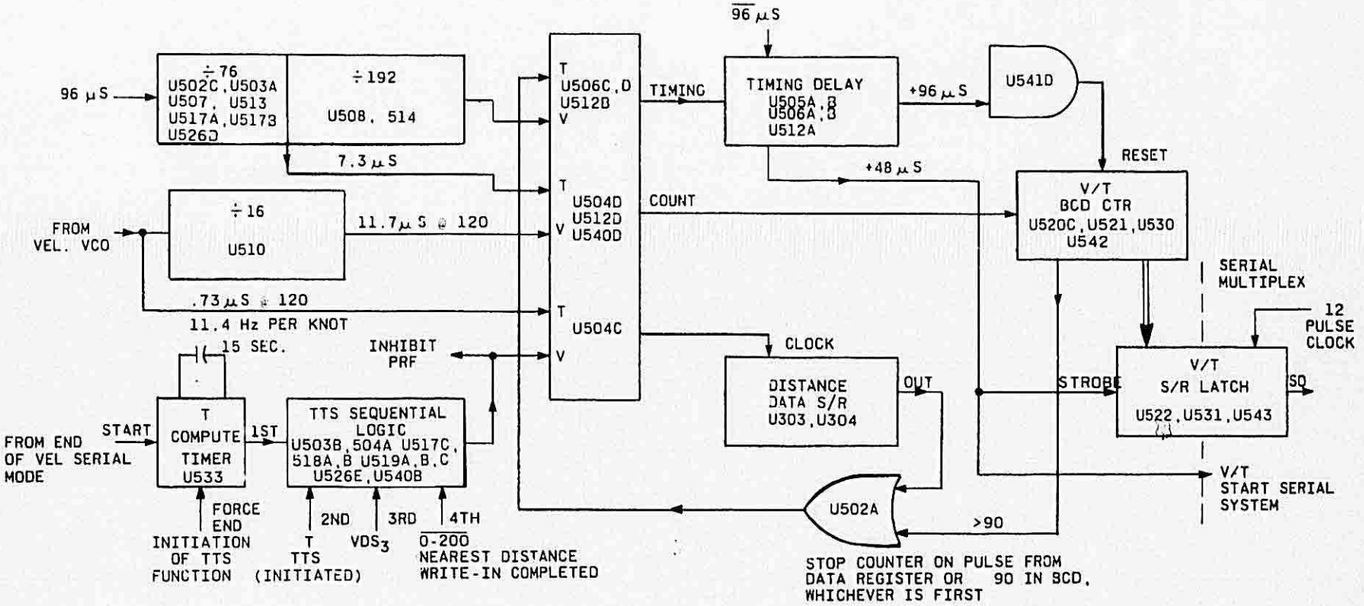


FIGURE 3-55. VELOCITY AND TTS COMPUTE, DETAILED BLOCK DIAGRAM

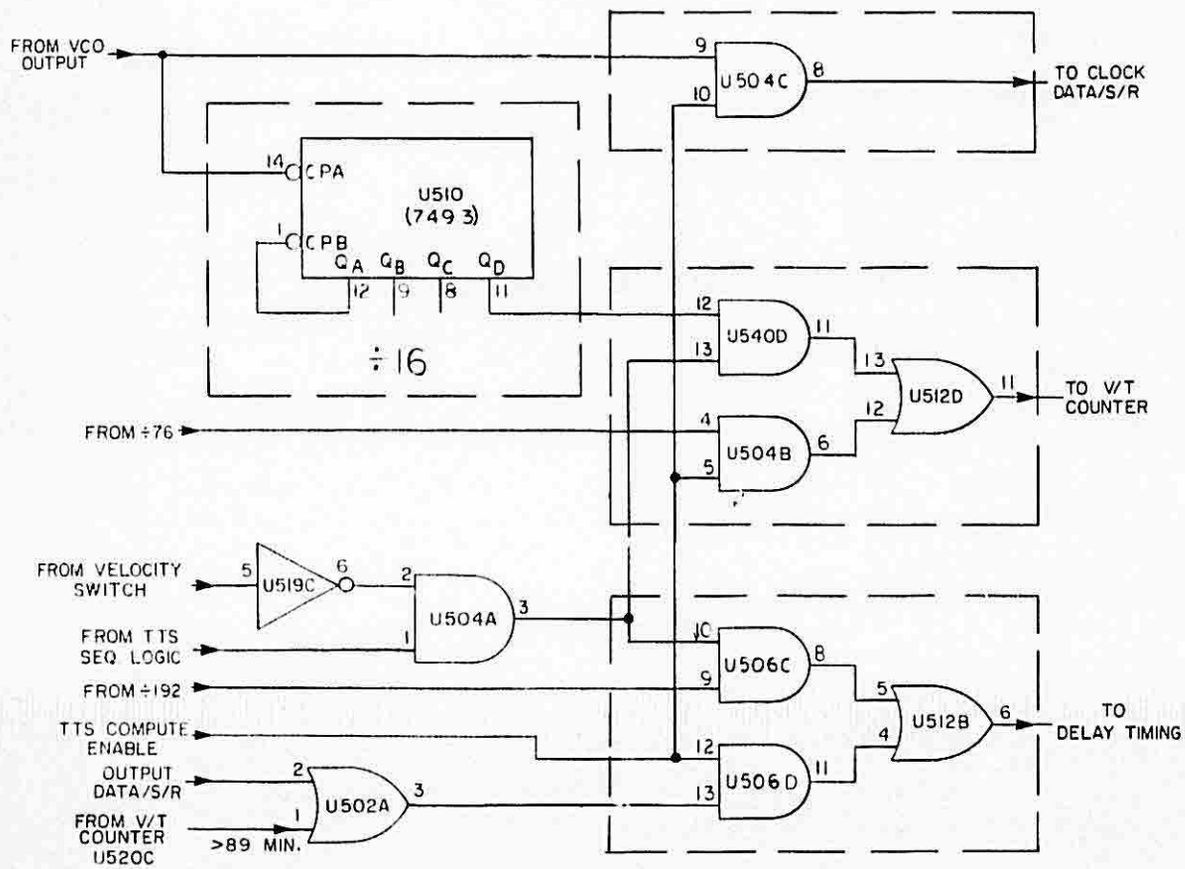


FIGURE 3-56. V/T ELECTRONIC SWITCH

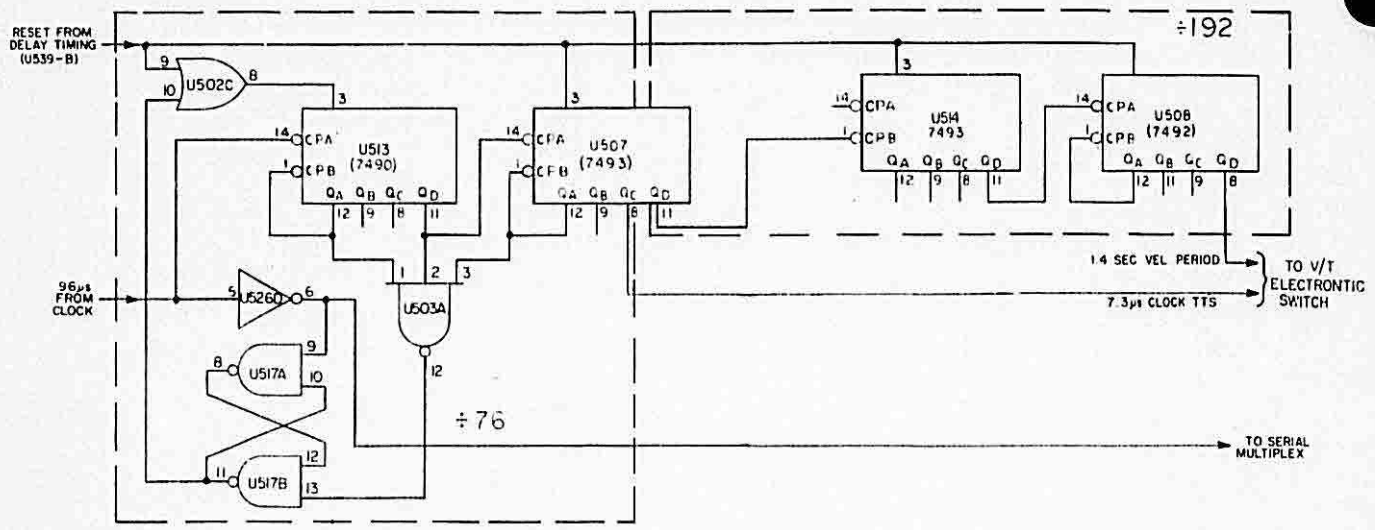


FIGURE 3-57. ÷76 AND ÷192 COUNTER

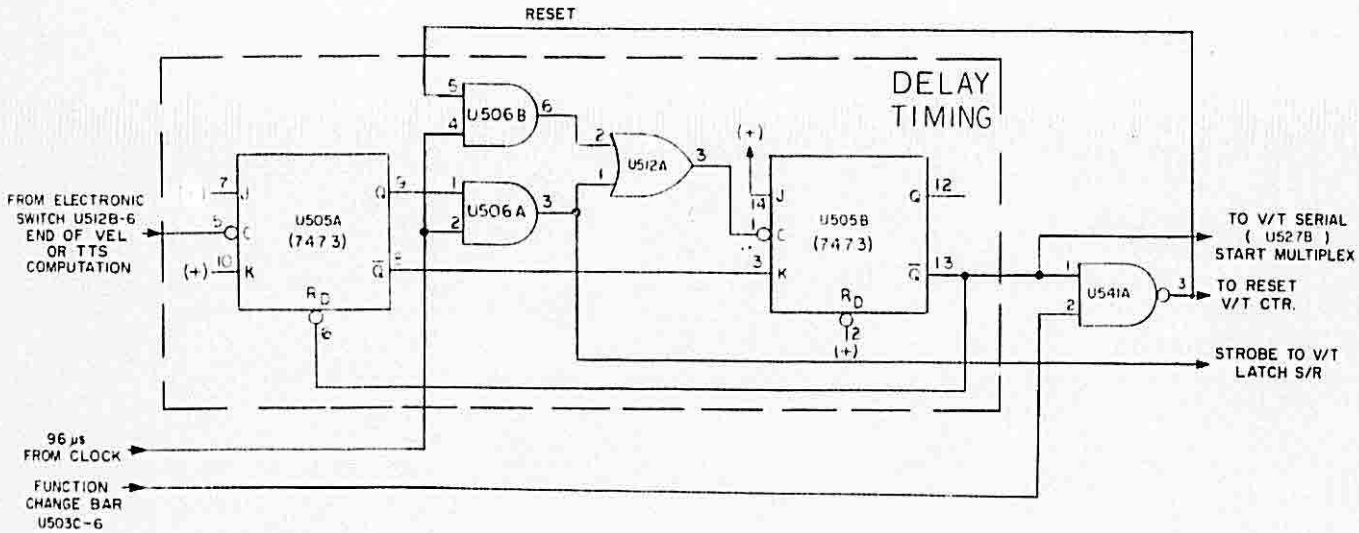


FIGURE 3-58. DELAY TIMING

SEE BLOW-UP

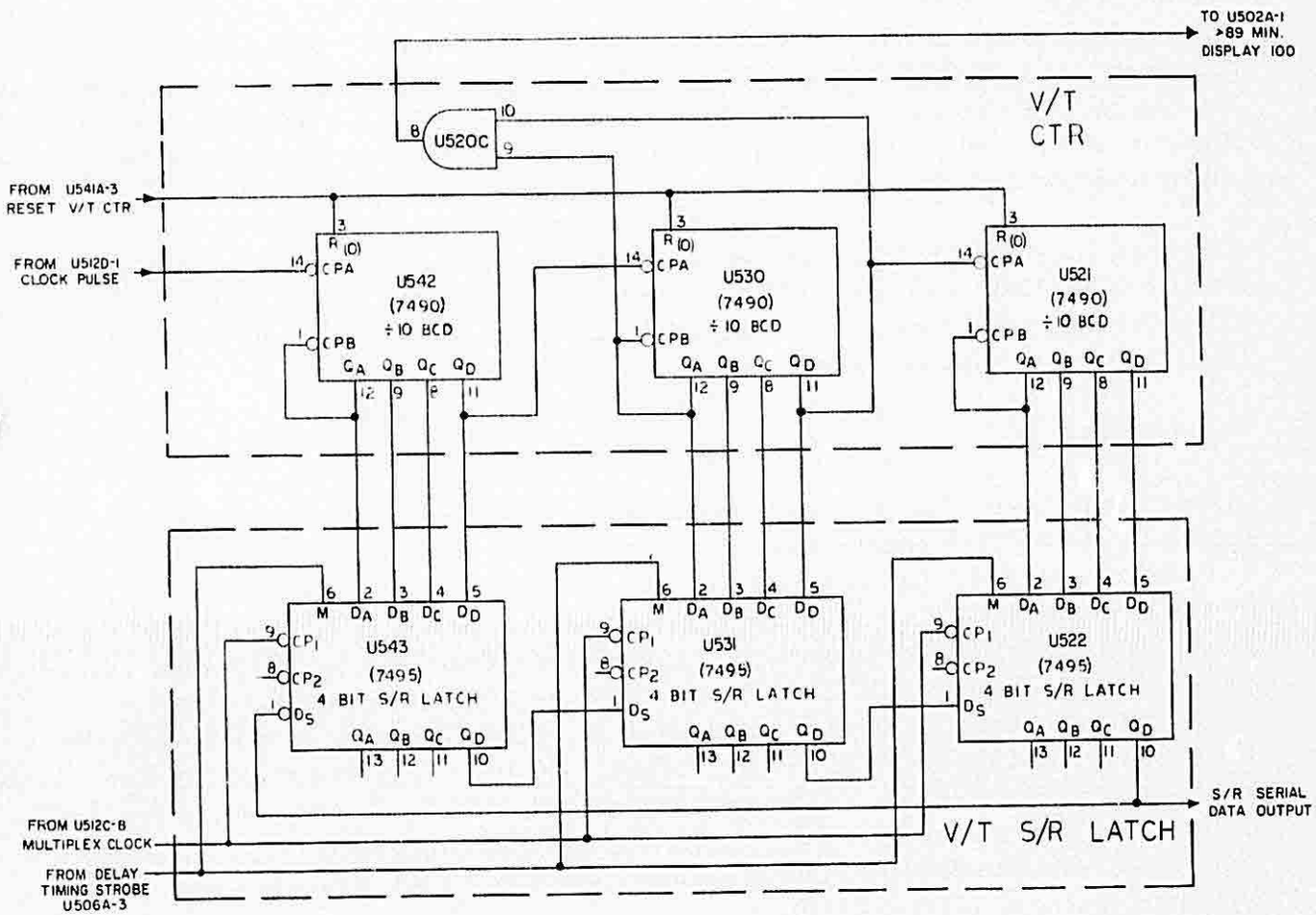


FIGURE 3-59. VEL/TTS COMPUTE AND SHIFT REGISTER

SEE BLOW-UP

3.7.16.2 Serial Multiplex

The serial multiplex serves to transfer BCD data from either the distance or VT Counters and Latches into the Display Shift Register. The data, which is loaded into the Shift Register Latches in parallel form, is recirculated and shifted out in serial form to the Display Shift Register. This transfer process, which would normally require 12 separate lines, requires only one data line and one clock line. A 12 pulse clock provides shift pulses for the multiplexing process. The clock is controlled by either of two separate serial control circuits; one for distance and the other for the velocity and TTS modes. Refer to Figure 3-60 for the schematic.

The Latches operate as follows: a strobe transfers data from the Counter output (connected to the Shift Register parallel inputs) for storage in the Latch; 12 shift pulses then shift the data from the Latch Shift Register into the display latches for loading in serial form; since the data out is also connected to the serial input, the data is also reinserted into the Shift Register; and a blanking pulse is applied to the Display Decoder for blanking the Decoder during multiplexing of the data.

The display information is strobed into Latches in BCD form using the parallel entry function of the Shift Register. The fourth distance digit (100s) is not multiplexed. In the distance mode, the Latches are U334, U326, and U317; for velocity and TTS modes, U543, U531, and U522 are used.

Distance Mode:

In the distance mode U529A, the distance serial, has a logic "1" at its D input. A VDS3 pulse will clock U529A causing the Q output to go high, enabling AND gate U520D. Twelve, 1.2 microsecond clock pulses through U520D and U512C will now serially remove the BCD distance data from the Distance Shift Register Latches (U334, U326, and U317). The twelve bits of BCD distance data removed from the Distance Shift Register are routed, and enter into, the display latches (U113, U114, and U115) through buffer U509A. Only twelve clock pulses are required to shift or transfer this BCD data so U512C also toggles ÷12 Counter U511. At the end of 12 counts U511 through U519F, clocks reset flip-flop U528A to reset the distance serial, U529A, and V/T serial, U529B. When reset the $\overline{Q}$ outputs of U529A and B are both high enabling NAND gate U541B to reset both the divide-by-12 (U511) and reset flip-flop (U528A) as well as enable the BCD to Seven Segment Display Decoders (U118, U119, and U120).

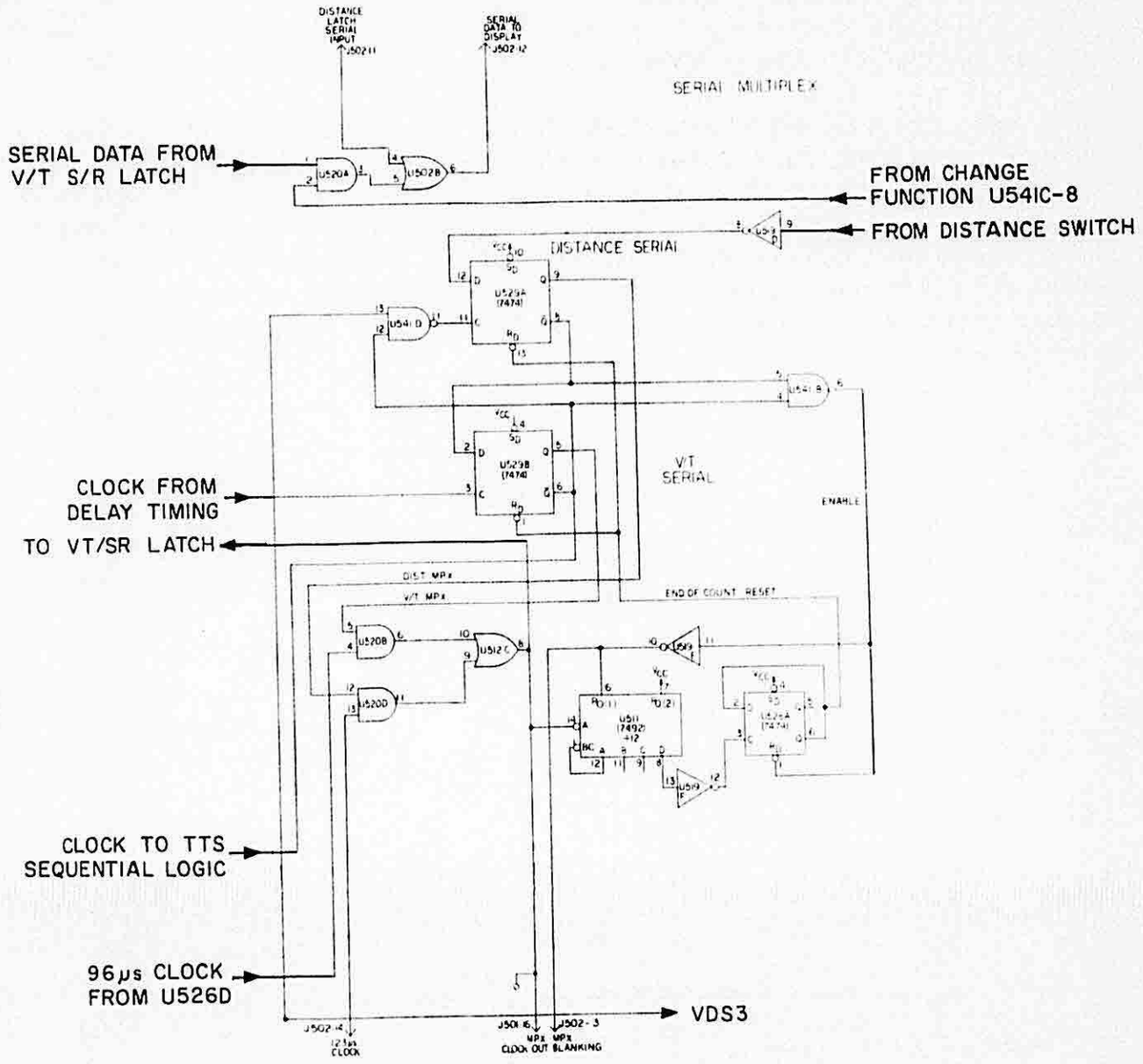


FIGURE 3-60. SERIAL MULTIPLEX

SEE BLOW-UP

3.7.16.2 Serial Multiplex, Continued

Velocity and Time-To-Station (TTS) Modes:

After velocity or TTS data is entered into the V/T S/R Latches the resetting of the display timing circuit U529B, the V/T Serial. Logic "1" at U529B's D input will appear at the Q output to enable U520B. This allows the inverted, by U520D, 96 microsecond clock to drive the V/T Shift Register Latches and ÷12 Counter. Similar to as in the distance mode, twelve clock pulses serially remove the BCD data from the V/T S/R and through U520A and U502B enter the data into the display Shift Registers. The distance and V/T serial are then reset to await either a VDS3 pulse or a reset clock from the delay timing circuit.

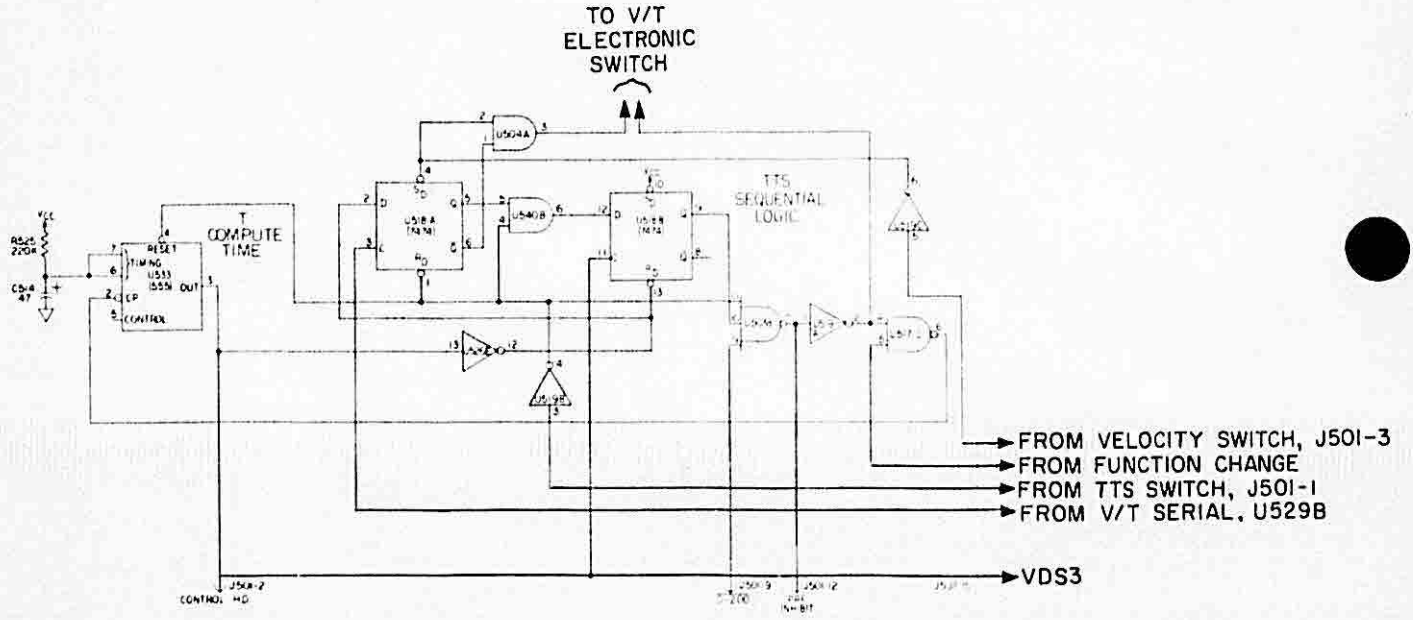


FIGURE 3-61. T COMPUTF TIME AND TTS SEQUENTIAL LOGIC

SEE BLOW-UP

3.8 TRUTH TABLES

To aid in troubleshooting and understanding the logic circuits of the DME 195 the following truth tables are provided.

TABLE 3.12 7473 DUAL JK MASTER/SLAVE FLIP-FLOP

t_n		$t_n + 1$
J	K	Q
L	L	Qn
L	H	L
H	L	H
H	H	Qn

Logic low to R_D, clear port, sets Q output to logic low.

TABLE 3.13 7474 DUAL D TYPE FLIP-FLOP

t_n	$t_n + 1$	
D	Q	Q
L	L	H
H	H	L

Logic low to S_D, preset port, sets Q output to logic high.

Logic low to R_D, clear port, sets Q output to logic low.

TABLE 3.14 7490 BCD DECADE COUNTER

Count	Output			
	Q_A	Q_B	Q_C	Q_D
0	L	L	L	L
1	H	L	L	L
2	L	H	L	L
3	H	H	L	L
4	L	L	H	L
5	H	L	H	L
6	L	H	H	L
7	H	H	H	L
8	L	L	L	H
9	H	L	L	H

Logic high to R_O, reset ports, sets all outputs to logic low.

TABLE 3.15 7793 4-BIT BINARY COUNTER

Count	Output			
	Q_A	Q_B	Q_C	Q_D
0	L	L	L	L
1	H	L	L	L
2	L	H	L	L
3	H	H	L	L
4	L	L	H	L
5	H	L	H	L
6	L	H	H	L
7	H	H	H	L
8	L	L	L	H
9	H	L	L	H
10	L	H	L	H
11	H	H	L	H
12	L	L	H	H
13	H	L	H	H
14	L	H	H	H
15	H	H	H	H

Logic high to R_O ports sets all output to logic low.

TABLE 3.16 74LS75 4-BIT BISTABLE LATCH

INPUT		OUTPUT	
D	E	Q	$\overline{Q}$
L	H	L	H
H	H	H	L
X	L	Q_o	$\overline{Q}_o$

TABLE 3.17 14502 STROBED HEX INVERTER/BUFFER

Logic Table For Each Gate		
Input		Output
D_n	Disable	Q_n
0	0	1
1	0	0
X	1	High Impedance

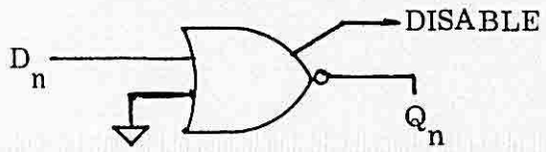


TABLE 3.18 SUMMARY OF LOGIC GATES

Inputs		Gate Output				
A	B	AND	NAND	OR	NOR	EX OR
L	L	L	H	L	H	L
L	H	L	H	H	L	H
H	L	L	H	H	L	H
H	H	H	L	H	L	L

INDEX'D TERMS/ABBREVIATION GLOSSARY

VCO - Voltage Controlled Oscillator
SYNC - Synchronous
BCD - Binary Coded Decimal
V/T - Velocity/Time
VEL - Velocity
TTS - Time-To-Station
VDS - Valid Data Strobe
PRF - Pulse Repetition Frequency
S/R - Shift Register
CTR - Counter
M or MI - Mile
BUFF - Buffer
R NAV - Area Navigation
SRD - Step Recovery Diode
L.O. - Local Oscillator
ECL - Emitter Coupled Logic
TTL - Transistor Transistor Logic
IF - Intermediate Frequency
AGC - Automatic Gain Control
XMIT - Transmit (er)
CLC - Course Line Computer
PPS - Pulse Pair Per Second
KN - Nautical Mile
$\triangle$ - "A change of"
PUT - Programmable Unijunction Transistor

VDS1 = Pulse whose time relative to the encode period represents the DME distance to the ground station.
VDS2 = Same as VDS1 unless optional R NAV is used. With R NAV the synchronous position of VDS2 may lead or lag VDS1, and VDS2 will be present one period later (approx. +33ms).
VDS3 = Further processed to reduce jitter, but with consequent higher countdown.

SI - serial input
SO - serial output
SW - switch
PI - parallel input
PO - parallel output
MPX - multiplex

DME 195

MAINTENANCE

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4.1 GENERAL

This Maintenance Section provides information necessary to recognize improper operation of the DME, localize the trouble to the malfunctioning board, and repair the board. For this purpose, the maintenance is separated into various levels; each level is more complex since it requires more detailed tests.

The first level of maintenance is performed with the DME in the case to check the operation of each of the three functions; distance (miles), velocity (knots), and TTS (min). The second level of maintenance permits isolation of the malfunction to the appropriate PC board. This procedure is not 100% effective since it covers only the major signal paths.

In addition, alignment and adjustment procedures are given in Section 4.5.

4.1.1 Indicator Disassembly and Reassembly

The following procedure may be followed to gain access to the Indicator's subassemblies. Refer to Figure 4-1.

A. Disassembly

1. To remove dust cover:
   a) at the rear of the Indicator, remove the two screws which hold the cover to the chassis.
   b) slide the Indicator forward from the dust cover.

2. To remove the front panel:
   a) the ON-OFF/Volume knob is removed after loosening its No. 2 setscrews with an allen wrench.
   b) from each side of the front panel remove two screws.
   c) set the N1-N2-HLD switch to HLD.
   d) gently pull the front panel forward from the flex circuit assembly.
   e) from the DIM/PUSH TEST control shaft remove a "hat" shaped switch section and a spring.

3. To open the flex circuit assembly:
   a) remove six screws holding the "U" shaped chassis to the flex circuits.
   b) spread the legs of the chassis slightly to free the display circuit boards, then slide the flex circuits through the open end of the "U".
   c) from the center of the top of the flex circuit remove one screw.

B. Reassembly

Reassembly is basically the reverse of the disassembly. Refer to the flex circuit assembly drawing when folding and closing the assembly.

Reassembly Notes:

1. When reinstalling the front panel carefully align the N1-N2-HOLD mask with the switch shaft.
2. Be sure all lamps are aligned with their openings in the front panel.

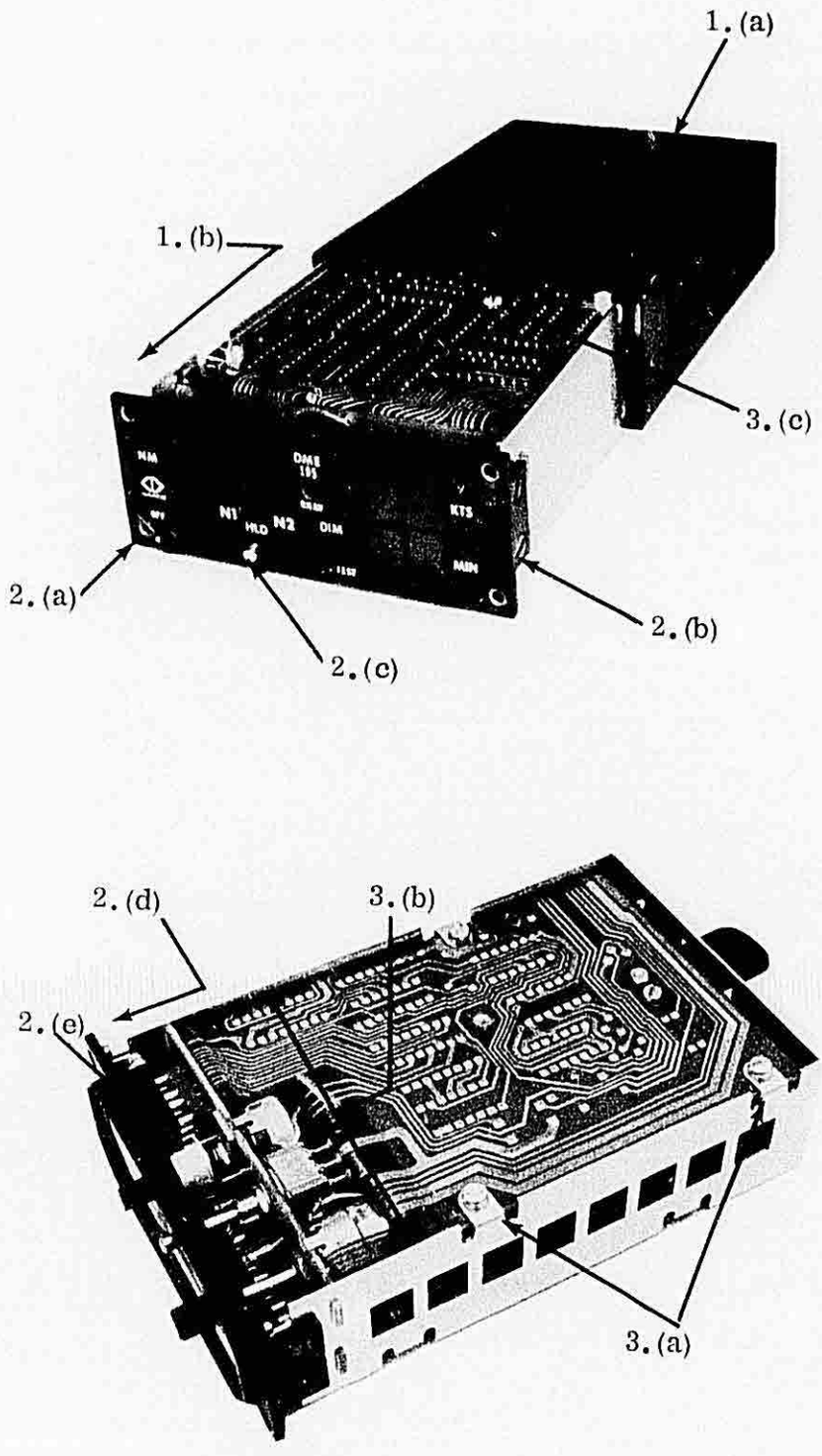


FIGURE 4-1. INDICATOR ASSEMBLY

4.1.2 Remote Unit Disassembly and Reassembly

Refer to Figure 4-2 which shows the Remote Unit with its subassemblies folded out. This figure also shows how each is secured to the chassis.

Note that should the Power Supply be hinged out or removed, be sure when reassembling, to use a thermal compound for heatsinking.

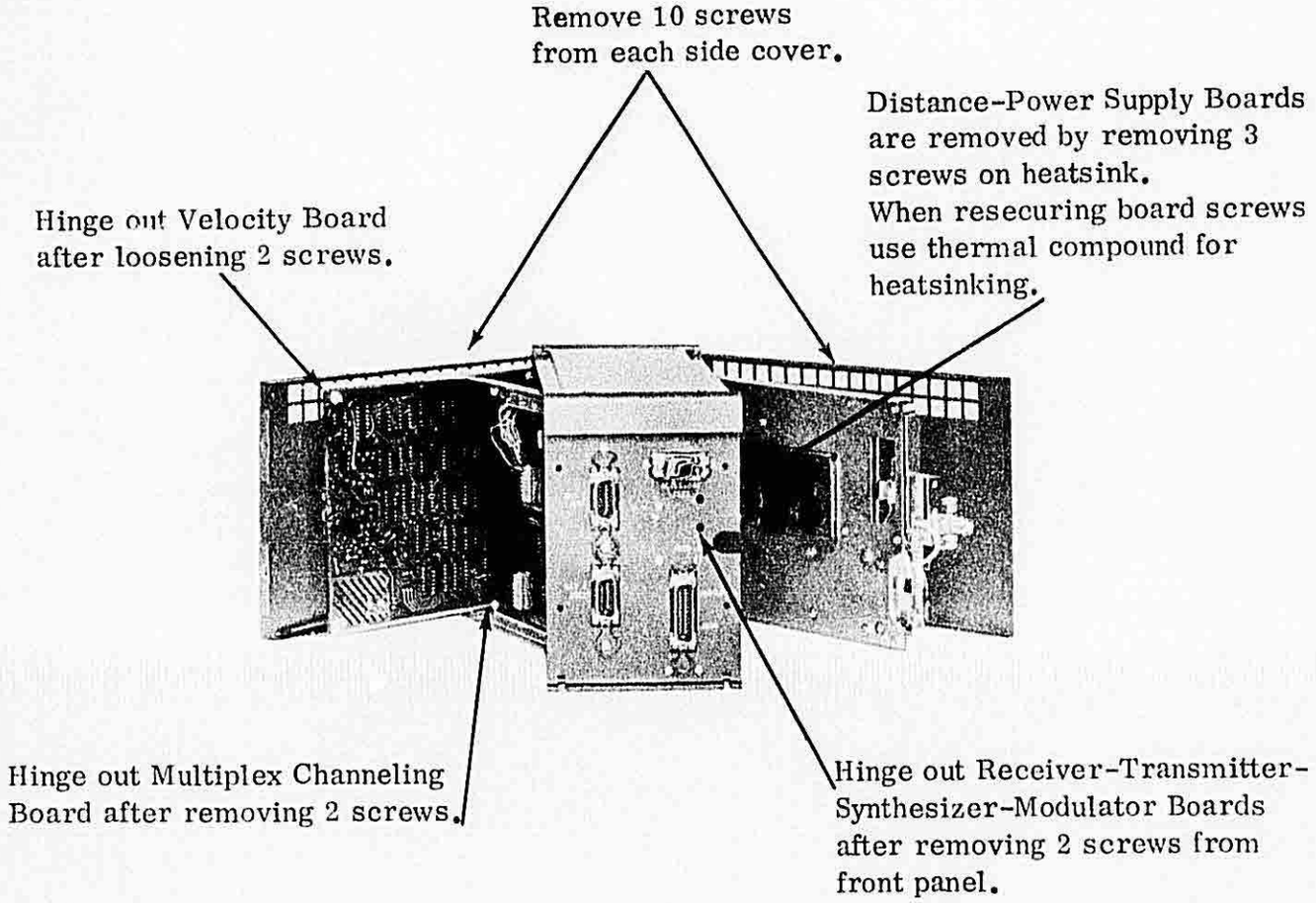


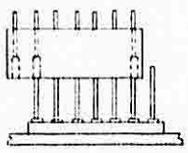
FIGURE 4-2. INTERROGATOR/RECEIVER (Remote Unit)

4.2 WIRING

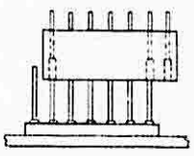
The DME 195 construction is modular with a wiring harness interconnecting the PC boards. Wires in the harness are connected to the PC boards by soldering and/or inserting into 14 or 16 pin connectors located on the three large PC boards; wires are soldered to all other PC boards.

WARNING!

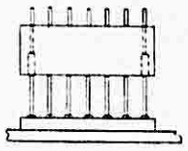
When replacing a PC board connector be sure that the pins mate properly BEFORE energizing the Unit. The following connections can happen:



WRONG



WRONG



RIGHT

TABLE 4.1 PC BOARD IDENTIFIERS

Symbol Number Group	PC Board
100	Indicator
200	Channel Multiplex
300	Distance
400	Power Supply and Modulator
500	Velocity
600	Transmitter
700	Synthesizer
800	Receiver

4.3 MAINTENANCE

4.3.1 Basic DME Control Circuits

Before attempting to isolate any trouble in the DME, knowledge of the circuit operation is necessary; refer to Section 3 for the Circuit Description. As shown, in Figure 4-3, some circuits provide basic clock and control signals that are necessary to the operation of other circuits. In addition to these basic signals that are common to all modes of operation, there are other localized control loops such as AGC, signal density, etc. Each mode of operation has a unique group of operating conditions that will be covered in the next level of maintenance. The basic conditions required for circuit operation and interrelationships between circuits are discussed in the following text.

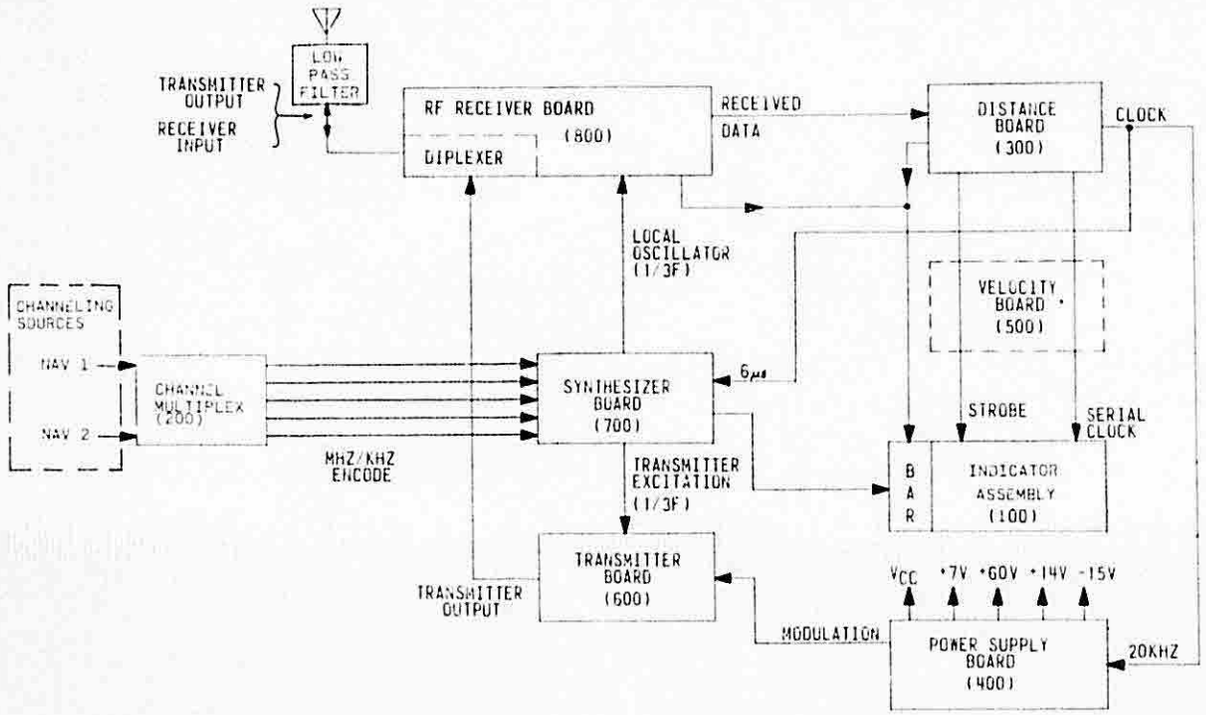


FIGURE 4-3. MODULAR INTERCONNECTIONS

4.3.1.1 Clock Control of Synthesizer and Power Supply

The clock generator (on distance board) provides timing signals throughout the DME; however, +5 volts operating power must be obtained from the switching regulator power supply. The DC/DC converter power supply requires a 20 KHz signal from the clock to produce the higher operating voltages. The synthesizer provides RF excitation to the transmitter and local oscillator injection to the receiver only when clock pulses are supplied. A synthesizer malfunction would affect either or both the receiver and transmitter. Since the ground station generates "squitter" when no interrogations are present, we must simulate this or feed pulse pairs into the receiver to enable operation of the transmitter. This is done by normal receiver noise. The transmitter provides an output when a signal is received, clock pulses are applied to the synchronous timing and it is enabled to generate a pulse pair from the modulator; modulator output then applies the power to the transmitter in accordance with the pulse pairs applied (X or Y pulse spacing). A clock generator malfunction would affect the receiver, modulator, power supply, and transmitter operation. The receiver output, processed properly on the distance board, provides a strobe to the display-latch; if clock pulses are fed to the Indicator assembly but no strobe is evident, the malfunction could be on the receiver or distance board. Refer to Figure 4-3 for block diagram.

The above operating characteristics may be utilized in planning an approach to troubleshooting the DME 195; an overall check is as follows. The check for +14, -15, and +60 volts from the DC/DC converter confirms operation of the switching regulator (+7V), DC/DC converter, and the presence of 20 KHz pulses from the clock. The check for transmitter output confirms operation of the DC/DC converter, pulse generator, synthesizer, noise being present, decoder, synchronous timing, modulator, and transmitter. Check for receiver output confirms operation of the receiver with its AGC circuits. Check for strobe and clock outputs from the distance board confirms operation of the switching regulator, receiver, synthesizer, and the transmitter. Visual check of display confirms operation of all circuits.

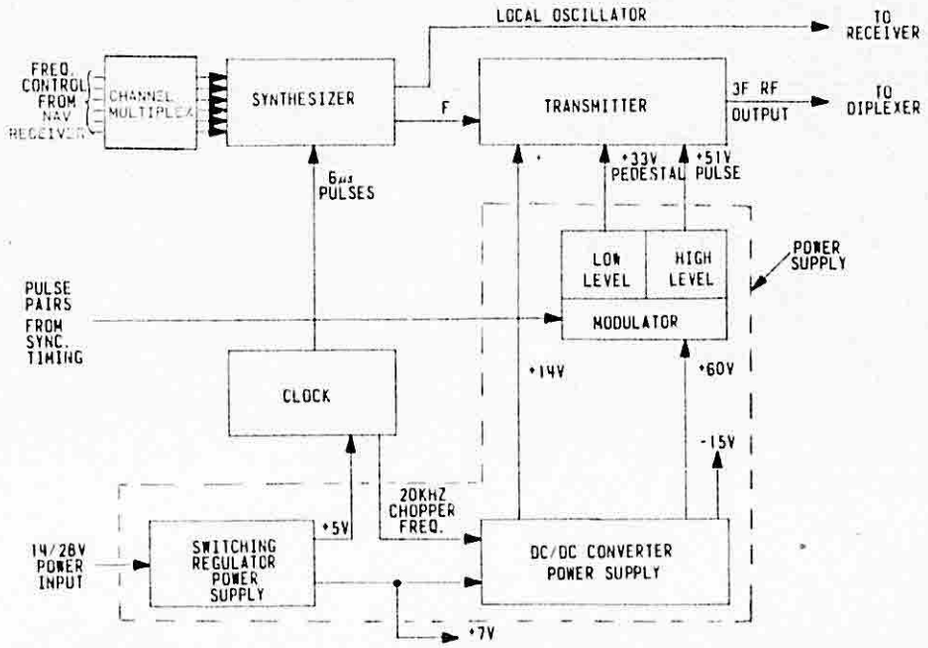


FIGURE 4-4. DME 195, RF GENERATION AND CONTROL

4.3.1.2 Receiver/Transmitter Operation Sequence

The basic receive/transmit operation cycle starts when squitter from the ground station has been received at the diplexer and is fed to the receiver. The receiver detects the squitter and the decoder recognizes the pulse spacing; this 2.4 microsecond width data then enables the transmitter through the synchronous timing as shown in Figure 4-5. When an "epic start" is fed to the PRF generator, the synchronous timing is enabled. The resulting 0-48 microsecond pulse performs two functions; inhibits the decoder during this epic, and enagles the modulator encoder. When enabled, the modulator provides two outputs: a pair of +33 volt pedestal pulses to the low level stages of the transmitter and a receiver disable to the diplexer; and a pair of +51 volt pulses to the high level module of the transmitter. The transmitter output is fed into the diplexer, which then connects the transmitted signal to the antenna through the Low Pass Filter.

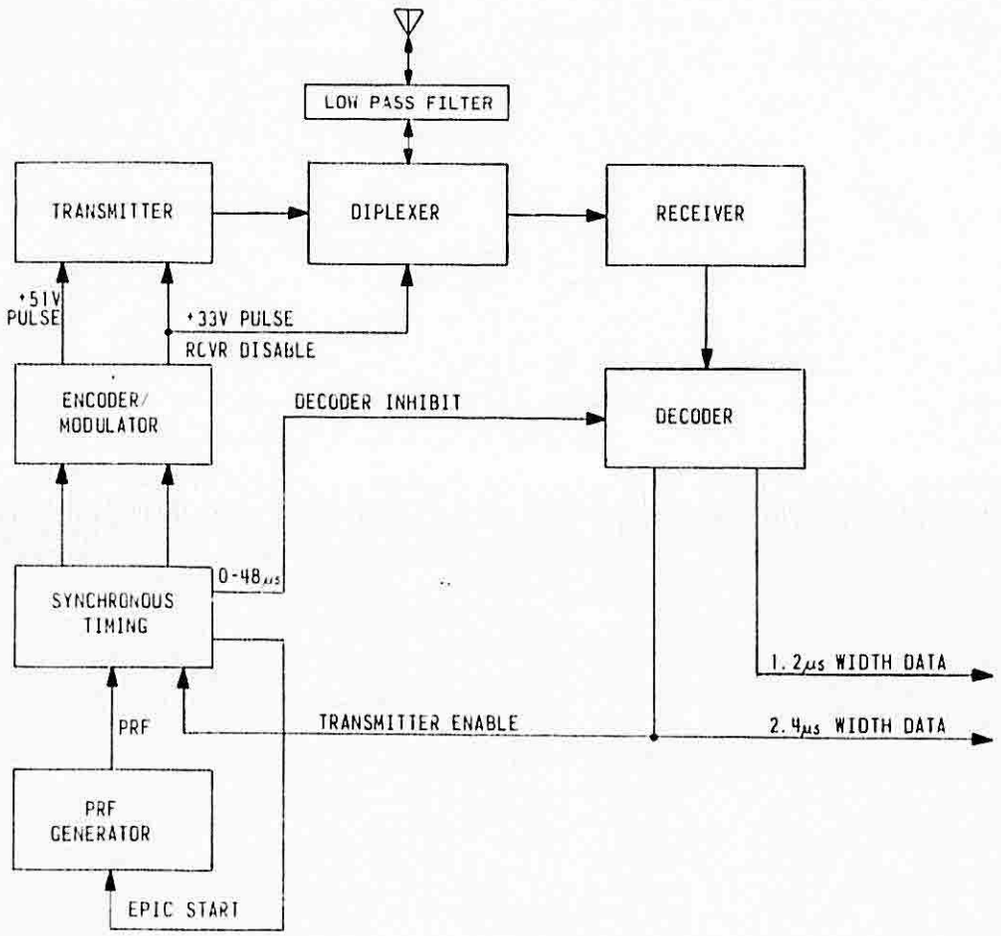
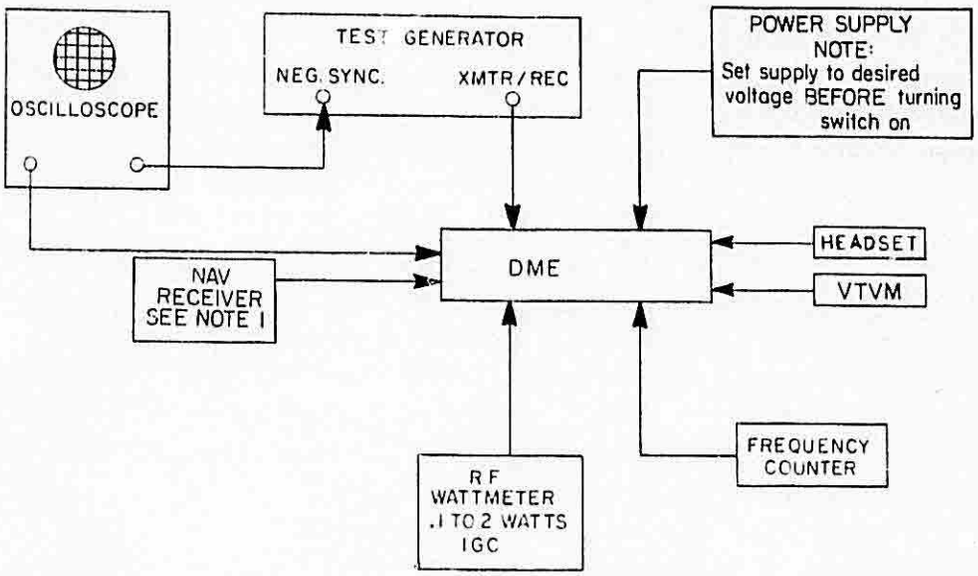


FIGURE 4-5. RECEIVER/TRANSMITTER CONTROL



NOTE 1

For NAV/DME channeling code (programming) refer to the label on the connector end bell of the Remote Unit. The absence of a label indicates std. NARCO DME Channeling.

RF Signal Generator
HP 608D or equivalent

VTVM
RCA Voltohmyst or equivalent

Test Generator
IFR's ATC 1200Y3 or equivalent

Power Supply
10/36v, 5amp
(Must support surge current for turn ON of DME.)

Oscilloscope
Tektronix 515A or equivalent

Frequency Counter
HP 524 or equivalent

RF Wattmeter
Bird Termaline, Model 61
or equivalent

* HP = Hewlett-Packard

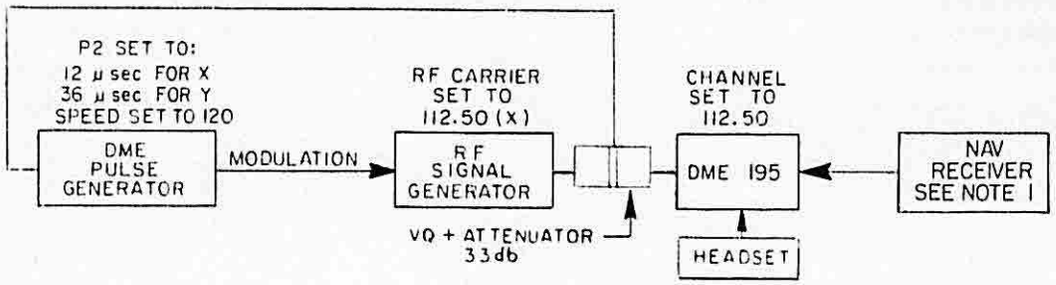


FIGURE 4-6. DME 195 TEST SET-UP

4.4 TROUBLESHOOTING FLOW CHARTS

The troubleshooting procedures are given in the flow charts, Figures 4-7 and 4-8. The first flow chart provides a testing sequence for an operational checkout without removing the DME 195 from its outer cases. The second flow chart provides a testing sequence for checkout of each PC board in the DME. This flow chart must be used in conjunction with the PC board interconnection block diagram (Figure 4-3) and Table 4.2 for signal interpretation.

Each flow chart has a series of questions (diamond shaped decision blocks) and procedures (rectangular instruction blocks) starting at the upper left corner of each flow chart. Beginning with an instruction block, a question in the decision block that follows must be answered about circuit operation. If the answer is "YES", the "YES" path is followed toward the bottom of the flow chart. Procedural blocks permit changing the test conditions before making any decision. The "NO" decision, from the right side of the diamond shaped block, indicates the circuit at fault and the board to troubleshoot.

4.4.1 Overall DME 195 Checkout Flow Chart (Figure 4-7)

This first level flow chart permits checkout of the distance, velocity, and time-to-station functions with the DME in its case. The DME pulse generator permits simulating operating conditions and observing the Indicator for each function. Refer to Figure 4-6 for the test setup. If each decision has a "YES" answer, the DME operation is correct. If any decision has a "NO" response, the DME is not operating properly and the "NO" line identifies the area at fault.

4.4.2 Trouble Isolation Flow Chart, PC Board Level (Figure 4-8)

Having confirmed the DME 195 is not operating properly through the use of the first level flow chart, the second level flow chart (Figure 4-8) is then used to locate the PC board at fault. Figure 4-3 shows all PC boards and major data interconnections between boards; appropriate test points are indicated on the flow chart for monitoring data. This method of troubleshooting utilizes only major data flow, other minor feedback loops and interconnections such as AGC, epic start, PRF enable, etc., are indicated on the system functional block diagram, Figure 6-1. It is considered that a great percentage of DME faults will be evident at the test points indicated. Having identified the malfunction to the PC board at fault, repair or replacement of the PC board should return the DME to operational readiness.

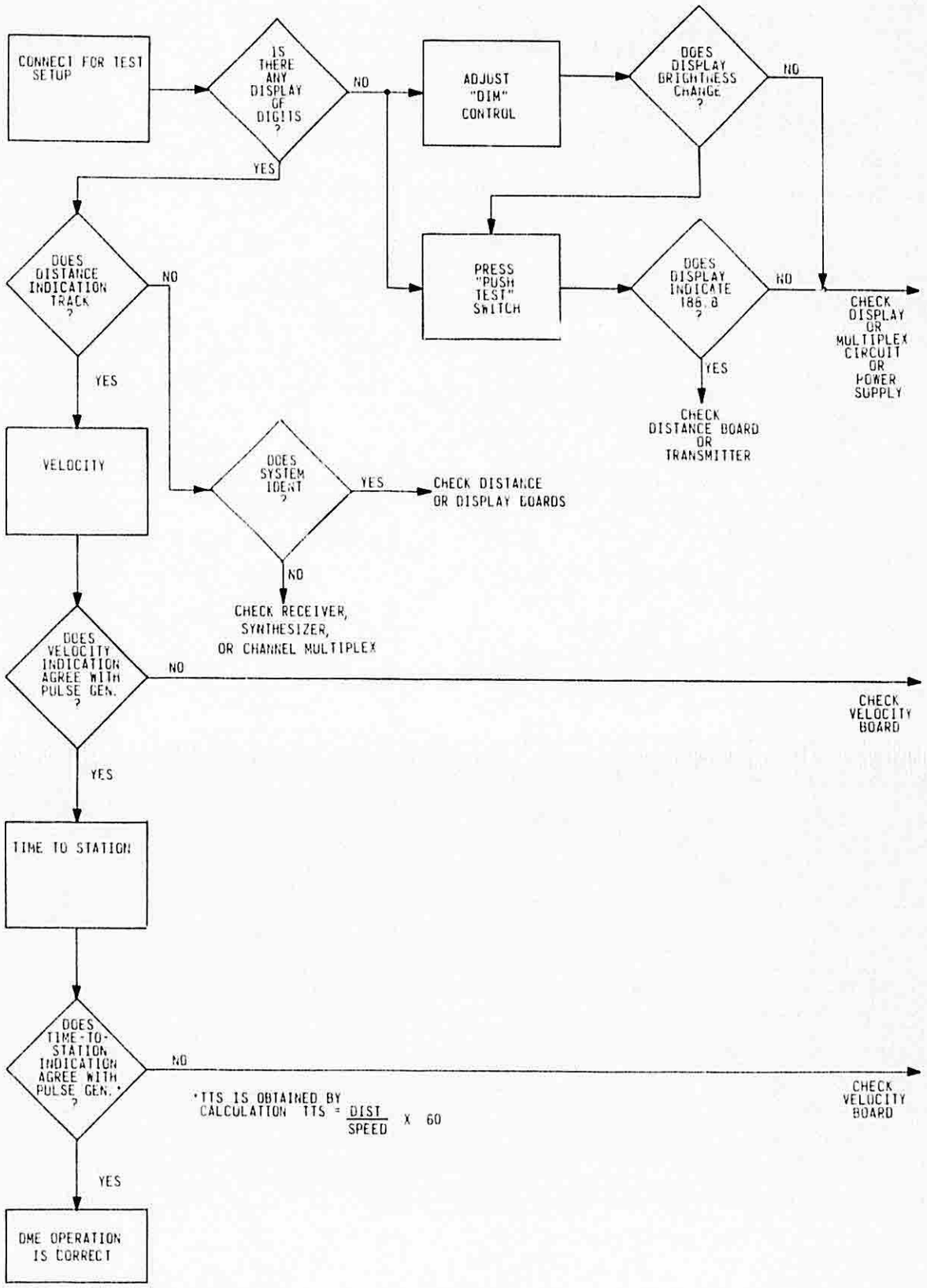


FIGURE 4-7. DME 195 FUNCTIONAL CHECKOUT FLOW CHART

SEE BLOW-UP

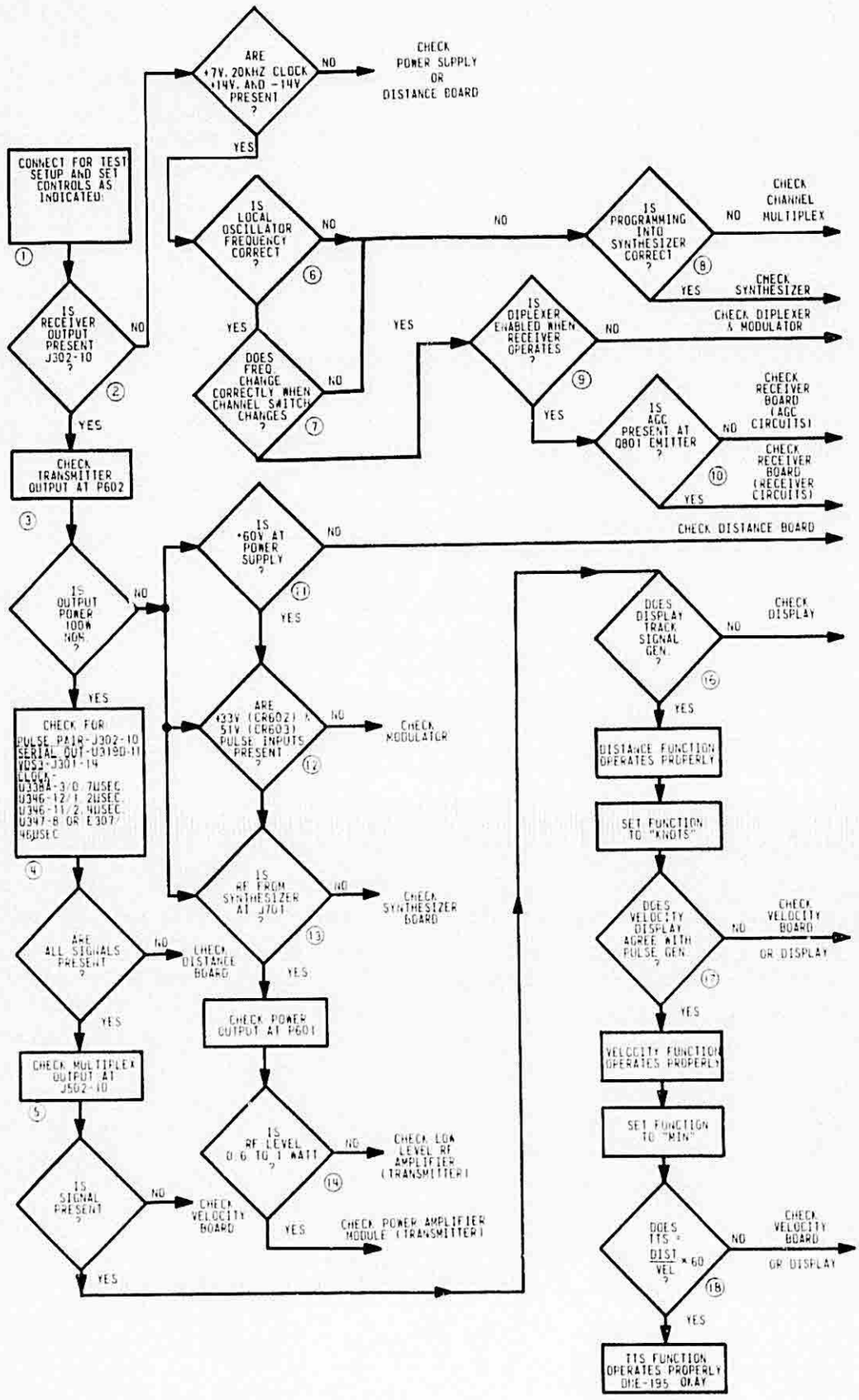


FIGURE 4-8. DME 195 TROUBLE ISOLATION FLOW CHART

SEE BLOW-UP

TABLE 4.2 TROUBLE ISOLATION FLOW CHART, TEST POINTS, AND SIGNAL INTERPRETATION.

