TM-8042300506

OPERATION AND
MAINTENANCE MANUAL

AIRBORNE AUTOMATIC ANTENNA COUPLER

ACU-150A

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WARNING

WITH CERTAIN TYPES OF ANTENNAS, SEVERAL KILOVOLTS MAY BE PRESENT AT THE OUTPUT, E3 OR J6, OF THE ANTENNA COUPLER WHEN TRANSMITTING. THE RADIO OPERATOR AND SERVICE TECHNICIAN SHOULD EXERCISE CAUTION NOT TO CONTACT E3 OR J6 WHILE TRANSMITTING. (E3 IS THE OUTPUT OF THE H-N ADAPTOR.)

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SECTION 1
GENERAL INFORMATION

1.1 SCOPE

This maintenance manual contains information necessary to install, operate, maintain and repair the ACU-150 Automatic Antenna Coupler.

1.2 DESCRIPTION

1.2.1 GENERAL

The ACU-150 Automatic HF Antenna Coupler is a small, light weight unit designed to be installed in aircraft, vehicles, base stations or any location protected from direct exposure to the elements. It is compatible with all Sunair airborne HF/SSB transceivers (except the ASB-850 which contains an integral coupler). It will tune a wide variety of commonly used antennas over the frequency range of 1.6 to 30 MHz without the necessity of adding external reactive components (inductors or capacitors) to the antenna.

All circuitry is fully transistorized and mounted on plug-in printed circuit boards for ease of maintenance and repair. The tunable reactive components are driven by reliable d-c servo motors controlled by solid-state power-derated servo amplifiers to insure high reliability.

No frequency or band information from the transmitter is required as the coupler tunes solely from information contained in the r-f input signal. The tuning cycle is fast, averaging 3 seconds, and the transmitter output is fully protected during tuning by a 3 dB 50 ohm resistive load.

Operation of the ACU-150 Coupler requires only the initiation of a "Tune" command. When tuning has been completed (minimum VSWR of the antenna at the selected frequency), the Green light on the panel indicates the transceiver is ready for use. The ACU-150 continuously monitors the antenna VSWR when transmitting. If the antenna becomes untuned during operation (VSWR exceeds 1.5:1), a Red fault indication will light on the panel and the operator repeats the tune cycle.

The ACU-150 coupler will tune a wide variety of antennas. The resulting communications capability is dependent upon several factors: frequency, antenna Q, antenna radiation efficiency and coupler efficiency. These factors must all be considered when installing the system, particularly the antenna. For a detailed discussion of antenna installations, refer to section 2.8.

The ACU-150A ( ) contains plug in assembly 3A8A2 part number (8042385099) that conditions the ACU-150 for use with the ASB-320, ASB-130, ASB-125/60, ASB-100A or ASB-500.

When using the ASB-320, ASB-130, ASB-125/60, or the ASB-100A, the "Tune" pulse is generated by channeling the companion transceiver and momentarily depressing the microphone push to talk button. When using the ASB-500, the "Tune" pulse is generated by depressing the TUNE button in the control head.

1.2.2 AUTOMATIC ANTENNA COUPLER SUBASSEMBLIES

The following subassemblies are contained in the Antenna Coupler.

1.2.2.1 PHASE AND AMPLITUDE DETECTOR PAD, (3A1A1), part number 8033313099

This plug in assembly provides the phase and amplitude error voltages along with the reflected power output. It also contains the 3 DB PAD to provide a 50 ohm load for the transmitter while the unit is tuning.

1.2.2.2 CONTROL LOGIC (3A2), part number 6035010083

This plug in PC board contains circuitry for initiating a TUNE cycle, terminating a TUNE cycle and detecting reflected power. It also has a time delay circuit for shutting off the unit if it does not tune correctly.

1.2.2.3 PHASE AND AMPLITUDE CONTROL (3A3), Sunair part number 6035020089

This plug in PC board contains the phase and amplitude servo preamplifiers and drives the SERVO AMPLIFIER (3A5). The inputs to 3A3 are provided by 3A2 and switches in the L4 and the C1 assemblies.

1.2.2.4 C3 AND C6 CONTROL (3A4), part number 8033340096

This plug in PC board contains the logic circuitry for controlling the switching of the C3 and C6 assembly.

1.2.2.5 SERVO MOTOR CONTROL (3A5), part number 8033350091

This plug in PC board and heat sink control the operation of the two servo motors in the unit. One servo amplifier drives the variable inductor motor. The other servo amplifier drives the variable capacitor. The inputs to the servo amplifiers are provided by the PHASE AND AMPLITUDE CONTROL (3A3).

1.2.2.6 C3 AND C6 ASSEMBLY, part number 8033317094

This assembly contains two motors that switch transmitting capacitors in series or in shunt with the antenna. The operation of this assembly is controlled by (3A4).

1.2.2.7 L4 ASSEMBLY, part number 8033319097

This assembly contains a servo motor and a variable inductor with an inductance of 0.2 to 18 microhenries. It is used across the antenna and is one of the RF tuning elements.

1.2.2.8 C1 ASSEMBLY, part number 8033316098.

This contains the vacuum variable capacitor that has a range of 7 to 1000 picofarads. It is the series tuning element and is driven by a servo motor in the assembly.

1.2.2.9 FILTER-REGULATOR (3A8A2)

The 5V regulator, R.F. Detector, and oth control functions are located on this board.

1.2.2.10 CHASSIS ASSEMBLY (ACU-150)

The chassis assembly contains all the chassis wiring plus certain power resistors and a 12V chassis mounted regulator. It also contains the gain control used for setting the reflected power threshold for terminating the tune cycle. A shielded filter box is used around the input power connector to prevent RF from appearing on the control lines.

1.3 SPECIFICATIONS

Electrical and physical specifications of the Sunair ACU-150 Automatic HF Antenna Coupler are listed below.

1.3.1 GENERAL

FREQUENCY RANGE: 1.6 to 30 MHz

POWER CAPABILITY: 130 watts PEP, 100 watts Average.

INPUT VSWR: 1.3:1 typical, 1.5:1 maximum

INPUT IMPEDANCE: 50 ohms resistive, nominal

D.C. POWER INPUT: 27.5VDC, +10%-20% 3 Amps Tuning. 1.1A Transmitting or Standby.

ENVIRONMENTAL:

TSO DESIGN: C-31c and C-32c, Category BAAAAX

ALTITUDE: 30,000 Ft (TSO Category B)

TEMPERATURE: -46°C to +55°C (TSO Category B)

HUMIDITY: 95% at +50°C

VIBRATION: 10 to 500Hz at 5G (TSO Category A)

SHOCK: 6G in all planes, 15G Crash Safety

DIMENSIONS: ½ ATR Case

4.875W x 7.625H x 15L (IN)
12.38W x 19.37H x 38.10L (CM)
Add 1.625 IN H (4.13 CM) for Shockmount.

WEIGHT: 15.8 lbs (7.2 kg); 17.5 lbs (8.0 kg) including Shockmount.

ANTENNA MATCHING CAPABILITY:

Wire: 8 ft to 80 ft (2.44 m to 24.4 m), grounded and ungrounded, V and longwire.

Whip: 8 ft (2.44 m) and longer.

Integral Airframe: Shunt and Notch.

1.4 EQUIPMENT SUPPLIED

ACU-150A - Automatic Antenna Coupler (8042300093).

8042300506 Operation and Maintenance Manual (Includes Installation Procedure)

8042300891 Connector Kit consisting of:

- 8040001790 Shockmount Assembly
- 0742190005 Connector, RF input PL-259
- 0742070000 Reducing Adapter for PL-259 for use with RG-58A/u
- 1001320034 Control connector 26 pin Female (Includes reducing adapter and cable clamp)
- 0753160005 Rf Output connector, Type HN UG-59D/U
- 8042390700 connector HN adaptor.

0994670028 Light Panel – used when indicator lights not in control head.

8033390603 Ground Strap

1.5 EQUIPMENT REQUIRED, NOT SUPPLIED

1.5.1 Transceiver – Specify Type

1.5.2 Cable, Control – 8033007508
For use from ACU-150 ( ) to companion transceiver. Shielded and jacketed. 18 AWG#20 and 4 shielded wires.

1.5.3 Cable, Coaxial – 0588130001 RG-58A/U
For use from transceiver to ACU-150 ( ).

1.5.4 Cable, Coaxial – 0588640000 RG-8A/U
For use from J6, RF output of ACU-150 ( ) to antenna, if required.

1.5.5 Encapsulated Anti-Precipitation Static Wire Antenna Kit or Customer furnished antenna. 0951580001

1.5.6 Options – Connector, Sunair part number 0753970007, can be used to convert an existing SAC-69 installation for use with the ACU-150A( ). See Figure 1.2 for wiring instructions.

1.5.7 Extender card (to service P.C. boards) 8033393114

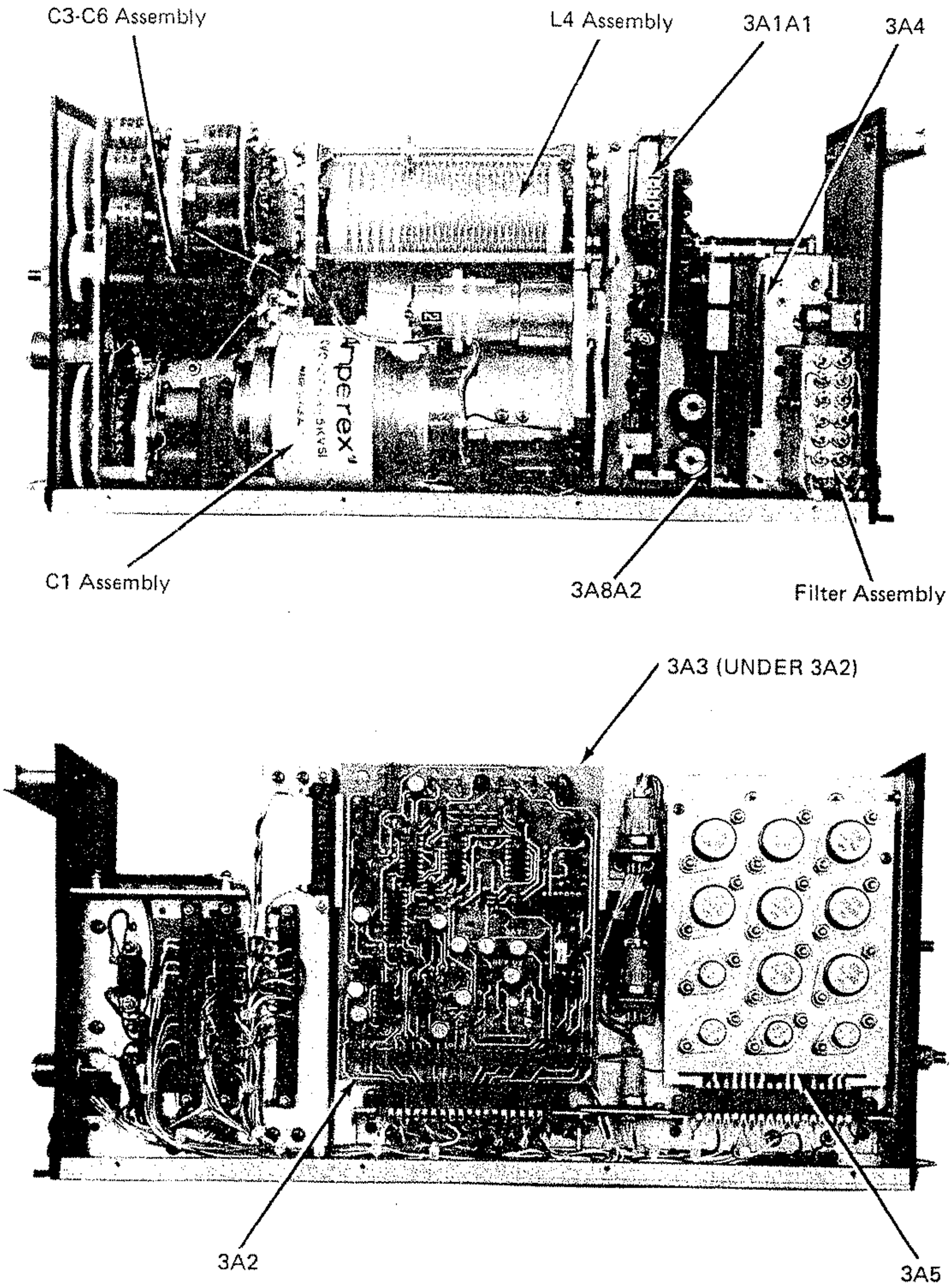

Figure 1.1 ACU-150, Major Assembly Locations

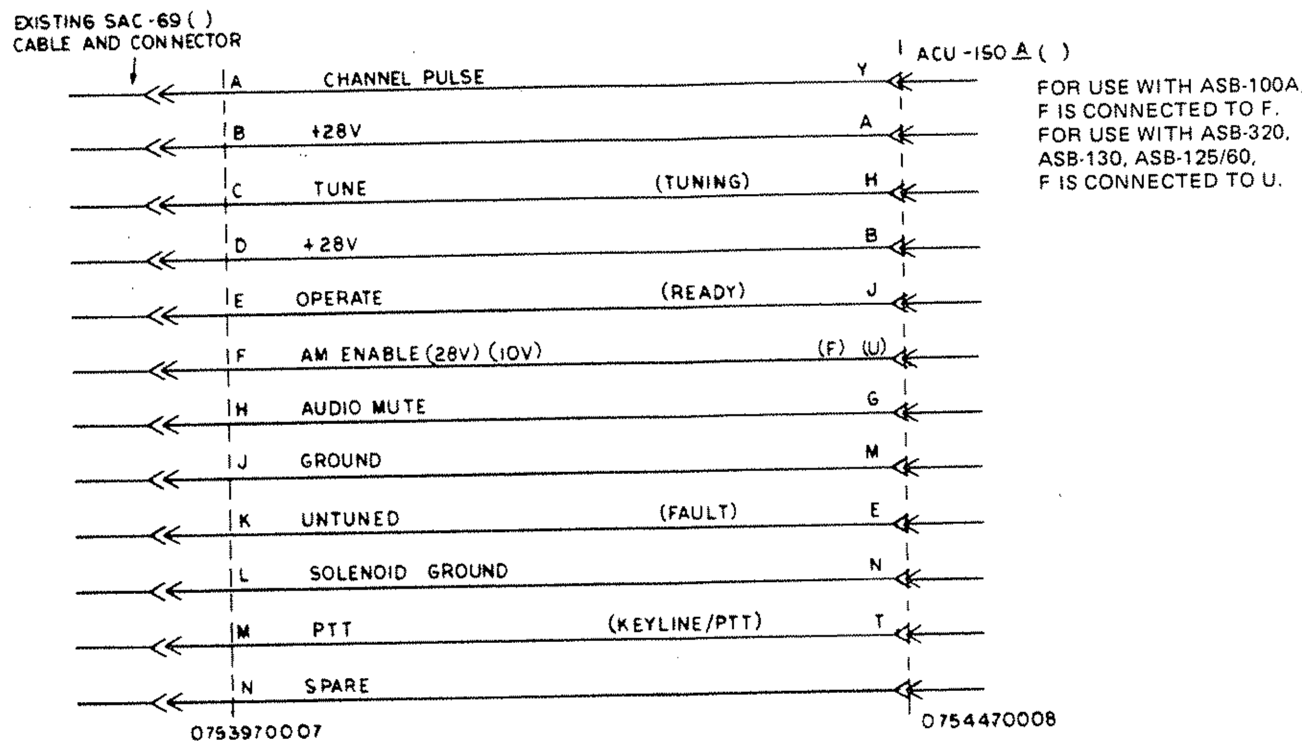

Figure 1.2 Adapter Cable SAC-69 to ACU-150A ( )

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SECTION 2

INSTALLATION

2.1 GENERAL

Section 2 contains all necessary instructions for the unpacking, inspection, and if necessary reshipping of damaged equipment or parts. In addition further information regarding location and mounting considerations, power requirements, antenna and ground system hook-ups, and final checkouts after installation, are also provided.

2.2 UNPACKING AND INSPECTION

Unpack and inspect all parts and equipment as soon as received.

NOTE

Be sure to retain the shipping carton and its associated packing materials should it be necessary to reship damaged equipment.

Do not accept a shipment where there are visible signs of damage to the cartons until a complete inspection is made. If there is a shortage or any evidence of damage is noted, insist on a notation to that effect on the shipping papers before signing the receipt from the carrier.

If concealed damage is discovered after a shipment has been accepted, notify the carrier immediately in writing and await his inspection before making any disposition of the shipment. A full report of the damage should also be forwarded to Sunair. Include the following:

(a) Order Number

(b) Model and Serial Number

(c) Name of Transportation Agency.

2.3 RESHIPPING INFORMATION

The shipping cartons for the ACU-150 have been carefully designed to protect the antenna coupler and accessories during shipment. This carton and its associated packing materials should be used to reship the coupler.

If the original shipping carton is not available, be sure to carefully pack each unit separately, using suitable cushioning material. Very special attention should be given to providing enough packing material around controls, connectors, and other protrusions from the unit. Rigid cardboard should be placed at the corners of the equipment to protect against damage if the carton is dropped.

When returning one or more subassemblies for repair, you must ship AIR PARCEL POST consigned to:

SUNAIR ELECTRONICS, INC.
3101 SW 3rd Avenue
Ft. Lauderdale, Florida 33315
U.S.A.

Plainly mark with indelible ink all mailing documents as follows:

U.S. GOODS RETURNED FOR REPAIR
VALUE FOR CUSTOMS – $100.00

and be sure to mark on all sides of the package

"FRAGILE – ELECTRONIC EQUIPMENT"

NOTE

Before shipping, carefully inspect the package to be sure it is marked properly and is securely wrapped.

2.4 GENERAL INSTALLATION AND MOUNTING INFORMATION

General installation procedures and mounting requirements are given for the ACU-150 antenna coupler. Satisfactory operation of this equipment will depend upon the care and thoroughness taken during installation.

2.4.1 GENERAL INSTALLATION

a. Carefully plan the antenna installation to minimize the length of wire between the coupler output and the antenna itself. This lead should be kept as short as physically possible. 6 inches or less is optimum, the wire inside the aircraft is a part of the antenna, but will radiate inside the fuselage, not outside. This energy may cause interference with other electronic equipment in the vicinity. This interference can often be reduced by using high voltage coaxial cable such as RG-8/U, between the coupler and the antenna feedthrough. The coax must be kept short because coax lengths longer than 3 feet can cause large losses, particularly at the antenna resonant and anti-resonant frequencies, when VSWR exceeds 10.

NOTE

Installation of the Antenna Coupler must conform to the Altitude/Temperature restrictions detailed in the equipment specifications.

b. The installations should be carefully planned beforehand in accordance with the drawings on the following pages.

2.5 POWER REQUIREMENTS

The ACU-150 is designed to operate from a nominal 27.5 VDC +10%-20% source. The input 27.5 VDC must be supplied by the companion transceiver so the antenna coupler power will be turned off when the transceiver is turned off.

2.6 GROUNDING REQUIREMENTS

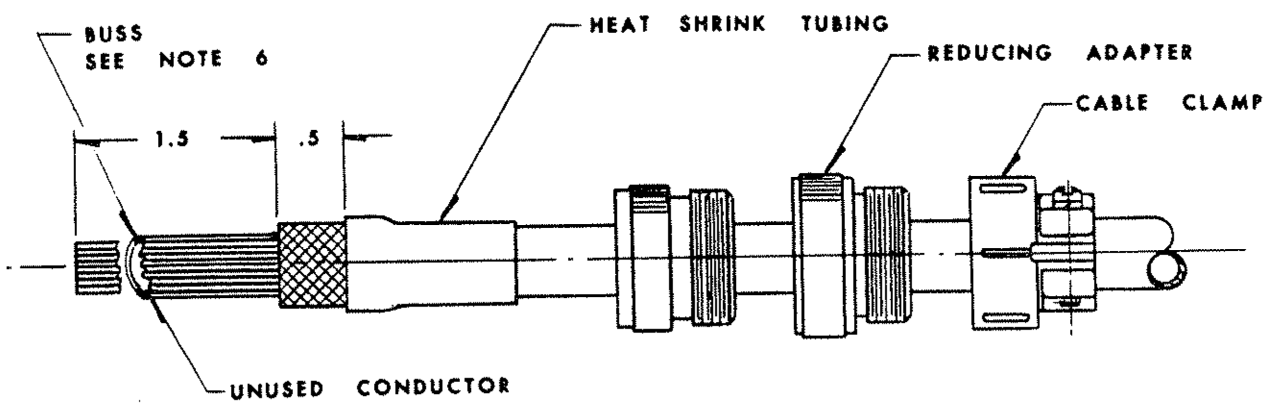
2.6.1 GENERAL

It is very important that all ground straps provided on the mounting racks and the ground strap attached to the rear panel of the antenna coupler be securely connected to the aircraft frame. The radiation resistance of some aircraft antennas is quite low, sometimes less than 1 ohm at the lower frequencies. In order not to decrease the efficiency the bonding straps from the coupler must be very securely bonded to the aircraft such that the resistance readings should be in the order of 1 milliohm or less from the aircraft frame to the ground portion of the antenna RF output connector, J6. Connecting all ground straps properly should result in an adequate ground system.

2.7 CABLE FABRICATION

2.7.1 USE OF COAX BETWEEN J6 (ANTENNA COUPLER OUTPUT) AND THE ANTENNA

As stated previously in paragraph 2.4.1, the use of a coax should be avoided, if possible, for maximum system efficiency. If coax must be used, it should be as short as possible. The loss introduced by the coax is directly related to the antenna impedance, particularly the real part. Maximum coax loss will generally occur when the antenna impedance is high and crossing from inductive to capacitive or from capacitive to inductive. (See paragraph 2.4.1)



NOTES.
1. STRIP OUTER RUBBER COVERING BACK FROM END OF CABLE AS SHOWN.
2. PULL BRAID BACK OVER OUTER RUBBER COVERING. PULL BRAID TIGHT TO MAKE SMALLEST DIAMETER OF CABLE.
3. SLIDE (a) CABLE CLAMP AND (b) REDUCING ADAPTERS OVER CABLE AS SHOWN.
4. PUT HEAT SHRINK TUBING OVER END OF BRAID AS SHOWN.
5. CHECK TO BE SURE CABLE CLAMP WILL SLIDE OVER HEAT SHRINK TUBING AND BRAID. THE TWO CLAMPS ON THE CABLE CLAMP SHOULD CLAMP OVER THE EXPOSED BRAID TO PROVIDE A GROUND FOR THE SHIELD.
6. ANY UNUSED CONDUCTORS SHOULD BE TIED TOGETHER WITH A SMALL BUSSWIRE AND SOLDERED TO OUTER BRAID AT ONE POINT. MAKE SURE CABLE CLAMP WILL PASS OVER BRAID.
7. CAUTION: IF 8033007508 OR 8033008008 ARE USED CARE SHOULD BE EXERCISED TO AVOID USE OF EXCESS HEAT ON THE BRAID TO PREVENT MELTING THE INNER CONDUCTOR INSULATION. (CONDUCTOR INSULATION IS PVC).
8. STRIP 1/8" OF INSULATION OFF CONDUCTORS TO BE SOLDERED IN CONNECTOR.
9. SOLDER WIRES INTO CONNECTOR.
10. SCREW ADAPTER INTO CONNECTOR. SLIDE CABLE CLAMPS UP CABLE AND TIGHTEN CLAMPS ON EXPOSED BRAID.
11. IF SUNAIR PART NO'S 8033007508 AND 8033008008 ARE NOT USED. BE SURE TO CHECK O.D. OF CABLE TO BE USED TO BE SURE IT WILL FIT THROUGHT I.D. OF CABLE CLAMP.

Figure 2.1 Cable Fabrication

2.7.2 GENERAL

The cables listed in paragraph 1.5 must be wired to their appropriate connections as shown in the Interconnect Wiring Diagrams (Figure 2.11 thru Figure 2.15).

All cables are available from Sunair. Since the wiring must be routed to various locations in the aircraft instrument panel the installer should fabricate this cable using standard aircraft installation practices. Figure 2.1 illustrates the method of fabricating the control connector. If the receiver/exciter and PA are located adjacent to the ACU-150 ( ), it may not be practical to use cable 8033007508. In this case, any cable used should be shielded, with the shield grounded on both ends.

2.7.3 CHECKS AFTER FABRICATION

Each cable should be checked after fabrication. The control cable should be checked for pin to pin continuity and for shorts to other pins. The RF cables should be checked for continuity and shorts.

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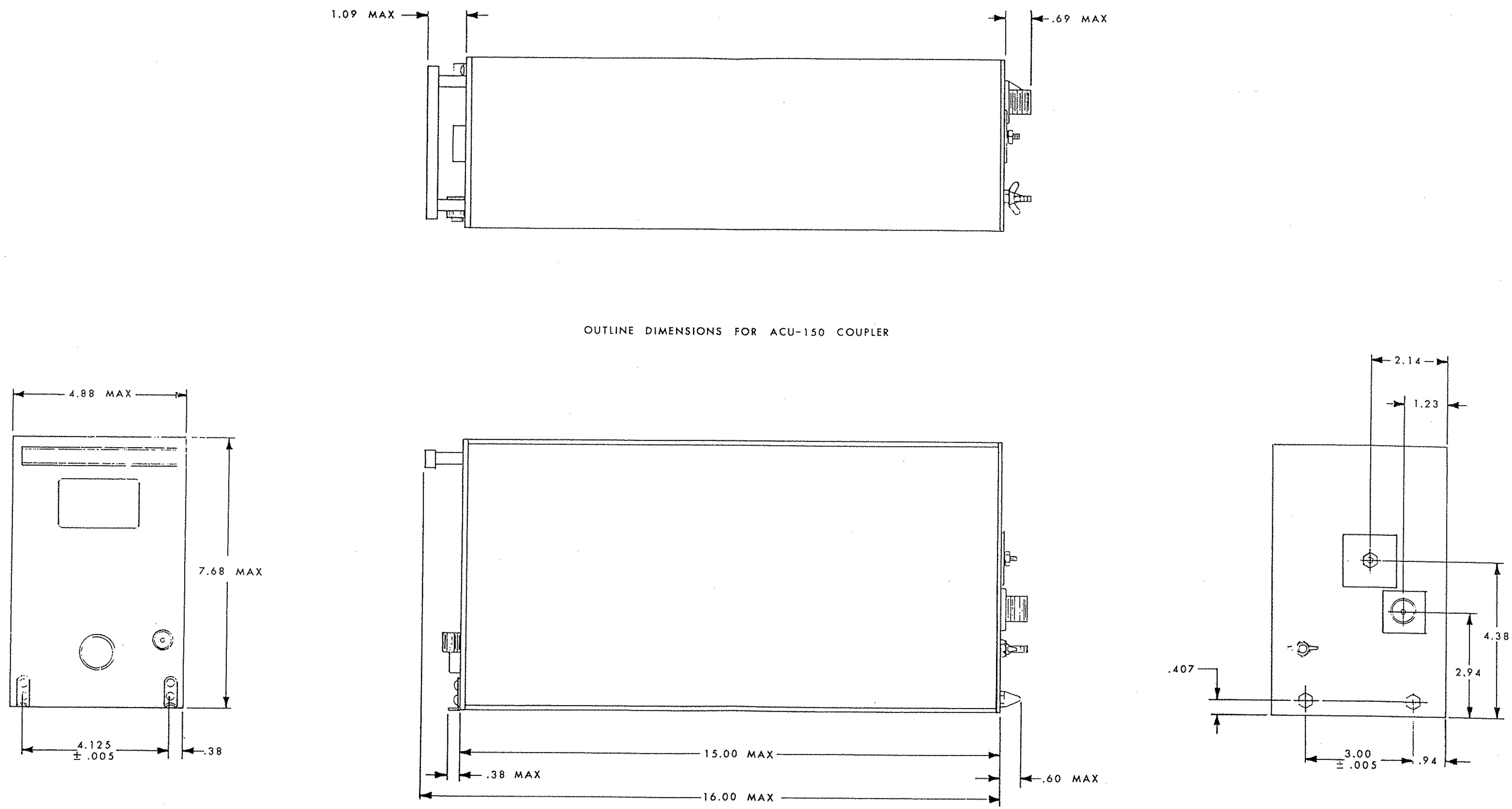


Figure 2.2 Outline Dimensions, ACU-150

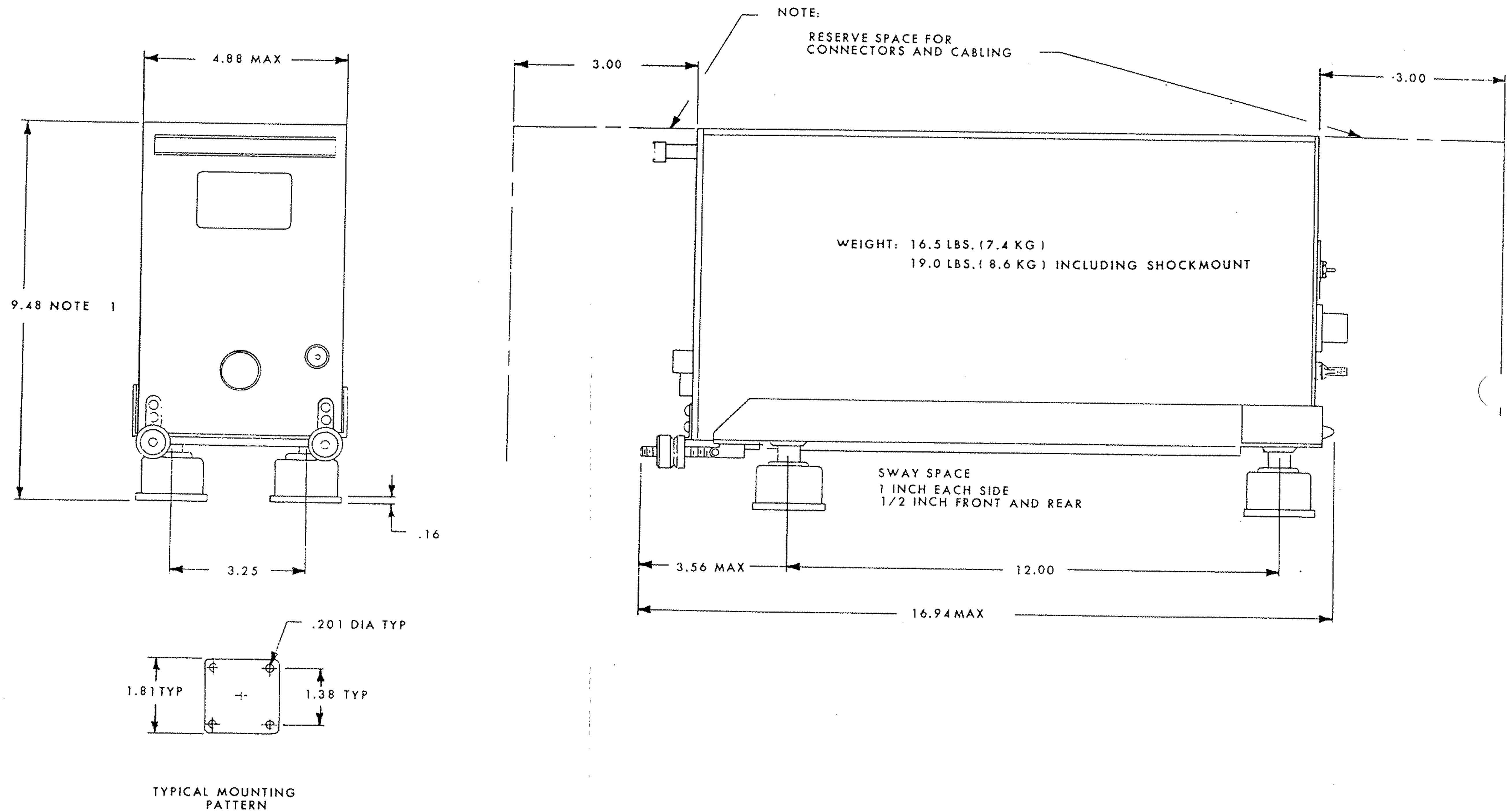


Figure 2.3 Installation Dimensions, ACU-150

2.8 ANTENNA INSTALLATION

2.8.1 GENERAL

The installation of a high frequency antenna on an aircraft involves the consideration of several factors. The shape or configuration of the antenna must allow the transceiver to transmit and receive as required by the user. The user or aircraft owner also usually has a requirement regarding appearance and flight qualities of the antenna and of course these should be considered by the installer also. However, as occurs in most things in nature, what is best for one parameter is not best for another. The HF antenna is no exception. What sometimes occurs is that the length, shape (configuration) and location of the antenna on an aircraft is something very visible and these factors receive the major consideration. The communications performance of the antenna is not readily apparent or known, particularly at the time of installation and decisions are made regarding the antenna installation which later prove to be bad for system operation. The solution then is to select an antenna that does not overly favor any factor to the detrement of the other factors.

2.8.2 FACTORS TO BE CONSIDERED

In order to select the best antenna, consideration must be given to the following factors:

1. Type of aircraft
   a. Size, shape, airspeed
2. Required communications range
3. Transmitter frequencies
4. Antenna flight requirements
5. Possible antenna coupler locations
6. Antenna radiation characteristics.

Aircraft size and shape is important as it may restrict the types of possible antennas. Aircraft speed must be considered, as 260 MPH and faster type of aircraft cannot generally use a wing tip attached V antenna. This type of aircraft may also operate in icing conditions which adversely affect V antennas more than the straight type.

The end users communications distance requirements must be considered, particularly if long range such as 800 miles and greater is required on frequencies as low as 6 to 8 MHz. This would require a V antenna or a long straight antenna 35 feet or longer if ungrounded.

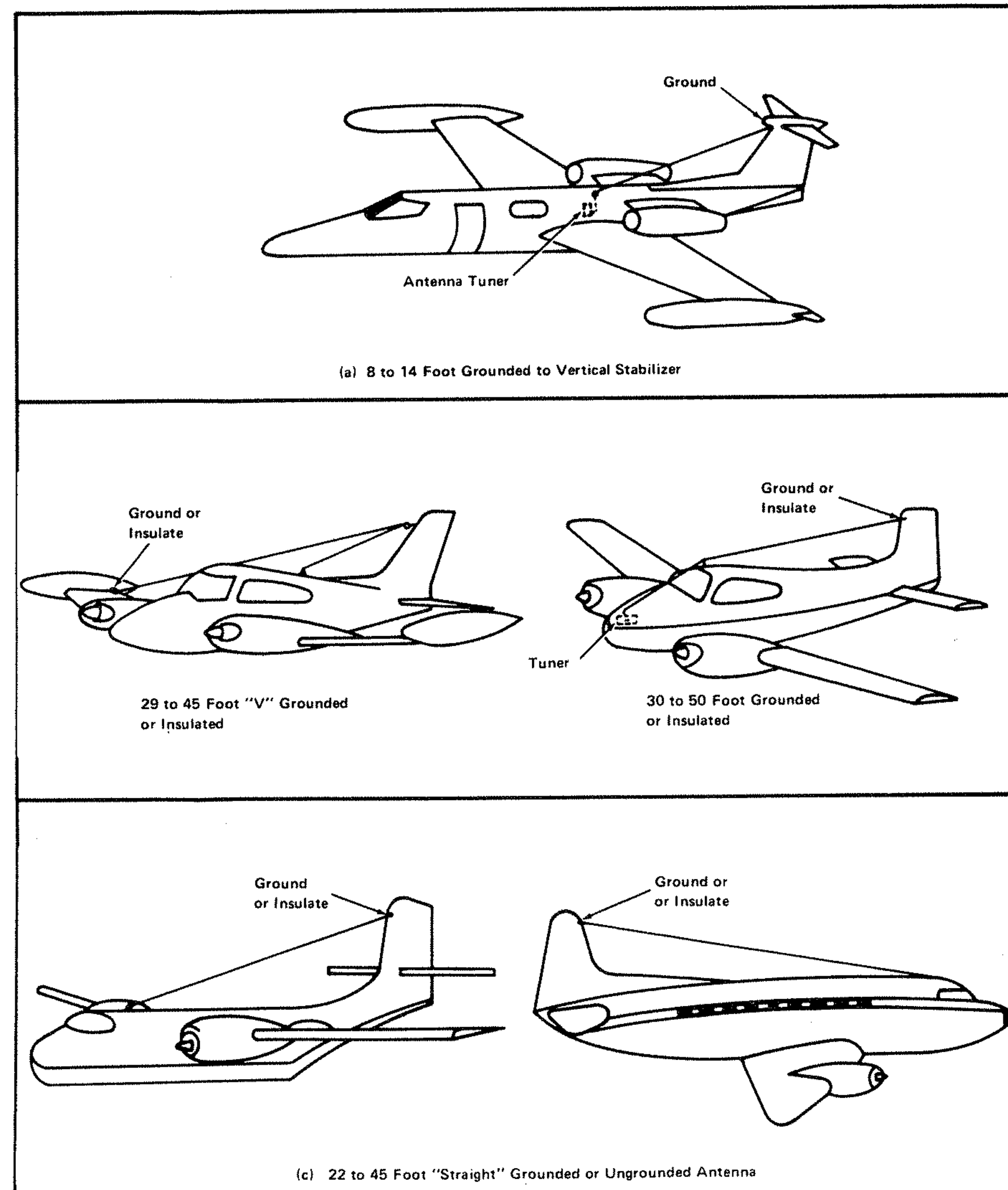
Transmitter frequencies are generally determined by the area of operation and stations to be worked. These in turn can affect the antenna selection. If most of the frequencies are above 5 MHz it is possible to use a shorter or straight antenna as coupler efficiency above 5 MHz is generally good regardless of the antenna type.