BLOCK NO.	TEST LOCATION	SIGNAL CHARACTERISTICS
1	See Figure 4-6	Connect test setup and set controls for test
2	Q802 Emitter	Data output from receiver pulse pair PRF = 28 Hz
3	P602	Transmitter output, 100W nominal, double pulse, pulse spacing for: X = 12 usec and Y = 36 usec, PRF of pulse pair = 28 Hz
4	J302-10 U319D-11 Clock: U338A-3 U346-12 U346-11 U347-8 or E307	TTL Data from receiver Serial distance to multiplex continuous pulses: Pulse width 0.7 usec 1.2 usec 2.4 usec 48 usec
5	J502-10	Serial distance from multiplex (same as U319D-11)
6	Q708 Collector	Refer to Table 3.1 for all LO Frequencies
7	Q708 Collector	Change channel switch and check tracking in Table 3.1.
8	U701 thru U705	Check input switching vs output code, refer to Table 3.10 for circuits to ground.
9	Preselector in: Junction C841/R829	-1.4 VDC
10	Q801 Emitter	Output: .8V dc down to .2V dc depending on signal strength
11	Junction CR453/C452	+60 VDC
12	CR602 Cath CR603 Cath	+33 Volt pulse pair +51 Volt pulse pair
13	J703	1.0 to 1.1 mw. Refer to Table 3.1 for frequency.
14	P601	0.6 to 1.0 watt pulsed RF
15	F450 Junction R450/C451	+7 VDC 20 KHz clock (5.0V)
16	Visual Display	Digital Change
17	Visual Display	Digital display must be equal to $\frac{\text{DISTANCE}}{\text{VELOCITY}} \times 60$

4.5 ALIGNMENT AND ADJUSTMENT

Connect as shown in Figure 4-6 and proceed with the alignment and adjustments.

4.5.1 Frequency and Pulse Measurements

4.5.1.1 Clock Generator Checkout and Adjustments

a. Apply power to DME 195.
b. Connect frequency counter to crystal oscillator output U301C-10; frequency should be 5.666666 MHz ± 75 Hz (+ = 5.666741, - = 5.666591).
c. If frequency is not within these limits, change value of capacitor C301 to obtain correct clock frequency.

4.5.1.2 Synthesizer Checkout and Adjustment

The frequency synthesizer checkout comprises a check of the ÷ 11/12 frequency prescaler followed by a check of VCO frequencies throughout the band. Procedures are given for adjustment of these circuits.

4.5.1.2.1 ÷ 10/11 Frequency Prescaler (U707)

1. Measure voltage drop across R716.

Note: If IC U707 is a Plessey SP 640/74068-1, the reading shall be 1.32 ± 0.02 VDC; if a Fairchild 95H90/74068-2, the reading shall be 1.25 ± 0.02 VDC.

2. If voltage indication is not correct, adjust R717 as required.

4.5.1.2.2 Voltage Controlled Oscillator (VCO) Checkout (Q705)

1. Connect frequency counter to VCO buffer (Q704 or Q708) at J703.
2. Set channel switch to 117.90. The frequency counter reading shall be 383.333 MHz.
3. Connect DC Voltmeter to VCO control line (junction of R734 and Q706 collector) and record voltage.
4. Connect jumper from Q705 collector to ground and record voltage. The voltages should fall between -9 and -9.6 VDC, a difference of 0.5 and 0.7 VDC.
5. If the voltage difference is not between 0.5 and 0.7 VDC, adjust L707 and repeat steps 3 and 4 as required.
6. Check KHz channeling as follows:
   a. With MHz selector at 117, rotate KHz control from 0.1 to 0.9 and record frequencies; an indication of 380.33 MHz should be obtained for 117.0 channel.
   b. Refer to Table 3.1 for VCO frequency at each KHz channel. Each KHz step should increase frequency in 333 KHz steps.
7. Check 0.10 MHz as follows:
   a. With 0.10 MHz selector at 0.0, rotate the MHz control from 108.0 to 117.0 and record frequencies.
   b. Refer to Table 3.1 for VCO frequencies at each MHz channel. Each MHz step should increase frequency in 3.33 MHz steps; 112 to 113 should be a 6.66 MHz step.
8. Set MHz switch to 108.0 and check that VCO control line voltage falls between -6.0 and 8.0 VDC.

4.5.1.2.3 Transmit Buffer Amplifier

a. Connect J703 to RF Wattmeter and set channel selector switch to 117.9
b. Check power output, and record.
c. Set channel selector switch to 108.0; output power shall be 1.0 $\pm$ 0.5 dB less than power output at 117.9 channel.
d. If not within these limits, adjust L705 as required.
e. With channel selector switch set to 117.9, adjust L703 for 0 DBM output.
f. Rotate channel selector switch through all MHz channels. All MHz frequencies shall fall between +1 dB -3 dB power limits.
g. If not within these limits, Readjust L703.
DO NOT ADJUST L706!

4.5.1.3 Power Supply Checkout and Adjustment

The power supply check confirms proper operation of the switching regulator. The output of this 7 volt (nominal) power supply shall be 7.3 volts maximum; if not, connect a DC voltmeter from F450 to ground and proceed as follows: (14v = 7.3v/28v = 7.3 $\pm$ .5v).

a. If above 7.3 VDC, connect a resistor test box across R454 and vary resistance until a 7.3 volt reading is obtained. Solder an equivalent value resistor across R454.

b. If below 7.3 VDC, connect a resistor test box across R456 and vary resistance until a 7.3 volt reading is obtained. Solder an equivalent value resistor across R454.

4.5.2 Alignment

The alignment procedures given in this section are provided as a method of checking the tuning of RF circuits in the DME 195. Connect for alignment check as shown in Figure 4-9. In most cases it will be found that gain and bandwidth are within the specified limits. Although alignment instructions are given, it is suggested that alignment be performed only when absolutely necessary.

4.5.2.1 Cautions

The transmitter power amplifier cannot be disassembled for repair. Any tampering will void the warranty. If found to be defective, it must be exchanged as a module available at NARCO.

The preselector has been aligned at the factory - further alignment should not be required.

In the course of alignment, it is necessary to remove shielding covers for access to various circuits. After test and adjustment, the cover(s) must be replaced and secured as they originally were. Thus when replacing a cover that was soldered on, observe the grounding, and re-solder at the EXACT point(s) as previously soldered.

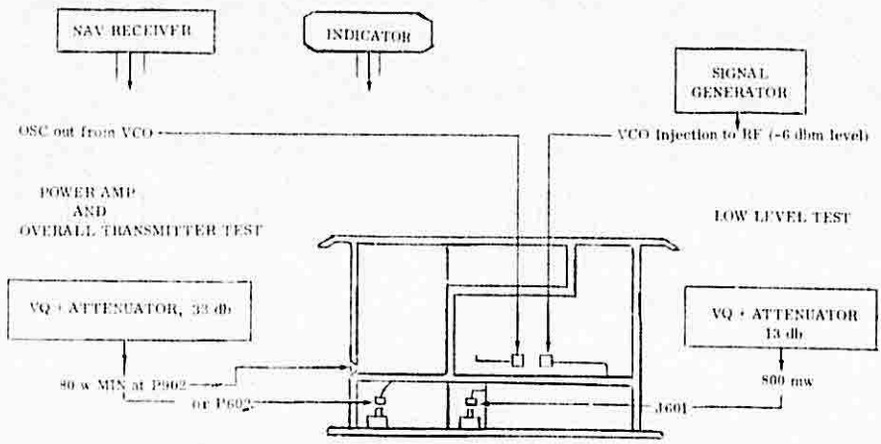


FIGURE 4-9. ALIGNMENT TEST SET-UP

4.5.2.2 Receiver Alignment

The preselector is factory aligned and should not require field alignment. If it should prove defective, replace it with a factory aligned replacement.

In this IF alignment, L803 through L808 are tuned by adjusting the coil cores to provide a minimum AGC voltage. The cores can be rotated for tuning, however, after tuning in and out for a peak many times this excessive core movement will loosen the threads and the coil can become sensitive to vibrations. If the slug becomes loose, it should be removed, a single strand of lacing cord or equivalent inserted into the coil, and the slug once more screwed in for adjustment. At this time, the additional friction between threads will hold the core in place. Under no conditions should cement be used to secure the core.

Procedure:

1. Connect as shown in Figure 4-6.
2. Connect a VTVM to R807. The cover over the Receiver Board should be removed, a short length (about 1 inch) of bus wire should be soldered to the lead of R807; reinstall the cover and connect the VTVM to the bus wire.
3. Set the 1200Y3 output attenuator to produce 2.5 vdc on the VTVM.
4. Tune L803 through L808 for minimum AGC voltage. As tuning progresses reduce the input RF level to maintain the AGC at approximately 2.5 vdc.

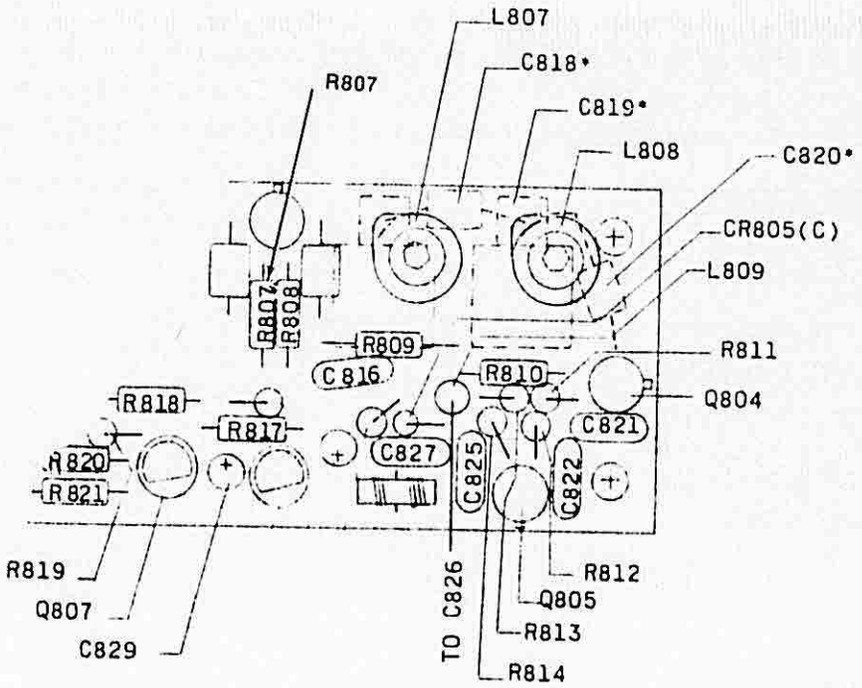


FIGURE 4-10. RECEIVER ALIGNMENT

4.5.2.3 RF Transmitter

The RF Transmitter comprises the synthesizer low level RF amplifier, and the RF amplifier module. The exciter tuning comprises the synthesizer VCO coupling into the transmitter/receiver buffer (Q708) and coupling of local oscillator output to the receiver; all circuits are located on the synthesizer board. The low level RF amplifier and RF power amplifier module are located on the transmitter board.

CAUTION: The RF Power Amplifier module is a sealed unit. The warranty is void if opened.

Refer to Section 4.5.1.2 for synthesizer checkout and adjustment.

4.5.2.3.1 Low Level RF Amplifier

a. Connect as shown in Figure 4-9. (Low Level Test)

b. Turn power ON and adjust the 608 for approximately -6 DBM.
NOTE: Adjust attenuator as required to keep RF amplifier out of saturation while tuning.

c. Check frequency response at output and adjust all inductors for maximum power across the band (345 to 385 MHz) with both ends of the band equal in power.

d. Set the 608 attenuator to -3 DBM and check power output. Power output should be 600 milliwatts minimum across the band at J601.

e. Set the 608 attenuator to 0 DBM; power across the band shall not exceed 1.0 watt. Any further increase in drive should not increase the power output of 1.0 watt across the band. Adjust filter (C619 through C622) if required.
NOTE: In the bandpass filter, C619 can be used to adjust power across the band, C622 flatness of response, and C620/C621 affect skirt selectivity.

f. Set the 608 attenuator to -6 DBM while monitoring for oscillations on the pulse. Select a new value for R615 as required to eliminate the oscillations. The voltage across R615 shall not exceed -5.5 VDC.

g. Connect synthesizer output to exciter RF input and check for performance as in step e above while channeling the DME 195 from 108 to 117 MHz.

CAUTION: Do not connect the exciter to the power amplifier module if the power exceeds 1.0 watt.

4.5.2.3.2 Power Amplifier Module Check

a. Connect as shown in Figure 4-9. (Power Amp and Overall Test)

b. Set the 608 or an operating synthesizer to 0 DBM at 345 MHz, and change frequency slowly to 385 MHz. The minimum power output at the antenna or at the output of MSC shall be 100 watts nominal, 80 watts minimum.

CAUTION: The RF Power Amplifier module is a sealed unit. The warranty is void if opened.

4.5.2.3.3 Ground Speed Adjustment

1. Set R501 to the center of its range.
2. Tune DME 195 to test generator frequency, do not use Ident for this adjustment.
3. Set generator to 150 knots.
4. Adjust R513 for 150 knots. (Allow sufficient time to acquire data, about two (2) minutes).
5. Set generator for 100 knots and check ground speed readout. If necessary adjust R501 for the 100 knot readout.
6. Set generator to 200 knots, wait, readout should be 200 knots.
7. If not, repeat steps 3 through 6.

5.1 GENERAL

This section provides a complete list of all the Electrical Parts. as well as the Mechanical Parts of the DME 195.

The Electrical listing is in alphanumerical order based upon the component symbol letter and number.

The Mechanical list shows those parts of the Indicator and its subassemblies and the Remote Unit and its subassemblies.

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
C101	21555-0048	CAPACITOR, Tantalum, 1.0 mf P/M 20%, 35v
C102	21555-0048	CAPACITOR, Tantalum, 1.0 mf P/M 20%, 35v
C103	21555-0048	CAPACITOR, Tantalum, 1.0 mf P/M 20%, 35v
C104	21555-0048	CAPACITOR, Tantalum, 1.0 mf P/M 20%, 35v
C105	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C106	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C107	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C108	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C109	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C110	23094-0175	CAPACITOR, Mylar, 0.1 mf P/M 10%, 200v
C111	23094-0175	CAPACITOR, Mylar, 0.1 mf P/M 10%, 200v
C112	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C113	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C201	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C202	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C203	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C204	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C205	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C206	23094-0175	CAPACITOR, Mylar, .1 mf P/M 10%, 200v
C207	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C208	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C209	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C210	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C211	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C212	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C213	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C214	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C215	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C216	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C217	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C218	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C219	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C220	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C221	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C222	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C223	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
C224	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C225	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C226	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C227	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C228	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C229	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C230	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C231	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C232	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C233	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C234	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C235	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C236	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C237	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C301	24052-SEL	CAPACITOR, Mica, Selected, P/M 5%, 500v
C302	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C303	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C304	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C307	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C308	23094-0175	CAPACITOR, Mylar, .1 mf P/M 10%, 200v
C309	21555-0118	CAPACITOR, Tantalum, 22 mf P/M 10%, 15v
C312	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C313	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C314	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C315	21291-0003	CAPACITOR, Ceramic Disc, .001 mf P/M 20%, 500v
C317	21555-0003	CAPACITOR, Tantalum, 47 mf P/M 10%, 6v
C318	23094-0163	CAPACITOR, Mylar, .01 mf P/M 10%, 200v
C319	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C320	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C321	21291-0003	CAPACITOR, Ceramic Disc, .001 mf P/M 20%, 500v
C322	21555-0026	CAPACITOR, Tantalum, 10 mf P/M 10%, 20v
C323	21555-0044	CAPACITOR, Tantalum, .47 mf P/M 10%, 35v
C401	21563-0001	CAPACITOR, Aluminum Electrolytic, 80 mf, 60v
C402	24052-0560	CAPACITOR, Mica, 56 pf P/M 5%, 300v

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
C410	23094-0175	CAPACITOR, Mylar, .1 mf P/M 10%, 200v
C411	23103-0154	CAPACITOR, Mylar, .22 mf P/M 10%, 100v
C412	23094-0175	CAPACITOR, Mylar, .1 mf P/M 10%, 200v
C413	23094-0158	CAPACITOR, Mylar, 0.0039 mf P/M 10%, 200v
C414	21563-0001	CAPACITOR, Electrolytic, 80 mf, 60v
C415	21555-0066	CAPACITOR, Tantalum, 3.3 mf P/M 10%, 60v
C450	21555-0032	CAPACITOR, Tantalum, 47 mf +150% -10%, 20v
C451	24052-0361	CAPACITOR, Mica, 360 pf P/M 10%, 300v
C452	21554-0008	CAPACITOR, Electrolytic, 5 mf +100% -10%, 150v
C453	21555-0065	CAPACITOR, Tantalum, 220 mf P/M 10%, 10v
C454	21554-0043	CAPACITOR, Electrolytic, 50 mf +150% -10%, 20v
C455	21291-0003	CAPACITOR, Ceramic Disc, .001 mf P/M 20%, 500v
C456	21554-0017	CAPACITOR, Electrolytic, 100 mf +150% -10%, 35v
C457	23094-0166	CAPACITOR, Mylar, .018 mf P/M 10%, 200v
C458	21554-0006	CAPACITOR, Electrolytic, 25 mf +150% -10%, 50v
C501	23094-0163	CAPACITOR, Mylar, .01 mf P/M 10%, 200v
C502	21555-0018	CAPACITOR, Tantalum, 22 mf P/M 20%, 15v
C503	21555-0044	CAPACITOR, Tantalum, .47 mf P/M 20%, 35v
C504	23094-0175	CAPACITOR, Mylar, .1 mf P/M 10%, 200v
C505	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C506	21555-0044	CAPACITOR, Tantalum, .47 mf P/M 20%, 35v
C507	21555-0167	CAPACITOR, Tantalum, 180 mf P/M 10%, 10v
C508	21555-0167	CAPACITOR, Tantalum, 180 mf P/M 10%, 10v
C509	21554-0044	CAPACITOR, Tantalum, 500 mf +150% -10%, 15v
C510	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C511	21555-0103	CAPACITOR, Tantalum, 47 mf P/M 10%, 6v
C512	21555-0103	CAPACITOR, Tantalum, 47 mf P/M 10%, 6v
C513	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C514	21555-0103	CAPACITOR, Tantalum, 47 mf P/M 10%, 6v
C515	21291-0019	CAPACITOR, Ceramic Disc, .001 mf P/M 10%, 500v
C516	21291-0030	CAPACITOR, Ceramic Disc, .01 mf P/M 20%, 50v
C517	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C518	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C601	24037-0014	CAPACITOR, Mica, 33 pf P/M 10%, 350v, UNELCO
C602	24037-0018	CAPACITOR, Mica, 250 pf P/M 10%, 350v, UNELCO
C603	24037-0016	CAPACITOR, Mica, 22 pf P/M 10%, 350v, UNELCO
C604	24037-0018	CAPACITOR, Mica, 250 pf P/M 10%, 350v, UNELCO
C605	24037-0017	CAPACITOR, Mica, 18 pf P/M 10%, 350v, UNELCO

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
C606	21296-0002	CAPACITOR, Ceramic, Feed-thru, 500 pf P/M 20%, 250v
C607	24037-0018	CAPACITOR, Mica, 250 pf P/M 10%, 350v, UNELCO
C608	24037-0024	CAPACITOR, Mica, 5 pf P/M 10%, 350v, UNELCO
C609	24037-0018	CAPACITOR, Mica, 250 pf P/M 10%, 350v, UNELCO
C610	24037-0023	CAPACITOR, Mica, 15 pf P/M 10%, 350v, UNELCO
C611	24037-0018	CAPACITOR, Mica, 250 pf P/M 10%, 350v, UNELCO
C612	24037-0016	CAPACITOR, Mica, 22 pf P/M 10%, 350v, UNELCO
C613	24037-0018	CAPACITOR, Mica, 250 pf P/M 10%, 350v, UNELCO
C614	24037-0013	CAPACITOR, Mica, 39 pf P/M 10%, 350v, UNELCO
C615	21296-0006	CAPACITOR, Ceramic, Feed-thru, 100 pf P/M 20%, 250v
C616	24037-0018	CAPACITOR, Mica, 250 pf P/M 10%, 350v, UNELCO
C617	24548-0001	CAPACITOR, Porcelain, 12 pf P/M 5%, 500v, ATC
C618	24037-0010	CAPACITOR, Mica, 20 pf P/M 10%, 350v, UNELCO
C619	22052-0002	CAPACITOR, Teflon, Variable, 0.5 - 2.2 pf, Voltronics
C620	22052-0002	CAPACITOR, Teflon, Variable, 0.5 - 2.2 pf, Voltronics
C621	22052-0002	CAPACITOR, Teflon, Variable, 0.5 - 2.2 pf, Voltronics
C622	22052-0002	CAPACITOR, Teflon, Variable, 0.5 - 2.2 pf, Voltronics
C623	21296-0002	CAPACITOR, Ceramic, Feed-thru, 500 pf P/M 20%, 250v
C701	24515-0001	CAPACITOR, Ceramic Disc, .1 mf +80% -20%, 10v
C702	24515-0005	CAPACITOR, Ceramic Disc, .05 mf +80% -20%, 10v
C703	21291-0005	CAPACITOR, Ceramic Disc, .01 mf +80% -20%, 50v
C704	21291-0005	CAPACITOR, Ceramic Disc, .01 mf +80% -20%, 50v
C705	21291-0005	CAPACITOR, Ceramic Disc, .01 mf +80% -20%, 50v
C706	24052-0121	CAPACITOR, Mica, 120 pf P/M 5%, 300v
C707	21291-0005	CAPACITOR, Ceramic Disc, .01 mf +80% -20%, 50v
C708	24052-0150	CAPACITOR, Mica, 15 pf P/M 1 pf, 500v
C709	24052-0150	CAPACITOR, Mica, 15 pf P/M 1 pf, 500v
C710	24052-0121	CAPACITOR, Mica, 120 pf P/M 5%, 300v
C711	24052-0209	CAPACITOR, Mica, 2.0 pf P/M .25 pf, 500v
C712	24052-0121	CAPACITOR, Mica, 120 pf P/M 5%, 300v
C713	24052-0470	CAPACITOR, Mica, 47 pf P/M 5%, 300v
C714	21291-0019	CAPACITOR, Ceramic Disc, 1000 pf +80% -20%, 50v
C716	23094-0175	CAPACITOR, Mylar, .1 mf P/M 10%, 200v

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
C717	24052-0470	CAPACITOR, Mica, 47 pf P/M 5%, 300v
C718	21555-0024	CAPACITOR, Tantalum, 2.2 mf P/M 10%, 20v
C719	24052-0470	CAPACITOR, Mica, 47 pf P/M 5%, 300v
C720	23094-0179	CAPACITOR, Mylar, .22 mf P/M 10%, 200v
C722	24052-0470	CAPACITOR, Mica, 47 pf P/M 5%, 300v
C723	24550-1334	CAPACITOR, Monolythic Ceramic, .33 mf P/M 20%
C724	24055-0309	CAPACITOR, Mica, 3 pf P/M .5 pf, 500v
C725	21555-0018	CAPACITOR, Tantalum, 22 mf P/M 10%, 15v
C801	24052-0330	CAPACITOR, Mica, 33 pf P/M 5%, 500v
C802	24052-0220	CAPACITOR, Mica, 22 pf P/M 5%, 500v
C803	24509-0109	CAPACITOR, Ceramic Disc, 1.0 pf P/M 5%, 500v
C804	21291-0019	CAPACITOR, Ceramic Disc, 1000 pf P/M 10%, 500v
C805	24037-0014	CAPACITOR, Mica, 33 pf P/M 10%, 350v UNELCO
C806	24509-0478	CAPACITOR, Ceramic Disc, 0.47 pf P/M 5%, 500v
C807	24037-0014	CAPACITOR, Mica, 33 pf P/M 10%, 350v UNELCO
C808	24509-0279	CAPACITOR, Ceramic Disc, 2.7 pf P/M 5%, 500v
C809	24509-0109	CAPACITOR, Ceramic Disc, 1.0 pf P/M 5%, 500v
C810	21291-0019	CAPACITOR, Ceramic Disc, 1000 pf P/M 10%, 500v
C811	24037-0014	CAPACITOR, Mica, 33 pf P/M 10%, 350v UNELCO
C812	24509-0478	CAPACITOR, Ceramic Disc, 0.47 pf P/M 5%, 500v
C813	24037-0014	CAPACITOR, Mica, 33 pf P/M 10%, 350v UNELCO
C814	24509-0279	CAPACITOR, Ceramic Disc, 2.7 pf P/M 5%, 500v
C815	24509-0109	CAPACITOR, Ceramic Disc, 1.0 pf P/M 5%, 500v
C816	21291-0019	CAPACITOR, Ceramic Disc, 1000 pf P/M 10%, 500v
C817	24037-0014	CAPACITOR, Mica, 33 pf P/M 10%, 350v UNELCO
C818	24509-0478	CAPACITOR, Ceramic Disc, 0.47 pf P/M 5%, 500v
C819	24037-0014	CAPACITOR, Mica, 33 pf P/M 10%, 350v UNELCO
C820	24509-0279	CAPACITOR, Ceramic Disc, 2.7 pf P/M 5%, 500v
C821	23107-0125	CAPACITOR, Ceramic Disc, 0.1 pf P/M 10%, 500v
C822	24502-0470	CAPACITOR, Mica, 47 pf P/M 5%, 300v
C823	21296-0006	CAPACITOR, Ceramic, Feed-thru, 100 pf P/M 10%, 250v
C824	21296-0006	CAPACITOR, Ceramic, Feed-thru, 100 pf P/M 10%, 250v
C825	21291-0019	CAPACITOR, Ceramic Disc, 1000 pf P/M 10%, 500v

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
C826	21296-0005	CAPACITOR, Ceramic, Feed-thru, 1000 pf P/M 10%, 250v
C827	24516-0100	CAPACITOR, Ceramic Disc, NPO 10 pf P/M 1 pf, 500v
C828	21564-0042	CAPACITOR, Tantalum, 2.2 mf P/M 20%, 20v
C829	21564-0042	CAPACITOR, Tantalum, 2.2 mf P/M 20%, 20v
C830	23107-0109	CAPACITOR, Mylar, .0047 mf P/M 10%, 100v
C831	24052-0470	CAPACITOR, Mica, 47 pf P/M 5%, 500v
C832	23107-0125	CAPACITOR, Mylar, .1 mf P/M 10%, 100v
C833	21564-0042	CAPACITOR, Tantalum, 2.2 mf P/M 20%, 20v
C834	24052-0470	CAPACITOR, Mica, 47 pf P/M 5%, 500v
C835	24052-0470	CAPACITOR, Mica, 47 pf P/M 5%, 500v
C836	24052-0220	CAPACITOR, Mica, 22 pf P/M 5%, 500v
C837	24055-0309	CAPACITOR, Mica, 3.0 pf P/M .5 pf, 300v
C838	24055-0309	CAPACITOR, Mica, 3.0 pf P/M .5 pf, 300v
C839	21296-0006	CAPACITOR, Ceramic, Feed-thru, 100 pf P/M 10%, 250v
C840	23094-0175	CAPACITOR, Mylar, 0.1 mf P/M 10%, 200v
CR101	75028-0001	DIODE, Silicon, 25v
CR102	75028-0001	DIODE, Silicon, 25v
CR103	75028-0001	DIODE, Silicon, 25v
CR104	75014-0001	DIODE, Germanium, 35v
CR105	75204-0045	DIODE, Silicon, 600v
CR301	75025-0003	DIODE, Silicon, Zener, 11v
CR401	75047-0007	DIODE, Zener, 51v P/M 1%
CR410	75046-0001	DIODE, Silicon, Current Limit
CR411	75046-0001	DIODE, Silicon, Current Limit
CR412	75047-0006	DIODE, Silicon, Zener, P/M 1%, 36v
CR413	75047-0008	DIODE, Silicon, Zener, P/M 1%, 56v
CR414	75047-0006	DIODE, Silicon, Zener, P/M 1%, 36v
CR450	75216-0003	DIODE, Silicon, 1N4935
CR451	75216-0003	DIODE, Silicon, 1N4935
CR452	75216-0003	DIODE, Silicon, 1N4935
CR453	75216-0003	DIODE, Silicon, 1N4935
CR454	75216-0003	DIODE, Silicon, 1N4935
CR455	75204-0045	DIODE, Silicon,
CR456	75215-0002	DIODE, Silicon, MR821

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
CR501	75027-0004	DIODE, Silicon, Zener, 5%, 5.6v
CR502	75028-0001	DIODE, Silicon, PIV, 25v
CR503	75028-0001	DIODE, Silicon, PIV, 25v
CR504	75027-0004	DIODE, Silicon, Zener, 5%, 5.6v
CR601	75045-0001	DIODE, Silicon, Step Recovery, Alpha DVB6092-S5
CR602	75047-0005	DIODE, Silicon, Zener, 33v, P/M 1%, Motorola
CR603	75047-0007	DIODE, Silicon, Zener, 51v, P/M 1%, Motorola
CR701	75028-0001	DIODE, Silicon, 25v
CR702	75028-0001	DIODE, Silicon, 25v
CR703	75028-0001	DIODE, Silicon, 25v
CR704	75027-0004	DIODE, Silicon, Zener, 5.6v, 1N752A
CR705	75025-0005	DIODE, Silicon, Zener, 10v
CR706	75028-0001	DIODE, Silicon, 25v
CR707	75043-0001	DIODE, Tuning, BB105A
CR801	75034-0001	DIODE, Silicon, Hot Carrier
CR802	75034-0001	DIODE, Silicon, Hot Carrier
CR803	75034-0001	DIODE, Silicon, Hot Carrier
CR804	75034-0001	DIODE, Silicon, Hot Carrier
CR805	75034-0001	DIODE, Silicon, Hot Carrier
CR806	75019-0004	DIODE, Silicon
CR807	75019-0004	DIODE, Silicon
CR808	75019-0004	DIODE, Silicon
CR809	75044-0001	DIODE, Silicon, PIN, MNP 3401
CR810	75044-0001	DIODE, Silicon, PIN, MNP 3401
DS101	12000-0028	LAMP, Incandescent, 5.0v (No. 713)
DS102	12000-0028	LAMP, Incandescent, 5.0v (No. 713)
DS103	12000-0028	LAMP, Incandescent, 5.0v (No. 713)
DS104	12007-0001	READOUT, Digital, 7 Segment
DS105	12007-0001	READOUT, Digital, 7 Segment
DS106	12007-0001	READOUT, Digital, 7 Segment
DS107	12007-0001	READOUT, Digital, 7 Segment
DS108	12007-0001	READOUT, Digital, 7 Segment
DS109	12000-0028	LAMP, Incandescent, 5.0v (No. 713)
DS110	12007-0001	READOUT, Digital, 7 Segment

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
DS111	12000-0022	LAMP, Incandescent, 5.0v (No. 7153)
DS112	12007-0001	READOUT, Digital, 7 Segment
DS113	12007-0001	READOUT, Digital, 7 Segment
DS114	12007-0001	READOUT, Digital, 7 Segment
F450	66516-0015	FUSE, 7A
J101	41355-0005	CONNECTOR, Right Angle, PC Type
J201	41322-0002	IC, Socket, 16 Pin
J202	41322-0002	IC, Socket, 16 Pin
J301	41340-0001	CONNECTOR, 14 Pin
J302	41340-0001	CONNECTOR, 14 Pin
J501	41340-0002	CONNECTOR, 16 Pin
J502	41340-0002	CONNECTOR, 16 Pin
J601		Part of Z608
J602		Part of Z608
J701	41340-0002	CONNECTOR, 16 Pin
J702	41340-0002	CONNECTOR, 16 Pin
J703	41244-0002	CONNECTOR, RF, Miniature, Screw-On
J901	41285-0002	CONNECTOR, 14 Pin
J902	41285-0002	CONNECTOR, 14 Pin
J903	41328-0002	CONNECTOR, 9 Pin
J904	41285-0005	CONNECTOR, 24 Pin
K901	65148-0001	RELAY, Miniature, Plug-In
L401	11451-0050	CHOKE, 300 uh P/M 5%
L410	11451-0047	CHOKE, 220 mh
L411	11451-0050	CHOKE, 300 mh
L450	11842-0001	CHOKE
L451	11487-0002	CHOKE, Filter
L601	11713-0021	INDUCTOR, Air Wound, 1-1/2 turns, .080 dia., #24 wire
L602	11713-0020	INDUCTOR, Air Wound, 2-1/2 turns, .080 dia., #24 wire
L603	11713-0020	INDUCTOR, Air Wound, 2-1/2 turns, .080 dia., #24 wire
L604	11713-0004	INDUCTOR, Air Wound, 3-1/2 turns, .080 dia., #24 wire
L605	90039-0012	INDUCTOR, Silver Strap

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
L606	11713-0021	INDUCTOR, Air Wound, 1-1/2 turns, .080 dia., #24 wire
L607	90039-0012	INDUCTOR, Silver Strap
L608	11863-0001	INDUCTOR, Air Wound, 1 turn, .187 dia., #20 wire
L609	11864-0001	INDUCTOR, Air Wound, 1 turn, .125 dia., #24 wire
L610	11451-0004	INDUCTOR, RF, Insulated, .47 uh P/M 20%
L611	11451-0004	INDUCTOR, RF, Insulated, .47 uh P/M 20%
L701	11713-0007	COIL, RF, 12-1/2 turns, .080 dia., P.S. Red
L702	11713-0019	COIL, RF, 5-1/2 turns, .080 dia., P.S. Green
L703		COIL, RF, 1/2 turn, #24 bus wire
L704	11713-0004	COIL, RF, 2-1/2 turns, .080 dia., P.S. Orange
L705	11713-0015	COIL, RF, 4-1/2 turns, .080 dia., P.S. Yellow
L706	11713-0008	COIL, RF, 1-1/2 turns, .125 dia., P.S. Brown
L801	11798-0003	COIL, Toroid
L802	11713-0021	COIL, RF, 1-1/2 turns, P.S.
L803	11870-0001	COIL, RF
L804	11870-0001	COIL, RF
L805	11870-0001	COIL, RF
L806	11870-0001	COIL, RF
L807	11870-0001	COIL, RF
L808	11870-0001	COIL, RF
L809	11451-0048	CHOKE, 240 uh
L810	11798-0002	COIL, Toroid
L811	11713-0005	COIL, RF, 7-1/2 turns, P.S.
L812	11713-0004	COIL, RF, 3-1/2 turns, P.S.
P601	41244-0001	CONNECTOR, RF, Amphenol
P602	41244-0001	CONNECTOR, RF, Amphenol
P703	41244-0001	CONNECTOR, RF, Amphenol
P801	41244-0001	CONNECTOR, RF, Amphenol
P903	41328-0001	CONNECTOR, 9 Pin

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
Q101	75639-0001	TRANSISTOR, Silicon, Darlington, NPN ... 2N6388
Q102	75595-0003	TRANSISTOR, Silicon, NPN 2N5172
Q103	75595-0003	TRANSISTOR, Silicon, NPN 2N5172
Q104	75595-0003	TRANSISTOR, Silicon, NPN 2N5172
Q301	75624-0001	TRANSISTOR, Silicon, PUT 2N6027
Q302	75624-0001	TRANSISTOR, Silicon, PUT 2N6027
Q303	75596-0003	TRANSISTOR, Silicon, PNP 2N5138
Q401	75639-0004	TRANSISTOR, Selected 2N6388
Q410	75634-0001	TRANSISTOR, Silicon, PNP 2N2905A
Q411	75634-0001	TRANSISTOR, Silicon, PNP 2N2905A
Q412	75639-0001	TRANSISTOR, Silicon. 2N6388
Q413	75640-0004	THYRISTOR, Silicon, RCA S2060A
Q450	75633-0003	TRANSISTOR, Silicon, NPN 2N3643
Q451	75632-0001	TRANSISTOR, Silicon, PNP 2N5194
Q452	75810-0001	TRANSISTOR, Silicon, PNP 2N3762S
Q453	75809-0002	TRANSISTOR, Silicon, NPN ..... TIP 35A
Q501	75596-0002	TRANSISTOR, Silicon, PNP 2N5138
Q502	75596-0002	TRANSISTOR, Silicon, PNP 2N5138
Q503	75595-0003	TRANSISTOR, Silicon, NPN 2N5172
Q504	75624-0001	TRANSISTOR, Silicon, PUT 2N6027
Q601	75635-0001	TRANSISTOR, Silicon, NPN, RF Power ... SSS
Q602	75635-0001	TRANSISTOR, Silicon, NPN, RF Power ... SSS
Q603	75636-0001	TRANSISTOR, Silicon, NPN, RF Power ... SSS
Q604	75637-0001	TRANSISTOR, Silicon, NPN, RF Power ... SSS
Q701	75561-0038	TRANSISTOR, Silicon, PNP 2N4258
Q702	75629-0001	TRANSISTOR, Silicon, NPN MMT74
Q703	75629-0001	TRANSISTOR, Silicon, NPN MMT74
Q704	75629-0001	TRANSISTOR, Silicon, NPN MMT74
Q705	75629-0001	TRANSISTOR, Silicon, NPN MMT74
Q706	75596-0002	TRANSISTOR, Silicon, PNP 2N5138
Q707	75595-0003	TRANSISTOR, Silicon, NPN 2N5172
Q708	75629-0001	TRANSISTOR, Silicon, NPN MMT74

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
Q801	75622-0001	TRANSISTOR, Silicon, NPN..... SRF215
Q802	75622-0001	TRANSISTOR, Silicon, NPN..... SRF215
Q803	75622-0001	TRANSISTOR, Silicon, NPN..... SRF215
Q804	75622-0001	TRANSISTOR, Silicon, NPN..... SRF215
Q805	75622-0001	TRANSISTOR, Silicon, NPN..... SRF215
Q806	75551-0001	TRANSISTOR, Silicon, NPN..... 2N3415
Q807	75551-0001	TRANSISTOR, Silicon, NPN..... 2N3415
Q808	75596-0001	TRANSISTOR, Silicon, PNP..... 2N5138
Q809	75551-0001	TRANSISTOR, Silicon, NPN..... 2N3415
Q810	75551-0001	TRANSISTOR, Silicon, NPN..... 2N3415
Q811	75622-0001	TRANSISTOR, Silicon, NPN..... SRF215

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
R101	31192-0562	RESISTOR, Fixed, Comp, 5.6K P/M 10%, 1/4w
R102	31195-0151	RESISTOR, Fixed, Comp, 150 P/M 5%, 1/4w
R103	31195-0330	RESISTOR, Fixed, Comp, 33 P/M 5%, 1/4w
R104	32059-0006	RESISTOR, Variable, 2.5K w/switch (S101)
R105	32059-0007	RESISTOR, Variable, 100 ohms
R106	31195-0510	RESISTOR, Fixed, Comp, 51 P/M 5%, 1/4w
R107	31195-0510	RESISTOR, Fixed, Comp, 51 P/M 5%, 1/4w
R108	31195-0510	RESISTOR, Fixed, Comp, 51 P/M 5%, 1/4w
R109	31195-0510	RESISTOR, Fixed, Comp, 51 P/M 5%, 1/4w
R110	31192-0222	RESISTOR, Fixed, Comp, 2.2K P/M 10%, 1/4w
R111	31195-0221	RESISTOR, Fixed, Comp, 220 P/M 5%, 1/4w
R112	31195-0221	RESISTOR, Fixed, Comp, 220 P/M 5%, 1/4w
R113	31195-0221	RESISTOR, Fixed, Comp, 220 P/M 5%, 1/4w
R114	31195-0221	RESISTOR, Fixed, Comp, 220 P/M 5%, 1/4w
R115	31195-0270	RESISTOR, Fixed, Comp, 27 P/M 5%, 1/4w
R116	31192-0562	RESISTOR, Fixed, Comp, 5.6K P/M 10%, 1/4w
R117	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R118	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R119	31192-0222	RESISTOR, Fixed, Comp, 2.2K P/M 10%, 1/4w
R201	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R202	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R203	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R204	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R205	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R206	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R207	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R208	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R209	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R210	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R211	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R212	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R213	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R214	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R215	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
R216	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R217	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R218	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R219	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R220	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R221	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R222	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R223	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R224	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R225	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R226	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R227	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R228	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R229	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R230	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R231	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R232	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R233	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R234	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R235	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R236	31195-0102	RESISTOR, Fixed, Comp, 1K P/M 5%, 1/4w
R237	31195-0332	RESISTOR, Fixed, Comp, 3.3K P/M 5%, 1/4w
R238	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R239	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R240	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R241	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R242	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R243	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R244	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R245	31192-0393	RESISTOR, Fixed, Comp, 39K P/M 10%, 1/4w
R246	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R247	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R248	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R249	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R250	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R251	31192-0393	RESISTOR, Fixed, Comp, 39K P/M 10%, 1/4w
R252	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R253	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R254	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R255	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
R256	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R257	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R258	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R259	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R260	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R261	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R262	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R263	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R264	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R265	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R266	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R267	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R268	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R269	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R270	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R271	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R272	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R273	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R274	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R275	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R276	31192-SEL	RESISTOR, Fixed, Comp, Selected at P/M 10%, 1/4w
R301	31192-0151	RESISTOR, Fixed, Comp, 150 P/M 10%, 1/4w
R302	31192-0103	RESISTOR, Fixed, Comp, 10K P/M 10%, 1/4w
R303	31192-0101	RESISTOR, Fixed, Comp, 100 P/M 10%, 1/4w
R304	31192-0103	RESISTOR, Fixed, Comp, 10K P/M 10%, 1/4w
R305	31192-0681	RESISTOR, Fixed, Comp, 680 P/M 10%, 1/4w
R306	31192-0222	RESISTOR, Fixed, Comp, 2.2K P/M 10%, 1/4w
R307	31192-0222	RESISTOR, Fixed, Comp, 2.2K P/M 10%, 1/4w
R308	31199-0451	RESISTOR, Fixed, Film, 332K P/M 1%, 1/4w
R309	31195-0564	RESISTOR, Fixed, Comp, 560K P/M 5%, 1/4w
R310	31192-0681	RESISTOR, Fixed, Comp, 680 P/M 10%, 1/4w
R311	31192-0222	RESISTOR, Fixed, Comp, 2.2K P/M 10%, 1/4w
R312	31192-0562	RESISTOR, Fixed, Comp, 5.6K P/M 10%, 1/4w
R313	31192-0683	RESISTOR, Fixed, Comp, 58K P/M 10%, 1/4w
R314	31192-0472	RESISTOR, Fixed, Comp, 4.7K P/M 10%, 1/4w
R315	31195-0820	RESISTOR, Fixed, Comp, 82 P/M 5%, 1/4w

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
R316	31192-0562	RESISTOR, Fixed, Comp, 5.6K P/M 10%, 1/4w
R317	31192-0470	RESISTOR, Fixed, Comp, 47 P/M 10%, 1/4w
R318	31192-0472	RESISTOR, Fixed, Comp, 4.7K P/M 10%, 1/4w
R401	31192-0101	RESISTOR, Fixed, Comp, 100 P/M 10%, 1/4w
R402	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R410	31192-0221	RESISTOR, Fixed, Comp, 220 P/M 10%, 1/4w
R411	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R412	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R413	31192-0221	RESISTOR, Fixed, Comp, 220 P/M 10%, 1/4w
R414	31192-0220	RESISTOR, Fixed, Comp, 22 P/M 10%, 1/4w
R415	31192-0103	RESISTOR, Fixed, Comp, 10K P/M 10%, 1/4w
R416	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R417	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R418	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R419	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R420	31192-0331	RESISTOR, Fixed, Comp, 330 P/M 10%, 1/4w
R421	31192-0563	RESISTOR, Fixed, Comp, 56K P/M 10%, 1/4w
R422	31192-0274	RESISTOR, Fixed, Comp, 270K P/M 10%, 1/4w
R423	31192-SEL	RESISTOR, Fixed, Comp, SEL 10%, 1/4w
R450	31192-0152	RESISTOR, Fixed, Comp, 1.5K P/M 10%, 1/4w
R451	31141-0680	RESISTOR, Fixed, Comp, 68 P/M 10%, 1/4w
R452	31192-0821	RESISTOR, Fixed, Comp, 820 P/M 10%, 1/4w
R453	31192-0680	RESISTOR, Fixed, Comp, 68 P/M 10%, 1/4w
R454	31199-0289	RESISTOR, Fixed, Film, 8.25K P/M 1%, 1/4w
R455	31192-0331	RESISTOR, Fixed, Comp, 330 P/M 10%, 1/4w
R456	31199-0238	RESISTOR, Fixed, Film, 2.43K P/M 1%, 1/4w
R457	31192-0270	RESISTOR, Fixed, Comp, 27 P/M 10%, 1/4w
R458	31192-0564	RESISTOR, Fixed, Comp, 560K P/M 10%, 1/4w
R501	31192-0562	RESISTOR, Fixed, Comp, 5.6K P/M 10%, 1/4w
R502	31192-0562	RESISTOR, Fixed, Comp, 5.6K P/M 10%, 1/4w
R503	31192-0562	RESISTOR, Fixed, Comp, 5.6K P/M 10%, 1/4w
R504	31195-0561	RESISTOR, Fixed, Comp, 560 P/M 5%, 1/4w
R505	31192-0390	RESISTOR, Fixed, Comp, 39 P/M 10%, 1/4w
R506	31192-0222	RESISTOR, Fixed, Comp, 2.2K P/M 10%, 1/4w
R507	31192-0221	RESISTOR, Fixed, Comp, 220 P/M 10%, 1/4w
R508	31192-0153	RESISTOR, Fixed, Comp, 15K P/M 10%, 1/4w
R509	31192-0153	RESISTOR, Fixed, Comp, 15K P/M 10%, 1/4w
R510	31192-0331	RESISTOR, Fixed, Comp, 330 P/M 10%, 1/4w

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
R511	31192-0221	RESISTOR, Fixed, Comp, 220 P/M 10%, 1/4w
R512	31192-0221	RESISTOR, Fixed, Comp, 220 P/M 10%, 1/4w
R513	31192-0221	RESISTOR, Fixed, Comp, 220 P/M 10%, 1/4w
R514	31192-0221	RESISTOR, Fised, Comp, 220 P/M 10%, 1/4w
R515	32054-0008	RESISTOR, Variable, 10K P/M 20%, 1w
R516	31195-0203	RESISTOR, Fixed, Comp, 20K P/M 5%, 1/4w
R517	31195-0682	RESISTOR, Fixed, Comp, 6.8K P/M 5%, 1/4w
R518	31195-0333	RESISTOR, Fixed, Comp, 33K P/M 5%, 1/4w
R519	31195-0681	RESISTOR, Fixed, Comp, 680 P/M 5%, 1/4w
R520	31195-0153	RESISTOR, Fixed, Comp, 15K P/M 5%, 1/4w
R521	31195-0203	RESISTOR, Fixed, Comp, 20K P/M 5%, 1/4w
R522	31192-0152	RESISTOR, Fixed, Comp, 1.5K P/M 10%, 1/4w
R523	31195-0333	RESISTOR, Fixed, Comp, 33K P/M 5%, 1/4w
R524	31192-0152	RESISTOR, Fixed, Comp, 1.5K P/M 10%, 1/4w
R525	31195-0224	RESISTOR, Fixed, Comp, 220K P/M 5%, 1/4w
R526	31195-0333	RESISTOR, Fixed, Comp, 33K P/M 5%, 1/4w
R527	31192-0562	RESISTOR, Fixed, Comp, 5.6K P/M 10%, 1/4w
R528	31192-0221	RESISTOR, Fixed, Comp, 220 P/M 10%, 1/4w
R601	31195-0101	RESISTOR, Carbon, 100 P/M 5%, 1/4w
R602	31195-0680	RESISTOR, Carbon, 68 P/M 5%, 1/4w
R603	31195-0101	RESISTOR, Carbon, 100 P/M 5%, 1/4w
R604	31192-0153	RESISTOR, Carbon, 15K P/M 10%, 1/4w
R605	31192-0472	RESISTOR, Carbon, 4.7K P/M 10%, 1/4w
R606	31192-0101	RESISTOR, Carbon, 100 P/M 10%, 1/4w
R607	31192-0153	RESISTOR, Carbon, 15K P/M 10%, 1/4w
R608	31192-0472	RESISTOR, Carbon, 4.7K P/M 10%, 1/4w
R609	31192-0101	RESISTOR, Carbon, 100 P/M 10%, 1/4w
R610	31192-0392	RESISTOR, Carbon, 3.9K P/M 10%, 1/4w
R611	31192-0272	RESISTOR, Carbon, 2.7K P/M 10%, 1/4w
R612	31192-0101	RESISTOR, Carbon, 100 P/M 10%, 1/4w
R613	31192-0100	RESISTOR, Carbon, 10 P/M 10%, 1/4w
R614	31192-0272	RESISTOR, Carbon, 2.7K P/M 10%, 1/4w
R615	31192-SEL	RESISTOR, Carbon, Selected P/M 10%, 1/4w (560 ohms nominal)

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
R706	31192-0474	RESISTOR, Fixed, Comp, 470K P/M 10%, 1/4w
R714	31192-0390	RESISTOR, Fixed, Comp, 39 P/M 10%, 1/4w
R715	31192-0101	RESISTOR, Fixed, Comp, 100 P/M 10%, 1/4w
R716	31195-0680	RESISTOR, Fixed, Comp, 68 P/M 5%, 1/2w
R717	32075-0001	RESISTOR, Variable, 100 ohms
R718	31195-0181	RESISTOR, Fixed, Comp, 180 P/M 10%, 1/4w
R719	31195-0271	RESISTOR, Fixed, Comp, 270 P/M 5%, 1/4w
R720	31192-0471	RESISTOR, Fixed, Comp, 470 P/M 10%, 1/4w
R721	31195-0221	RESISTOR, Fixed, Comp, 220 P/M 5%, 1/4w
R722	31192-0471	RESISTOR, Fixed, Comp, 470 P/M 10%, 1/4w
R723	31195-0821	RESISTOR, Fixed, Comp, 820 P/M 5%, 1/4w
R724	31192-0221	RESISTOR, Fixed, Comp, 220 P/M 10%, 1/4w
R725	31192-0152	RESISTOR, Fixed, Comp, 1.5K P/M 10%, 1/4w
R726	31192-0101	RESISTOR, Fixed, Comp, 100 P/M 10%, 1/4w
R727	31195-0103	RESISTOR, Fixed, Comp, 10K P/M 5%, 1/4w
R728	31192-0182	RESISTOR, Fixed, Comp, 1.8K P/M 10%, 1/4w
R729	31195-0103	RESISTOR, Fixed, Comp, 10K P/M 5%, 1/4w
R730	31192-0182	RESISTOR, Fixed, Comp, 1.8K P/M 10%, 1/4w
R731	31195-0682	RESISTOR, Fixed, Comp, 6.8K P/M 5%, 1/4w
R732	31195-0103	RESISTOR, Fixed, Comp, 10K P/M 5%, 1/4w
R733	31192-0105	RESISTOR, Fixed, Comp, 1 Meg P/M 10%, 1/4w
R734	31195-0103	RESISTOR, Fixed, Comp, 10K P/M 5%, 1/4w
R735	31192-0471	RESISTOR, Fixed, Comp, 470 P/M 10%, 1/4w
R736	31192-0561	RESISTOR, Fixed, Comp, 560 P/M 10%, 1/4w
R737	31192-0102	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w
R738	31195-0223	RESISTOR, Fixed, Comp, 22K P/M 10%, 1/4w
R739	31192-0222	RESISTOR, Fixed, Comp, 2.2K P/M 10%, 1/4w
R740	31192-0151	RESISTOR, Fixed, Comp, 150 P/M 10%, 1/4w
R741	31192-0821	RESISTOR, Fixed, Comp, 820 P/M 10%, 1/4w
R742	31192-0471	RESISTOR, Fixed, Comp, 470 P/M 10%, 1/4w
R801	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R802	31192-0152	RESISTOR, Fixed, Comp, 1.5K P/M 10%, 1/4w
R803	31192-0101	RESISTOR, Fixed, Comp, 100 P/M 10%, 1/4w
R804	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R805	31192-0152	RESISTOR, Fixed, Comp, 1.5K P/M 10%, 1/4w

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
R806	31192-0101	RESISTOR, Fixed, Comp, 100 P/M 10%, 1/4w
R807	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R808	31192-0152	RESISTOR, Fixed, Comp, 1.5K P/M 10%, 1/4w
R809	31192-0101	RESISTOR, Fixed, Comp, 100 P/M 10%, 1/4w
R810	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R811	31192-0152	RESISTOR, Fixed, Comp, 1.5K P/M 10%, 1/4w
R812	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R813	31192-0101	RESISTOR, Fixed, Comp, 100 P/M 10%, 1/4w
R814	31192-0152	RESISTOR, Fixed, Comp, 1.5K P/M 10%, 1/4w
R815	31192-0474	RESISTOR, Fixed, Comp, 470K P/M 10%, 1/4w
R816	31192-0472	RESISTOR, Fixed, Comp, 4.7K P/M 10%, 1/4w
R817	31192-0474	RESISTOR, Fixed, Comp, 470K P/M 10%, 1/4w
R818	31192-0471	RESISTOR, Fixed, Comp, 470 P/M 10%, 1/4w
R819	31192-0332	RESISTOR, Fixed, Comp, 3.3K P/M 10%, 1/4w
R820	31192-0331	RESISTOR, Fixed, Comp, 330 P/M 10%, 1/4w
R821	31192-0100	RESISTOR, Fixed, Comp, 10 P/M 10%, 1/4w
R822	31192-0331	RESISTOR, Fixed, Comp, 330 P/M 10%, 1/4w
R823	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R824	31192-0331	RESISTOR, Fixed, Comp, 330 P/M 10%, 1/4w
R825	31192-0682	RESISTOR, Fixed, Comp, 6.8K P/M 10%, 1/4w
R826	31192-0474	RESISTOR, Fixed, Comp, 470K P/M 10%, 1/4w
R827	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R828	31192-0683	RESISTOR, Fixed, Comp, 68K P/M 10%, 1/4w
R829	31192-0471	RESISTOR, Fixed, Comp, 470 P/M 10%, 1/4w
R830	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R831	31192-0471	RESISTOR, Fixed, Comp, 470 P/M 10%, 1/4w
R832	31192-0222	RESISTOR, Fixed, Comp, 2.2K P/M 10%, 1/4w
R833	31192-0222	RESISTOR, Fixed, Comp, 2.2K P/M 10%, 1/4w
R834	31192-0104	RESISTOR, Fixed, Comp, 100K P/M 10%, 1/4w
R901	31136-0181	RESISTOR, Fixed, Comp, 180 ohms P/M 10%, 2w
RT410	31205-0002	THERMISTOR, Temp, Comp, 100 ohms
RT601	31214-0472	THERMISTOR, Silicon, PTC, 4.7K P/M 10%

P/M means Plus or Minus

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
S101		(Used with R104)
S102	61497-0005	SWITCH, Toggle, Miniature
S103		SWITCH, (Formed by item 16 & 01213-0101, Item 17)
T450	11841-0001	TRANSFORMER, DC to DC
T701	11839-0001	BALUN
T801		BALUN
T802		BALUN
T803	11837-0001	BALUN
U101	74056-0001	IC, Dual D Type Edge Triggered Flip-Flop . 7474
U102	74024-0001	IC, Quadruple, 2 Input Pos. AND Gate 7408
U103	74055-0001	IC, 4 Bit Universal Shift Register 7495
U104	74055-0001	IC, 4 Bit Universal Shift Register 7495
U105	74041-0001	IC, BCD to 7 Segment Decoder-Driver 7447A
U106	74041-0001	IC, BCD to 7 Segment Decoder-Driver 7447A
U107	74055-0001	IC, 4 Bit Universal Shift Register 7495
U108	74041-0001	IC, BCD to 7 Segment Decoder-Driver 7447A
U109	74039-0002	IC, Voltage Regulator, 5v 7805
U110	74041-0001	IC, BCD to 7 Segment Decoder-Driver 7447A
U111	74055-0001	IC, 4 Bit Universal Shift Register 7495
U112	74054-0001	IC, Hex Buffer 7407
U113	74055-0001	IC, 4 Bit Universal Shift Register 7495
U114	74055-0001	IC, 4 Bit Universal Shift Register 7495
U115	74055-0001	IC, 4 Bit Universal Shift Register 7495
U116	74055-0001	IC, 4 Bit Universal Shift Register 7495
U117	74041-0001	IC, BCD to 7 Segment Decoder-Driver 7447A
U118	74041-0001	IC, BCD to 7 Segment Decoder-Driver 7447A
U119	74041-0001	IC, BCD to 7 Segment Decoder-Driver 7447A
U120	74041-0001	IC, BCD to 7 Segment Decoder-Driver 7447A
U201	74100-0001	IC, MCMOS Triple Gate 14501
U202	74101-0001	IC, CMOS Strobed Hex Inver/Buff 14502
U204	74069-0002	IC, Quadruple Bistable Latch 74LS75
U205	74101-0001	IC, CMOS Strobed Hex Inver/Buff 14502
U206	74053-0002	IC, Quadruple 2 Input Ex. OR Gate 7486

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
U207	74101-0001	IC, CMOS Strobed Hex Inver/Buff 14502
U208	74100-0001	IC, MCMOS Triple Gate.....14501
U209	74069-0002	IC, Quadruple Bistable Latch 74LS75
U210	74101-0001	IC, CMOS Strobed Hex Inver/Buff 14502
U211	74069-0002	IC, Quadruple Bistable Latch 74LS75
U213	74101-0001	IC, CMOS Strobed Hex Inver/Buff 14502
U301	74051-0001	IC, Hex Inverter.....7404
U302	74058-0001	IC, Dual J-K, Master-Slave Flip-Flop 7473
U303	74049-0001	IC, Dual 250 Bit Shift Register 2528
U304	74049-0001	IC, Dual 250 Bit Shift Register 2528
U305	74024-0001	IC, Quadruple, 2 Input Pos. AND Gate 7408
U306	74045-0001	IC, Quadruple, 2 Input Pos. OR Gate 7432
U307	74066-0001	IC, Dual Peripheral Driver.....75461A
U308	74056-0001	IC, Dual D Type Edge Triggered, Flip-Flop 7474
U309	74058-0001	IC, Dual J-K, Master-Slave Flip-Flop 7473
U310	74058-0001	IC, Dual J-K, Master-Slave Flip-Flop.....7473
U311	74019-0001	IC, Quadruple, 2 Input Pos. NAND Gate....7400
U312	74019-0001	IC, Quadruple, 2 Input Pos. NAND Gate....7400
U313	74058-0001	IC, Dual J-K, Master-Slave Flip-Flop 7473
U314	74051-0001	IC, Hex Inverter 7404
U315	74046-0001	IC, Dual 8 Bit Shift Register .....8277B or 9328
U316	74065-0001	IC, Timer .....S or NE555V
U317	74055-0001	IC, 4 Bit Universal Shift Register 7495
U318	74027-0001	IC, Decade Counter 7490
U319	74024-0001	IC, Quadruple, 2 Input Pos. AND Gate.....7408
U320	74019-0001	IC, Quadruple, 2 Input Pos. NAND Gate....7400
U321	74058-0001	IC, Dual J-K, Master-Slave Flip-Flop.....7473
U322	74024-0001	IC, Quadruple, 2 Input Pos. AND Gate.....7408
U323	74044-0001	IC, Triple 3 Input Pos. AND Gate 7411
U324	74059-0001	IC, 5 Bit Shift Register.....7496
U325	74065-0001	IC, Timer .....S or NE555V
U326	74055-0001	IC, 4 Bit Universal Shift Register 7495
U327	74027-0001	IC, Decade Counter 7490
U328	74024-0001	IC, Quadruple, 2 Input Pos. AND Gate 7408
U329	74056-0001	IC, Dual D Type Edge Triggered, Flip-Flop 7474
U330	74044-0001	IC, Triple 3 Input Pos. AND Gate.....7411

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
U331	74045-0001	IC, Quadruple, 2 Input Pos. OR Gate 7432
U332	74048-0001	IC, 4 Bit Binary Counter 7493
U333	74059-0001	IC, 5 Bit Shift Register 7496
U334	74055-0001	IC, 4 Bit Universal Shift Register.....7495
U335	74027-0001	IC, Decade Counter.....7490
U336	74058-0001	IC, Dual J-K, Master-Slave Flip-Flop.....7473
U337	74069-0001	IC, Quadruple Bistable Latch.....7475
U338	74053-0001	IC, Quadruple 2 Input Ex. OR Gate.....7486
U339	74060-0001	IC, Monostable Multivibrator.....74121
U340	74058-0001	IC, Dual J-K, Master-Slave Flip-Flop 7473
U341	74076-0001	IC, 8 Input Multiplex 74151
U342	74065-0002	IC, Timer.....S or NE555V
U343	74024-0001	IC, Quadruple, 2 Input Pos. AND Gate.....7408
U344	74024-0001	IC, Quadruple, 2 Input Pos. AND Gate.....7408
U345	74051-0001	IC, Hex Inverter.....7404
U346	74043-0001	IC, Syn. 4 Bit Binary Counter.....74161
U347	74048-0001	IC, 4 Bit Binary Counter 7493
U450	74039-0002	IC, Voltage Regulator, 5v 7805
U451	74063-0001	IC, ...205
U501	74039-0002	IC, Voltage Regulator, 5v 7805
U502	74045-0001	IC, Quadruple, 2 Input Pos. OR Gate 7432
U503	74070-0001	IC, 3 Input Pos. NAND Gate 7410
U504	74024-0001	IC, Quadruple, 2 Input Pos. AND Gate 7408
U505	74058-0001	IC, Dual J-K, Master-Slave Flip-Flop 7473
U506	74024-0001	IC, Quadruple, 2 Input Pos. AND Gate 7408
U507	74048-0001	IC, 4 Bit Binary Counter 7493
U508	74057-0001	IC, Divide By 12 Counter 7492
U509	74054-0001	IC, Hex Buffer.....7407
U510	74048-0001	IC, 4 Bit Binary Counter 7493
U511	74057-0001	IC, Divide By 12 Counter 7492
U512	74045-0001	IC, Quadruple, 2 Input Pos. OR Gate.....7432
U513	74027-0001	IC, Decade Counter 7490
U514	74048-0001	IC, 4 Bit Binary Counter.....7493
U515	74069-0001	IC, Quadruple, Bistable Latch 7475

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
U516	74094-0001	IC, BCD Up/Down Counter.....74190
U517	74019-0001	IC, Quadruple, 2 Input Pos. NAND Gate....7400
U518	74056-0001	IC, Dual D Type Edge Triggered Flip-Flop .7474
U519	74051-0001	IC, Hex Inverter.....7404
U520	74024-0001	IC, Quadruple, 2 Input Pos. AND Gate 7408
U521	74027-0001	IC, Decade Counter 7490
U522	74055-0001	IC, 4 Bit Universal Shift Register 7495
U523	74056-0001	IC, Dual D Type Edge Triggered Flip-Flop..7474
U524	74053-0002	IC, Quadruple, 2 Input Ex OR Gate.....7486
U525	74095-0001	IC, Binary Adder 7483
U526	74051-0001	IC, Hex Inverter.....7404
U527	74048-0001	IC, 4 Bit Binary Counter 7493
U528	74056-0001	IC, Dual D Type Edge Triggered Flip-Flop..7474
U529	74056-0001	IC, Dual D Type Edge Triggered Flip-Flop..7474
U530	74027-0001	IC, Decade Counter 7490
U531	74055-0001	IC, 4 Bit Universal Shift Register.....7495
U532	74022-0002	IC, Op-Amp 741CV
U533	74065-0001	IC, Timer .....S or NE555V
U534	74062-0001	IC, Dual Retriggered Monostable Multi.....74123
U535	74096-0001	IC, Quadruple, 2 Input Pos. NOR Gate 7402
U536	74056-0001	IC, Dual D Type Edge Triggered Flip-Flop..7474
U537	74019-0001	IC, Quadruple, 2 Input Pos. NAND Gate....7400
U538	74048-0001	IC, 4 Bit Binary Counter.....7493
U539	74048-0001	IC, 4 Bit Binary Counter.....7493
U540	74024-0001	IC, Quadruple, 2 Input Pos. AND Gate 7408
U541	74019-0001	IC, Quadruple, 2 Input Pos. NAND Gate....7400
U542	74027-0001	IC, Decade Counter 7490
U543	74055-0001	IC, 4 Bit Universal Shift Register.....7495
U701	74052-0001	IC, Dual 4 Line-to-1-Line Data Mult.....74153
U702	74052-0001	IC, Dual 4 Line-to-1-Line Data Mult.....74153
U703	74052-0001	IC, Dual 4 Line-to-1-Line Data Mult.....74153
U704	74017-0001	IC, Hex Inverter.....MC836P
U705	74025-0001	IC, Triple, 3 Input NAND Gate MC862P

ELECTRICAL PARTS LIST

Symbol No.	Part Number	Description
U706	74073-0001	IC, Synchronous, Decade Counter.....93510
U707	74068-0001	IC, High Speed VHF Prescaler SP640
U708	74067-0001	IC, Dual 4 Input Pos. NAND Gate.....N74H20
U709	74075-0001	IC, Quadruple, Exclusive OR Gate.....N7486
U710	74043-0001	IC, Syn. 4 Bit Binary Counter.....74161
U711	74007-0002	IC, J-K, Master-Slave Flip-Flop.....900V
U712	74032-0001	IC, Phase/Frequency Detector MC4044P
U713	74039-0002	IC, Voltage Regulator, 5v 7805
Y301	72042-0001	TRANSMITTER, 5.666.660 MHz
Z601	11137-0002	CHOKE, RF, 9 turns, #32, 68 ohms
Z602	11137-0002	CHOKE, RF, 9 turns, #32, 68 ohms
Z603	11137-0006	CHOKE, RF, 25 turns, #34, 100 ohms
Z604	11137-0006	CHOKE, RF, 25 turns, #34, 100 ohms
Z605	11137-0002	CHOKE, RF, 9 turns, #32, 68 ohms
Z606	57795-0001	FILTER, Microstrip, Band-Pass
Z607	31213-0002	ATTENUATOR, Thick Film, 2 db
Z608	57755-0001	MODULE, Amplifier, RF Power (MSC)
Z701	11454-0003	BEAD, Ferrite
Z702	11454-0003	BEAD, Ferrite

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.1	01212-0101	DME 195 REMOTE UNIT (Interrogator/Receiver	1
-1	04782-0001	NAMEPLATE.	1
-2	04725-0001	LABEL, Patent Notice.	1
-3	57932-0001	COVER, Side (Left and Right	2
		(Attaching Parts)	
-4	82814-0502	SCREW, Mach, Bind Hd, 4-40 x 3/16	12
	81324-0004	LOCKWASHER, Split, #4	12
-5	82958-0004	SCREW, Taptite, Pan Hd, 4-40 x 5/16	8
	81324-0004	LOCKWASHER, Split, #4	8
	81290-0001	NUT, "U", 4-40	8
		- - - - * - - - -	
-6	57940-0101	COVER, Top	1
		(Attaching Parts)	
-7	82990-0003	SCREW, Mach, Undercut Flat Hd, 4-40 x 1/4	4
		- - - - * - - - -	
		NOTE: To remove a hinged assembly one must loosen or remove its attaching parts as well as loosen the appropriate screws (item -31) to raise the corner of item -30, the Hinge Plate Assy, to slip the hinge tab out. For general access just remove or loosen the attaching parts and swing out.	
-8	No Number	HINGE ASSY (Consists of hinge brackets and Preselector/IF/Synthesizer/Transmitter, and Modulator Bd Assy) (See Figure 5.2 for breakdown)	NP
		(Attaching Parts)	
-9	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4.	2
	82802-0003	LOCKWASHER, Int. Tooth, #4	2
		- - - - * - - - -	
-10	01211-0101	VELOCITY PC BOARD ASSY (See Figure 5.7 for breakdown)	1
		(Attaching Parts)	
-11	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4.	2
	81324-0004	LOCKWASHER, Split, #4	2
		- - - - * - - - -	
-12	57922-0101	BRACKET, Top (Velocity Bd)	1
		(Attaching Parts)	
-13	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4.	2
	81324-0004	LOCKWASHER, Split, #4	2
	81708-0002	LUG, Rubber.	1
		- - - - * - - - -	

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.1-14	57922-0102	BRACKET, Bottom (Velocity Bd)	1
		(Attaching Parts)	
-15	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4	2
	81324-0004	LOCKWASHER, Split, #4	2
		- - - - * - - - -	
-16	01215-0101	CHANNELING MULTIPLEX PC BD ASSY (See Figure 5.8 for breakdown)	1
		(Attaching Parts)	
-17	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4	2
	82802-0003	LOCKWASHER, Split, #4	2
		- - - - * - - - -	
-18	57922-0103	BRACKET, Top (C/M Bd)	1
-18A	57937-0001	SHIELD, Cable	1
		(Attaching Parts)	
-19	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4	2
	81324-0004	LOCKWASHER, Split, #4	2
	81708-0002	LUG, Rubber.	1
		- - - - * - - - -	
-20	57922-0104	BRACKET, Bottom (C/M Bd)	1
		(Attaching Parts)	
-21	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4.	2
	81324-0004	LOCKWASHER, Split, #4	2
		- - - - * - - - -	
5.1-	No Number	DISTANCE AND POWER SUPPLY ASSY	-
		(Attaching Parts)	
-22	82814-0404	SCREW, Mach, Bind Hd, 4-40 x 5/16.	3
		- - - - * - - - -	
-23	57757-0101	BRACKET, Top (D & P/S Bds)	1
		(Attaching Parts)	
-24	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4	3
	82802-0003	LOCKWASHER, Int. Tooth, #4	1
	81324-0004	LOCKWASHER, Split, #4	1
	81702-0004	LUG, Solder	1
	83011-0011	INSULATOR	2
	81329-0004	WASHER, Flat, #4.	2
		- - - - * - - - -	

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.1-25	57757-0102	BRACKET, Bottom (D & P/S Bds)	1
		(Attaching Parts)	
-26	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4	3
	82802-0003	LOCKWASHER, Int. Tooth, #4	1
	81324-0004	LOCKWASHER, Split, #4	2
		- - - - * - - - -	
-27	01674-0101	DISTANCE PC BOARD ASSY (See Figure 5.9 for breakdown)	1
-28	01678-0102	POWER SUPPLY ASSY (See Figure 5.10 for breakdown)	1
-29	57926-0101	GROMMET, Strip (Cut and use in 5 places)	AR
-30	57926-0101	HINGE PLATE ASSY (Top)	1
		(Attaching Parts)	
-31	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4	4
		- - - - * - - - -	
-32	57931-0001	HEATSINK	1
		(Attaching Parts)	
-33	82815-0405	SCREW, Mach, Bind Hd, 6-32 x 3/8	4
	81324-0006	LOCKWASHER, Split, #6	4
		- - - - * - - - -	
-34	57929-0001	PANEL, Rear	1
-35	57923-0102	PANEL AND HINGE BRACKET ASSY	1
		(Attaching Parts)	
-36	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4	2
		- - - - * - - - -	
-37	No Number	FRONT PANEL ASSY (See Figure 5.11 for breakdown)	-
-38	57954-0101	TRAY ASSY	Ref

QTY

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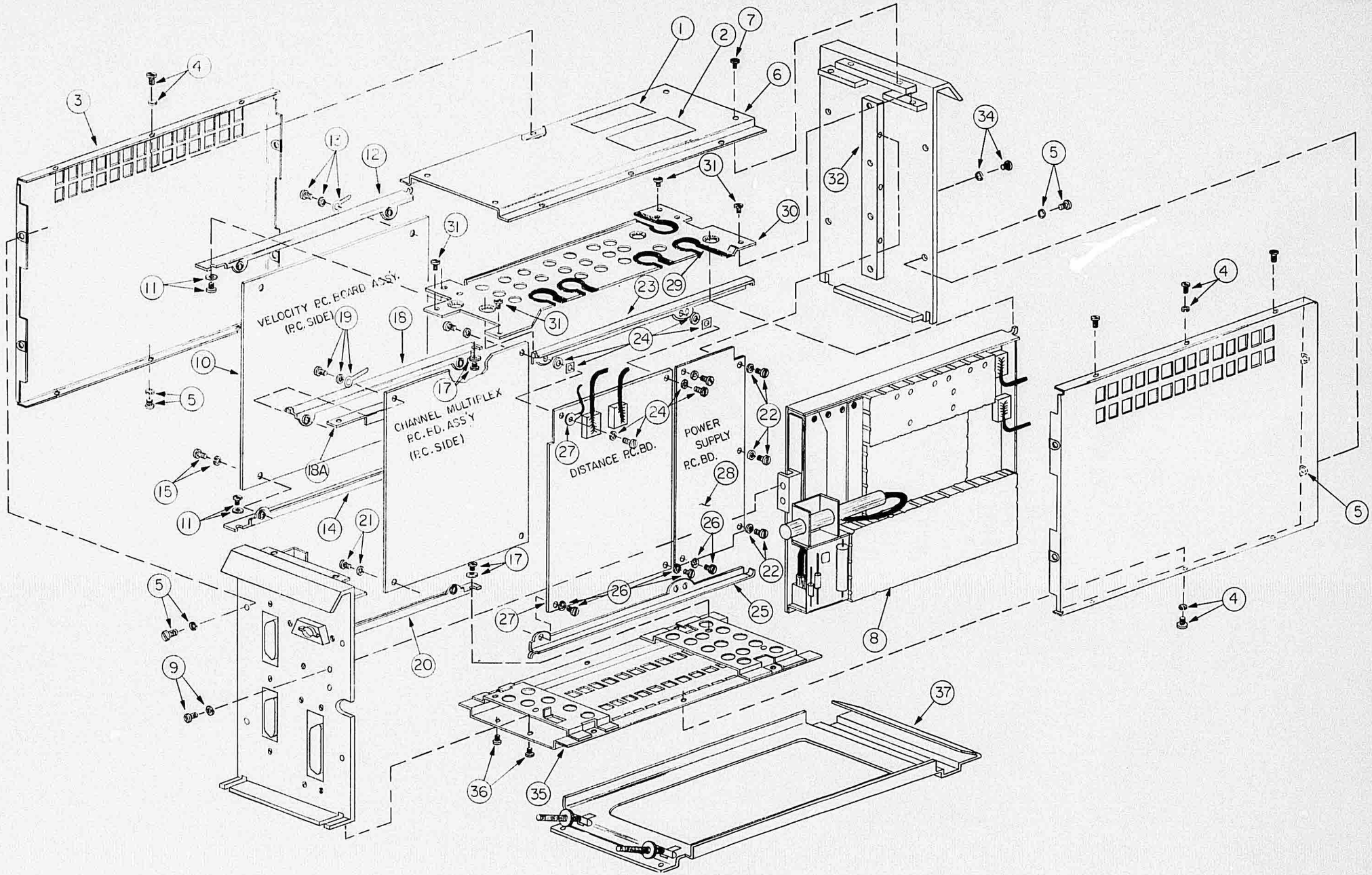

FIGURE 5.1 DME 195 REMOTE UNIT (Interrogator/Receiver)

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.2	No Number	HINGE ASSY (See Figure 5.1, item -8 for Next Higher Assembly)	Ref
-1	83020-0005	INSULATOR	1
-2	01679-0102	SYNTHESIZER PC BD ASSY (See Figure 5.3 for breakdown)	1
		(Attaching Parts)	
-3	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4	3
	82802-0003	LOCKWASHER, Split, #4	3
		- - - - * - - - -	
-4	57793-0101	MODULATOR BRACKET ASSY (See Figure 5.4 for breakdown)	1
		(Attaching Parts)	
-5	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4	1
	82802-0003	LOCKWASHER, Split, #4	1
-5A	82812-0002	SCREW, Mach, Bind Hd, 2-56 x 3/16	1
	82802-0001	LOCKWASHER, Split, #2	1
		- - - - * - - - -	
-5B	57938-0104	LOW PASS FILTER ASSY	1
		(Attaching Parts)	
-5C	82815-0405	SCREW, Mach, Bind Hd, 6-32 x 3/8	2
	81324-0006	LOCKWASHER, Split, #6	2
		- - - - * - - - -	
-6	01216-0101	RECEIVER/PRESELECTOR PC BD ASSY (See Figure 5.5 for breakdown)	1
		(Attaching Parts)	
-7	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4	3
	82802-0003	LOCKWASHER, Int. Tooth, #4	3
		- - - - * - - - -	
-8	01673-0101	TRANSMITTER P C BD ASSY (See Figure 5.6 for breakdown)	1
		(Attaching Parts)	
-9	82892-0002	SCREW, Mach, Pan Hd, 4-40 x 3/16	2
	81329-0004	WASHER, Flat, #4	2
		- - - - * - - - -	
-10	57742-0101	PLATE, Base	1

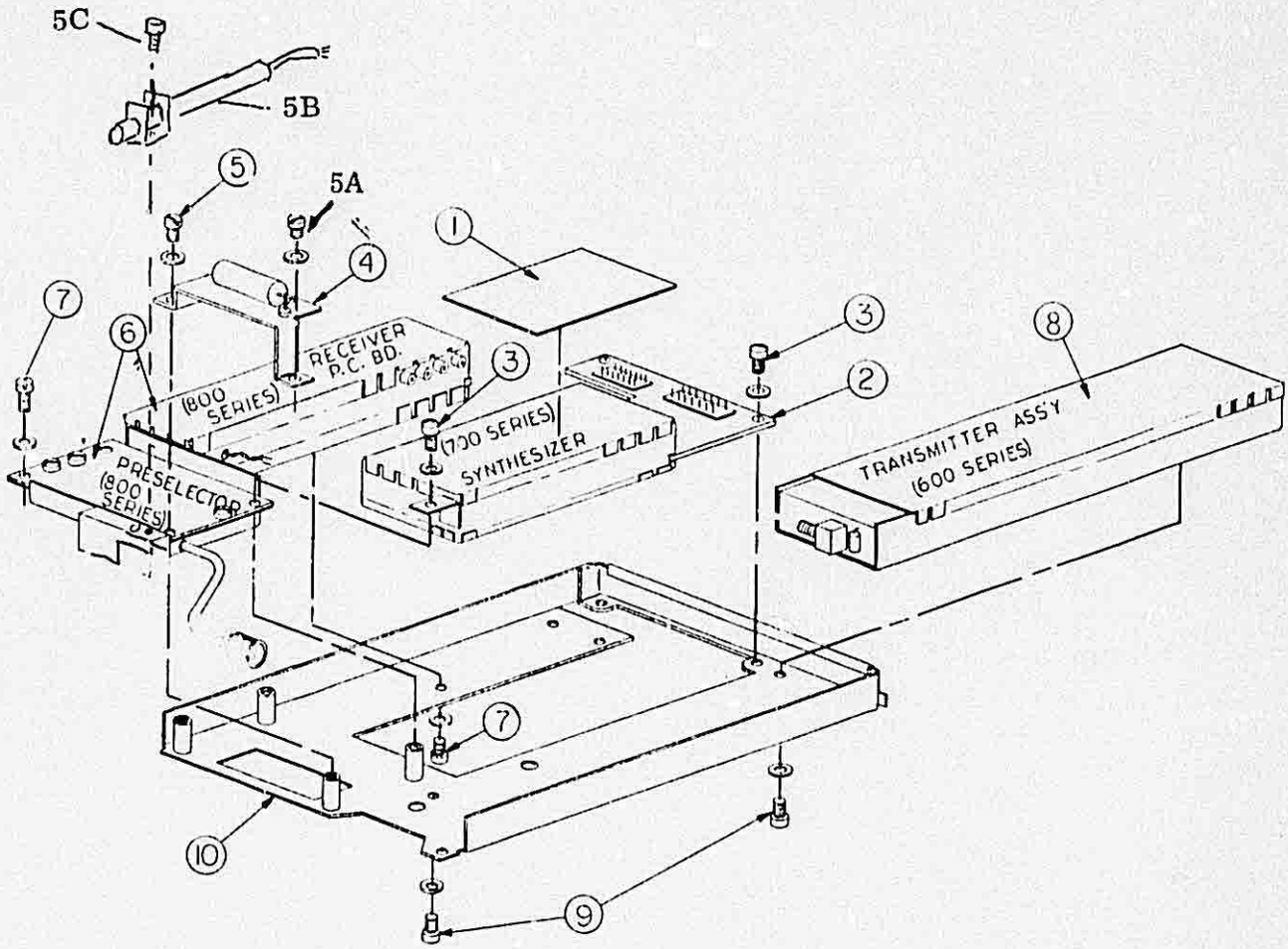

FIGURE 5.2 HINGE ASSY

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.3	01679-0102	SYNTHESIZER PC BD ASSY (See Figure 5.2, item -2 for Next Higher Assembly).	Ref
-1	57768-0001	COVER (Top)	1
-2	83020-0006	INSULATOR, Phenolic	1
-3	57768-0002	COVER (Bottom)	1
-4	74039-0002 U713	IC, Voltage Regulator (5v) (7805)	1
		(Attaching Parts)	
-5	82803-0003	SCREW, Mach, Rnd Hd, 4-40 x 1/4	1
	82900-0004	NUT, Hex, 4-40 (thin)	1
		- - - - * - - - -	
-6	84047-0003	CRADLE, Component Mounting	1
-7	57820-0001	SHIELD.	1
-8	57751-0101	SYNTHESIZER SHIELD ASSY	1
-9	83201-0001	INSULATOR, Component Mounting	3
-10	90058-0001	CABLE, Coax, RG-188 A/U	AR
-11	41244-0002 J703	CONNECTOR, Miniature, RF, Screw-on	1

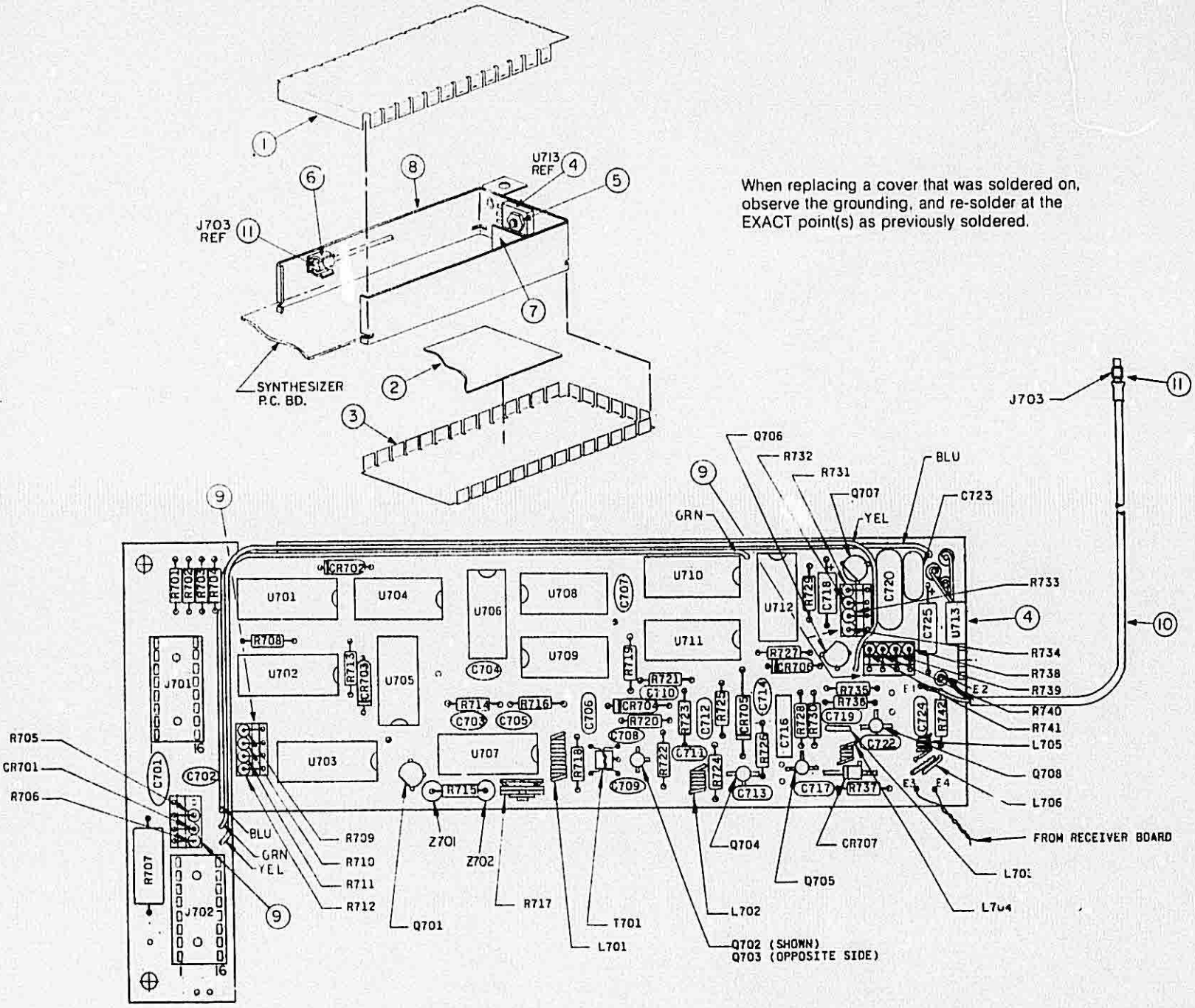

FIGURE 5.3 SYNTHESIZER PC BD ASSY

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER		DESCRIPTION	QTY
5.4	57793-0101		MODULATOR BRACKET ASSY (See Figure 5.2, item -4 for Next Higher Assembly).	Ref
-1	21563-0001	C401	CAPACITOR, Tantalum, 80 mf, 60v	1
-2	24052-0560	C402	CAPACITOR, Mica, 56 pf P/M 5%, 300v	1
-3	75047-0007	CR401	DIODE, Zener, 51v P/M 1%	1
-4	11451-0050	L401	CHOKE, 330 mh P/M 5%	1
-5	31192-0101	R401	RESISTOR, Fixed, Comp, 100 P/M 10%, 1/4w	1
-6	31192-0102	R402	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w	1
-7	75639-0004	Q401	TRANSISTOR, Silicon, SELECTED 2N6388	1
			(Attaching Parts)	
-8	82814-0003		SCREW, Mach, Bind Hd, 4-40 x 1/4	1
	81335-0013		INSULATOR, Shoulder	1
	81324-0004		LOCKWASHER, Split, #4	1
	82900-0003		NUT, Hex, 4-40	1
-9	57780-0101		BRACKET	1

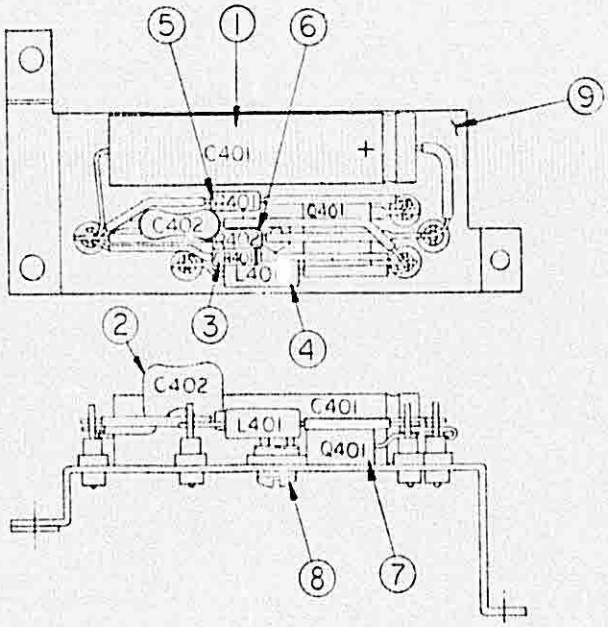

FIGURE 5.4 MODULATOR BRACKET ASSY

SEE BLOW-UP

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.5	01216-0101	RECEIVER/PRESELECTOR PC BD ASSY (See Figure 5.2, item -6 for Next Higher Assembly)	Ref
-1	57917-0102	PRESELECTOR	1
-2	57735-0001	COVER	1
-3	57749-0001	SPACER	1
-4	57789-0001	CLAMP, Shielding	2
-5	81211-0003	SPACER	2
-6	81218-0001	SPACER	1
-7	99065-0004	TAPE, Double Sided	1
-8	57761-0002	SHIELD, Receiver	1
-9	57762-0002	COVER, Top	1
-10	57762-0001	COVER, Bottom	1
-11	57955-0001	SHIELD, Can	6
-12	57948-0001	STRAP	3
-13	99065-0007	TAPE, Double Sided	3
-14	90058-0001	CABLE, Coax, RG 188 A/U	AR
-15	82892-0002	SCREW, Mach, Pan Hd, 4-40 x 3/16	3
-16	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4	4
-17	82826-0002	SCREW, Mach, Round Hd, 3-48 x 3/16	4
-18	82802-0003	LOCKWASHER, Int. Tooth, #4	7
-19	82802-0033	LOCKWASHER, Int. Tooth, #3	4

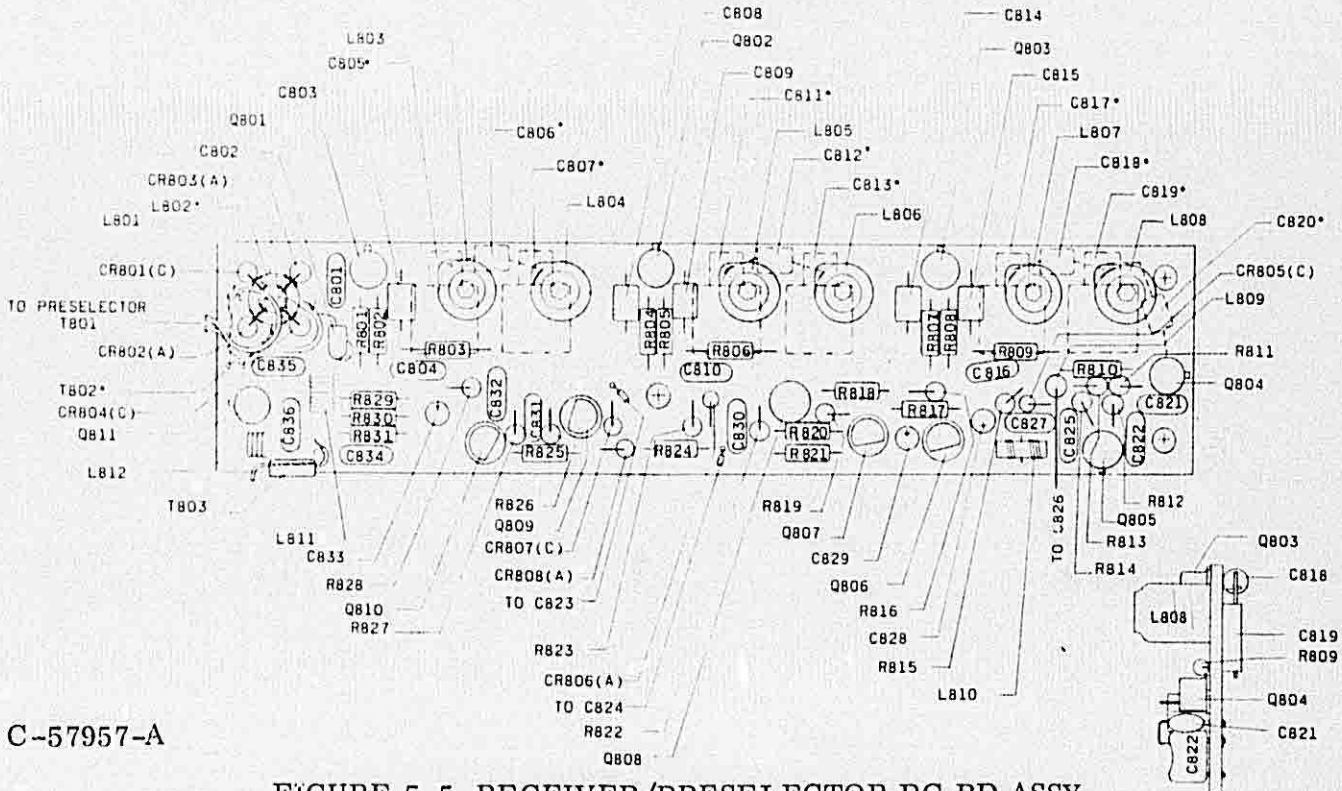

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FIGURE 5.5 RECEIVER/PRESELECTOR PC BD ASSY

SEE BLOW-UP

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER.	PART NUMBER		DESCRIPTION	QTY
5.6	01673-0101		TRANSMITTER PC BD ASSY (See Figure 5.2, item -8 for Next Higher Assembly).	Ref
-1	57736-0001		COVER.	1
-2	57792-0001		COVER, Transmitter Filter	1
-3	57816-0001		SHIELD, Transmitter	1
-4	57815-0001		SHIELD	1
			(Attaching Parts)	
-5	82812-0001		SCREW, Mach, Round Hd, 2-56 x 1/8	1
	82802-0001		LOCKWASHER, Int. Tooth, #2	1
			- - - - * - - - -	
-6	57790-0001		BLOCK, Attenuator	1
			(Attaching Parts)	
-7	82812-0001		SCREW, Mach, Round Hd, 2-56 x 1/8	1
	82802-0001		LOCKWASHER, Int. Tooth, #2	1
			- - - - * - - - -	
-8	31195-0101	R601	RESISTOR, Fixed, Comp, 100 P/M 5%, 1/4w . . .	1
-9	31195-0680	R602	RESISTOR, Fixed, Comp, 68 P/M 5%, 1/4w	1
-10	31195-0101	R603	RESISTOR, Fixed, Comp, 100 P/M 5%, 1/4w . . .	1
-11	57774-0001		PLATE.	1
			(Attaching Parts)	
-12	82812-0004		SCREW, Mach, Round Hd, 2-56 x 5/16	1
	82802-0001		LOCKWASHER, Int. Tooth, #2	2
	82900-0001		NUT, Hex, 2-56.	1
			- - - - * - - - -	
-13	75045-0001	CR601	DIODE, Step Recovery, Alpha DVB6092-S5.	1
-14	81423-0008		TERMINAL.	1
-15	41244-0001	P703	CONNECTOR, RF	1
-16	90071-0001		CABLE, Coax, RG 178B	AR
-17	81423-0005		TERMINAL.	3
			(Attaching Parts)	
-18	82812-0001		SCREW, Mach, Round Hd, 2-56 x 1/8	3
	82802-0001		LOCKWASHER, Int. Tooth, #2	3
			- - - - * - - - -	
-19	57795-0001	Z606	FILTER, Microstrip, Band-Pass	1
			(Attaching Parts)	
-20	82892-0002		SCREW, Mach, Pan Hd, 4-40 x 3/16	1
	82864-0003		SCREW, Mach, Round Hd, Nylon, 4-40 x 3/16 . . .	1
			- - - - * - - - -	

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DISCRIPTION	QTY
5.6 -22	81456-0003	BUSHING	5
-23	57750-0001	OVERLAY	1
		(Attaching Parts)	
-24	82812-0002	SCREW, Mach, Round Hd, 2-56 x 3/16.	1
	82802-0001	LOCKWASHER, Int. Tooth, #2	1
	82900-0001	NUT, Hex, 2-56	1
		- - - - * - - - -	
-25	83011-0005	INSULATOR, 1-3/8 lg x 5/8 w	1
-26	57755-0001 Z608	MODULE, Amplifier, RF Power (with J602)	1
		(Attaching Parts)	
-27	82892-0002	SCREW, Mach, Pan Hd, 4-40 x 3/16.	4
	81329-0004	WASHER, Flat, #4.	4
		- - - - * - - - -	
-28	24037-0014 C601	CAPACITOR, Mica, 33 pf P/M 10%, 350V UNELCO	1
-29	24037-0016 C603	CAPACITOR, Mica, 22 pf P/M 10%, 350V UNELCO	1
-30	24037-0024 C608	CAPACITOR, Mica, 5 pf P/M 10%, 350V UNELCO	1
-31	24037-0016 C612	CAPACITOR, Mica, 22 pf P/M 10%, 350V UNELCO	1
		(Attaching Parts)	
-32	99065-0004	TAPE, Double-sided.	4
		- - - - * - - - -	
-33	84167-0001	CAP, Transistor.	1
-34	75636-0001 Q603	TRANSISTOR, Silicon, NPN, RF Power, SSS	1
-35	83022-0002	TRANSIPAD.	1
-36	75637-0001 Q604	TRANSISTOR, Silicon, NPN, RF Power, SSS.	1
		(Attaching Parts)	
-37	82900-0011	NUT, Hex, 8-32	1
		- - - - * - - - -	
-38	75635-0001 Q601	TRANSISTOR, Silicon, NPN, RF Power, SSS	1
-39	75635-0001 Q602	TRANSISTOR, Silicon, NPN, RF Power, SSS	1
-40	83022-0001	TRANSIPAD.	2
-41	90039-0004	STRIP, Electrical	AR
-42	57737-0101	BOX, Transmitter	1

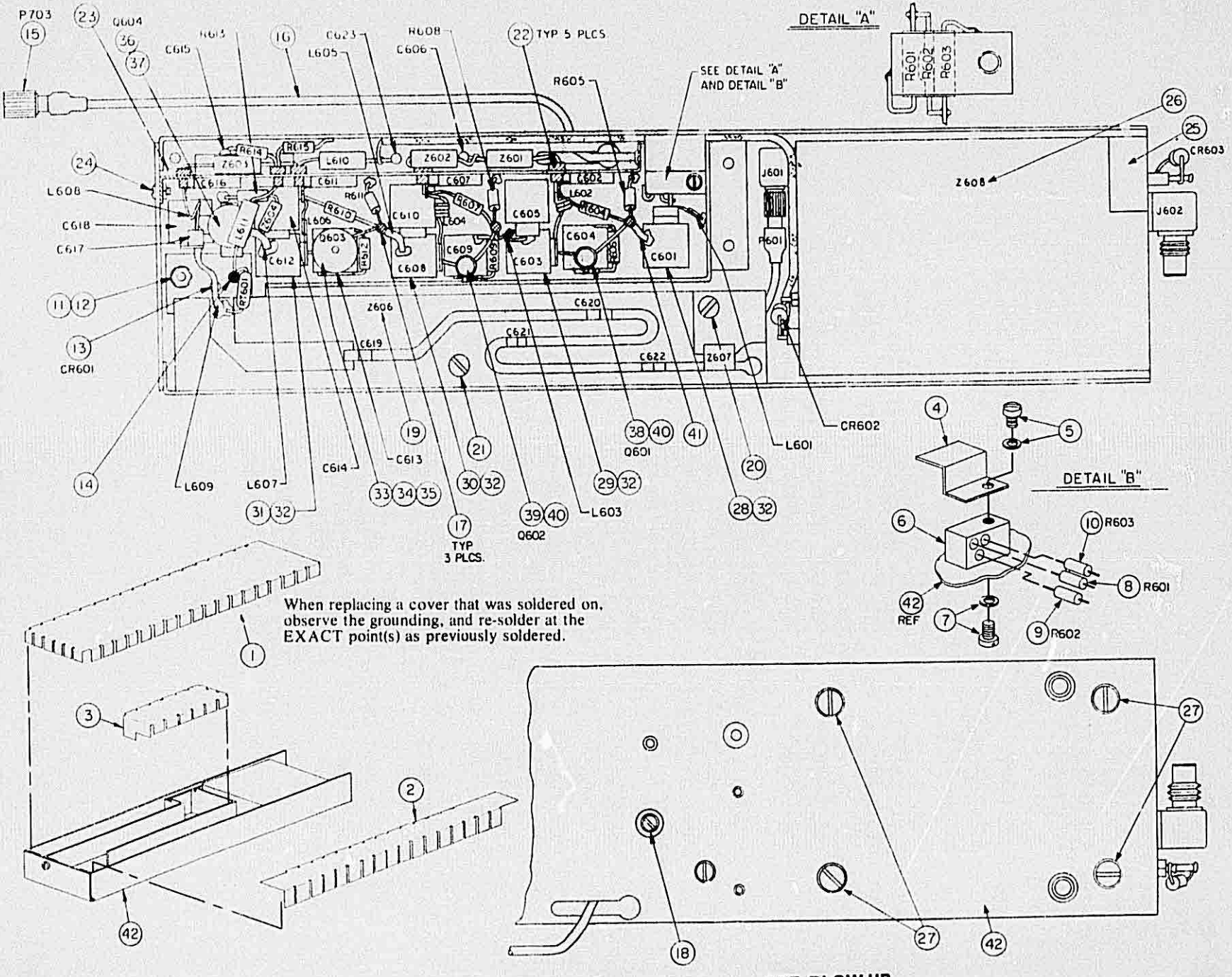
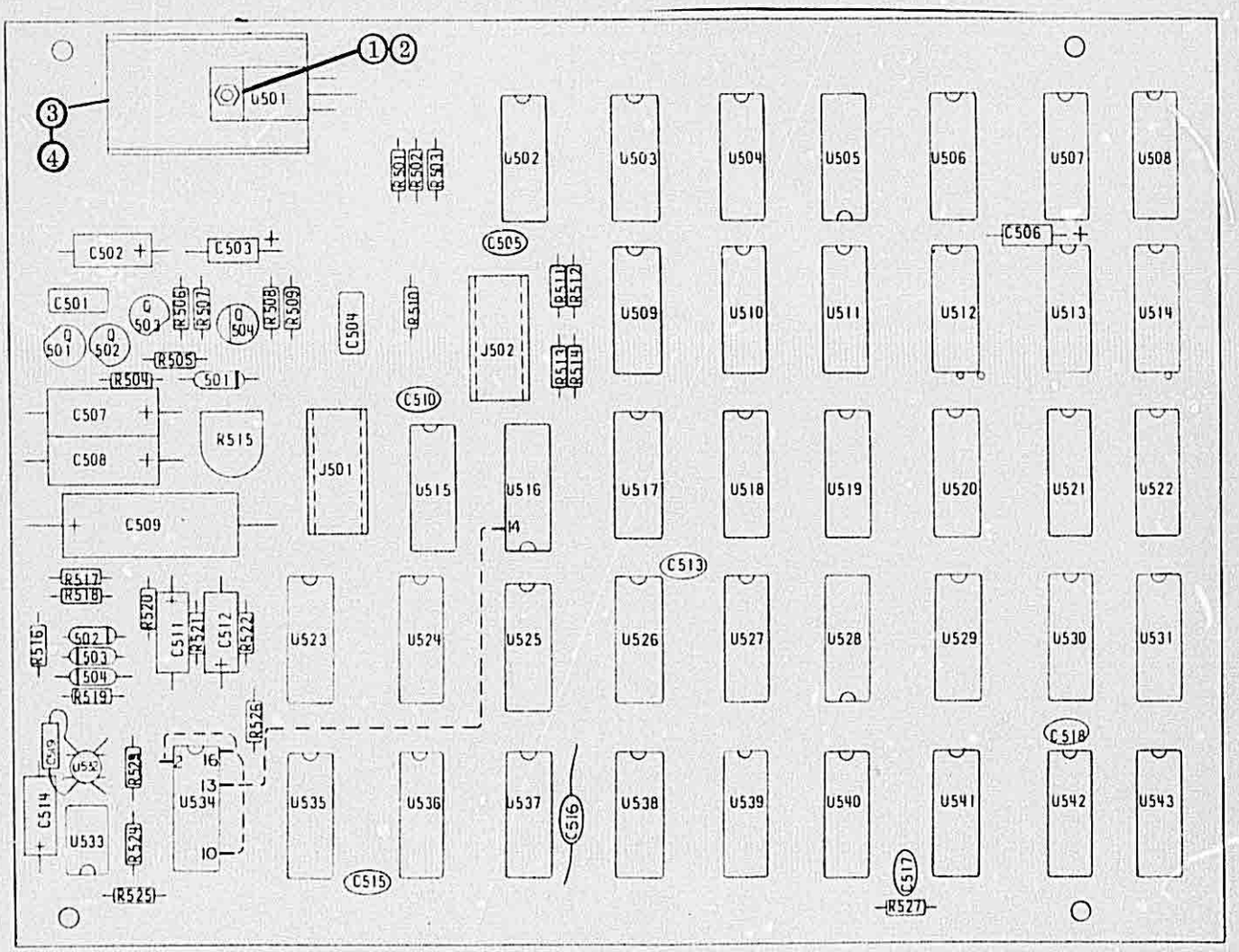


FIGURE 5.6 TRANSMITTER PC BD ASSY

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER		DESCRIPTION	QTY
5.7	01211-0101		VELOCITY PC BD ASSY (See Figure 5.1, item -10 for Next Higher Assembly)	Ref
-1	74039-0002	U501	IC, Voltage Regulator, 5v	1
			(Attaching Parts)	
-2	82892-0003		SCREW, Mach, Pan Hd, 4-40 x 1/4	1
	82900-0003		NUT, Hex, 4-40	1
			- - - - * - - - -	
-3	57791-0001		HEATSINK	1
			(Attaching Parts)	
-4	82845-0002		SCREW, Mach, Flat Hd, 2-56 x 3/16	1
	82900-0001		NUT, Hex, 2-56	1
			- - - - * - - - -	



ALL COMPONENTS SHOWN AS ◁▭▷ ARE DIODES. CR'S

D-57901-D

FIGURE 5.7 VELOCITY PC BD ASSY

SEE BLOW-UP

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.8	01215-0101	CHANNELING MULTIPLEX PC BD ASSY (See Figure 5.1	
		, item -16 for Next Higher Assembly.	Ref
-1	42077-0101	PROGRAMMING CARD.	2

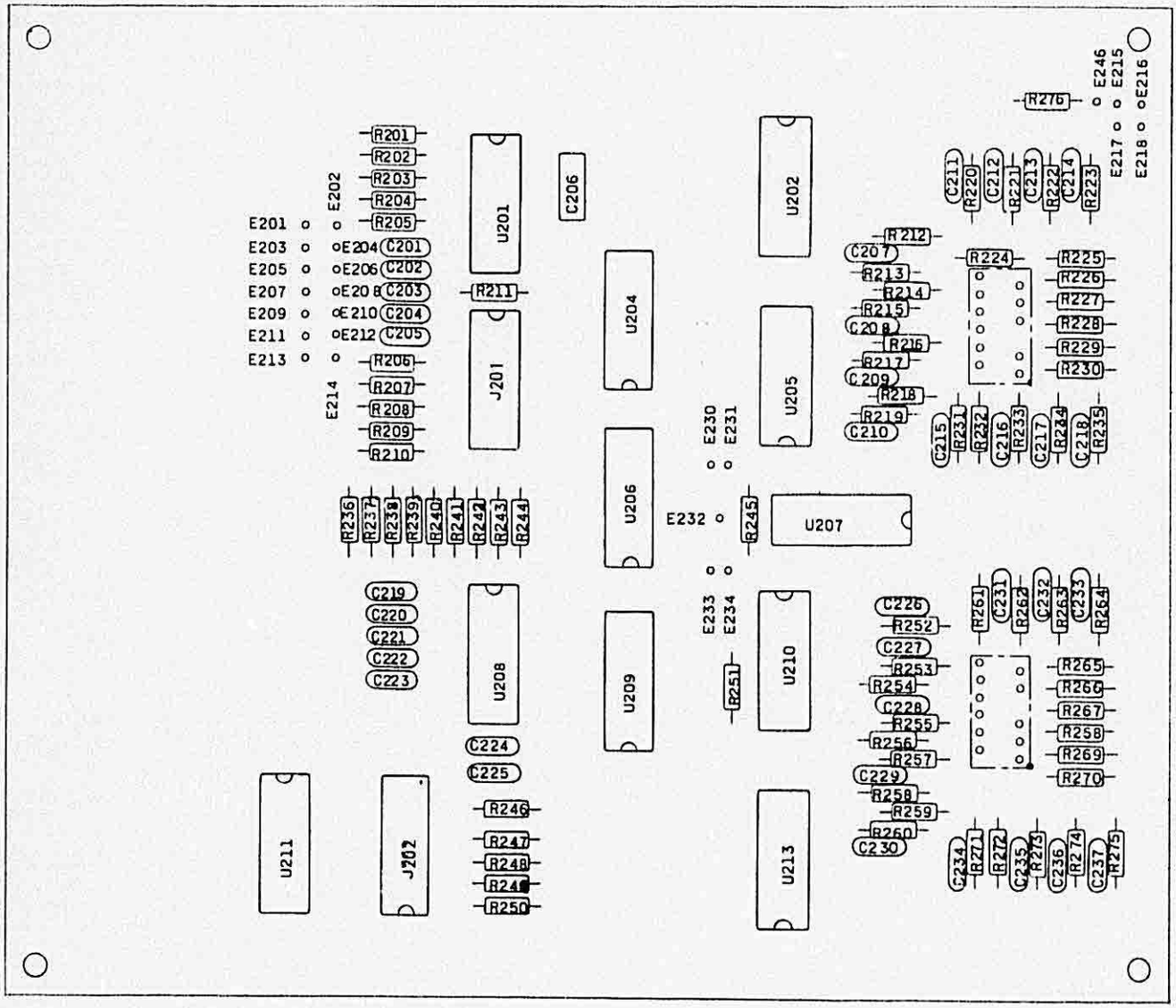


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FIGURE 5.8 CHANNELING MULTIPLEX PC BD ASSY

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.9	01674-0101	DISTANCE PC BOARD ASSY (See Figure 5.1, item -27 for Next Higher Assembly)	Ref
-1	99065-0004	TAPE, Double sided	1

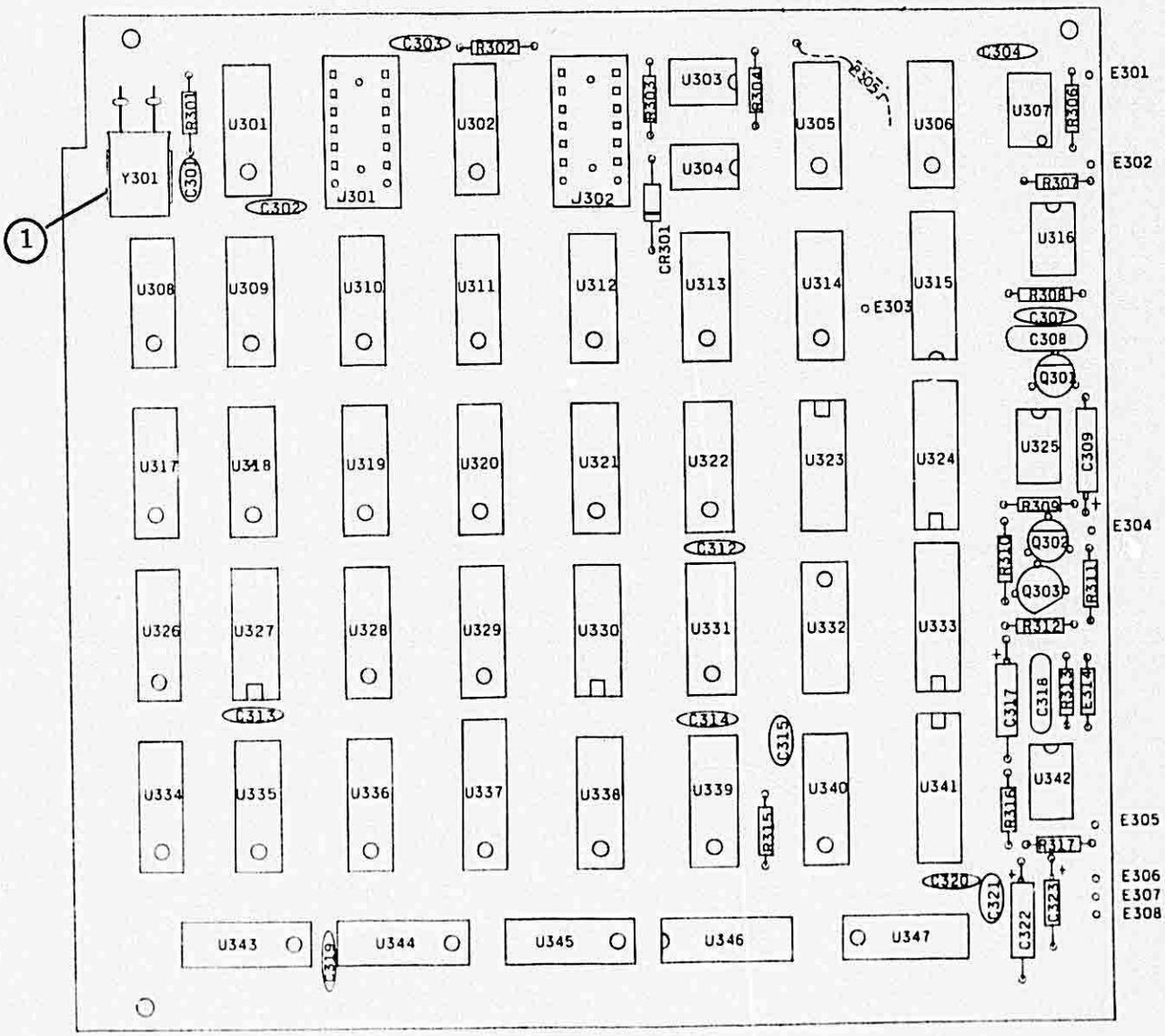

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FIGURE 5.9 DISTANCE PC BOARD ASSY

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.10	01678-0102	POWER SUPPLY ASSY (See Figure 5.1, item -28 for Next Higher Assembly)	Ref
-1	82017-0001	CLAMP, Cable (Used to lift assembly)	1
-2	11842-0001 L450	CHOKE	1
		(Attaching Parts)	
-3	83023-0001	INSULATOR	1
	81160-0006	GROMMET	1
	81355-0003	RIVET, Plastic	1
		- - - - * - - - -	
-4	11841-0001 T450	TRANSFORMER, DC to DC	1
		(Attaching Parts)	
-5	83023-0001	INSULATOR	1
	81355-0004	RIVET, Plastic	1
		- - - - * - - - -	
-6	75639-0001 Q412	TRANSISTOR, Silicon, 2N6388 (w/ Mica Insulator) .	1
-7	75640-0004 Q413	THYRISTOR, Silicon, RCA S2060A (w/Mica Insul) .	1
-8	75809-0002 Q453	TRANSISTOR, Silicon, NPN, TIP 35A (w/Mica Insul)	1
		(Attaching Parts)	
-9	82879-0003	SCREW, Mach, Flat Hd, 100°, 4-40 x 5/16	3
	81335-0012	BUSHING, Insulating	3
	82900-0003	NUT, Hex, 4-40	3
		- - - - * - - - -	
-10	75632-0001 Q451	TRANSISTOR, Silicon, PNP, 2N5194 (w/Mica Insul) .	1
		(Attaching Parts)	
-11	82879-0003	SCREW, Mach, Flat Hd, 100°, 4-40 x 5/16	1
	82900-0003	NUT, Hex, 4-40	1
		- - - - * - - - -	
-12	74039-0002 U450	IC, Voltage Regulator, 5v, 7805	1
		(Attaching Parts)	
-13	82879-0003	SCREW, Mach, Flat Hd, 100°, 4-40 x 5/16	1
	82900-0003	NUT, Hex, 4-40	1
		- - - - * - - - -	
-14	84167-0001	CAP, Insulated, Transistor (for Q410, Q411, Q452) .	3
-15	57756-0101	PLATE	1

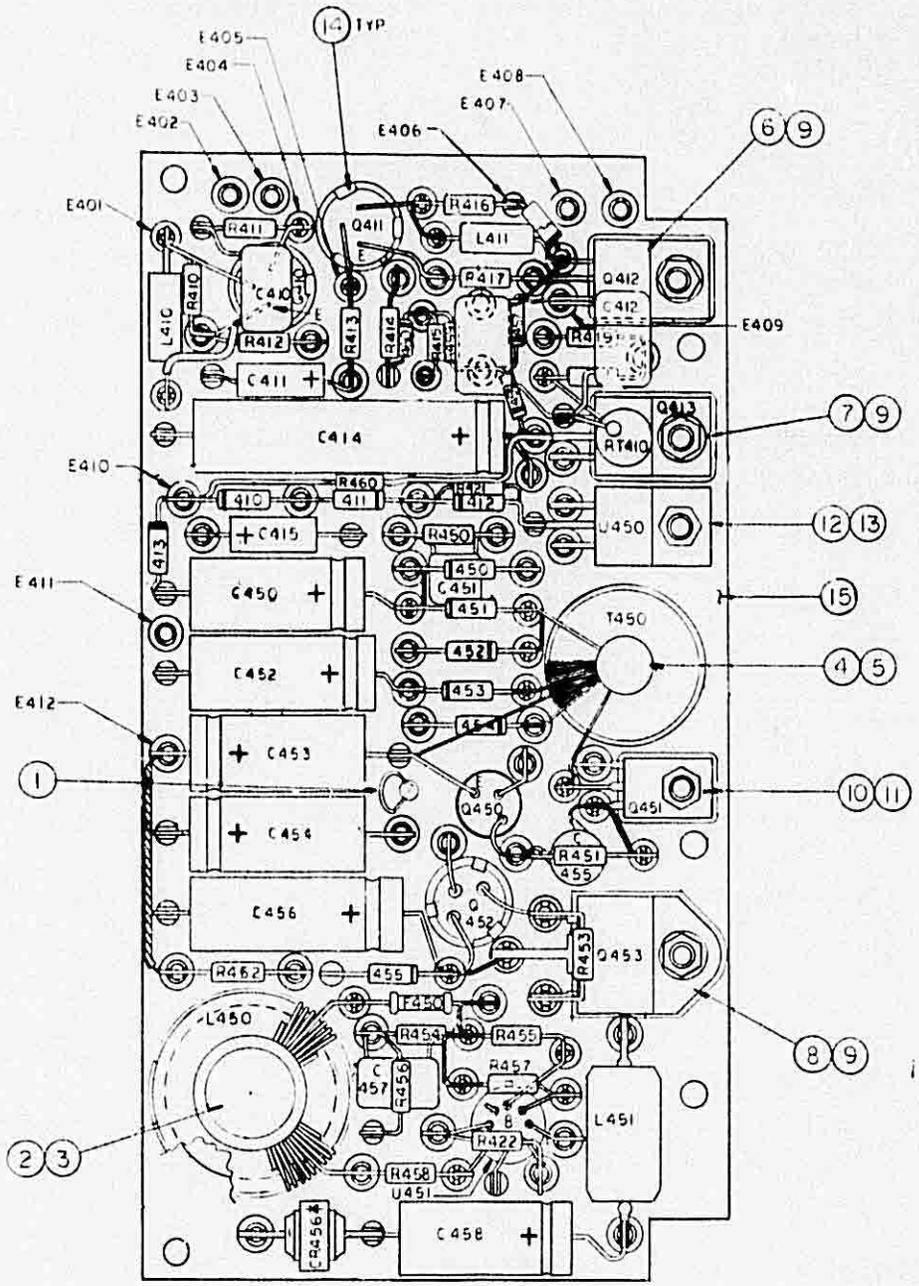

FIGURE 5-10 POWER SUPPLY ASSY

SEE BLOW-UP

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.11	No Number	FRONT PANEL ASSY (See Figure 5.1, item -37 for Next Higher Assembly).	Ref
-1	57934-0101	BRACKET (Dual Connector)	1
		(Attaching Parts)	
-2	82414-0404	SCREW, Mach, Bind Hd, 4-40 x 5/16	3
	81324-0004	WASHER, Lock, Split, #4	3
		- - - - * - - - -	
-3	41285-0002 J901	CONNECTOR, 14 Pin (attached by eyelets).	1
-4	41285-0002 J902	CONNECTOR, 14 Pin (attached by eyelets)	1
-5	65148-0001 K901	RELAY, Miniature	1
		(Attaching Parts)	
-6	82414-0404	SCREW, Mach, Bind Hd, 4-40 x 5/16	2
	81324-0004	WASHER, Lock, Split, #4	2
		- - - - * - - - -	
-7	57933-0101	BRACKET (Relay and Connector)	1
		(Attaching Parts)	
-8	82414-0404	SCREW, Mach, Bind Hd, 4-40 x 5/16	2
	81324-0004	WASHER, Lock, Split, #4	2
		- - - - * - - - -	
-9	41285-0005 J904	CONNECTOR, 24 Pin (attached by eyelets)	1
-10	41328-0002 J903	CONNECTOR, 9 Pin.	1
		(Attaching Parts)	
-11		Hardware supplied with connector.	2
		- - - - * - - - -	
-12	57939-0101	BRACKET	2
		(Attaching Parts)	
-13	82814-0404	SCREW, Mach, Bind Hd, 4-40 x 5/16	2
	81324-0004	WASHER, Lock, Split, #4	2
		- - - - * - - - -	
-14	57950-0001	PANEL, Front	1

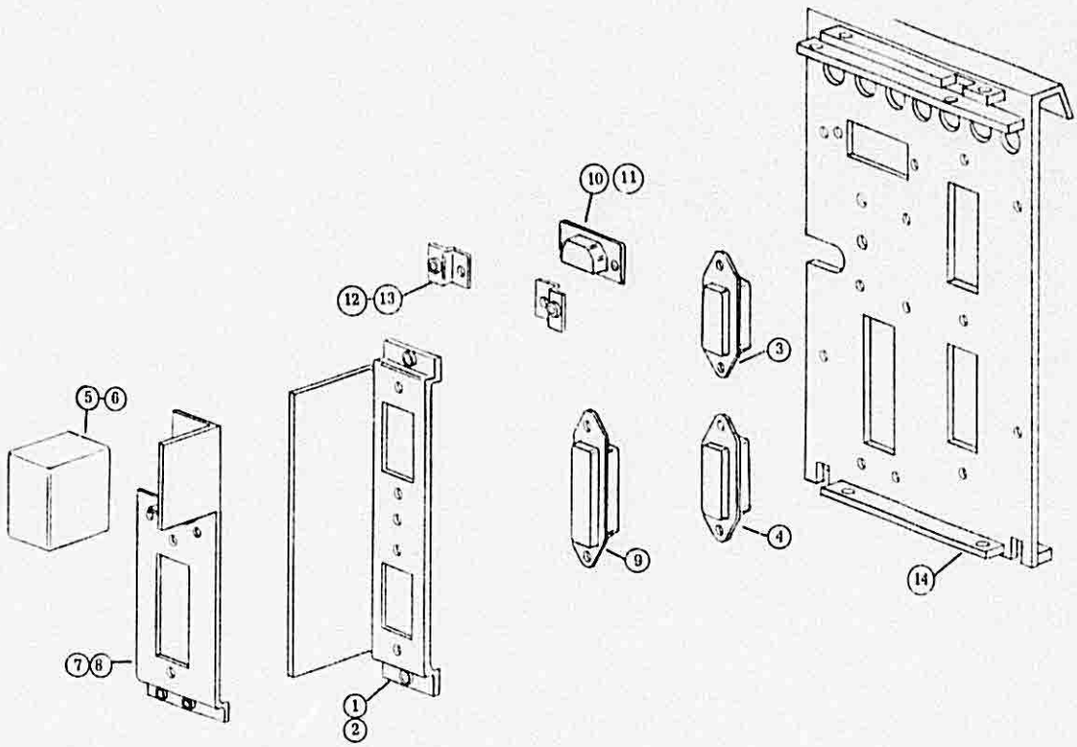

FIGURE 5.11 FRONT PANEL ASSY

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.12	01213-0101	DME 195 INDICATOR.	1
-1	04781-0001	LABEL.	1
-2	57911-0001	COVER.	1
		(Attaching Parts)	
-3	82892-0002	SCREW, Mach, Pan Hd, 4-40 x 3/16	2
		- - - - * - - - -	
-4	88170-0004	KNOB (ON-OFF-VOL)	1
		(Attaching Parts)	
-5	82887-0213	SETSCREW, Hex Socket, 2-56 x 3/32	1
	82887-0212	SETSCREW, Hex Socket, 2-56 x 1/16	1
		- - - - * - - - -	
-6	57907-0002	TRIM PANEL.	1
		(Attaching Parts)	
-7	82819-0303	SCREW, Mach, Flat Hd, Black, 4-40 x 1/4	4
		- - - - * - - - -	
-8	56250-0002	KNOB (Dimmer and Ident Push to Test)	1
-9	57748-0001	CUP (Test Switch).	1
-10	55660-0006	SPRING, Coil Compression	1
-11	57908-0001	LENS, Green (RNAV)	1
-12	57908-0002	LENS, Amber (Hold)	1
-13	04770-0001	ESCUTCHEON, Trim Panel	1
-14	57909-0001	SWITCH, Mask	1
-15	01214-0101	FLEXIBLE CIRCUIT ASSY (See Figure 5.13 for breakdown)	1
		(Attaching Parts)	
-16	82892-0002	SCREW, Mach, Pan Hd, 4-40 x 3/16	7
		- - - - * - - - -	
-17	83011-0004	INSULATOR	1
-18	81351-0001	NUT, Self-clinching, 4-40	4
-19	57910-0101	FRAME.	1