The antenna aerodynamic requirements are related to the aircraft type and operating capabilities. Generally, the best aerodynamic design results in the poorest radiating antenna when considering only ungrounded antennas and care must be taken here in order not to degrade the system operation.

The antenna coupler location dictates the location of one end of the antenna. The output of the coupler is the beginning of the antenna and the antenna wire inside the aircraft must be restricted in length, ideally not more than 6 inches to a maximum of 12 inches, unless coax feed is used for the antenna.

The antenna radiation characteristics (how well does it radiate or receive a signal) is generally the hardest to determine. It is always best to install an antenna that has proven to perform well in past installations. The antennas shown on the following pages have all been installed and used with success on various aircraft. Some will work better on one type of aircraft than another, particularly the grounded type. The grounded antenna to the engine nacelle or tail empendage has worked well on many different aircraft. It may be necessary to try several locations and types of antennas in order to satisfy all of the factors outlined here and not overly compromise any one factor.

TYPICAL ANTENNA CONFIGURATION



(a) 8 to 14 Foot Grounded to Vertical Stabilizer

29 to 45 Foot "V" Grounded or Insulated

30 to 50 Foot Grounded or Insulated

(c) 22 to 45 Foot "Straight" Grounded or Ungrounded Antenna

Figure 2.4 Typical Antenna Configurations

TYPICAL ANTENNA CONFIGURATION

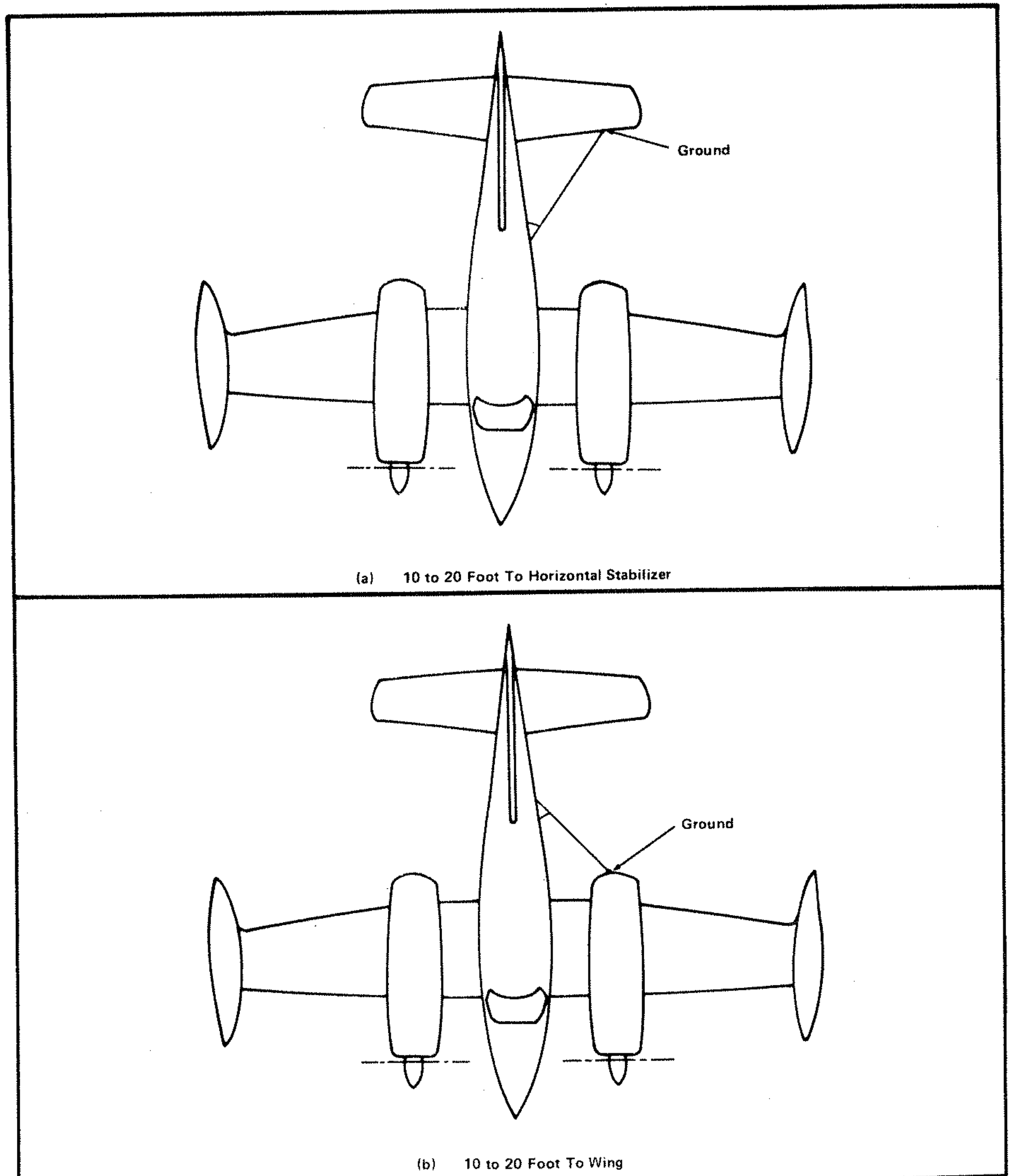


Figure 2.5 Typical Antenna Configurations (Cont.)

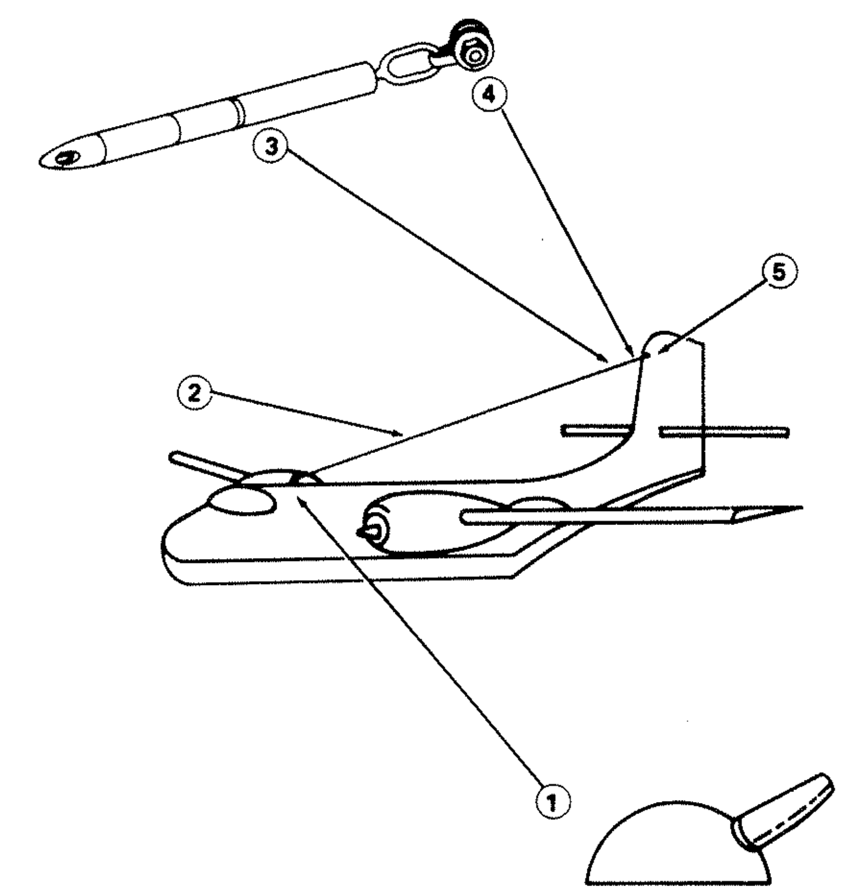


Figure 2.6 Antenna Kit Installation

ANTENNA KIT (ANTI-PRECIP) PN 095158001	
ITEM	DESCRIPTION
1	Feed-thru Insulator
2	60 Feet Insulated Antenna Wire
3	Insulated Tension Unit
4	Shackle AN115-B
5	Vertical Fin Anchor (Not Supplied)
6	Wire Retraction Tool
7	Installation Suggestions

Table 2.1 Antenna Kit Components

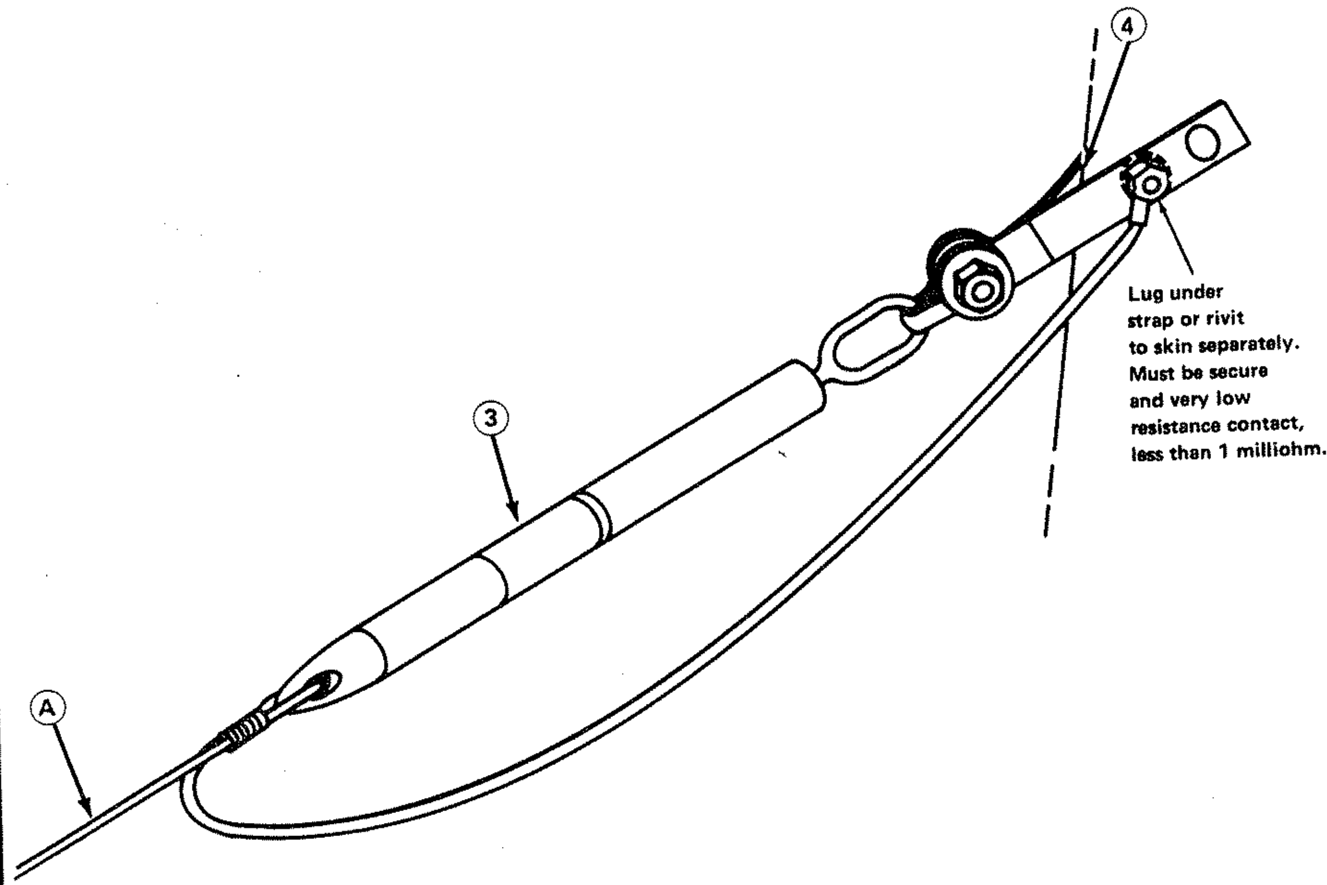


Figure 2.7 Antenna Grounding

2.8.3 ANTENNA KIT INSTALLATION

For information to install the Antenna Kit (PN0951580001) refer to Figure 2.6. Items that the Antenna Kit consists of are listed in Table 2.1.

2.8.4 ANTENNA GROUNDING METHOD

For straight grounded antennas (see figure 2.7), the antenna (A) from feed through insulator (Item 1, Table 2.1) is fed through the insulated tension unit (Item 3) and clamped or tied with nylon cord (as shown) to proper length. Ground antenna with ground lug to Item 4 of Table 2.1 or aircraft skin.

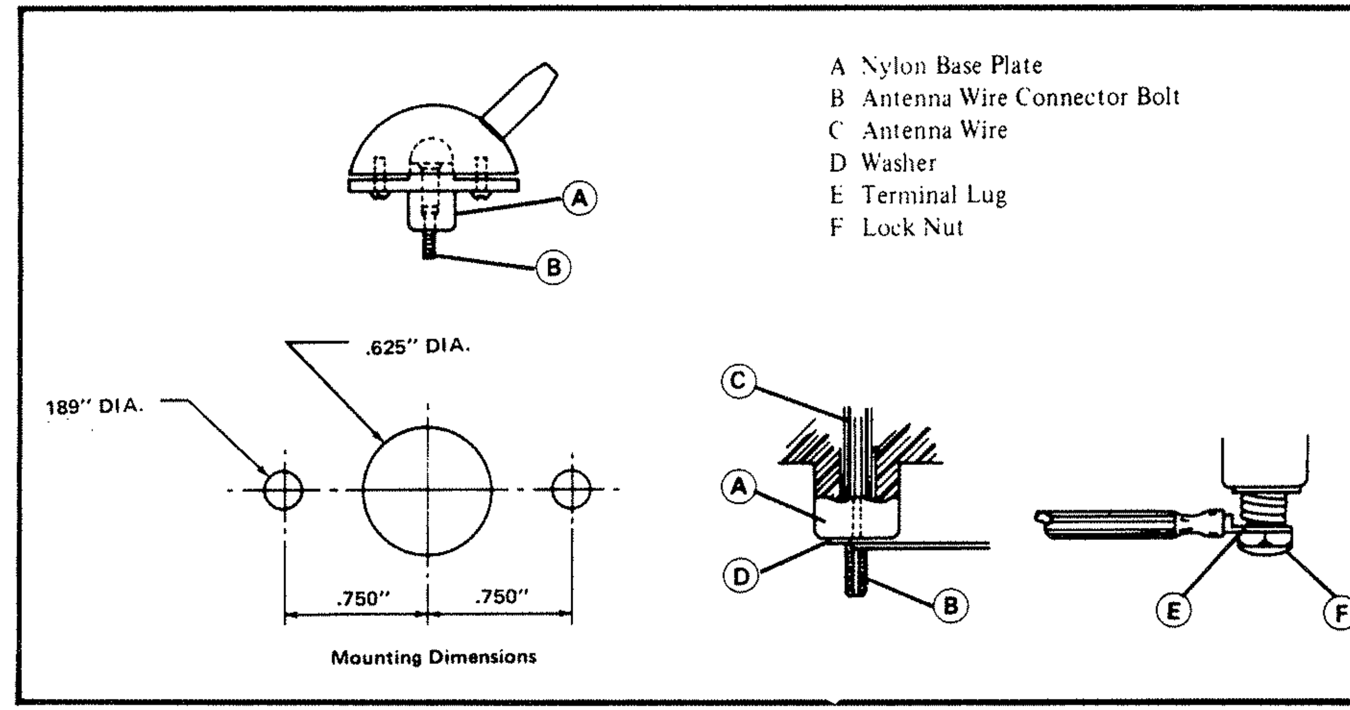


Figure 2.8 Feed-Thru Insulator

2.8.5 FEED-THRU INSULATOR

For proper installation of the Feed-Thru Insulator (PN0713080001, Item 1 of Table 2.1) refer to Figure 2.8 and the following text.

Strip back polyethylene shield (C) to expose approximately 4" of antenna wire core. Insert core into connector bolt (B) and extract from slot. Insert washer (D) as shown. Wind wire around connector bolt (B) 3½ to 4 turns. Install terminal lug (E) of antenna lead and secure with lock nut (F). as shown in Fig. 2.8.

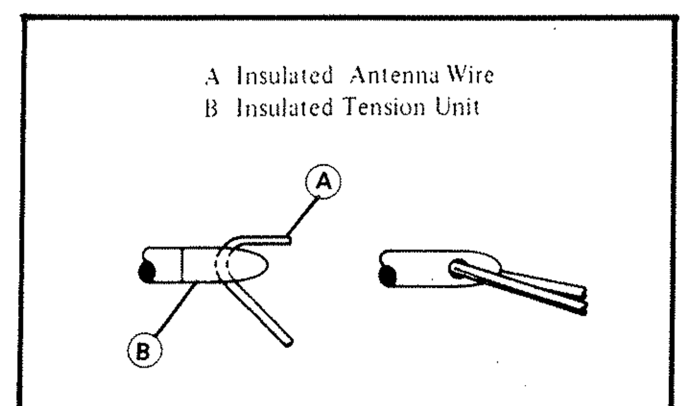


Figure 2.9 Insulated Tension Unit

2.8.6 INSULATED TENSION UNIT

Application of an Insulated Tension Unit (PN0713220007, Item 3 of Table 2.1) for a "V" type antenna, refer to Figure 2.9.

The Antenna (A) is connected to the feed-thru insulator (Item 1, Table 2.1) and routed via the vertical stabilizer by the use of the insulated tension unit (B), as shown. The end is connected at the wing tip.

2.9 FIELD MODIFICATIONS TO TRANSCEIVERS FOR COMPATIBILITY WITH ACU-150A ( )

The modifications shown in this paragraph are required whenever an ACU-150A ( ) antenna coupler is used with a radio that originally used a channelized fixed tuned coupler. If the ACU-150A ( ) and the radio were originally shipped together, as a system, the modification has already been done at the factory.

2.9.1 AM ENABLE LINES

No internal change is required for the AM Key function. The ACU-150 has two AM Enable lines.

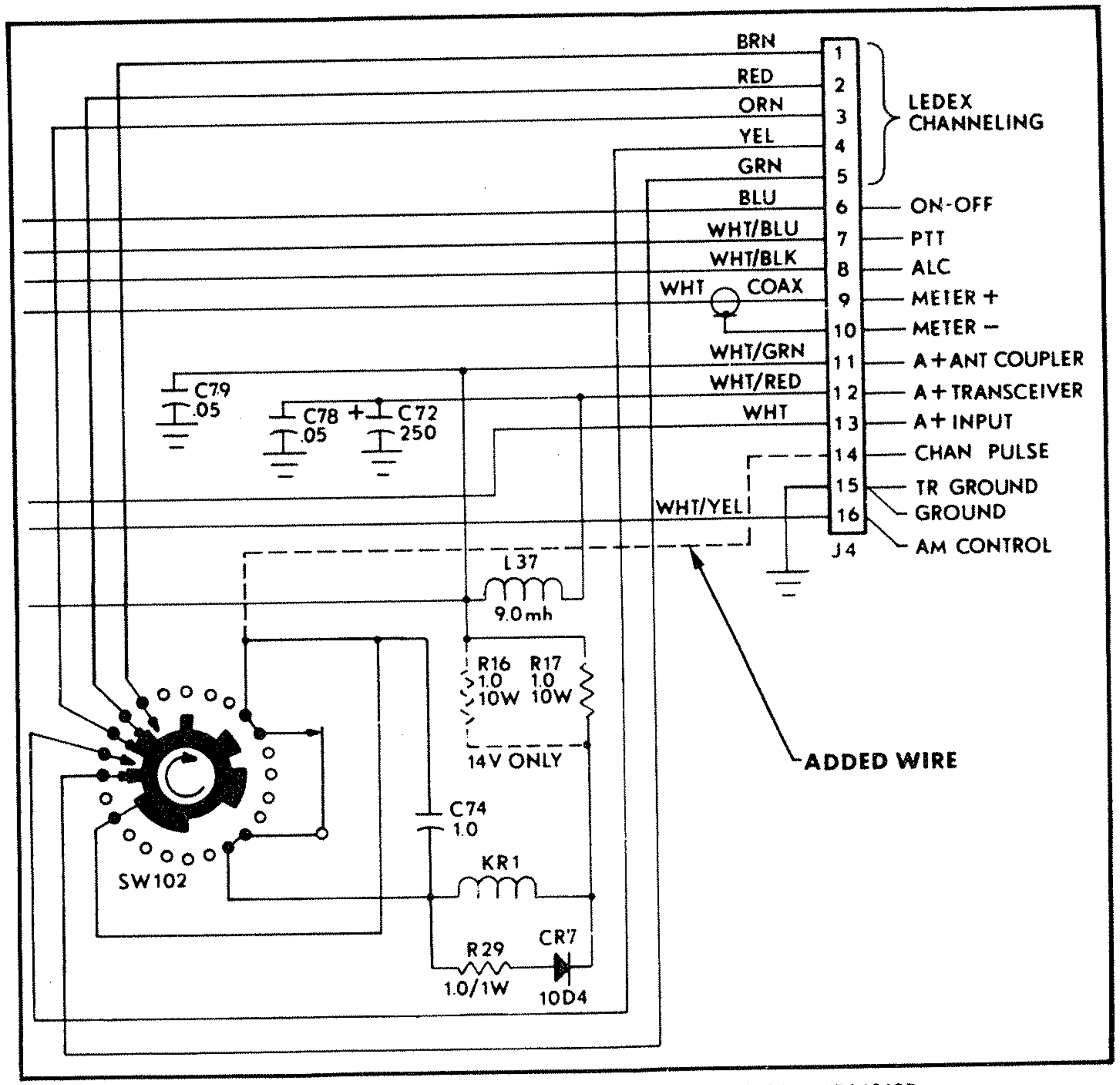
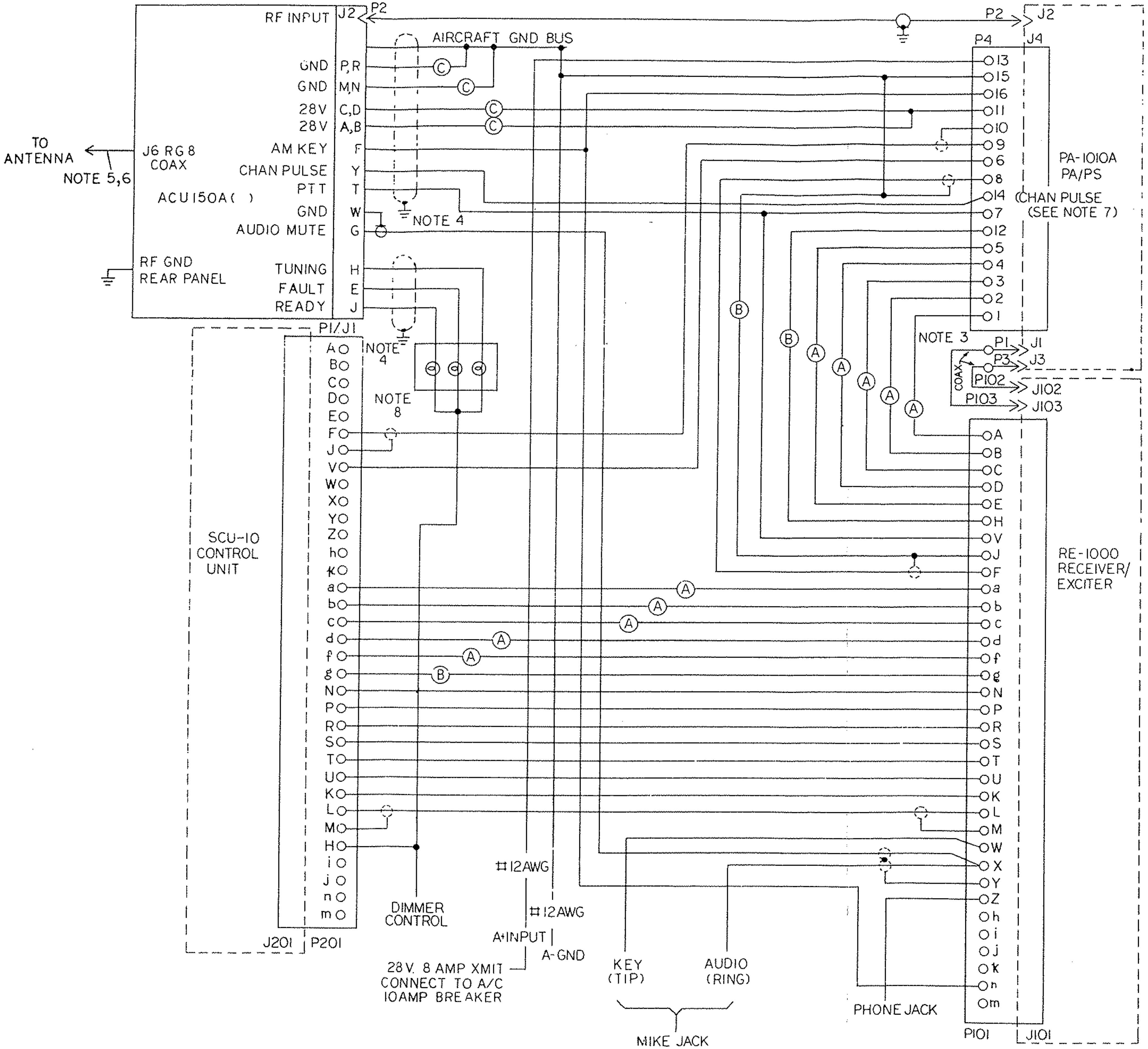


Figure 2.10 Channel Pulse Modifications for PA-1010, PA1010A and PA1010B

Pin U of J1, on the ACU-150, is used for 10 volts AM Enable. Pin F of J1, on the ACU-150, is used for 28 VDC AM Enable.

2.9.2 PA1010, PA1010A, PA1010B POWER AMPLIFIER (ASB-100A, ASB-60/125/130)

On the power amplifier chassis, a pin on J4 must be made available in order to connect a channel pulse to the Antenna Coupler. Pin 14 is used. The ground must be removed from pin 14 of J4. A wire is installed in pin 14 and connected to the channeling wafer side of the interrupter. This is shown schematically in Figure 2.10. The wire in pin 14 of P4 is removed and moved over to pin 15, P4. The schematic illustrates the wiring after the wiring modification.



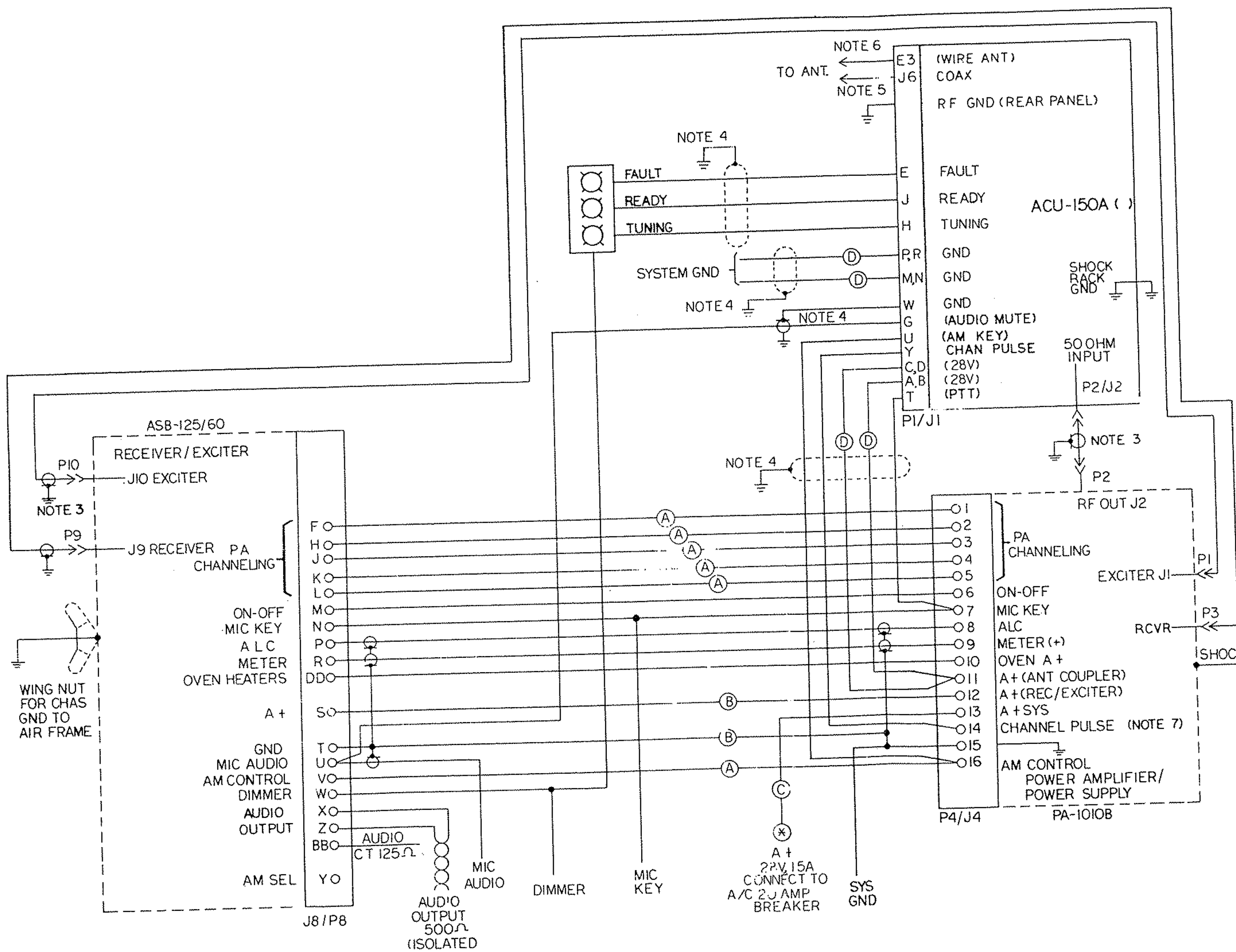
WIRE	LENGTH	SIZE AWG
A	UP TO 24FT	#20
	24FT TO 39FT	#18
	39FT TO 62FT	#16
B	UP TO 12FT	#20
	12FT TO 20FT	#18
	20FT TO 31FT	#16
	31FT TO 50FT	#14
C	UP TO 12FT	2#20
	12FT TO 20FT	2#20
	20FT TO 31FT	4#20
	MORE THAN 31FT	4#20
ACU-150 J1 ACCEPTS # 20 MAX A,B,C,&D +28V: M,N,P, & R GROUND		

UNIT		CONNECTOR	REDUCING ADAPTER	CABLE CLAMP	TYPE
	SYM	PART NO.	PART NO.	PART NO.	
PA-1010A	P4	0747260001			16 PIN
	P2	0742190005	0742070000		PL-259
	P1	0747020001			RF UG-536 B/U TYPE N MALE
	P3	0744030005			RF BNC MALE
RE-1000	101	0747400008			34 PIN
	102	0744030005			RF BNC MALE
	103	0747020001			RF UG-536 B/U TYPE N MALE
ACU-150A	P1	0754470008	1001250001	0740250001	26 PIN
	P2	0742190005	0742070000		UHF PL-259
	P6	0753160005			HN UG59A/U (MALE)
		8042390700	(WIRE ANT)		
SCU-10	P201	0747400008			34 PIN

NOTES:

1. UNLESS OTHERWISE INDICATED WIRES (INCLUDING SHIELDED) SHOULD BE AWG #24 OR LARGER
2. ALL SHIELDED WIRE INSULATED TYPE.
3. COAX CABLE 50 OHM TYPE RG-58A/U OR EQUIVALENT.
4. ALL WIRES COMING FROM ACU-150 ( ) P1 MUST BE SHIELDED AND THE SHIELD GROUNDED TO AIRCRAFT GROUND ON BOTH ENDS.
5. THE LENGTH OF THE COAX FROM J6 TO THE ANTENNA FEEDTHRU SHOULD BE AS SHORT AS POSSIBLE. USE RG-8A/U, RG-213/U OR RG-214/U.
6. THE FEED WIRE FROM E3 TO THE ANTENNA FEEDTHRU SHOULD BE AS SHORT AS POSSIBLE TO MINIMIZE RADIATION INSIDE THE AIRCRAFT.
7. PA-1010B MODIFIED TO PROVIDE CHANNEL PULSE ON PIN 14. SEE ACU-150A ( ) MAINTENACE MANUAL FOR CHANGES REQUIRED, IF NOT ALREADY MODIFIED.
8. LIGHT PANEL IS SUNAIR PART NO. 0994670028.