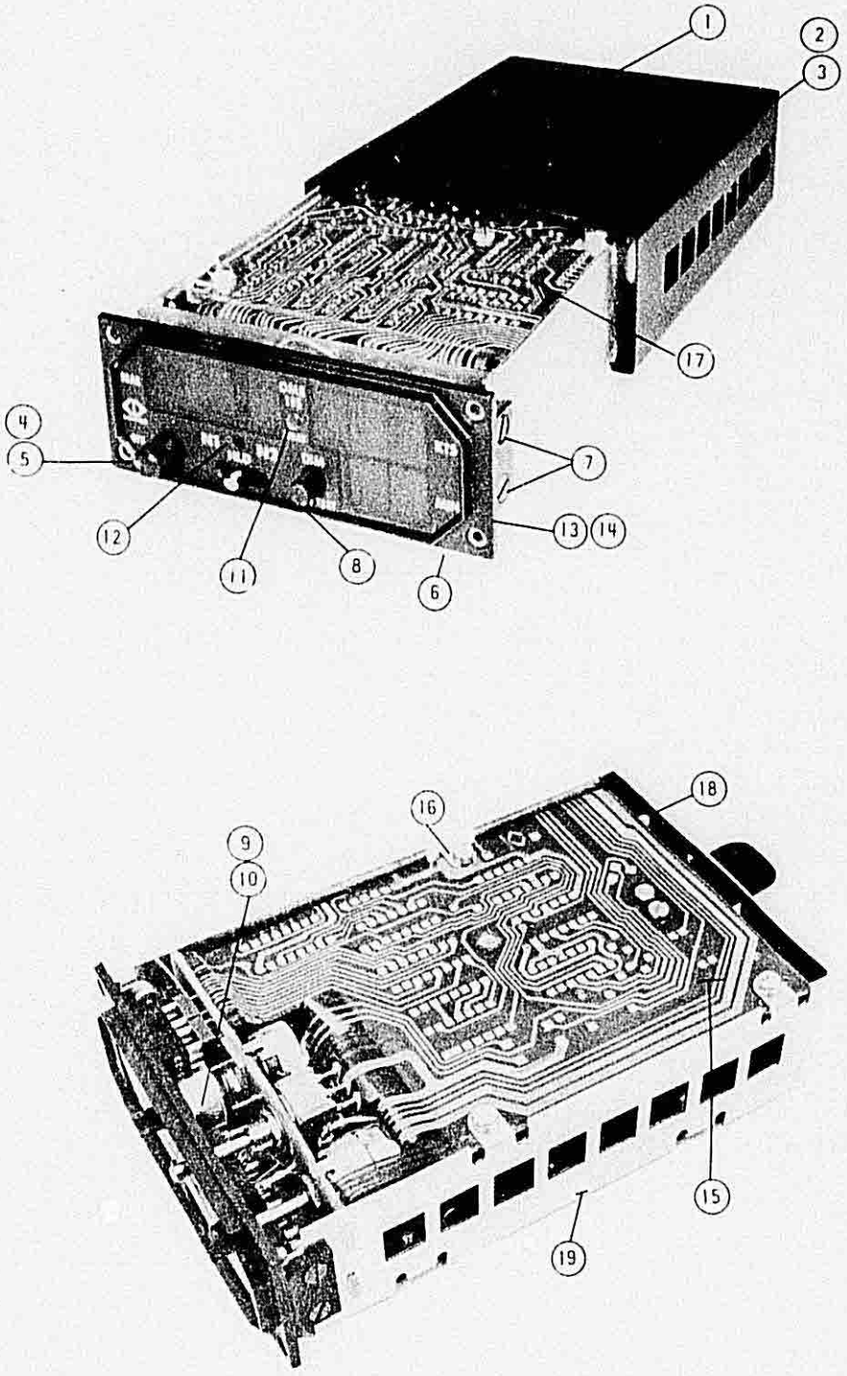

FIGURE 5.12 DME 195 INDICATOR

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.13	01214-0101	FLEXIBLE CIRCUIT ASSY (See Figure 5.12, item -15 for Next Higher Assembly)	Ref
-1	74039-0002 U109	IC, Voltage Regulator, 5v, 7805	1
		(Attaching Parts)	
-2	82892-0404	SCREW, Mach, Pan Hd, 4-40 x 5/16	1
	82802-0003	LOCKWASHER, Int. Tooth, #4.	1
	82900-0003	NUT, Hex, 4-40	1
		- - - - * - - - -	
-3	57920-0001	HEATSINK	1
		(Attaching Parts)	
-4	82845-0002	SCREW, Mach, Flat Hd, 2-56 x 3/16.	1
	82900-0001	NUT, Hex, 2-56	1
		- - - - * - - - -	
-5	75639-0001 Q101	TRANSISTOR, Silicon, Darlington, NPN, 2N6388 . .	1
		(Attaching Parts)	
-6	82892-0404	SCREW, Mach, Pan Hd, 4-40 x 5/16.	1
	82802-0003	LOCKWASHER, Int. Tooth, #4.	1
	82900-0003	NUT, Hex, 4-40	1
		- - - - * - - - -	
-7	57921-0001	HEATSINK	1
		(Attaching Parts)	
-8	82845-0002	SCREW, Mach, Flat Hd, 2-56 x 3/16.	1
	82900-0001	NUT, Hex, 2-56	1
		- - - - * - - - -	
-9	90039-0004	BUS, Silver Strap	AR
-10	41308-0006	POST, Slide Lock (pair)	1
-11	41355-0005 J101	CONNECTOR, PC type, Right Angle	1
		(Attaching Parts)	
-12	82892-0404	SCREW, Mach, Pan Hd, 4-40 x 5/16.	2
	82802-0003	LOCKWASHER, Int. Tooth, #4	2
	82900-0003	NUT, Hex, 4-40	2
		- - - - * - - - -	
-13	82997-0007	STANDOFF, Self-clinching, 4-40	1
-14	81222-0001	SPACER, Backup	1
-15	81733-0015	TERMINAL (part of S103).	2
-16	42076-0001	SOCKET, 8 Pin	9
-17	82996-0002	NUT, Self-clinching, #4-40	6
-18	57906-0101	FLEXIBLE CIRCUIT.	1

QTY

.12, item -15 for
. . . . . Ref
. 1

. 1
. 1
. 1

. 1

. 1
. 1

PN, 2N6388 . . 1

. 1
. 1
. 1

. 1

. 1
. 1

. . . . . AR
. 1
. 1

. 2
. 2
. 2

. 1
. 1
. 2
. 9
. 6
. 1

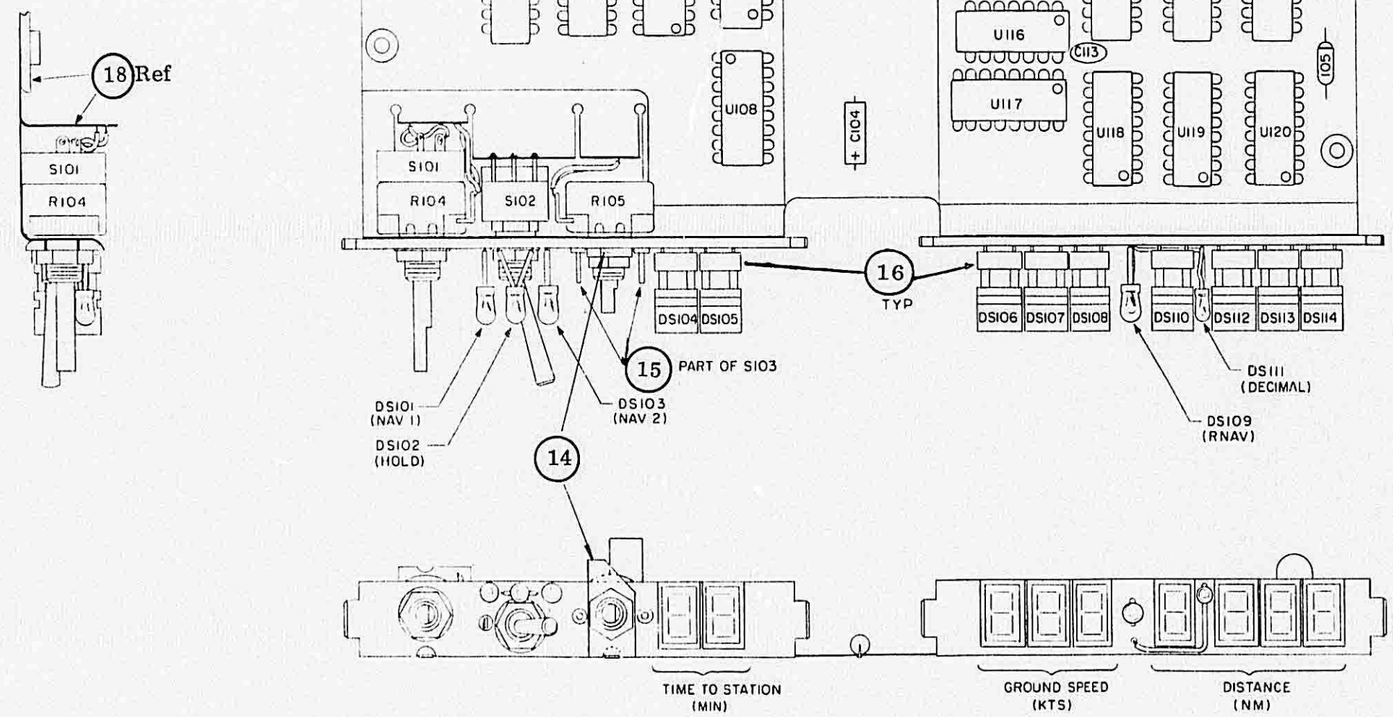

FIGURE 5.13 FLEXIBLE CIRCUIT ASSY

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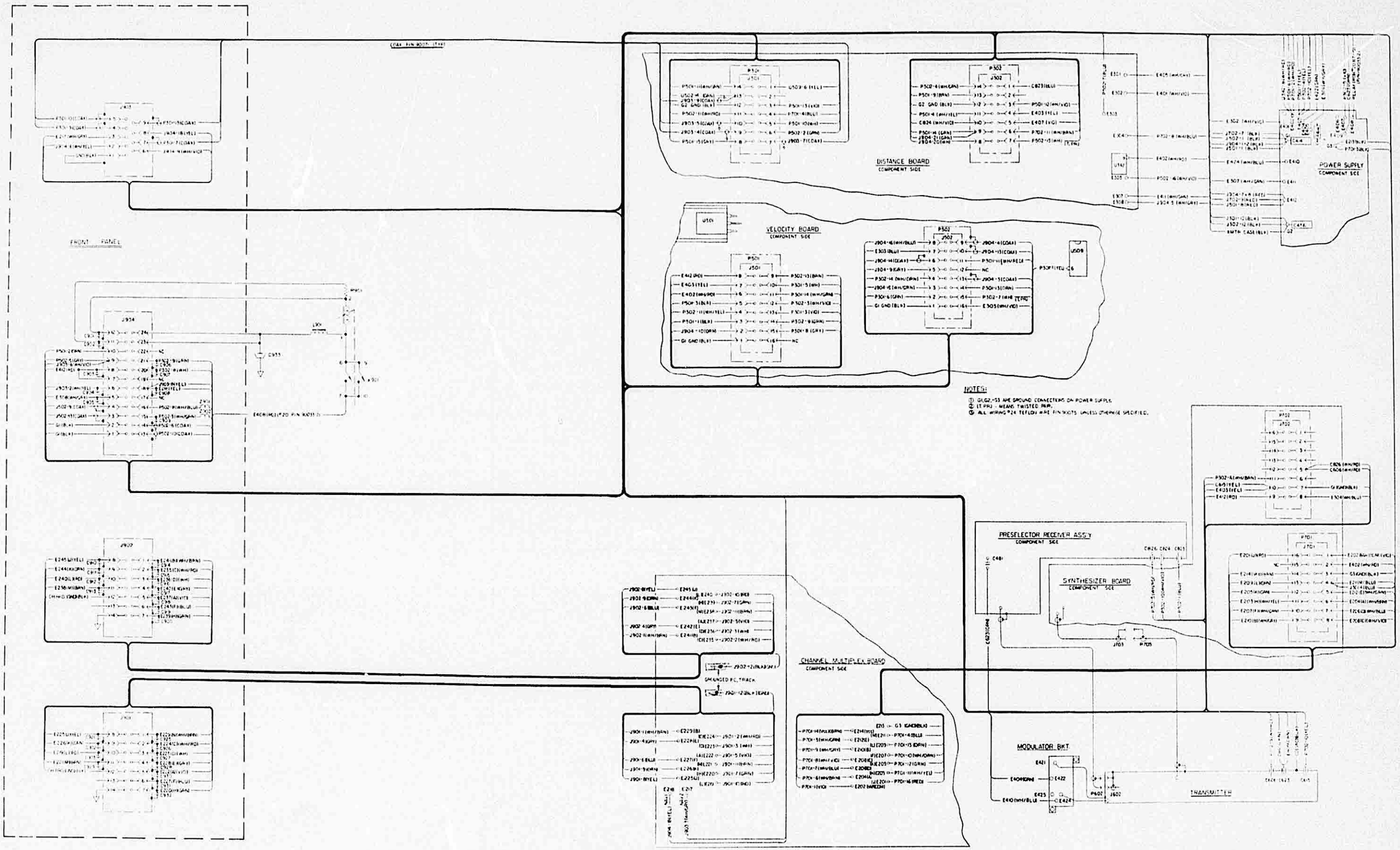
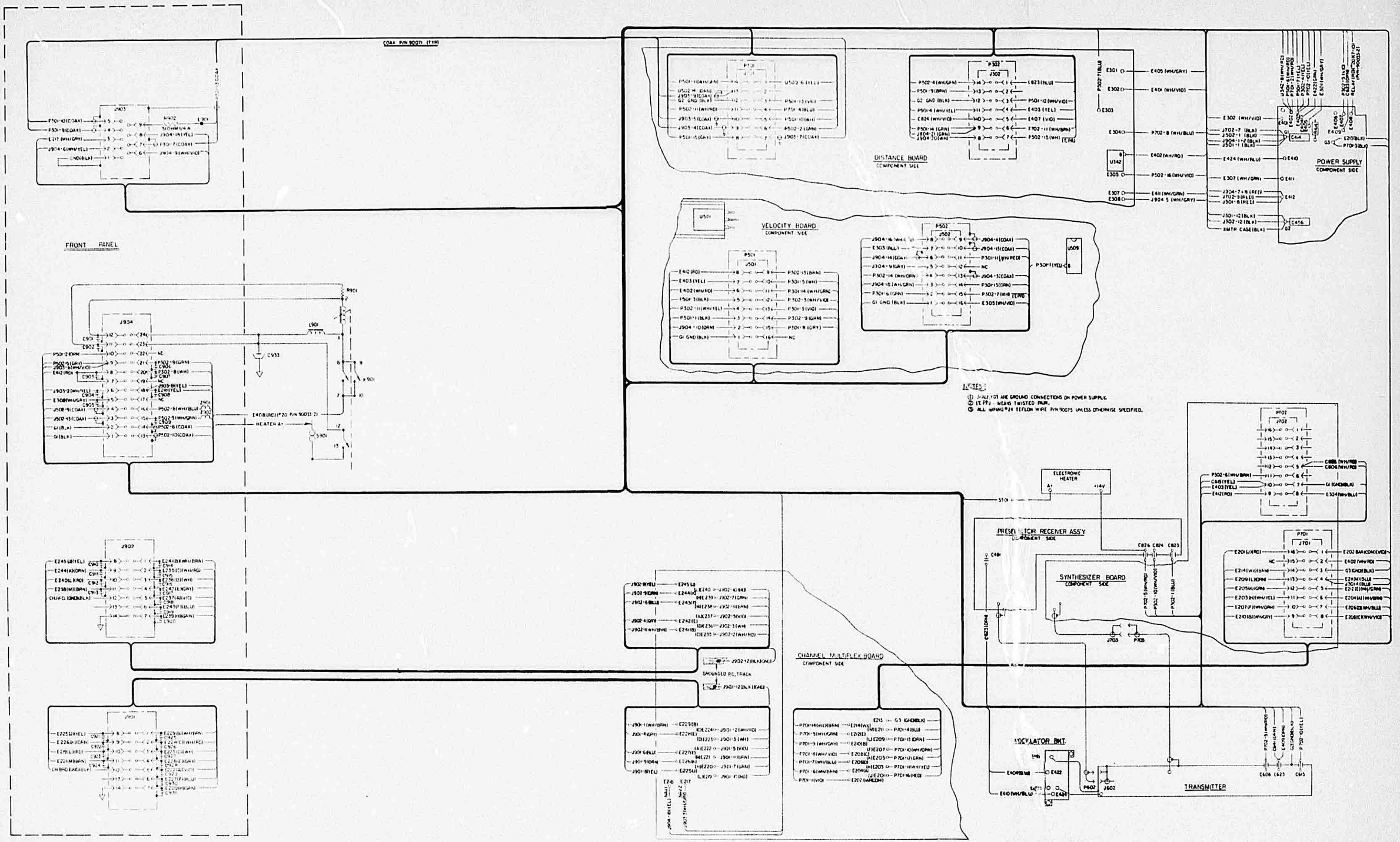


FIGURE 5.14 DME 195 INTERNAL WIRING DIAGRAM

SEE BLOW-UP

SEE BLOW-UP



SEE BLOW-UP

SEE BLOW-UP

FIGURE 5-14A DME-195 INTERNAL WIRING DIAGRAM (B) CHASSIS

NARCO AVIONICS DME 195

SCHEMATICS, SECTION 6

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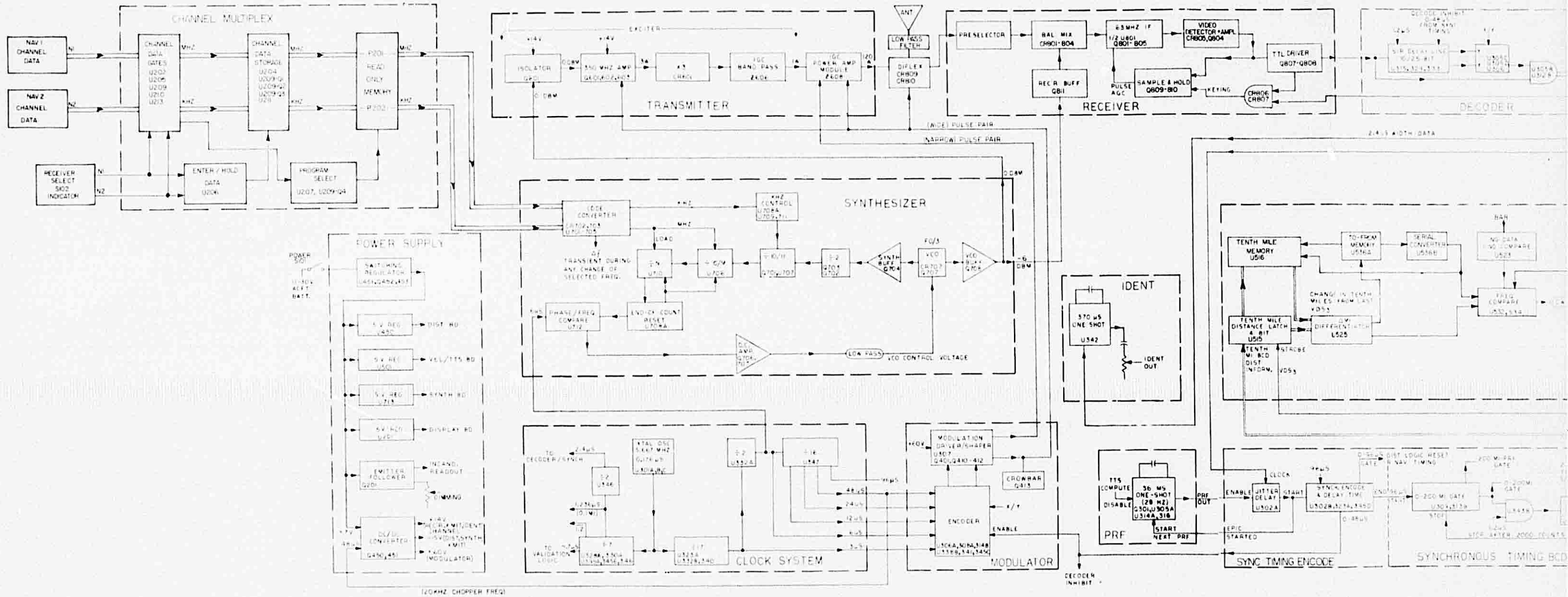


FIGURE 6-1. DME 195 SYSTEM BLOCK DIAGRAM

SEE BLOW-UP

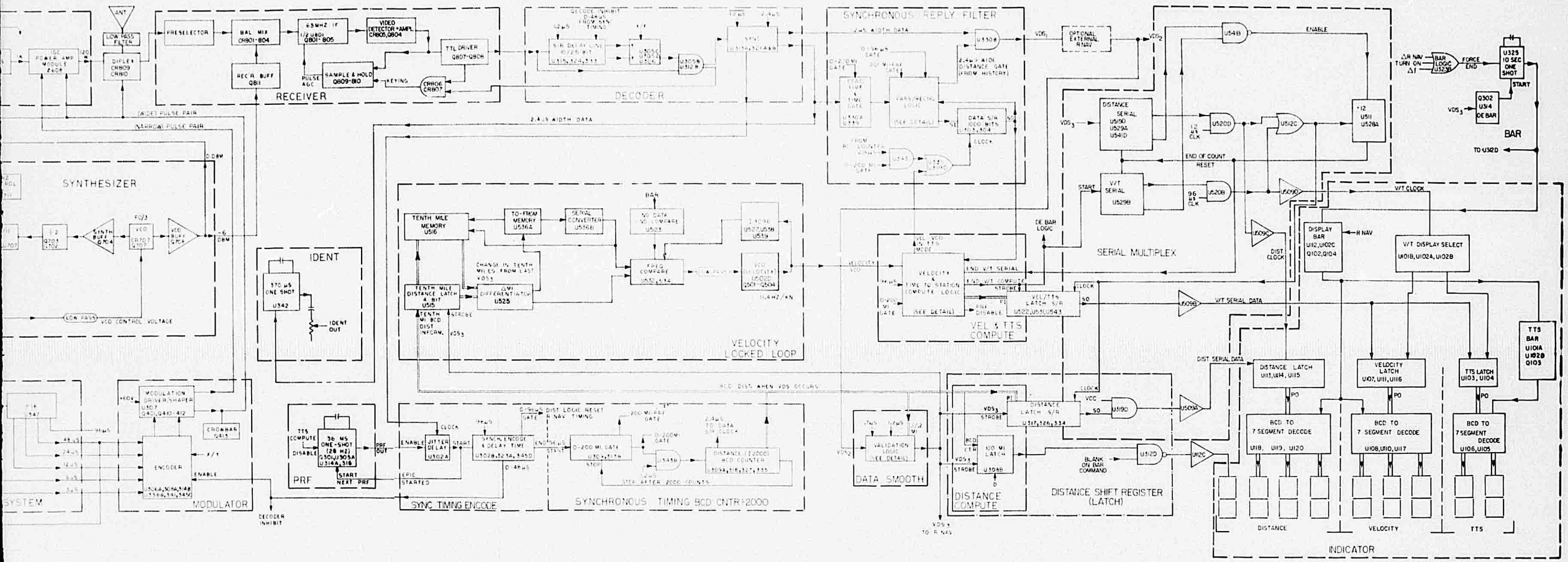
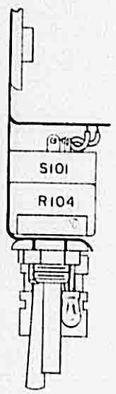


FIGURE 6-1. DME 195 SYSTEM BLOCK DIAGRAM

SEE BLOW-UP



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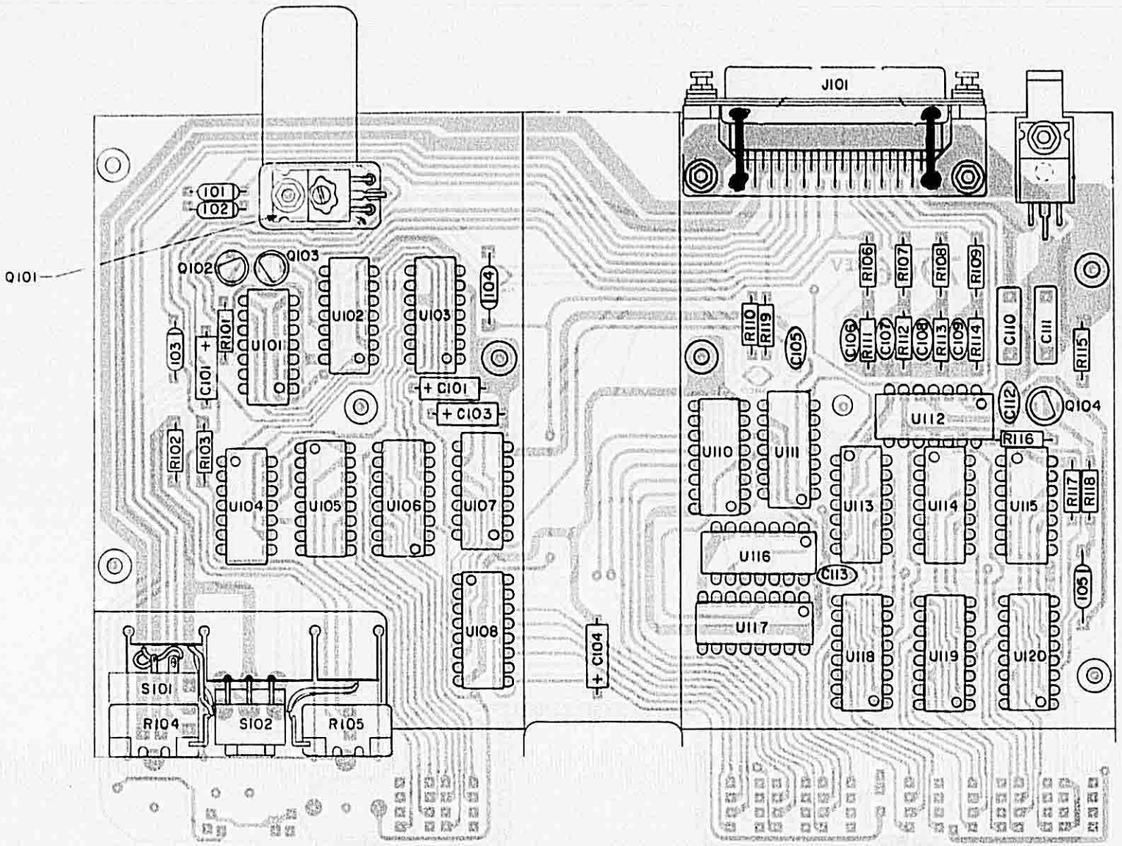
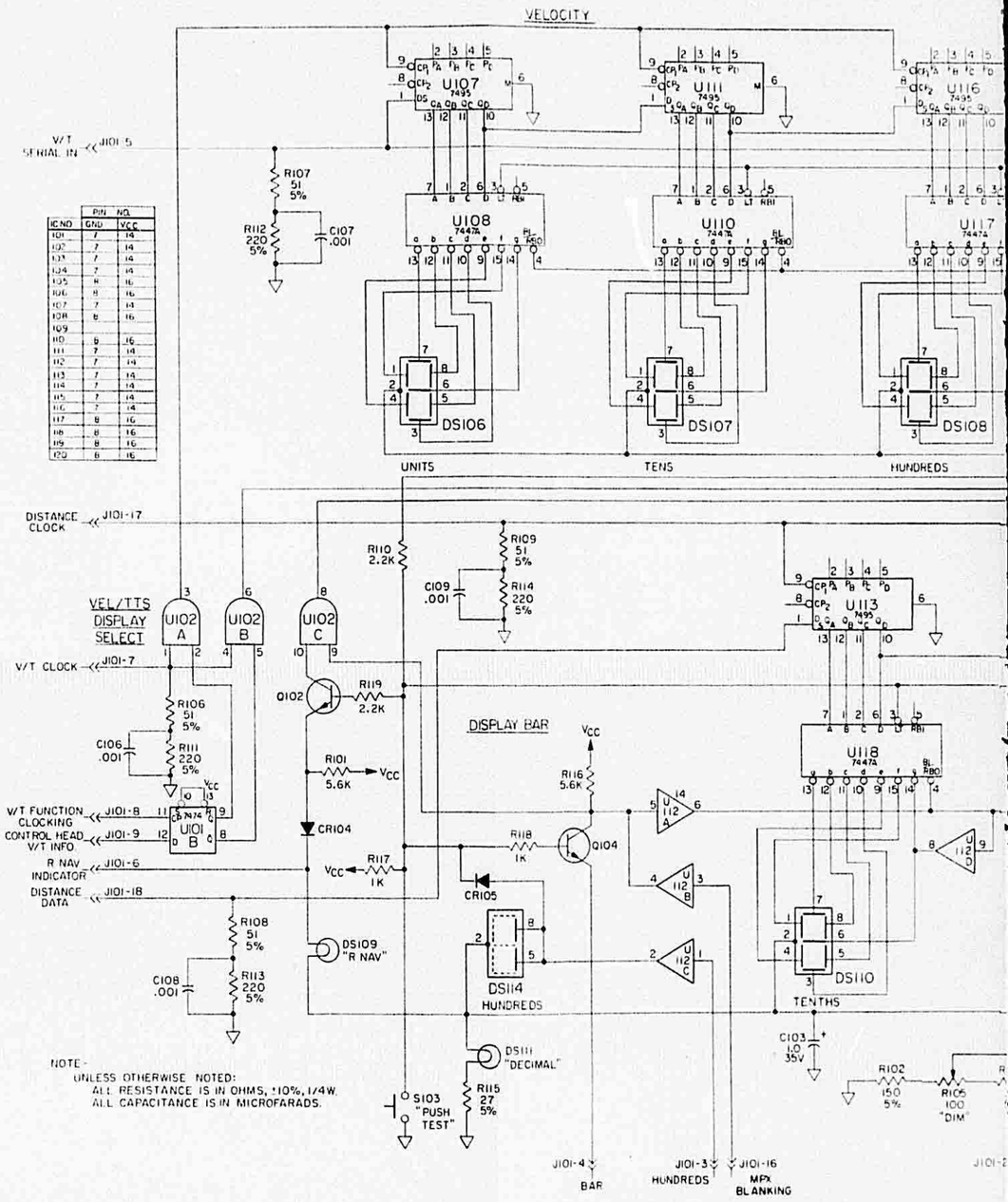




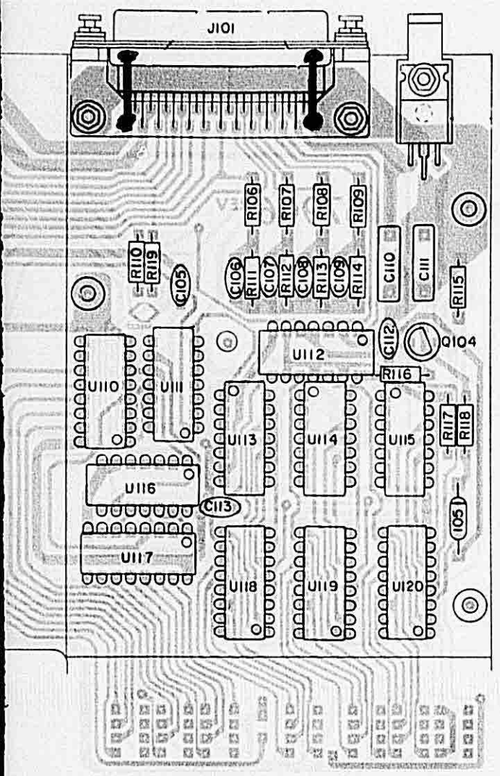
NOTES:

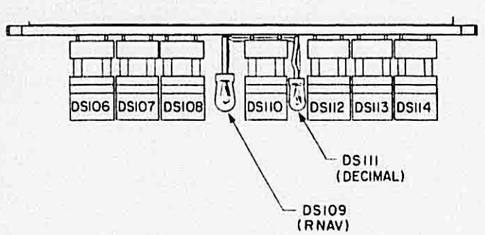
1. ⬭ INDICATES DIODE. CR OMITTED FOR CLARITY. BAR INDICATES CATHODE END.

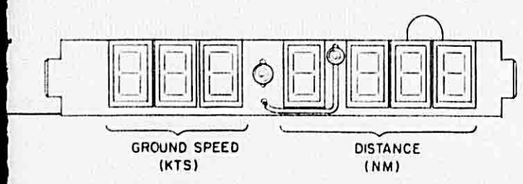
SEE BLOW-UP

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.



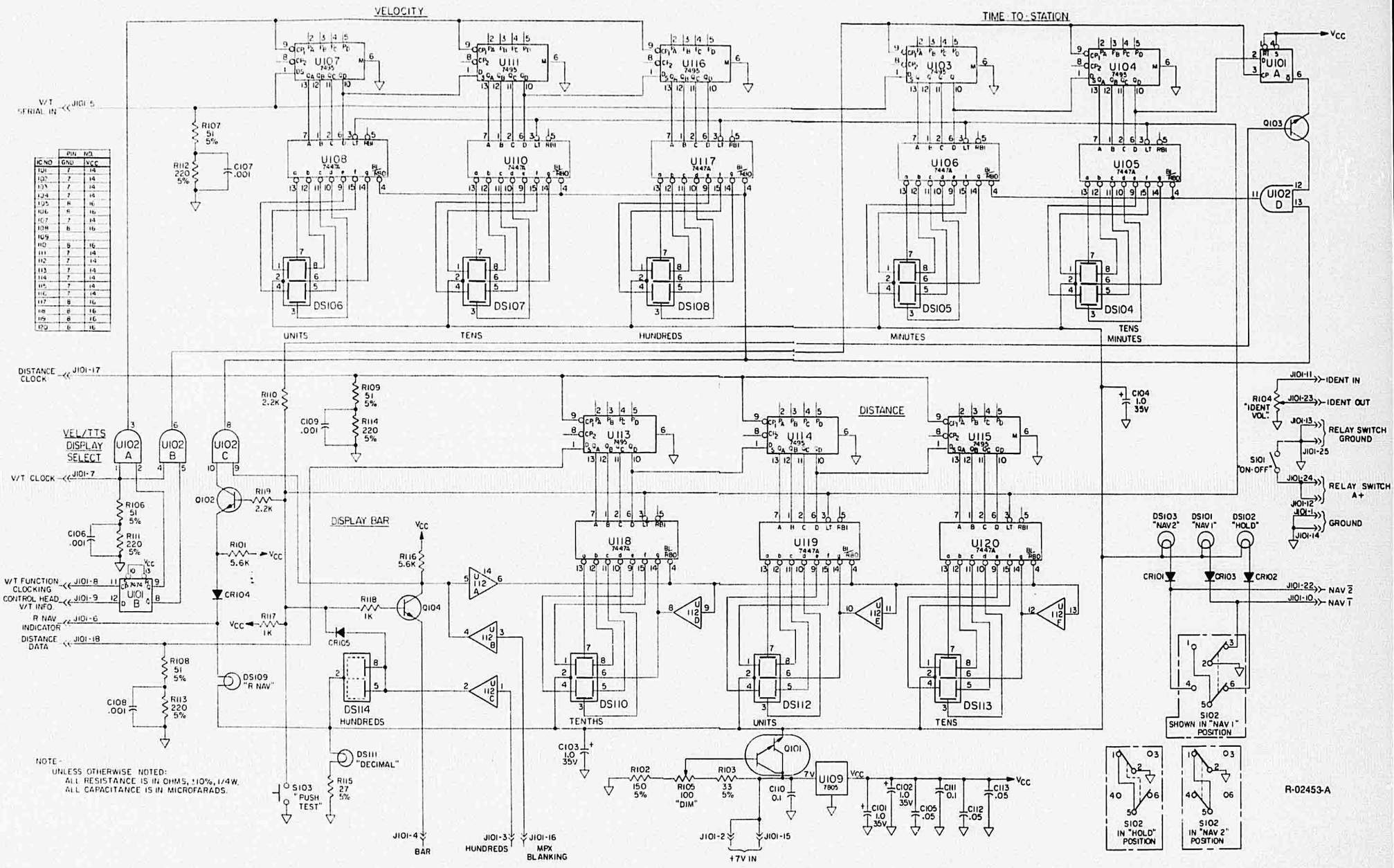




DICATES CATHODE END.

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.

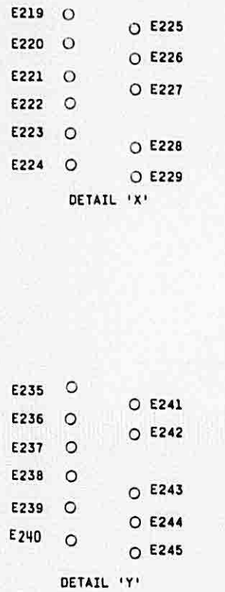


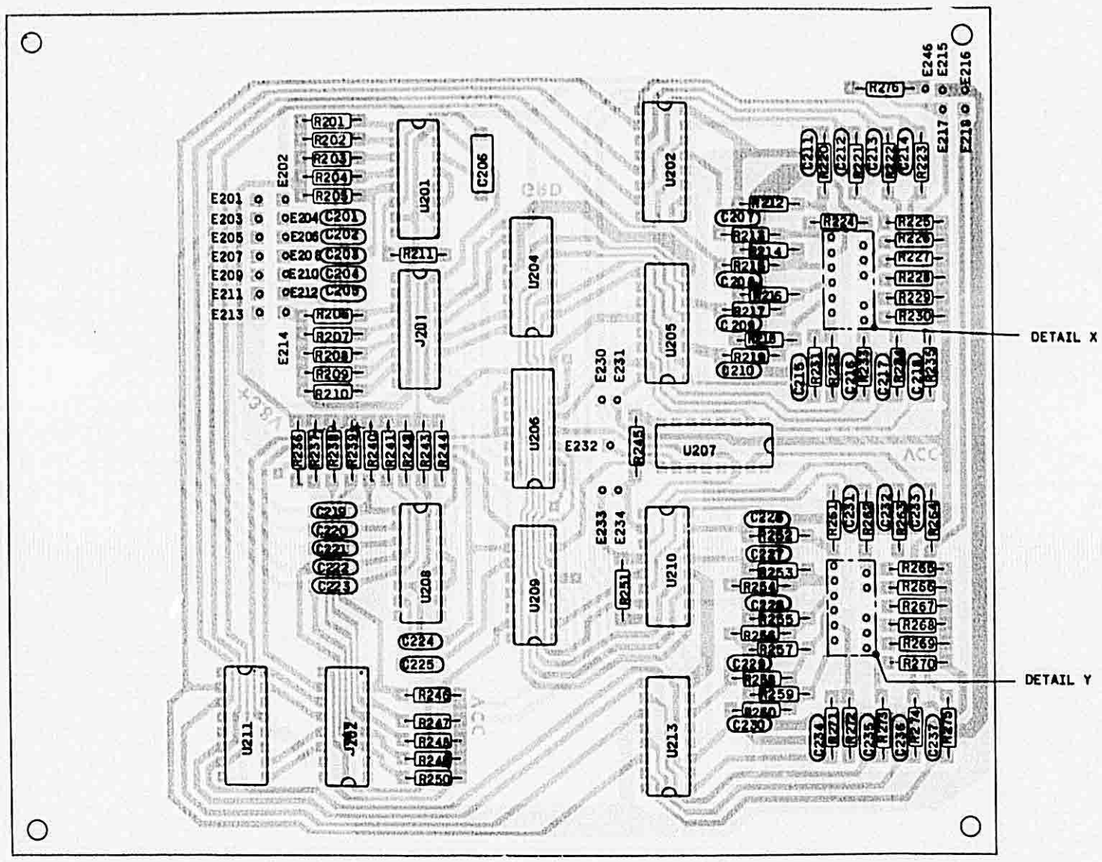
NOTE -
UNLESS OTHERWISE NOTED:
ALL RESISTANCE IS IN OHMS, ±10%, 1/4W.
ALL CAPACITANCE IS IN MICROFARADS.

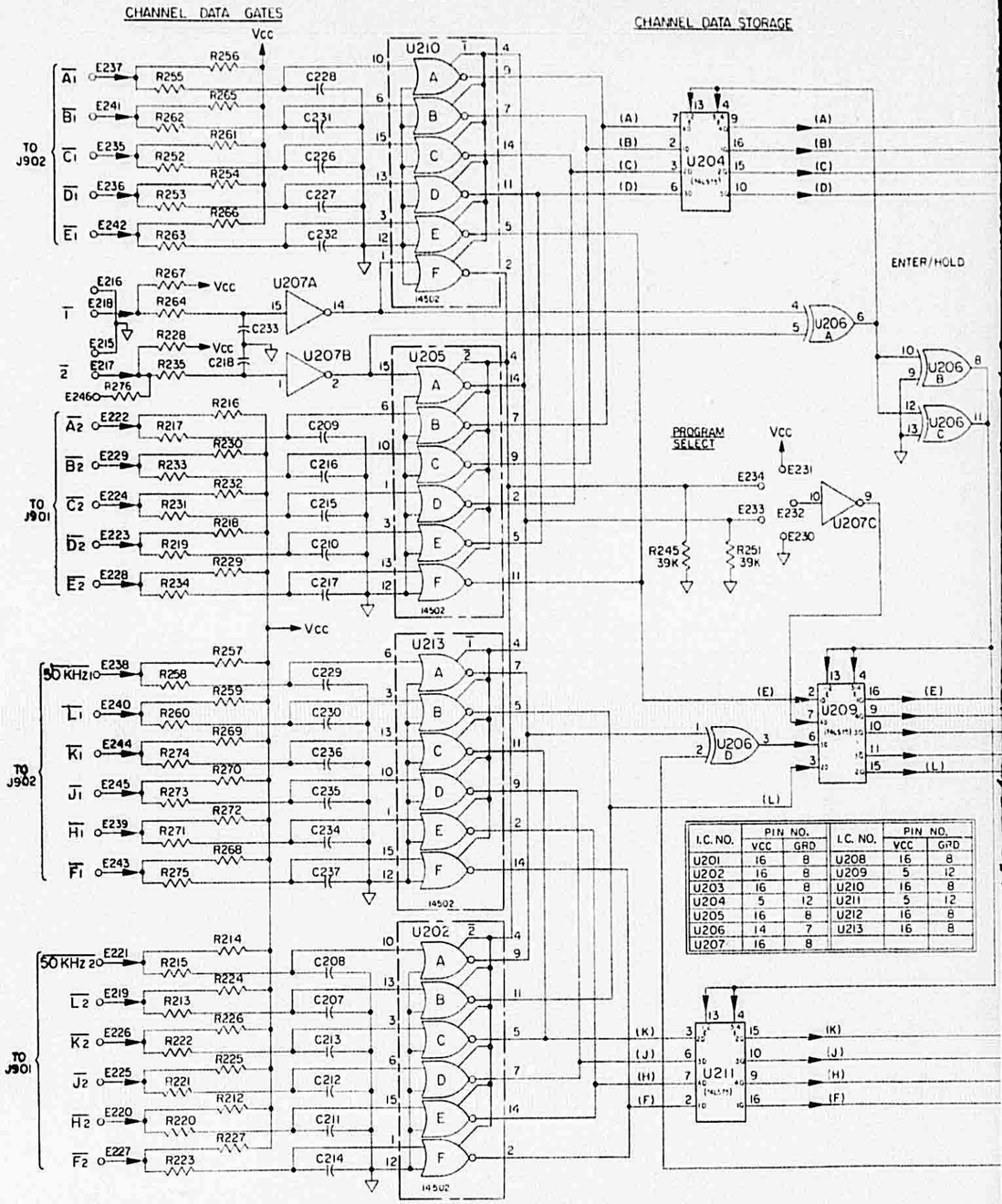
	PIN NO.	
IC NO	GND	VCC
101	7	14
102	7	14
103	7	14
104	7	14
105	8	16
106	8	16
107	7	14
108	8	16
109		
110	8	16
111	7	14
112	7	14
113	7	14
114	7	14
115	7	14
116	7	14
117	8	16
118	8	16
119	8	16
120	8	16

FIGURE 6-2. DME 195 INDICATOR SCHEMATIC

SEE BLOW-UP



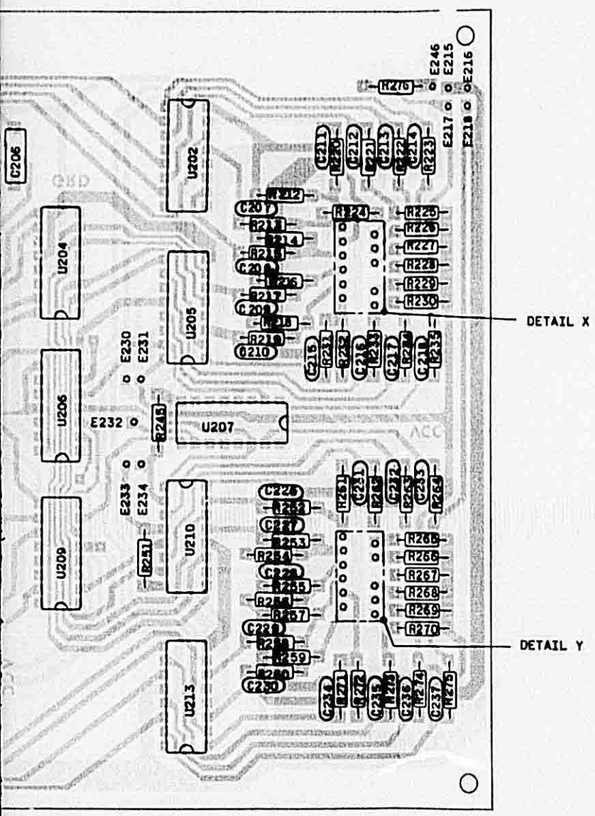




Solder runs shown in GREY
are those on the "BOTTOM" (non-component)
side of the board.

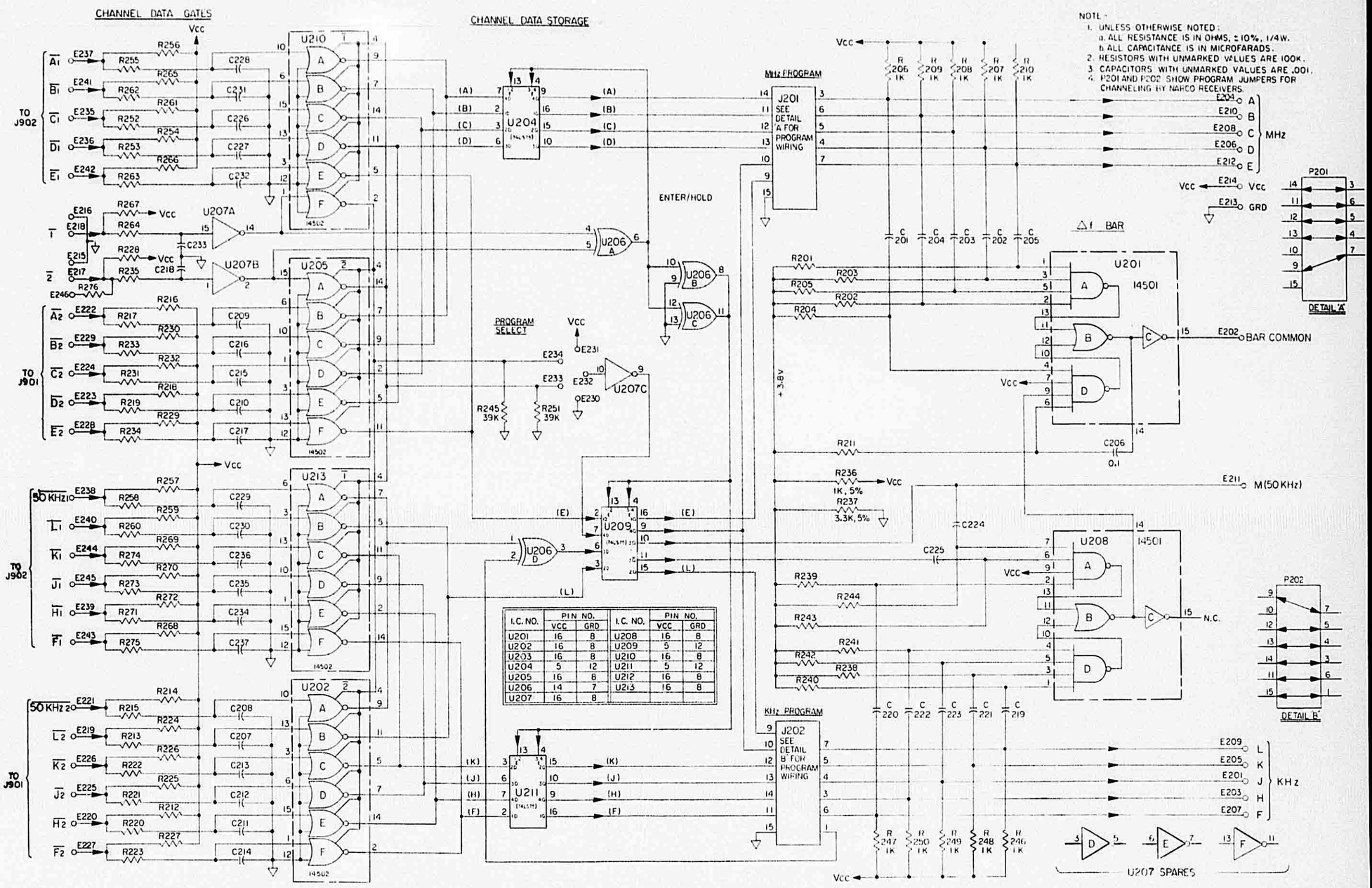
Solder runs shown in PINK
are those on the "TOP" (component)
side of the board.

SEE BLOW-UP



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.



B-02451-A

FIGURE 6-3. DME 195 CHANNEL MULTIPLEX SCHEMATIC

SEE BLOW-UP

CHANNEL DATA GATES

CHANNEL DATA STORAGE

NOTE
1. UNLESS OTHERWISE NOTED:
   a. ALL RESISTANCE IS IN OHMS, ± 10%, 1/4W.
   b. ALL CAPACITANCE IS IN MICROFARADS.
2. RESISTORS WITH UNMARKED VALUES ARE 100K.
3. CAPACITORS WITH UNMARKED VALUES ARE .001.
4. P201 AND P202 SHOW PROGRAM JUMPERS FOR CHANNELING BY NARCO RECEIVERS.

MHz PROGRAM

ENTER/HOLD

PROGRAM SELECT

KHz PROGRAM

Δf BAR

U207 SPARES

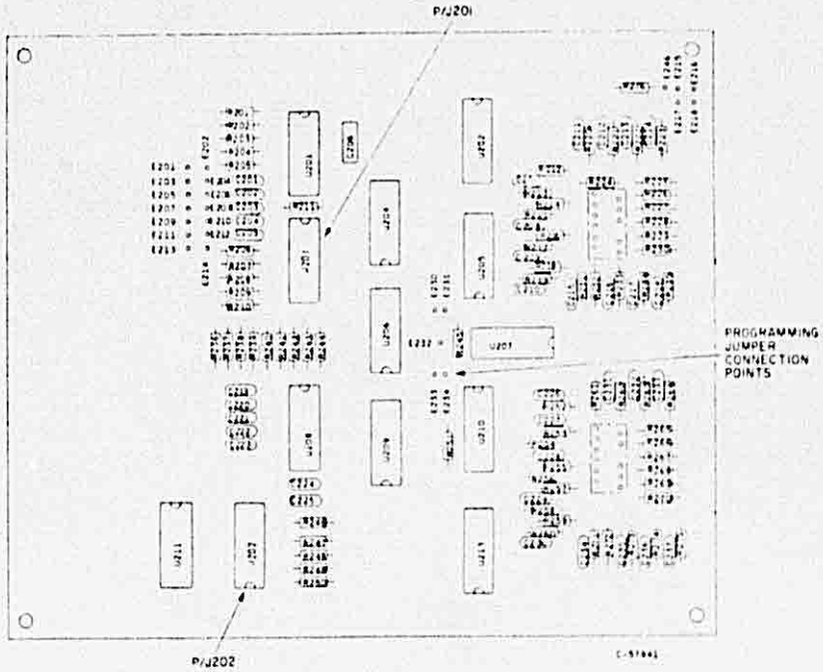
I.C. NO.	PIN NO. VCC	PIN NO. GRD	I.C. NO.	PIN NO. VCC	PIN NO. GRD
U201	16	8	U208	16	8
U202	16	8	U209	5	12
U203	16	8	U210	16	8
U204	5	12	U211	5	12
U205	16	8	U212	16	8
U206	14	7	U213	16	8
U207	16	8			

FIGURE 6-3A DME-195 CHANNEL MULTIPLEX SCHEMATIC (A) CHASSIS

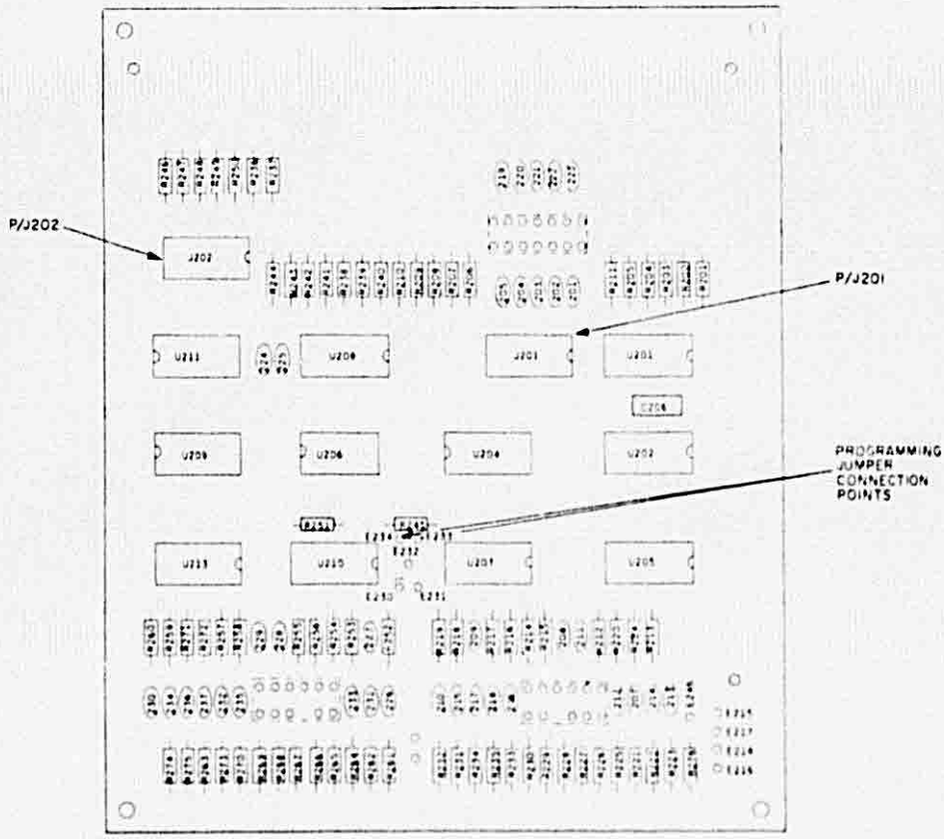
SEE BLOW-UP

SEE BLOW-UP

These assemblies are electrically identical.



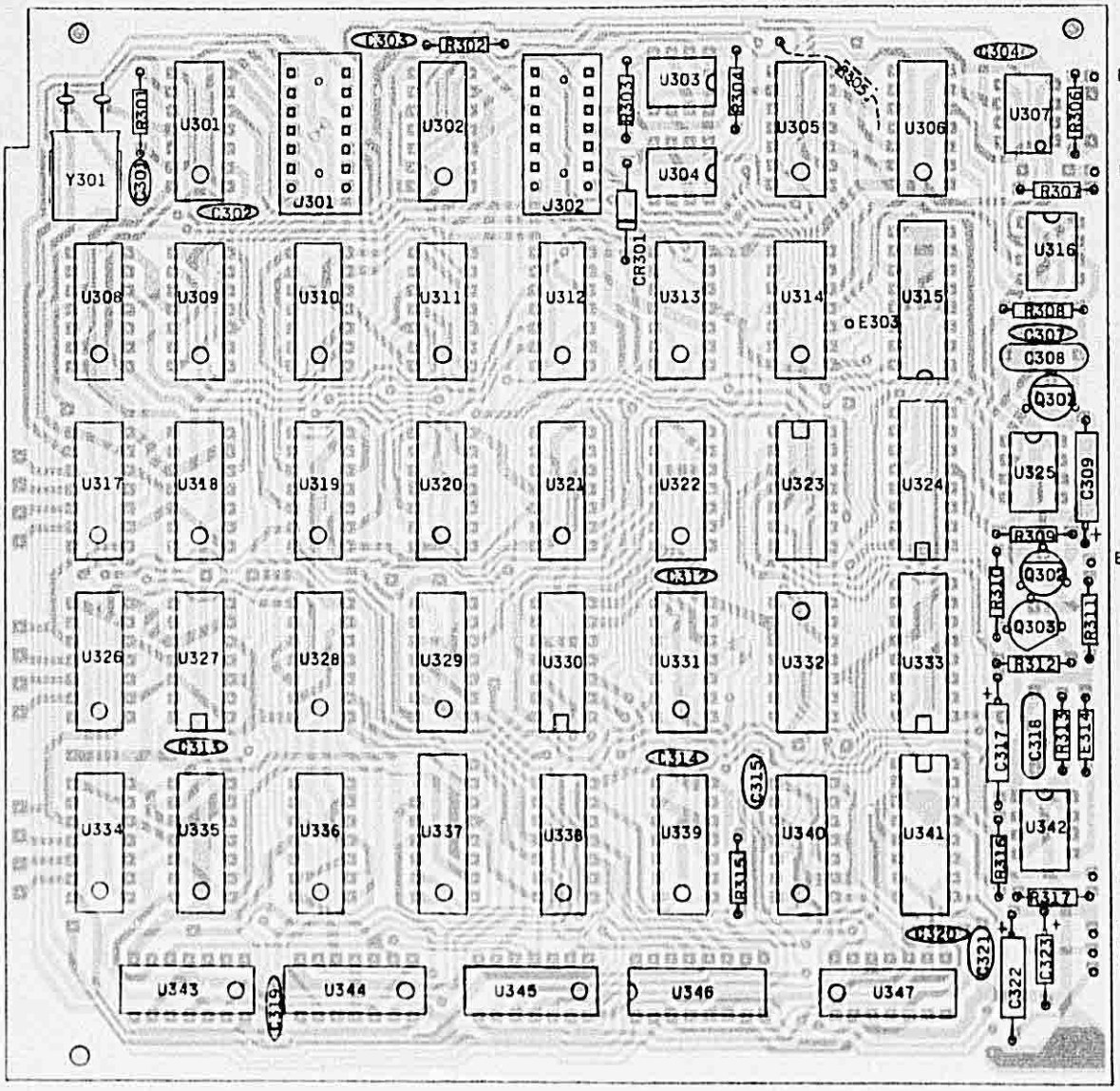
Component Assembly Early Models



Component Assembly Later Models

FIGURE 6-3A (Sheet 2) DME-195 CHANNEL MULTIPLEX

SEE BLOW-UP



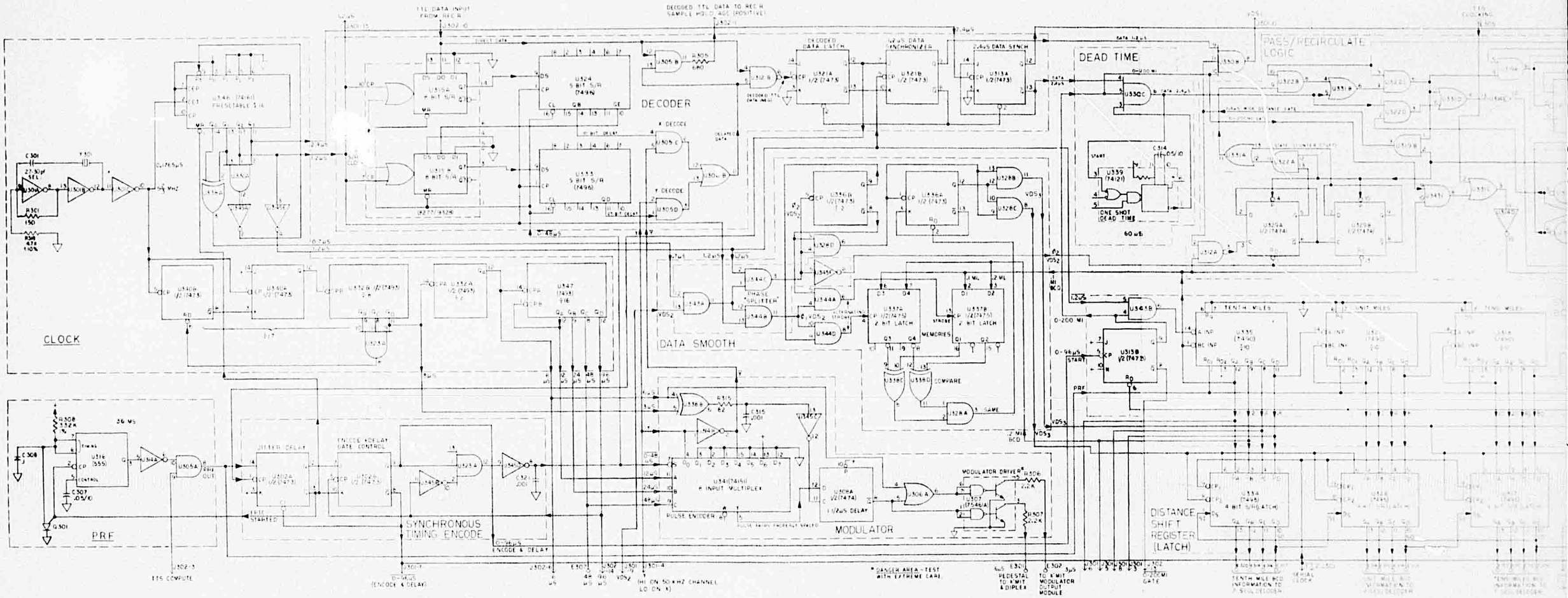
D-57782-F
E-95098-A

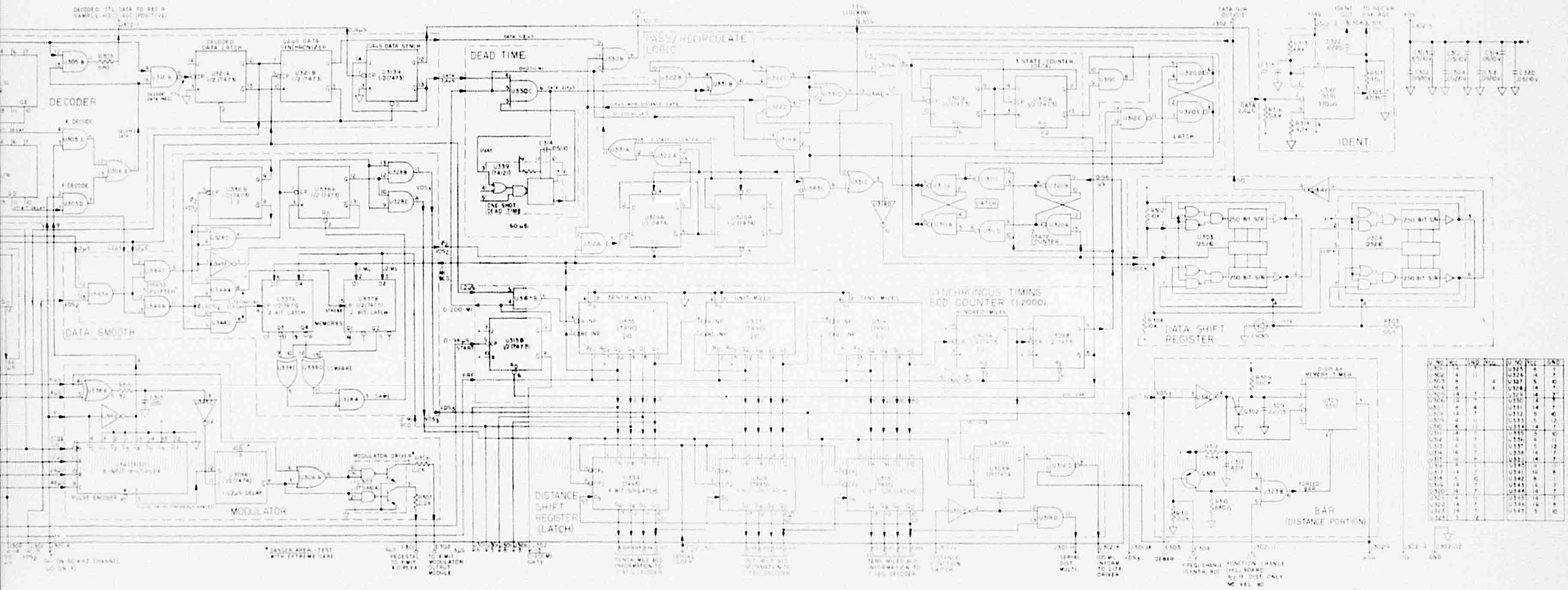
DISTANCE PC BOARD

Solder runs shown in GREY
are those on the "BOTTOM" (non-component)
side of the board.