Figure 2.12 Interconnect Diagram, ASB-100A/ACU-150A ( ) System



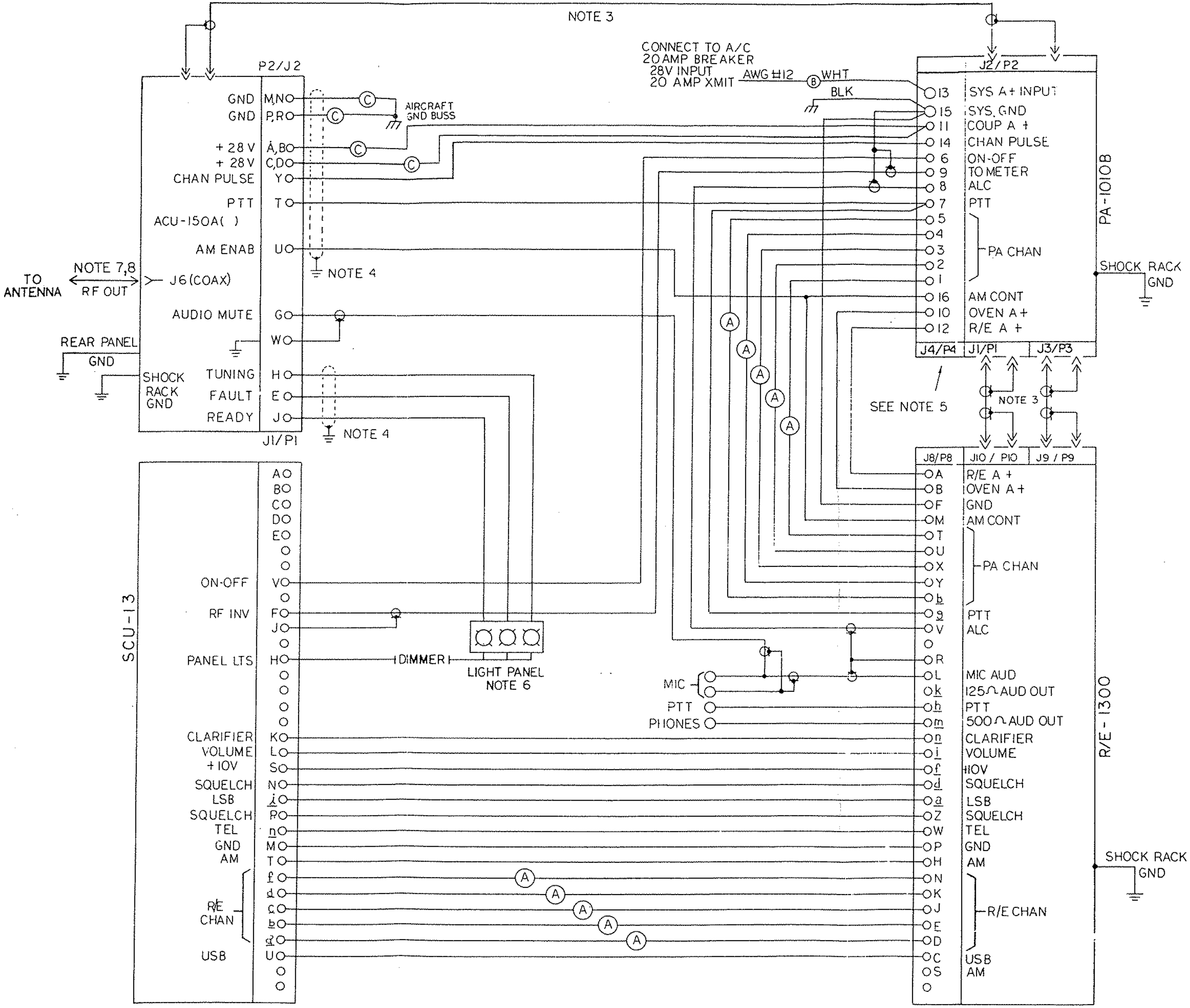
SIZE	LENGTH	SIZE AWG
A	UP TO 24 FT	#20
	24 FT TO 39 FT	#18
	MORE THAN 39 FT	#16
B	UP TO 12 FT	#20
	12 FT TO 20 FT	#18
	20 FT TO 31 FT	#16
	MORE THAN 31 FT	#14
C	UP TO 10 FT	#16
	10 FT TO 18 FT	#14
	18 FT TO 35 FT	#12
D	UP TO 12 FT	2#20
	12 FT TO 20 FT	2#20
	20 FT TO 31 FT	4#20
	MORE THAN 31 FT	4#20

ACU-150 J1 ACCEPTS #20 MAXIMUM
A,B,C & D -28V M,N,P & R -GND

UNIT	SYM	CONNECTOR PART NO.	REDUCING ADAPTER PART NO.	CABLE CLAMP	TYPE
PA-1010B	P1	0747020001			N UG-536 B/U
	P2	0742190005	0742070000		PL-259
	P3	0744030005			BNC PLUG MALE
	P4	0747260001			16PIN PLUG
ASB-125/60	P8	0749960001			26 PIN
	P9	0744030005			BNC UG-88/U
	P10	0744030005			BNC UG-88/U
ACU-150A	P1	0754470008	1001250001	0740250001	26 PIN
	P2	0742190005	0742070000		PL-259
	P6	0753160005			HN UG59A/U (MALE)
		8042390700	(WIRE ANT)		

NOTES:
1. UNLESS OTHERWISE SPECIFIED, ALL WIRES (INCLUDING COAX) SHOULD BE AWG #24 OR LARGER.
2. ALL SHIELDED WIRE INSULATED TYPE.
3. COAX CABLE RG-58A/U.
4. ALL WIRES COMING FROM ACU-150 ( ) P1 MUST BE SHIELDED AND THE SHIELD GROUNDED TO AIRCRAFT GROUND ON BOTH ENDS.
5. THE LENGTH OF COAX SHOULD BE AS SHORT AS POSSIBLE FROM J6 TO THE ANTENNA FEEDTHRU. RG-8A/U, RG-213/U OR RG-214U SHOULD BE USED.
6. THE LENGTH OF WIRE TO THE ANTENNA FEEDTHRU SHOULD BE AS SHORT AS POSSIBLE TO REDUCE RADIATION INSIDE THE AIRCRAFT.
7. PA 1010B MODIFIED TO BE USED WITH ANTOMATIC ANTENNA COUPLER, SEE ACU-150A ( ) MAINTENANCE MANUAL FOR CHANNEL PULSE MODIFICATION.

Figure 2.13 Interconnect Diagram, ASB-125/60 / ACU-150A ( ) System

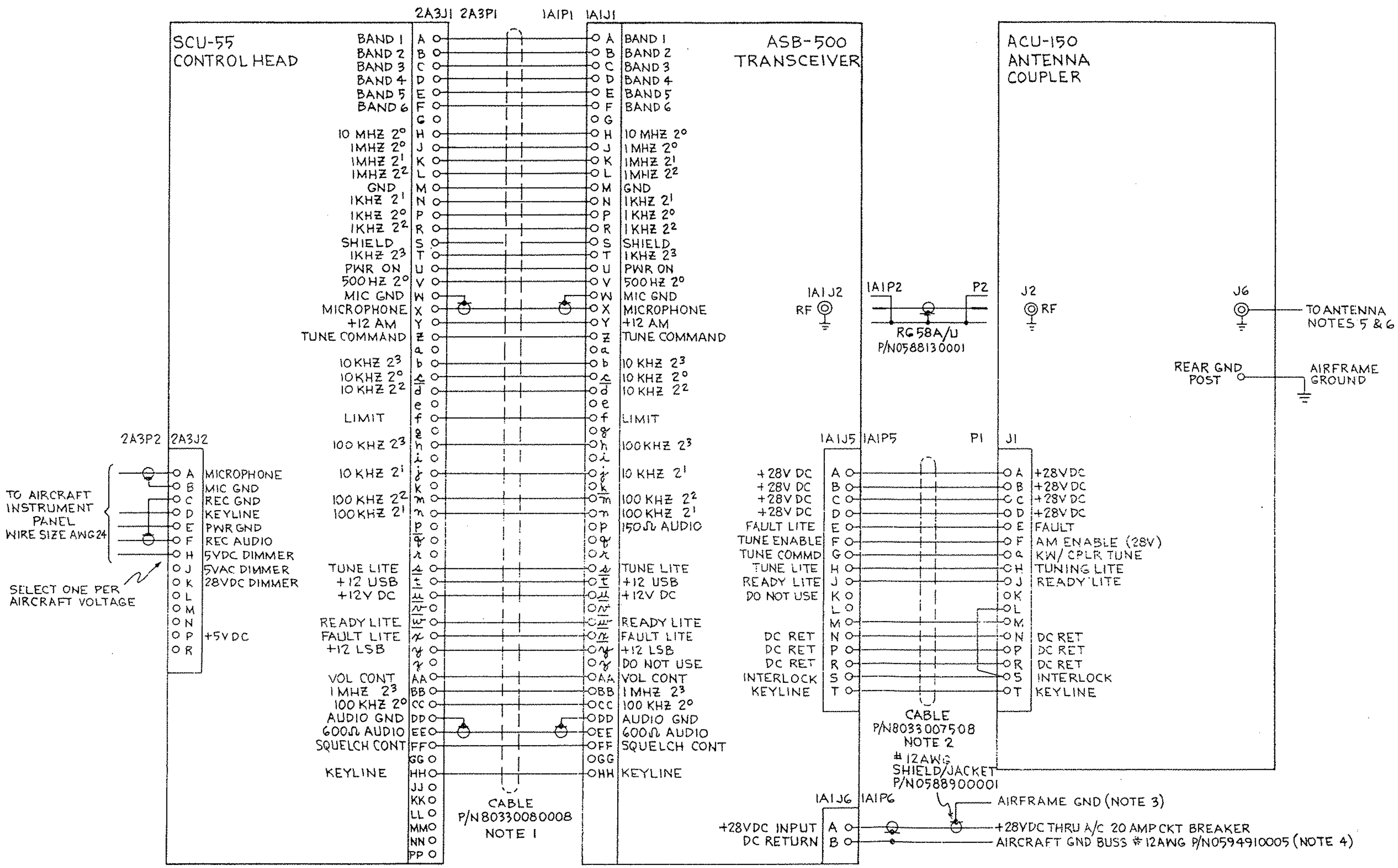


SIZE	LENGTH	SIZE AWG
A	UP TO 12 FT	#20
	12 FT TO 20 FT	#18
	20 FT TO 31 FT	#16
	MORE THAN 31 FT	#14
B	UP TO 10 FT	#16
	10 FT TO 18 FT	#14
	18 FT TO 35 FT	#12
C	UP TO 12 FT	2 #20
	12 FT TO 20 FT	2 #20
	20 FT TO 31 FT	4 #20
	MORE THAN 31 FT	4 #20
	ACU 150A( ) J1 ACCEPTS AWG #20 MAX A,B,C&D +28V M,N,P&R GND	

UNIT	SYM	CONNECTOR PART NO.	REDUCING ADAPTER PART NO.	CABLE CLAMP PART NO.	TYPE
R/E-1300	P8 P9 P10	0747400008 0744030005 0752630008			34 PIN RECTANGULAR "BNC" TYPE UG 88/U "BNC" AMPH NO14625
PA-1010B	P1 P2 P3 P4	0740200001 0742190005 0744030005 0747260001	0742070000		"N" TYPE UG-536 B/U "UHF" TYPE PL259 "BNC" TYPE UG-88/U CANNON "SK" SERIES 16 PIN
SCU-13	P201	0747400008			34 PIN RECTANGULAR
ACU-150( )	P1 P2 P6	0754470008 0742190005 0753160005 8042390700	1001250001 0742070000 (WIRE ANT)	0740250001	26 PIN PL-259 UHF" HN UG.59A/U (MALE)

NOTES:
1. UNLESS OTHERWISE INDICATED WIRES (INCLUDING SHIELDED) SHOULD BE AWG #24 OR LARGER.
2. ALL SHIELDED WIRE INSULATED TYPE.
3. COAX CABLE RG-58 A/U
4. ALL WIRES COMING FROM ACU-150 ( ) P1 MUST BE SHIELDED AND THE SHIELD GROUNDED TO AIRCRAFT GROUND ON BOTH ENDS.
5. PA-1010B MODIFIED TO BE USED WITH AUTOMTIC ANTENNA COUPLER. SEE ACU-150 A ( ) MAINTENCE MANUAL FOR PA-1010B CHANNEL PULSE MODIFICATION.
6. LIGHT PANEL IS SUNAIR PART NO. 0994670028.
7. THE LENGTH OF COAX BETWEEN J6 AND THE ANTENNA SHOULD BE AS SHORT AS POSSIBLE. COAX SHOULD BE RG-8A/U, RG-213A/U OR RG-214 A/U.
2. THE LENGTH OF WIRE TO ANTENNA FEED THROUGH SHOULD BE AS SHORT AS POSSIBLE TO REDUCE RADIATION INSIDE THE AIRCRAFT.

Figure 2.14 Interconnect Diagram, ASB-130/ACU-150A ( ) System



1.0 CABLE 8033008008 SHIELDED & JACKETED CONSISTS OF 4 AWG 22 SHIELDED & JACKETED WIRES & 53 AWG 24 WIRES. CONNECT OUTER SHIELD TO PIN S AT BOTH ENDS.

2.0 CABLE 8033007508 SHIELDED & JACKETED CONSISTS OF 4 AWG 22 SHIELDED & JACKETED WIRES & 18 AWG 20 WIRES. GROUND OUTER SHIELD TO CONNECTOR AS SHOWN IN NOTE 10 OF FIGURE 2.1

3.0 CABLE 0588900001 SHIELDED & JACKETED AWG 12, SHIELD CONNECTED TO 1A1P6 PIN B AND TO AIRFRAME GROUND AT OTHER END.

4.0 WIRE 0594910005 TO BE AS SHORT AS POSSIBLE TO AIRCRAFT GROUND BUSS.

5.0 THE LENGTH OF COAX BETWEEN J6 AND THE ANTENNA FEEDTHRU SHOULD BE AS SHORT AS POSSIBLE. COAX SHOULD BE RG-8A/U, RG-213A/U OR RG-214A/U

6.0 THE LENGTH OF WIRE TO THE ANTENNA FEEDTHRU SHOULD BE AS SHORT AS POSSIBLE TO REDUCE RADIATION INSIDE THE AIRCRAFT.

CONNECTORS		REDUCING ADAPTER	CABLE CLAMP
SYM	PART NO.		
1A1P1	1003390030		
1A1P2	0744030005		
1A1P5	0754630005		0754270009
1A1P6	0754650006		1000200001
2A3P1	0754510000	1001250028	0754270009
2A3P2	0754940004		
P1	075447000B	1001250001	0740250001
P2	0742190005	0742070000	
P6	0753160005		
	8042390700	(WIRE ANT)	

Figure 2.15 Interconnect Diagram, ASB-500/ACU-150A ( ) System

SECTION 3
OPERATION

3.1 TEST AFTER INSTALLATION FOR PROPER OPERATION

Terminate the RF output from the transceiver with a 50 ohm load with a suitable wattmeter connected in series. Place the transceiver in the sideband mode and initiate a tune cycle by channeling the transceiver and depressing the mike button or by pushing the TUNE button, depending on the transceiver used. The transceiver should go into the AM mode (30 to 40 watts) and the antenna coupler should not tune. After approximately 45 seconds, the time delay should run out and shut off the transmitter. The TUNING light should be on during the 45 second interval and the FAULT light should be illuminated after the end of the time interval. Place the wattmeter in series between the PA output and the antenna coupler input, J2. Tune all frequencies used and check the reflected power on each. The reflected power should be less than 4 watts reflected for 100 watts forward for each channel. If the reflected power exceeds the limit for any frequency, advance the GAIN control clockwise and recheck all frequencies. The GAIN control has been adjusted at the factory for best operation for a nominal antenna. However, since antennas will change from one aircraft to another, minor adjustments might have to be made after installation. Continue checking all channels until they all tune with the maximum gain setting possible as this will result in the least reflected power on each channel.

If the antenna coupler fails to tune one or more channels, the GAIN control might have to be reduced slightly counter clockwise. Make sure there is no amplitude modulation on the carrier because this can cause the coupler to not tune properly.

3.2 OPERATOR INSTRUCTIONS

3.2.1 ASB-100A, ASB-125, ASB-130, ASB-60, OR ASB-320 AND ACU-150A SYSTEMS

Turn on the associated transceiver. The FAULT light should come on. Channel the transceiver to the desired channel and momentarily depress the push to talk button on the microphone. The TUNING light should be illuminated and the receiver should be silenced. After a period of time, typically 5 seconds or less, the green READY light should come on and the receiver should come back on. The READY light indicates that the antenna coupler is tuned and the transmitter is ready to use.

If, while transmitting, the FAULT light comes on occasionally, the antenna coupler should be re-tuned. This can be caused by the characteristic of the antenna changing from ground to airborne or due to weather conditions.

3.2.2 GAIN CONTROL

The gain control used for the ASB-150A is the one located on the front panel of the antenna coupler.

The gain control is normally set at the factory for +15 VDC on the anode of 3A2CR22. This usually results in a VSWR of less than 1.3:1 for a 28 ft. ungrounded antenna. For some grounded antennas, the gain control may be advanced maximum clockwise and all frequencies will tune. However, some ungrounded antennas require that the gain control be turned slightly counter clockwise. The gain control should be advanced the maximum clockwise possible to achieve the best VSWR. Operation with the gain control at maximum counter clockwise minimum gain will generally result in a VSWR less than 1.5:1.

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SECTION 4

THEORY OF OPERATION

4.0 GENERAL THEORY OF OPERATION

The ACU-150 ( ) line of antenna couplers are fully automatic and are designed to be used with Sunair's line of airborne transceivers and ground based transceivers. Figure 4.1 is a block diagram of the ACU-150 ( ).

4.1 RF PATH AND ANTENNA TUNING ELEMENTS

Referring to Figure 4.1, the heavy line indicates the RF path. The antenna tuning elements consists of L4, C1, C3 and C6. L4 is a variable inductor that has an inductance range of 0.2 to 18 microhenries nominal. C1 is a vacuum variable capacitor with a range of 7 to 1000 pf nominal. C3 is a switched series capacitor that has 225 pf, 125 pf, 75 pf, and 25 pf. C6 is used in shunt with the antenna and steps 100 pf, 300 pf, 500 pf, 800 pf, and 1200 pf. The input to the variable capacitor is always 12.5 ohms resistive (when the coupler is tuned) and broadband transformer T1 is used to transform 12.5 ohms to 50 ohms. The Pad, Phase and Amplitude Detector (3A1A1), is always monitoring the reflected power (P_R), amplitude error and phase error. Two antenna outputs are provided, a screw type for wire antennas, and a type HN high voltage connector for antennas driven with a coaxial output, J6. Wire antennas are connected to the HN adaptor.

4.2 ANALOG AND DIGITAL CONTROL FUNCTIONS

The Servo Motor Control assembly (3A5) supplies the analog control drive for the C1 servo motor and the L4 servo motor. (These motors are located in the C1 assembly and the L4 assembly.) The two motors that control the switching of the C3 and C6 assembly (3A4) are located in that assembly. The C3 and C6 Control PC board controls the operation of the C3 and C6 motors. Logic functions on the Control Logic (3A2) PC board and the Phase and Amplitude Control (3A3) PC board, control the tuning cycle and operation of the servo motors.

4.3 ACU-150 ( ) SCHEMATIC DIAGRAM

A chassis wiring diagram of the Antenna Coupler is shown in Figure 5.1. The antenna coupler consists of the following subassemblies:

Pad, Phase and Amplitude Detectors P.C. Board	3A1A1
Control Logic P.C. Board	3A2
Phase and Amplitude Control P.C. Board	3A3
C3 and C6 Control P.C. Board	3A4
Servo Motor Control P.C. Board	3A5
Filter Regulator-P.C. Board	3A8A2
C1 Assembly	3A9
L4 Assembly	3A10
C3 and C6 Assembly	3A11

4.4 ANTENNA COUPLER SUBASSEMBLIES

Each of the subassemblies will be discussed in the following paragraphs.

4.4.1 PAD AND PHASE AND AMPLITUDE DETECTORS, (3A1A1)

A schematic diagram of the Pad, Phase and Amplitude Detectors is shown in Figure 5.2. A 3 DB pad attenuator, consisting of R7, 8, 9, 11, 12, and 13, is used to offer a near constant 50 ohm load for the Power Amplifier during a tune cycle. C17 is a compensation capacitor to balance lead inductance of the pad resistors. Relay K1, the Pad relay, is energized by circuitry on 3A2 and is controlled by reflected power. If the reflected power exceeds the 1.5 VSWR, relay K1 is energized and the pad is pulled in. This feature offers further protection for the power amplifier.

4.4.1.1 AMPLITUDE DETECTOR

The amplitude detector consists of transformer T1 and associated circuitry. The purpose of the magnitude (amplitude) detector is to determine if the magnitude of the impedance at the input to the 12.5-50 ohm transformer is greater than or less than 50 ohms. When the magnitude of the impedance is 50 ohms, the output of the magnitude detector is near zero (null). In order to determine the magnitude of the impedance on the line, a voltage sample and a current sample are taken. The current sample is derived from transformer T1, diode CR2, and R2-C6 time constant.

The voltage sample is generated by capacitive divider L1, C1 and C2. L1 provides frequency compensation for the voltage sample. The voltage sample is rectified with diode CR3 and time constant R3 and C3. The voltage sample is adjusted to be equal to the current sample with the output of the detector terminated in a non-reactive 50 ohm load. It should be noted that both voltage and current samples are independent of the phase of the RF signal flowing through the line because both samples are rectified DC voltages.

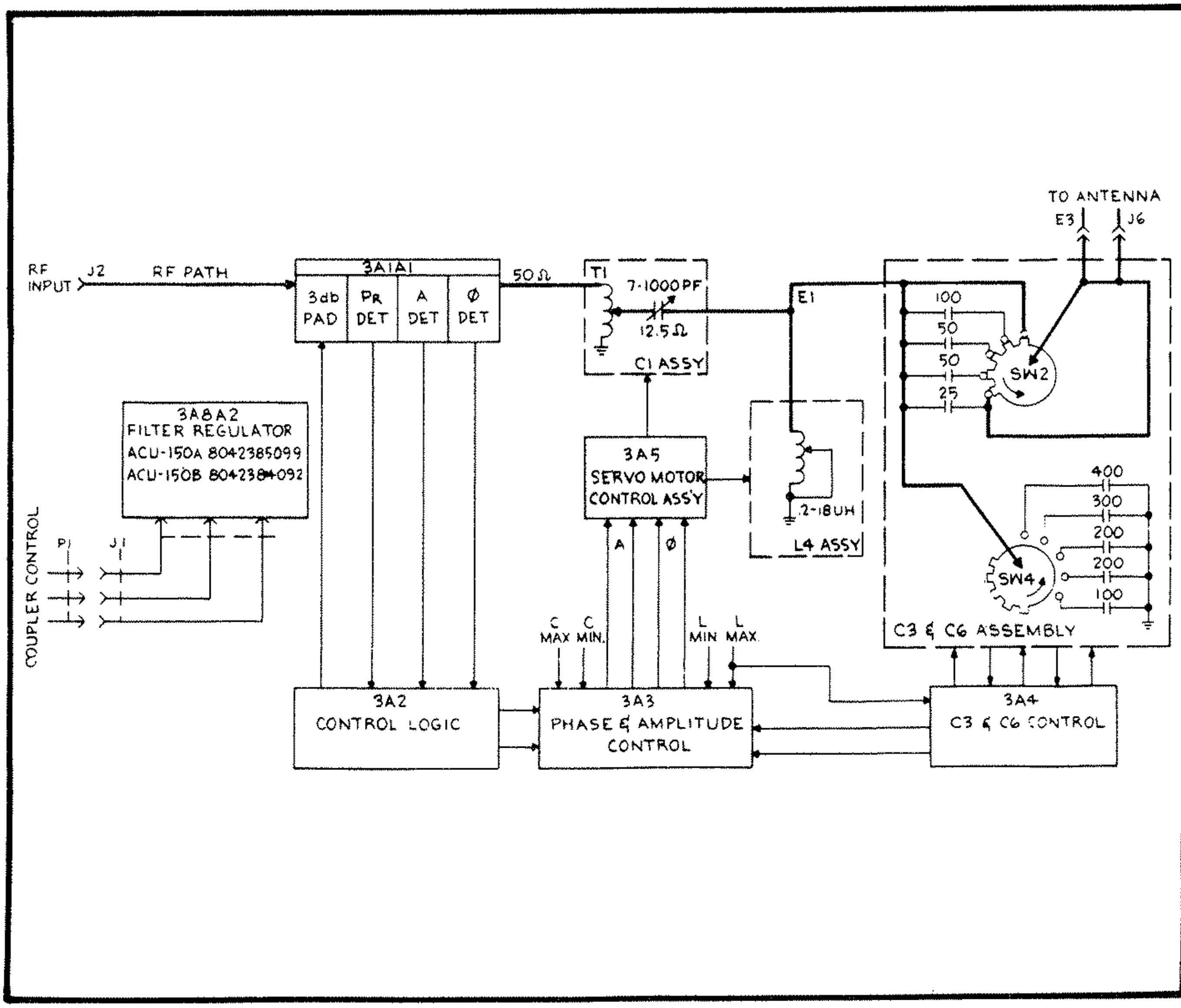

Figure 4.1 Block Diagram, ACU-150 ( )

The output from the magnitude detector is taken between pins 6 and 9, and since the voltage sample and the current sample are opposite, the output is at null when the detector is terminated in 50 ohms. If the magnitude of the impedance on the line is greater than 50 ohms, the current sample decreases and the voltage sample increases, resulting in a negative error voltage measured from pin 6 to pin 9. A magnitude less than 50 ohms causes the current sample voltage to increase and the voltage sample to decrease and the error voltage is positive from pin 6 to pin 9. This error voltage is fed to the 3A3 P.C. board where it is amplified and used to control the servo motor that drives the variable inductor, L4. A magnitude greater than 50 ohms will drive the inductor toward minimum inductance. A magnitude less than 50 ohms will drive L4 toward maximum inductance.

Other components associated with the amplitude detector –

R1 is used to flatten the response of the current sample transformer T1. C24 is a variable capacitor used to compensate for the inductance in the wiring of K1 and the pad resistors. C16, in conjunction with C1, provides the proper division for the voltage sample. L4 and L6, with C5 and C12, prevent RF voltages on the board from getting on the DC outputs.

4.4.1.2 REFLECTED POWER DETECTOR

A reflected power detector is provided to detect when the reflected power on the line is below the VSWR limit. Since reflected power is a function of the magnitude and the phase on the line, a detector must be used to detect both of these. Diode CR1 is floating between the current sample (AC) and the voltage sample (AC). C4 couples the AC voltage sample to the cathode of CR1 therefore any DC voltage generated by CR1 is a function of the difference in the amplitude and the phase of the voltage across CR1. The output of the reflected power detector is taken from pin 6 to pin K and is null when the detector is terminated with a 50 ohm load. When the load on the detector is anything other than 50 ohms, the output from pin 6 to pin K increases in a positive direction. The output of the reflected power detector is fed to 3A2 and is used on this board to control the tuning cycle. Inductor L5 and capacitor C13 prevent RF from appearing on the DC line. R14 and C18 are used to flatten the response of the reflected power detector. C18 is adjusted to provide the least variation of reflected power output from 2 to 30 MHz, when E14 is terminated with a 50 ohm load.

4.4.1.3 PHASE DETECTOR (Ø means phase)

The phase detector consists of transformer T2 and associated circuitry. An AC voltage sample, derived from C22 and R6, is fed to the centertap of T2. T2 provides a current sample. The voltage sample is shifted 90 degrees in phase by C22 and R6. The AC output of T2, measured across R4, is the sum of two quadrature voltages and is changed to DC by CR4 and CR5. C7, C8 and R5 provide the time constant and load for T2. R5 is adjusted for null with the phase detector terminated by 50 ohms. The DC phase detector output is taken from pin 7 to pin 8 and is positive for a positive phase angle and negative for a negative phase angle. The DC output is fed to the 3A3 P.C. board where it is amplified and used to control the servo motor that drives the vacuum variable capacitor. L3 and C9 provide isolation for the RF voltage at the center tap of T2. L7 and L8 and C14 and C15 prevent RF from appearing on the phase detector DC lines. C10 and C11 are RF bypasses.

4.4.1.4 AMPLITUDE DETECTOR, PHASE DETECTOR, AND REFLECTED POWER DETECTOR REFERENCE

The three detectors are all referenced to a floating voltage, 12V REF. This action is required because all three detectors operate into differential amplifiers that are floated between +28 VDC and ground.

4.4.1.5 TUNE CONTROL RELAY

K2 is the tune control relay and is energized by circuitry on the 3A2 board. When a tune cycle is initiated, K2 is energized and switches +28 VDC and +12 VDC to circuits that are used during the tune cycle.

4.4.2 CONTROL LOGIC (3A2)
See Figure 5.3

This plug-in module controls all the major functions in the coupler. It is composed of the following basic circuits:

1. Reflected Power Amplifier
2. Time Delay Circuit
3. Tune BSMV
4. Fault BSMV
5. 50 ohm BSMV
6. Light Drivers
7. RF Detector
8. Modulation Indicator Control
9. Other Circuitry
10. Circuitry contained on PC board but not used for ACU-150 ( ).
11. Diode List

Each of these circuits will be discussed individually.

4.4.2.1 REFLECTED POWER AMPLIFIER
(Logic "1" = +3 to +5 VDC)
(Logic "0" = 0 to +.5 VDC)

The reflected power amplifier consists of U1, Q1, Q2, Q3, Q4, and Q5 and associated components. The output from the reflected power detector (3A1A1) is fed to the input of U1, a differential amplifier. The reflected power detector output is floating on the 12V reference and U1 output, pin 10, is also at 12 VDC. U1 operates between +28 VDC and ground. Transistor Q1 emitter is referenced to 12 VDC. Therefore, when the reflected power detector has an output, pin 4 of U1 goes positive with respect to pin 5 of U1. This causes pin 10 of U1 to decrease below +12 VDC and transistor Q1 conducts. R8 is connected to the base of Q1 and is driven by the GAIN control located on the front panel. The GAIN control voltage can be varied from +12 VDC to 18 VDC, thereby effectively adjusting the threshold of reflected power that will cause an output from Q1.

Q2 and Q3 amplify the output of Q1. The collector of Q3 is important and is designated 50 ohm (—). When the collector of Q3 is at ground, the reflected power has dropped below the threshold and the system is correctly tuned.

Q4 drives Q5 and is a short time delay circuit. C32 can be discharged rapidly with CR3, but charges up slowly through R17. This action prevents a momentary drop in reflected power from terminating the tuning cycle. During the tune cycle, the reflected power may drop below the threshold several times for a short interval of time before finally coming to a steady condition of no reflected power.

The short time delay circuit prevents premature termination of the tune cycle. R17, in conjunction with C32, acts as a noise filter to remove sharp noise pulses. Q5 changes the 28 VDC signals in the reflected power amplifier to a logic level suitable to apply to the logic circuits. A logic "1" output from Q5 emitter terminates the tune cycle. Resistors R53 and R54 are attenuator resistors and reduce the input to the differential amplifier when the coupler is not in the tune cycle. C39 is a filter capacitor used to prevent transmitter turn on spikes from causing a fault light during normal operate mode.

The purpose of R54 is to compensate for the difference in input power level from tuning (30 watts input, attenuated to 15 watts [3db pad] into the phase and amplitude detectors) and 100 or 130 watts power during normal operate conditions. R63 and CR29 are used to disable the reflected power amplifier any time the transmitter is not keyed on.

4.4.2.2 TIME DELAY CIRCUIT

The time delay circuit consists of Q16, Q17, Q18, and associated circuitry. R46 is an adjustment used to set the length of the time delay, normally 40-45 seconds. When a tune cycle is initiated, the collector of Q16 rises to near 12 VDC. C40 begins charging through R47 and the voltage on the anode of Q17 increases toward 8 VDC. Q17 is a PUT (Programmable Unijunction Transistor) and will fire when the anode voltage reaches the voltage applied to the gate. R50 and R49 divide the 12 VDC down to approximately 8 volts.

When Q17 fires, a pulse is generated across R48. This positive pulse saturates Q18. The collector of Q18 drops to ground and CR21 re-sets the TUNE BSMV while CR20 re-sets the fault BSMV. This action terminates the tune cycle and turns on the FAULT light. CR26 (thru U2C and Q6), places a logic 0 on the L max line when the time delay fires. This action is required to terminate the L4 force function at the end of the time delay.

4.4.2.3 TUNE BSMV

This BSMV (toggle) consists of U3B and C, R33, and R34. C35, along with R25 and R26, provide sufficient loading on pin 6 to assure that the TUNE BSMV will come on with logic 0 on pin 6 when the unit is first turned on. When a TUNE pulse (+28 VDC or +12 VDC) is applied to pin A, the anode of CR17, Q15 is saturated and diode CR18 turns on the TUNE BSMV by effectively grounding pin 8 of U3. Pin 6 of U3 now has a logic 1 and Q9 and Q10 are saturated. Q9 causes the TUNING light to be illuminated while Q10 places a ground on the interlock line and the tune control relay on 3A1A1 is pulled in.

The TUNE BSMV is re-set at the end of the tune cycle by a logic output from U4C pin 8. U4C is an AND gate that produces a logic 0 output when RF is present and when the emitter of Q5 is at logic 1. (The emitter of Q5 will be logic 1 when the reflected power has fallen below the threshold.) In other words, the TUNE BSMV is re-set when Rf is present and the reflected power drops below the theshold. An output from U4 pin 8 is brought out to 3A2 pin 10. This output is used to terminate the TUNE cycle when used with the ASB-320, 100A, 125/60 or ASB-130.

4.4.2.4 FAULT BSMV

The FAULT BSMV consists of U4A and U4B, R35 and R36. When the unit is initially turned on, C41 causes U4 pin 6 to be logic 0. Pin 3 of U4 is logic 1 and drives Q12 to saturation by R28. This ground on the collector of Q12 causes the FAULT lamp to be illuminated. The FAULT BSMV is re-set by U4 pin 8, logic 0, that signals the tuned condition. The FAULT BSMV is also set by U5A pin 11, logic 0. U5A is a NAND gate that has a logic 0 output when there is reflected power present (Q3 collector logic 1) and the tuner is not in the TUNE mode (U3 pin 8, logic 1). This feature provides the ability to have the FAULT light come on any time the antenna changes or the frequency has been changed without tuning the antenna coupler.

Diode CR25 re-sets the 50 ohm BSMV and saturates Q14, causing the 3DB pad to be switched into the RF path. This action assures a 50 ohm load for the transmitter when the reflected power exceeds the threshold. As mentioned previously the time delay will also set the FAULT BSMV with a logic 0 applied to the cathode of CR20. CR9 re-sets the FAULT BSMV (fault light off) during the tune mode.

4.4.2.5 50 OHM BSMV

The 50 OHM BSMV is contained in U6C and U6D. R38 and R39 are cross coupling resistors to make the two gates a latch. The purpose of the 50 OHM BSMV is to control the 3DB attenuator relay. When a TUNE pulse initiates a tuning cycle, diode CR15 pulls U6 pin 8 to logic 0. This causes logic 1 on pin 11 of U6, causing R40 to saturate Q14. When the collector of Q14 is at ground, the pad relay is energized and the 3DB attenuator is switched between the transmitter output and the 50:12.5 ohm transformer. When RF power is present at the input of the coupler (logic 1 on pin 3 of U3) and when the reflected power is below the threshold (logic 0 on the collector of Q3, logic 1 on pin 3 of U6) logic 0 will be present on pin 6 of U6. This logic 0 sets the 50 OHM BSMV and switches the 3Db attenuator out of the RF path, allowing the coupler to tune on full RF power during the last few milliseconds of the tune cycle.

There are some frequency impedance combinations that will cause the 50 OHM BSMV to be set and the tuner will not tune. When this occurs, after a few milliseconds, R29-C36 time constant will charge up to logic 1 and Q13 collector will drive U6 pin 13 to logic 0. When this occurs, the 50 OHM BSMV is re-set and the 3Db attenuator is again switched into the circuit. In other words, if the reflected power does not stay below the threshold the pad will be switched in again. This action is required to prevent transmitting into an open or short circuit.

4.4.2.6 LAMP DRIVERS

The three tuner status lamp, located in the control panel or the light panel, are controlled by Q9, Q11 and Q12. These light drivers are saturated by the logic circuits at the appropriate time. The FAULT light driver is Q12 and is saturated (collector at ground) anytime the FAULT BSMV is set (logic 1 on pin 3 of U4). The READY light is driven by Q11 and is saturated by pin 11 of U4. This will occur when the tuning cycle is complete and the unit is ready to use. The TUNING light is controlled by Q9 and it is saturated any time the TUNE BSMV is set (logic 1 on pin 6 of U3).

4.4.2.7 RF DETECTOR

Q8 generates a logic 0 on its collector when RF is present at the input of the coupler. 3A8A2, R3, CR1, and CR2 detect the RF from the PA and generate a DC output. This output is fed to R23 and saturates Q8. R23 and C34 delay the time of saturation of Q8 and prevent Rf signal pertubations from turning the tuner off when the transmitter is first keyed on.

4.4.2.8 MODULATION INDICATOR CONTROL

Q20, Q21, CR6, CR11, R60, R61, and R62 are used for modulating the green READY light when this PC board is used in other systems. These components are not actively used in the ACU-150 ( ).

4.4.2.9 OTHER CIRCUITRY

Q19, R57, R58, and R59 are used to cause the Pad relay (3DB attenuator) to be energized any time the antenna coupler is in a tuning cycle and there is no RF present. This condition can occur if a tuning cycle is initiated and the frequency of transmission is changed. When the transmitter is keyed on again, after the frequency change, the Pad relay is pulled in and the transmitter will see a 50 ohm load rather than an open or a short. The Pad relay is pulled in by the action of U5C and diode CR27. If the coupler is in a tune mode, a logic 1 appears on pin 6 of U3 and also on pin 1 of U5. If no RF is present, a logic 1 will appear on the collector of Q19 and pin 2 of U5. When a logic 1 appears on pin 1 and pin 2 of U5, a logic 0 appears on pin 3 of U5, causing a logic 0 on pin 13 of U6, via CR27. This logic 0 on pin 13 of U6 causes Q14 to saturate and the Pad relay pulls in.

Capacitors C1 through C24 and C25, C44, C45, C48, C50, C51, C52 and C53 are RF bypasses to prevent RF on the wiring from entering the PC board and disturbing the operation of the logic circuits. C26, R2 and R1 provide filtering between the reflected power detector and the input to the differential amplifier, U1. R5, C27 and C28 provide filtering on the 28 volt line for the amplifier U1. R4, C29 and C30 are feedback networks to stabilize the operation of U1. R3 is the negative feedback resistor and determines the gain of U1. R6 is an isolation resistor from pin 10 of U1 and the base of Q1. C31 increases the AC gain of the reflected power amplifier. CR1 and R7 reduce the gain of the reflected power amplifier when the interlock line is at 12 volts. (When the unit is in the receive mode the interlock line rises to 12 volts.) CR22 and R8 set the threshold of the reflected power amplifier and connect to the gain control potentiometer. R9 is an isolation resistor for the emitter of Q1 while R10 and R11 divide the output of Q1 down to a voltage suitable to drive the base of Q2. R13 is the collector load for Q2 and R14 is the drive resistor to the base of Q3. R15 is the collector load for Q3 and R16 is the collector load for Q4. R55 is a bias resistor for pin 9 of U2. R41 and R43 form a divider to the base of Q15 while R42 is the collector load for Q15. R63 and CR29 turn off the reflected power amplifier any time the transmitter is not keyed on.

4.2.2.10 SW 12V DIFFERENTIATING NETWORK

CR12, R31, C37, C38, C43, CR13 and R32 are used to turn on the Fault light when a channelized transmitter is changed to another channel. The channel pulse circuitry on 3A8A2 generates a voltage that is applied to 3A2 pin 2. This voltage is differentiated and fed to pin 9 of U5 and the FAULT BSMV is set via CR14.

4.4.2.11 OTHER CIRCUITRY CONTAINED ON PC BOARD BUT NOT USED IN THE ACU-150 ( )

Some circuits on 3A2 are not actively used for operation of the ACU-150 ( ) but are used for functions when this PC board is utilized in other equipment. The following is a list of all components not used for ACU-150 ( ) operation:

C3-C6 Control – Components U2A, U2B, U2D, R19, R20, R21, C33 and Q7. These components are not actively used on the 3A2 board for the ACU-150.

R51, R52, U5B, CR23 and CR24 are used in other applications to terminate the tune cycle but are not actively used in the ACU-150 ( ).

4.4.2.12 DIODE FUNCTION LIST

Since diodes are used for logic functions, it is important to indicate the purpose of the diodes used on 3A2. The following Table 4.1, lists the diode, the major line and its specific function.

DIODE	LINE	FUNCTION
CR22	GAIN	Isolates the gain voltage, supplied by the GAIN control from the base voltage of Q1.
CR1	Interlock	Isolates Q1 base voltage from the collector of Q10 when Q10 is saturated.
CR2	Base of Q4	This zener diode (3.6V) isolates the base of Q4 from the collector of Q3 and allows the collector to rise to a logic 1 level.
CR3	Collector of Q4	CR3 allows for the fast discharge of C32 when the reflected power rises to above the threshold.
CR5	CPLR TUNE	CR5 is used to discharge C32 during the interval of the CPLR TUNE pulse. This prevents C32 from having a logic 1 immediately after the CPLR TUNE pulse and shutting off the unit prematurely.
CR7	CPLR TUNE	CR7 generates a logic 0 on the C1 Home line and sets the C1 Home BSMV on 3A3.
CR8	CPLR TUNE	CR8 generates a logic 0 on the L4 Home line and sets the L4 Home BSMV on 3A3.
CR10	50(-)	Allows the fast discharge of C36 so the Pad relay can drop out fast when a 50 ohm impedance has been found.
CR9	Pin 3 of U4	When the TUNE BSMV is set, CR9 turns off the fault light and resets the Fault BSMV.
CR12	SW12V	Prevents the negative going edge of this voltage from generating a spike.
CR13	C38 and R32 junction	This zener diode prevents a positive spike greater than 5 volts.

Table 4.1 Control Logic (3A2) Diode Functions

DIODE	LINE	FUNCTION
CR16	Lmax	This diode forces the Pad relay to pull in when the inductor reaches maximum inductance. It is required to prevent the coupler from locking up at certain impedance – frequency combinations.
CR15	CPLR TUNE	Forces the Pad relay to pull in when a tuning cycle is initiated.
CR17	CPLR TUNE (Pin A)	Isolates the CPLR TUNE input from the base of transistor Q15.
CR18	CPLR TUNE	CR18 sets the tune BSMV when a tune cycle is started.
CR19	Anode of Q17	Rapidly discharges C40 when a tune cycle is ended.
CR20	Collector of Q18 (Time Delay)	Sets the Fault BSMV when the time delay runs out and causes the Red light to be illuminated.
CR21	Collector of Q18	CR21 re-sets the Tune BSMV when the time delay runs out.
CR14	U5 pin 8	CR14 sets the Fault BSMV when SW12V is applied to 3A2.
CR23	U5 pin 6	CR 23 re-sets the Tune BSMV when nominal 28V is applied to 3A2, if the coupler is in the tune mode (Tune BSMV is set). This function not used in the ACU-150 ( ).
CR24	U5 pin 6	Sets the Fault BSMV when 28V Nom is switched to 3A2, if the unit is in the tune mode. This function not used in the ACU-150 ( ).
CR27	U5 pin 3	If, during a tune mode, the collector of Q19 goes to a logic 1 (indicating no RF input), CR27 causes a logic 0 on pin 13 of U6, pulling the Pad relay in.
CR25	U5 pin 11	If the coupler is NOT in a tune mode (logic 1 on pin 12 of U5) and the reflected power exceeds the threshold (logic 1 on pin 13 of U5). U5 pin 11 will have logic 0 and CR25 will cause the Pad relay to pull in.
CR26	Collector of Q6 Function (Time Delay)	If the time delay runs out while L4 is being forced toward maximum L, CR26 places a logic 0 on the Lmax line and terminates the force function.

Table 4.1 Control Logic (3A2) Diode Functions (Cont.)

4.4.3 PHASE AND AMPLITUDE CONTROL (3A3)

See Figure 5.4

This plug in module contains all the circuitry to control the servo motors that drive the variable tuning elements, C1 and L4. The following major functions are contained on the board:

1. Phase Preamplifier (U1)
2. Amplitude Preamplifier (U3)
3. Phase and Amplitude Level Changer
4. Positive and Negative Phase Detectors
5. Greater than 50 Ohm and Less than 50 Ohm Detectors
6. Lmin-Cmax Gate
7. Positive and Negative Phase Drivers
8. Greater than and less than Drivers
9. Lmin, 0 Phase, Greater than 50 Ohm Detector
10. Positive Phase, Greater than 50 Ohm Detector
11. C1 Home BSMV
12. L4 Home BSMV
13. L4 Force BSMV
14. Phase Shorting Switch
15. Amplitude Shorting Switch
16. Brake Circuit
17. Lmin Pulse Reversing Circuit
18. Lmax Reversing Circuit
19. Other Components

Each of these functions will be discussed in later paragraphs.

4.4.3.1 GENERAL OPERATIONS OF THE PHASE AND AMPLITUDE CONTROL BOARD

The phase and amplitude detectors, along with the reflected power detector, are constantly monitoring the input to the tuning elements. The 50:12.5 Ohm transformer transfers the impedance at the input to C1 (12.5 ohms) to 50 Ohms when the unit is tuned. The Phase preamplifier and the positive and negative phase drivers control the servo amplifier in such a manner that when the phase is positive, C1 decreases in value (less pf) and when the phase is negative, it increases in capacitance. The amplitude preamplifier, along with the greater than 50 ohm and the less than 50 ohm drivers, controls the amplitude servo to drive the inductor L4 toward minimum inductance for an amplitude greater than 50 ohms and toward maximum inductance for an amplitude less than 50 ohms. Both the phase and the amplitude servos are closed loop but are interrupted for various functions while the closed loop tuning is in progress.

The 50(-) and the 50(+) lines are two control lines from the control logic board (3A2) and signify that the reflected power has dropped below the threshold. The 50(-) line has a negative pulse (logic 0) while the 50(+) line has a logic 1 to signify that the reflected power is below the threshold. During a tuning cycle, when the reflected power drops to below the threshold, the 50(+) line drives through diodes CR8 and CR25 to short out the drives to both phase and amplitude drivers to effectively remove the drive to both servo motors. Q8 generates a brake pulse for both the phase and the amplitude servo amplifiers. The action of the 50(-) and the 50(+) lines effectively removes the drive and applies a brake pulse to both servos, even if there is a phase error or an amplitude error present. (A small phase and amplitude error could exist while the reflected power would be below the acceptable threshold.)

During the tuning cycle certain combinations of events are monitored and, when these occur, are used to control other functions. The following combinations of events are detected:

1. When the phase is positive and the magnitude is greater than 50 ohms.

2. When the inductor is at minimum, the phase error is zero, and the amplitude is greater than 50 ohms.

3. When the inductor is at minimum and the capacitor is at maximum.

When a tuning cycle is initiated, the C1 Home BSMV begins driving the variable capacitor toward maximum capacity and the L4 Home BSMV begins driving the inductor toward minimum inductance. This method of homing is required in order to force the phase positive so tuning can be accomplished and the unit will not lock up at certain impedance-frequency combinations. The homing of both elements is stopped as soon as the phase is positive and the amplitude is greater than 50 ohms.

Since the homing functions are driving the elements toward minimum L and maximum C, as soon as the amplitude error voltage becomes the same polarity as the homing voltage and the phase becomes positive, the homing function can be turned off and the tuning can be accomplished in a shorter time. (Greater than 50 ohms drives the L toward minimum and positive phase drives the capacitor toward minimum, so further homing of the capacitor would result in longer tuning time.)

When the inductor is at minimum, the phase error zero and the magnitude is greater than 50 ohms, the coupler would hang up if it weren't for a detection circuit (2 above). Since the magnitude is greater than 50 ohms and the inductor is at minimum L, the inductor would just remain stationary (greater than 50 ohms drives the L toward minimum) and the capacitor would also remain stationary since there is no phase error.

The third detector mentioned above is for Lmin and Cmax. This condition is detected in U5 pin 6 and is connected to 3A4 where it is compared with the status of C3, the capacitor placed in series with the antenna. If the condition of Lmin and Cmax exists, and if C3 is not in the home position, then the next step of C3 is inserted. This action reduces tuning time.

The L4 Force BSMV is set by the condition of Lmin and Cmax. This condition can occur when tuning certain antennas from a high frequency, such as 20 MHz and then moving to 2 MHz. The capacitor will run to maximum because of the home function and the inductor will run to minimum. However, at this time, the phase will be negative and the magnitude will be greater than 50 ohms and both elements would remain stationary if it were not for the L4 Force BSMV. The L4 Force BSMV will force the L toward maximum inductance until the phase becomes positive and then normal tuning will take over. The L4 Force BSMV is re-set by the condition of positive phase and amplitude greater than 50 ohms.

The servo amplifier is controlled by transistors Q6 and Q7 for phase drive and Q13 and Q14 for amplitude drive. During the normal tuning portion of the tune cycle, when there is no Home, Force, Lmin, Lmax, Cmin, or Cmax conditions, the level changers drive Q6, Q7, Q13 and Q14 in a normal closed loop manner. These drives are interrupted or removed from the servo driver transistors as shown below:

Q6 Positive Phase Driver – This transistor has only one source of input, the positive phase error from the phase level changer.

Q7 Negative Phase Driver – This transistor has two sources of drive. One is from the negative phase error voltage from the phase level changer (R23) and the C1 home drive (R22).

Q13 Less than 50 Ohm Driver – The error voltage from the amplitude level changer is fed to the base through R60. The L4 force drive is applied through R61. CR41 applies a pulse to force the inductor off Lmin.

Q14 Greater than 50 Ohm Driver – The L4 Home drive is applied through R57 and the error voltage from the amplitude level changer is fed to the base via R58. R76 supplies a drive voltage to force the inductor off the Lmax switch when it reaches maximum L.

4.4.3.2 PHASE PREAMPLIFIER (U1)

The phase preamplifier is contained in U1 and associated circuitry. The output from the phase detector is floating about +12 VDC and is fed to pin 4 and 5 of U1. This circuit is a differential amplifier and if pin 5 goes positive with respect to pin 4, the output, pin 10, will rise above +12 VDC. (The differential amplifier operates between +28 VDC and ground; pin 10 is at +12 VDC with no input between pins 4 and 5). The input to the differential amplifier is very small at null (voltage and current in phase), but rises to ±1 volt while tuning.

Diodes CR1 and CR2 are used to protect the input of the differential amplifier from excessive inputs from the phase detector. C23, along with R1 and R2, filters noise pulses from the input. R3 and C22 provide filtering for the 28 volts to the amplifier. R4 and C24, along with C25, provide feedback to stabilize the frequency response of the amplifier. R5 is a negative feedback resistor to limit the gain of the amplifier. R6 is an isolation resistor to the input of the level changer, Q1 and Q2.

4.4.3.3 AMPLITUDE PREAMPLIFIER (U3)

The amplitude preamplifier consists of U3 and associated components. The operation of the amplitude preamplifier is exactly the same as the phase preamplifier, except the amplitude preamplifier has more gain. This is accomplished by making the feedback resistor (R45) larger than for the phase preamplifier. The output of the amplitude preamplifier (pin 10) is also floating about +12 VDC and must be shifted in a level changer.

R41, 42, 43, 44, and 46 perform identical functions as in the phase preamplifier. C27, 28, 29 and 30 also perform the same functions as in the phase preamplifier. CR20 and CR21 protect the amplifier from over load.

4.4.3.4 PHASE AND AMPLITUDE LEVEL CHANGER

The phase level changer consists of Q1, Q2, Q3 and associated components. A positive phase angle will cause U1 pin 10 to rise above +12 VDC. This action will cause transistor Q1 to conduct (its emitter is referenced to +12 VDC). When Q1 conducts, the voltage drop across R11 causes Q3 to conduct. When Q3 conducts, a positive voltage appears on the collector. This voltage supplies the drive for the servo preamplifier for a positive phase angle.

If the output voltage of the phase preamplifier drops below +12 VDC (the condition for a negative phase angle) Q2 will conduct and a positive voltage will appear on the collector of Q2. This voltage is the drive voltage for the phase servo preamplifier for a negative phase angle. The amplitude level changer consist of Q10, Q11 and Q12. It operates identically to the phase level changer. R47 is the collector load for Q10 while R9, 10, 48, and 49 are isolation resistors that provide degeneration for Q1, 2, 10, and 11. R12 and R51 provide degeneration for Q3 and Q12, respectively.

4.4.3.5 POSITIVE AND NEGATIVE PHASE DETECTORS

A positive phase is detected when a logic 1 appears across R14. R13 divides the output of Q3 to a logic 1 level. This signal is fed to pin 9 of U2 and compared with the greater than 50 ohm logic input on pin 10. When both are logic 1, a logic 0 appears on pin 8 of U2. The logic 1 across R14 also saturates Q4 thru R70. Q4 collector will rise to logic 1 when the phase error is zero (provided the amplitude is greater than 50 ohms, L is at minimum, and C is not at maximum). A negative phase angle appears as a positive voltage across R67. R7 divides Q2 output down to approximately 1 volt. If the phase error is zero, Q4 or Q18 will not be saturated.

4.4.3.6 GREATER THAN 50 OHMS AND LESS THAN 50 OHM DETECTOR

The greater than 50 ohm signal is divided by R50 and appears across R68 as a logic 1. Less than 50 ohms is divided by R52 and appears across R69. If the amplitude error is greater than. 50 ohms or zero, Q19 will not be saturated.

4.4.3.7 LMIN–CMAX GATE

When the inductor is at minimum L and the capacitor is at maximum C, these logic 0 inputs are fed to U5 pin 10 and pin 13, respectively. The logic 0's are inverted to logic 1's in U5C and U5D and are compared in U5B. When U5 pin 4 and pin 5 are both logic 1, pin 6 is logic 0 and indicates the condition of Lmin-Cmax. This is used to set the L4 Force BSMV U4C and D and is fed to 3A4 on pin D.

4.4.3.8 POSITIVE AND NEGATIVE PHASE DRIVERS

These two transistors, Q6 for positive phase and Q7 for negative phase, are used to drive the phase servo bridge. R26 and R28 are used for degeneration for the devices. R16 and R25 couple the positive phase drive from Q3 collector. When the collector of Q6 is less than 28 volts, the servo motor will run in a direction to decrease the capacitance. When the collector of Q7 is less than 28 volts, the phase servo will run in a direction to increase the capacitance. R8 and R23 couple the drive from Q2 collector.

4.4.3.9 GREATER THAN AND LESS THAN DRIVERS

Q13 is the amplitude driver for an amplitude less than 50 ohms. Q14 is the amplitude driver for an amplitude greater than 50 ohms. If the collector of Q13 is less than 28 volts, the servo motor will run in a direction to increase the inductance. If the collector of Q14 is less than 28 volts, the servo motor will run in a direction to decrease the value of inductance. R53 and R60 couple the less than 50 ohm drive from Q12 collector. R54 and R58 couple the greater than 50 ohm drive from the collector of Q11.

4.4.3.10 LMIN, 0 PHASE, GREATER THAN 50 OHM DETECTOR

This detector consists of transistors Q4 and Q18 (for zero phase) and Q19 for greater than 50 ohms. These three transistors operate into a common collector load, R15, and the collectors will rise to logic 1 when all three transistors are cutoff.

Diode CR34 prevents the collectors from rising to a logic 1 unless a logic 0 is on the Lmin line. The logic 1, indicating Lmin, 0 phase, and greater than 50 ohms, appearing on the collectors of Q4, 18, and 19, is fed through R71 to the base of Q17 and is inverted to a logic 0. R72 is the collector load for Q17. This logic zero is fed to the 3A4 board on pin E. This control signal causes circuitry on 3A4 to switch a value of C3 in series with the antenna.

CR33 inhibits the Lmin, 0 phase, greater than 50 ohm function when the capacitor is at Cmax. CR19 prevents a logic 1 from appearing on Q4 collector while C1 is being homed.

4.4.3.11 POSITIVE PHASE AND GREATER THAN 50 OHM DETECTOR

This function is accomplished by recognizing a positive phase and a magnitude greater than 50 ohms. The positive phase is detected by a logic 1 across R14. This logic 1 is fed to gate U2D pin 9. Greater than 50 ohms appears as a logic 1 across R68 and is fed to gate U2D pin 10. A logic 0 results on U2D pin 8. Diode CR15 terminates the L4 Home BSMV, CR16 terminates the L4 Force BSMV and the logic 0 input to pin 5 of gate U2B terminates the C1 Home BSMV.

4.4.3.12 C1 HOME BSMV

The C1 Home BSMV (toggle or latch) consists of U2 gates A and B and cross coupling resistors R17 and R18. C26 is a delay capacitor to assure that U2 pin 3 will be a logic 0 when power is first applied to the circuit. When a Tune pulse is initiated, a logic 0 appears on the C1 Home line and a logic 1 appears on pin 3 of gate U2A. This logic 1 is fed through R22 to the base of Q7 and the variable capacitor is forced to run toward Cmax. This forcing of C1 will continue until Cmax is reached or the phase becomes positive and the magnitude is greater than 50 ohms. Cmax logic 0 will stop the C1 home through CR7 while positive phase and magnitude greater than 50 ohms will terminate the home function with the logic 0 on pin 5 of gate U2B. When the C1 Home BSMV is set (logic 0 on pin 6 of U2B), a logic 1 appears on pin 11 of gate U2C. This output saturates Q5 through R19.

Diodes CR9 and 10 short out any drive that might be coming from the phase level changers. This action is required to prevent turning on both sides of the phase servo at the same time. The C1 Home logic 0 input to pin 13 of gate U2C also shorts out any drive that may come from the phase level changers to prevent the capacitor from moving during the duration of the Tune pulse. This action is required to prevent the capacitor from moving if the unit is already tuned.

4.4.3.13 L4 HOME BSMV

The L4 Home BSMV consists of U4 gates A and B and cross coupling resistors R31 and R32. Capacitor C32 is a time delay capacitor to assure that pin 3 of U4 will be a logic 0 when power is first applied to the board. When a Tune pulse is initiated, a logic 0 appears on the Home L4 line. This causes a logic 1 on pin 3 of U4 gate A. This logic 1 drives the base of Q14, the greater than 50 ohm driver, through CR35 and R57. This action causes the inductor to run toward the homed position – Lmin. The L4 Home drive can be turned off by a positive phase-greater than 50 ohm logic 0 through CR15. If the inductor reaches Lmin, a logic 0 on the Lmin line will turn off the L4 Home drive through CR17.

4.4.3.14 L4 FORCE BSMV

The L4 Force BSMV consists of U4 gates C and D and cross coupling resistors R33 and R34. C31 is a time delay capacitor to assure that U4 pin 8 will be logic 0 when power is first turned on. The L4 Force BSMV is turned on only when Lmin and Cmax occur simultaneously. When this condition occurs, a logic 0 output from pin 6 of U5 gate B causes pin 8 of U4 to become a logic 1. This logic 1 is fed through CR39 and R61 to the base of Q13, the less than 50 ohm driver. This action forces the inductor to run toward maximum inductance.

This action is required for some frequency-impedance combinations when the capacitor is maximum and the inductor is minimum but the magnitude is still greater than 50 ohms. The L4 Force function is terminated by a positive phase and greater than 50 ohm condition through CR16. Pin R is shorted to logic 0 by circuitry on 3A4 to inhibit the L4 force function when Lmin-Cmax occurs and C3 is not in the home position.

4.4.3.15 PHASE SHORTING SWITCH

Q5, in conjunction with CR9 and CR10, shorts out the drive from the positive phase driver and the negative phase driver. This action is required when the C1 Home BSMV is set or when a Tune pulse is initiated. When the C1 Home BSMV is set, drive is supplied to the base of Q7. If the phase were positive, drive would be supplied to the base of Q6 and both sides of the servo would be turned on at the same time. Therefore, the shorting switch shorts out the positive phase drive (if it occurs) and prevents this from happening.

When a Tune pulse is initiated, a logic 1 is forced to appear on the 50(+) line by circuitry on 3A2. This logic 1 is fed to the base of Q5 through CR8 and R21, causing both positive and negative drive to be shorted out. This action is required because if the coupler is already tuned, it prevents the capacitor from moving during the interval of the Tune pulse, and results in a faster tune. R24 provides the back bias for diodes CR9 and CR10.

4.4.3.16 AMPLITUDE SHORTING SWITCH

Q15, along with CR26 and CR27, shorts out the drive from the amplitude drivers Q13 and Q14. The greater than 50 ohm and the less than 50 ohm drive must be shorted out whenever the L4 Home BSMV is set, L4 Force BSMV is set or a Tune pulse is initiated. When the L4 Home BSMV is set, the base of Q14 is driven so the inductor will be driven toward minimum L. If the amplitude error is less than 50 ohms, Q13 would also be turned on, resulting in both sides of the L4 servo being turned on at the same time. Q15 prevents this by shorting out both drive voltages. When the L4 Force BSMV is set, the base of Q13 is driven and if the amplitude error is greater than 50 ohms, then Q14 would also be turned on.

Q15 also prevents this from occurring. If either the L4 Home BSMV or the L4 Force BSMV are turned on, U5 gate A will have a logic 1 output that will saturate Q15 through R55. When a Tune pulse is initiated, the logic 1 on the 50(+) line saturates Q15 through CR25 and R56. This action prevents the inductor from moving during the interval of the Tune pulse and results in a faster tune. R59 provides the back bias for diodes CR26 and CR27.

4.4.3.17 BRAKE CIRCUIT

Each time the reflected power drops below a predetermined threshold, a brake pulse is generated in order to reduce the gain of both servo amplifiers and dampen oscillation. The 50(+) line has a logic 1 each time the reflected power is below the threshold while the 50(-) line has a logic 0. Q8 and R36 form an emitter follower circuit that provides current gain for the pulse. The brake diodes in the servo amplifier are driven through R37. R78 is a voltage dropping resistor that prevents excess dissipation in Q8.

4.4.3.18 LMIN PULSE REVERSING CIRCUIT

C35, CR40, CR41, and R38 generate a pulse each time the inductor reaches Lmin. When the Lmin switch closes, a logic 1 is generated on pin 8 of U5. This pulse is differentiated in C35. The negative spike is clipped by CR40 and the positive portion is fed to the base of Q13 by CR41. If the inductor is being driven toward Lmin at a fast speed, some means must be provided to stop it or it will hit the end stop. While the inductor is being driven, Q14 is being driven by a greater than 50 ohm error signal or by the L4 Home BSMV. When Lmin is reached, CR23 removes the error voltage drive and CR17 terminates the L4 Home function. At the same time, the Lmin Pulse Reversing Circuit reverses the drive on the inductor for the duration of the pulse. This is effective in stopping the inductor and preventing it from hitting the end stop.

4.4.3.19 LMAX REVERSING CIRCUIT

This circuit consists of CR37, R73, R74, R75, Q20, CR36 and R76. When L4 is being driven toward Lmax, whether by error voltage (less than 50 ohms) or by the L4 Force BSMV, it has to be stopped rapidly to prevent hitting the end stop and must be forced off Lmax. It must be forced off Lmax because the Lmax signal is used on 3A4 to switch in C6 capacitors across the antenna. If the inductor were allowed to close the Lmax switch and keep it closed, the C6 capacitor drive motor would continually run. Therefore, an Lmax logic 0 applied to the cathode of CR37 cuts off Q20 and its collector rises to a logic 1 and drives the base of Q14 through CR36 and R76. Since Q14 is the greater than 50 ohm driver, the inductor will be forced toward Lmin until the inductor roller is no longer contacting the Lmax switch. R73 provides a logic 1 bias for the Lmax line. R74 saturates Q20 when there is no Lmax signal. R75 is the collector load for Q20. CR24 shorts out the drive to Q13 when Lmax is reached.

4.4.3.20 OTHER COMPONENTS

R30 supplies a logic 1 bias for the Lmin-Cmax line. R29 supplies the logic 1 bias for the L4 Home BSMV. R35 supplies a logic 1 bias for the Lmin line. R77 supplies a logic 1 bias for the Cmax line. CR18 is an isolation diode between the Lmin line and pin 10 of U5. Capacitors C1-C13, C34, etc. are rf bypass capacitors to prevent rf on the wires from disturbing the logic function on the PC board.

4.4.3.21 DIODE FUNCTION LIST

The following Table 4.2 lists the diodes on 3A3 and their function.

DIODE	LINE	FUNCTION
CR5	Cmin	Removes the drive voltage from the positive phase driver when the capacitor reaches minimum C to prevent turning on both sides of the servo amp at the same time.
CR4	Cmin	Sets the C1 Home BSMV to force the capacitor toward maximum C when the Cmin switch closes.
CR8	50(+)	Drives R21 to saturate Q5 and remove the drive from the phase drivers when the reflected power drops below the threshold.
CR25	50(+)	Drives R56 to saturate Q15 and remove the drive from the amplitude drivers when the reflected power drops below the threshold.
CR19	Lmin 0ϕ, greater than 50	Prevents the Lmin, 0ϕ, greater than 50 ohm function from occuring when the C1 Home BSMV is set.
CR11	50(-)	Shorts out the drive to the negative phase driver when the reflected power drops below the threshold. If the antenna coupler is tuned to a frequency that requires no auxiliary C3 or C6, and a tune cycle is initiated, both elements would begin homing. However, since when the transmitter is turned on, a logic 0 exists on the 50(-) line (coupler already tuned), CR11 prevents the capacitor from moving and the green light comes on immediately.
CR30	50(-)	This diode shorts out the drive to the greater than 50 ohm amplitude driver for the same reason as CR11. CR30 prevents the inductor from moving when a tune cycle is initiated and the coupler is already tuned.

Table 4.2 Phase and Amplitude Control (3A3) Diode Functions

DIODE	LINE	FUNCTION
CR17	Lmin	When the inductor reaches minimum L and the Lmin switch closes to ground, CR17 resets the L4 Home BSMV.
CR23	Lmin	CR17 removes the drive from the L4 Home BSMV when the inductor reaches Lmin, but there could be drive from the greater than 50 ohm level changer (if the amplitude of the impedance is greater than 50 ohms). CR23 shorts out any drive that could be present on R58.
CR12	Home L4	If a tuning cycle has been initiated and the L4 Force BSMV is set and ANOTHER tune pulse is initiated, the L4 Home BSMV will also be set. This action would cause drive to both amplitude drivers and the amplitude servo amplifier would have both sides turned on and could destroy the transistors. CR12 resets the L4 Force BSMV each time a tuning cycle is initiated, thereby preventing this double drive condition from occurring.
CR7	Cmax	When the variable capacitor reaches maximum C, and the Cmax switch closes to ground, CR7 resets the C1 Home BSMV and removes the drive from R22 at the base of Q7, which had driven the capacitor toward maximum.
CR6	Cmax	If there is error voltage from the negative phase level changer after CR7 resets the C1 Home BSMV, CR6 will short out this drive.
CR33	Cmax	CR33 forces a logic 0 on the Lmin, 0 phase, and greater than 50 ohm line (Collectors of Q4, Q18, Q19) to inhibit this function with the capacitor at maximum.
CR24	Lmax	When the L4 Force BSMV is set by Lmin-Cmax combination, the inductor is driven toward maximum L by the drive from R61. When the inductor reaches Lmax and the Lmax switch closes to ground, CR24 shorts out the drive to the base of Q13, but does not reset the L4 force function.
CR22	50(-)	CR22 turns off the L4 force function anytime the reflected power drops below the threshold.
CR37	Lmax	CR37 places a logic 0 on the base of Q20 and generates a drive voltage to force the inductor off the Lmax switch. When the inductor moves off the Lmax switch, the drive is removed.
CR15	Positive Phase and Greater than 50 ohms	When the phase becomes positive and the amplitude is greater than 50 ohms, CR15 resets the L4 Home BSMV.

Table 4.2 Phase and Amplitude Control (3A3) Diode Functions (Cont.)

DIODE	LINE	FUNCTION
CR16	Positive Phase and Greater than 50 ohms	CR16 resets the L4 Force BSMV, if it is set, when the phase becomes positive and the amplitude is greater than 50 ohms.
CR3	C1 Home	When the C1 Home BSMV is set drive is applied to Q7 through R22. If the phase is positive, drive would also be applied to Q6 through R25, CR3 shorts out this drive during the interval of the C1 Home logic 0 pulse to prevent drive to Q6 and Q7 at the same time.
CR9	Collector of Q5	Shorts out the drive to Q6 when the reflected power is less than the treshold.
CR10	Collector of Q5	Shorts out the drive to Q7 when the reflected power is less than the threshold.
CR26	Collector of Q15	Shorts out the drive to Q13 when the reflected power is less than the threshold.
CR27	Collector of Q15	Shorts out the drive to Q14 when the reflected power is less than the threshold.
CR35	U4, pin 3	CR35 isolates the drive from the collector of Q20 from pin 3, U4.
CR36	Collector of Q20	CR36 isolates the drive from pin 3 of U4 from the collector of Q20.
CR34	Lmin, 0 phase, Greater than 50 ohms	When the inductor is at minimum L the logic 0 is inverted in U5C to a logic 1 and allows the Lmin, 0 phase, greater than 50 ohm line to rise to logic 1.
CR1	Input of U1	Protective diode to prevent overvoltage on pins 4 and 5.
CR2	Input of U1	Protective diode to prevent overvoltage on pins 4 and 5.
CR20	Input of U3	Protective diode to prevent overvoltage on pins 4 and 5.
CR21	Input of U3	Protective diode to prevent overvoltage on pins 4 and 5.
CR40 & CR41	Base of Q13	CR40 and CR41 form a voltage doubler circuit to generate a positive pulse on the base of Q13 when the inductor reaches minimum. Lmin is inverted to a logic 1 in U5, pin 8 and differentiated in C35. This action is required to prevent the inductor from hitting the end stop when it is driven by a home function and reaches Lmin before the variable capacitor reaches maximum.

Table 4.2 Phase and Amplitude Control (3A3) Diode Functions (Cont.)

DIODE	LINE	FUNCTION
CR18	Lmin	Isolates the Lmin line from pin 10 of U5.
CR19	0Ø, greater than 50 ohms	Prevents this function when the C1 Home BSMV is set.
CR39	U4, pin 8	Isolates the L4 Force drive from the base of Q13.

Table 4.2 Phase and Amplitude Control (3A3) Diode Functions (Cont.)

4.4.4 C3 & C6 CONTROL (3A4)

See Figure 5.5

This plug in board is used to control the antenna modification capacitors, C3 and C6, which are located in the RF section. C6 is composed of 12-100pf transmitting capacitors and they are switched in shunt with the variable inductor, L4. C6 is stepped in steps of 100, 300, 500, 800 and 1200 pf. That is, the first step of the C6 is 100pf, the second step is 300pf, the third step is 500 pf, etc. C3 is also located in the RF compartment and is composed of 4 transmitting capacitors, 100pf, 50pf, 50pf, and 25pf. The C3 capacitors are switched in series with the antenna in steps of 225pf, 125pf, 75pf and 25pf. The C3 and C6 antenna modification capacitors are required to tune a large range of antenna impedances.

3A4 consists of three integrated circuits, three transistors, two relays and associated circuitry. The major functions of 3A4 can be separated as follows:

1. C6 Home BSMV (latch or flip-flop)
2. C3 Home BSMV
3. C6 Advance BSMV
4. K1 driver
5. K2 driver
6. K1 motor control
7. K2 motor control
8. C3 Advance functions
9. Other circuitry

These individual functions will be discussed in detail.

4.4.4.1 C6 HOME BSMV

This BSMV consists of U1A and U1B and associated circuitry. Its purpose is to remove all capacitance from the inductor, L4, when a tuning cycle is initiated. When a tuning cycle is initiated Q15 collector (located on 3A2) generates a logic 0 (0-.3V) and diode CR1 causes a logic 0 on pin 1 of U1. This action causes a logic 1 on pin 3 of U1 and gate B of U1 has a logic 0 on its output, pin 6. The cross coupling resistors R3 and R4 cause the BSMV to remain in that condition. R1 is a bias resistor that causes a logic 1 on pin 1. R2 and C18 force the BSMV to "come up" in the right condition when the unit is first turned on. (A logic 0 should be on pin 3 when the unit is first turned on.)

Immediately after the tuning cycle is initiated, pin 6 of U1 has a logic 0 and CR4 pulls pin 1 of U2 to a logic 0. R8 is a bias resistor. This action causes Q2 to be saturated by R12. Relay K1 is pulled in and the motor that controls C6 begins to run. When the motor runs, SW3 (on the C3-C6 assembly) revolves until the wiper comes to position 5. (See Figure 4.4.) This is the C6 home position. The logic 0 generated by SW3 position 5 is fed to 3XA4 pin A.

4.4.4.2 C3 HOME BSMV

The C3 Home BSMV consists of U3 A and B. Its purpose is to assure that C3 capacity is not in series with the antenna when a tuning cycle is started. When a tuning cycle is initiated, Q15 collector generates a logic 0 and CR2 causes a logic 0 on pin 1 of U3. (R15 is a bias resistor to assure a logic 1 on pin 1.) When the logic 0 appears on pin 1 of U3, pin 6 of U3 has a logic 0 and the cross coupling resistors, R19 and R20, cause the BSMV to remain in that condition. (R18 and C21 assure that the BSMV will come up in the proper condition as soon as power is applied.)

The logic 0 on pin 6 of U3 is inverted to a logic 1 in U3C (pin 8) and Q3 is saturated. This action causes K2 to pull in and the C3 control motor begins to turn. SW1 in the C3-C6 Assembly will rotate until the wiper reaches position 2, the C3 home position. 3XA4, pin 7, couples the logic 0 generated by SW1 position 2 to U3 pin 4 via CR14. (R9 is a bias resistor for the C3 home line.) SW1 of the C3-C6 Assembly is now in the home position and the series capacitors are shorted out.

4.4.4.3 C6 ADVANCE BSMV

The C6 advance BSMV consists of the U1C and U1D and cross coupling resistors R5 and R6. (R7 and C19 are used to make the BSMV come up in the proper condition when it is turned on.) Each time the variable inductor, L4, reaches maximum L, the Lmax switch generates a logic 0. This logic 0 is fed to U1 pin 11 via CR20, which sets the C6 advance BSMV and causes a logic 0 to appear on pin 2 of U2. This action causes Q2 to saturate and K1 pulls in and the C6 motor begins to run. As soon as SW3 of the C3-C6 assembly is in position 1 (100pf across L4), a logic 0 is fed to pin 4 of 3XA4; and the C6 advance BSMV is reset via CR3.

This action will continue and another step of C6 will be switched across L4 until L4 stops contacting the Lmax switch. L4 will begin running toward Lmin when the phase is positive and the magnitude is greater than 50 ohms, or when C6 reaches position 16 and the magnitude is greater than 50 ohms, even if the phase is negative. This is caused by position 16 on SW3 of the C3-C6 assembly placing a logic 0 on the cathode of CR23 and simulating a plus phase and greater than 50 ohm condition. Pin F on 3XA4 connects to pin C on 3XA3, the plus phase-greater than 50 ohm output. The C6 motor will step one step of C6 for each Lmax pulse, until 1200 pf is reached. At this time, the first step of C3 will be inserted. If the C6 advance BSMV is set and C6 reaches the home position, CR21 will reset this BSMV.

4.4.4.4 K1 DRIVER

Transistor Q2 drives K1. A logic 1 on pin 3 of U2 causes Q2 to saturate and relay K1 pulls in and the C6 motor begins to run, switching C6 across the inductor. R12 is the base drive resistor for Q2.

4.4.4.5 K2 DRIVER

Transistor Q3 is the driver for relay K2. A logic 1 on pin 8 of U3 drives Q3 to saturation through R21, the base drive resistor. When Q3 saturates, relay K2 pulls in and the C3 motor begins to run, switching capacity in series with the antenna.