Solder runs shown in PINK
are those on the "TOP" (component)
side of the board.

SEE BLOW-UP


CLOCK
PRF
DECODER
DATA SMOOTH
SYNCHRONOUS TIMING ENCODE
MODULATOR
DEAD TIME
PASS/RECIRCULATE LOGIC
DISTANCE SHIFT REGISTER (LATCH)
TTL DATA INPUT FROM RECR
DECODED TTL DATA TO RECR
SAMPLE HOLD AGC (POSITIVE)
ONE SHOT DEAD TIME
60 uS
PHASE SPLITTER
MEMORIES
COMPARE
PULSE ENCODER
MODULATOR DRIVER
JITTER DELAY
ENCODE + DELAY GATE CONTROL
1 1/2uS DELAY
PEDESTAL TO X MIT & DIPLEX
TO X MIT MODULATOR OUTPUT MODULE
TENTH MILE BCD INFORMATION TO X SHIFT DECODER
SERIAL CLOCK
SEE BLOW-UP
SEE BLO



R-02416

FIGURE 6-4. DME 195 DISTANCE SCHEMATIC

SEE BLOW-UP

CLOCK

DECODER

DATA SMOOTH

PRF

SYNCHRONOUS TIMING ENCODE

MODULATOR

DEAD TIME

PASS/RECIRCULATE LOGIC

SYNCHRONOUS BCD COUNTER

DISTANCE SHIFT REGISTER (LATCH)

SEE BLOW-UP

SEE BLOW-UP

FIG

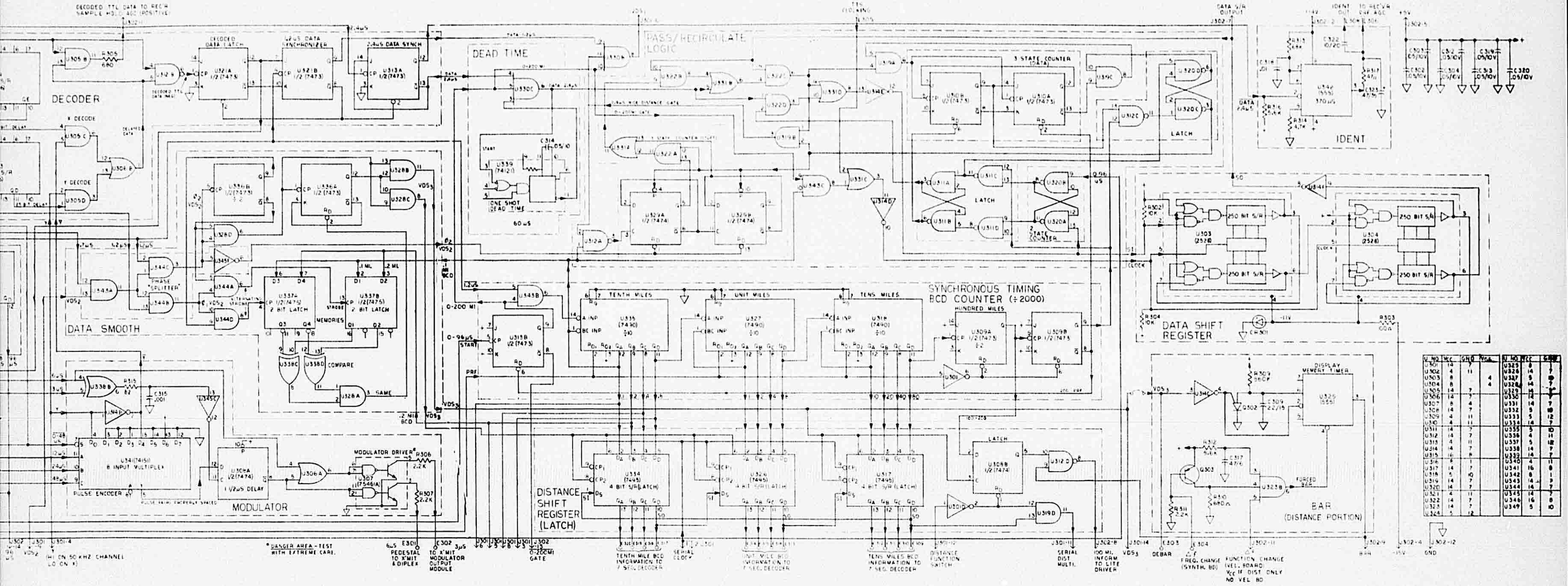
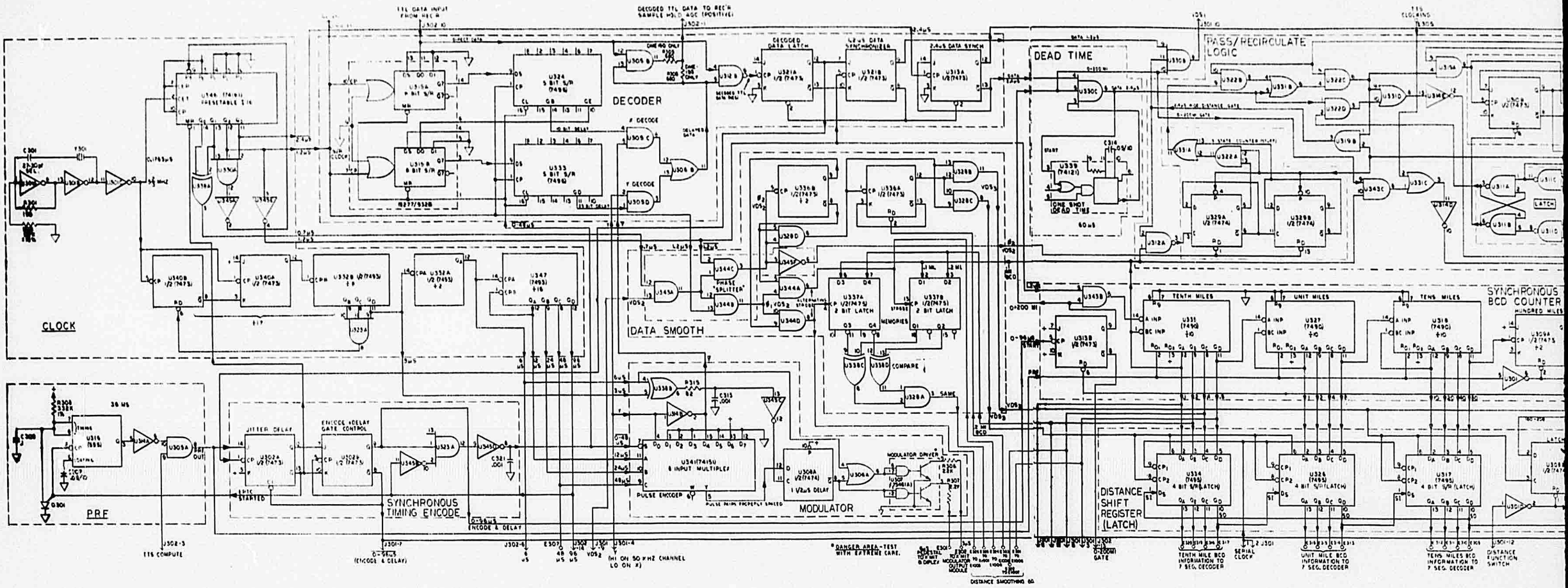


FIGURE 6-4A DME-195 DISTANCE SCHEMATIC (A) CHASSIS


CLOCK
DATA SMOOTH
DECODER
DEAD TIME
PASS/RECIRCULATE LOGIC
SYNCHRONOUS BCD COUNTER
PRF
SYNCHRONOUS TIMING ENCODE
MODULATOR
DISTANCE SHIFT REGISTER (LATCH)
TTL DATA INPUT FROM REC'R
DECODED TTL DATA TO REC'R SAMPLE HOLD AGC (POSITIVE)
TTL CLOCKING
TTL COMPUTE
JITTER DELAY
ENCODE DELAY GATE CONTROL
PULSE ENCODER
PHASE "SPLITTER"
MEMORIES
COMPARE
SAME
TENTH MILES
UNIT MILES
TENS MILES
HUNDRED MILES
TENTH MILE BCD INFORMATION TO 7 SEG. DECODER
UNIT MILE BCD INFORMATION TO 7 SEG. DECODER
TENS MILES BCD INFORMATION TO 7 SEG. DECODER
DISTANCE FUNCTION SWITCH
SERIAL CLOCK
SEE BLOW-UP
SEE BLOW-U

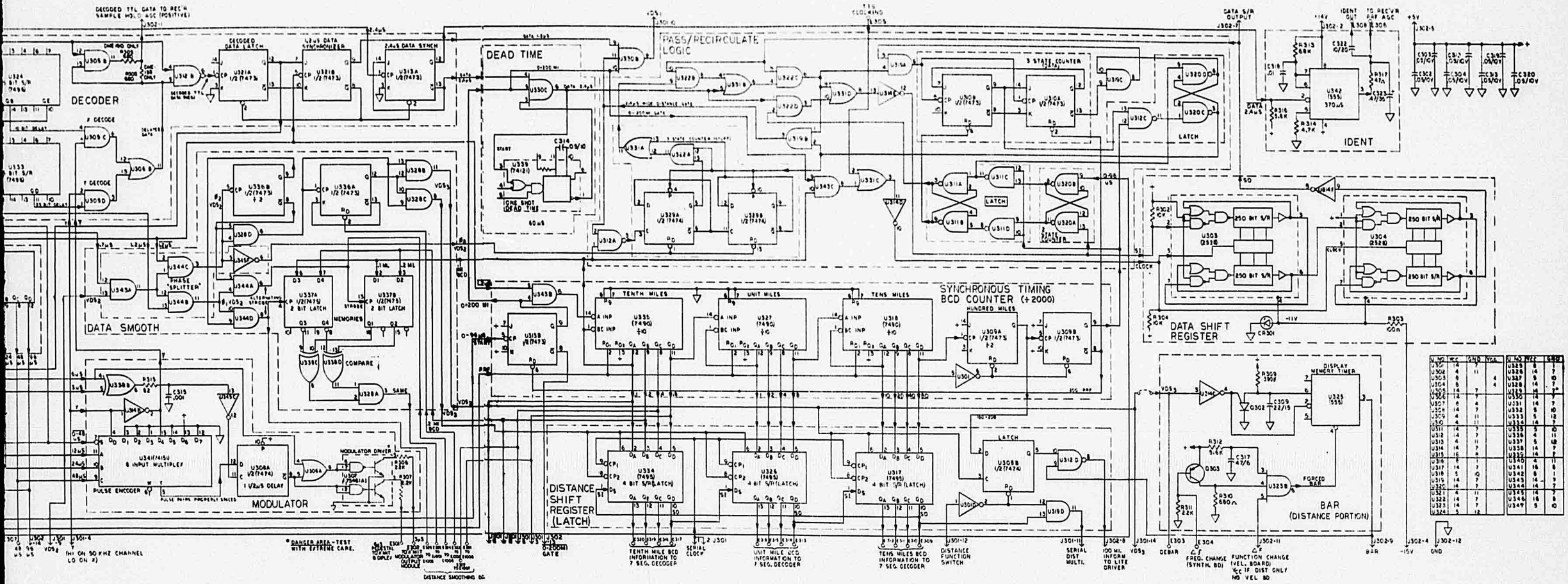


FIGURE 6-4B DME-195 DISTANCE SCHEMATIC (A) CHASSIS

SEE BLOW-UP

CLOCK

PRF

DECODER

DATA SMOOTH

MODULATOR

DEAD TIME

SYNCHRONOUS TIMING ENCODE

DISTANCE SHIFT REGISTER (LATCH)

MEMORIES

DECODED DATA LATCH

2.4µS DATA SYNCHRONIZER

2.4µS DATA SYNCH

PHASE SPLITTER

PULSE ENCODER

MODULATOR DRIVER

JITTER DELAY

ENCODE +DELAY GATE CONTROL

ENCODE & DELAY

COMPARE

TTL DATA INPUT FROM REC'R

DECODED TTL DATA TO REC'R SAMPLE HOLD AGC (POSITIVE)

DME NO ONLY

DECODED TTL DATA (NEG)

DELAYED DATA

X DECODE

Y DECODE

PULSE PAIRS PROPERLY SPACED

* DANGER AREA - TEST WITH EXTREME CARE.

DISTANCE SMOOTHING BD.

TENTH MILE BCD INFORMATION TO T SHIFT DECODER

SEE BLOW-UP

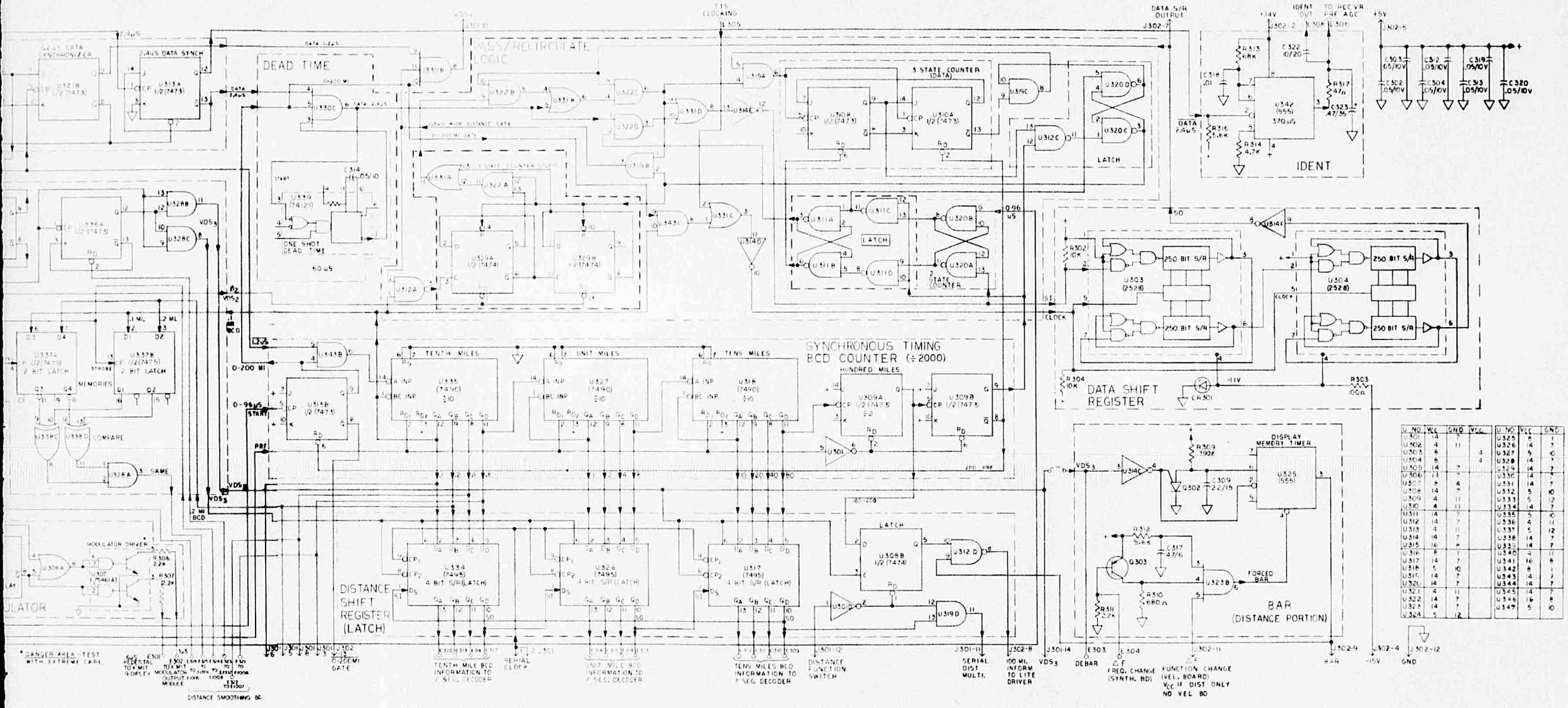
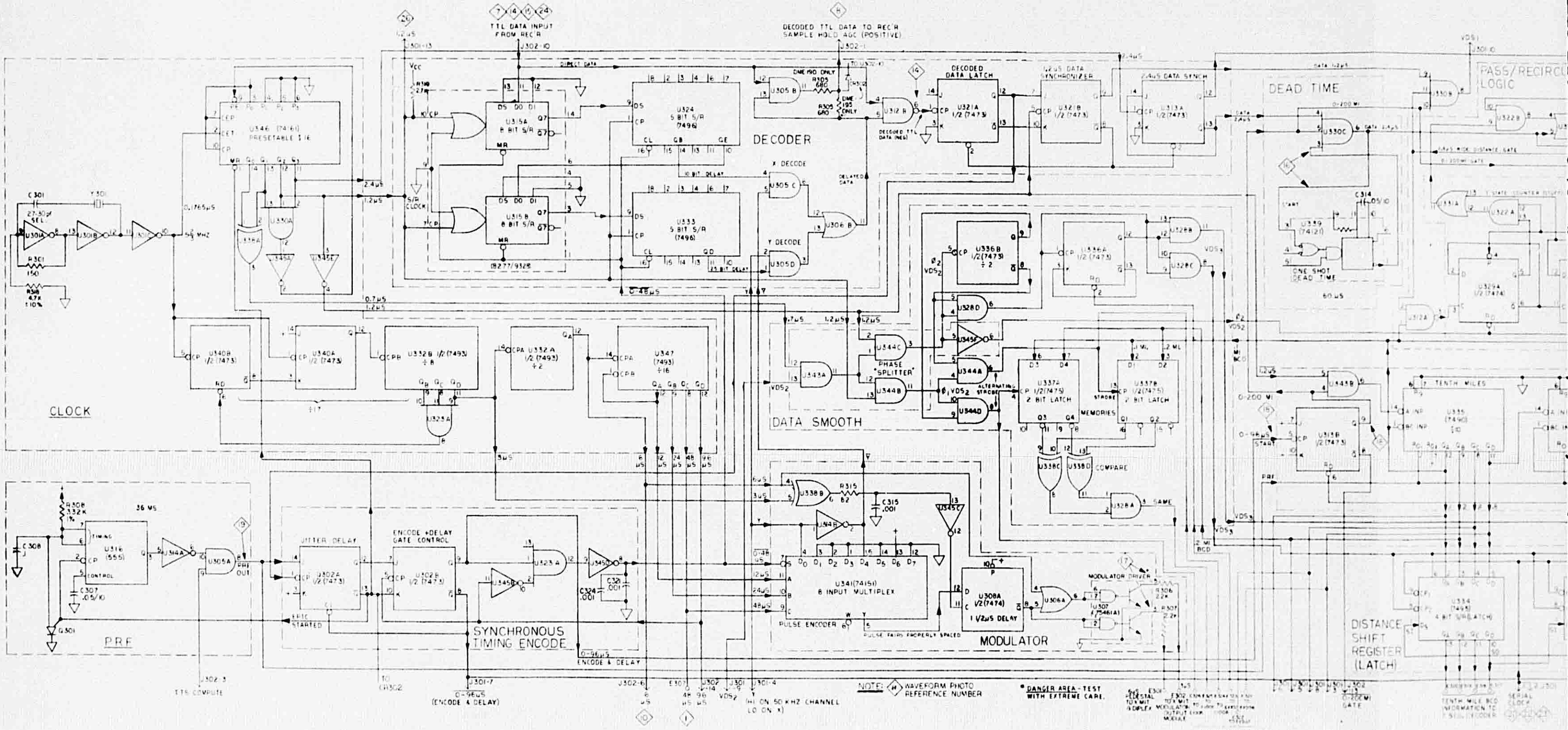
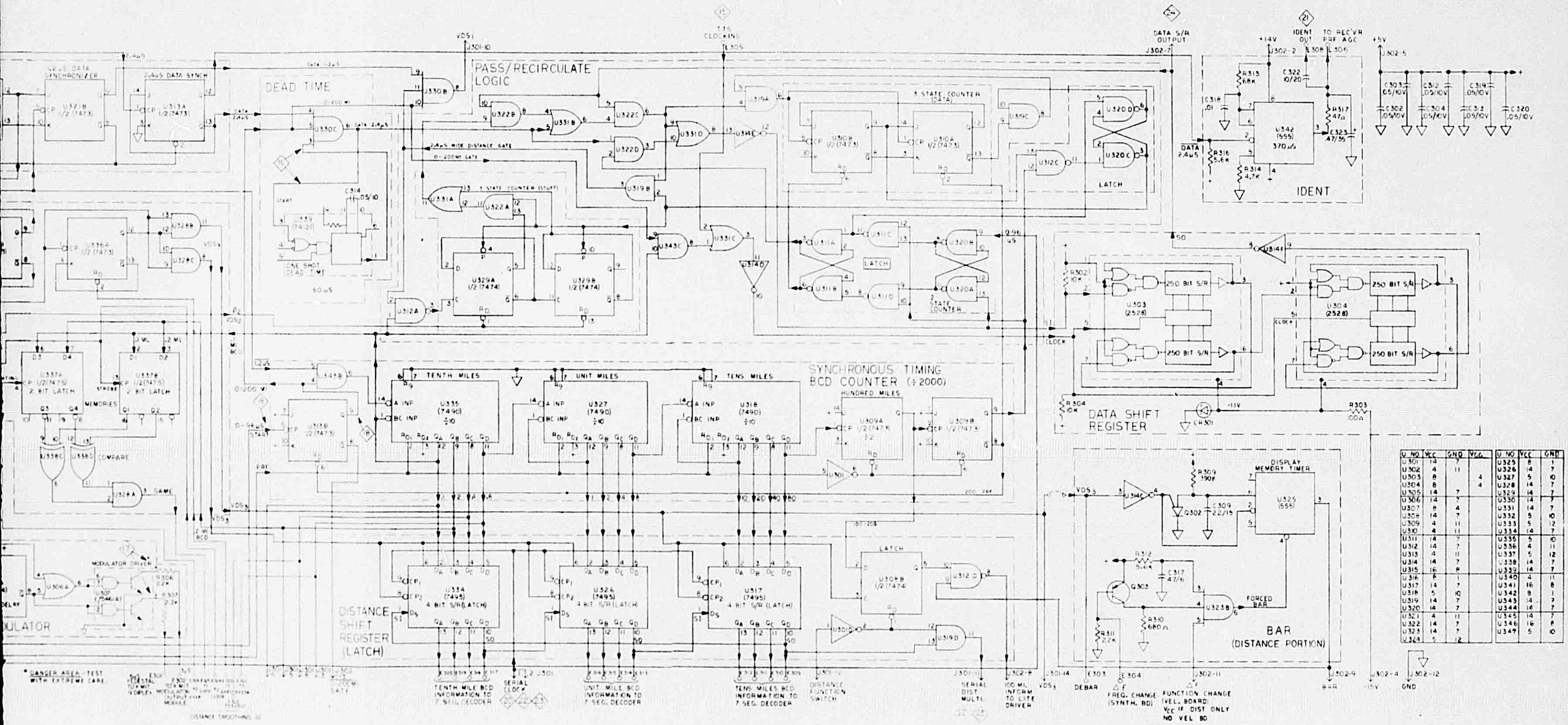


FIGURE 6-4C DME-195 DISTANCE SCHEMATIC (B) CHASSIS


CLOCK
PRF
SYNCHRONOUS TIMING ENCODE
DECODER
DATA SMOOTH
MODULATOR
DEAD TIME
PASS/RECIRC LOGIC
DISTANCE SHIFT REGISTER (LATCH)
TTL DATA INPUT FROM REC'R
DECODED TTL DATA TO REC'R SAMPLE HOLD AGC (POSITIVE)
DECODED DATA LATCH
1.2µS DATA SYNCHRONIZER
2.4µS DATA SYNCH
PHASE "SPLITTER"
ALTERNATING STROBE
MEMORIES
COMPARE
SAME
PULSE ENCODER
PULSE PAIRS PROPERLY SPACED
ONE SHOT DEAD TIME
JITTER DELAY
ENCODE +DELAY GATE CONTROL
ENCODE & DELAY
TTS COMPUTE
(HI ON 50 KHZ CHANNEL LO ON X)
NOTE: WAVEFORM PHOTO REFERENCE NUMBER
DANGER AREA - TEST WITH EXTREME CARE.
SERIAL CLOCK
TENTH MILE BCD INFORMATION TO DISPLAY DECODER

SEE BLOW-UP



U NO	Vcc	GND	Vgg
U301	14	7	
U302	4	11	
U303	8		4
U304	8		4
U305	14	7	
U306	14	7	
U307	8	4	
U308	14	7	
U309	4	11	
U310	4	11	
U311	14	7	
U312	14	7	
U313	4	11	
U314	14	7	
U315	16	8	
U316	8	1	
U317	14	7	
U318	5	10	
U319	14	7	
U320	14	7	
U321	4	11	
U322	14	7	
U323	14	7	
U324	5	12	

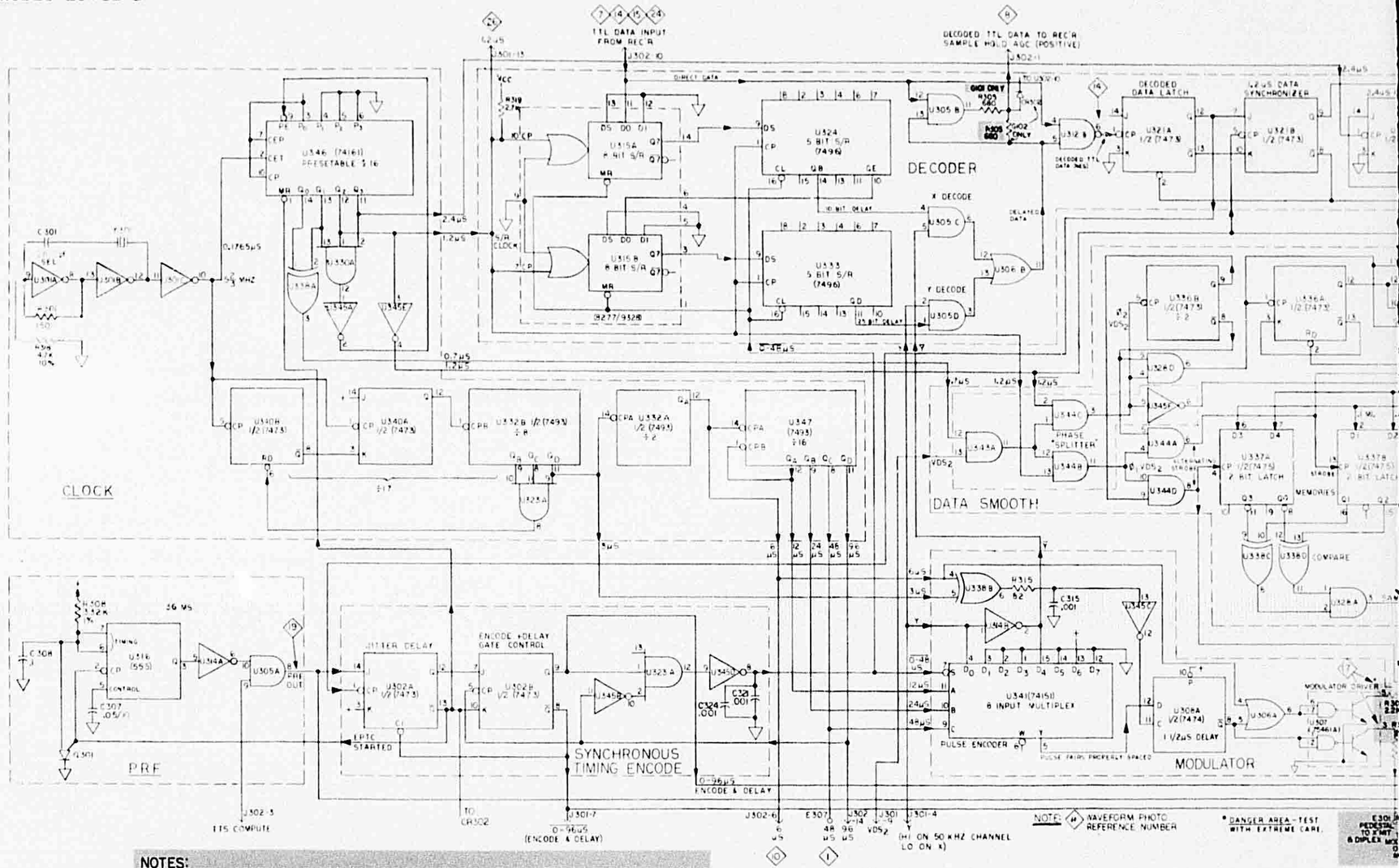
U NO	Vcc	GND
U325	8	1
U326	14	7
U327	5	10
U328	14	7
U329	14	7
U330	14	7
U331	14	7
U332	5	10
U333	5	12
U334	14	7
U335	5	10
U336	4	11
U337	5	12
U338	14	7
U339	14	7
U340	4	11
U341	16	8
U342	8	1
U343	14	7
U344	14	7
U345	14	7
U346	16	8
U347	5	10

FIGURE 6-4D DME-195 DISTANCE SCHEMATIC (C) CHASSIS

NARCO AVIONICS DME 195

Chassis Level Code JA D DADBAB

This schematic is to update the distance board to Chassis Level D and contains only minor changes.



"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

NOTES:

1. SCHEMATIC AS SHOWN FOR G101 (DME 190).
2. FOR G102 (DME 195/190 TSO) CHANGE R305 CONNECTIONS AS SHOWN. DELETE R319 AND C324. NO EXTERNAL CONNECTION AT E306

SEE BLOW-UP

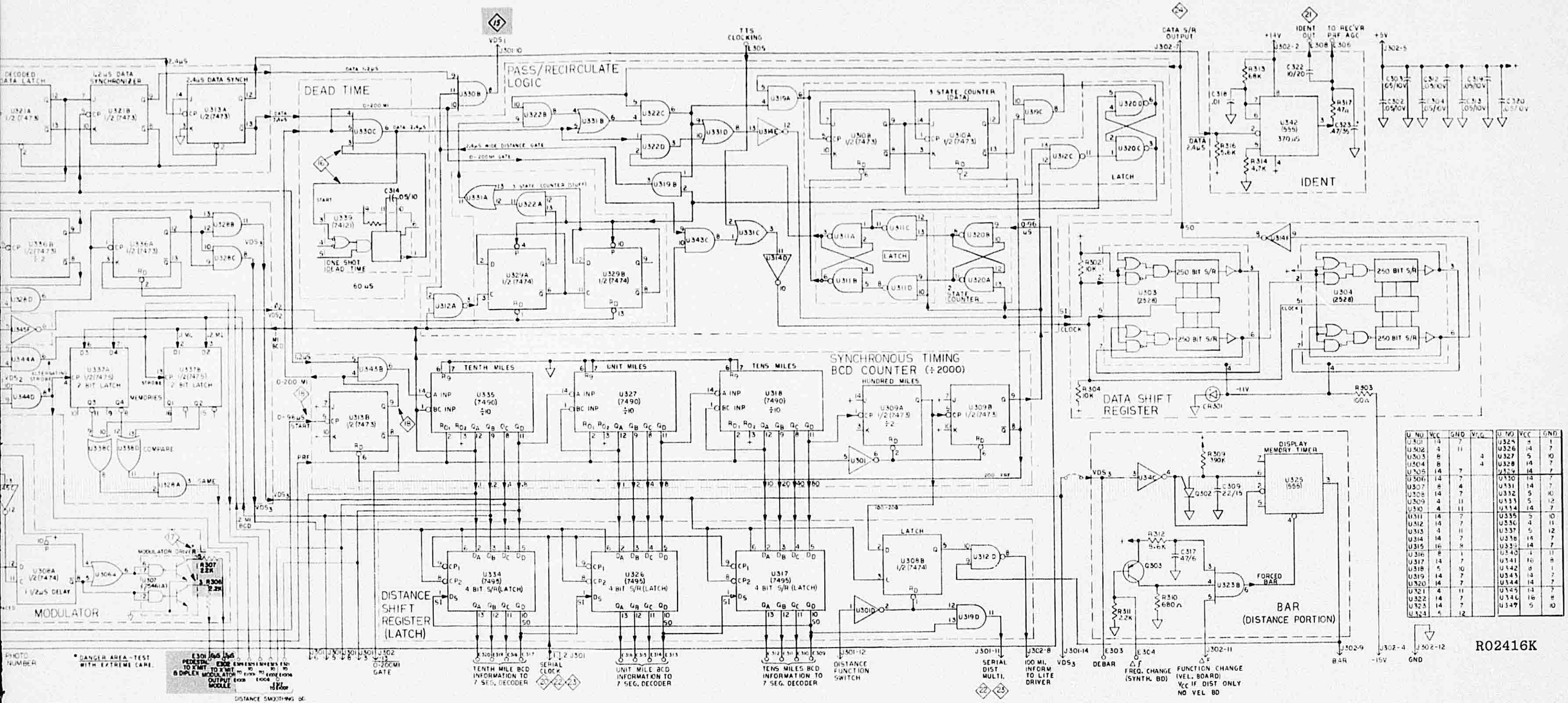
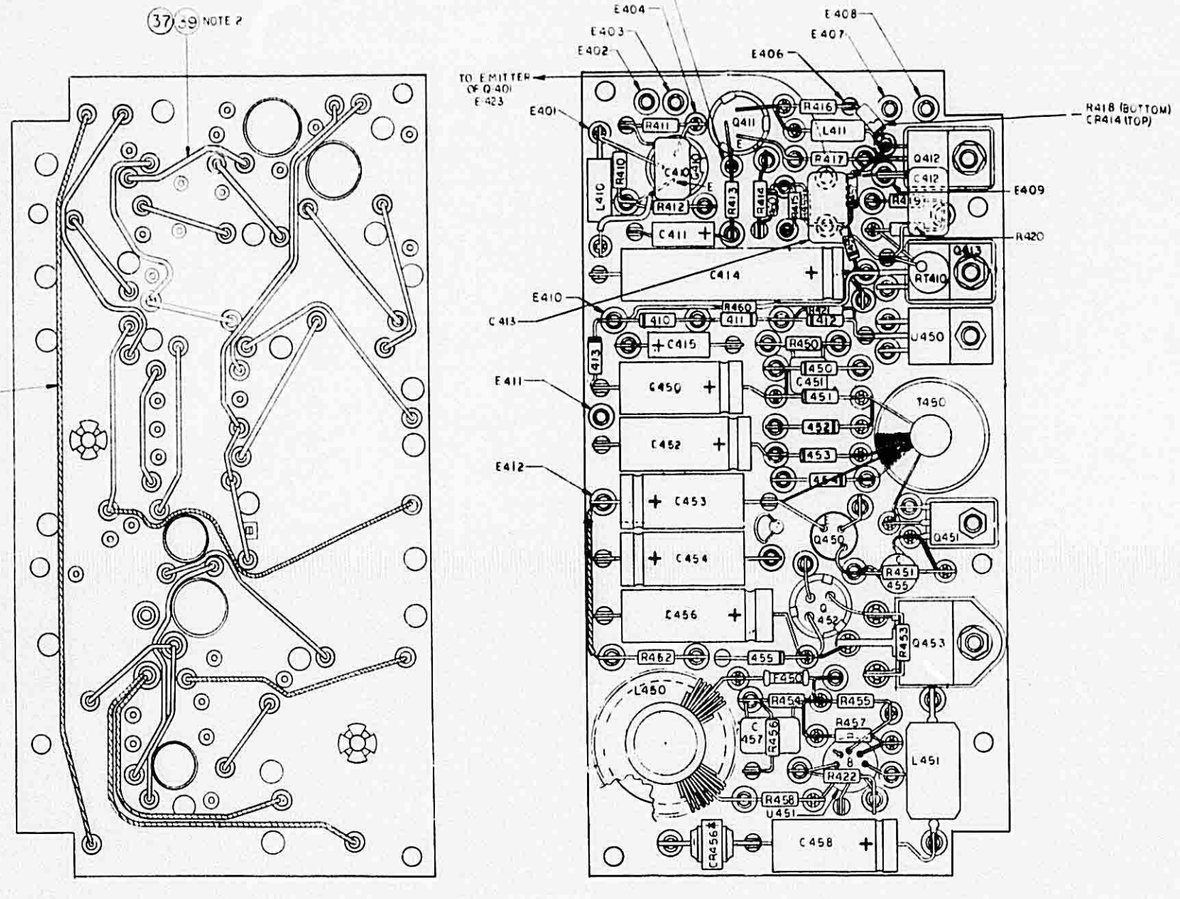


FIGURE 6-12. DME 195 DISTANCE SCHEMATIC
(Chassis Level D)

SEE BLOW-UP

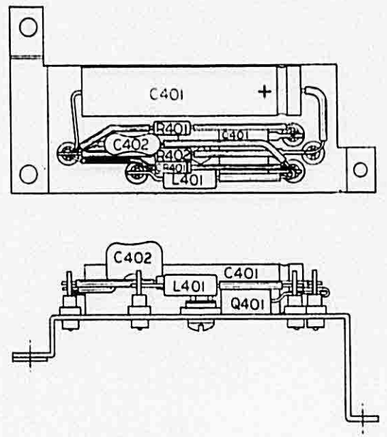
SEE BLOW-UP



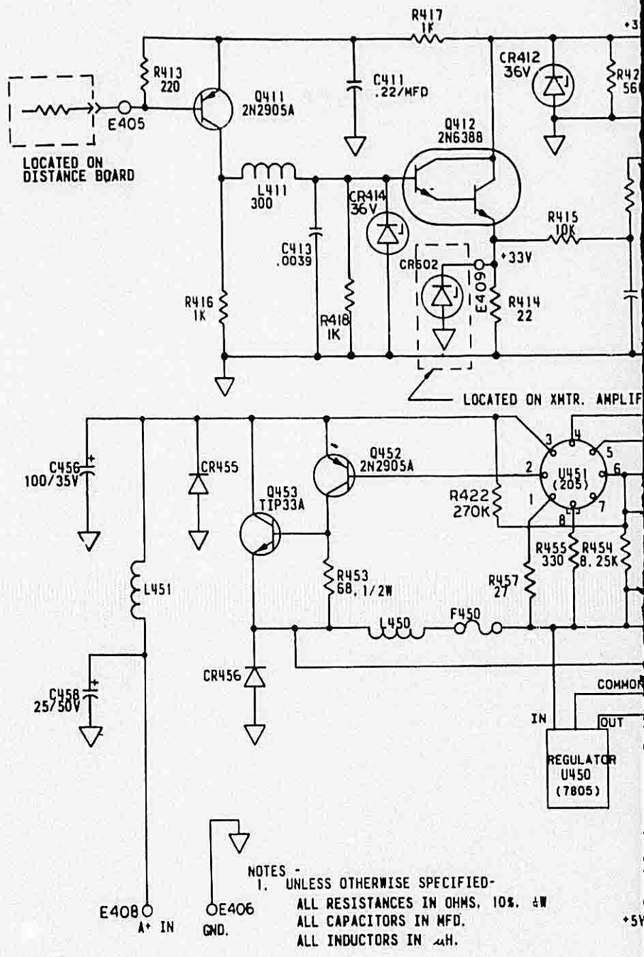
POWER SUPPLY ASSY

SEE BLOW-UP

D-57783-F

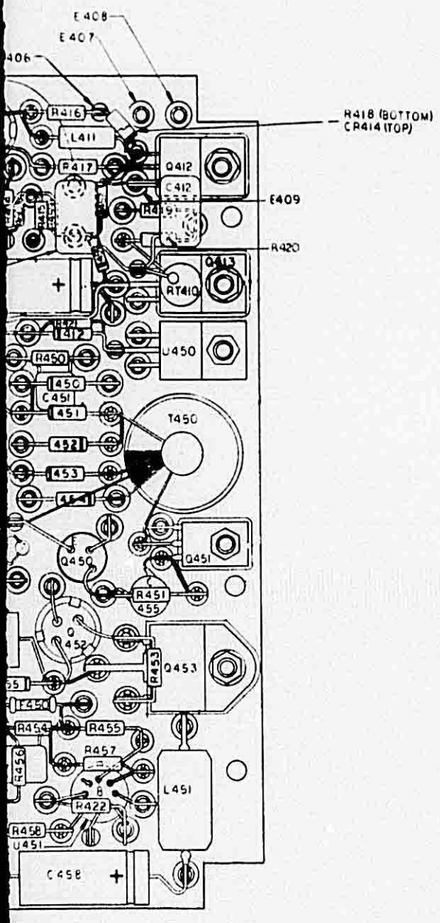


MODULATOR ASSY B-57793-E

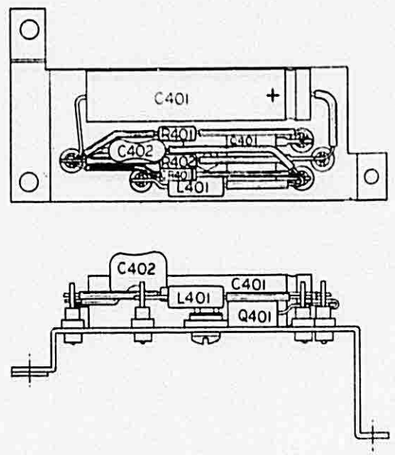


FIG

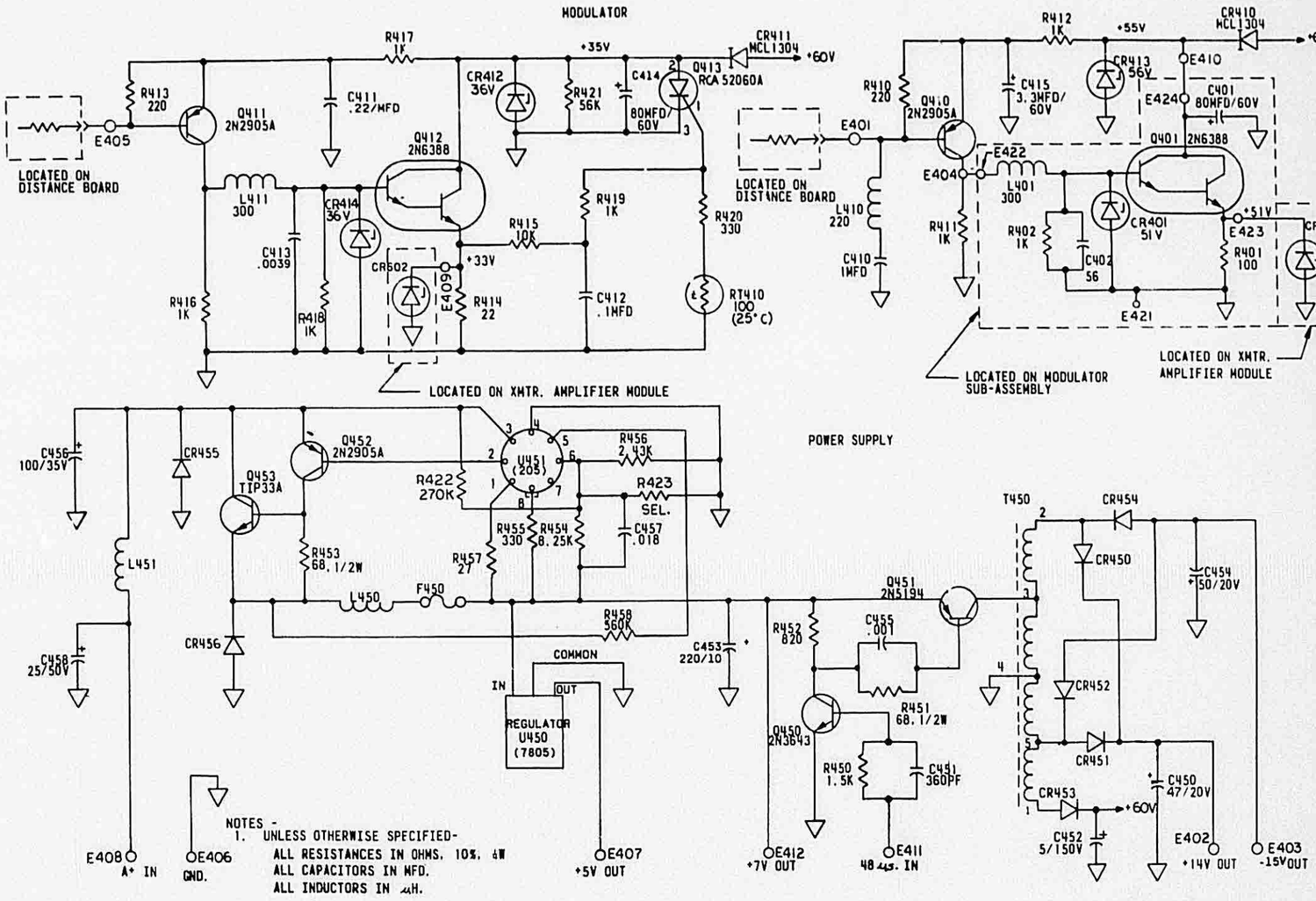
SEE BLOW-UP



D-57783-F



MODULATOR ASSY B-57793-E



C-02415-B

FIGURE 6-5. DME 195 POWER SUPPLY AND MODULATOR SCHEMATIC

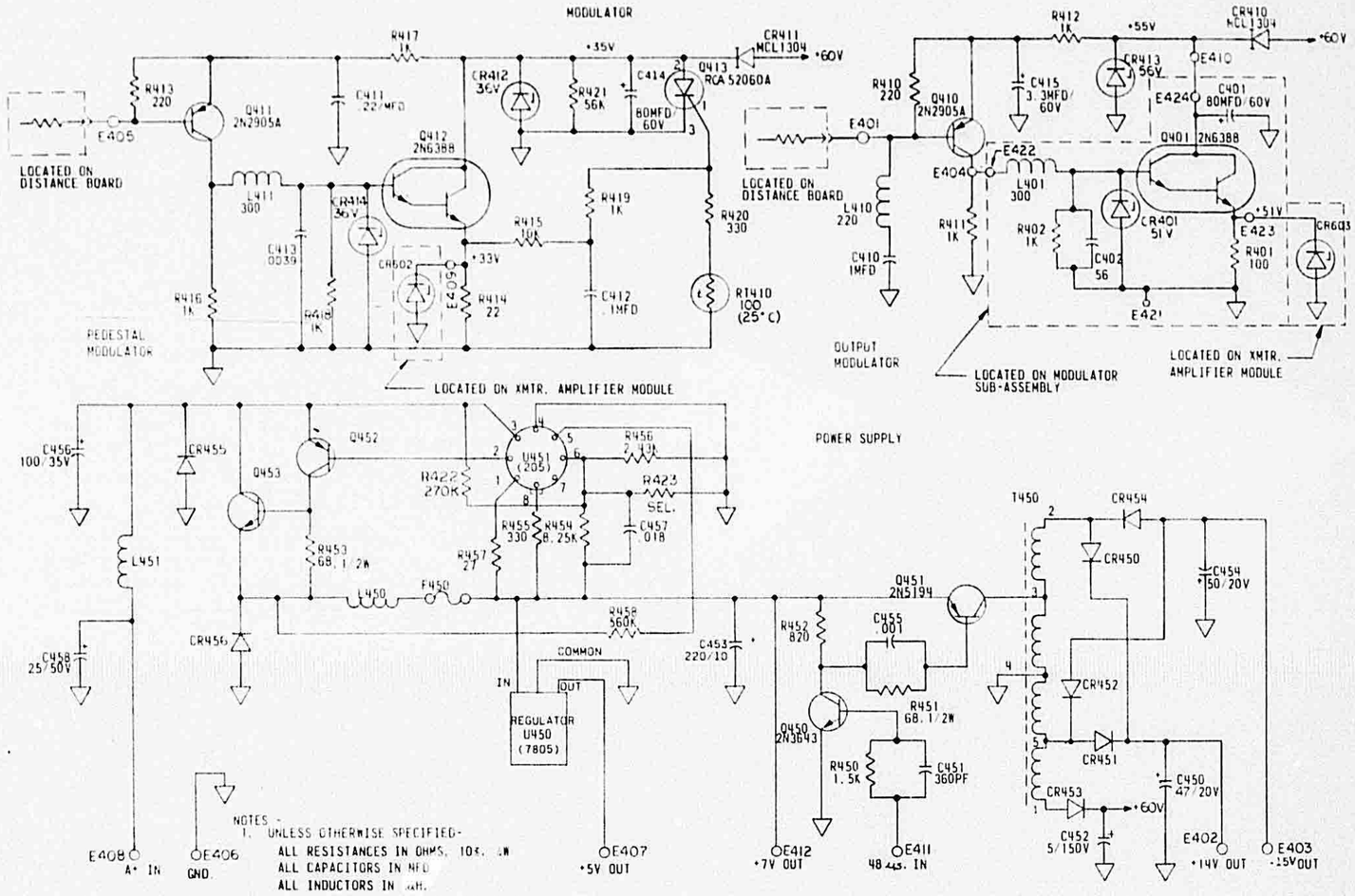


FIGURE 6-5A DME-195 POWER SUPPLY/MODULATOR SCHEMATIC (A) CHASSIS

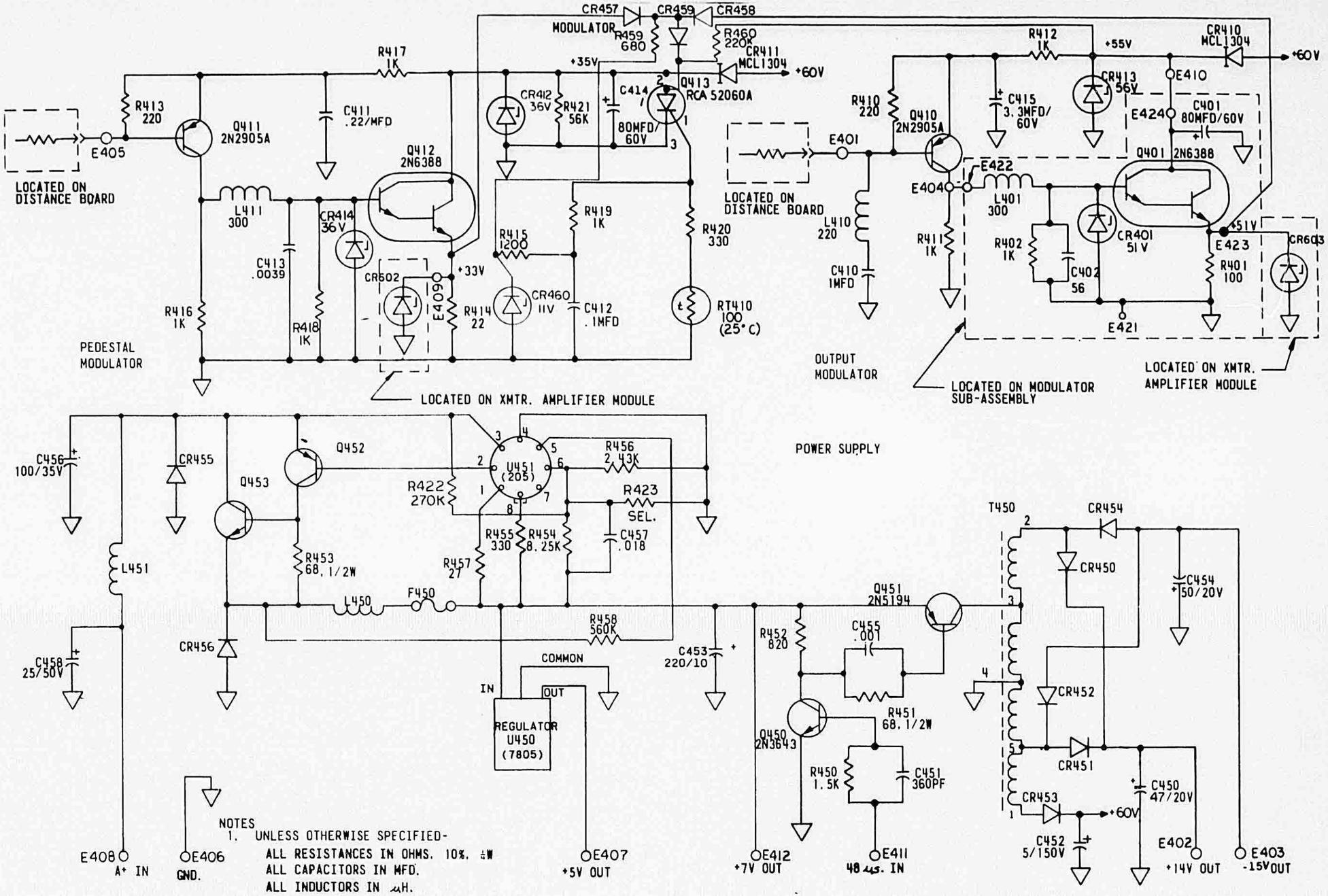


FIGURE 6-5B DME-195 POWER/MODULATOR SCHEMATIC (A) CHASSIS

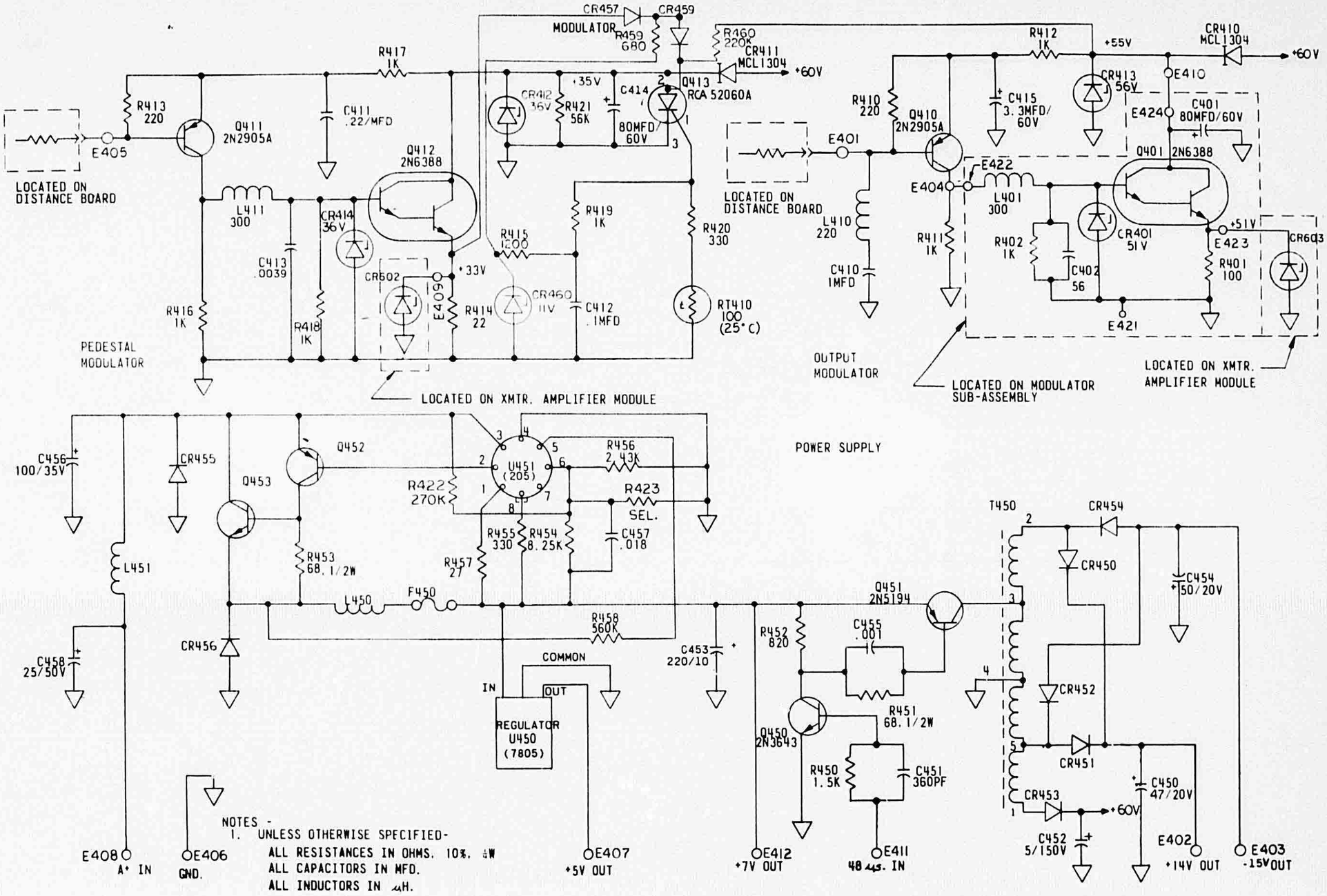
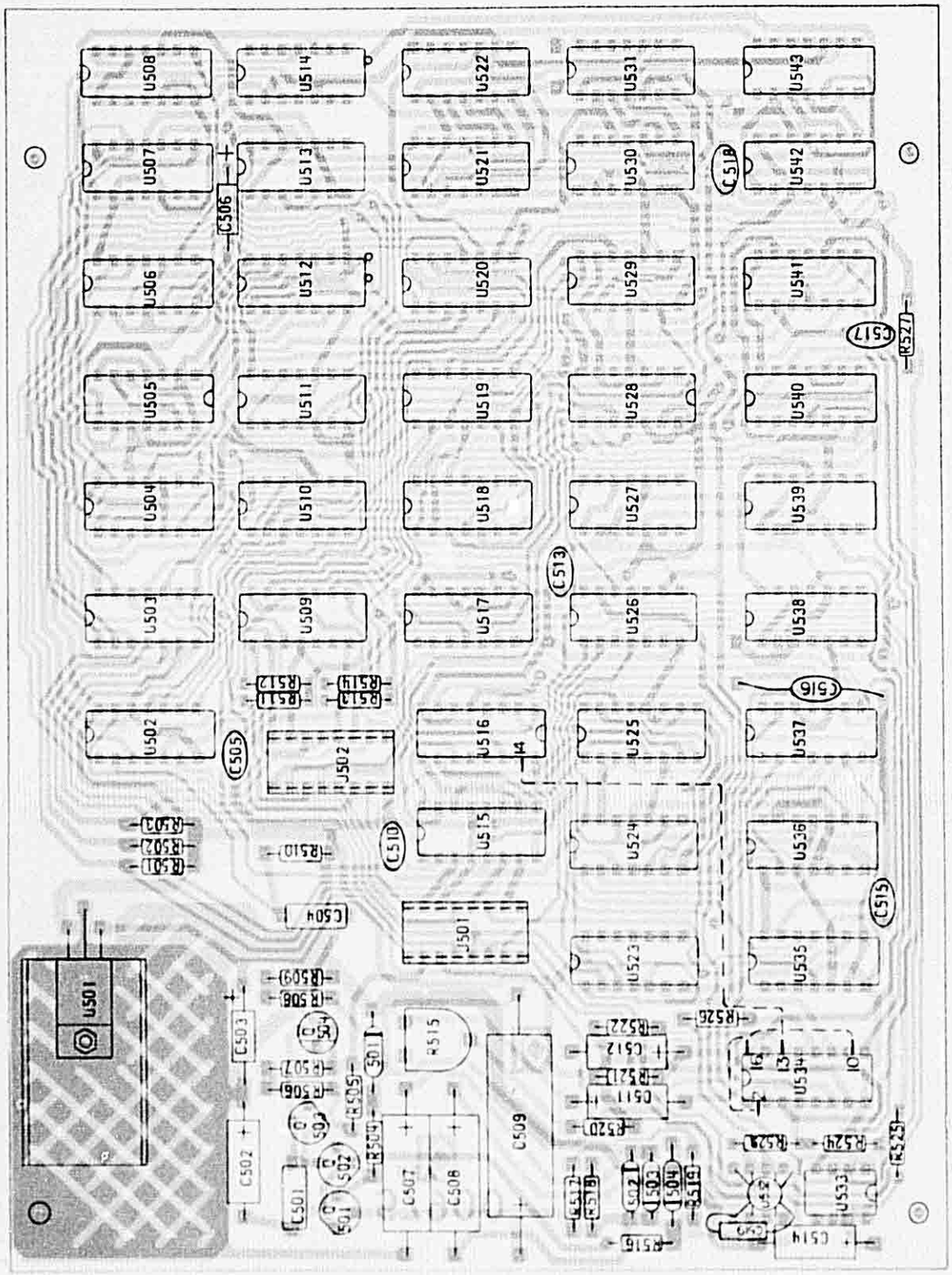


FIGURE 6-5C DME-195 POWER SUPPLY/MODULATOR SCHEMATIC (A) CHASSIS



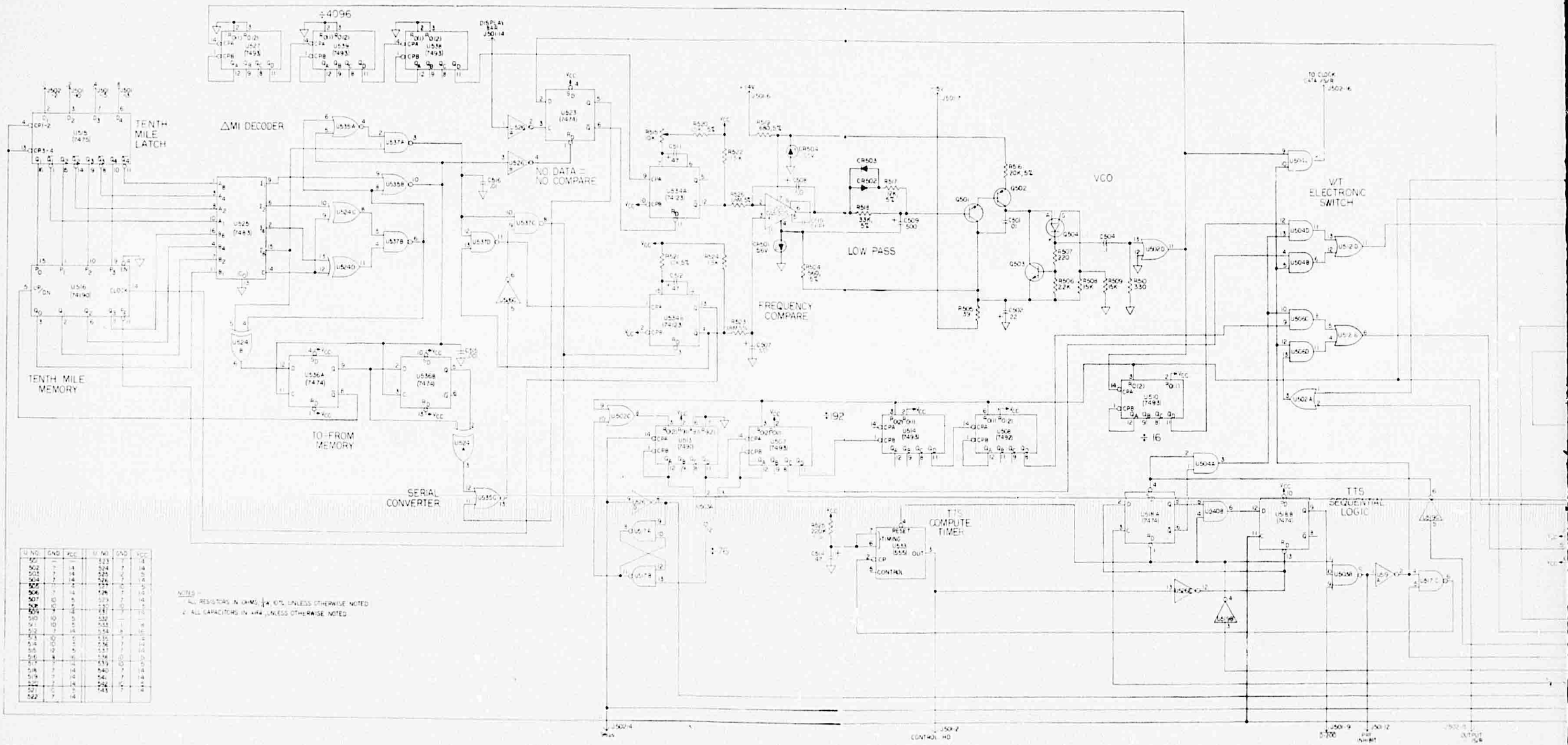
D-57901-D
E-95134A

SEE BLOW-UP

VELOCITY PC BOARD

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.