4.4.4.6 K1 MOTOR CONTROL

K1 motor control consists of K1 and associated components. When K1 is energized, pole 2 of K1 connects to pin 5 and a ground is placed on one side of the C6 motor. (Pin 14 of 3XA4.) The C6 motor then runs until relay K1 is de-energized. When the relay is de-energized pole 2 of K1 contacts pin 4 and the side of the motor that was at ground is switched to the 28V line, effectively dynamically braking the motor and preventing overshoot. Diode CR11 clamps the positive going spike across the relay coil to protect transistor Q2 from overvoltage. Diode CR12 clamps the positive going spike across the contacts of the relay. Diode CR13 clamps the negative going spike across the relay contacts.

4.4.4.7 K2 MOTOR CONTROL

K2 motor control consists of K2 and associated components. When K2 is energized, the C3 motor runs until the relay is de-energized. Diodes CR15, 16 and 17 are spike supressors. The operation of the K2 relay is identical to the K1 relay, except the K2 relay controls the C3 motor and the K1 relay controls the C6 motor. Pole 6 of K2 places a logic 0 on pin 10 of U1 when the C3 motor first starts to turn. This action is required to force the C6 motor to home. Each time a C3 is switched in series with the antenna, all the C6 is removed.

4.4.4.8 C3 ADVANCE FUNCTIONS

The series capacitor is switched into the RF tuning circuits when the following 3 conditions exist:

1. SW3 WIPER (ON THE C3-C6 ASSEMBLY) COMES TO POSITION 16.

When a tuning cycle is started, all capacitance, C3 and C6 is removed from the RF tuning circuit. The tuning cycle begins with just a series C1 and the shunt L4. NO ANTENNA MODIFICATION CAPACITORS ARE USED UNLESS THEY ARE REQUIRED. The inductor L4 and the vacuum variable capacitor C1 both begin tuning and if the inductor reaches Lmax, C6 is switched across the inductor. If C6 reaches 1200pf and the circuit still needs more shunt C, the next position is SW3 position 16. This generates a logic 0 on 3XA4 pin 2 and resets the C6 advance BSMV via CR21. CR5 generates a logic 0 to pin 1 of U2 so the C6 motor will not stop on position 16. The logic 0 generated on pin 4 of U2 is inverted in U2B and a logic 1 appears on pin 9 of U2. If the C6 home BSMV is not set (it is set when it has logic 0 on pin 6) then a logic 0 will be generated on pin 8 of U2. This logic 0 will cause a logic 0 on pin 10 of U3 through CR8. R14 is a bias resistor. The resulting logic 1 on pin 8 of U3 will saturate Q3 causing the C3 motor to advance one position. It should be noted that if the C6 home BSMV is set, pin 6 of U1 will have a logic 0 and this will inhibit SW3 position 16 from advancing C3. This action is required to prevent C3 from advancing one position when C6 homes. (If C3 is already home.)

2. L MIN. 0 PHASE ERROR AND GREATER THAN 50 OHMS.

During the tuning cycle, certain impedances will cause the inductor to run to minimum inductance and the capacitor to resonate. If this happens, no tuning can occur and the time delay will run out if certain actions are not taken. On the 3A3 board (Phase and Amplitude Control) the condition of Lmin. 0 phase error. and greater than 50 ohms is detected and fed to 3A4 on pin 5 of 3XA4. A logic 0 is provided on pin 5 and through CR9. a logic 0 is forced on pin 10 of U3. This causes a logic 1 on pin 8 of U3 and C3 is advanced.

3. L MIN-C MAX AND C3 IS NOT IN THE HOME POSITION.

If, during a tuning cycle, the inductor reaches minimum L and the capacitor reaches maximum capacity, and if some C3 is switched into the circuit, then some action must be taken. If some C3 is already in the RF tuning circuit it means that the inductor has already been to maximum L at least one time. Therefore, when Lmin-Cmax condition exists and C3 is not homed. the next step of C3 should be inserted. This is accomplished by transistor Q1 and other circuits. Lmin-Cmax is detected on 3A3 and fed to the 3A4 board on pin 6 of 3XA4. This logic 0 is transferred to the base of Q1 via CR10 and is inverted to a logic 1 on the collector of Q1. R10 is the base bias resistor and R11 is the collector load resistor.

The logic 1 on the collector of Q1 is fed to pin 12 of U2. If C3 is not in the home position, pin 13 of U2 will be a logic 1 and pin 11 of U2 will be logic 0, forcing a logic 0 on pin 10 of U3 through CR7. This action causes logic 1 on pin 8 of U3, causing C3 to advance one or more positions. The L4 force function generated on 3A3 is inhibited by a logic 0 on pin 11 of U3. Diode CR24 is connected to 3A3 pin R by 3XA4 pin J. The L4 force/inhibit prevents L4 from running up to the Lmax again and shortens tuning time. When C3 is not in the home position, a logic 1 on pin 12 of U3 generates the L4 force inhibit.

4.4.4.9 OTHER CIRCUITRY

Capacitors C1 through C17, C22 and C23 are RF bypasses to prevent RF in the tuning compartment from entering the PC board. Diode CR18 connects the 75pf line (pin 16) to the Home L4 line (pin 15). If, during the tuning cycle, C3 reaches 75pf, a logic 0 is generated by SW1 on the C3 and C6 assembly. When SW1 reaches position 21 (75pf) a logic 0 is generated and connected to pin 16 of 3XA4. Diode CR18 forces a logic 0 on the Home L4 line and the inductor will begin homing toward minimum L. This action reduces tuning time.

4.4.4.10 C3 AND C6 CONTROL (3A4) DIODE FUNCTIONS

DIODE	LINE	FUNCTION
CR1	Q15 Collector	Sets the C6 home BSMV when a tuning cycle is initiated.
CR2	Q15 Collector	Sets the C3 home BSMV when a tuning cycle is initiated.
CR3	C6 (100-1200)	Resets the C6 advance BSMV when the C6 capacitor is in positions 100pf, 300pf, 500pf, 800pf and 1200pf.
CR4	U2 pin 1	When the C6 home BSMV is set, CR4 places a logic 0 on pin 1 of U2 and causes the C6 motor to run.
CR5	C6 position 16	Causes a logic 0 on pin 1 of U2 and causes the C6 motor to keep running and not stop on position 16.
CR7	U2 pin 11	When the condition of Lmin and Cmax occurs, and C3 is not in the home position, CR7 places a logic 0 on pin 10 of U3, causing the C3 motor to advance.
CR8	U2 pin 8	When the C6 home BSMV is not set (C6 motor not homing), and the C6 control wafer comes to position 16, U2 pin 8 has a logic 0; CR8 causes the C3 motor to advance. If the C6 home BSMV is set, there will be a logic 1 on pin 2 of U2 and the C3 motor will not be advanced. This action prevents C3 from advancing when C6 is homing.
CR9	Lmin, 0ϕ, greater than 50 ohms	When this condition occurs, CR9 causes the C3 motor to advance.
CR10	Lmin-Cmax	Causes a logic 0 on the base of Q1 when this condition exists. Will advance C3 if C3 is not in the home position.
CR11	Across K1	Clamps relay turn off inductive spike to 28V.
CR12	K1 pin 4	Clamps voltage spikes across the relay contacts to 28V.
CR13	K1 pin 5	Clamps negative voltage spikes across relay contacts to ground.
CR14	C3 Home	When C3 is in the home position, a logic 0 on this line resets the C3 home BSMV.
CR15, 16, 17	K2 Relay	Perform the same voltage transient protection as CR11, 12 and 13.
CR18	75pf	This diode causes L4 to home when C3 reaches 75pf.

Table 4.3 C3 and C6 Control (3A4) Diode Functions

DIODE	LINE	FUNCTION
CR21	C6 Home	CR21 resets the C6 Advance BSMV when C6 reaches home.
CR22	C6 Home	CR22 resets the C6 Home BSMV when the C6 capacitor reaches the home position.
CR23	C6 position 16	This diode places a logic 0 on the +Ø, greater than 50 ohm line when C6 reaches position 16. When the inductor reaches Lmax, and is being forced by the L4 force function, C6 will switch through its capacitive range until the phase is positive and the magnitude is greater than 50 ohms. If the capacitor reaches 1200pf, the phase is not positive and the magnitude is not greater than 50 ohms, then position 16 on C6 will terminate the L4 force function.
CR24	L4 Force inhibit	CR24 places a logic 0 on pin J of 3XA4 and inhibits the L4 force function on 3A3. This inhibit function occurs only when C3 is not in the home position.

Table 4.3 C3 and C6 Control (3A4) Diode Functions (Cont.)

4.4.5 SERVO MOTOR CONTROL (3A5)

The servo motor control assembly is a plug-in board and is shown schematically in Figure 5.6.

The amplitude and the phase servo amplifiers are identical, so only one will be discussed. The servo amplifiers drive the motors for the vacuum variable capacitor and the variable inductor directly. The phase servo will be discussed.

The +Ø input is on pin 3 and is driven from 3A3 by the positive phase driver 3A3Q6. When this line drops below 28 VDC, transistor Q1 is allowed to conduct through R2. R1 is a bias resistor to keep Q1 cutoff when pin 3 is at 28 VDC. Q1 conducting causes a positive voltage to appear on the emitter of Q2, which is connected to the Ø servo motor. At the same time R6 and R7 voltage divider causes Q4 to conduct, creating a path to ground for the other side of the Ø motor. Therefore, negative drive on pin 3 causes a positive voltage on pin 6 with respect to pin 7 and the servo motor will run in one direction at a speed proportional to the magnitude of the voltage.

If a negative drive is presented on pin 4, the negative Ø drive, R8 will allow Q6 to conduct. R9 is a bias resistor to keep Q6 cut off when pin 4 is at 28 VDC. Q6 conducting causes a positive voltage on the emitter of Q5, and a positive voltage is applied to one side of the servo amplifier. At the same time, Q3 is caused to conduct by voltage divider R3 and R4. When Q3 conducts, a current path to ground is provided for the other side of the servo motor. A negative drive on pin 4 causes a positive voltage between pin 6 and pin 7 and the servo motor will turn in the opposite direction than it did for negative drive on pin 3.

It should be noted that the operation of the servo amplifier is completely analog. That is, pin 3 could be at 12 volts and pin 4 at 10 volts and the motor would operate in a direction for a negative phase. Pin 4 could be 22 volts and pin 3 zero volts and the motor would turn in a direction for a positive phase.

C1 and R5 are used for a spike filter network. Diode CR1 clamps positive voltage spikes to the 28 VDC input. CR2 clamps negative voltage transients to ground. CR5 and CR6 are also transient supressor diodes. CR3 and CR4 are brake diodes and are driven from the brake circuit on 3A3. The purpose of these diodes is to dampen oscillation when 50 ohm crossovers are detected.

The amplitude servo amplifier has identical components and operates in the same manner as the phase servo.

4.4.6 FILTER REGULATOR (3A8A2)

The filter regulator board contains the following basic circuit functions.

1. **5 Volt Regulator.**
2. **RF Detector**
3. **Anti-Oscillation Circuit**
4. **Tune Pulse Command Switch.**

4.4.6.1 5 VOLT REGULATOR

The 5 volt regulator is composed of R1, CR3, C1 and C2. The 12V input is brought to pin E and is filtered by C1. R1 drops the 12 VDC to 5 VDC. CR3 is a zener diode and regulates the 5 VDC that is used for the logic circuits on 3A2, 3A3, 3A4, and 3A8A2. C2 is a filter capacitor for the 5 VDC output. The 5 volt output is fed to pin B.

4.4.6.2 RF DETECTOR

The RF detector is composed of R3, CR1, CR2, and C4. The RF input to the antenna coupler is fed to pin 3 on a coax. When RF is present a positive DC voltage is rectified by CR1 and CR2 and fed to pin D. The RF detector is important in the operation of the antenna coupler. Logic circuits on 3A2 accept the output from the RF detector and use it to signal the end of a tune cycle when (a) RF is present and (b) the reflected power is below the threshold.

4.4.6.3 ANTI-OSCILLATION CIRCUIT

This circuit is important to the operation of the antenna coupler when certain extremely high Q impedances are being tuned. That is, when a very small change of L4 or C1 causes a tremendous change in the output, from the magnitude and phase detectors, and the driven elements are oscillating about the tune point. The anti-oscillation circuit consists of Q1, Q2, Q3 and associated circuit components.

If the elements are oscillating about the tune point, the 50(+) line will have positive pulses, indicating that the reflected power has dropped below the required threshold for a brief moment. These 50(+) pulses are fed to pin 15 and through C3 to the base of Q1. Q1, R2, R4 and C5 form a boot strap circuit. For each 50(+) pulse, C5 is charged up to the peak value of the pulse. The next pulse increases the voltage on C5, and subsequent pulses continue to increase the voltage across C5. This is essentially a staircase for repeated 50(+) pulses. The voltage on C5 is fed through R27 to the base of Q2 and charges C6. Q2 is a high impedance darlington and causes a near constant DC voltage on the emitter of Q2. The voltage across R6 continues to increase until it reaches the breakdown voltage of the zener diode, CR13 (6.8V). When CR13 conducts, Q3 is saturated and R23 (100K) is switched across the output of the reflected power detector. This action causes the reflected power to drop below the threshold and the antenna coupler tune cycle ends. C9 and C10 are RF bypasses.

The anti-oscillation circuit is dormant except during a tune cycle. The collector voltages for Q1 and Q2 are switched off at the end of a tune cycle. Diodes **CR5 and 15** are connected to the C6 relay and inhibits the 50(+) inputs that might occur when C6 is switching.

4.4.6.4 SPECIAL ACTIVE CIRCUITRY ON 3A8A2 FOR USE WITH THE ACU-150A ( )

For operation with the ASB-320, 100A, 125/60 and the ASB-130 the mode of operation for the antenna coupler is to first channel the transceiver to the desired frequency and then depress the push to talk button on the microphone in order to initiate a tune pulse. Additional circuitry is required to accomplish this. Figure 5.7 is a schematic diagram of the Filter Regulator board (3A8A2) for the ACU-150A ( ).

Q4, U1, Q5, Q6 and K1 and associated circuitry are used to generate the functions needed. The channel pulse line, pin 2, is normally at +28 VDC. When the companion transceiver is channeled, the channel pulse line drops to near ground and Q4 conducts, causing a logic 1 to appear across R11. This logic 1 is inverted in U1A and sets the BSMV U1C and U1D so a logic 1 appears on U1 pin 6.

R15 and R16 are cross coupling resistors used to latch the gates B and C. R14 and C7 load the BSMV to assure that when power is first applied the BSMV will come up with a logic 0 on pin 6. After the channel pulse, with a logic 1 on U1 pin 6, R17 drives the base of Q5, saturating Q5. With Q5 saturated (collector at near ground) R24 causes Q6 to conduct. When Q6 conducts, approximately 15 volts appears across R20. This voltage is used to turn on the fault BSMV on 3A2 (causing the Fault light to be illuminated) and also applies voltage to one side of K2 on the 3A1A1 board.

When the PTT line goes to ground (microphone push to talk button depressed), relay K2 on the 3A1A1 board latches up. When K2 is energized (K2 is the Tune control relay), switched 28V is applied to pin 11 of 3A8A2 and 3A8A2 K1 pulls in. This action mutes the audio by placing a ground on K1 pin 5. (The transmit audio must be muted during the Tune cycle to prevent modulation of the carrier.)

Pole 6, of K1, switches 28 volts onto pin 1, supplying the 28 VDC AM enable voltage. The 28 VDC AM enable voltage is divided down to 10 VDC through R25 and CR4 to provide the 10 VDC AM enable voltage.

When the Tune cycle is initiated, R21, C8 and R22 differentiate the leading edge of the SW 28 volts to generate a Tune Start pulse. This pulse is fed to 3A2 pin A. After the completion of the Tune cycle, a logic 0 from 3A2 is fed to 3A8A2 pin C and CR9 resets the Channel Pulse BSMV. If the time delay runs out, a logic 0 on pin H, through CR8, resets the Channel Pulse BSMV.

Other components on the board are R8, R9, R10, and R11. R8 is the base drive resistor for Q4 while R9 keeps Q4 cutoff when the channel pulse is at 28 volts. R10 supplies degeneration for Q4 and R11 divides the 28 volts down to a logic 1 level across R12. CR11 clamps the relay inductive kick to 28 volts. CR10, 12, and 14 are isolation diodes.

4.4.6.5 SWITCHING FUNCTION ROUTING FOR (3A8A2)

In order to use the ACU-150 antenna coupler with a number of different transceivers without changing the chassis wiring some means must be provided to route different input lines to other connectors. This is done on the 3A8A2 board by utilizing printed circuit jumpers on the different versions of the board. Partial schematics emphasizing the printed circuit jumpers are shown in Figures 4.2. Most of the input control lines to J1 are identified as dual functions. During the follow ing discussion the function for the particular transceiver will be used.

4.4.6.5.1 SWITCHING FUNCTION ROUTING FOR THE ACU-150A ( )

Refer to Figure 4.2. When the transceiver (ASB-320, 100A, 125/60 or 130) is channeled to a new frequency, +15 volts is supplied to K2(+). K2 is the Tune control relay and the tune cycle does not begin until the PTT line is shorted to ground. CR16, from 3A8A2 pin L to pin R, provides the ground for K2. K2 pulls in and latches because CR 16, pin M is grounded when the relay is energized. After the tune cycle is completed, the Channel Pulse BSMV is reset and the +15 VDC is removed from 3A8A2 pin 14. The Tune Start pulse is generated on the 3A8A2 board by differentiation of the SW28 VDC by C8 and R22. The heavy dark lines indicate the printed circuit jumpers.

4.4.6.5.2 SWITCHING FUNCTIONS WITH ASB-500

The tune command for the ASB-500 originates in the control head by depressing the TUNE pushbutton. When this is done, a +12VDC pulse is applied to pin a (KW/CPLR) of J1. This tune command is applied to pin 6 of 3A8A2 and through R29 to the base of Q7. The tune command (+12V) is also applied to pin A of 3A2. Q7 is saturated and +15V is applied to pin 14 of 3A1A1. At the same time, the tune command applied to pin A of 3A2 causes a ground on the interlock line. This ground, through CR17 and the jumper from pin L to pin S of P1, causes a ground on pin R of 3A1A1 and relay K2 pulls in. Termination of the tune cycle is accomplished in the same manner as for the ASB-125, ASB-320, or ASB-100A.

4.4.7 C1 ASSEMBLY (3A9)

The C1 assembly consists of C1, the vacuum variable capacitor, the Ø servo motor, T1 (12.5-50 ohm transformer), and the Cmax and Cmin switches. This subassembly is shown schematically in Figure 5.1 and a photograph in Figure 5.9.

Capacitor C1 has a range of 7-1000pf and is driven by the Ø motor to increase capacitance for a negative phase and to decrease capacitance for a positive phase. C1 is connected from the center tap of the transformer to the antenna and changes both the magnitude and the phase presented to the transformer. (C1 does not alter the real part of the antenna impedance, however.) C1 is controlled by the phase detector on 3A1A1 except for the C1 home function.

Transformer T1 transforms the 12.5 ohm input to C1 (when tuned) to 50 ohms for the transmitter output. Cmin and Cmax switches provide a logic 0 when the capacitor reaches its limits.

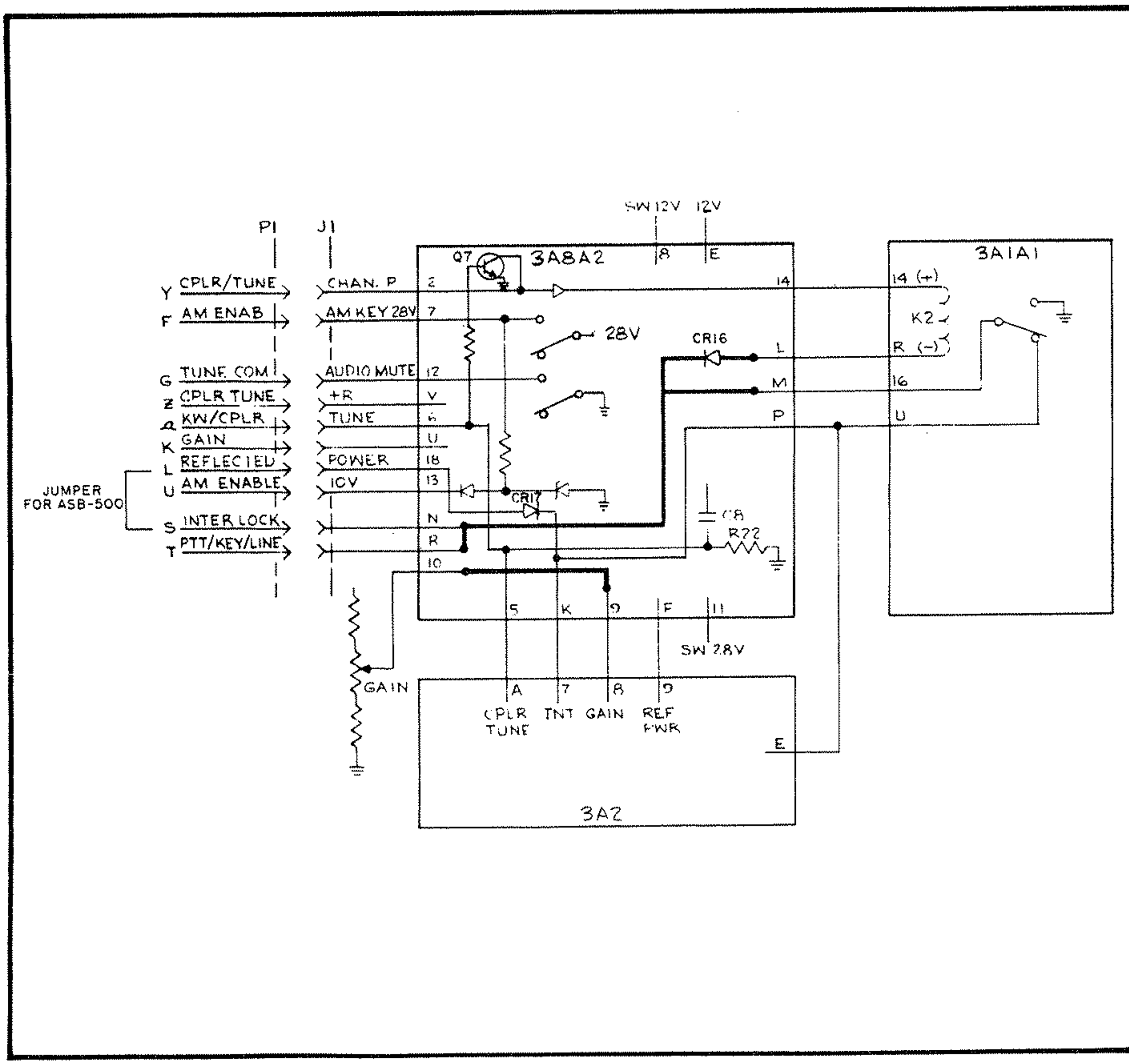

Figure 4.2 Switching Function Routing for ACU-150A ( )

4.4.8 L4 ASSEMBLY (3A10)

See Figure 5.10. This assembly consists of a .2 to 18 microhenry variable inductor, the amplitude servo motor and the limit switches. The amplitude detector on 3A1A1 drives the variable inductor toward maximum inductance for an amplitude less than 50 ohms and toward minimum inductance for an amplitude greater than 50 ohms. L4 is under the control of the amplitude detector except for the L4 home and L4 force functions. The variable inductor is connected in parallel with the antenna (or antenna modified by C6-C3 capacitors) and changes both the amplitude and the phase presented to 3A1. However, L4 can change the real part of the antenna impedance, where C1 cannot change the real part. The Lmin and Lmax switches indicate when the inductor reaches its limits.

4.4.9 C3 AND C6 ANTENNA MODIFICATION CAPACITORS (3A11)

These modification capacitors are used when the antenna coupler cannot tune a particular frequency-impedance point within the range of the C1 and L4 network. Operation of these capacitors is controlled by circuitry on 3A4. The schematic diagram is shown in Figure 4.4. SW1 and SW3 are motor control switch wafers that can signal 3A4 the exact location of SW2 and SW4. SW2 and SW4 are high voltage ceramic switches that switch the RF power from the C1-L4 tuning network to the antenna. Figure 5.11 is a photograph of the C3-C6 Assembly.

When a tune cycle is initiated, if any C3 or C6 is in the circuit, motors B1 and B2 are controlled by 3A4 and cause SW1 and SW3 to advance to the home positions. SW1 homes to position 2 and SW2 is positioned as shown. In this condition, all the C3 capacitors are shorted. SW3 homes to position 5 and SW4 is positioned as shown in the schematic. In this position, all C6 capacitors are removed from the circuit. When no C3 or C6 capacitors are used (SW1 and SW3 are already in the home position) and a tune cycle is initiated, motors B1 and B2 do not run.

During the tune cycle, when L4 reaches Lmax, circuitry on 3A4 causes C6 to advance to position 1 and stop. C6 remains in this position until another Lmax pulse is generated. At this time, C6 will advance to position 23. This action will continue, one advance of C6 for each Lmax pulse, until C6 reaches position 16. By referring to the schematic diagram it can be seen that the total C6 capacity placed in shunt with the antenna is stepped as follows: 100pf, 300pf, 500pf, 800pf, and 1200pf. If, after C6 is 1200pf, another Lmax pulse occurs, SW3 is advanced to position 16 and the first step of C3 is inserted in series with the antenna, and C6 is forced to go to the home position. If Lmax pulses continue to occur, the same sequence will continue. For a few rare frequency-impedance conditions, C6 will go through three complete cycles, resulting in C3 being 75pf. Circuitry on 3A4 causes L4 to run toward minimum inductance when C6 reaches 75pf. When L4 reaches Lmin, C1 will be at maximum and circuitry on 3A4 will cause C3 to decrease to 25pf.

There are special conditions when C3 will be inserted in series with the antenna without C6 being switched at all. These conditions are:

1. Lmin, 0ϕ, greater than 50 ohms.
2. Lmin, Cmax and C3 not in the home position.

Circuitry on 3A3 and 3A4 control the switching of C3 for these conditions.

There are 25 combinations of C3 and C6 capacitor configurations and it can be seen that the range of antenna impedance, that can be tuned, is large. The C3 capacitors are generally used only when the magnitude of the impedance is less than 12.5 ohms. The C6 capacitors are used only when the impedance of the antenna is out of the range of the 18 microhenry inductor.

4.4.10 TYPICAL TUNING SEQUENCE

The impedance selected for this example is for a Jetstar antenna at 2 MHz. This impedance is .58 +j34 and was selected because it requires C6 to go through all steps to 1200pf, switch in the first step of C3, and again switch in 100pf of C6. The tuning sequence will be broken up into four steps as follows:

- (a) Initial conditions immediately after the Tune cycle is initiated.
  1. Conditions on 3A2
  2. Conditions on 3A3
  3. Conditions on 3A4
  4. Conditions on 3A11
- (b) C1 and L4 Operation during the Tune cycle.
- (c) Termination of the Tune cycle.

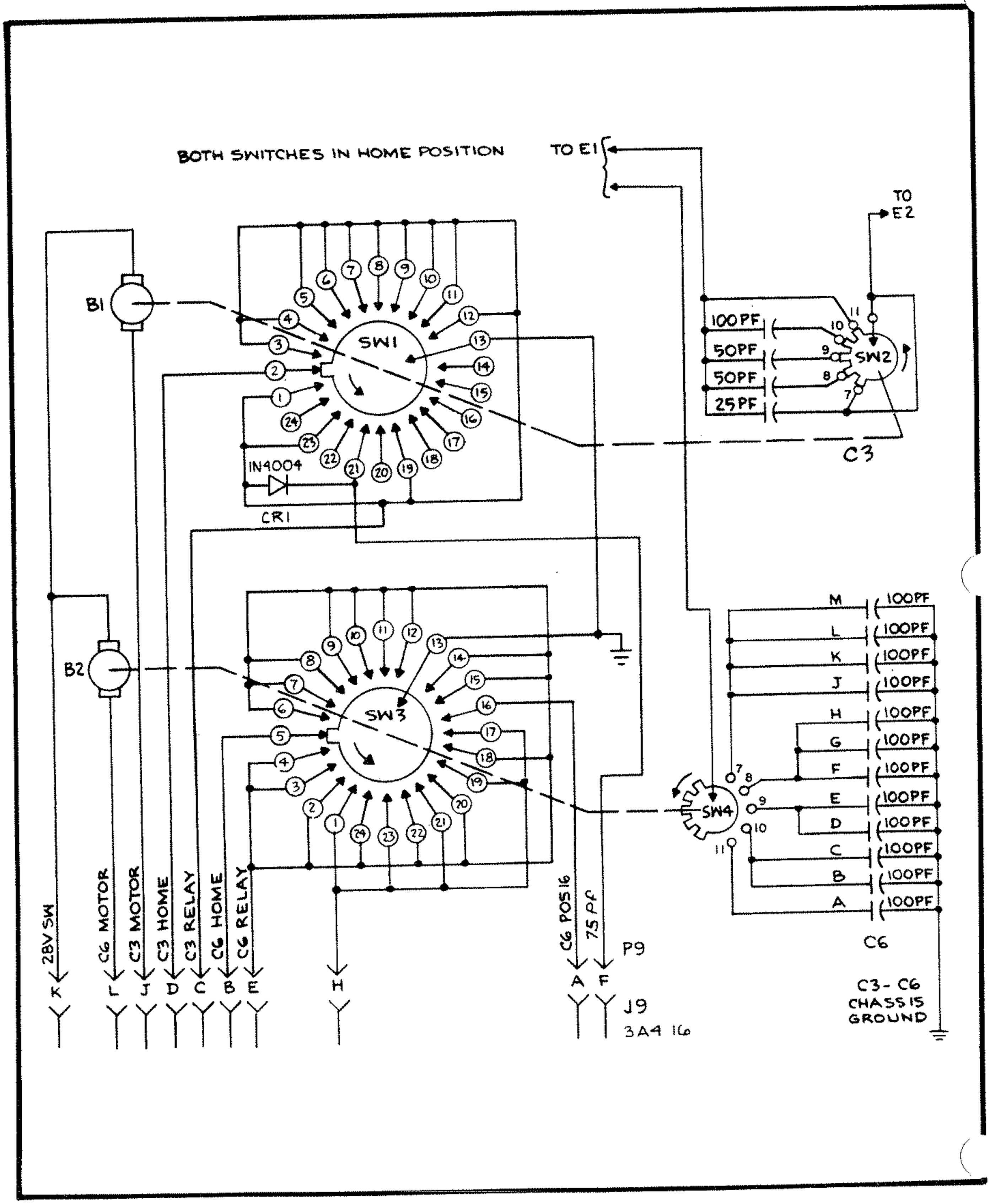

Figure 4.4 C3-C6 Antenna Modification Capacitors

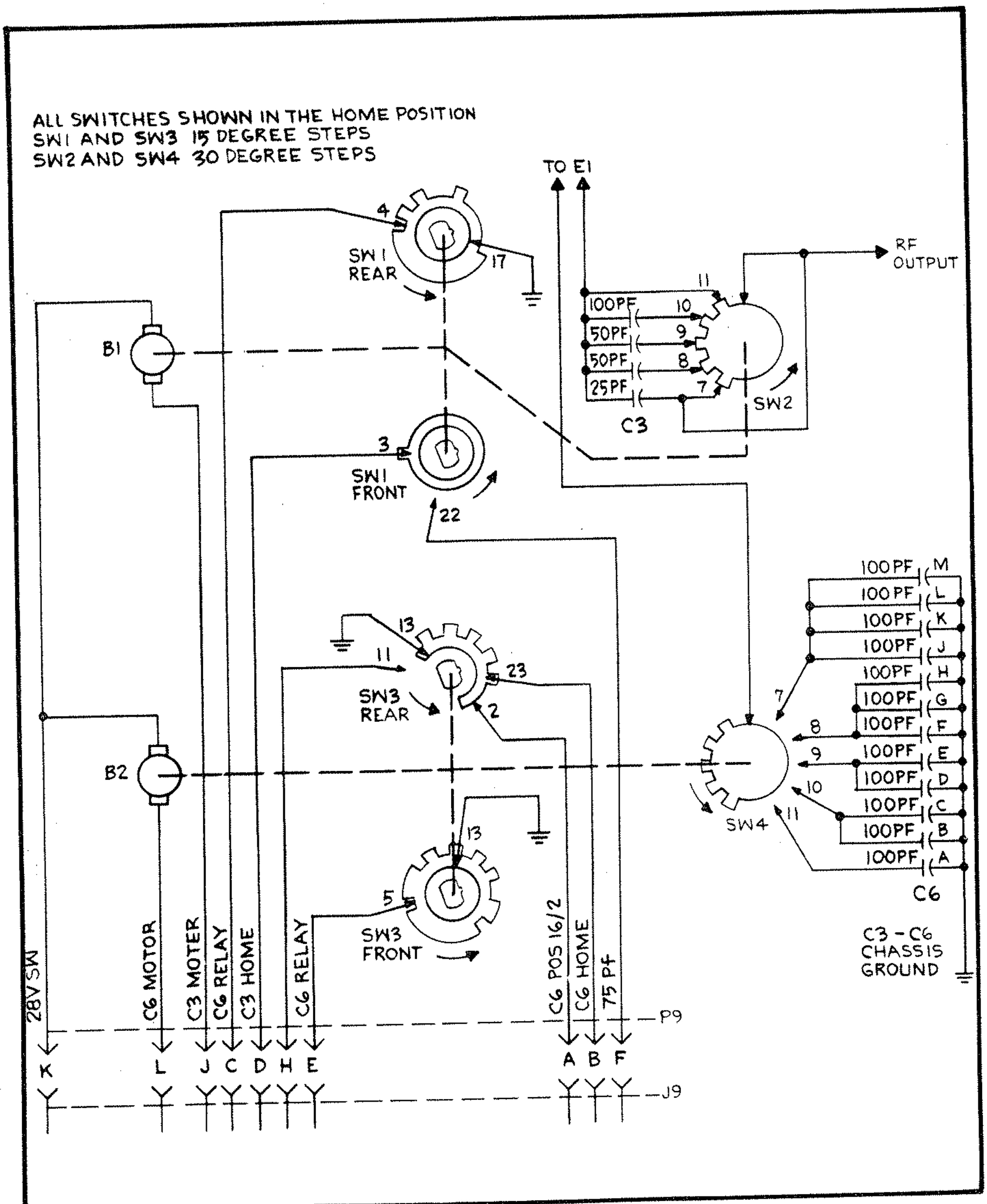

Figure 4.4A C3-C6 Antenna Modification Capacitors (Rev. H and higher)

4.4.10.1 INITIAL CONDITIONS IMMEDIATELY AFTER THE TUNE CYCLE IS INITIATED

4.4.10.1.1 CONDITIONS ON 3A2

The tune start pulse is applied to pin A of 3XA2 generating a tune start pulse. Q15 is saturated and the following actions occur on 3A2:

ACTION	PURPOSE
1. The Tune BSMV is set	Saturates Q9 and Q10, illuminating the Tune light and grounding the interlock line. This action pulls in the Tune Control relay on 3A1A1 and switches 28 VDC, 12 VDC, and keys on the transmitter.
2. The 50 ohm BSMV is set	This action pulls in the pad relay to assure a near 50 ohm load on the transmitter.
3. C1 Home and L4 Home pulses are generated	To set the C1 Home BSMV and the L4 Home BSMV on 3A3.
4. R17-C32 and R15-C31 time constants are discharged	To prevent getting a false tune in case the transmitter power is delayed in coming on. Also, to prevent the driven elements from moving during the duration of the tune pulse.
5. The Fault BSMV is turned off	It is turned off, if it is on, by the tune pulse and will be set again by the time delay or reflected power.

4.4.10.2 CONDITIONS ON 3A3

ACTION	PURPOSE
1. The C1 Home BSMV is set	To force C1 to begin running toward Cmax.
2. The L4 Home BSMV is set	To force L4 to run toward Lmin.

4.4.10.3 CONDITIONS ON 3A4

ACTION	PURPOSE
1. C6 Home BSMV is set	To force C6 to the home position and remove all C6 from the antenna.
2. C3 Home BSMV is set	To force C3 to the Home position and short out C3.

Both C3 and C6 Home BSMVs are set by the collector of Q15, 3A2 pin S and 3A4 pin 3.

4.4.10.4 CONDITIONS ON 3A11 (C3 AND C6 ASSEMBLY)

ACTION	PURPOSE
1. SW3 moves to position 5,	C6 is removed from the antenna.
2. SW1 moves to position 2,	C3 is shorted out.