U NO.	GND	VCC	U NO.	GND	VCC
501	—	—	523	7	14
502	7	14	524	7	14
503	7	14	525	8	16
504	7	14	526	8	16
505	8	16	527	7	14
506	7	14	528	7	14
507	10	5	529	10	5
508	10	5	530	—	—
509	8	16	531	—	—
510	10	5	532	—	—
511	10	5	533	—	—
512	7	14	534	7	14
513	10	5	535	7	14
514	10	5	536	7	14
515	8	16	537	7	14
516	8	16	538	10	5
517	8	16	539	10	5
518	7	14	540	7	14
519	7	14	541	7	14
520	7	14	542	7	14
521	7	14	543	7	14
522	7	14			

NOTES:
1. ALL RESISTORS IN OHMS, ¼W, 10% UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS IN MFD, UNLESS OTHERWISE NOTED.

SEE BLOW-UP

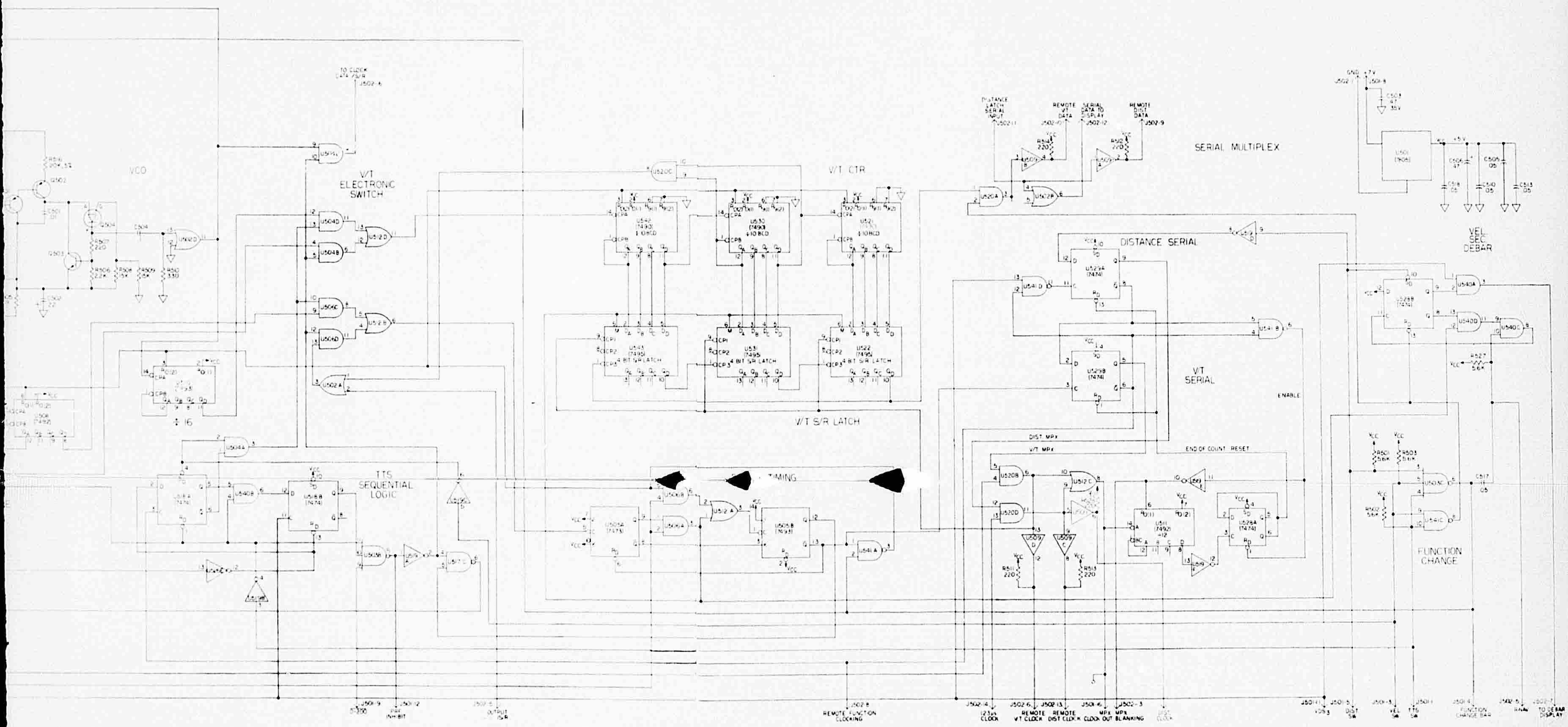


FIGURE 6-6. DME 195 VELOCITY SCHEMATIC

R02465-B

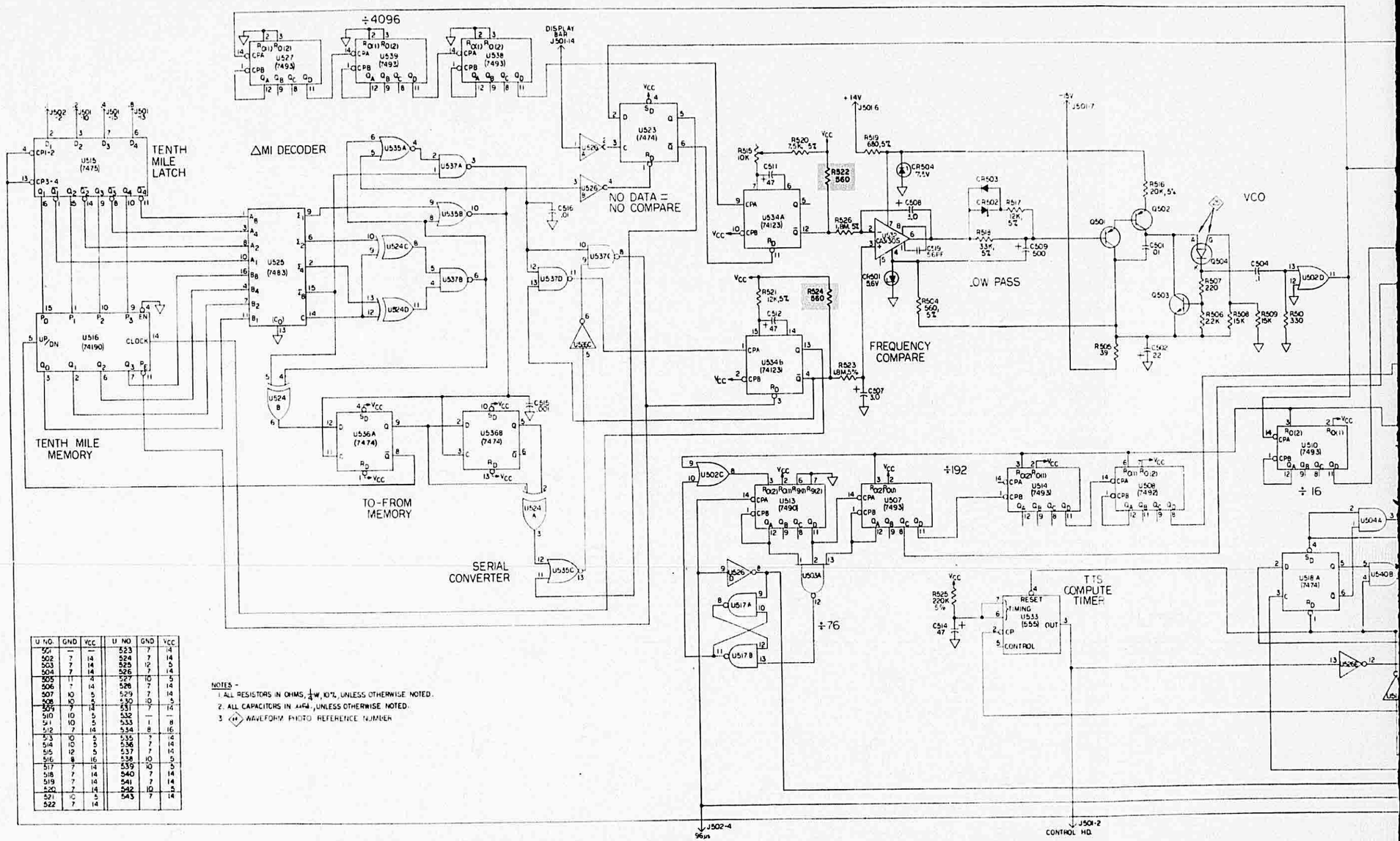
SEE BLOW-UP

NARCO AVIONICS DME 195

Chassis Level JADDAJFC C B
This change will improve velocity accuracy at very low speeds

Changed: R522 to 31192-0561 RESISTOR, Fixed Comp, 560 ±5%, 1/4W
R524 to 31192-0561 RESISTOR, Fixed Comp, 560 ±5%, 1/4W

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

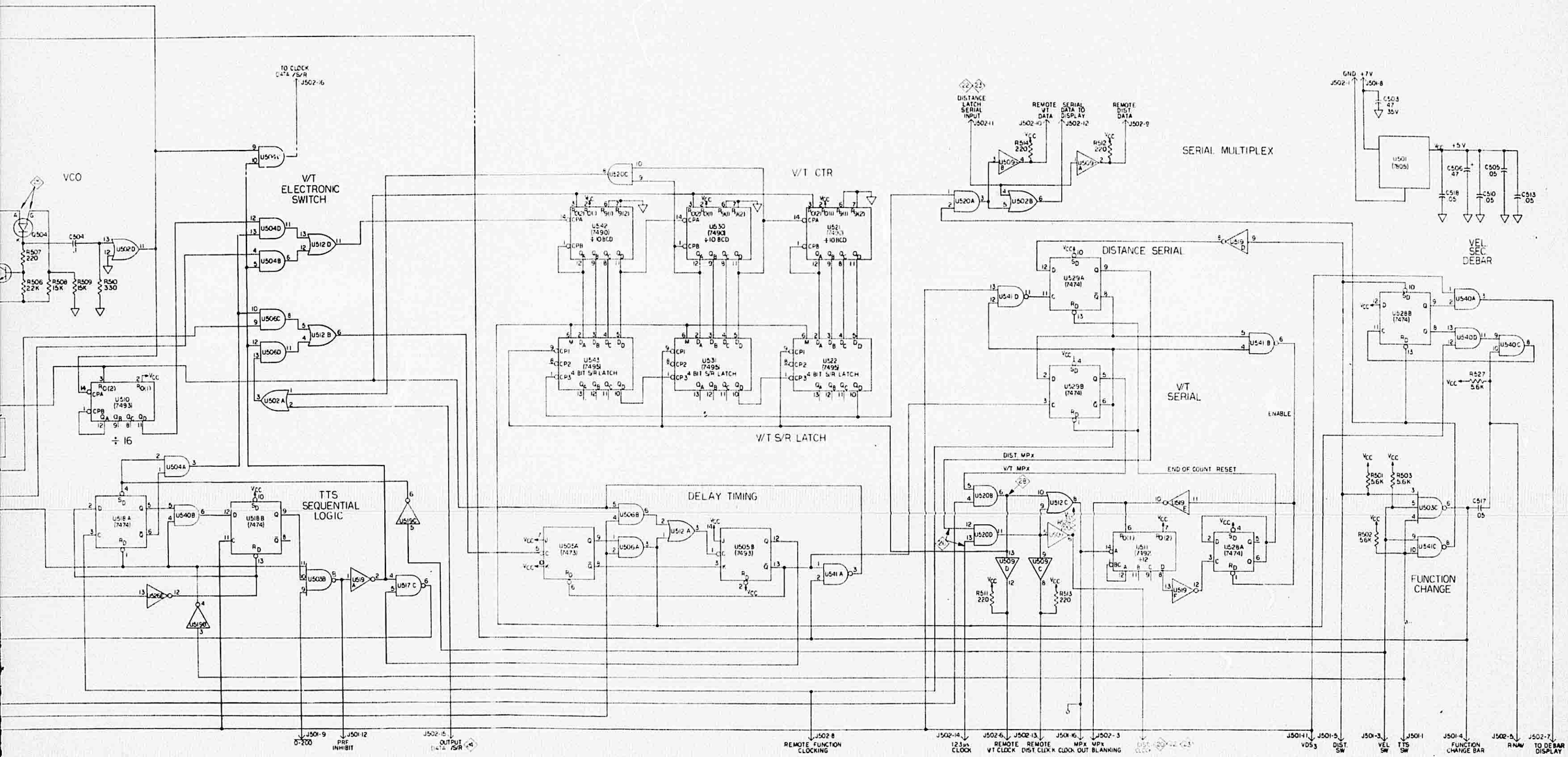


U NO.	GND	VCC	U NO	GND	VCC
501	—	—	523	7	14
502	7	14	524	7	14
503	7	14	525	12	5
504	7	14	526	7	14
505	11	4	527	10	5
506	7	14	528	7	14
507	10	5	529	7	14
508	10	5	530	10	5
509	7	14	531	7	14
510	10	5	532	—	—
511	10	5	533	1	8
512	7	14	534	8	16
513	10	5	535	7	14
514	10	5	536	7	14
515	12	5	537	7	14
516	8	16	538	10	5
517	7	14	539	10	5
518	7	14	540	7	14
519	7	14	541	7	14
520	7	14	542	10	5
521	10	5	543	7	14
522	7	14			

NOTES -
1. ALL RESISTORS IN OHMS, 1/4W, 10%, UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS IN μμF, UNLESS OTHERWISE NOTED.
3. ⟨##⟩ WAVEFORM PHOTO REFERENCE NUMBER

SEE BLOW-UP

SEE BLOW-UP

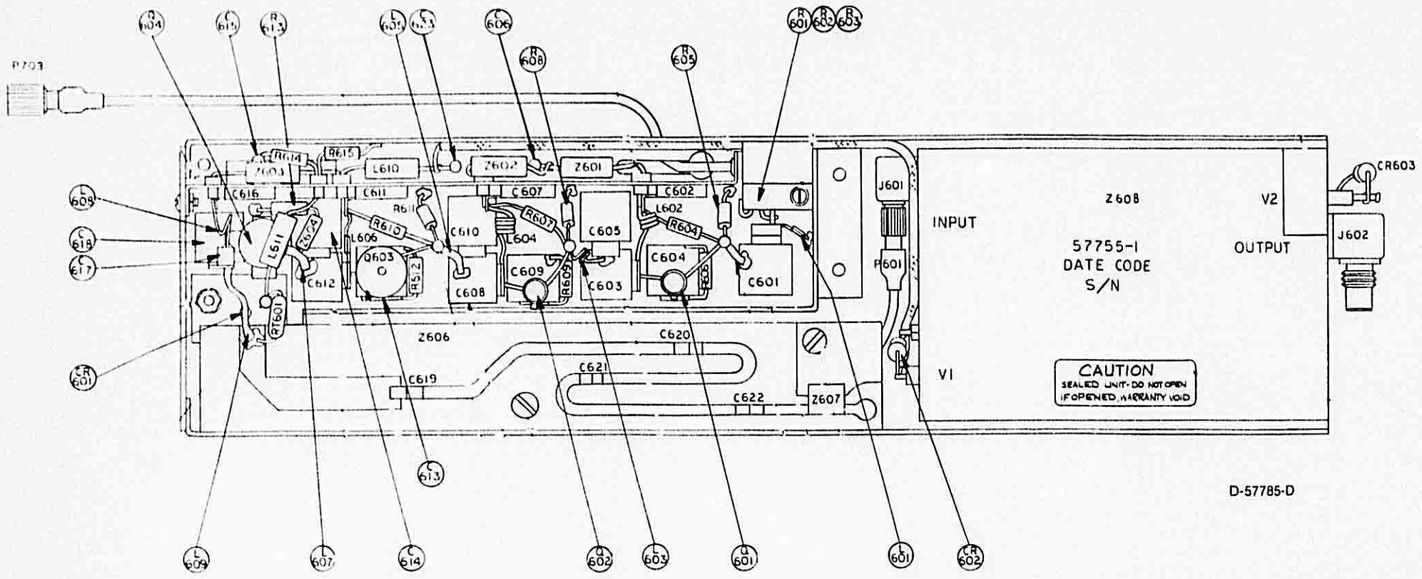


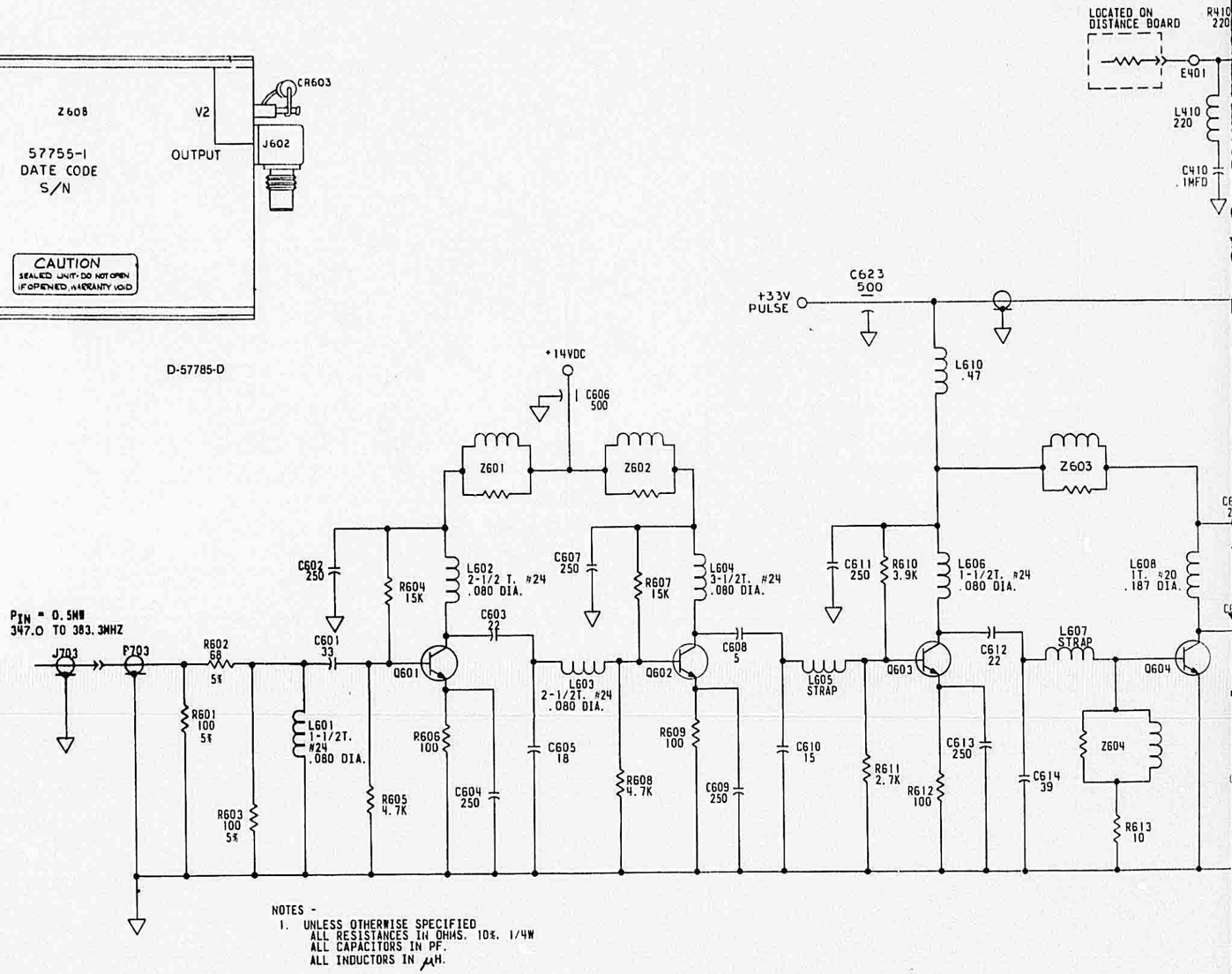
R02465D

FIGURE 6-6A. DME 195 VELOCITY SCHEMATIC
(Chassis Level C)

SEE BLOW-UP

SEE BLOW-UP


P703
J601
P601
INPUT
Z608
57755-1
DATE CODE
S/N
V2
OUTPUT
J602
CR603
V1
CAUTION
SEALED UNIT- DO NOT OPEN
IF OPENED, WARRANTY VOID
Z606
Z607
D-57785-D


LOCATED ON DISTANCE BOARD
E401
L410 220
C410 .1MFD
+33V PULSE
C623 500
L610 .47
+14VDC
C606 500
Z601
Z602
Z603
C602 250
R604 15K
L602 2-1/2 T. #24 .080 DIA.
C607 250
R607 15K
L604 3-1/2T. #24 .080 DIA.
C611 250
R610 3.9K
L606 1-1/2T. #24 .080 DIA.
L608 1T. #20 .187 DIA.
P IN = 0.5MW 347.0 TO 383.3MHZ
J703
P703
R602 68 5%
C601 33
C603 22
Q601
Q602
Q603
Q604
C608 5
L607 STRAP
C612 22
L605 STRAP
R601 100 5%
L601 1-1/2T. #24 .080 DIA.
R606 100
L603 2-1/2T. #24 .080 DIA.
R609 100
C610 15
C613 250
Z604
R603 100 5%
R605 4.7K
C604 250
C605 18
R608 4.7K
C609 250
R611 2.7K
R612 100
C614 39
R613 10
NOTES -
1. UNLESS OTHERWISE SPECIFIED
ALL RESISTANCES IN OHMS. 10%. 1/4W
ALL CAPACITORS IN PF.
ALL INDUCTORS IN μH.

FIGURE

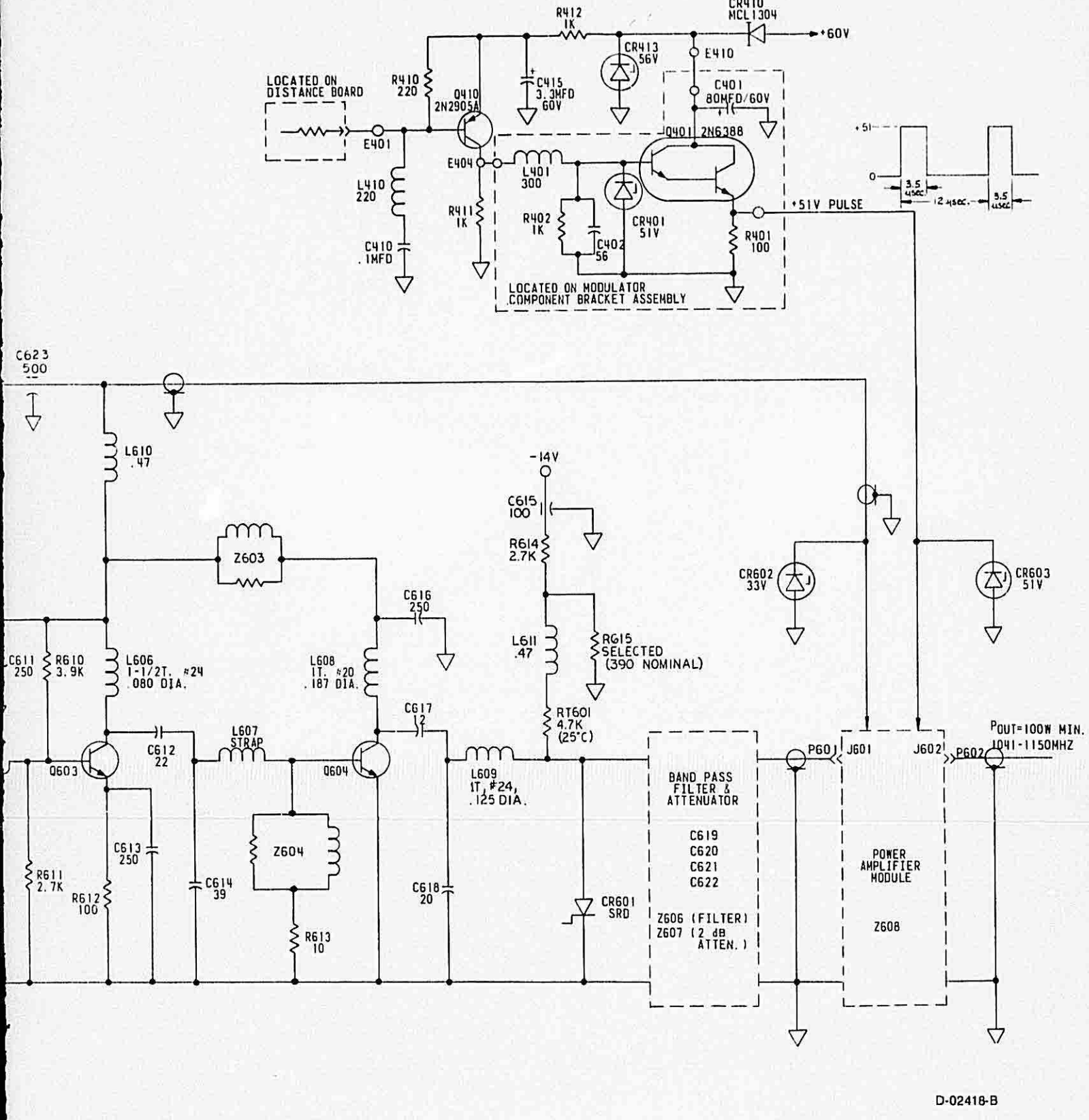
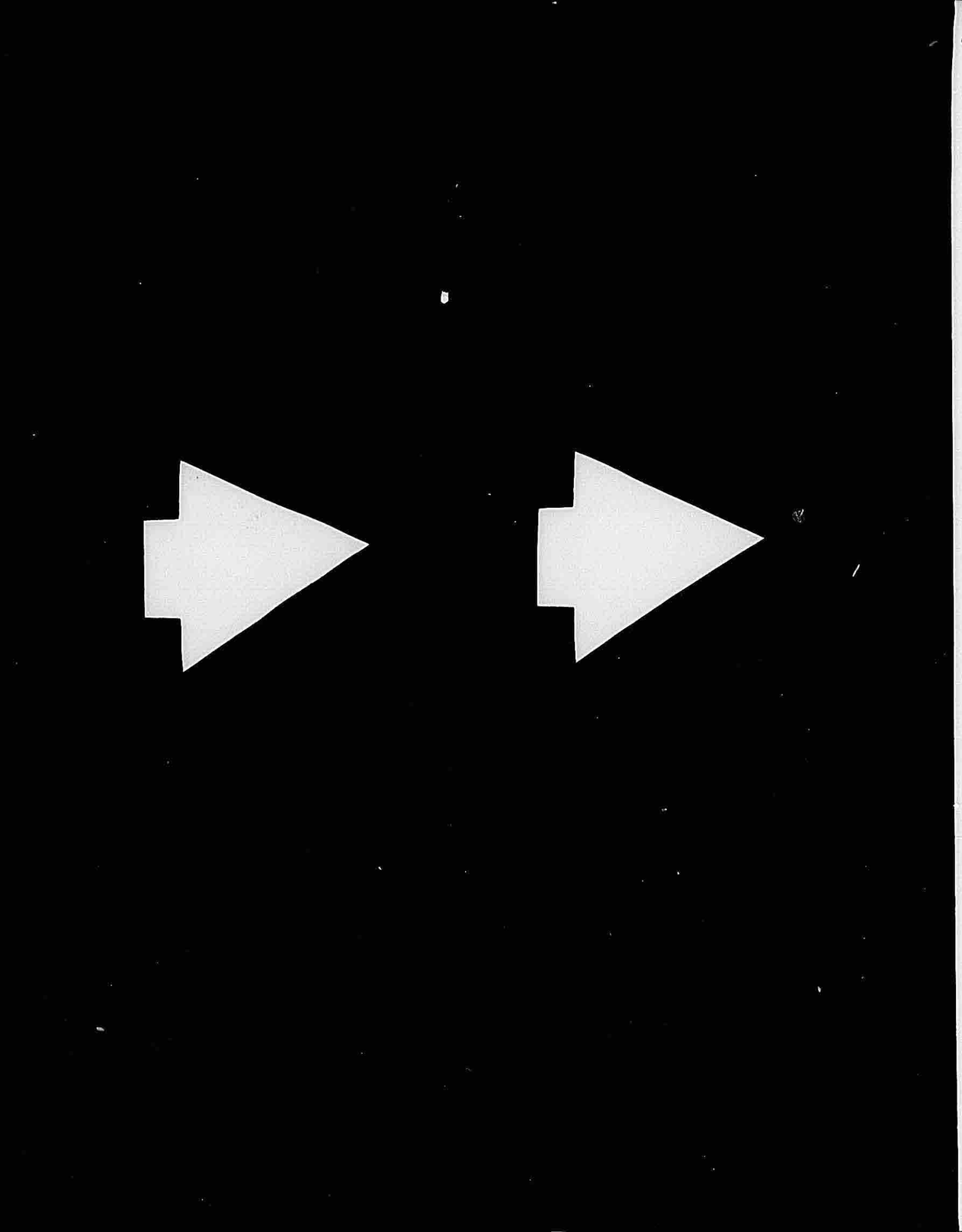


FIGURE 6-7. DME 195 TRANSMITTER SCHEMATIC



NARCO AVIONICS DME 195

Chassis Level Code JADDAHF B C
These changes implement the change of Q602 to a new transistor

Changed:	R608	31218-0392	RESISTOR, Fixed Comp, 39K ±5%, 1/4W
	L604	11713-0015	INDUCTOR, Air Wound, 4½ turns, .080 dia., #24 Wire
	Q602	75646-0001	TRANSISTOR, Silicon, NPN, RF Power
Added:	R617	31218-0821	RESISTOR, Fixed Comp, 820 ±5%, 1/4W
	R616	31218-0111	RESISTOR, Fixed Comp, 110 ±5%, 1/4W
	C624	24552-1109	CAPACITOR, Ceramic, 1 pF ±.5 pF, 50 Vdc
	C625	23107-0109	CAPACITOR, Mylar, 4700 pF ±10%, 100 Vdc
	Z609	11454-0001	BEAD, Ferrite

Chassis Level Code JADDAHF C CB
This change will improve ease of service

Changed:	Z606	57979-0101	FILTER, Bandpass

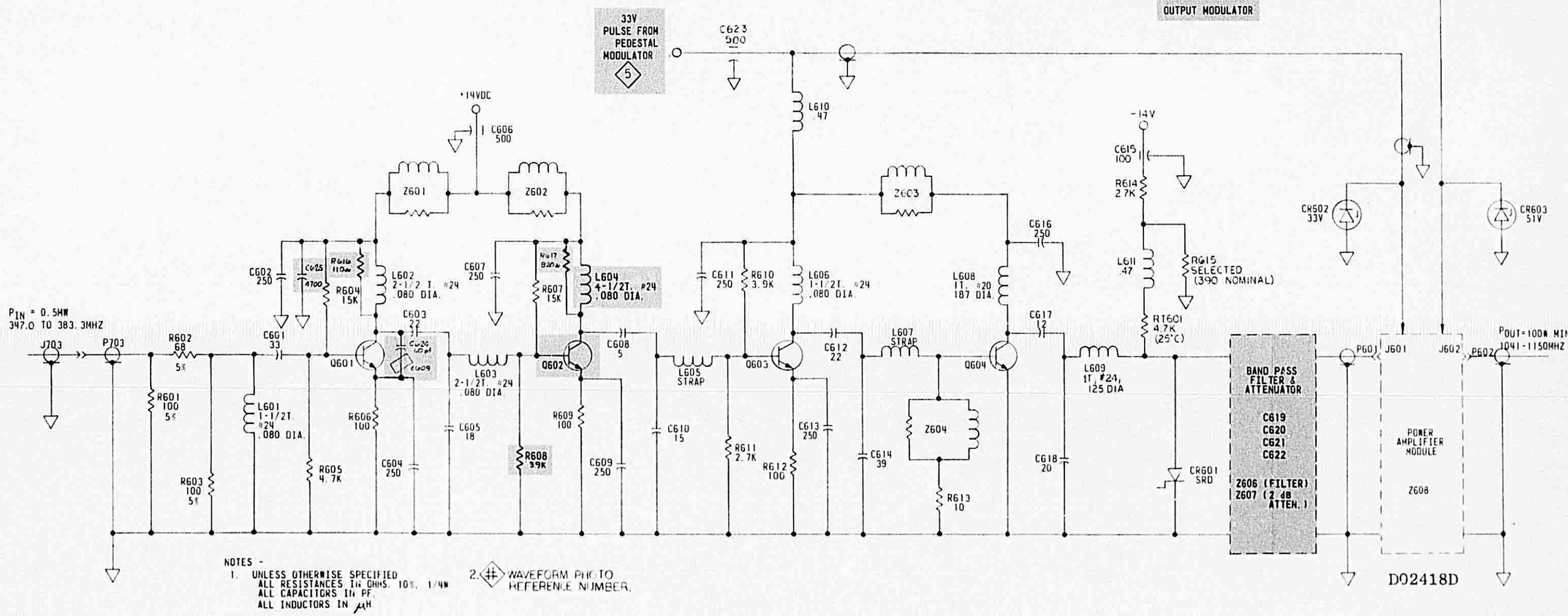
PIN 347.0

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

sistor
%, 1/4W
ns, .080 dia.,

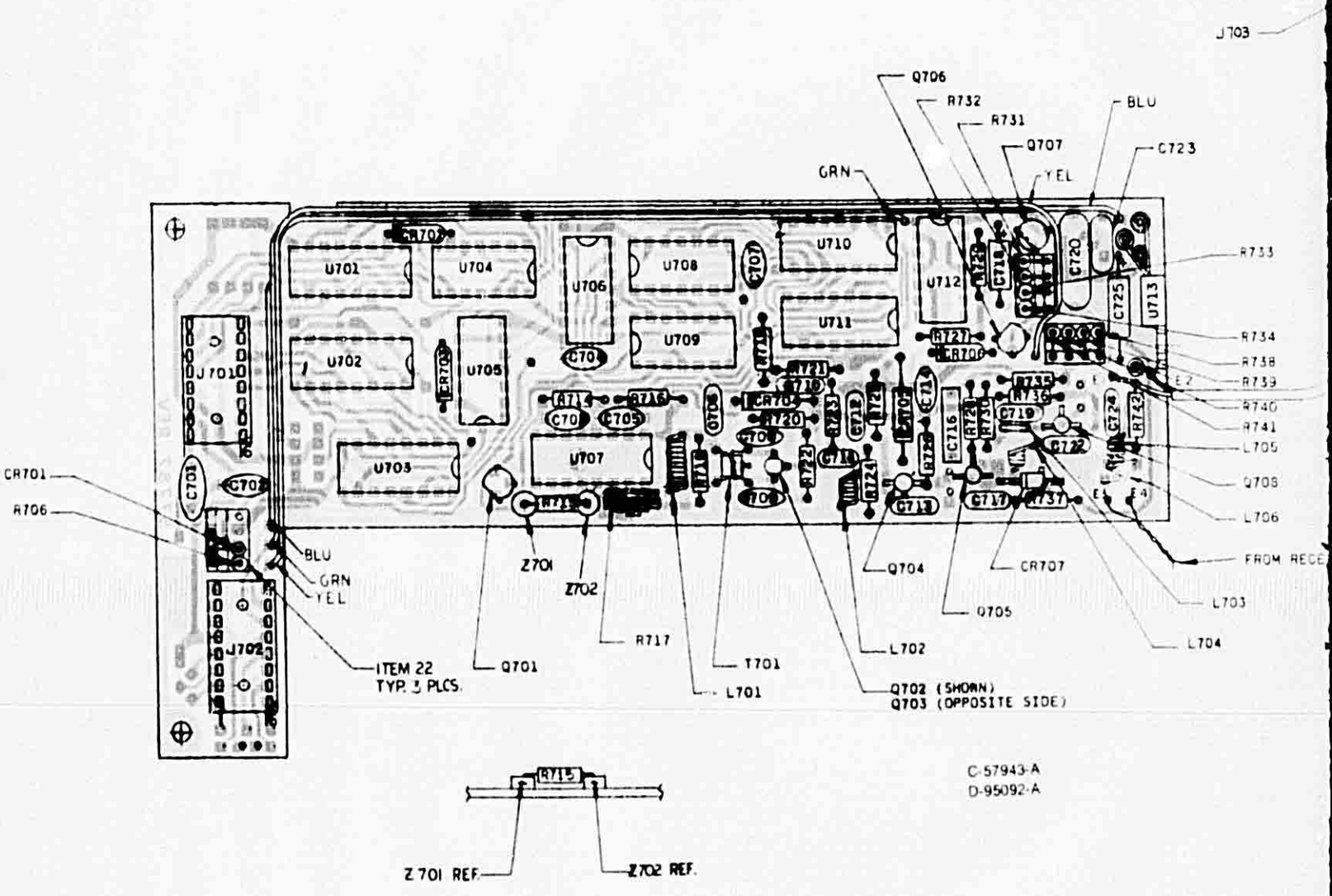
Power
%, 1/4W
%, 1/4W
pF, 50 Vdc
0%, 100 Vdc

the schematic
here a change,
ype substitution



NOTES -
1. UNLESS OTHERWISE SPECIFIED
ALL RESISTANCES IN OHMS, 10%, 1/4W
ALL CAPACITORS IN PF
ALL INDUCTORS IN μH
2. (#) WAVEFORM PHOTO REFERENCE NUMBER.

FIGURE 6-7A. DME 195 TRANSMITTER SCHEMATIC
(Chassis Levels B and C)

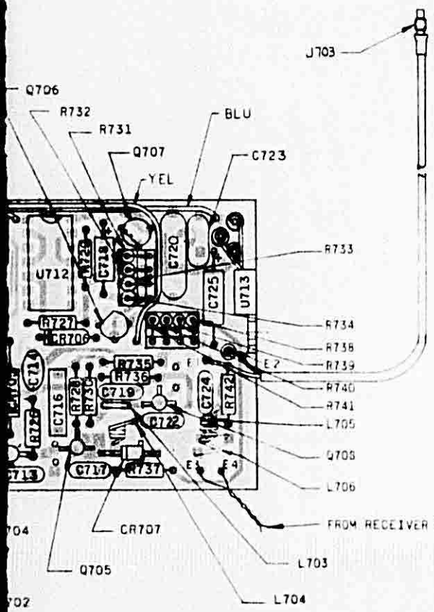


C-57943-A
D-95092-A

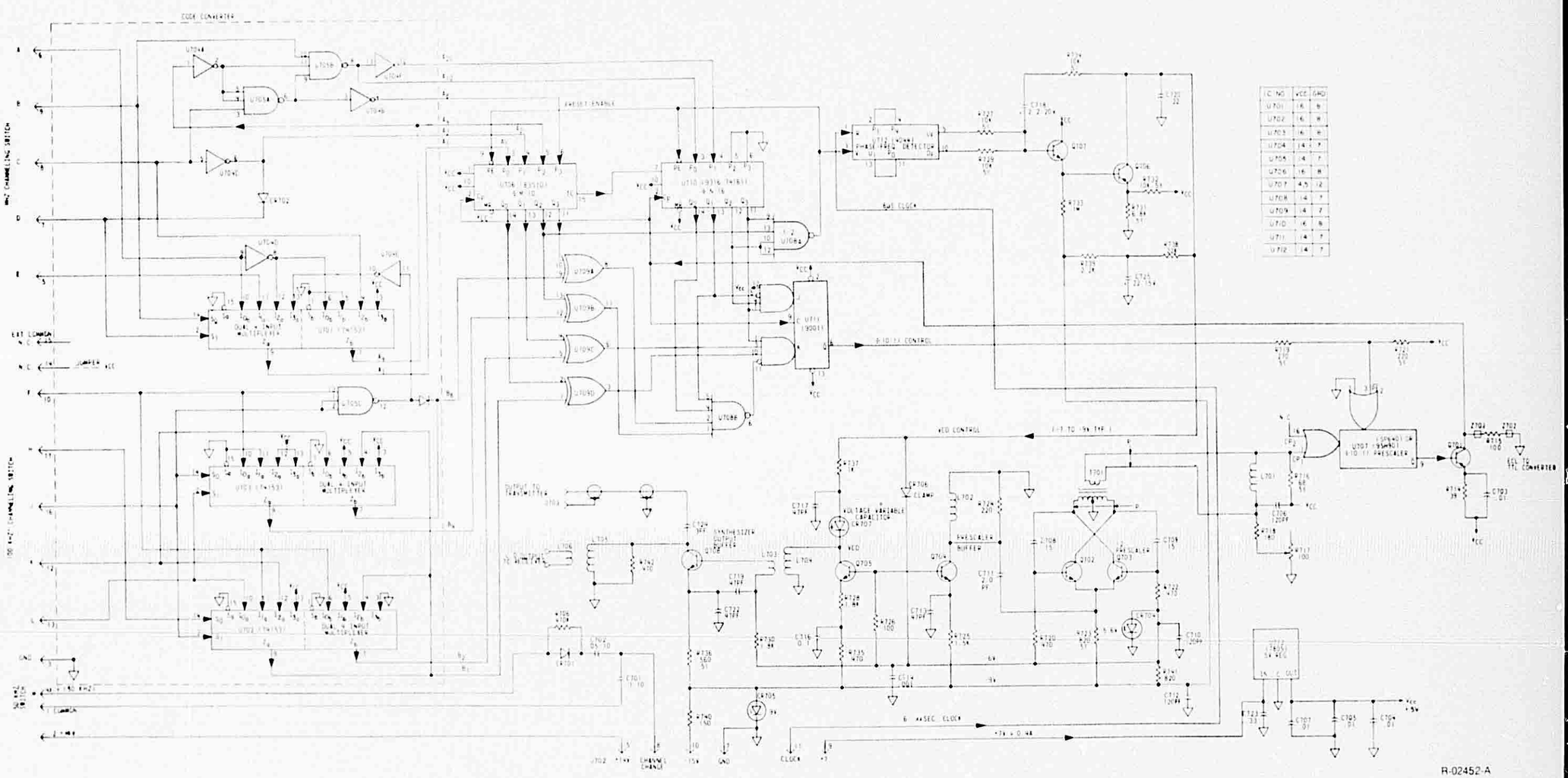
Solder runs shown in GREY
are those on the "BOTTOM" (non-component)
side of the board.

Solder runs shown in PINK
are those on the "TOP" (component)
side of the board.

SEE BLOW-UP



C-57943-A
D-95092-A



IC NO	VCC	GND
U701	16	8
U702	16	8
U703	16	8
U704	14	7
U705	14	7
U706	16	8
U708	16	8
U707	4.5	12
U708	14	7
U709	14	7
U710	16	8
U711	14	7
U712	14	7

s shown in GREY
on the "BOTTOM" (non-component)
board

s shown in PINK
on the "TOP" (component)
board

FIGURE 6-8. DME 195 SYNTHESIZER SCHEMATIC

SEE BLOW-UP

NARCO AVIONICS DME 195

Chassis Level JADDAO B AB
This change will improve operation at temperatures below -50°F.

Changed: CR705 to 75025-0012 DIODE, Zener, ±2%, 10V

Chassis Level JADDAD C AB
This change will permit use of the Plessey SP640 or Fairchild 11C90 in U707 slot

Added: R743 31192-0471 RESISTOR, Fixed Comp, 470 ±10%, 1/4W
95H90 to 11C90

Chassis Level JADDAD D AC
This change will improve operation at extremely high temperatures.

Changed: L701 to 11713-0005 RF COIL, 7½ turns, .080 dia., #24 wire

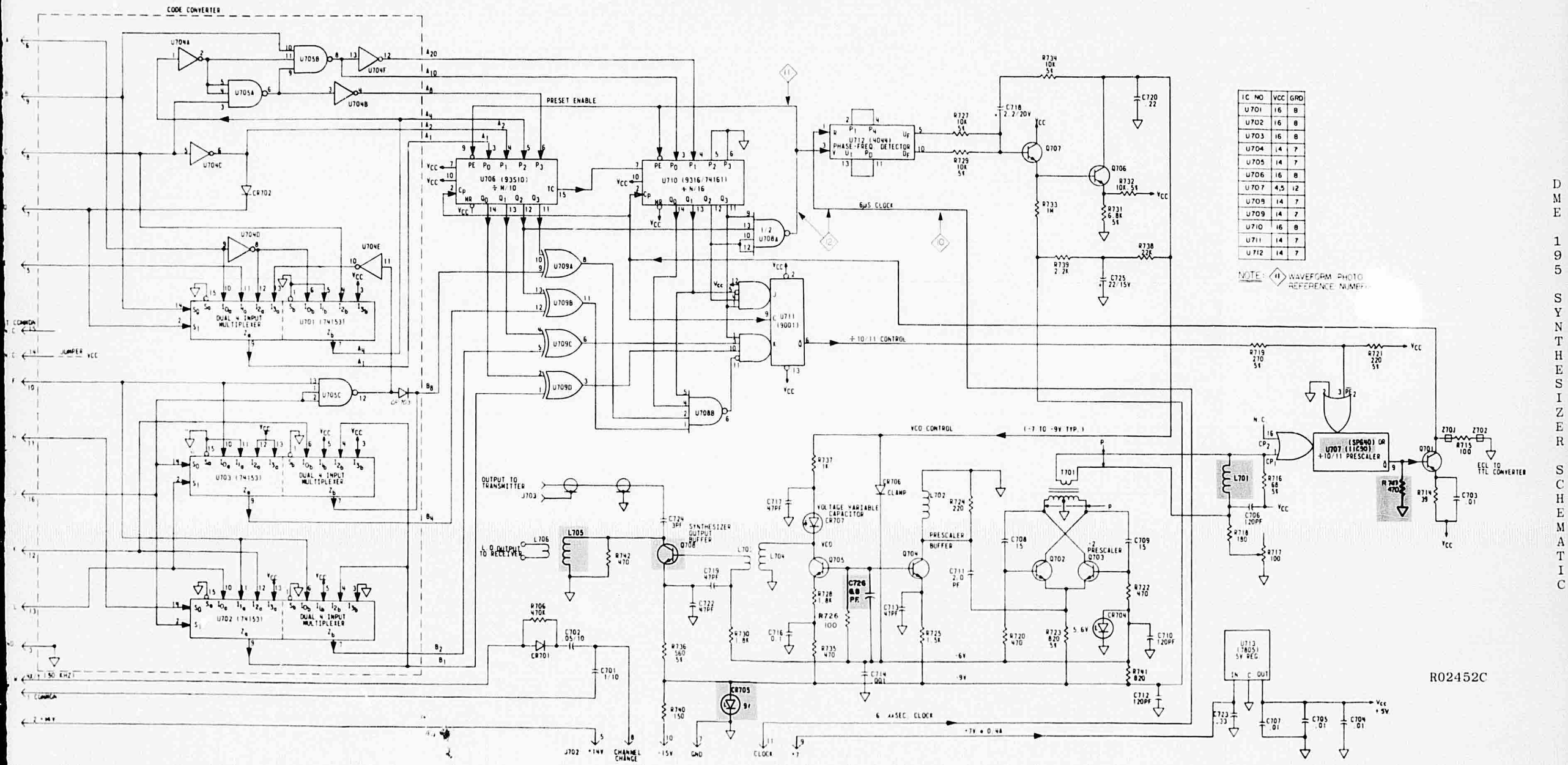
Chassis Level JADDAG E AC
This change will accomodate a change in vendors for Q708

Changed: Q708 to 75629-0002 TRANSISTOR, RF, NPN, MMT2857

Chassis Level JADDAJ F CC
This change will improve the balance between transmitter and receiver

Changed: L705 to 11713-0019 RF COIL, 5½ turns, .080 dia., #24 wire
Added: C726 24552-1689 CAPACITOR, Ceramic, 6.8 pF ±.5 pF, 50V

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."



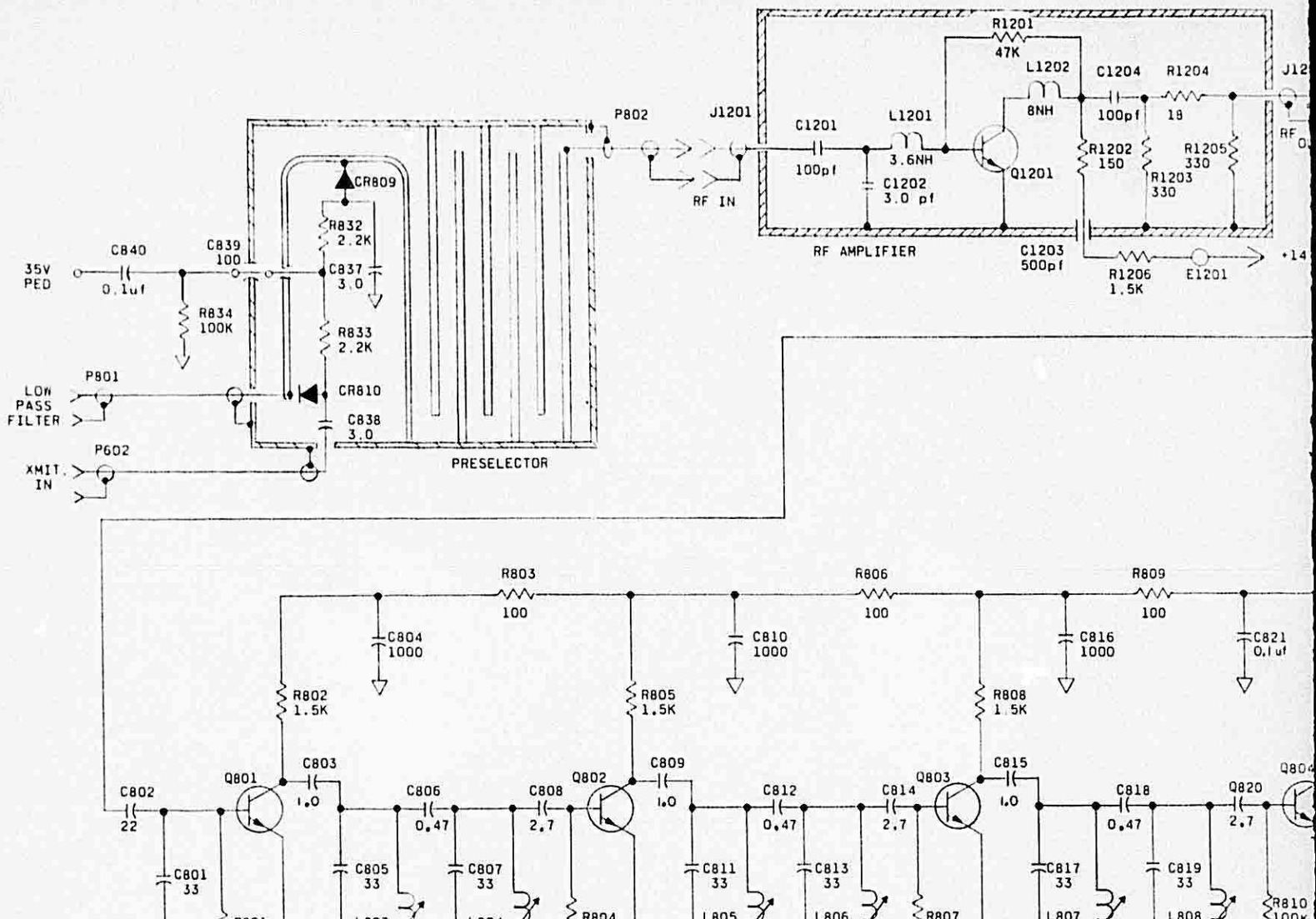
IC NO	VCC	GRD
U701	16	8
U702	16	8
U703	16	8
U704	14	7
U705	14	7
U706	16	8
U707	4,5	12
U708	14	7
U709	14	7
U710	16	8
U711	14	7
U712	14	7

NOTE: ⟨11⟩ WAVEFORM PHOTO REFERENCE NUMBER

FIGURE 6-8A. DME 195 SYNTHESIZER SCHEMATIC
(Chassis Levels B,C,D,E, and F)

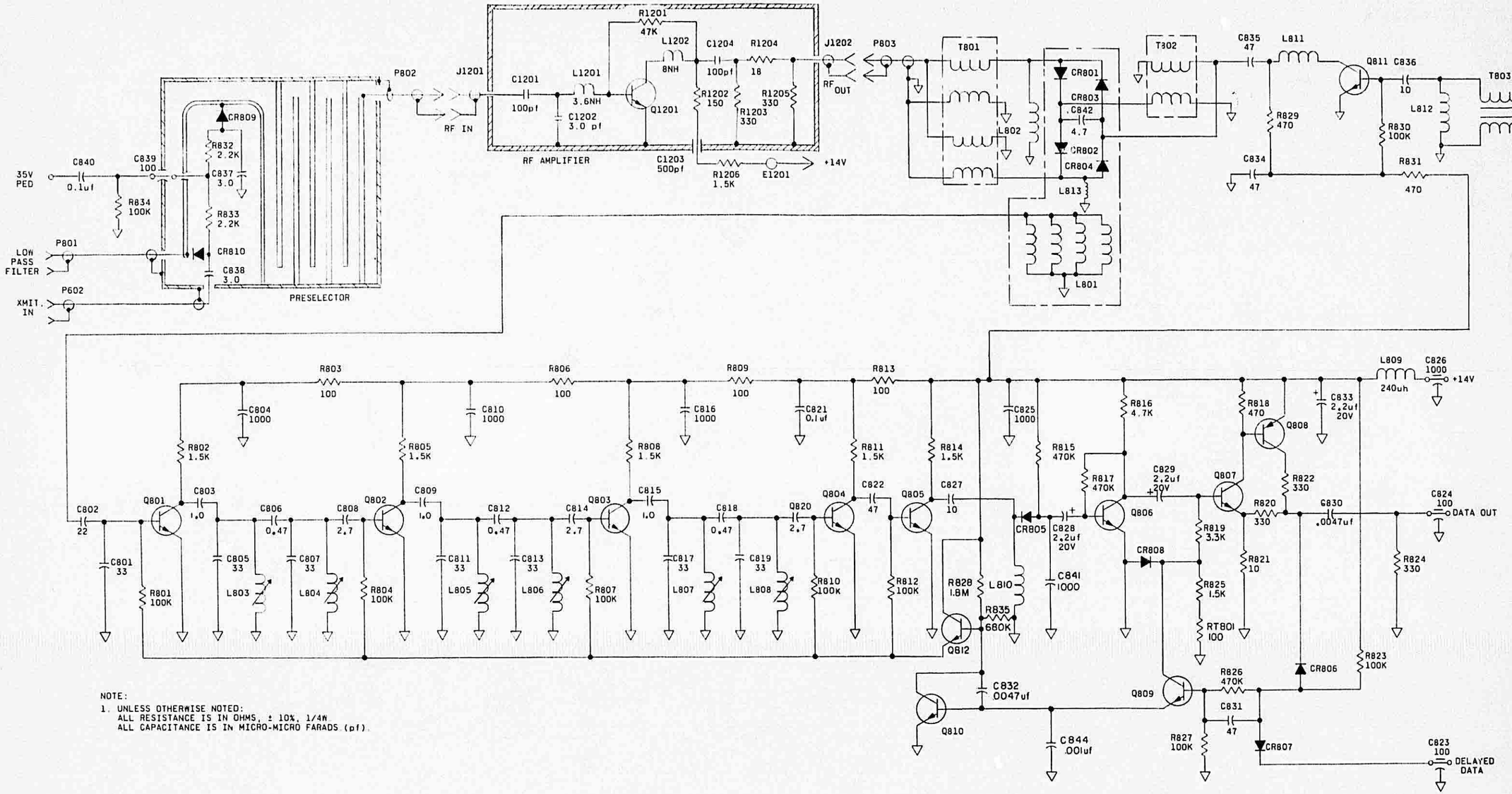
SEE BLOW-UP

SEE BLOW-UP



NOTE:

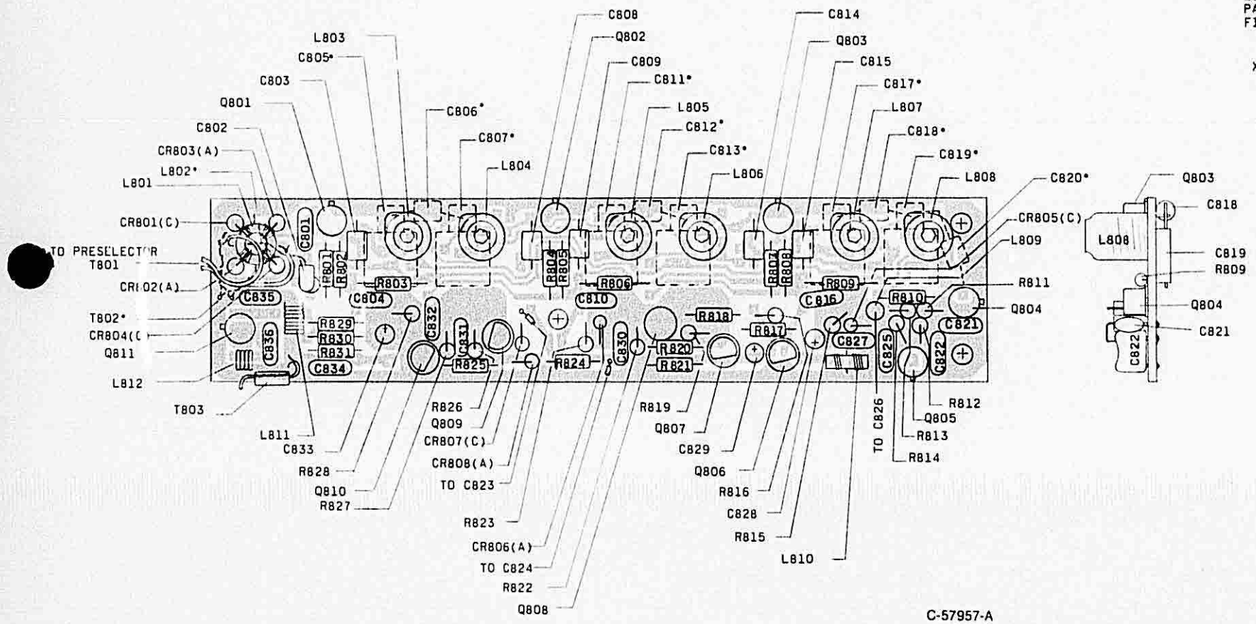
1. UNLESS OTHERWISE NOTED:
   ALL RESISTANCE IS IN OHMS, ± 10%, 1/4W.
   ALL CAPACITANCE IS IN MICRO-MICRO FARADS (pf).



NOTE:
1. UNLESS OTHERWISE NOTED:
   ALL RESISTANCE IS IN OHMS, ± 10%, 1/4W
   ALL CAPACITANCE IS IN MICRO-MICRO FARADS (pf).

FIGURE 6-9A DME-195 RECEIVER/PRESELECTOR SCHEMATIC (A) CHASSIS

SEE BLOW-UP

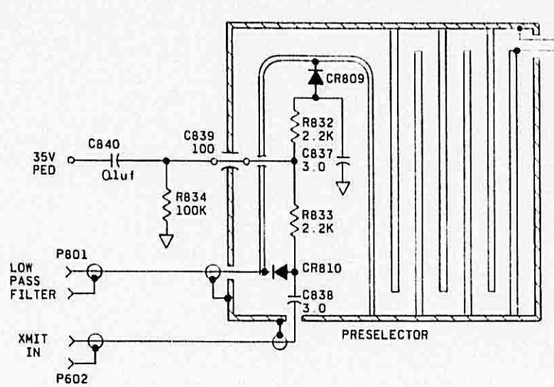


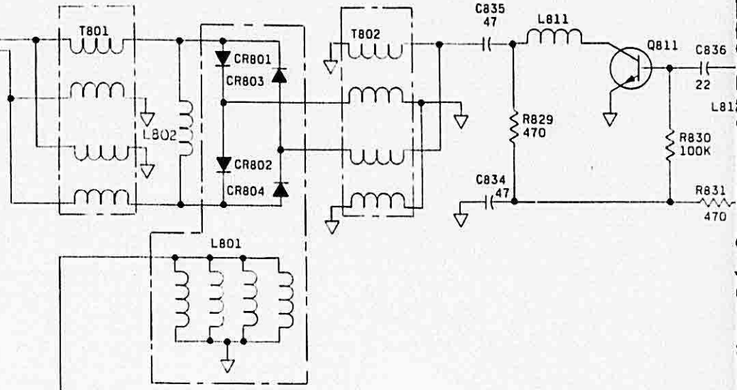
C-57957-A

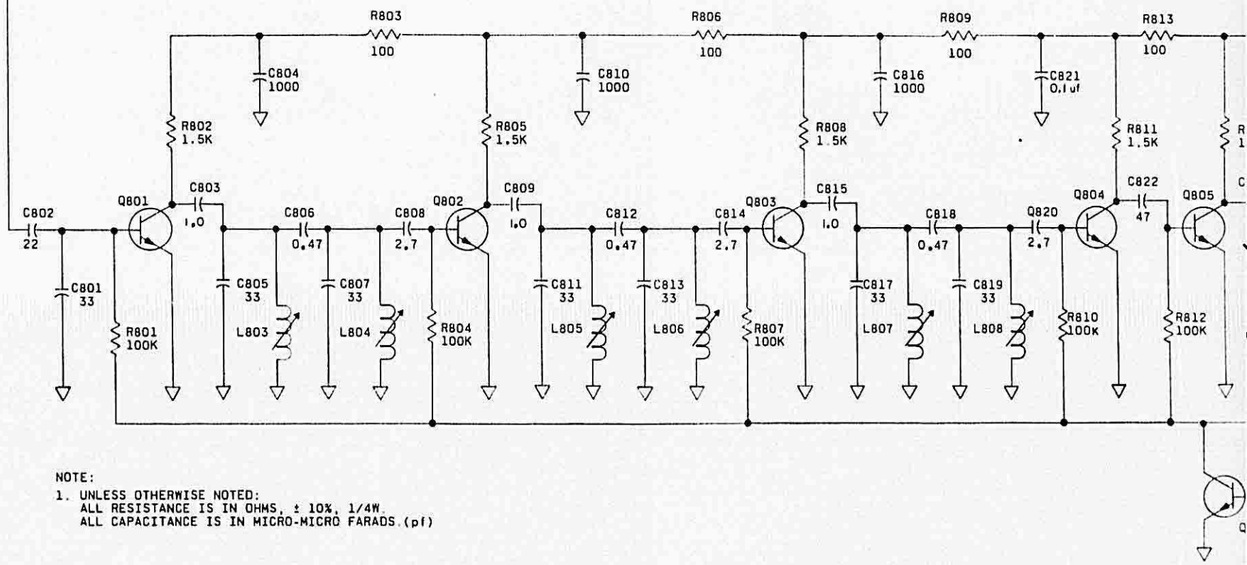
D-95130-A

Solder runs shown in GREY
are those on the "BOTTOM" (non-component)
side of the board.

SEE BLOW-UP







NOTE:
1. UNLESS OTHERWISE NOTED:
   ALL RESISTANCE IS IN OHMS, ± 10%, 1/4W.
   ALL CAPACITANCE IS IN MICRO-MICRO FARADS (pf)

D-02455-A

FIGURE 6-9.

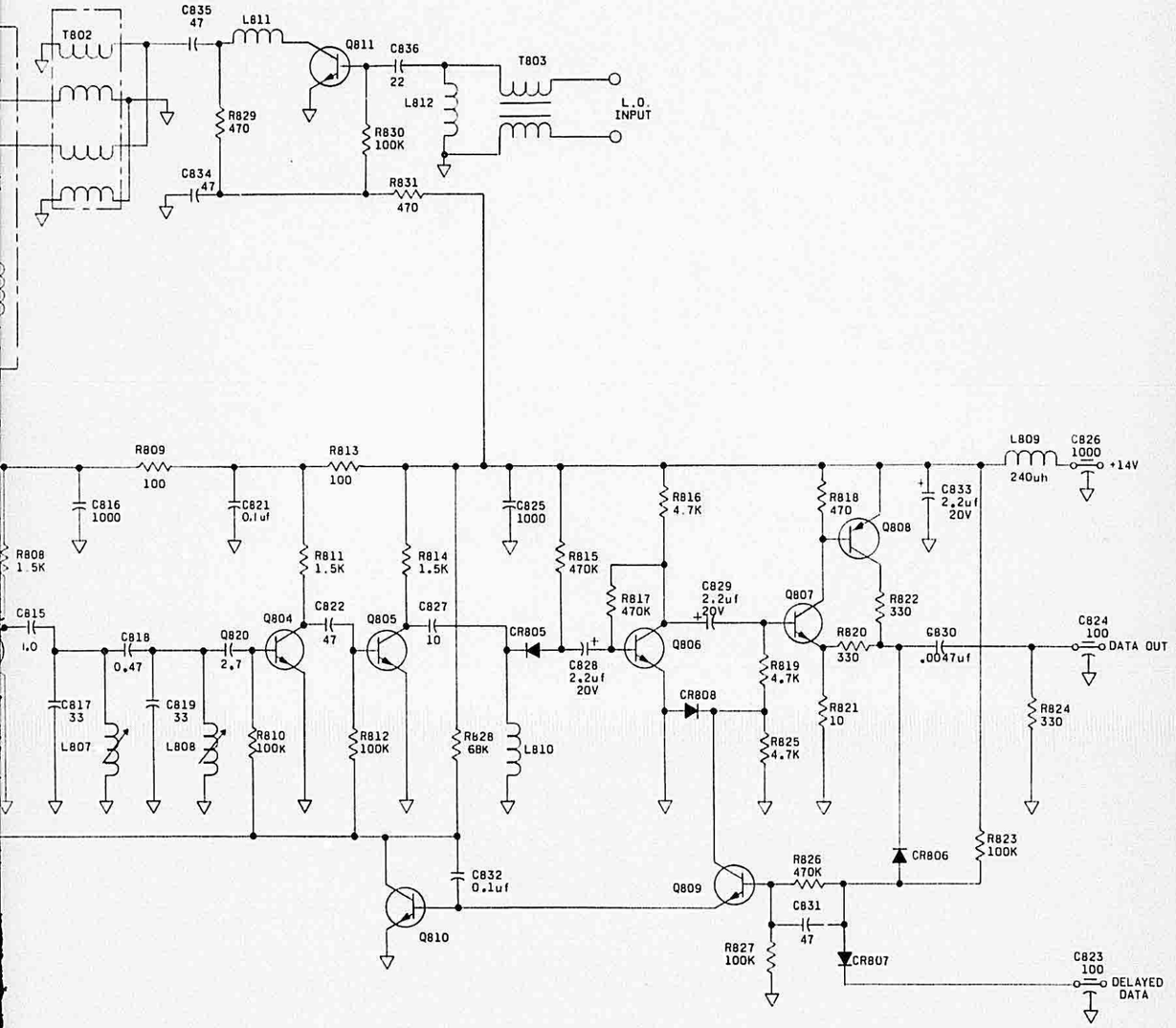
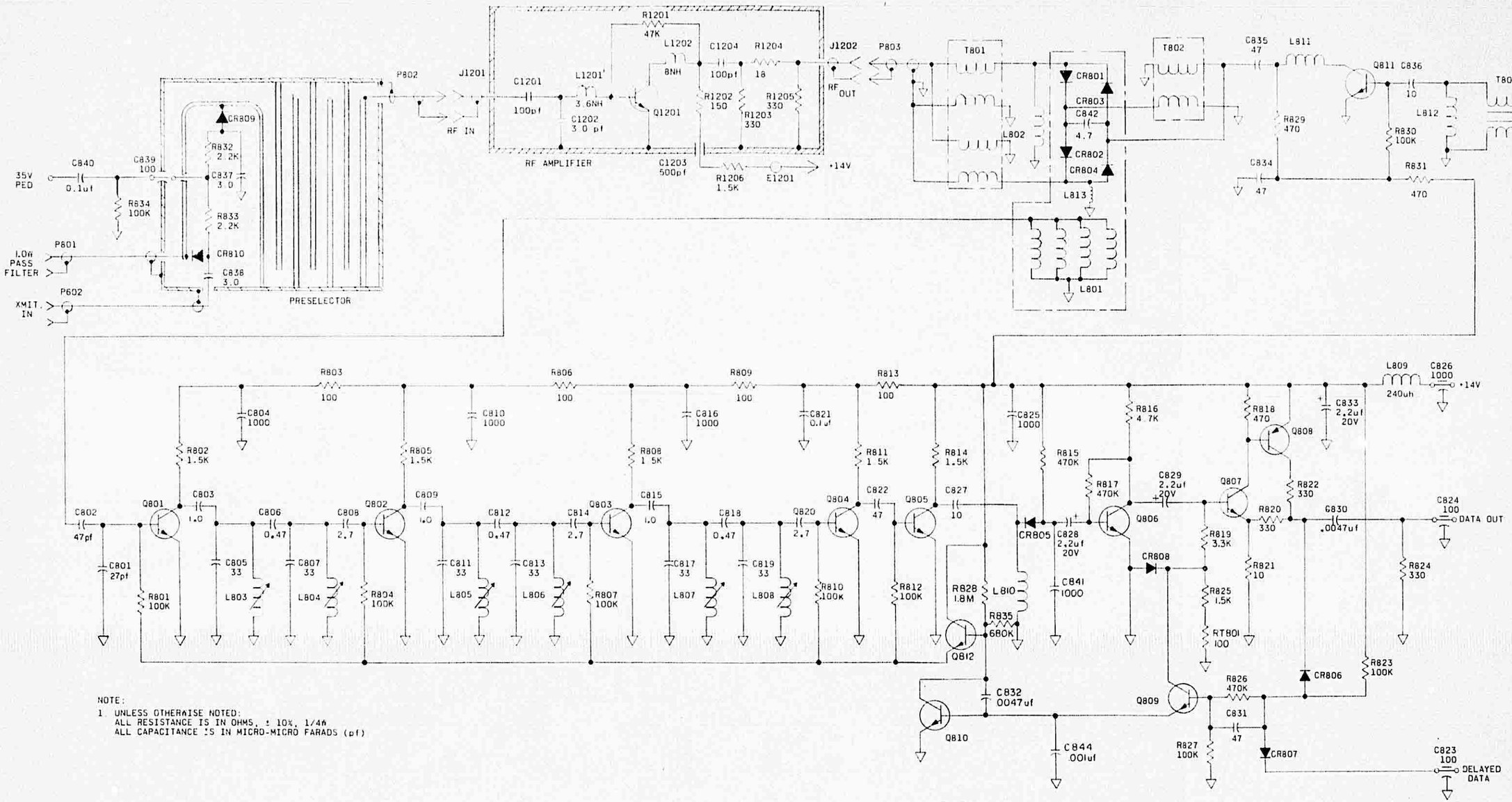


FIGURE 6-9. DME 195 RECEIVER/PRESELECTOR SCHEMATIC

SEE BLOW-UP



NOTE:
1. UNLESS OTHERWISE NOTED:
   ALL RESISTANCE IS IN OHMS, ± 10%, 1/4W
   ALL CAPACITANCE IS IN MICRO-MICRO FARADS (pf)

FIGURE 6-9B DME-195 RECEIVER/PRESELECTOR SCHEMATIC (B) CHASSIS

SEE BLOW-UP

SEE BLOW-UP

Chassis Level Code HACDA C BAB
These changes will improve signal rejection

Changed:	C821	21291-0019	CAPACITOR, Ceramic, 1000 pF ±10%, 500V
	C832	Location	
Added:	C845	23107-0125	CAPACITOR, Mylar, .01 mF ±10%, 100V
	C846	23107-0125	CAPACITOR, Mylar, .01 mF ±10%, 100V
	R836	31192-0181	RESISTOR, Fixed Comp, 180 ±10%,1/4W

Deleted: C841 and C844

Chassis Level Code HACDA D BAB
These changes will eliminate the possibility of IF regeneration

Changed:	C828	21555-0044	CAPACITOR, Tantalum, .47 mF ±20%, 35V
Added:	C841	24516-0100	CAPACITOR, Ceramic, 10 pf ±10%, 500V
	L814	11485-0034	CHOKE, 56 uh ±10%

Chassis Level Code JADDA E DAC
These changes will improve receiver sensitivity

Changed:	R1206	31218-0821	RESISTOR, Fixed Comp, 820 ±5%, 1/4W
	C1201	24551-0004	CAPACITOR, Ceramic, 2.9 pF, 50V

Deleted: R1203, R1204 and R1205

Chassis Level Code JADDA F EAC
This change will inhibit a double VDS1 Pulse

Changed:	C830	23107-0107	CAPACITOR, Mylar, .0033 mF

Chassis Level Code JADDA G FAC
This change will improve Power Out

Changed:	C838	24054-0409	CAPACITOR, Mica, 4.0 pF ±5%, 300V

Chassis Level Code JADDA H FBC
These changes will reduce spurious sidebands

Changed: R1206 to R820

Added:	Z801	11454-0001	Ferrite Band
	R1207	31218-0183	RESISTOR, Fixed Comp, 18K ±10%, 1/4W
	C1205	21296-0002	CAPACITOR, Feedthru, 500 pF

Chassis Level Code JADDA J FBC
This change deletes the low pass filter to increase transmitter power output

Changed:	Item 52 from	57938-0104	Low Pass Filter
	to	57977-0102	Connector Assy

SEE BLOW-UP

±10%, 500V

%, 100V
%, 100V
10%,1/4W

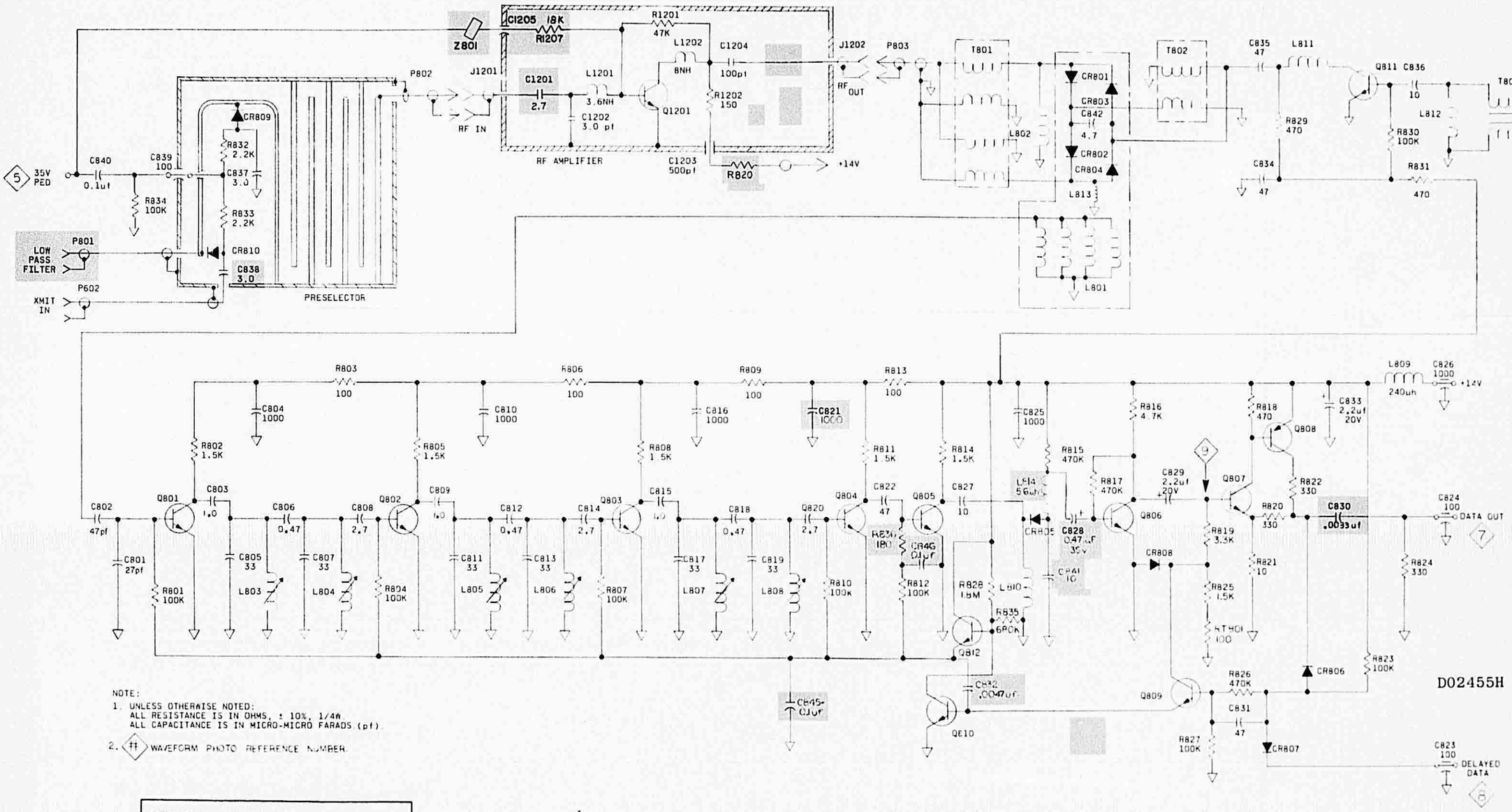
ration
±20%, 35V
10%, 500V

%, 1/4W
50V

300V

10%, 1/4W

nitter power



NOTE:
1. UNLESS OTHERWISE NOTED:
   ALL RESISTANCE IS IN OHMS, ± 10%, 1/4W
   ALL CAPACITANCE IS IN MICRO-MICRO FARADS (pf).
2. ◇ ## WAVEFORM PHOTO REFERENCE NUMBER

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

FIGURE 6-9C. DME 195 RECEIVER/PRESELECTOR SCHEMATIC
(Chassis Level C, D, E, F, G, H,and J)

SEE BLOW-UP

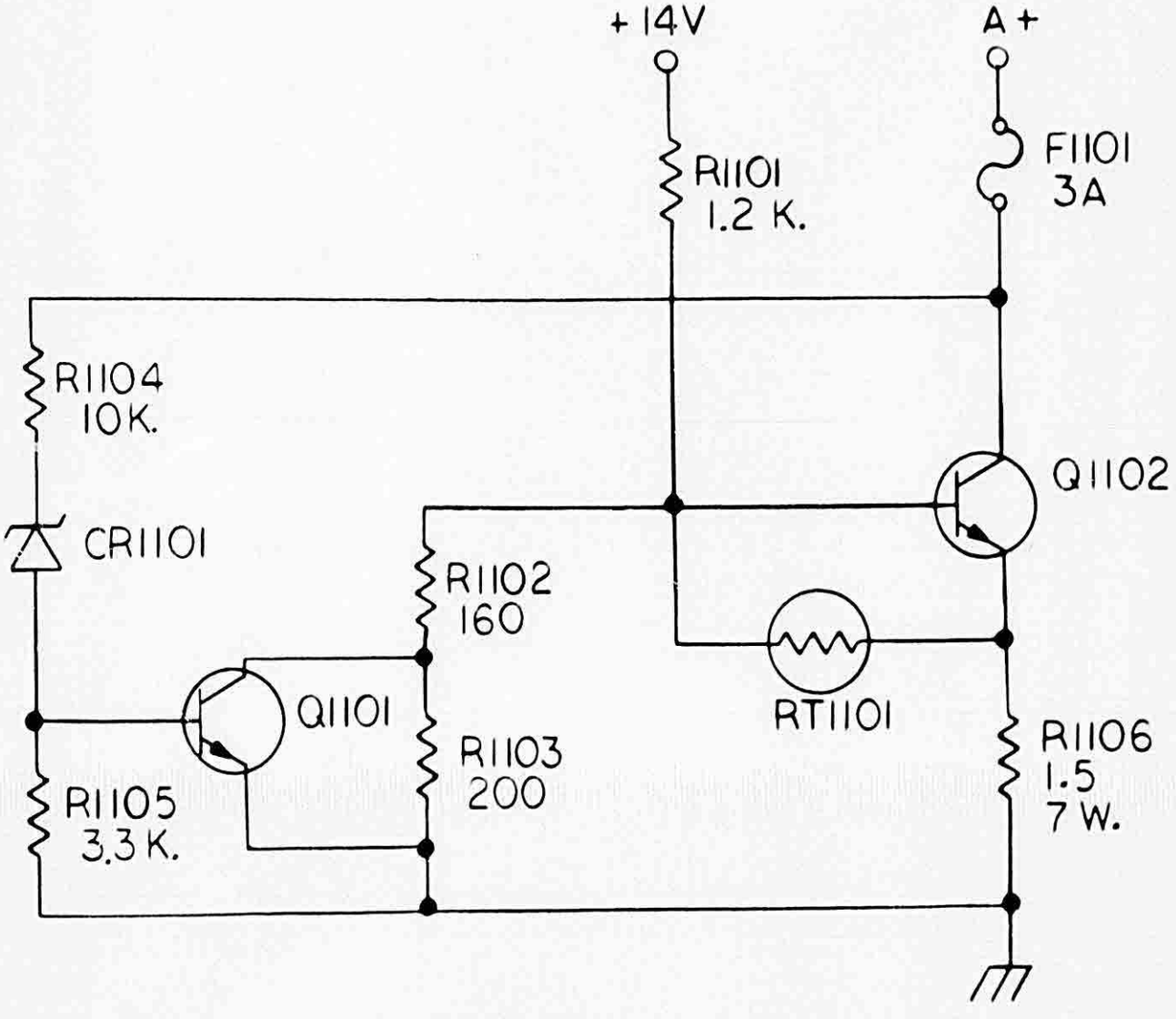


FIGURE 6-10 DME-195 HEATER SCHEMATIC (A) CHASSIS

Chassis Level J ADDADBAB

This schematic updates the electronic heater and contains only minor changes.

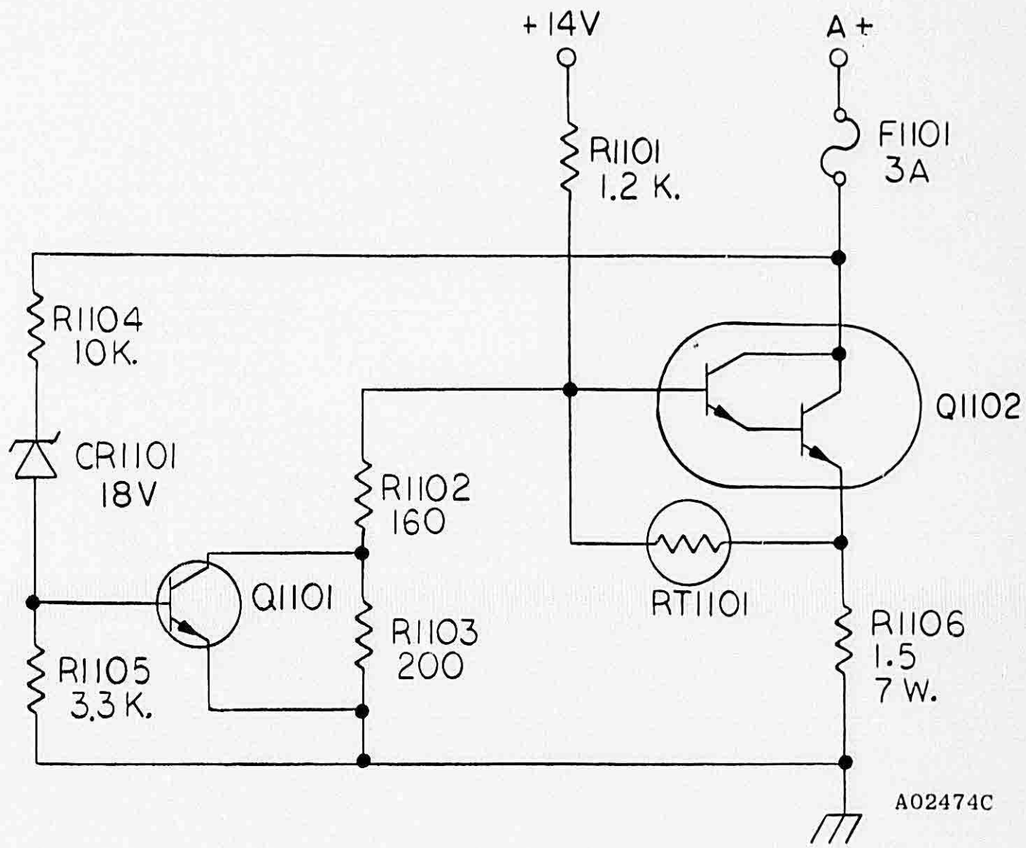
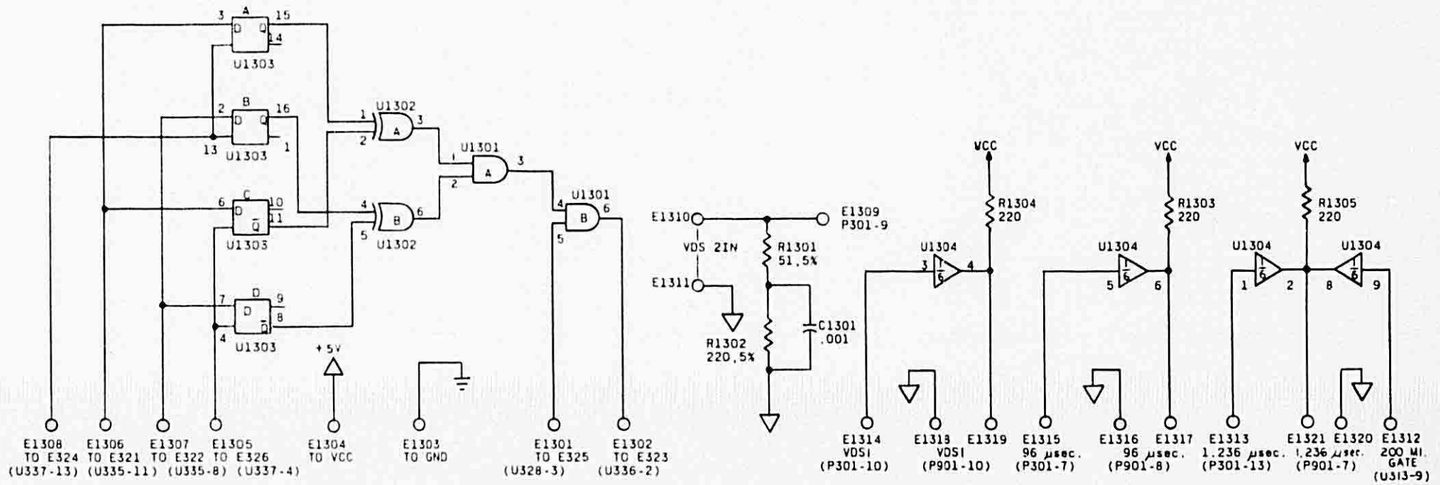


FIGURE 6-10A. DME-195 HEATER SCHEMATIC



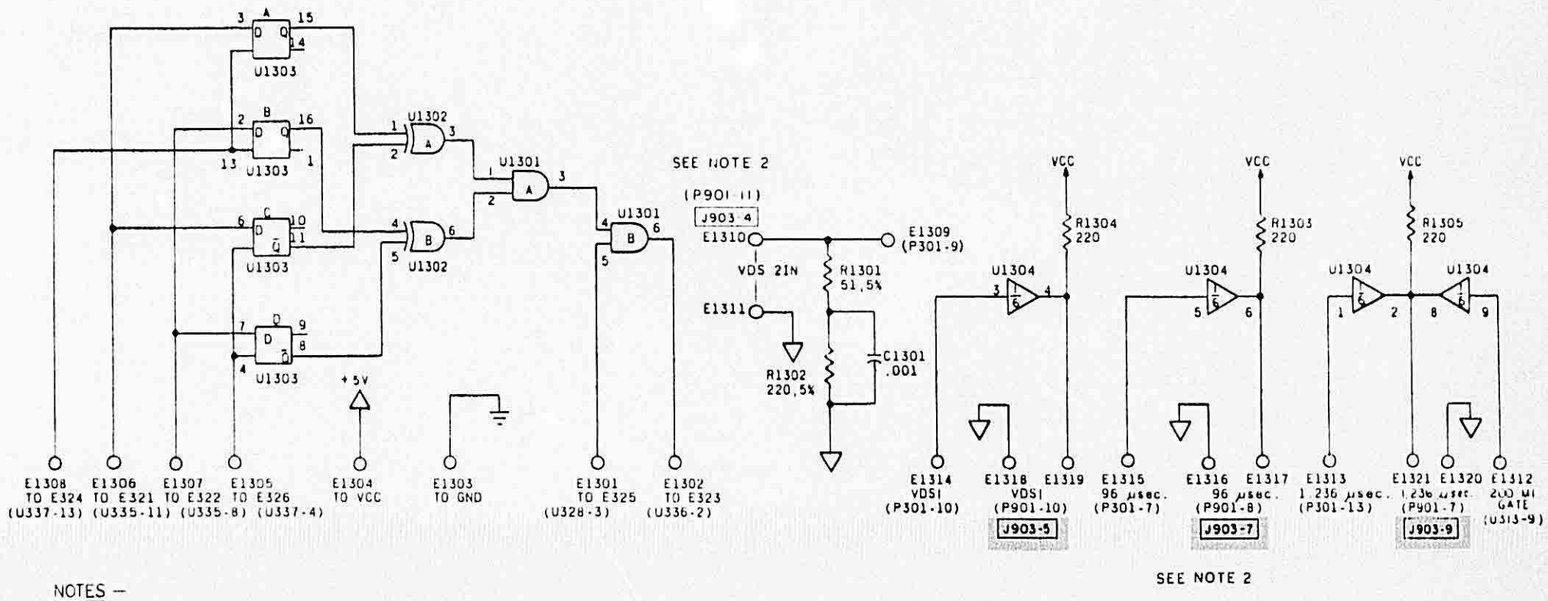
NOTES –

1. UNLESS OTHERWISE NOTED, RESISTORS ARE $\frac{1}{4}$W, 10%.

FIGURE 6-11 DME-195 SMOOTHING/BUFFERING SCHEMATIC (A) CHASSIS

Chassis Level Code JA D DADBAB

This schematic will update the smoothing board and contains only minor changes.



NOTES –

1. UNLESS OTHERWISE NOTED, RESISTORS ARE $\frac{1}{4}$W, 10%.
2. ( ) REFER TO EXTERNAL CONNECTIONS ON DME 190 TSO, P901.
   [ ] REFER TO EXTERNAL CONNECTIONS ON DME 195, J903.

02476B

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

DME 195 SMOOTHING/BUFFERING SCHEMATIC

FIGURE 6-11A. DME 195 SMOOTHING/BUFFERING SCHEMATIC (Chassis Level D)

2.5 MECHANICAL INSTALLATION

2.5.1 Interrogator/Receiver Unit (Remote Unit)

A. Locate the DME Antenna and Remote Unit as closely as possible to one another; this shortens the antenna coax cable thereby reducing signal loss and improving performance.

B. Locate the tray for the Remote Unit to provide adequate clearance for cable removal and Unit removal for service. Mount the tray with 6-32 or larger screws and related hardware. Provide a ground lug to ground the black wire in the Interconnect Cable. Obstructions that block airflow through the bottom of the tray, and out the sides should be avoided.

C. Mount the Remote Unit into the tray and tighten the lock nuts on the tray. The Remote Unit may be mounted either end first for cable convenience. The lock nuts are automatically secured by the use of a spring washer which provides tension on the screw threads.

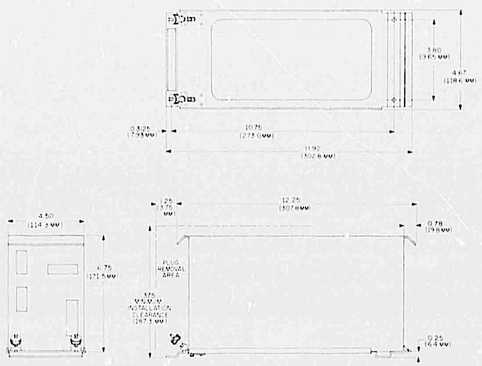
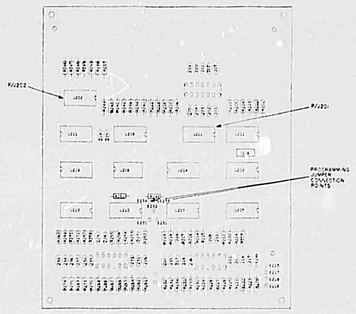


FIGURE 2-1. INTERROGATOR/RECEIVER-TRAY INSTALLATION DRAWING



NOTES: This assembly is electrically identical to the assembly shown in Figure 2-9.

Refer to Tables 2.7 and 2.8 for programming instructions.

FIGURE 2-9A CHANNEL MULTIPLEX COMPONENT BOARD LATER MODELS

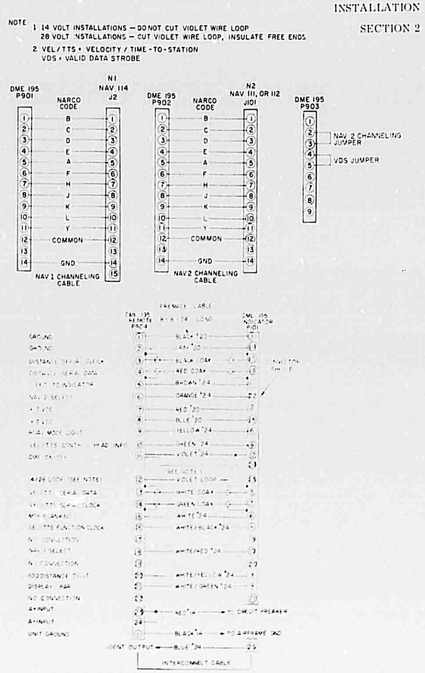


FIGURE 2-12. STANDARD DME WIRING

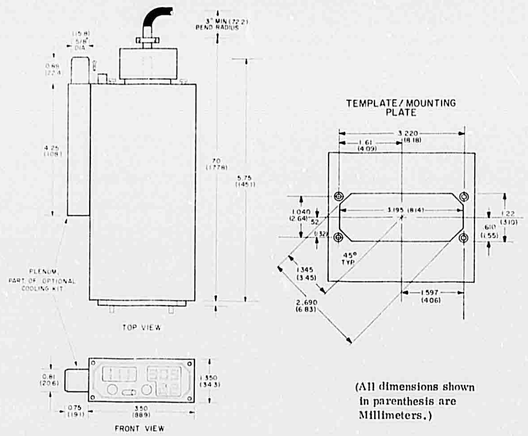
2.5.2 Indicator

The Indicator should be mounted for ease of viewing and manipulation of controls by the pilot. A metal template, 3-3/4 inches square having an octangonal cutout is supplied in the Installation Kit. See Figure 2-2. This template may be used for one of the following:

1. As a template for marking the instrument panel when the Indicator will be rear mounted directly to the instrument panel. See Subsection 2.5.2.2A.
2. As a mounting plate to allow front removal of the Indicator. See Subsection 2.5.2.2B.
3. As a mounting plate if the Indicator is to be mounted in a standard 3" instrument hole. See Subsections 2.5.2.3A and B.

NOTE

Indicator mounting screws must not penetrate the Indicator more than 1/4 inch.



(All dimensions shown in parenthesis are Millimeters.)

FIGURE 2-2. INDICATOR INSTALLATION DRAWING

2.5.2.1 Indicator Cooling Kit, Optional

A cooling kit, while not required, is available for the Indicator as noted in Section 2.4. Cooling of the Indicator is normally by means of conduction, convection, and radiation. If any one of these effects is absent or restricted, the addition of a cooling kit is recommended.

If a cooling kit is part of the installation, be sure sufficient room exists for the plenum and duct hose. Generally the cooling kit will require rear mounting of the Indicator.

Installation:

Refer to Figure 2-3
This kit is similar to numerous cooling kits now in the field. Standard installation precautions should be observed, such as:

1. Scoop hole location should be approximately one foot below the unit's air intake.
2. Scoop to be positioned to "scoop" air in, flat of the "D" forward.
3. Manifold outlet ports facing upward.
4. A sealant, such as Silastic 732, be applied between skin and mounting flange of the scoop.
5. Drain hole on bottom of scoop must be clear of ALL obstructions.
6. Length of cooling duct(s) should be cut for the specific installation. Avoid dips in the line that could cause puddling in the line.
7. The plenum is attached to the RIGHT side of the Indicator (as viewed from the rear). Slip the plenum's forward lip into and under the leading vent hole in the Indicator. Position the plenum flush against the Indicator's side and secure it in place with the screw already in the rear of the Indicator. (See Indicator Installation Drawing.)

The Kit can supply ram air cooling to one or two equipments and be mounted on either side of the aircraft, forward of the instrument panel. If only one manifold port is used, cap the other.

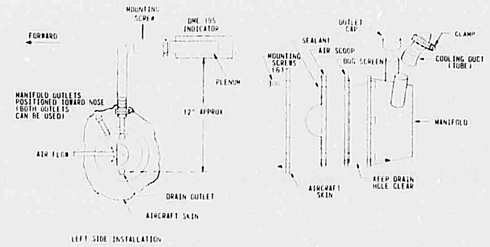


FIGURE 2-3. COOLING KIT INSTALLATION

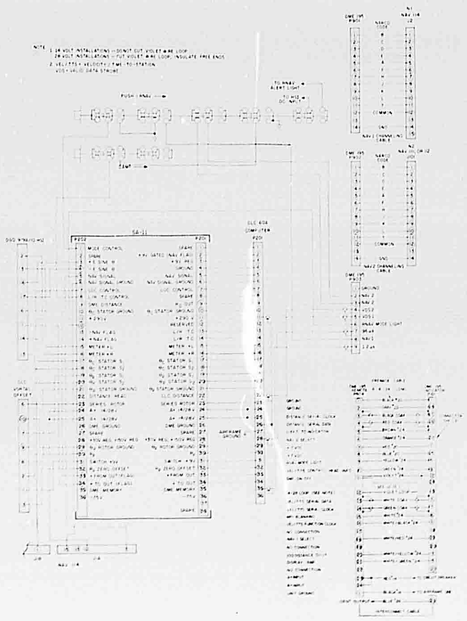


FIGURE 2-16. NAV 1-RNAV WIRING DIAGRAM

2.6.6.3 Continued

Connections to P903 are shown in Figure 2-16. Physical requirements for the coax cable connections are illustrated in Figure 2-19.

The accessory connector is wired to a CLC 60A System or to similar RNAV components. For pulse signals use 50 ohm coaxial cable (RG 178 B/U or equivalent) or the 4 coaxial cable supplied with the CLC 60A where indicated in the Interconnect Wiring Diagram. All exposed center conductors must be kept to a minimum length to prevent RF effects. Standard hook-up wire may be used on other connections.

The System is designed to indicate when RNAV operation is in use by grounding P903, Pin 6. This illuminates the RNAV indicator light and causes velocity and time-to-station to extinguish.

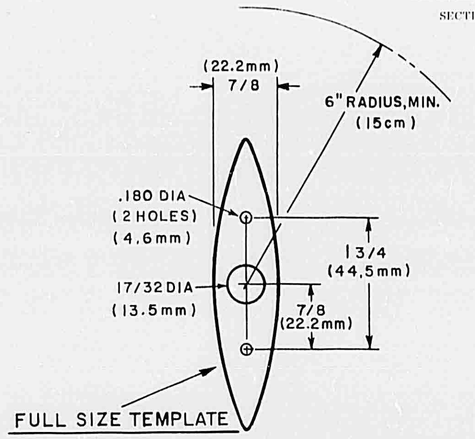
When RNAV is engaged, the RNAV System VOR receiver is automatically selected as the DME channeling source. This is accomplished by routing the DME's NAV Selector Switch wiring through P903 and the Mode Control Pushbutton Assembly as shown in Figures 2-15 and 2-16. By connecting the channeling ground through the accessory connector the DME 195 will be channeled by the RNAV VOR receiver in RNAV operation regardless of the position of the NAV selector switch and lights, in the DME 195 indicator.

A .01 uf ceramic capacitor must be added to the DME's Distance Board. This capacitor is soldered in parallel with C321. Access to the Distance Board is by removing the right side cover, then pivoting the Receiver-Transmitter Assy out from the Unit.

FIGURE 2-19. P903 CABLE ASSEMBLY

FIGURE 2-20. DISTANCE BD's C321

This completes the NAV 1-RNAV installation wiring.



B-07362-AW557

FIGURE 2-1. UDA-3 ANTENNA INSTALLATION DRAWING

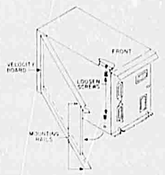


FIGURE 2-8. DME 195 VELOCITY BOARD ACCESS

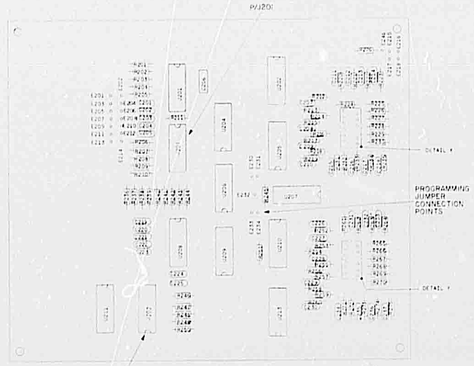
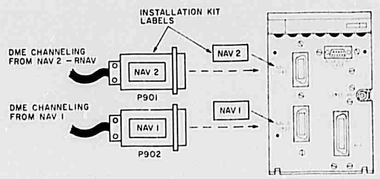


FIGURE 2-9. CHANNEL MULTIPLEX COMPONENT BOARD



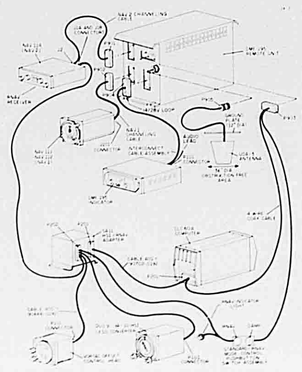


FIGURE 2-21. NAV 2-RNAV WIRING PICTORIAL

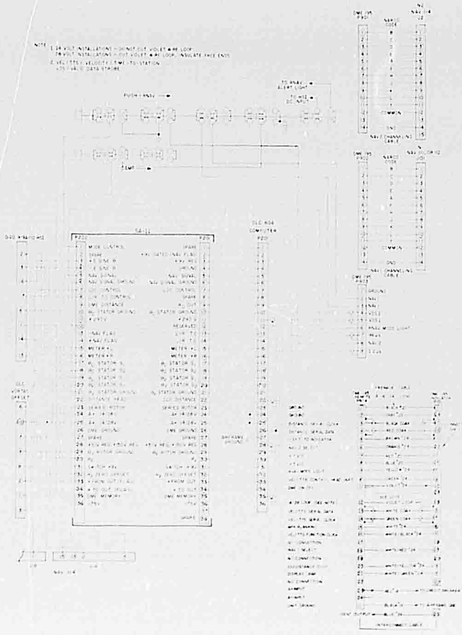


FIGURE 2-22. NAV 2-RNAV WIRING DIAGRAM

2.6.7.3 RNAV Connections to Accessory Connector (P903)

The Dealer Starter Kit contains a pin extractor tool for removal of two factory installed jumpers (see Figure 2-24). Once extracted, these pins are discarded since additional pins are provided in the installation Kit.

Connections to P903 are shown in Figure 2-22. Physical requirements for the coax cable connections are illustrated in Figure 2-27.

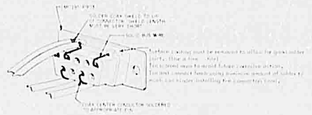


FIGURE 2-27. CABLE ASSEMBLY

The accessory connector is wired to a CLC 60A System. For pulse signals use 50 ohm coaxial cable (RG 178 B/U or equivalent) or the 4 coaxial cable supplied with the CLC 60A where indicated in the Interconnect Wiring Diagram. All exposed center conductors must be kept to a minimum length to prevent RF effects. Standard hook-up wire may be used on other connections. The System is designed to indicate when RNAV operation is in use by grounding P101, Pin 6. This illuminates the RNAV indicator light and causes velocity an and time-to-station to extinguish. By connecting the channeling ground through the acce accessory connector the DME 195 will be channeled by the RNAV VOR Receiver in RNAV operation regardless of the position of the NAV Selector Switch and lights, in the DME 195 Indicator.

A 0.01 uf ceramic capacitor must be added to the DME's Distance Board. This capacitor is soldered in parallel with C321. Access to the Distance Board is by removing the right side cover, then pivoting the Receiver-Transmitter Assy out from the Unit.

FIGURE 2-28. DISTANCE BD's C321

This completes the NAV 2-RNAV installation wiring.

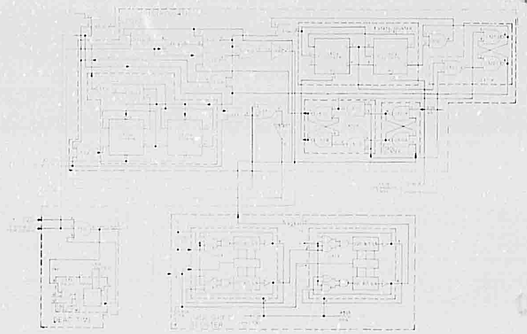


FIGURE 3-30. SYNCHRONOUS REPLY FILTER SCHEMATIC

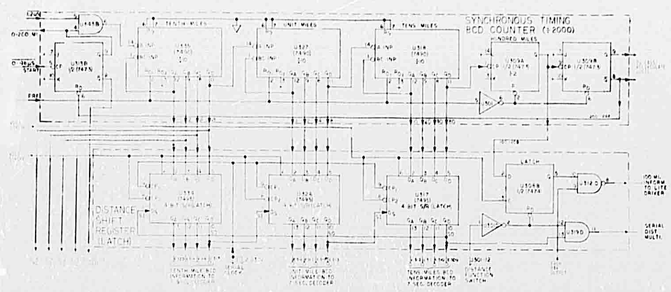


FIGURE 3-8A. 0-200 MILE COUNTER AND DISTANCE SHIFT REGISTER

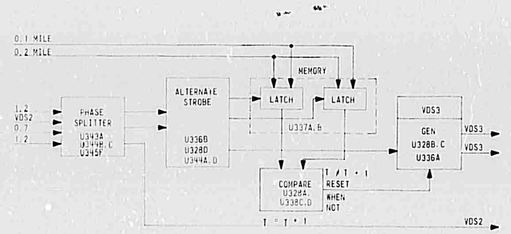


FIGURE 3-31. DATA SMOOTH, BLOCK DIAGRAM

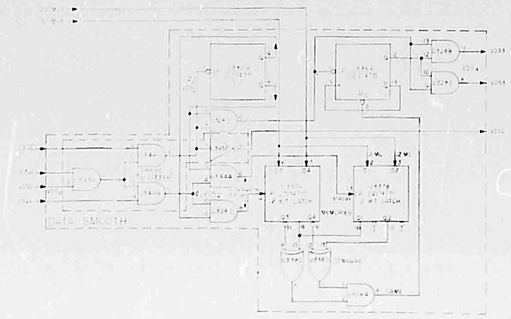


FIGURE 3-32. DATA SMOOTH, SCHEMATIC DIAGRAM

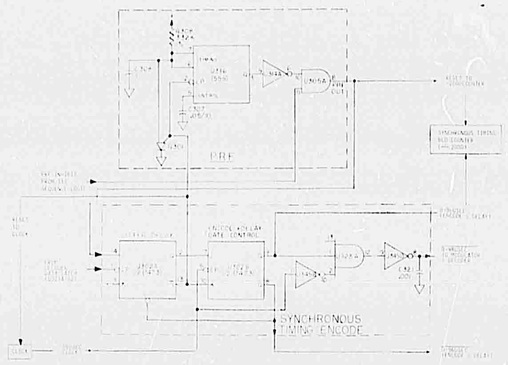


FIGURE 3-10. PRF AND SYNCHRONOUS TIMING ENCODE SCHEMATIC DIAGRAM

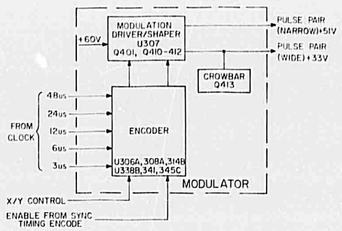


FIGURE 3-11. MODULATOR, BLOCK DIAGRAM

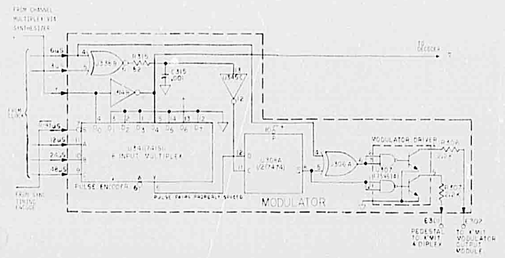


FIGURE 3-12. MODULATOR ENCODER, SCHEMATIC DIAGRAM

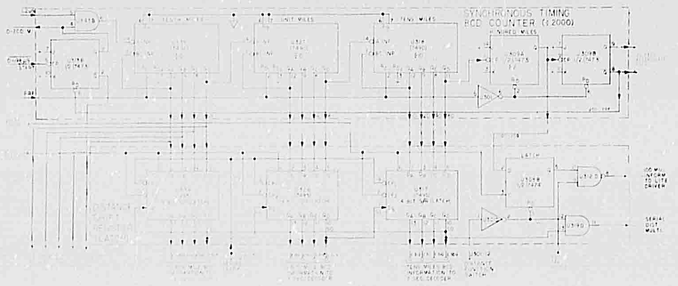


FIGURE 3-33. 0-200 MILE COUNTER AND DISTANCE SHIFT REGISTER

3.7.9 Indicator

3.7.9.1 General

A simultaneous display of distance, velocity and time-to-station is provided by the indicator. In addition the indicator's N1-N2-HLD switch selects the DME channeling source or places the channel Multiplex and Synthesizer circuits in a HOLD condition. The HOLD function allows the DME to continue operating on a selected channel while the Nav receivers are set to new channels.

Illumination of all nine, incandescent, seven segment, numerical displays are activated by a PUSH TEST function. Eight of the displays will indicate "8", to check all segments, while the hundreds digit of the distance display will indicate "1"; since "1" is the maximum count for this digit. To indicate an invalid display, such as loss of receive signal or insufficient data for an accurate display, a lighted bar will show in the tenths, units, and tens distance displays. The distance hundreds digit plus the velocity and time-to-station displays will remain blank. If only the time-to-station display shows blank it is likely that the 99 minute capability of the DME 195 has been exceeded.

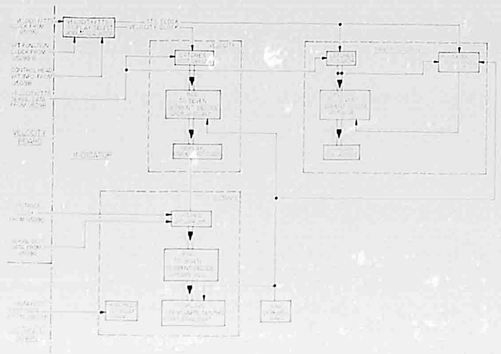


FIGURE 3-34. INDICATOR, DISPLAY BLOCK DIAGRAM

3.7.4.5 IF Amplifiers and Detector

The five stage, Q801 thru Q805, IF amplifier is tuned to 63 MHz by three double tuned interstage networks and a single tuned coil, L810. Capacitive coupling is used between each of the elements. Video detection is performed by diode CR805.

AGC voltage is applied to each of the IF transistors. These transistors are selected for dc beta with IF gain being proportional to the operating current.

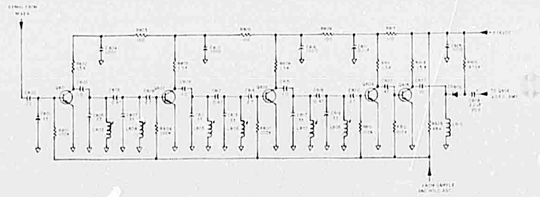


FIGURE 3-24. IF AMPLIFICATION AND DETECTION

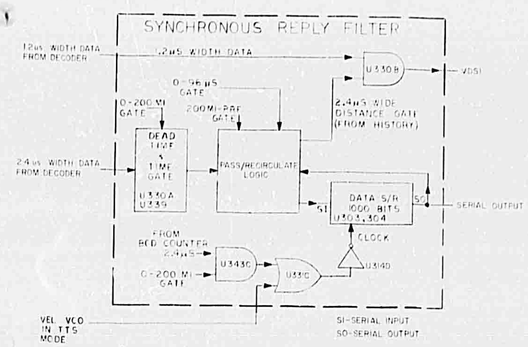


FIGURE 3-28. SYNCHRONOUS REPLY FILTER, BASIC BLOCK DIAGRAM

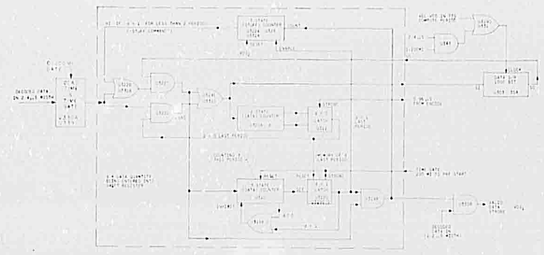


FIGURE 3-29. SYNCHRONOUS REPLY FILTER, DETAILED BLOCK DIAGRAM

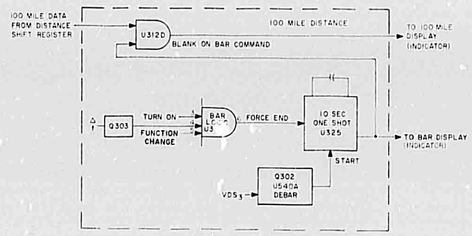


FIGURE 3-35. BAR FUNCTION, BLOCK DIAGRAM

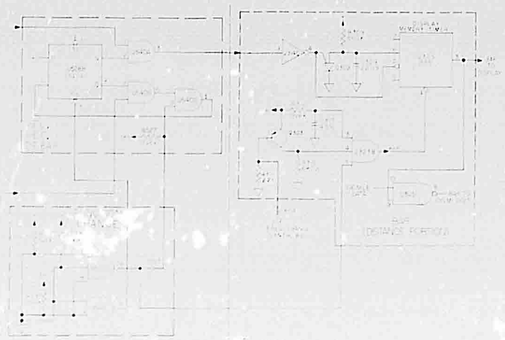


FIGURE 3-36. BAR FUNCTION, SCHEMATIC

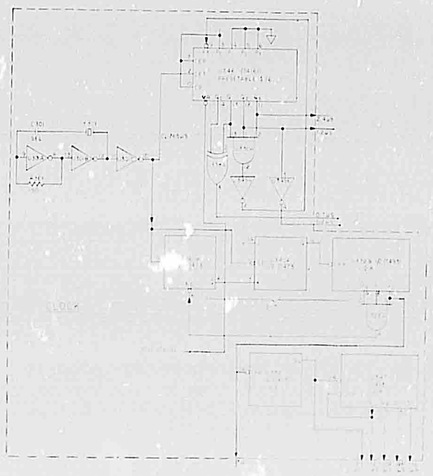


FIGURE 3-39. CLOCK GENERATOR, SCHEMATIC

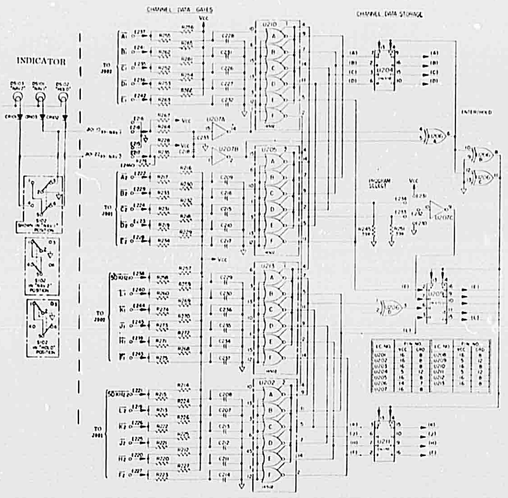


FIGURE 3-41. CHANNEL MULTIPLEX SWITCHING

3.7.14 Frequency Synthesizer Description

The frequency synthesizer serves as the RF exciter for the transmitter as well as the local oscillator (LO) for the superheterodyne receiver. The synthesizer operates from 347.00 to 383.33 MHz, which is 1/3 of the transmitter's frequency range of 1041 through 1150 MHz.

The basic frequency of this ÷N synthesizer is controlled by the 6-microsecond reference pulses from the Clock Generator; the output frequency, however, is selected by the pilot when he sets a Nav receiver channel selector to the desired channel as shown in Figure 3-41. The calibrations of this channel selector are 108.00 through 117.95, which are the VHF frequencies of the paired VOR/DME channels. The actual paired DME transmit frequencies are 1041 through 1150 MHz. Table 3.1 provides all paired frequency versus VCO frequency information.

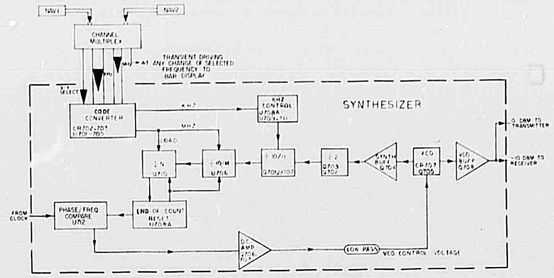


FIGURE 3-42. SYNTHESIZER BLOCK DIAGRAM

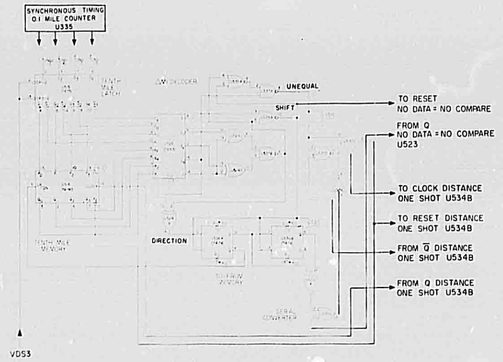


FIGURE 3-51. △MILE DECODER

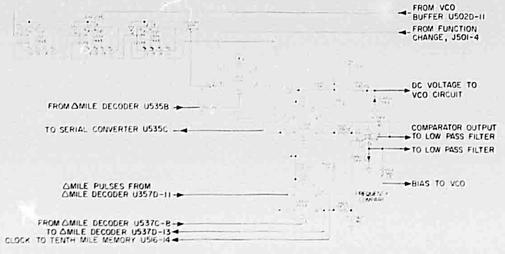


FIGURE 3-52. FREQUENCY COMPARE AND ÷ 4096 COUNTER

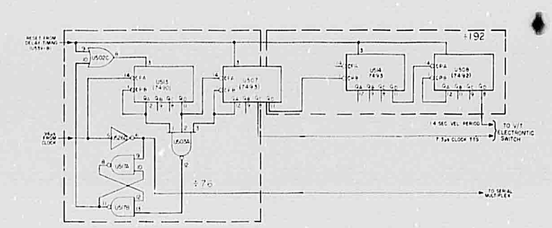


FIGURE 3-57. ÷76 AND ÷192 COUNTER

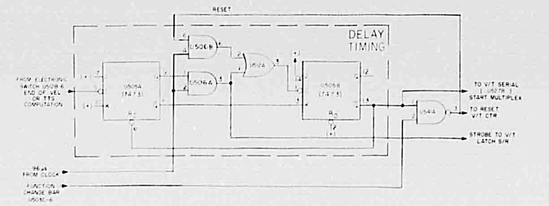


FIGURE 3-58. DELAY TIMING

3.7.14 Frequency Synthesizer Description, Continued

The basic synthesizer signal generator is Q705, the voltage controlled oscillator (VCO) shown in Figure 3-43. When the pilot sets his frequency controls, the synthesizer logic produces a VCO control voltage that sets the VCO to the required operating frequency for that channel. The control voltage applied to the VCO determines the effective capacitance of voltage variable capacitor CR707. This capacitor and C717 are series connected across L704 to form a tank circuit, which determines the frequency of the VCO. The following describes synthesizer operation when channel 26 (VOR 108.9 MHz, the transmitter 1050 MHz, and synthesizer 350 MHz) is selected.

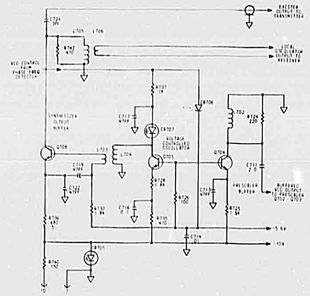


FIGURE 3-43. VCO AND BUFFER AMPLIFIERS

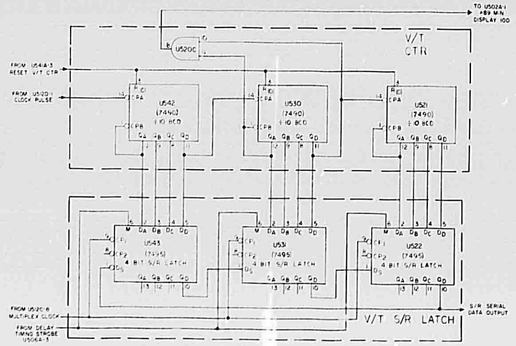


FIGURE 3-59. VF L/TTS COMI TE AND SHIFT REGISTER

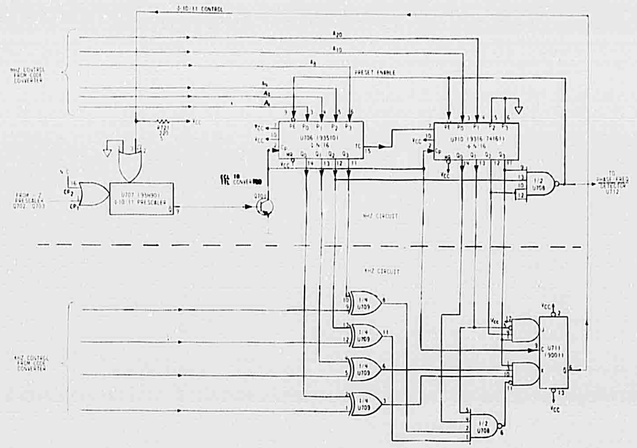


FIGURE 3-45. ÷ N AND ÷10 FREQUENCY DIVIDERS

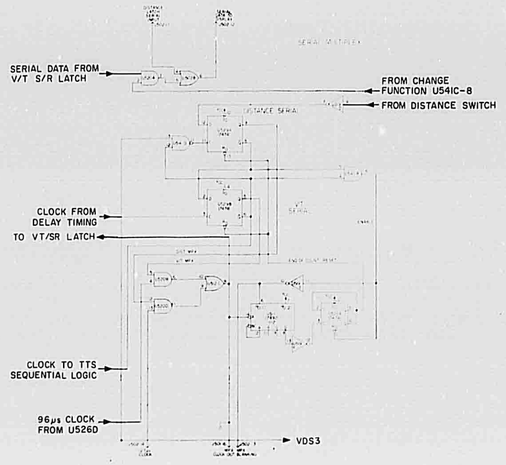


FIGURE 3-60. SERIAL MULTIPLEX

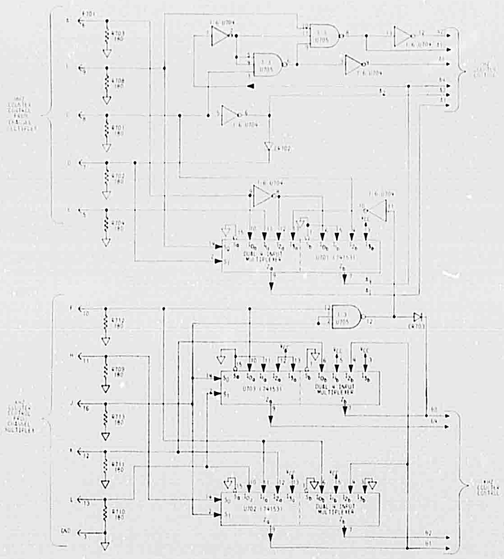


FIGURE 3-47. CODE CONVERTER, SCHEMATIC DIAGRAM

3.7.16.2 Serial Multiplex, Continued

Velocity and Time-To-Station (TTS) Modes:

After velocity or TTS data is entered into the V/T S/R Latches the resetting of the display timing circuit U529B, the V/T Serial. Logic "1" at U529B's D input will appear at the Q output to enable U520B. This allows the inverted, by U520D, 96 microsecond clock to drive the V/T Shift Register Latches and ÷ 12 Counter. Similar to as in the distance mode, twelve clock pulses serially remove the BCD data from the V/T S/R and through U520A and U502B enter the data into the display Shift Registers. The distance and V/T serial are then reset to await either a VDS3 pulse or a reset clock from the delay timing circuit.