4.4.10.2 C1 AND L4 OPERATION

The impedance presented (.58 +j34) with L4 across it and C1 in series, presents an impedance magnitude greater than 50 ohms with a negative phase. C1 will run to Cmax because of the home function (or because of the negative phase) and L4 will run to Lmin because of the L4 force or the magnitude error voltage. With L4 at min and C1 at maximum, the L4 force function will force L4 to run to Lmax. The first Lmax pulse will switch in 100pf of C6. the second Lmax pulse will switch in 300pf of C6. etc. until C6 is 1200pf. At this time the magnitude is still greater than 50 ohms and the phase is negative. Since L4 is being forced toward Lmax, the force causes another Lmax pulse and SW3 advances to position 16 and the first step of C3 is switched in and C6 homes. Also, the L4 force function is terminated. The condition at this time is that the antenna, .58 +j34 has 225pf in series with it.

The impedance presented to the antenna coupler is now .58 -j320. With nearly 18 microhenries across the antenna (.58 -j320) and C1 at maximum, the magnitude is greater than 50 ohms and the phase is positive. C1 begins to decrease in capacity (driven by a positive phase angle) and L4 begins to run toward Lmin (driven by an amplitude signal greater than 50 ohms and the L4 force terminated). Normal servo operation takes over. The action of L4 and C1 decreasing causes the amplitude error to reverse and L4 begins running back toward Lmax while the capacitor resonates along zero phase. The inductor reaches Lmax and 100pf of C6 is switched across the antenna (.58 -j320). This added capacity has raised the real part of the antenna to greater than 50 ohms and both elements tune to null.

4.4.10.3 TERMINATION OF THE TUNE CYCLE

When C1 and L4 are close to the correct values, along with 225pf of series C and 100pf of shunt C. the reflected power has dropped below the threshold and a logic output on the collector of 3A2Q3 (50(-) line) indicates this condition. The 50(-) logic 0 is inverted in 3A2U6A and combined with a logic 1 on pin 5 of 3A2U6B. The logic 1 on pin 5 indicates that RF is present and is derived from the RF detector. The resulting logic 0, on pin 6 of 3A2U6, causes the 50 ohm BSMV to be reset and the pad relay falls out.

This action removes the 3DB pad and full tune power is applied to the phase and amplitude detectors. C1 and L4 are now driven with more error voltage and they will position themselves accordingly. The first time the pad relay falls out, it is usually for a short duration and the pad may pull in again. On some tunes the 50 ohm BSMV may be set and reset several times before the reflected power remains below the threshold continuously.

This action is extremely important to the tuning of the coupler. Each time a 50 ohm point is found the following occurs:

1. The 50 ohm BSMV is set.
2. Relay K1 (on 3A1A1) falls out applying full power to the phase and amplitude detectors.
3. The 50(+) line shorts out the outputs from the level changers on 3A3.
4. The 50(+) line causes a brake pulse to be generated.

All four of the above actions are required to reduce servo loop oscillation and reduce tuning time.

When the reflected power has settled below the threshold. 3A2Q5 will generate a logic 1 and terminate the tune cycle.

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SECTION 5
MAINTENANCE AND REPAIR

5.1 REQUIRED TEST EQUIPMENT

1. Transmitter compatible with the ACU-150 or Test Fixture and 40 watt Transmitter.

2. "THRULINE" wattmeter, Bird model 43 with 100 watt 2-30MHz element.

3. H.P. 412A VTVM or equivalent.

4. Dummy Load, 50 ohm, 80 watt: Bird model 81 B or equivalent.

5. Adapter SO-239 to BNC.

6. Coax cable: 5 ft. (approximately) RG-58A/U. Coax terminated on both ends with male BNC connectors.

7. BNC to clip lead cable approximately 3 ft. long (for phase and amplitude balance).

5.2 MATERIALS REQUIRED

1. Lubricants

   Blue Cramolin, Sunair part number 1001270002

   Red Cramolin, Sunair part number 1001270011 (For lubrication of variable inductor, L4)

   Beacon 325 grease (made by Esso) or equivalent for lubrication of the vacuum variable shaft.

2. *HUMISEAL 1B31 – 1 quart size. Sunair part number 1002570000 (for PC board repair)

3. Extender Card (optional). Sunair part number 0833393106

*HUMISEAL is a trademark of COLUMBIA TECHNICAL Corporation

5.3 FAULT ISOLATION

Should a failure occur in the ACU-150 ( ), prior to proceeding to the detailed test of section 5.5, refer to Table 5-1 to isolate the problem to a subassembly level. The use of Table 5-1 should result in fewer tests and less maintenance time.

5.4 DISASSEMBLY

To perform maintenance and repairs to the ACU-150, the top cover assembly must be removed. This is accomplished by removing the eight screws on the bottom of the cover (4 on each side), two from the front panel and two from the rear panel. The top cover lifts off, exposing the interior of the coupler. After removing the top cover, carefully check for broken wires, foreign matter, corrosion or burned components. For removal of the C1 assembly, L4 assembly and the C3 and C6 assembly, see Figures 5.12 and 5.13.

5.5 TEST AND REPAIR

Connect the ACU-150 to the companion transceiver or a 28 volt DC power supply. Certain functional test for the coupler internal tuning components can be performed with a 28 VDC power supply, but to check actual tuning, the companion transceiver must be used in order to supply the required 40 watts of RF power.

CAUTION

All the connectors for the plug-in P.C. boards are dual readout types and care should be exercised to prevent shorting one side to the other or adjacent pins to each other.

SYMPTOM	PROBABLE CAUSE	REMEDY
No FAULT light when system is turned on.	1. Trouble on 3A2. Probably 3A2Q12 2. Broken wire in cable. 3. Defective bulb. 4. No 12VDC or 5VDC in antenna coupler. 5. Open choke in coupler filter assembly.	1. Replace or repair 3A2 board 2. Repair. 3. Replace. 4. Repair. 5. Replace choke.
No Tuning or Ready light.	1. Same probable causes listed for FAULT light on 3A2 PC board, but look for faults with READY and TUNING drive circuits.	1. Replace board or repair as required.
When TUNE button is depressed, antenna coupler does not run.	1. No RF getting to antenna coupler. 2. Check 3A2Q10 to see if collector is going to ground to pull in TUNE CONTROL relay. 3. Check TUNE CONTROL relay on 3A1A1.	1. Check RF cables. Check transceiver 50 ohm power output. 2. Replace 3A2 or Q10. 3. Replace relay.
When transceiver is channeled, the FAULT light does not come on, when used with ASB-320/125/100A.	1. Check circuitry on 3A8A2 to see if K2(+) output is going to 15VDC when transceiver is channeled. 2. Check 12VDC and 5VDC in antenna coupler. 3. Check differenting circuitry on 3A2, (CR12, C43, etc.)	1. Replace 3A8A2 or repair. 2. Repair using normal trouble shooting techniques. 3. Replace 3A2 or repair.
After transceiver is channeled and FAULT light comes on, PTT is grounded and unit does not go into a tune mode.	1. Check for ground on K2(-) while PTT at ground. If no ground, probably is open wire in cable or open choke in filter assembly. 2. 3A1A1K2 (TUNE CONTROL) relay is bad.	1. Repair wire or replace choke. 2. Replace relay.
After initiating a TUNE command, TUNING light comes on, RF is getting to the antenna coupler, but the motors do not run.	1. 3A1A1K2 (TUNE CONTROL) relay is faulty. 2. No 28 VDC getting to the SERVO AMP. 3. Bad 3A5, SERVO AMPLIFIER 4. Bad motor (motors) 5. Broken wire to one or both servo motors.	1. Replace relay. 2. Check R4, R5, R6, or R7 3. Replace SERVO AMP. 4. Check motor(s) and replace. 5. Repair.

Table 5.1 Fault Isolation Table

SYMPTOM	PROBABLE CAUSE	REMEDY
Amber light comes on with CPLR TUNE pulse, but motors do not run.	1. Relay 3A1A1K1 faulty. 2. R3, R4, R5 or R6 open 3. 3A5 faulty 4. Bad motor 5. Reflected power detector faulty 6. 3A2U1 faulty	Repair using normal trouble-shooting techniques.
Coupler fuse blows	1. Short in ACU-150 on 28V line	1. Remove short
Amber light comes on with CPLR TUNE pulse but transmitter is keyed on.	1. 3A2Q10 faulty 2. Broken cable wire	1. Replace transistor 2. Check cable.
Antenna tuner tunes properly but cannot key transmitter with microphone.	3A1A1K2 relay or broken wire in cable	Replace relay or check cable.
Roller on L4 runs to either end of coil and hits bracket	1. L max or L min switch not working properly 2. Broken wire 3. 3A3 reversing circuit or brake circuit not working	Replace faulty components.
No amber light when CPLR TUNE pushbutton depressed.	1. Broken wire 2. 3A2Q15 is faulty 3. 3A2CR17 open 4. Amber bulb burned out 5. Tune BSMV not functioning	Repair using normal trouble-shooting techniques.
Red light comes on after 5 seconds and RCVR sounds like it is tuned.	1. Gain control in Antenna Coupler panel set too high 2. Broken wire in gain control circuit 3. Diode 3A2CR22 open	1. Readjust gain control 2. Repair using normal trouble-shooting techniques
Red light comes on after 40 seconds but reflected power is zero and coupler is tuned.	1. Low tuning power from transmitter 2. RF detector not functioning	Repair using normal trouble-shooting techniques.

Table 5.1 Fault Isolation Table (Cont.)

SYMPTOM	PROBABLE CAUSE	REMEDY
Excess reflected power when tuning above 20 MHz.	1. 3A1C24 in coupler should be adjusted	1. Adjust C24
Excess reflected power on all frequencies.	1. Gain control adjusted too low 2. Phase Detector and magnitude detector should be readjusted	1. Adjust gain control 2. Readjust Phase and magnitude detectors.
Will not tune below 3 MHz. Time delay continues to run out.	1. L max switch not working properly 2. C3 and C6 assembly not working properly.	Repair using normal trouble-shooting techniques.
Antenna Coupler tunes ok gets green light but red light comes on SB or CW.	1. Antenna or lead in arcing 2. Antenna tuner arcing internally 3. Frequency of transmit signal shifting from AM to SB or CW 4. Gain control adjusted too high	1. Check antenna for arcing 2. Check antenna tuner for arcing 3. Check transmitter frequency. 4. Readjust gain control.
Capacitor C1 decreases to minimum and motor stalls.	1. C min microswitch not operating 2. Microswitch bracket not set properly 3. 3A2CR4 open 4. Broken wire	Check C min switch for proper operation. Check for broken wire.
When transceiver initially turned on FAULT light does not come on.	1. Bulb bad 2. 3A2U4 A&B (fault BSMV) not coming on in proper state	Repair using normal trouble-shooting techniques.
Time Delay does not operate.	3A2Q17 or 3A2CR20 bad	Replace faulty components.
Green Ready light does not go off when keyed on in AM after a tune cycle.	AM carrier power too high	Readjust
L4 and C1 oscillate on same frequencies.	1. Anti-oscillation circuit on 3A8A2 not functioning. 2. Gain control set too high. 3. Antenna not connected	1. Repair by replacing faulty components. 2. Reduce gain control. 3. Repair

Table 5.1 Fault Isolation Table (Cont.)

SYMPTOM	PROBABLE CAUSE	REMEDY
Capacitor C1 oscillates but inductor L4 doesn't move.	1. Broken wire 2. Bad L4 motor 3. L4 servo amp bad	Repair using normal trouble-shooting techniques.
Inductor L4 oscillates but C1 does not move.	1. Broken wire 2. Bad C1 motor 3. C1 servo amp bad	Repair using normal trouble-shooting techniques.
5V line reads 0 to 4 VDC.	1. Shorted IC on 3A2, 3A3 or 3A4	Locate PC board with short and replace or repair.
12V line reads low voltage	Short on 12V line.	Remove PC boards and subassemblies to determine which module has short. Repair or replace subassembly.

Table 5.1 Fault Isolation Table (Cont.)

5.5.1 PRIMARY VOLTAGES

The primary Dc voltages in the ACU-150 are listed below:

28V all the time – This 28V is present any time the companion transceiver is turned on.

28V Nominal – This 28V exists when the coupler is not in a tune cycle.

Switched 28V – This voltage is present when the coupler is in a tune cycle.

12V all the time – This 12V exists when the transceiver is turned on.

12V Nominal – This exists when the coupler is not in a tune cycle.

SW 12V – This exists when the coupler is in a tune cycle.

5V – Exists any time the transceiver is turned on. This voltage is not switched from the tune cycle to the normal receive mode.

5.5.1.1 TEST FOR PRIMARY VOLTAGES

Apply 28 VDC input to the antenna coupler. Use the VTVM and check the pin voltages on 3XA1A1 connector. Relay K2, on 3A1A1, controls the switching of the switched primary voltages. K2 may be energized by placing a clip lead ground on TP-5 on the top of the PC board. When using the ASB-125, ASB-320, or the ASB-100A transceivers, the transceiver must be channeled in order to get 12VDC on one side of K2. When using the ASB-500 a TUNE pulse must be initiated on the control head to start a tune cycle.

3XA1A1 Connector Voltages (with 3A1A1 installed)
All voltages ±10% (Referenced to chassis ground)

PIN	FUNCTION	VOLTAGE NOM	VOLTAGE TUNE
A	GROUND	0	0
B			
C			
D			
E			
F			
H			
J	R7	0	Note 1
K	REF. PWR OUT	12V	12V
L	PAD RELAY (-)	28V	Note 2
M	PAD RELAY (+)	28V	28V
N	PAD RELAY	0	Note 3
P	SW 28V	0	28V
R	K2 (-)	12V	0
S	28V	28V	28V
T	NOM. 28V	28V	0
U	KEY/INT	Note 4	0
V			

PIN	FUNCTION	VOLTAGE NOM	VOLTAGE TUNE
1	GROUND	0	0
2			
3			
4			
5			
6	12V REF.	12V	12V
7	12V REF.	12V	12V
8	0 DET. OUT	12V	12V
9	AMP. DET. OUT	12V	12V
10	PAD RELAY	0	28V
11	SW 12V	0	12V
12	12V	12V	12V
13	TC RELAY NOM. 12V	12V	0
14	K2 (+)	12V	12V
15	SW 28V	0	28V
16	TC RELAY PTT/KEY	Note 4	0
17	CPLR IN	ODC	Note 5
18			

Table 5.2 3XA1A1 Connector Voltages

3XA1A1 Connector Voltage Notes: NOM. - 3A1A1K2 not energized; TUNE - 3A1A1K2 energized.

1. During the TUNE cycle, this voltage will be zero until the PAD relay is de-energized and then it should rise to approximately 9 VDC.

2. Will be zero volts during the TUNE cycle except the reflected power drops below the threshold and then it rises to 28 VDC.

3. This is the servo amplifier drive voltage. During the TUNE cycle, 18 to 22 volts, dropping to approximately 9 VDC near termination of the TUNE cycle.

4. When the coupler is not tuning, this voltage will be the PTT/Keyline voltage of the companion transceiver. This voltage will also drop to zero when companion transceiver is keyed with microphone.

5. CPLR IN – This is the RF input to the Phase, Amplitude and reflected power detectors. Will be 30 to 40 watts during the TUNE cycle.

3XA8A2 Connector Voltages (with PC board installed)
All voltages ± 10% (Referenced to chassis ground)

PIN	FUNCTION	VOLTAGE	
		NOM	TUNE
A	28V	28V	28V
B	5V	5V	5V
C	READY	Note 1	Note 1
D	RF DET. OUT	0	Note 2
E	12V	12V	12V
F	REF. PWR.	0	Note 4
H	Fault	Note 1	Note 1
J	SW 12V	0	12V
K	INT.	12V	0V
L	See Table 5.4		
M	See Table 5.4		
N	See Table 5.4		
P	See Table 5.4		
R	See Table 5.4		
S	ANTI OSC	12V	12V
T	GROUND	0	0
U	See Table 5.4		
V			

PIN	FUNCTION	VOLTAGE	
		NOM	TUNE
1	GROUND	0	0
2	See Table 5.4		
3	RF DET. IN	0	Note 2
4	GROUND	0	0
5	TUNE START	0	Note 3
6			
7	See Table 5.4		
8	SW 12V	0	12V
9	See Table 5.4		
10	See Table 5.4		
11	SW 28V	0	28V
12	See Table 5.4		
13	See Table 5.4		
14	See Table 5.4		
15	50 (+)	3V	Note 5
16	C6 MOTOR	0	Note 6
17	SW 12V	0	12V
18			

Table 5.3 3XA8A2 Connector Voltages Common for all Transceivers

3XA8A2 Connector Voltage Notes: NOM. - 3A1A1K2 not energized; TUNE - 3A1A1K2 energized.

1. READY – LOGIC "0" when READY LIGHT ON. LOGIC "1" all other times.
2. D.C. output on pin D only when 30 to 40 watts RF on pin 3. The DC should be between 4 and 8 VDC.
3. Should be a positive pulse of 12V or 28V and occurs only at the beginning of the TUNE cycle.
4. A DC output occurs only during the TUNE cycle or when there is reflected power. This will be 6 to 9 VDC for ACU-150A.
5. The 50(+) line is a logic "1" when the coupler is tuned. During the TUNE cycle positive pulses will occur each time the reflected power drops below the threshold.
6. The C6 motor line will be at 28V during the TUNE cycle except when the motor is running and during that time it will be at zero volts.

5.5.1.2 3XA8A2 CONNECTOR VOLTAGES
(Filter Regulator)

Using the same test setup for 3XA1A1, measure the pin voltages on 3XA8A2. The voltages on some of the pins of 3XA8A2 will depend on the transceiver that is used. Table 5.3 lists the voltages that are independent of the type of transceiver used. Table 5.4 lists the voltages that change depending on the type of transceiver used.

5.5.1.3 3XA4 CONNECTOR VOLTAGES
(C3 and C6 Control)

Use the same test setup used in 5.5.1.2 and check the pin voltages on 3XA4. Table 5.5 lists the pin voltages with explanatory notes.

5.5.1.4 3XA2, 3XA3, AND 3XA5 CONNECTOR VOLTAGES (Control Logic, Phase and Amplitude Control, and Servo Amplifier)

In order to check the pin voltages for these three plug in assemblies, they should be removed from the connectors. Remove the three assemblies and use the clip lead to energize 3A1A1K2 to simulate a TUNE cycle. Tables 5.6, 5.7 and 5.8 list the voltages for these three assemblies.

5.5.2 GROUNDING TEST THAT CAN BE PERFORMED

Certain functions can be simulated by removing subassemblies and grounding the pins of the connector. A short clip lead with a piece of bus wire works well.

5.5.2.1 3XA2 GROUNDING CHECKS

Remove 3A2 and 3A3 from their connectors. Turn on the companion transceiver or the power supply. Perform the following test on 3A2.

A. Ground pin 15. K1 on 3A1A1 should pull in and remain in as long as the ground is present.

B. Ground pin N. the READY light should be illuminated.

C. Ground pin 6. The TUNING light should be illuminated.

D. Ground pin 12. The FAULT light should be illuminated.

E. Pin 7. – INTERLOCK. This line is used for **different functions for the ASB-125, ASB-320, ASB-100A and the ASB-500. For the channelized transceivers, after channelling the companion transceiver, a ground placed on pin 7 will cause K2 on 3A1A1 to pull in. With the ASB-500, if the TUNE push-button is depressed and a ground is placed on pin 7, relay K2 will be energized.**

With the ASB-500, push the TUNE button and get relay 3A1A1K2 pulled in. A ground on pin 10 should cause relay K2 to drop out.

F. Pin 17. This is the time delay output and is used only with the ACU-150A. Channel the companion receiver and momentarily depress the mike "push to talk" button. Relay 3A1A1K2 should pull in. Place a ground on pin 17 and K2 should fall out.

G. Pin 10. This line is used only in the ACU-150A. Channel the companion receiver as in test F. above and pull in 3A1A1K2.

3XA8A2 Connector Voltages (with PC Board Installed)

PIN	FUNCTION	ASB-125,320,100A NOM	ASB-125,320,100A TUNE	ASB-500 NOM	ASB-500 TUNE	
2	CPLR TUNE/CHAN P	28V	28V	0	0	ACU-150A has 28V that drops to ground when the transceiver is channeled.
7	AM ENAB/KEY	0	28V	0	0	Used only on ACU-150A for automatic AM with ASB-100.
9,10	GAIN	*	*	*	*	Should be between 12 and 18V for all versions. ACU-150A controlled by front panel control.
6	TUNE COMM.	0	0	0	0	Used only with ASB-500 and has 12V pulse at beginning of TUNE cycle.
13	AM ENAB 10V	0	10	0	0	Used only with ASB-125, ASB-320.
14	K2(+)	0	12V	0	12V	
L	K2(-)	28V	0	12V	0	This line is one side of the tune control relay that is switched to ground.
M	KEY/PIT	28V	0	12V	0	
N	INTERLOCK	28V	0	12V	0	
P	KEY/INT	0	0	12V	0	See Figure 4-2.
R	KEY/PIT	28V	0	12V	0	
U	GAIN EXT	0	0	0	0	

Note: NOM - K2 not energized; TUNE - K2 energized.

Table 5.4 3XA8A2 Connector Voltages for Individual Transceivers

3XA4 Connector Voltages (with PC Board installed)
All voltages ±10% (Referenced to chassis ground)

(ϕ means phase)

PIN	FUNCTION	VOLTAGE NOM	VOLTAGE TUNE
A	C6 HOME	Note 1	Note 1
B			
C			
D			
E			
F	+ϕ > 50 OHMS	Note 8	Note 8
H			
J	L4 FORCE INHIB	Note 9	Note 9
K			
L	5V	5V	5V
M	SW 28V	0	28V
N			
P			
R			
S			
T			
U			
V	MOTOR GROUND	0	0

PIN	FUNCTION	VOLTAGE NOM	VOLTAGE TUNE
1	GROUND	0	0
2	C6 POS 16	Note 2	Note 2
3	Q15 COL	Note 3	Note 3
4	C6 100-1200	Note 4	Note 4
5	Lmin 0 ϕ	Note 5	Note 5
6	Lmin Cmax	Note 6	Note 6
7	C3 HOME	Note 7	Note 7
8	L max	Note 10	Note 10
9			
10			
11	C3 MOTOR	0	Note 11
12	SW 28V	0	28V
13	C3 RELAY	0	Note 12
14	C6 MOTOR	0	Note 13
15	HOME L4	Note 14	Note 14
16	75 Pf	Note 15	Note 15
17	C6 RELAY	0	Note 16
18	GROUND	0	0

Table 5.5 3XA4 Connector Voltages

3XA4 Connector Voltage Notes when ACU-150 has all modules installed.
NOM. - 3A1A1K2 not energized: TUNE - 3A1A1K2 energized.

1. If C6 in the home position Logic "0", if not, Logic "1".
2. Logic "1" unless C6 is on position 16.
3. Logic "0" only when TUNE cycle initiated.
4. Logic "0" only when C6 in 100, 300, 500, 800, or 1200 pf.
5. Logic "0" only when inductor at minimum and phase error is 0.
6. Logic "0" when L is minimum and C1 is maximum.
7. Logic "0" when C3 in the homed position.
8. Logic "0" when phase error positive and the magnitude error greater than 50 ohms.
9. Logic "0" when C3 is NOT in the homed position.
10. Logic "0" when the inductor is at maximum.
11. 28V during the TUNE cycle except when C3 motor is running.
12. 28V during the TUNE cycle except when C3 motor is running.
13. 28V during the TUNE cycle except when C6 motor running.
14. Logic "1" except when C3 in the 75Pf position. The logic "0" forces L4 to move toward Home position.
15. Logic "0" when C3 in the 75 Pf position.
16. 28V during the TUNE cycle except when C6 motor is running.

3XA2 Connector Voltages (PC Board removed from connector)
All voltages ± 10% (Referenced to chassis ground)

PIN	FUNCTION	VOLTAGE NOM	VOLTAGE TUNE
A	CPLR TUNE	Note 1	Note 1
B	RF DETECTOR	0	Note 2
C			
D			
E	REF PWR AMP INH	Note 3	0
F	12V REF	12V	12V
H	28V	28V	28V
J	28V NOM	28V	0
K	12V	12V	12V
L	TO ALC	Note 8	Note 8
M	XMIT BIAS	Note 8	Note 8
N	READY	Note 4	Note 4
P	5V	5V	5V
R	HOME L4	Note 11	Note 11
S	Q15 COL.	Note 13	Note 13
T	L max	Note 15	Note 15
U	C6+	Note 8	Note 8
V	C6 CONT	Note 8	Note 8

PIN	FUNCTION	VOLTAGE NOM	VOLTAGE TUNE
1	GROUND	0	0
2	SW 12V	0	12V
3	REF PWR	12V	12V
4	12V REF	12V	12V
5			
6	TUNING	Note 4	Note 4
7	INTERLOCK	Note 5	0
8	GAIN	Note 6	Note 6
9	REF PWR	Note 7	Note 7
10	ASB-320 READY	Note 9	Note 9
11	50(-)	Note 10	Note 10
12	FAULT	Note 4	Note 4
13	C1 HOME	Note 11	Note 11
14	50(+)	Note 12	Note 12
15	PAD RELAY	Note 14	Note 14
16	Lmin	Note 15	Note 15
17	TIME DELAY	Note 16	Note 16
18	GROUND	0	0

Table 5.6 3XA2 Connector Voltages

3XA2 Connector Voltage Notes when ACU-150 has all modules installed.
NOM. - 3A1A1K2 not energized; TUNE - 3A1A1K2 energized.

1. +12 or 28 VDC pulse when CPLR TUNE pulse generated.
2. 4 to 8 VDC when 30 to 40 watts input to coupler.
3. +12 or 28 VDC when transmitter not keyed. Depends on transmitter used.
4. TUNING, READY, OR FAULT lights may be 5V, 12V or 28V or other values depending on setting of dimmer control. When lights on, pin voltage near zero.
5. The interlock line may be 0 or 12V in the NOM mode when the transmitter is unkeyed, depending on the transmitter used.
6. 12 to 18 VDC controlled by front panel control.
7. 6 to 9 VDC when there is reflected power when using ACU-150A or B.
8. These functions not used in ACU-150.
9. Logic "0" terminates tune cycle with ASB-320. Logic "1" all other times.
10. Logic "0" when reflected power below threshold.
11. C1 HOME and L4 HOME lines logic "0" during CPLR TUNE pulse.
12. 50(+) line rises to logic "1" when reflected power below threshold.
13. Q15 COL logic "0" during CPLR TUNE pulse.
14. 0VDC during TUNE cycle except near end it rises to 28 VDC.
15. Lmin and Lmax both logic "0" when coil is maximum L or minimum L.
16. Logic "0" pulse when the time delay runs out.

3XA3 Connector Voltages (PC board removed from connector)
All voltages ± 10% (Referenced to chassis ground)

PIN	FUNCTION	VOLTAGE	
		NOM	TUNE
A	SW 28V	0	28V
B			
C	+ϕ>50 OHMS	Note 1	Note 1
D	Lmin Cmax	Note 2	Note 2
E	Lmin 0ϕ>50 OHMS	Note 4	Note 4
F			
H			
J			
K			
L			
M			
N			
P			
R	L4 FORCE INHIB.	Note 11	Note 11
S	SW 12V	0	12V
T	AMP BRAKE	Note 9	Note 9
U	AMP ERROR 12VREF	12V	12V
V	AMP DRIVE	Note 10	Note 10

PIN	FUNCTION	VOLTAGE	
		NOM	TUNE
1	GROUND	0	0
2	PHASE ERROR	12V	12V
3	Phase Error 12VREF	12V	12V
4	PHASE DRIVE	Note 3	Note 3
5	PHASE DRIVE	Note 3	Note 3
6	HOME C1	Note 5	Note 5
7	L max	Note 6	Note 6
8	C min	Note 7	Note 7
9	50(+)	Note 8	Note 8
10	50(-)	Note 8	Note 8
11	C max	Note 7	Note 7
12	PHASE BRAKE	Note 9	Note 9
13	5V	5V	5V
14	HOME L4	Note 5	Note 5
15	L min	Note 6	Note 6
16	AMP ERROR	12V	12V
17	AMP DRIVE	Note 10	Note 10
18	GROUND	0	0

Table 5.7 3XA3 Connector Voltages

3XA3 Connector Voltage Notes when ACU-150 has all modules installed
NOM. - 3A1A1K2 not energized; TUNE - 3A1A1K2 energized.

1. This pin has a logic "0" when the ϕ is positive and the magnitude greater than 50 ohms.
2. A logic "0" occurs when the inductor is at minimum and the capacitor, C1, is at maximum.
3. These pins drive the phase servo amplifier. The voltage can be between 0 and 22V depending on the phase detector output.
4. This pin will be logic "0" when the inductor is at minimum, the phase error is zero and the magnitude error is greater than 50 ohms.
5. These two lines have a logic "0" during the interval of the CPLR TUNE pulse.
6. These lines have a logic "0" when the is at maximum or minimum L.
7. These two lines have a logic "0" when C1 is at maximum or minimum.
8. The 50(+) and the 50(-) lines have a logic "1" and a logic "0" respectively when the reflected power drops below the threshold.
9. The phase and amplitude brake lines have a logic "1" of approximately 1.5V when there is a 50(+) or a 50(-) pulse.
10. These lines drive the amplitude servo and can be between 0 and 22 volts depending on the output of the amplitude detector.
11. The L4 Force Inhibit line has a logic "0" any time C3 is not in the home position.

3XA5 Connector Voltages (with the PC board removed)
All voltages ±10% (Referenced to chassis ground)

PIN	FUNCTION	VOLTAGE	
		NOM	TUNE
A			
B			
C			
D			
E			
F			
H			
J			
K			
L			
M			
N			
P			
R			
S			
T			
U			
V			

PIN	FUNCTION	VOLTAGE	
		NOM	TUNE
1	GROUND	0	0
2			
3	PHASE DRIVE	Note 1	Note 1
4	PHASE DRIVE	Note 1	Note 1
5	SW 28V	Note 2	Note 2
6	PHASE MOTOR	Note 3	Note 3
7	PHASE MOTOR	Note 3	Note 3
8	PHASE BRAKE	Note 4	Note 4
9			
10			
11	AMP MOTOR	Note 5	Note 5
12	AMP BRAKE	Note 4	Note 4
13			
14	AMP DRIVE	Note 6	Note 6
15			
16	AMP MOTOR	Note 5	Note 5
17	AMP DRIVE	Note 6	Note 6
18	GROUND	0	0

Table 5.8 3XA5 Connector Voltages

3XA5 Connector Voltage Notes when ACU-150 has all modules installed.
NOM. - 3A1A1K2 not energized; TUNE - 3A1A1K2 energized.

1. These lines can be between 0 and 22 VDC depending on the output of the phase detector.

2. This line will measure 28 VDC with 3A5 removed when 3A1A1K2 is energized. When the ACU-150 is tuning the voltage will be as high as 22 VDC and will drop to approximately 9 VDC just before the end of the tune cycle.

3. These lines will vary between near zero to 22 VDC when the antenna coupler is running.

4. The phase and amplitude brakes will rise approximately 1.5 VDC when the reflected power drops below the threshold.

5. These lines will vary between near zero and 22 VDC when the coupler is tuning.

6. These lines can be between 0 and 22 VDC depending on the output of the amplitude detector.

5.5.2.2 3XA3 GROUNDING CHECKS

CAUTION

With the 3A2 and 3A3 board removed, grounds placed in pins 4, 5 and 17 and V can cause C1 and L4 motors to drive the C1 sensor and the L4 roller wheel into the end stops. Remove the test ground from the pins before the driven element hits the end stop.

With 3A2 and 3A3 removed, but all other subassemblies installed, cause relay 3A1A1K2 (TUNE control) to be energized. (This action switches on 28 VDC and 12 VDC.) Note the position of the roller wheel on L4 and the position of the sensor arm on the C1 assembly. (See Figures 5.9 and 5.10.)

A. Pin 4 – This is the positive phase line and a ground on pin 4 will cause the C1 sensor arm to move toward the Cmin switch.

B. Pin 5 – This is the negative phase line and a ground on pin 5 will cause the C1 sensor arm to move toward the Cmax microswitch.

C. Pin 17 – This is the "less than 50 ohm" line and a ground on pin 17 will cause the L4 roller wheel to run toward the Lmax sensor.

D. Pin V – This is the "greater than 50 ohm" line and a ground on pin V will cause the L4 roller wheel to run toward the Lmin sensor.

If the grounding test in A, B, C and D do not result in the C1 and L4 motors running, it would indicate a problem in either the motors or the servo amplifier, 3A5. The servo motors can be checked by turning off the transceiver or the 28 VDC power supply and checking the motor resistance with an ohmmeter. The C1 and L4 motors should read approximately 8 to 12 ohms. If the motors are both good, then the problem would be in the servo amplifier.

All of the transistors in the 3A5 servo amplifier can be readily removed by removing the nuts on each transistor and unplugging the transistors (they plug into sockets). Each transistor may be checked for shorts or opens with a meter.

5.5.2.3 LMIN AND LMAX GROUNDING TEST

If all the subassemblies are in the ACU-150 and relay 3A1A1K2 is energized to provide SW 28 VDC, then certain test can be made to determine proper operation of the C3 and C6 assembly.

A. With 3A1A1K2 energized and NO RF INPUT TO THE COUPLER, place a clip lead ground on the Lmax sensor. (See Figures 5.10 and 5.11.) The C6 motor should begin to run. It should run continuously while the ground is on Lmax. Each time the wiper of SW3 contacts position 16, C3 motor should run to advance C3 one position. If the ground on Lmax is momentary, C6 should step one step for each ground pulse generated by the clip lead ground. As C6 is advanced one step at a time, it should step 100, 300, 500, 800, 1200 pf and the next pulse should cause C6 to go to the Home position.

Placing a clip lead ground on the Lmin sensor, under the same conditions for the Lmax test, will produce different results depending on the position of C6. If C6 is in the initial homed position, after a Tune start pulse, a ground on Lmin will only generate a pulse on 3A3 and cause the coil to jump toward maximum inductance. If C6 has gone through 100, 300, 500, 800, and 1200 pf and is in the homed position, a ground on Lmin will cause C3 to run continuously while the ground is on Lmin.

If a Tune start pulse is initiated, with NO RF INPUT to the ACU-150, and the Cmax switch is closed and a momentary ground is placed on Lmin, the coil will run to maximum L and C6 should begin running continuously. This action will also cause C3 to switch.

During the operation of the C3 and C6 switches check to see that the switch wipers for the ceramic wafers are aligned properly with the contacts. If the C3 and C6 assembly does not perform as it should, see detailed test for the 3A4 board in 5.5.3.4.

5.5.3 PC BOARD REPLACEMENT

If the primary voltage tests are all the proper values and the grounding test indicates that the C1, L4 and C3 and C6 functions are all operating properly, then it is recommended that 3A1A1, 3A2, and 3A3 be replaced (one at a time) with a known good board. If replacement PC boards are not available, then PC board test can be made to isolate the fault to a circuit on the PC board.

5.5.3.1 PC BOARD TEST AND REPAIR

CAUTION

PC boards 3A2A1, 3A2, and 3A3 are coated with Humiseal 1B31. This coating can be dissolved with a solution of trichloroethane. Care should be exercised when cleaning boards for component replacement to avoid getting any of the coating on the connector. After component replacement, the cleaned area should be re-coated with 1B31. If extensive component replacement has been done the connector fingers and the edges of the board should be masked with masking tape and the board should be submerged in 1B31 and allowed to air dry for 24 hours.*

*HUMISEAL is a trademark of the COLUMBIA TECHNICAL Corp.

In order to make electrical contact to the components on the coated PC boards, a sharp probe should be used to penetrate the coating and make good electrical contact with the components on the board.

5.5.3.2 CIRCUIT TEST ON 3A2 (Figure 5.3)

The following test performed with NO RF INPUT to the antenna coupler. If a companion transceiver is used, terminate its output with a 50 ohm load.

A. Fault BSMV – Place a momentary clip lead ground on 3A2U4 pin 3. The fault lamp should go off and the ready light should come on. Touch the ground to 3A2U4 pin 6 and the fault light should come back on.

B. Tune BSMV – Connect a clip lead to +28 VDC (28 VDC end of R2). Momentarily touch the 28V clip lead to 3A2 connector, pin A. (See Figure 5.3.) The fault light should go off and the tune light should come on. The transmitter (if used) will be keyed on for the ASB-500. The ASB-320 will not key on because it requires channeling the transceiver and depressing the PTT mike button. Wait approximately 45 seconds and the time delay should run out, causing the Tune light to go off and the fault light to come on. (This test checks the tune BSMV and the time delay circuit, Q16, Q17 and Q18.)