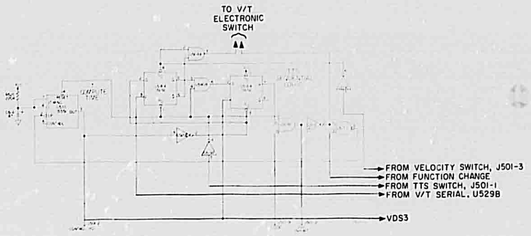


FIGURE 3-61. T COMPUTE TIME AND TTS SEQUENTIAL LOGIC

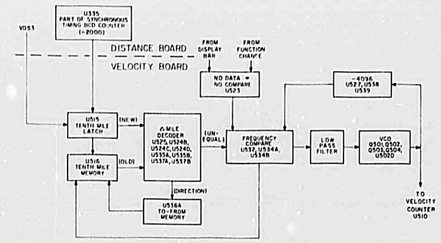


FIGURE 3-50. VELOCITY LOCKED LOOP

3.7.16 Velocity Locked Loop, Continued

If distances stored in the latch and memory are different, a logic 1 will occur at U537A-3; Table 3.11 provides the △Mile Decoder logic states. NAND gate U537D is enabled by the logic 1 from U537A and the logic 1 from the $\overline{Q}$ output of U534B, to clock U534B. U534B is a one shot multivibrator with its period determined by C512 and R521. When clocked, its $\overline{Q}$ output goes low inhibiting gate U537D for one period. The Q output of U534B goes high clocking the tenth mile memory, U516. U516 is a four bit, up-down counter, the direction of counting dependent upon the logic level at its pin 5. Pin 5 is connected to the to-from memory, U536A, which remembers the direction in which the aircraft was flying. When clocked U516 will change one count, up or down (if pin 5 is low it counts up, if high it counts down). The △Mile Decoder will again add the latch and tenth mile memory distances and if unequal will again fire U534B to clock U516.

This cycle continues until the BCD distances in U515 and U516 differ by 0.1 mile. If the direction of flight agrees with that stored in the to-from memory the previously described cycle will continue until latch and memory distances are equal: velocity may then be computed. If however the direction of flight does NOT agree with that stored in the to-from memory a shift pulse is generated at U535B-10, and a direction logic change occurs at U524D-6. The shift pulse clocks U536A to enter the new direction; refer to Table 3.11; the $\overline{Q}$ output state of U536A changes to direct U516 to count in the opposite direction. The shift pulse also clocks U536B, the serial converter. A change in direction is detected by the serial converter enabling NAND gate U537C. U537C's output goes low resetting U534B and entering the new tenth mile latch data into the tenth mile memory by addressing U516's $\overline{PE}$ port.

At this point the to-from memory is in the proper state for the direction of flight and velocity may be computed.

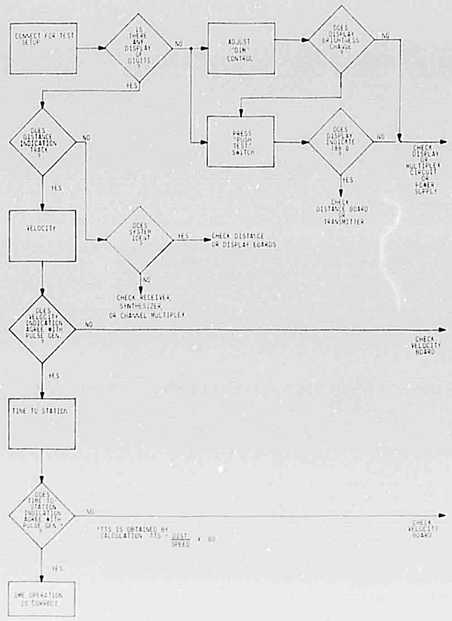


FIGURE 4-7. DME 195 FUNCTIONAL CHECKOUT FLOW CHART

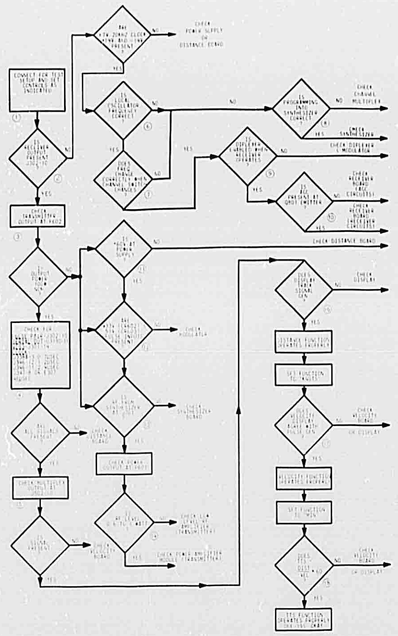


FIGURE 4-8. DME 195 TROUBLE ISOLATION FLOW CHART

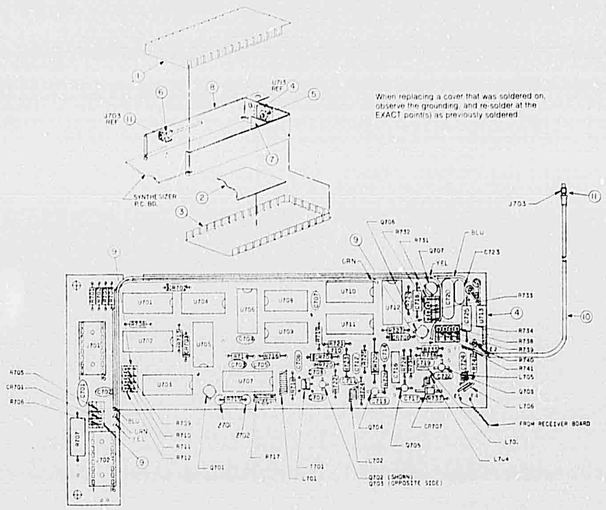
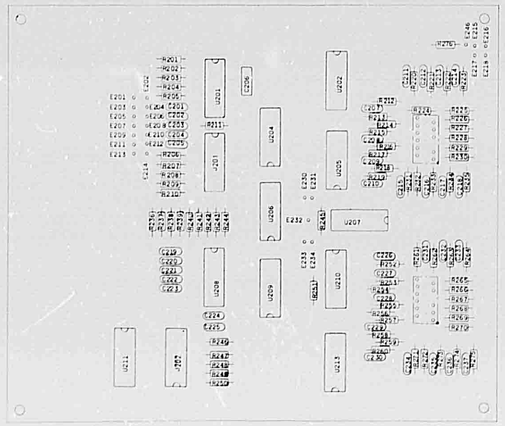


FIGURE 5.9 SYNTHESIZER PC BD ASSY

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.8	01215-0101	CHANNELING MULTIPLEX PC BD ASSY (See Figure 5.1	
		, Item -16 for Next Higher Assembly.	Ref
-1	42077-0101	PROGRAMMING CARD.	2



C-57941-B

FIGURE 5.8 CHANNELING MULTIPLEX PC BD ASSY

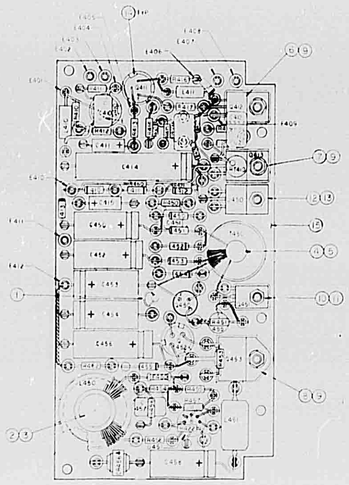


FIGURE 5-10 POWER SUPPLY ASSY

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER		DESCRIPTION	QTY
5.4	57793-0101		MODULATOR BRACKET ASSY (See Figure 5.2, Item -4 for Next Higher Assembly).	Ref
-1	21563-0001	C401	CAPACITOR, Tantalum, 80 mf, 60v	1
-2	24052-0560	C402	CAPACITOR, Mica, 56 pf P/M 5%, 300v	1
-3	75047-0007	CR401	DIODE, Zener, 51v P/M 1%	1
-4	11451-0050	L401	CHOKE, 330 mh P/M 5%	1
-5	31192-0101	R401	RESISTOR, Fixed, Comp, 100 P/M 10%, 1/4w	1
-6	31192-0102	R402	RESISTOR, Fixed, Comp, 1K P/M 10%, 1/4w	1
-7	75639-0004	Q401	TRANSISTOR, SiHcon, SELECTED 2N6388	1
			(Attaching Parts)	
-8	82814-0003		SCREW, Mach, Bind Hd, 4-40 x 1/4	1
	81335-0013		INSULATOR, Shoulder	1
	81324-0004		LOCKWASHER, Split, #4	1
	82900-0003		NUT, Hex, 4-40	1
-9	57790-0101		BRACKET	1

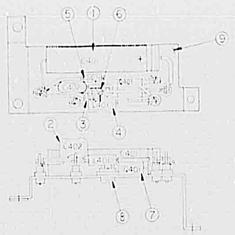
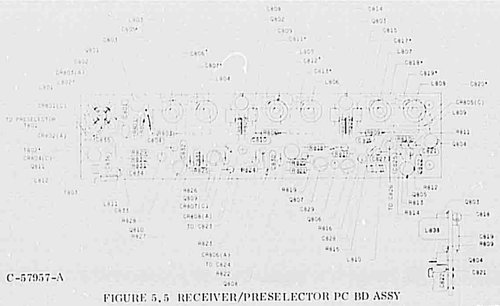


FIGURE 5.4 MODULATOR BRACKET ASSY

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION	QTY
5.5	01216-0101	RECEIVER/PRESELECTOR PC BD ASSY (See Figure 5.2, Item -6 for Next Higher Assembly)	Ref
-1	57917-0102	PRESELECTOR.	1
-2	57735-0001	COVER	1
-3	57749-0001	SPACER	1
-4	57789-0001	CLAMP, Shielding	2
-5	81211-0003	SPACER	2
-6	81218-0001	SPACER	1
-7	99065-0004	TAPE, Double Sided	1
-8	57761-0002	SHIELD, Receiver	1
-9	57762-0002	COVER, Top	1
-10	57762-0001	COVER, Bottom	1
-11	57955-0001	SHIELD, Can	6
-12	57948-0001	STRAP.	3
-13	99065-0007	TAPE, Double Sided.	3
-14	90058-0001	CABLE, Coax, RG 188 A/U	AR
-15	82892-0002	SCREW, Mach, Pan Hd, 4-40 x 3/16	3
-16	82892-0003	SCREW, Mach, Pan Hd, 4-40 x 1/4.	4
-17	82826-0002	SCREW, Mach, Round Hd, 3-48 x 3/16	4
-18	82802-0003	LOCKWASHER, Int. Tooth, #4	7
-19	82802-0033	LOCKWASHER, Int. Tooth, #3	4



C-57957-A

FIGURE 5.5 RECEIVER/PRESELECTOR PC BD ASSY

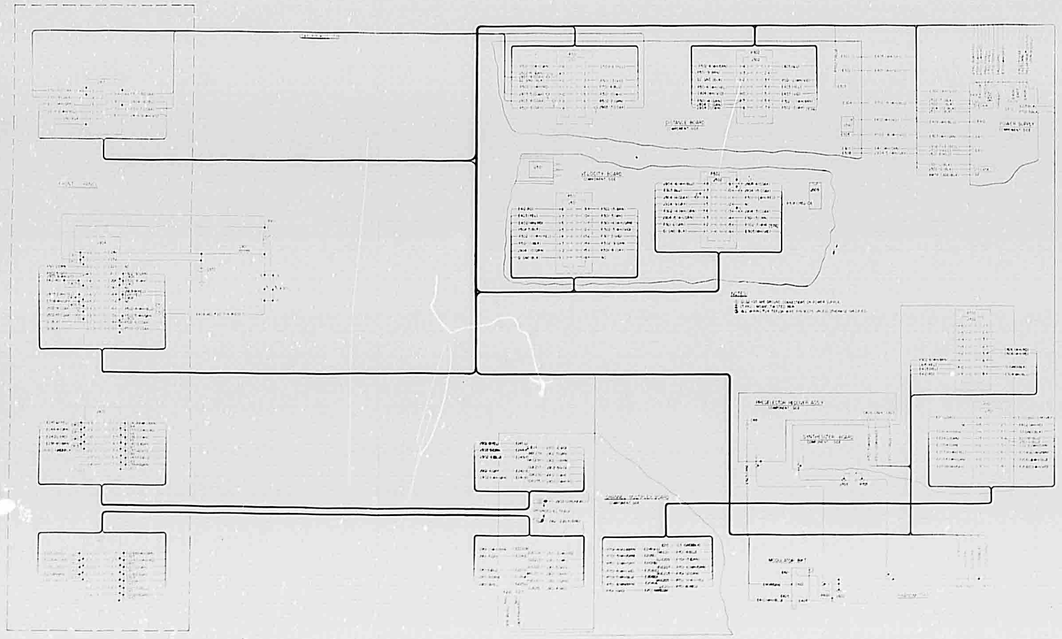


FIGURE 5.14 DME 195 INTERNAL WIRING DIAGRAM

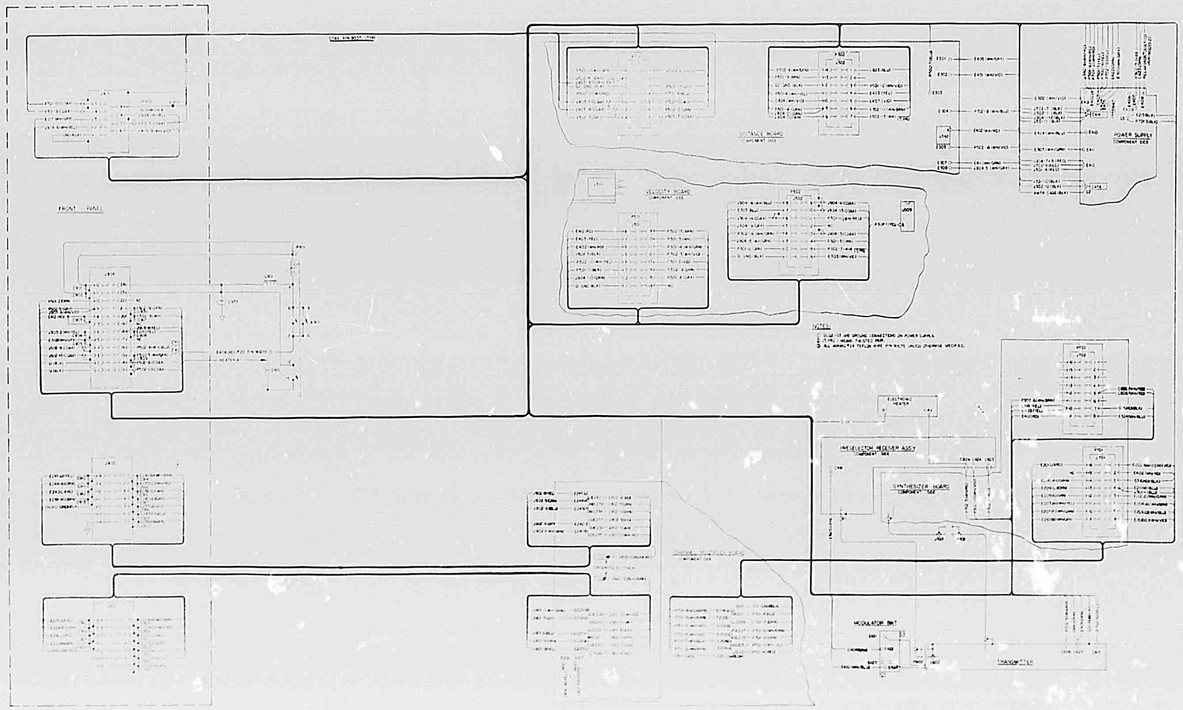


FIGURE 5-14A DME-195 INTERNAL WIRING DIAGRAM (B) CHASSIS

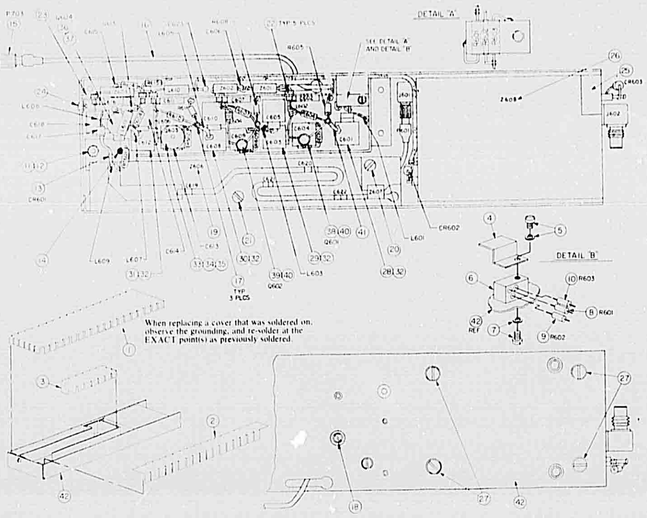
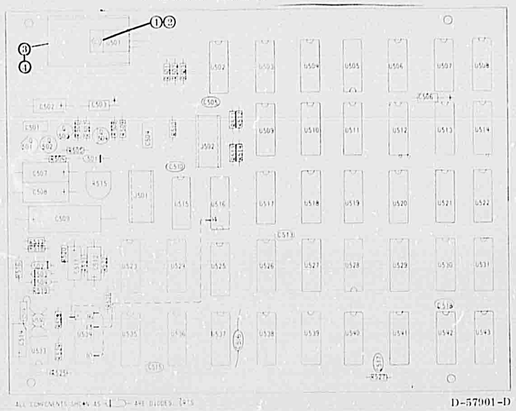


FIGURE 5.6 TRANSMITTER PC BD ASSY

MECHANICAL PARTS LIST

FIGURE AND INDEX NUMBER	PART NUMBER		DESCRIPTION	QTY
5.7	01211-0101		VELOCITY PC BD ASSY (See Figure 5.1, Item -10 for Next Higher Assembly)	Ref
-1	74039-0002	U501	IC, Voltage Regulator, 5v	1
			(Attaching Parts)	
-2	82892-0003		SCREW, Mach, Pan Hd, 4-40 x 1/4	1
	82900-0003		NUT, Hex, 4-40	1
-3	57791-0001		HEATSINK	1
			(Attaching Parts)	
-4	82845-0002		SCREW, Mach, Flat Hd, 2-56 x 3/16	1
	82900-0001		NUT, Hex, 2-56	1



D-57901-D

FIGURE 5.7 VELOCITY PC BD ASSY

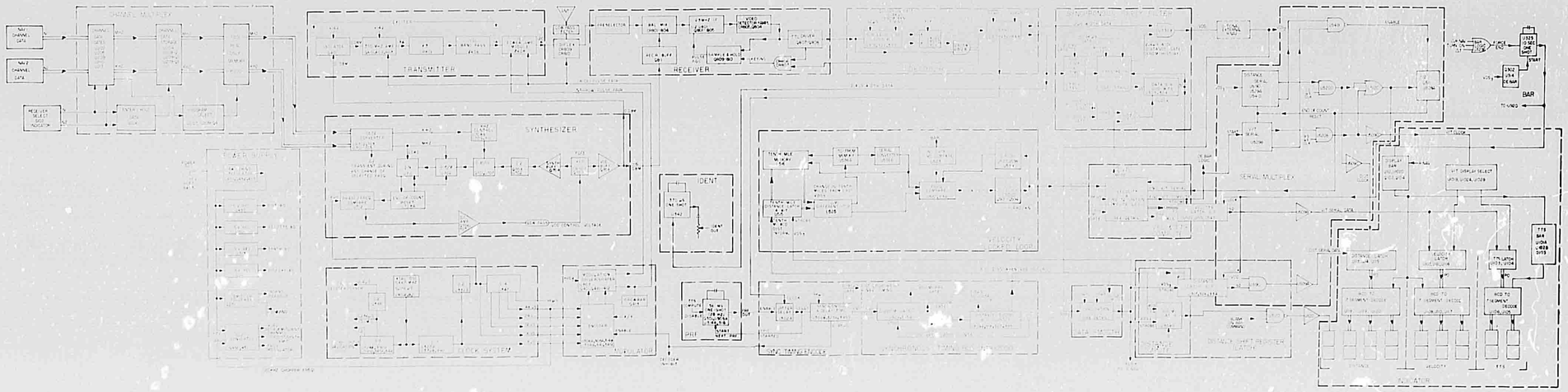


FIGURE 6-1. DME 195 SYSTEM BLOCK DIAGRAM

FIGURE 6-2. DME 195 INDICATOR SCHEMATIC

DISTANCE PC BOARD

FIGURE 6-3. DME 195 CHANNEL MULTIPLEX SCHEMATIC

FIGURE 6-4. DME 195 DISTANCE SCHEMATIC

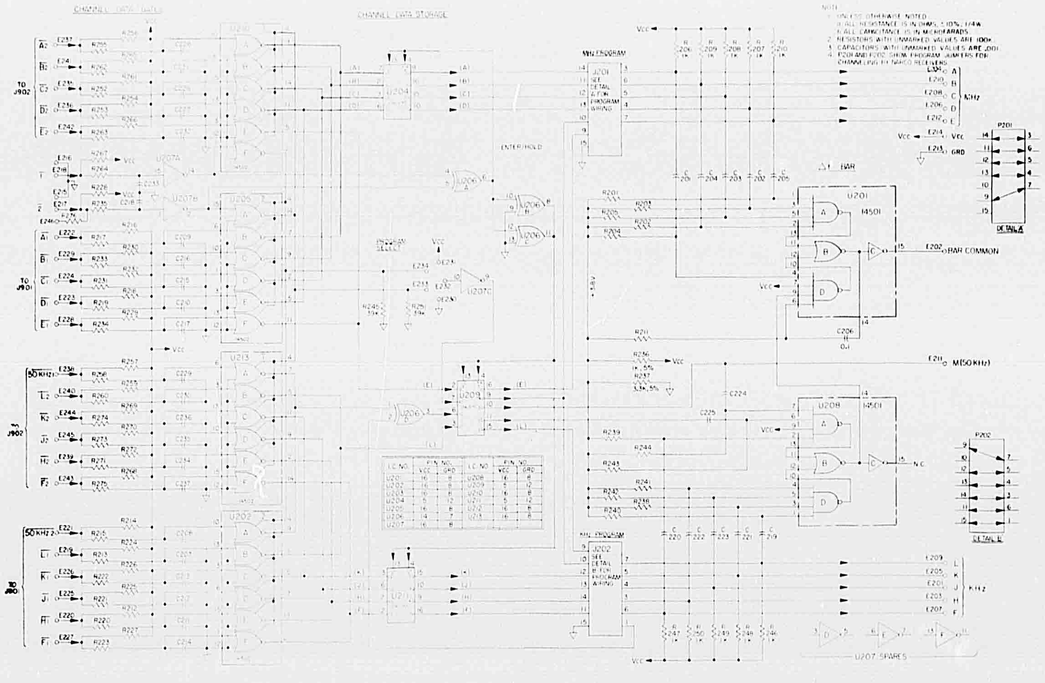
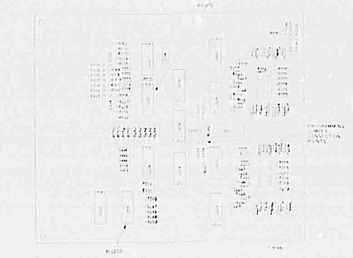
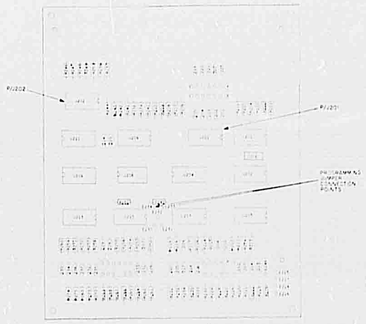


FIGURE 6-3A DME-195 CHANNEL MULTIPLEX SCHEMATIC (A) CHASSIS

These assemblies are electrically identical.



Component Assembly Early Models



Component Assembly Later Models

FIGURE 6-3A (Sheet 2) DME-195 CHANNEL MULTIPLEX

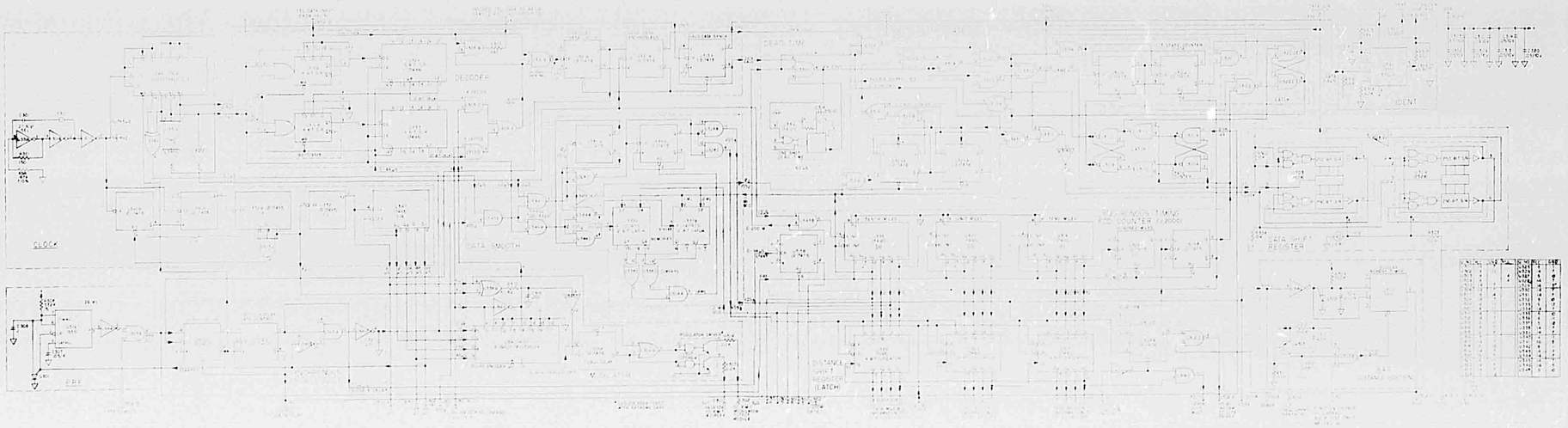


FIGURE 6-4A DME-195 DISTANCE SCHEMATIC (A) CHASSIS

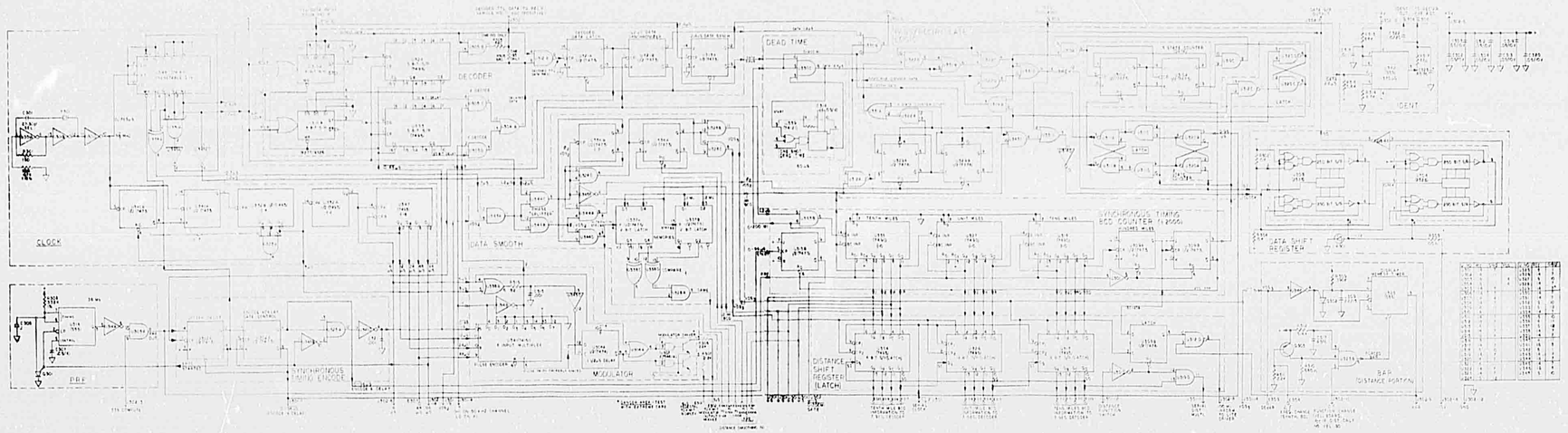
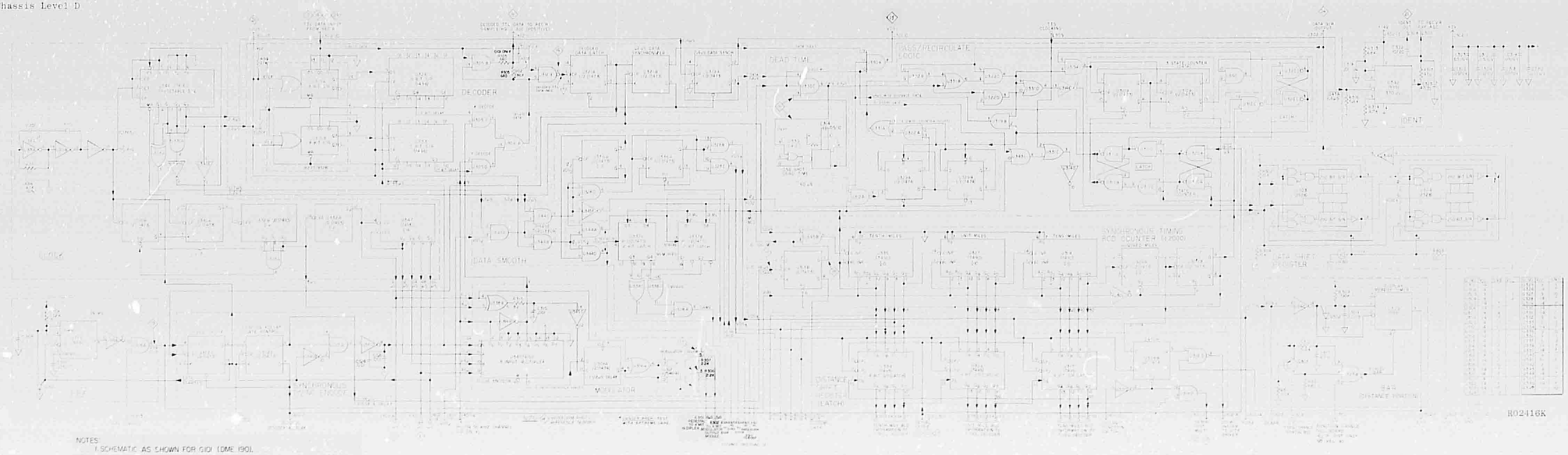


FIGURE 6-4B DME-195 DISTANCE SCHEMATIC (A) CHASSIS

Chassis Level Code JA D DADBAB

This schematic is to update the distance board to Chassis Level D and contains only minor changes.



"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

NOTES
1. SCHEMATIC AS SHOWN FOR GIO1 (DME 190).
2. FOR GIO2 (DME 195/190 TSO) CHANGE R305 CONNECTIONS AS SHOWN. DELETE R319 AND C324, NO EXTERNAL CONNECTION AT E306.

DME 195 DISTANCE SCHEMATIC

RO2416K

FIGURE 6-4E. DME 195 DISTANCE SCHEMATIC (Chassis Level D)

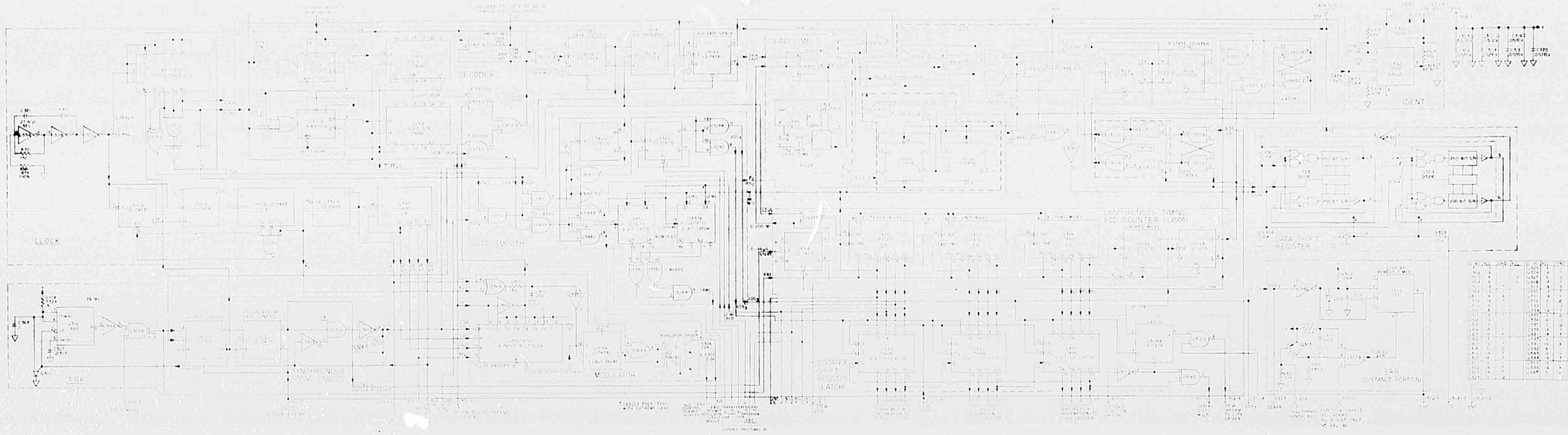
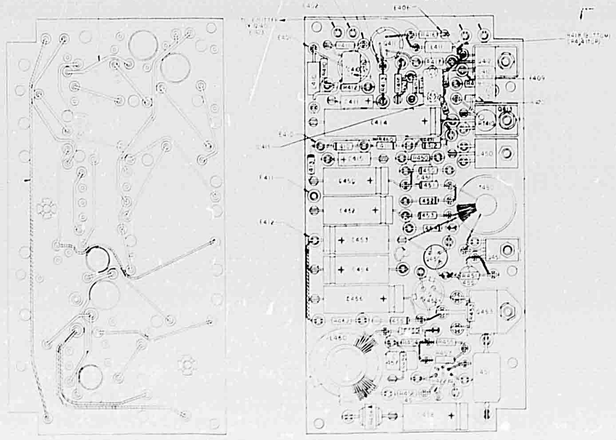
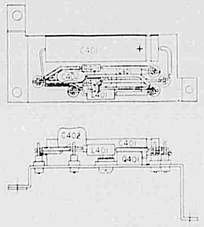


FIGURE 6-4C DME-195 DISTANCE SCHEMATIC (B) CHASSIS



POWER SUPPLY ASSY



MODULATOR ASSY B-57793-E

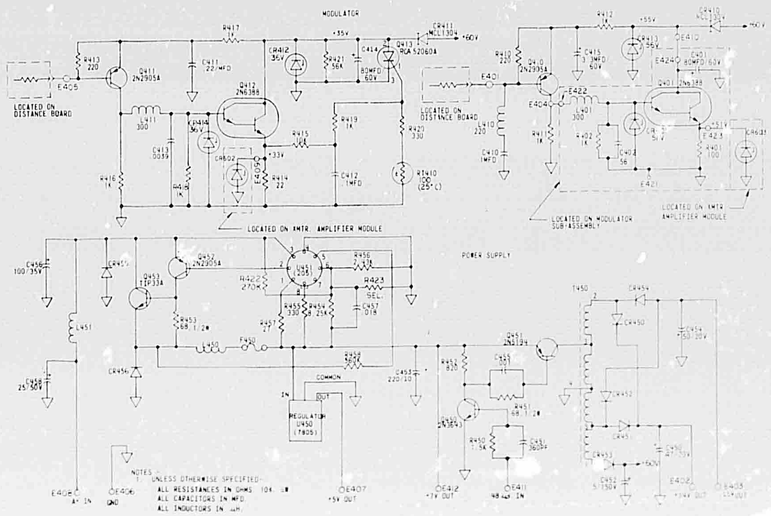


FIGURE 6-5. DME 195 POWER SUPPLY AND MODULATOR SCHEMATIC

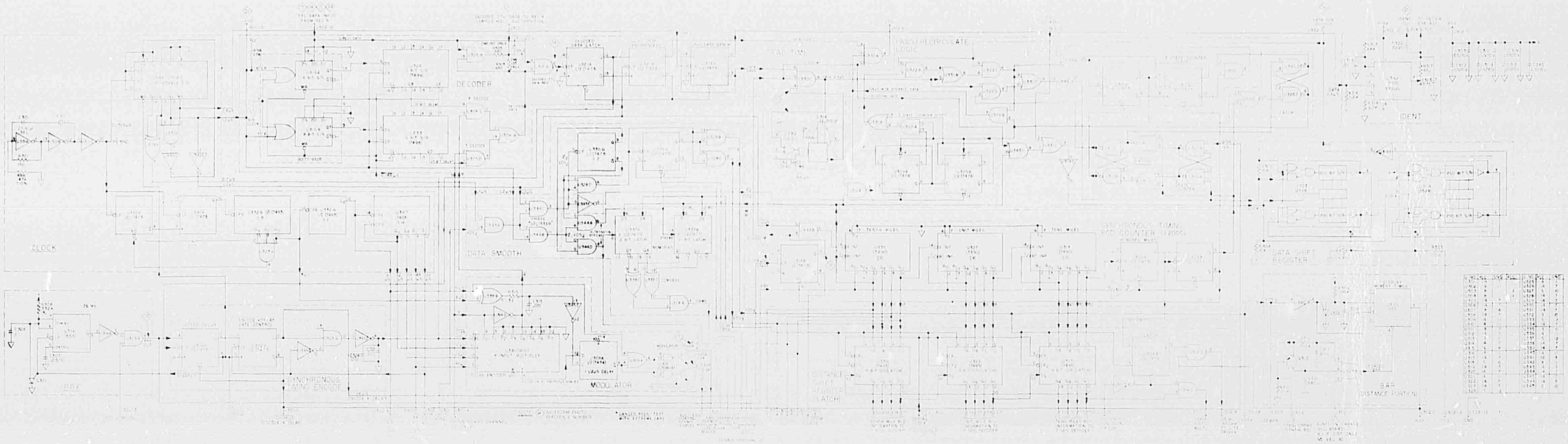


FIGURE 6-4D DME-195 DISTANCE SCHEMATIC (C) CHASSIS

NARCO AVIONICS DME 195

VELOCITY PC BOARD

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.

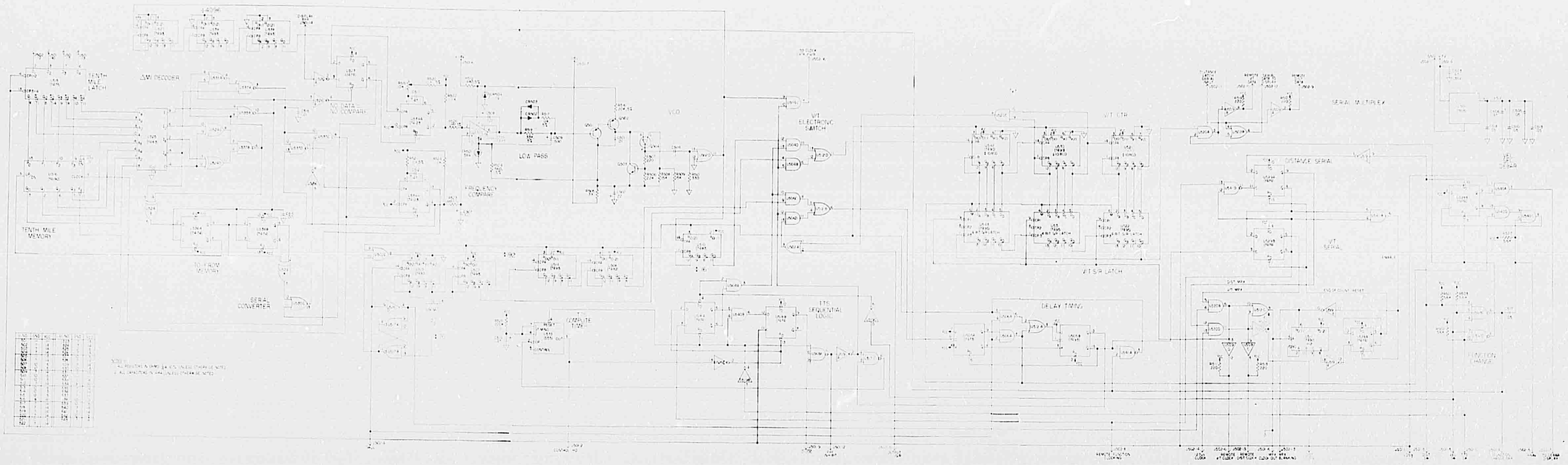


FIGURE 6-6. DME 195 VELOCITY SCHEMATIC R02465-B

Chassis Level JADDAO B AB
This change will improve operation at temperatures below -50°F.

Changed: CR705 to 75025-0012 DIODE, Zener, ±2%, 10V

Chassis Level JADDAD C AB
This change will permit use of the Plessey SP640 or Fairchild 11C90 in U707 slot

Added: R743 31192-0471 RESISTOR, Fixed Comp, 470 ±10%, 1/4W
95H90 to 11C90

Chassis Level JADDAD D AC
This change will improve operation at extremely high temperatures.

Changed: L701 to 11713-0005 RF COIL, 7½ turns, .080 dia., #24 wire

Chassis Level JADDAG E AC
This change will accomodate a change in vendors for Q708

Changed: Q708 to 75629-0002 TRANSISTOR, RF, NPN, MMT2857

Chassis Level JADDAJ F CC
This change will improve the balance between transmitter and receiver

Changed: L705 to 11713-0019 RF COIL, 5½ turns, .080 dia., #24 wire

Added: C726 24552-1689 CAPACITOR, Ceramic, 6.8 pF ±.5 pF, 50V

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

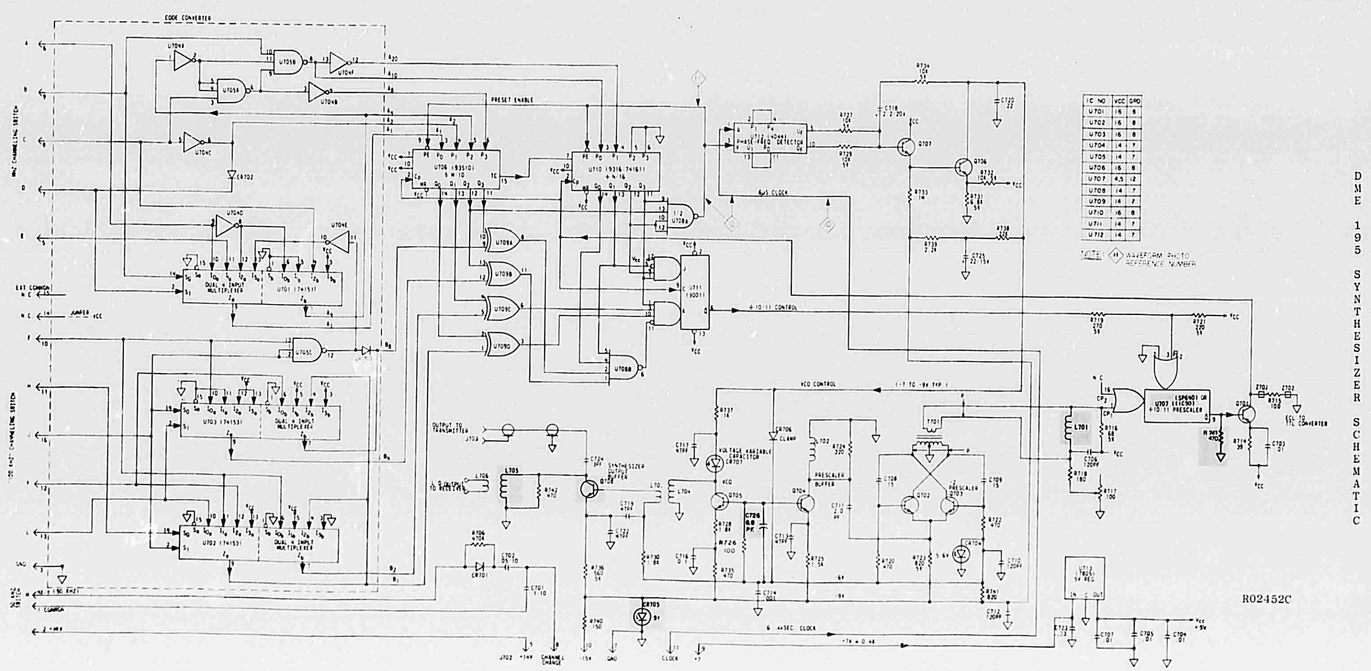


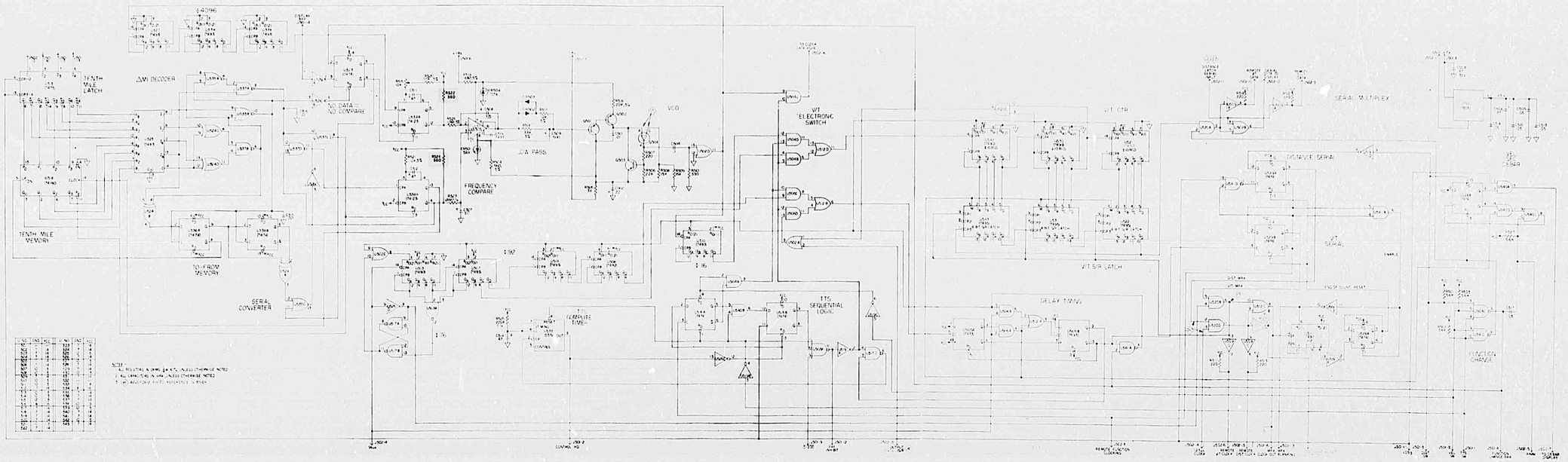
FIGURE 6-8A. DME 195 SYNTHESIZER SCHEMATIC
(Chassis Levels B,C,D,E, and F)

R02452C

Chassis Level JADDAJFC C B
This change will improve velocity accuracy at very low speeds

Changed: R522 to 31192-0561 RESISTOR, Fixed Comp, 560 ±5%, 1/4W
R524 to 31192-0561 RESISTOR, Fixed Comp, 560 ±5%, 1/4W

"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."



DME 195 VELOCITY SCHEMATIC

FIGURE 6-GA. DME 195 VELOCITY SCHEMATIC
(Chassis Level C)

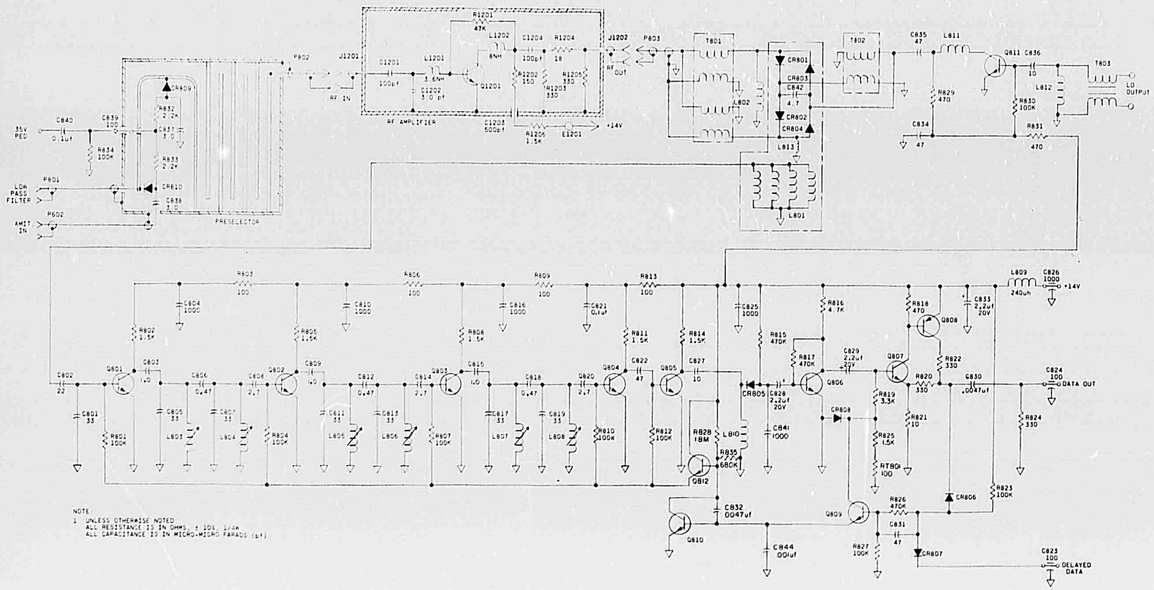
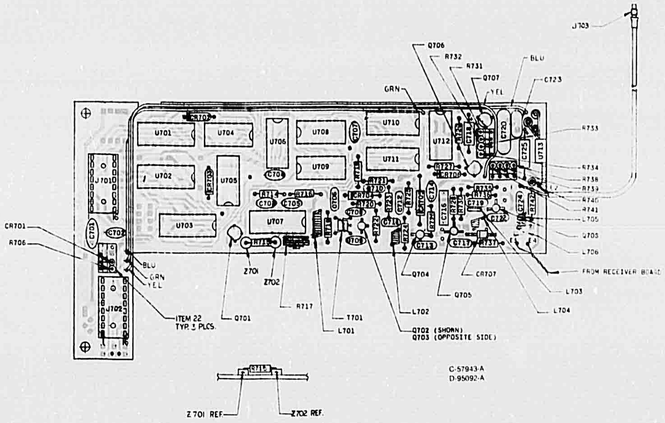


FIGURE 6-9A DME-195 RECEIVER/PRESELECTOR SCHEMATIC (A) CHASSIS



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

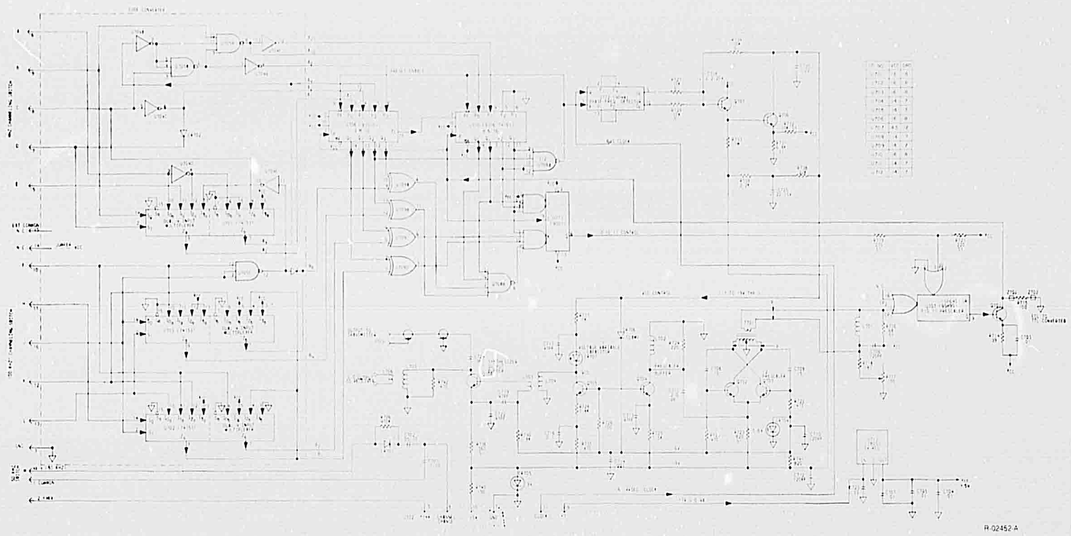
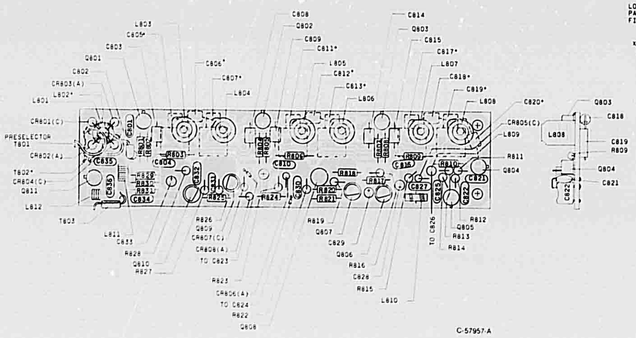


FIGURE 6-8. DME 195 SYNTHESIZER SCHEMATIC

NARCO AVIONICS DME 195

SCHEMATICS
SECTION 6



Solder runs shown in GREY
are those on the "BOTTOM" (non-component)
side of the board

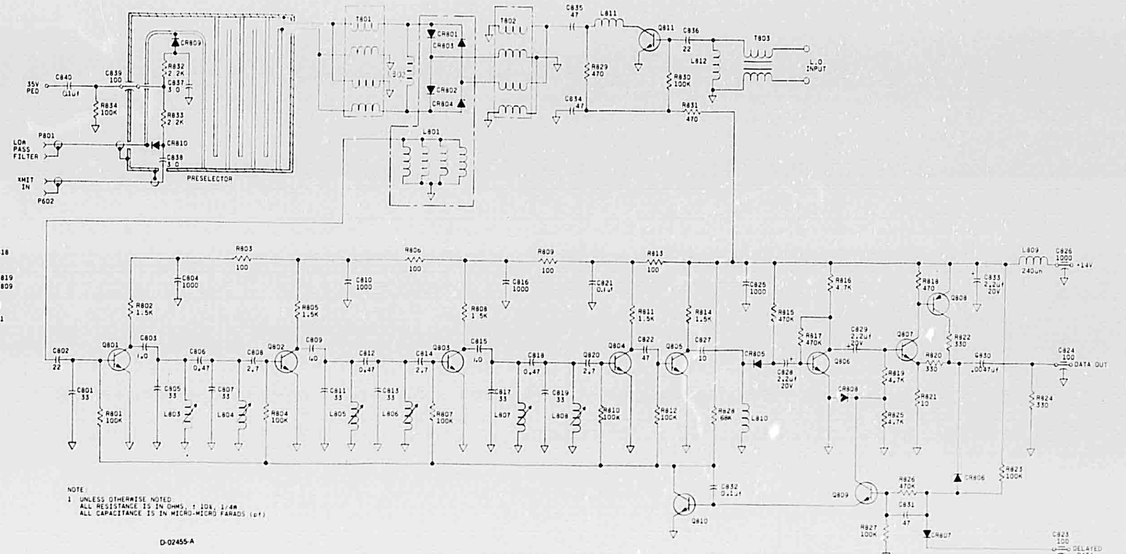


FIGURE 6-9. DME 195 RECEIVER/PRESELECTOR SCHEMATIC

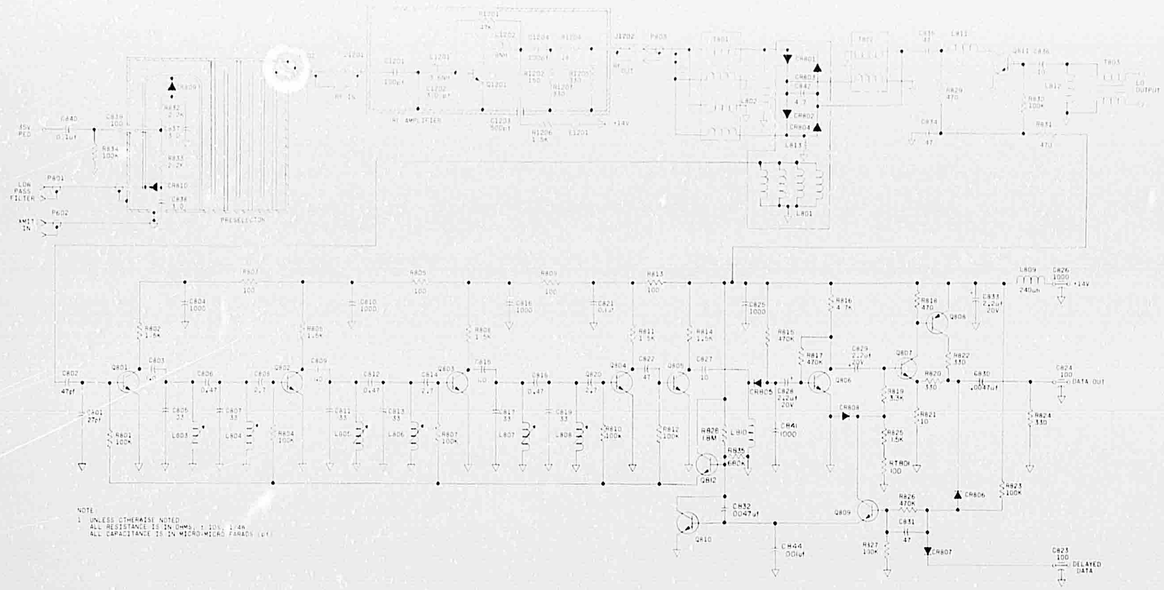


FIGURE 6-9B DME-195 RECEIVER/PRESELECTOR SCHEMATIC (B) CHASSIS

Chassis Level Code HACDA C BAB
These changes will improve signal rejection

Changed:	C821	21291-0019	CAPACITOR, Ceramic, 1000 pF ±10%, 500V
	C832	Location	
Added:	C845	23107-0125	CAPACITOR, Mylar, .01 mF ±10%, 100V
	C846	23107-0125	CAPACITOR, Mylar, .01 mF ±10%, 100V
	R836	31192-0181	RESISTOR, Fixed Comp, 180 ±10%,1/4W
Deleted:	C841 and C844		

Chassis Level Code HACDA D BAB
These changes will eliminate the possibility of IF regeneration

Changed:	C828	21555-0044	CAPACITOR, Tantalum, .47 mF ±20%, 35V
Added:	C841	24516-0100	CAPACITOR, Ceramic, 10 pf ±10%, 500V
	L814	11485-0034	CHOKE, 56 uh ±10%

Chassis Level Code JADDA E DAC
These changes will improve receiver sensitivity

Changed:	R1206	31218-0821	RESISTOR, Fixed Comp, 820 ±5%, 1/4W
	C1201	24551-0004	CAPACITOR, Ceramic, 2.9 pF, 50V
Deleted:	R1203, R1204 and R1205		

Chassis Level Code JADDA F EAC
This change will inhibit a double VDS1 Pulse

Changed:	C830	23107-0107	CAPACITOR, Mylar, .0033 mF

Chassis Level Code JADDA G FAC
This change will improve Power Out

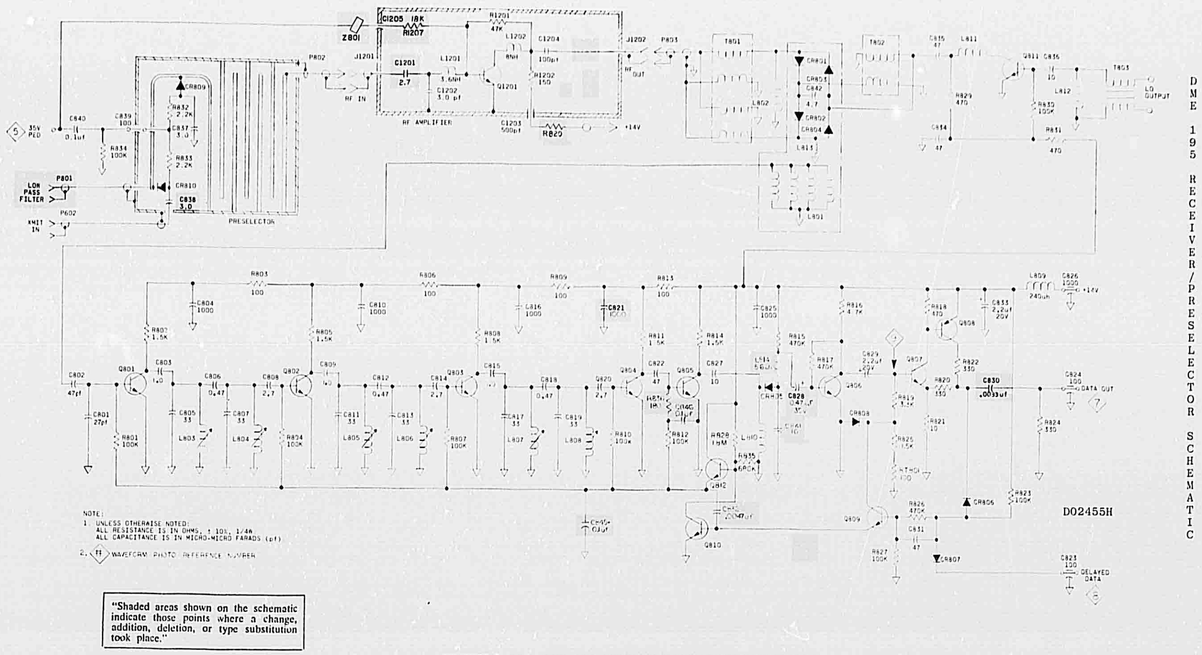
Changed:	C838	24054-0409	CAPACITOR, Mica, 4.0 pF ±5%, 300V

Chassis Level Code JADDA H FBC
These changes will reduce spurious sidebands

Changed:	R1206 to R820		
Added:	Z801	11454-0001	Ferrite Band
	R1207	31218-0183	RESISTOR, Fixed Comp, 18K ±10%, 1/4W
	C1205	21296-0002	CAPACITOR, Feedthru, 500 pF

Chassis Level Code JADDA J FBC
This change deletes the low pass filter to increase transmitter power output

Changed:	Item 52 from	57938-0104	Low Pass Filter
	to	57977-0102	Connector Assy



"Shaded areas shown on the schematic indicate those points where a change, addition, deletion, or type substitution took place."

FIGURE 6-9C. DME 195 RECEIVER/PRESELECTOR SCHEMATIC
(Chassis Level C, D, E, F, G, H,and J)