C. Tune BSMV and Ready Light – Initiate a tune cycle by applying a 28 VDC pulse to 3XA2 pin A. Use a 10K ¼ watt resistor and another clip lead to 28 VDC. Touch the 10K resistor to the RF detector, 3XA2 pin B, and the tune light should go off and the ready light should come on. Also, the transmitter should unkey if it is keyed on during the tune cycle. This test checks Q8, U3A, U4C, U3D, U4D and Q11.

D. Using the same clip lead with the 10K resistor, with the ready light on, touch 3XA1A1 pin K. The ready light should go off and the fault light should come on. Also, the pad relay, 3A1A1K1 should energize. This test checks 3A2U5A, CR25, U6C and D and Q14 for proper operation.

E. Q20 and Q21 – Initiate a tune cycle by applying a 28 VDC pulse to 3XA2 pin A. Simulate a tune by applying a 28 VDC pulse through the 10K resistor to pin B. With the ready light on, apply 28 VDC direct to 3XA2 pin M. The ready light should go off. Apply 28 VDC to pin M and L and the ready light should come back on.

F. Check the Time Delay Circuit – The time delay circuit may be checked by initiating a tune start pulse with no RF input to the antenna coupler. Check the collector of Q16. This voltage should be near zero before a tune start is applied and should rise to near 12 VDC during the tune cycle. A VTVM placed on the anode of Q17 should slowly rise to approximately 7 VDC and then the transistor should fire, causing a negative pulse on the collector of Q18. If the time delay needs to be re-adjusted, adjust R46 clockwise to increase the length of the time delay. If it needs to be shortened, adjust R46 counter-clockwise. Set the time delay to between 40 and 45 seconds.

G. If steps (A) through (F) do not result in the successful repair of the PC board, replace the PC board with a spare and return the faulty board for repair.

5.5.3.3. CIRCUIT CHECKS ON 3A3 (Figure 5.4)

NOTE

Make sure Lmin, Lmax, Cmin and Cmax switches are not engaged. Use the extender card for 3A3 and make sure the component side of 3A3 is facing the inductor, L4.

A. C1 Home BSMV – This BSMV is U2A and B. Place a momentary clip lead ground on U2 pin 6 and monitor U2 pin 3. The ground on U2 pin 6 should cause U2 pin 3 to rise to a logic 1. Place a momentary ground on U2 pin 3 and U2 pin 6 should rise to logic 1.

B. L4 Home BSMV – U4 A and B is the L4 home BSMV. Momentarily ground U4 pin 6 and U4 pin 3 should rise to a logic 1. Momentarily ground U4 pin 3 and U4 pin 6 should rise to logic 1.

C. L4 Force BSMV – U4 C and D is the L4 Force BSMV. Momentarily ground U4 pin 11 and U4 pin 8 should rise to logic 1. Momentarily ground U4 pin 11 and U4 pin 8 should return to logic 1.

D. Initiate a Tune pulse in order to get SW28VDC and SW12VDC to 3A3. (With no RF input to the antenna coupler)

1. Check the operation of the phase preamplifier. Monitor the collector of Q3 with a VTVM. Place a clip lead ground through a 10K ¼w resistor on 3A3U1 pin 4. Q3 collector should rise to 21 volts. (±10%). Remove the clip lead ground and Q3 collector should drop to zero volts. Move the ground to U1 pin 5. Monitor the collector of Q2 and it should rise to 7.6 volts (±10%). Remove the ground and Q2 collector should fall to near zero volts. When performing this test, the time delay may run out. If it does, just initiate another tune start pulse.

2. Check the amplitude preamplifier – Initiate a tune pulse in order to get SW28V and SW12V applied to 3A3. Monitor the collector of Q11 with a VTVM and place a clip lead ground (through a 10K ¼ watt resistor) on 3A3U3 pin 5. Q11 collector should rise to 21 volts (±10%). Remove the ground and Q12 collector should fall to zero volts. Move the ground to 3A3U3 pin 5 and monitor the collector of Q12. Q12 collector should rise to 7.6 volts (±10%) and should fall to zero when the clip lead ground is removed.

3. Check the +ϕ, greater than 50 ohm termination of the home and force functions. Initiate a tune pulse and monitor U2 pin 5 with a VTVM. Place a clip lead ground through a 10K resistor on pin 4 of U1. (This action simulates a +ϕ.) At the same time, place a clip lead ground through a 10K resistor on pin 5 of U3. (This simulates a magnitued error of greater than 50 ohms.) With both of these pins grounded through a 10K resistor, a logic 0 should appear on pin 5 of U2.

   The logic 0 on pin 5 of U2 will also terminate the L4 home BSMV, C1 home BSMV, and the L4 force BSMV, if set.

If steps (A) through (D) do not result in the isolation of the fault and successful repair of the 3A3 board, replace with a spare board and return the faulty board for repair.

5.5.3.4 CIRCUIT CHECKS ON 3A4, C3 AND C6 CONTROL
(See Figure 5.11 for C3 and C6 Assembly)

See Figure 5.5. This PC board is not coated and is somewhat easier to test than 3A2 and 3A3. The Lmin-Lmax test in 5.5.2.3 checked most of the circuitry on the 3A4 board. However, if these tests were not successful, the following test can be used to isolate a problem to a specific component. The following test should be performed with NO RF INPUT to the coupler and use the extender card. Make sure the components face the vacuum variable capacitor.

A. C6 Home BSMV – The operation of the C6 home BSMV can be checked by applying primary power to the antenna coupler (no tune start pulse) and manually moving C6 off the homed position. This can be accomplished by moving the large gear until the ground is removed from pin A of 3XA4. With no ground on the C6 home line, place a momentary ground on pin 6 of 3A4U1. Pin 3 should rise to a logic 1 and pin 6 should drop to a logic 0. Placing a momentary ground on pin 3 should restore the BSMV to the original condition.

B. C6 Advance BSMV – This consists of gates C and D of U1. A momentary ground on pin 11 should cause pin 8 to rise to a logic "1". A momentary ground on pin 8 should restore the BSMV to the original condition. (For the C6 advance BSMV to toggle and remain in a toggled condition, C6 cannot be in the 100, 300, 500, 800, or 1200 Pf position.)

C. C3 Home BSMV – Manually advance C3 wafer by turning the large gear on the C3 shaft until there is not a ground on pin 7 of 3XA4. Place a momentary ground on pin 6 of U3. Pin 3 should rise to a logic "1" and remain a logic "1". A momentary ground on pin 3 of U3 should restore the BSMV to its original condition.

D. Lmin Cmax – C3 Home Function – Apply a tune pulse in order to get SW 28 VDC to the C3 and C6 assembly. Move C3 off the homed position and apply a ground to 3XA4 pin 6. C3 should begin rotating and L4 should move toward maximum inductance. When the inductor reaches Lmax, C6 should begin running continuously, stepping C3 on step each time the C6 control wafer passes position 16.

E. Lmin, 0ϕ, Greater than 50 ohm Function – Initiate a tune pulse and ground pin 5 of 3XA4. C3 should run continuously while the ground is on pin 5 and should stop when the ground is removed.

F. If the preceding test does not result in a solution of the problem, transistors Q1, Q2, and Q3 can be checked with an ohmmeter for shorts and opens. Also, all diodes should be checked for forward conduction and back resistance.

5.5.3.5 PHASE AND AMPLITUDE DETECTOR AND PAD (3A1A1) (ϕ means phase)

See Figure 5.2 (See transmitter note after para. E.)

CAUTION

TP1, TP2, TP3, TP4 and TP5 on the 3A1A1 board are floating at +12VDC. All measurements made at these test points must be made with an instrument that is also floating and does not have the negative lead connected to ground. All measurements made in this test must be made with 3A3 removed from its connector.

A. Check the No Signal Offset of the Detectors – Connect the negative lead of the VTVM to TP3. With no RF input to the coupler, measure the voltage between TP1 (Amp.) and TP3. The static offset should be less than .02 VDC. Measure the static offset between TP2 (Ref. Pwr) and TP3. This offset should be less than 0.020 VDC. Check the offset of the phase detector by measuring the voltage between TP3 and TP4. It also should be less than .020 VDC.

B. Check the Balance of the Amplitude Detector – Remove the wire going from E14 to the transformer on the C1 assembly. Remove the wire on E14, move it out of the way and connect a 50 ohm load (Bird model 81B or equal) between E14 and the ground on the PC board or the card guide adjacent to E14. Use the BNC clip lead coaxial cable. MAKE SURE THAT THE LEADS ON THE COAXIAL CABLE ARE NO LONGER THAN 1/2 INCH. This is important because any longer lengths of exposed center conductor and braid will cause error in the phase detector readings.

With the phase detector board terminated with a 50 ohm load, connect the transmitter output to the coupler input and condition the transmitter for AM. A wattmeter connected between the transmitter output and the coupler input should be used to monitor the forward and reflected power. Connect the VTVM between TP3 (12V Ref.) and the amplitude detector output, TP1. The negative lead should be on TP3 and the positive lead on TP1.

Key the transmitter on AM and the wattmeter should read 30 to 40 watts forward and near zero at 2MHz. With the transmitter keyed on, the VTVM should read less than ±0.1VDC for all frequencies between 2 and 29.9 MHz, when the detector is terminated with a broadband 50 ohm load. If the balance (null voltage) exceeds ±0.1 VDC at any frequency, C21 should be adjusted for the best balance over the frequency range. It is best to adjust C21 to split the difference between the total null error. For example, if the error were .01V at 2MHz and .08V at 29.9MHz, then adjust C21 for -.035V at 2MHz and +.035V at 29.9MHz. After adjustment, proper operation can be checked by connecting the ungrounded side of R11 to E14 with a short clip lead. R11 is a 200 ohm resistor and will make the magnitude of the load less than 50 ohms. With R11 shunting the 50 ohm load, and the transmitter set to 2 MHz, the VTVM should read positive in excess of 0.1 VDC. Disconnect the BNC connector from the 50 ohm load and momentarily key the transmitter on. The VTVM should read negative in excess of 0.1 VDC. This condition simulates a magnitude in excess of 50 ohms (Open circuit).

C. Check the Operation of the Reflected Power Detector – Use the same test setup as in B. Terminate E14 with a 50 ohm load and disconnect R11. Key the transmitter on AM (30 to 40 watts) and monitor the reflected power output between TP3 and TP2. The reflected power output always goes positive. Check the null level from 2 to 29.9 MHz and note the results. The reflected power output should be as flat as possible over the frequency range and less than 0.1 VDC. If it exceeds the limit, adjust C18 for minimum reflected power output at 29.9 MHz. The reflected power detector output can be checked by shunting R11 across the 50 ohm load and by removing the 50 ohm load. In both cases, the reflected power output should increase to more than +0.1 VDC. If C18 is adjusted, the amplitude detector should be re-checked because there is a slight interaction between C18 and C21.

D. Check the Operation of the Phase Detector – Use the same test setup as in B and C. Remove R11 and terminate E14 with the 50 ohm load. With the VTVM connected between TP3 and TP4 (TP3 negative terminal of VTVM), key the transmitter on and check the null between for all frequencies between 2 and 29.9 MHz. The null should be less than ±0.1 VDC for all frequencies. If it is not, readjust R5 for the best overall null.

If the error is -.05V at 2 MHz and +.02V at 29.9 MHz, then split the difference. Readjust the error for -.035V at 2 MHz and +.035 at 29.9 MHz. After adjustment proper operation of the phase detector can be shown by momentarily shorting a 5 to 10 microhenry inductor from E14 to ground. The VTVM should read greater than +.1 VDC. This simulates a positive phase angle. A negative phase angle can be simulated by momentarily shorting a .001 to .005 microfarad capacitor from E14 to ground. The VTVM should read negative by more than 0.1 VDC.

E. If the above test reveals a malfunction in the phase, amplitude or reflected power detectors, the board should be removed and all diodes and chokes checked for proper resistance readings. Transformers T1 and T2 should be checked for continuity. After repair of the board, the areas that have been repaired should be re-sealed with 1B31. If extensive repair has been done to the board, the entire board can be submerged, taking care to mask the one board edge and avoid getting the sealer in the relay sockets and on the connector pins. If the board cannot be successfully repaired, replace with a spare board and return the faulty board for repair.

NOTE

The transmitter used to drive the antenna coupler for the above balance measurements must be free from harmonics. All harmonics must be suppressed at least 30 DB or measurement errors will occur.

5.5.3.6. CIRCUIT CHECKS ON FILTER REGULATOR (3A8A2) (See Figure 5.7)

CAUTION

When making checks on 3XA8A2 or 3A8A2 be careful not to short adjacent pins together. 5 VDC, 12 VDC and 28 VDC are all on the board and connector and shorts can damage to ICS on other boards.

As stated previously, there are two different boards that can be plugged into 3XA8A2. The active circuitry on both boards is common and has the same pin inputs and outputs.

A. Check Anti-Oscillation Circuit – Remove the RF input to the antenna coupler. Put the card extender into 3XA8A2. Plug 3A8A2 into the card extender, making sure the component side of the board is facing the C1 assembly. Connect the VTVM between the emitter of Q1 and ground, set to the 30 VDC scale. Connect a test lead to pin 15 of 3XA8A2. Turn the unit on and initiate a tune pulse. Rapidly ground and unground pin 15 and note the VTVM reading. It should increase to at least 10 VDC. If an oscilloscope is available, the bootstrap action can be observed. This action simulates 50(+) crossover pulses. Move the positive side of the VTVM to the collector of Q3. Turn the unit off and turn on again. Initiate a tune pulse and rapidly ground and unground pin 15, again simulating 50(+) crossover pulses. The collector of Q3 should decrease to near zero volts after about 1.5 seconds of simulated 50(+) pulses. If these procedures do not provide the proper results, check all the transistors and diodes to find the faulty component.

B. 5 VDC Regulator and RF Detector Circuit – These circuits can be repaired by finding the faulty component with ohmmeter checks and replacing the components.

C. SPECIAL ACTIVE CIRCUITRY USED ONLY ON THE ACU-150(A)

Q4, Q5, Q6, K1 and U1 are used to generate certain functions when a channel pulse is generated by the companion transceiver. Plug the PC board into the card extender making sure the component side faces the C1 assembly. Turn the unit off and turn back on. Make sure no RF is applied to the input of the antenna coupler. With the VTVM set to the 10 VDC scale, check the voltage on U1 pin 6. It should be a logic "0". Momentarily ground pin 8 and pin 6 should become a logic "1". Q5 collector should be near zero and Q6 collector should be 15 to 18 VDC. Apply a momentary ground to pin R of 3XA8A2 and relay K1 should pull in. Apply a momentary ground to pin H of 3XA8A2 and relay K1 should drop out and U1 BSMV B and C should be reset. This action simulates channeling the companion transceiver and then depressing the PTT microphone push button. The ground on pin H simulates the **time delay running out. Momentarily applying a 12VDC pulse to pin 6 will simulate the ASB-500 TUNE command. Relay 3A1A1K2 should energize.**

5.5.3.7 FILTER ASSEMBLY

This assembly is shown with the cover removed in Figure 5.1. This filter is used to remove unwanted conducted RF from the lines coming out of the antenna coupler. If a fault occurs in the filter assembly, remove the cover and check all chokes with an ohmmeter.

5.5.4 PERIODIC MAINTENANCE, ADJUSTMENTS, AND LUBRICATION

5.5.4.1 LUBRICATION OF C1 SHAFT

The C1 shaft can be lubricated with grease by using a squeeze tube type applicator and applying the grease to the shaft thread through the slot traveled by the sensor arm. (Refer to Figure 5.9.) In order to remove the shaft for cleaning, the C1 assembly must be removed from the chassis. Refer to Figures 5.12 and 5.13. After the screws are removed, unplug the C1 connector and remove the C1 assembly. Remove the large gear on the shaft, using a #8 six fluted bristol tool. Remove the capacitor end cap by unscrewing the 4 screws. Unscrew the capacitor shaft by turning counter-clockwise until the shaft comes out. Clean the shaft and relubricate with grease and re-assemble the unit.

5.5.4.2 ADJUSTMENT OF CMIN AND CMAX MICROSWITCHES

The switch adjustments can be made with the C1 assembly installed or removed from the chassis. If the C1 assembly is installed in the unit, it will be necessary to remove the bottom cover to gain access to the Cmin adjustment screws.

5.5.4.2.1 CMAX ADJUSTMENT

Refer to Figure 5.9. Turn the motor gear clockwise until the capacitor shaft jams. Back out the capacitor shaft one turn by (noting the position of the large gear set screw) turning the motor gear clockwise. The two screws holding the microswitch bracket can be loosened and the microswitch bracket adjusted so the switch is just closed with the capacitor shaft one full turn out from maximum capacity position. Tighten the two screws holding the Cmax bracket.

5.5.4.2.2 CMIN ADJUSTMENT

Refer to Figure 5.9. With the capacitor shaft one full turn out from the maximum position, rotate the motor gear counter-clockwise until the capacitor shaft is out 18 turns from the original position of one turn. In other words, the Cmin setting should be 19 total turns out. Loosen the two screws holding the Cmin bracket and adjust the microswitch bracket so the switch is just closed at 19 total turns. Retighten the screws.

5.5.4.3 L4 ADJUSTMENTS AND LUBRICATION

See Figure 5.10.

5.5.4.3.1 LMIN ADJUSTMENT

Turn the gear on L4 clockwise and move the roller wheel down the coil toward Lmin. Use an ohmmeter between the Lmin sensor and chassis ground and check where the roller wheel contacts the Lmin sensor. It should be between 3/4 to 1 inch from the end of the coil wire. If it needs to be re-adjusted, use two pliars and hold the sensor with one and adjust the elastic stop nut with the other. If the elastic stop nut is not tight, secure the nut to the sensor with glyptol after adjustment.

5.5.4.3.2 LMAX ADJUSTMENT

This adjustment is the same as for the Lmin except the roller wheel is run to the maximum inductance end of the coil (the end near the gear). The roller wheel should contact the Lmax sensor within 3/4 to 1 inch of the end of the coil wire. Adjust the same way as for the Lmin and use glyptol on the elastic stop nut if it is required.

5.5.4.3.3 LUBRICATION OF THE INDUCTOR

The ball bearings in the coil do not require any lubrication as they are sealed. The roller bar should be lubricated with several drops of CRAMOLIN RED. The coil should be run several times the full length of the coil in order to distribute the lubricant. One easy way to accomplish this is to tune an artificial antenna of 4-j1000 ohms at 2 MHz. After having run the coil from Lmin to Lmax several times, wipe all the residue off the roller bar and the roller wheel. Apply several drops of CRAMOLIN BLUE to the roller bar and run the coil several more times. After exercising the coil several times, wipe the roller bar clean of all liquid.

5.5.5 REMOVAL OF SUBASSEMBLIES

As indicated in Figures 5.12, 5.13 and 5.14 all subassemblies can be removed without unsoldering. The rear panel assembly can be removed by removing one screw from E2 and the remaining screws holding the rear panel to the chassis and side bars. C3 and C6 assembly can be readily removed by removing the 6 screws from the under side of the chassis as shown.

5.6 SCHEMATIC DIAGRAMS

The following pages contain schematic diagrams, charts, parts lists and spare parts requirements for all assemblies of the ACU-150 ( ).

PARTS LIST, CHASSIS ASSEMBLY (ACU-150)

REF SYMBOL	DESCRIPTION	SUNAIR PART NO
	Chassis Assembly	8042310099
CR3	Diode, Zener IN2976B	0405640005
J1	Connector, PC 18 PIN	0755980006
R2	Resistor, 75 ohm, 5%, 10W	0191040002
R3	Resistor, 1.5 ohm, 10%, 10W	0197620001
R4	Resistor, 22 ohm, 5%, 20W	0197660002
R5, R6	Resistor, 30 ohm, 5%, 20W	0197390005
R7	Resistor, 5 ohm, 5%, 20W	1000080021

PARTS LIST, ACU-150 ( ) FRONT PANEL

REF SYMBOL	DESCRIPTION	SUNAIR PART NO.
	Front Panel Assy ACU-150	8042380097
C1-13, 15	Capacitor, Feed Thru, 1000 PF	0258660007
C14	Capacitor, 0.47 UF, 20%, 50V	0283370009
J1	Connector, Power, 26 PIN	0754480003
J2	Connector, RF, UHF	0753300001
L1	Inductor, Choke, 6 UH	0563340002
L2	Inductor, Molded, 120 UH, 5%	0646660004
L3-13, 15		
R8	Potentiometer, 10K, 10%, 3/4W	0335900003
R9	Resistor, 10K, 10%, 1/4W	0170410005
R10	Resistor, 15K, 10%, 1/4W	0172350000

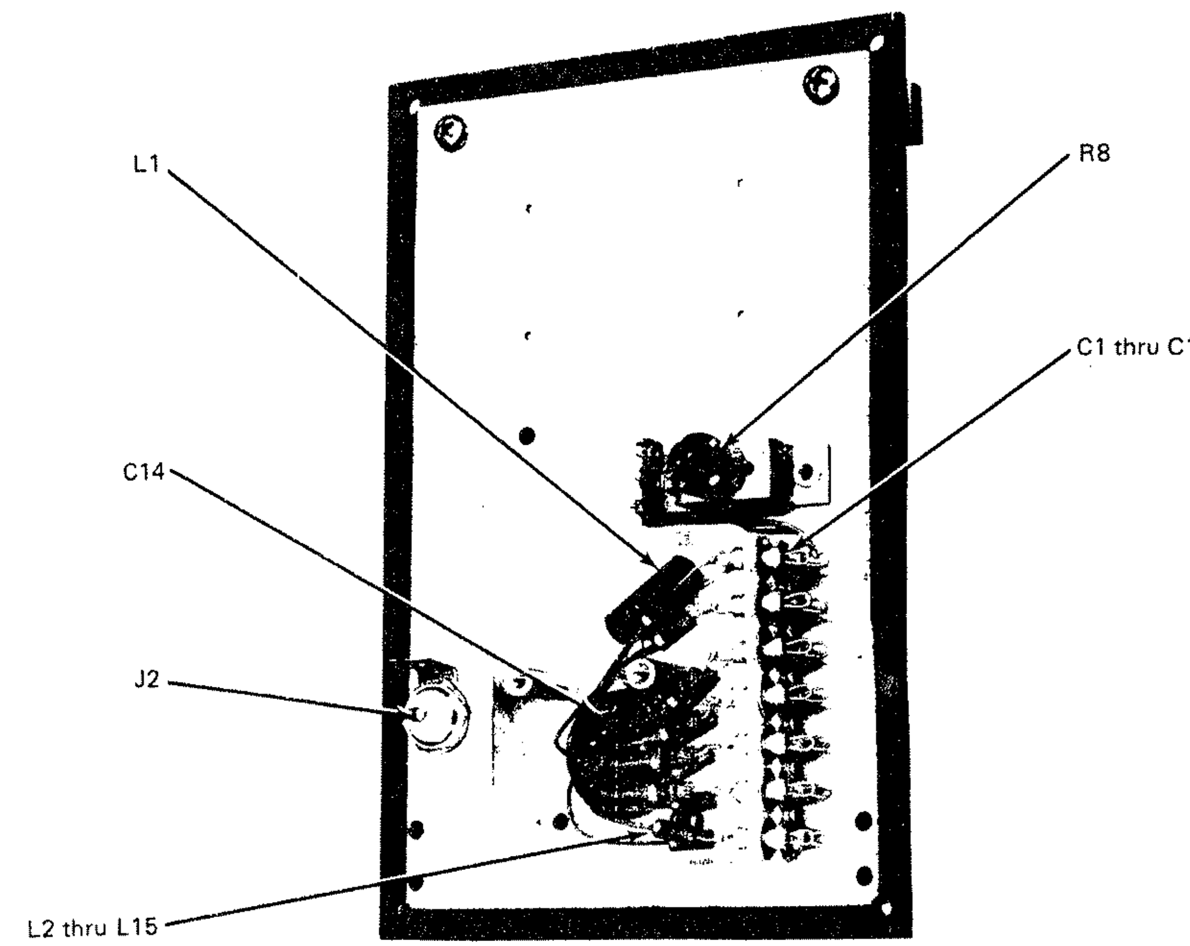
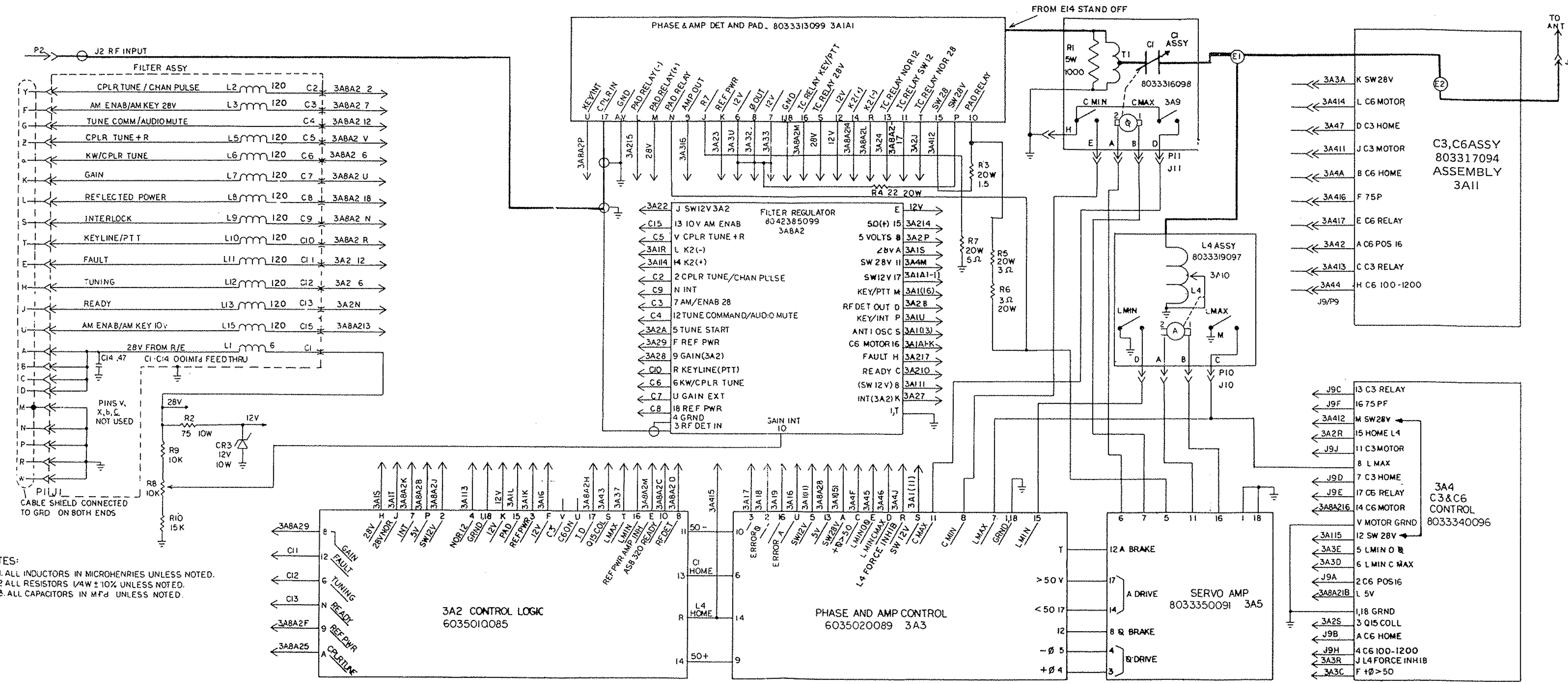


Figure 5.1

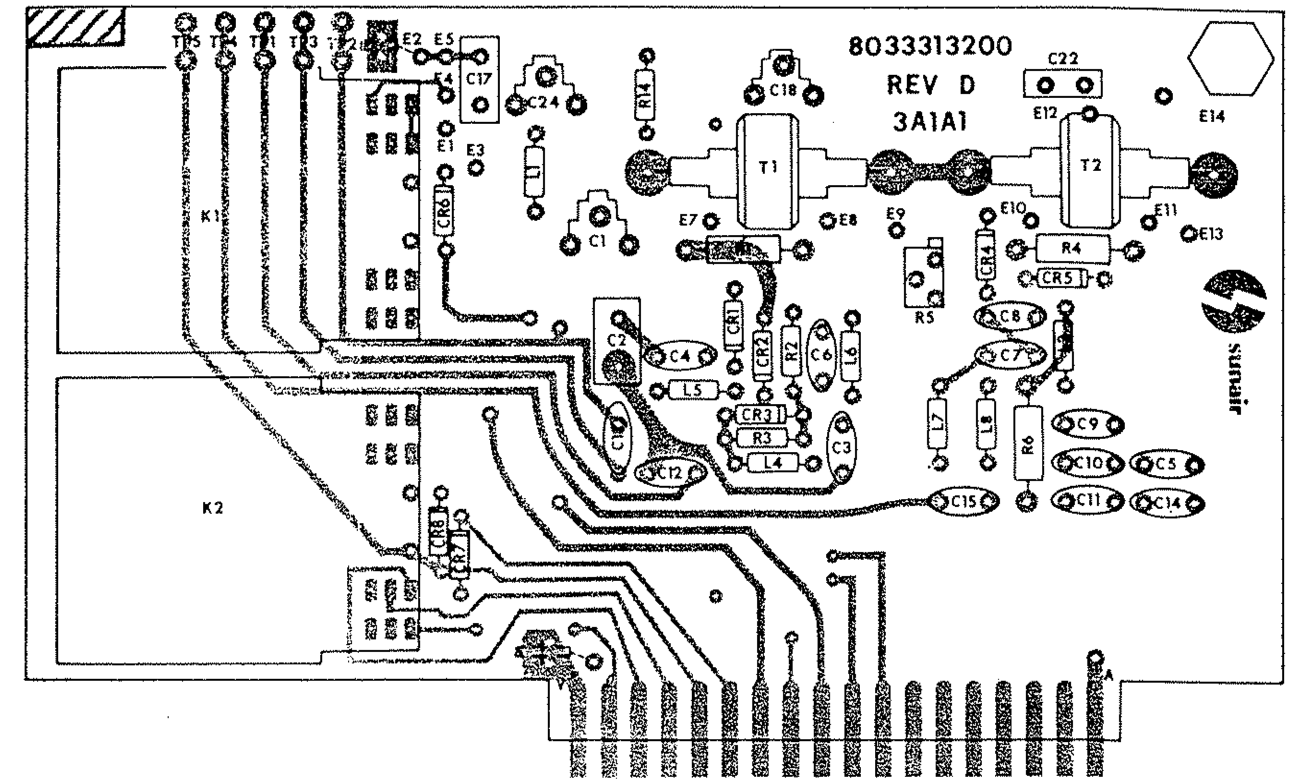


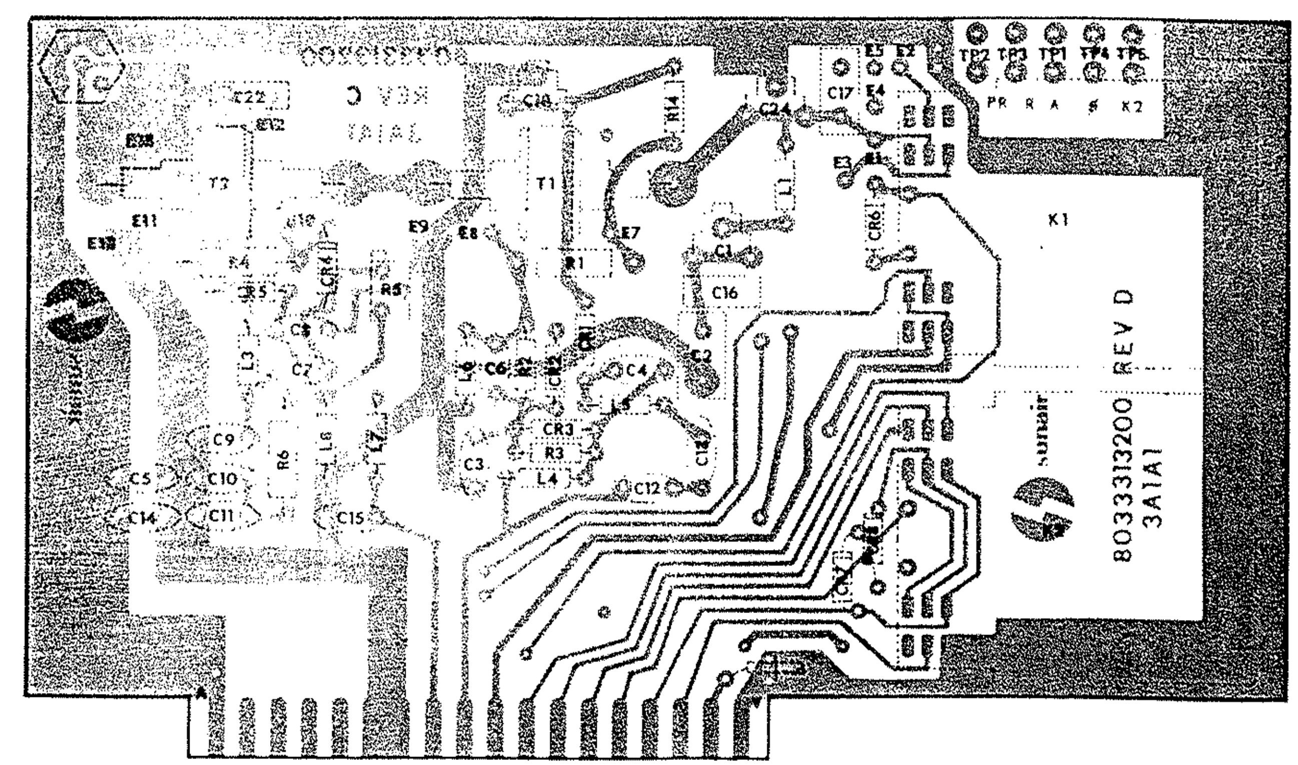
NOTES:
1. ALL INDUCTORS IN MICROHENRIES UNLESS NOTED.
2. ALL RESISTORS 1/4W ± 10% UNLESS NOTED.
3. ALL CAPACITORS IN MFd UNLESS NOTED.

Figure 5.1 Chassis Wiring Diagram, ACU-150 ( )

PARTS LIST, PAD, PHASE & AMPLITUDE DETECTORS (3A1A1)

REF SYMBOL	DESCRIPTION	SUNAIR PART NO
C22	Capacitor, 12 PF, 500 V, DM10, 5%	0260280003
C4,11	Capacitor, 0.02 UF, 25 V, Y5U	0269130004
C3,5-9,12, 13,15	Capacitor, 0.01 UF, 100 V, Z5V	0273210009
C10,14	Capacitor, 0.47 UF, 50 V, X5V, 20%	0283370009
C2	Capacitor, 390 PF, 500 V, DM15, 5%	0286000008
C17	Capacitor, 150 PF, 500 V, DM10, 5%	0293430004
C1,18,24	Capacitor, 4-40 PF, 25 V	0295490004
CR6-8	Diode, Rectifier, 1N4004	0405180004
CR1-5	Diode, Signal, Germ., 1N542E	0405610009
K1	Relayk4 PDT, 24 V, PC MT 7.5A	0661600009
K2	Relay, 4 PDT, 12 V, PC MT 7.5A	0661610004
L1	Inductor, Molded, 0.47 UH, 5%	0649410009
L3-8	Inductor, Molded, 1000 UH, 10%	0664940005
R14	Resistor, 100, 5%, 1/4 W	0171180003
R4,6	Resistor, 33, 10%, 1/2 W	0171700007
R2,3	Resistor, 12 K, 10%, 1/4 W	0183180003
R1	Resistor, 18, 5%, 1/2 W	0184730007
R7-9	Resistor, 75, 5%, 14 W	0191300004
R12,13	Resistor, 400, 5%, 14 W	0197380000
R11	Resistor, 200, 5%, 14 W	0197410006
R5	Potentiometer, 10 K, 5%, 0.6 W, 15 Turns	0344410005
T1	Transformer, Ampl. Detector	6035040802
T2	Transformer, Phase Detector	6035040900





NOTES:
UNLESS OTHERWISE NOTED
1. ALL CAPACITORS IN MFD
2. ALL RESISTORS 1/4W, ±10%
3. ALL INDUCTORS IN MILHENRIES

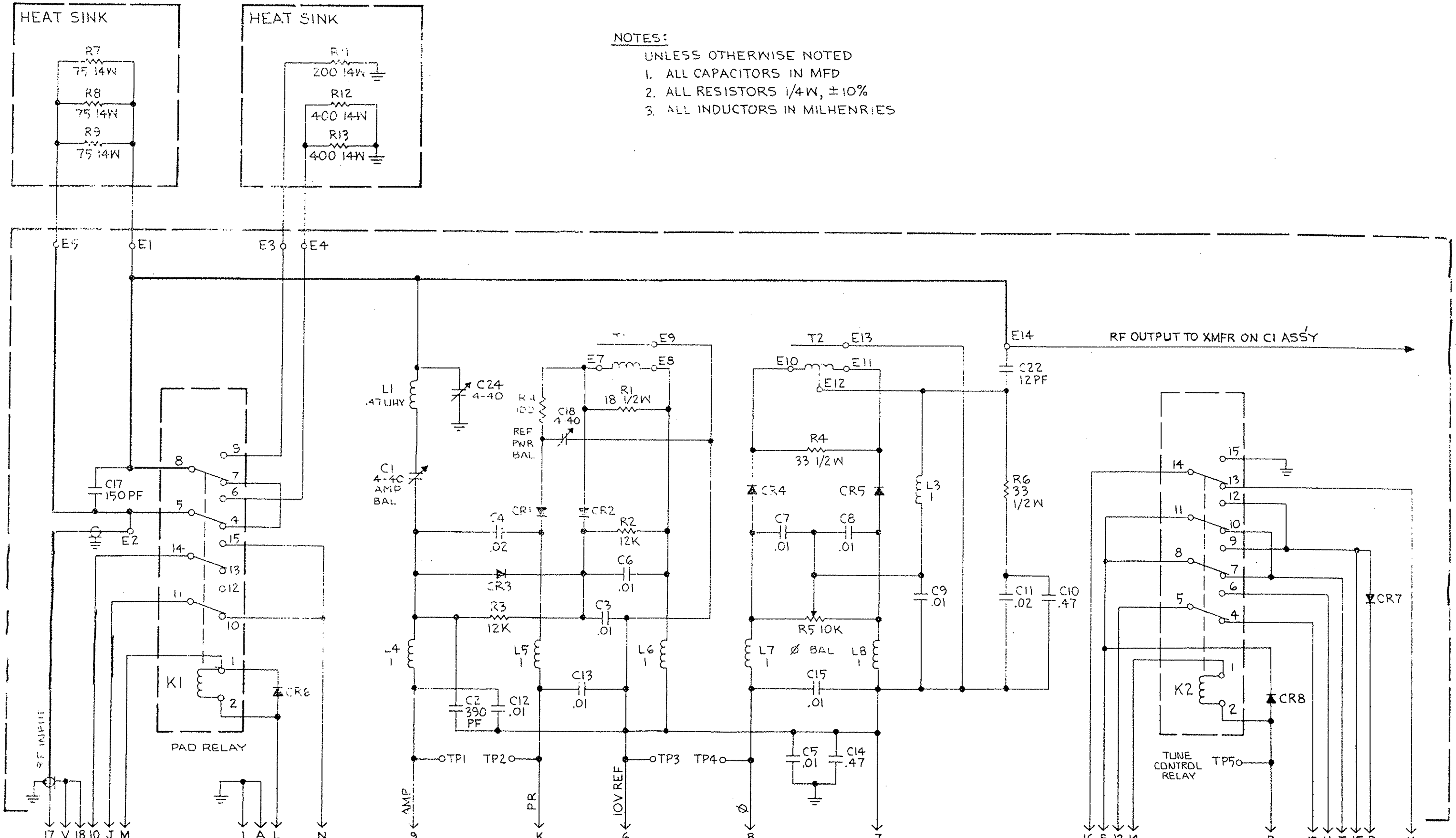
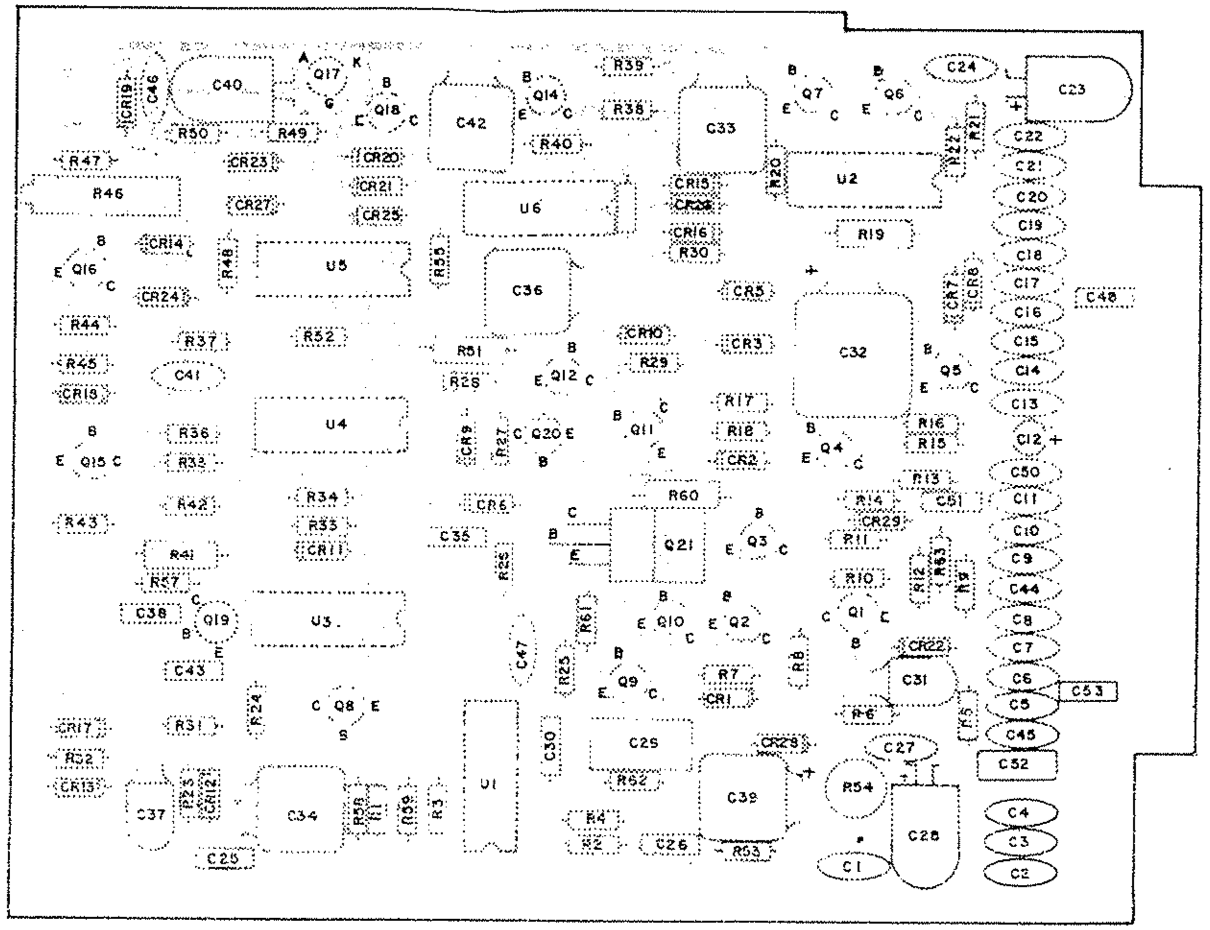
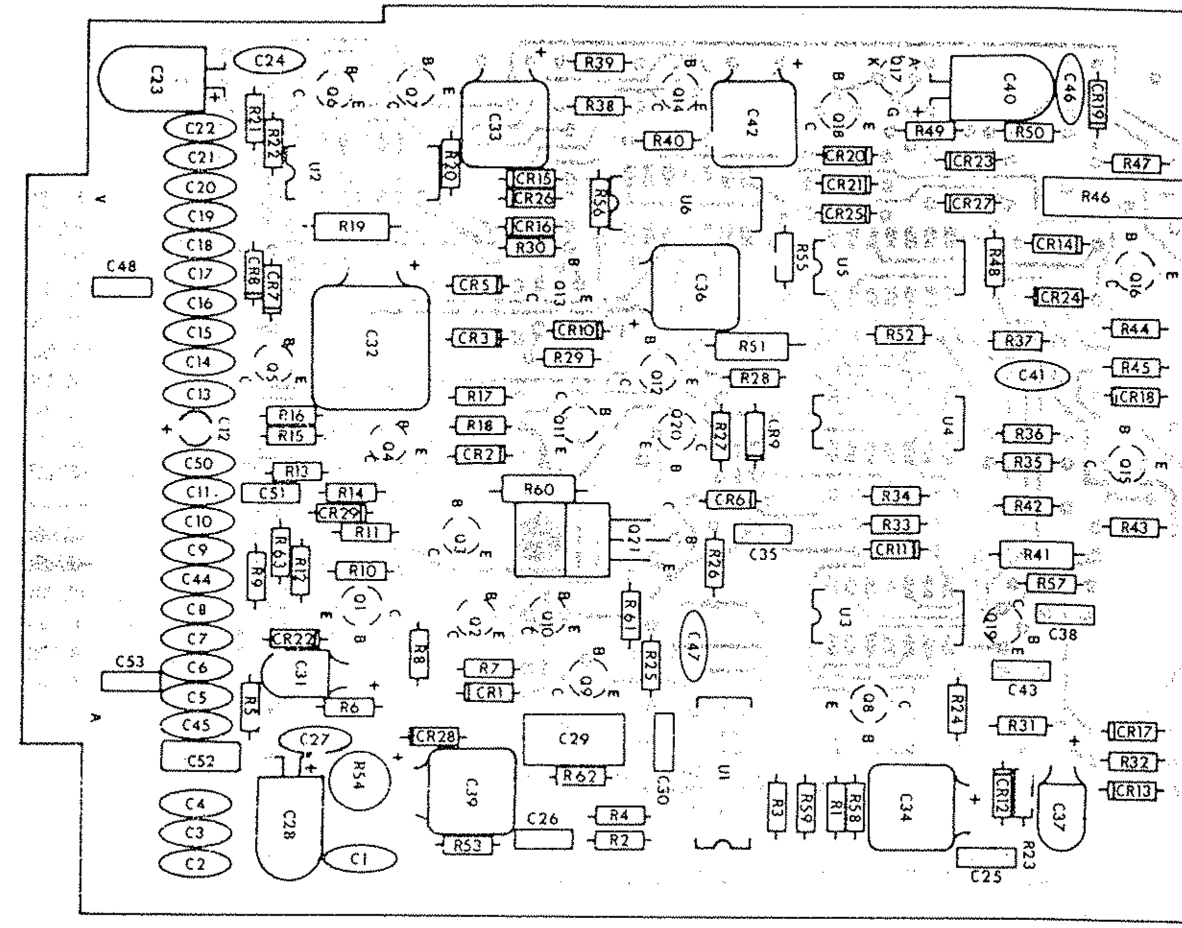


Figure 5.2 Pad, Phase and Amplitude Detectors (3A1A1) Schematic

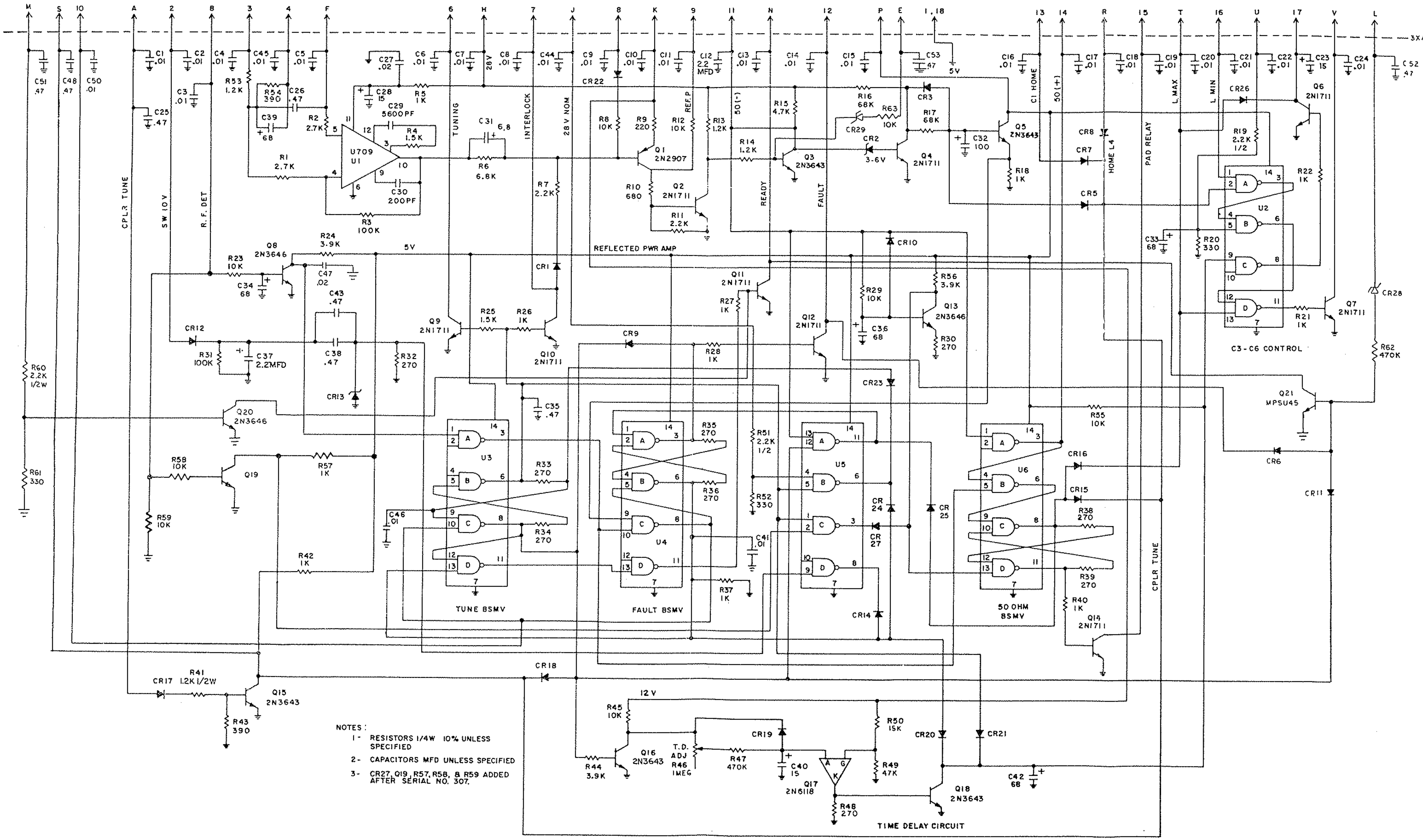




FARTS LIST, CONTROL LOGIC (3A2)

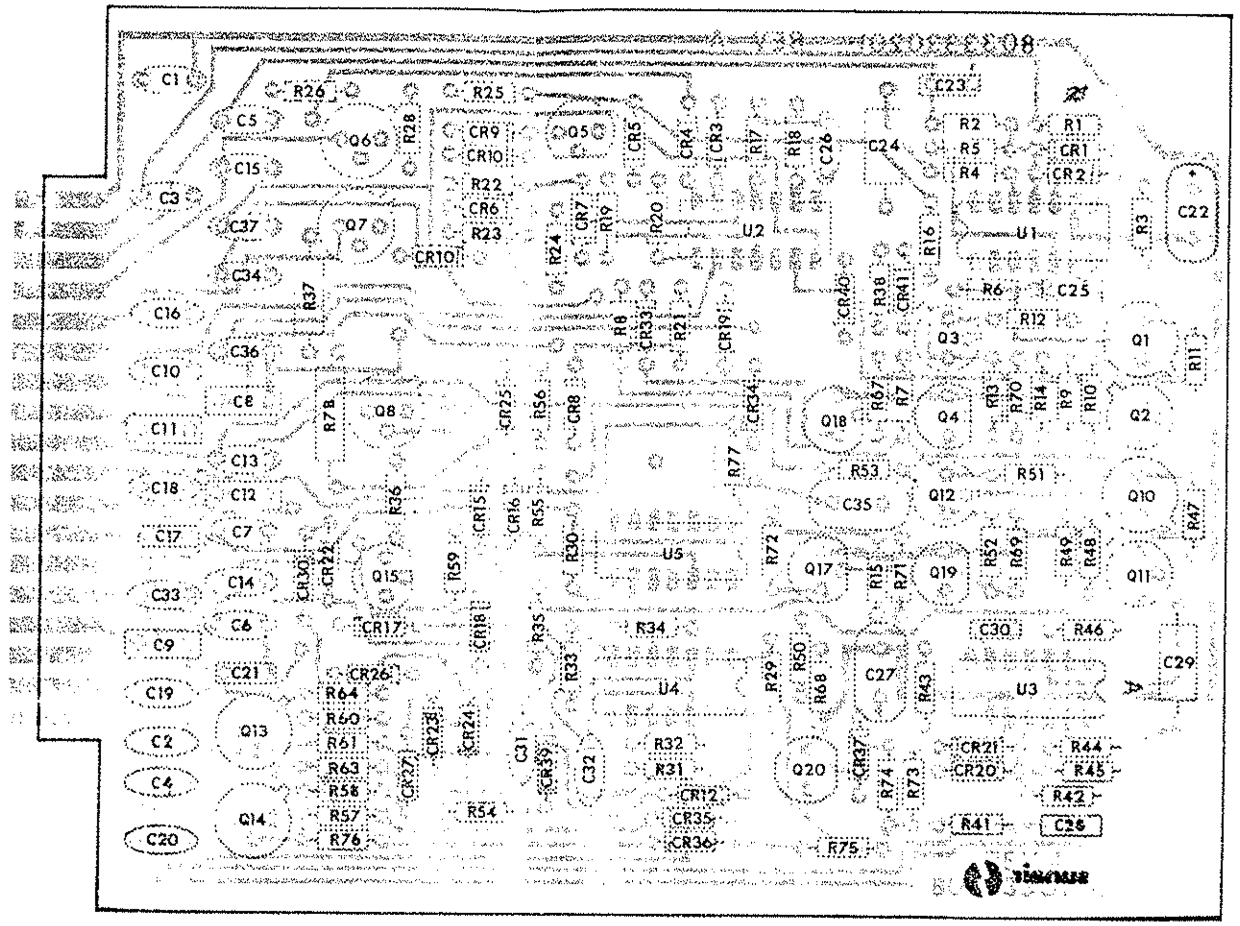
REF SYMBOL	DESCRIPTION	SUNAIR PART NO.
	Control Logic Ass'y	6035010083
C1-24,41, 44-46,49, 50	Capacitor, 0.01 UF, 100V	0273210009
C12, C37	CAPACITOR, 2.2 MFD, 15V	0296420000
C25,26,35, 38,43,48, 51-53	Capacitor, 0.47 UF, 20%, 50V	0283370009
C27,47	Capacitor, 0.02 UF, 25V	0269130004
C28, C40	Capacitor, 15 UF, 50V	0274000008
C29	Capacitor, Mylar, 5600 UF, 50V	0282270001
C30	Capacitor, 200 PF, 5%, 500V	0293050007
C31	Capacitor, 6.8 UF, 20V	0296780006
C32	Capacitor, 100 UF, 20V	0282230009
C33,34,36, 39,42	Capacitor 68 UF, 15V	0296540005
CR1,6,7,9, 11,14-18, 20-27	Diode, Signal, IN914	0442900007
CR2	Diode, Zener, IN5227B	0405250002
CR3-5, 10,12,19	Diode, Rectifier, IN4004	0405180004
CR8	Diode, Signal, IN270	0405510004
CR13,29	Diode, Zener, IN5231B	0405390009
CR28	Diode, Zener, IN5235B	0405200005
Q1	Transistor, PNP, 2N2907A	0448390001
Q2,4,7, 9-12,14,	Transistor, NPN, 2N1711	0448380005
Q3,5,15,18	Transistor, NPN, 2N3643	0443310009
Q8,13,19,16 20	Transistor, NPN, 2N3646	0442520000
Q17	Transistor, UJT, 2N6118	1001260007
Q21	Transistor, NPN, MPSU45	0448570009

REF SYMBOL	DESCRIPTION	SUNAIR PART NO.
R1,2	Resistor, 2.7K, 10%, 1/4W	0186670001
R3, 31	Resistor, 100K, 10%, 1/4W	0170390004
R4,25	Resistor, 1.5K, 10%, 1/4W	0172470005
R5,21,22 26-28,37, 40,42,57	Resistor, 1K, 10%, 1/4W	0171560001
R6	Resistor, 6.8K, 5%, 1/4W	0174810008
R7,8,12,23, 29, C45, 55,58,59, 63	Resistor, 10K, 10%, 1/4W	0170410005
R9	Resistor, 220 ohm, 10%, 1/4W	0171320000
R10	Resistor, 680 ohm, 10%, 1/4W	0176630007
R11	Resistor, 2.2K, 5%, 1/4W	0178070009
R13,14,53	Resistor, 1.2K, 10%, 1/4W	0181860007
R15	Resistor, 4.7K, 5%, 1/4W	0170770001
R16,17,50	Resistor, 68K, 10%, 1/4W	0173520006
R18,30, 32-36,38, 39,48	Resistor, 270 ohm, 10%, 1/4W	0178450006
R19,51,60	Resistor, 2.2K, 10%, 1/2W	0167360001
R20,52,61	Resistor, 330, 5%, 1/4W	0170910008
R24,44,56	Resistor, 3.9K, 10%, 1/4W	0178830003
R41	Resistor, 1.2K, 5%, 1/2W	0175960003
R43	Resistor, 390 ohm, 10%, 1/4W	0178330001
R46	Potentiometer, 1 MEG, 10%, 3/4W	0338490116
R49	Resistor, 39K, 10% 1/4W	0177800003
R54 *	Potentiometer, 1K,	1000850021
R62,47	Resistor, 470K, 10%, 1/4W	0180570005
U1	IC, Linear, UA709DC	0447330004
U2-6	IC, Digital, SN7400N	0448070006
	* R54 A	



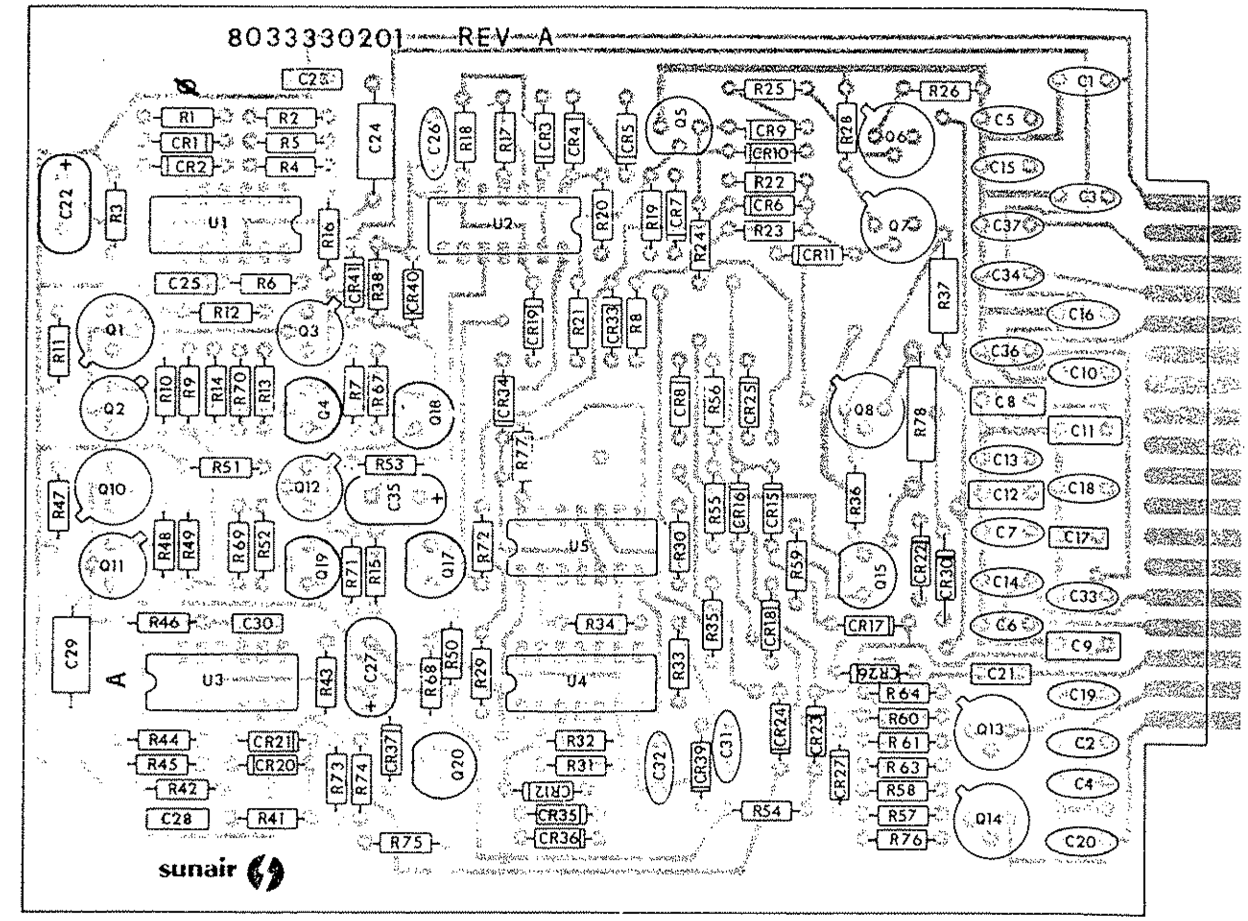
NOTES:
1 - RESISTORS 1/4W 10% UNLESS SPECIFIED
2 - CAPACITORS MFD UNLESS SPECIFIED
3 - CR27, Q19, R57, R58, & R59 ADDED AFTER SERIAL NO. 307.

Figure 5.3 Control Logic (3A2) Schematic



PARTS LIST, PHASE & AMPLITUDE CONTROL (3A3)

REF SYMBOL	DESCRIPTION	SUNAIR PART NO.
	Phase and Amplitude Control Ass'y	6035020089
C1-7,10 13,15,16 18-20,26, 31-34,36, 37	Capacitor, 0.01 UF, 100V	0273210009
C8,9,11,12, 17,23,28, 21,14	Capacitor, 0.47 UF, 20%, 50V	0283370009
C22,27,35	Capacitor, 15 UF, 35V	0282240004
C24,29	Capacitor, Mylar, 5600 UF, 50V	0282270001
C25,30	Capacitor, 200 PF, 5%, 500V	0293050007
CR1,2,4-8, 10,15-17, 20-27,33, 35,36, 39-41	Diode, Signal, IN914	0442900007
CR3,9,18, 19,30	Diode, Rectifier, IN4004	0405180004
CR11,12, 34,37	Diode, Signal, IN270	0405510004
Q1,6-8,10, 13,14	Transistor, NPN, 2N1711	0448380005
Q2,3,11,12	Transistor, PNP, 2N2907A	0448390001
Q4,5,15, 17-20	Transistor, NPN, 2N3646	0442520000
R1,2,41,42	Resistor, 2.7K, 10%, 1/4W	0186670001
R3,19,20, 29,30,43, 55,73-75, 77	Resistor, 1K, 10%, 1/4W	0171560001



REF SYMBOL	DESCRIPTION	SUNAIR PART NO.
R4,15,44, 72	Resistor, 1.5K, 10%, 1/4W	0172470005
R5	Resistor, 220K, 10%, 1/4W	0177780002
R6,46,71	Resistor, 6.8K, 5%, 1/4W	0174810008
R7	Resistor, 820 ohm, 10%, 1/4W	0178210005
R8,54	Resistor, 3.3K, 10%, 1/4W	0170890007
R9,10,12, 14,48,49 51	Resistor, 220 ohm, 10%, 1/4W	0171320000
R11,47	Resistor, 330 ohm, 5%, 1/4W	0170910008
R13,52	Resistor, 1.2K, 10%, 1/4W	0181860007
R16,24,25, 36,53,59, 60	Resistor, 10K, 10%, 1/4W	0170410005
R17,18, 31-34	Resistor, 270 ohm, 10%, 1/4W	0178450006
R21,22,56, 57,76	Resistor, 1.8K, 10%, 1/4W	0178190004
R23,58	Resistor, 3.9K, 10%, 1/4W	0178830003
R26,28,63, 64	Resistor, 68 ohm, 10%, 1/4W	0187960003
R35,50	Resistor, 470 ohm, 5%, 1/4W	0184110009
R37	Resistor, 5.6 ohm, 10%, 1/2W	0168030004
R38	Resistor, 68K, 10%, 1/4W	0173520006
R45	Resistor, 470K, 10%, 1/4W	0180570005
R61	Resistor, 4.7K, 5%, 1/4W	0170770001
R67,69	Resistor, 100 ohm, 5%, 1/4W	0171180003
R68	Resistor, 390 ohm, 10%, 1/4W	0178330001
R70	Resistor, 5.6K, 10%, 1/4W	0183060008
R78	Resistor, 30 ohm, 5%, 3W	0179240005
U1,3	IC. Linear, UA709DC	0447330004
U2,4,5	IC. Digital, SN7400N	0448070006

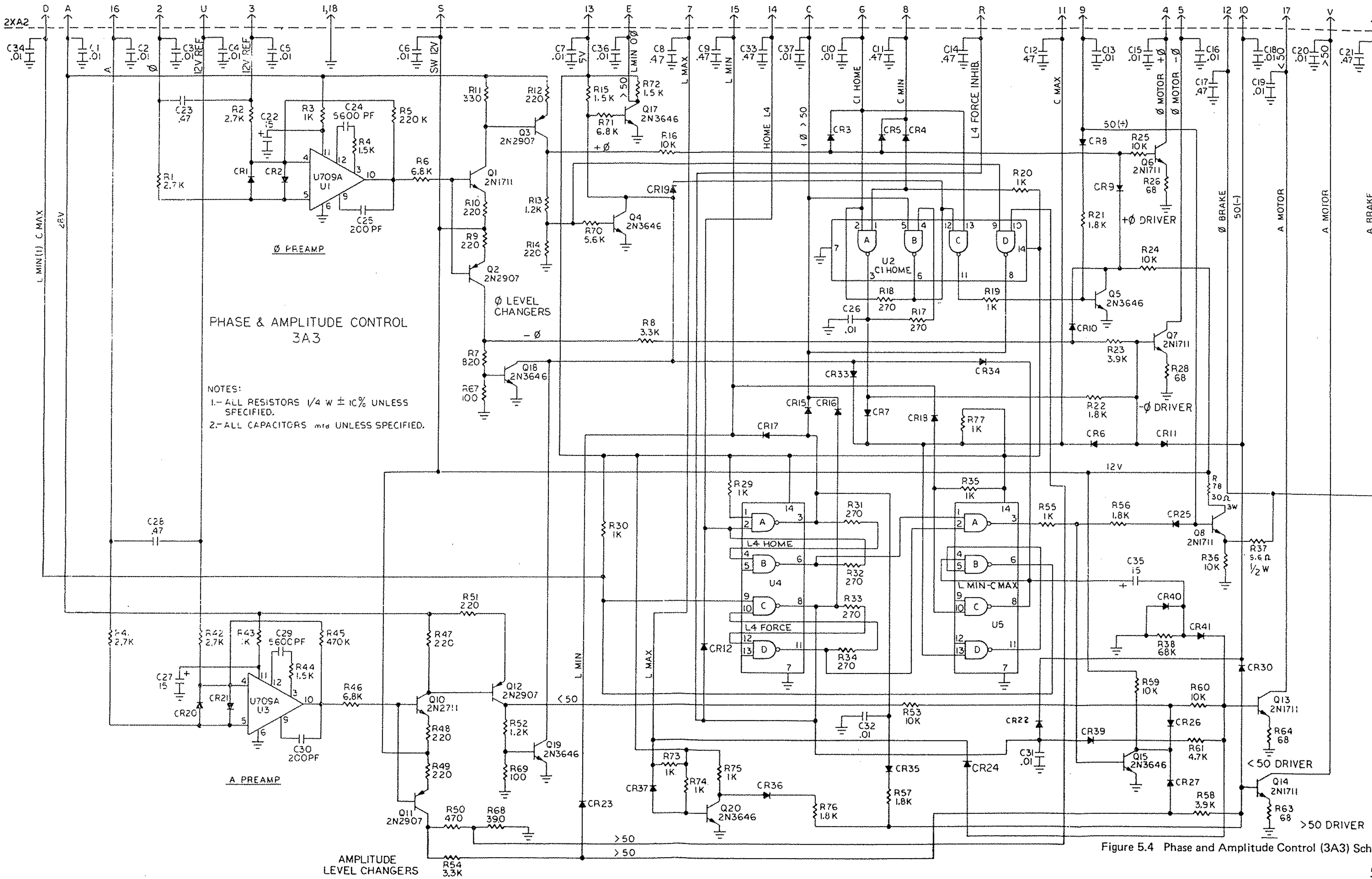
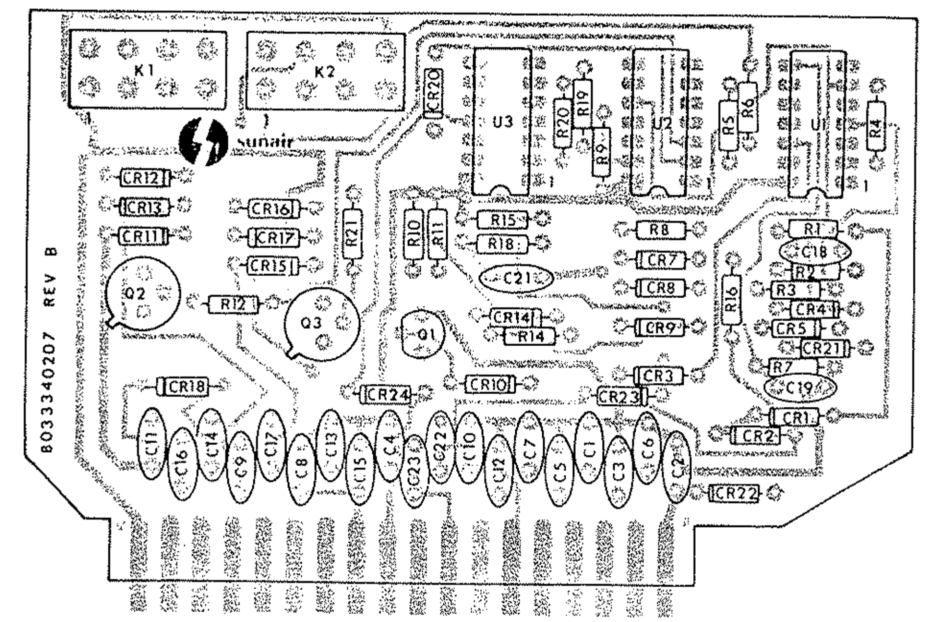
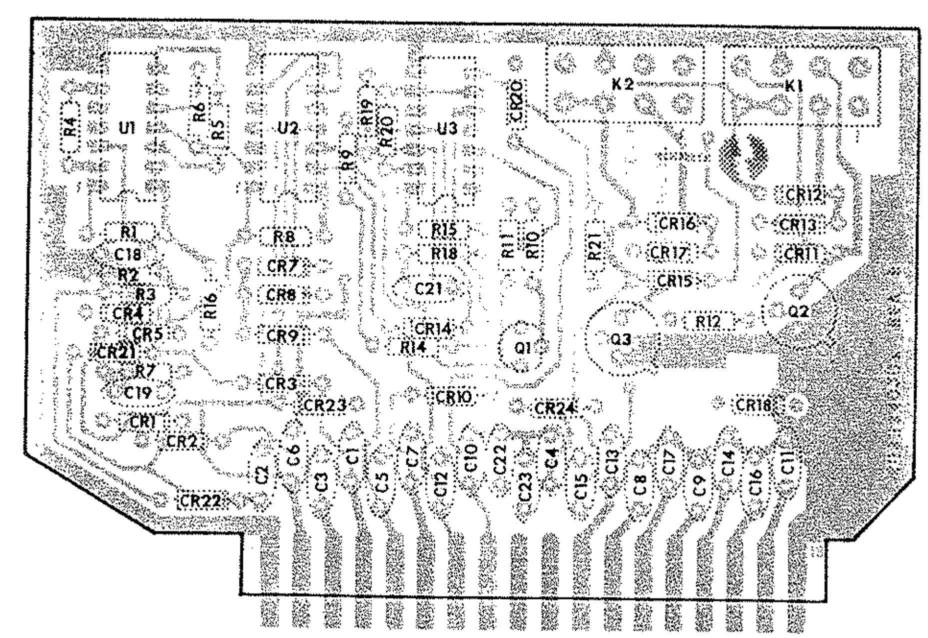


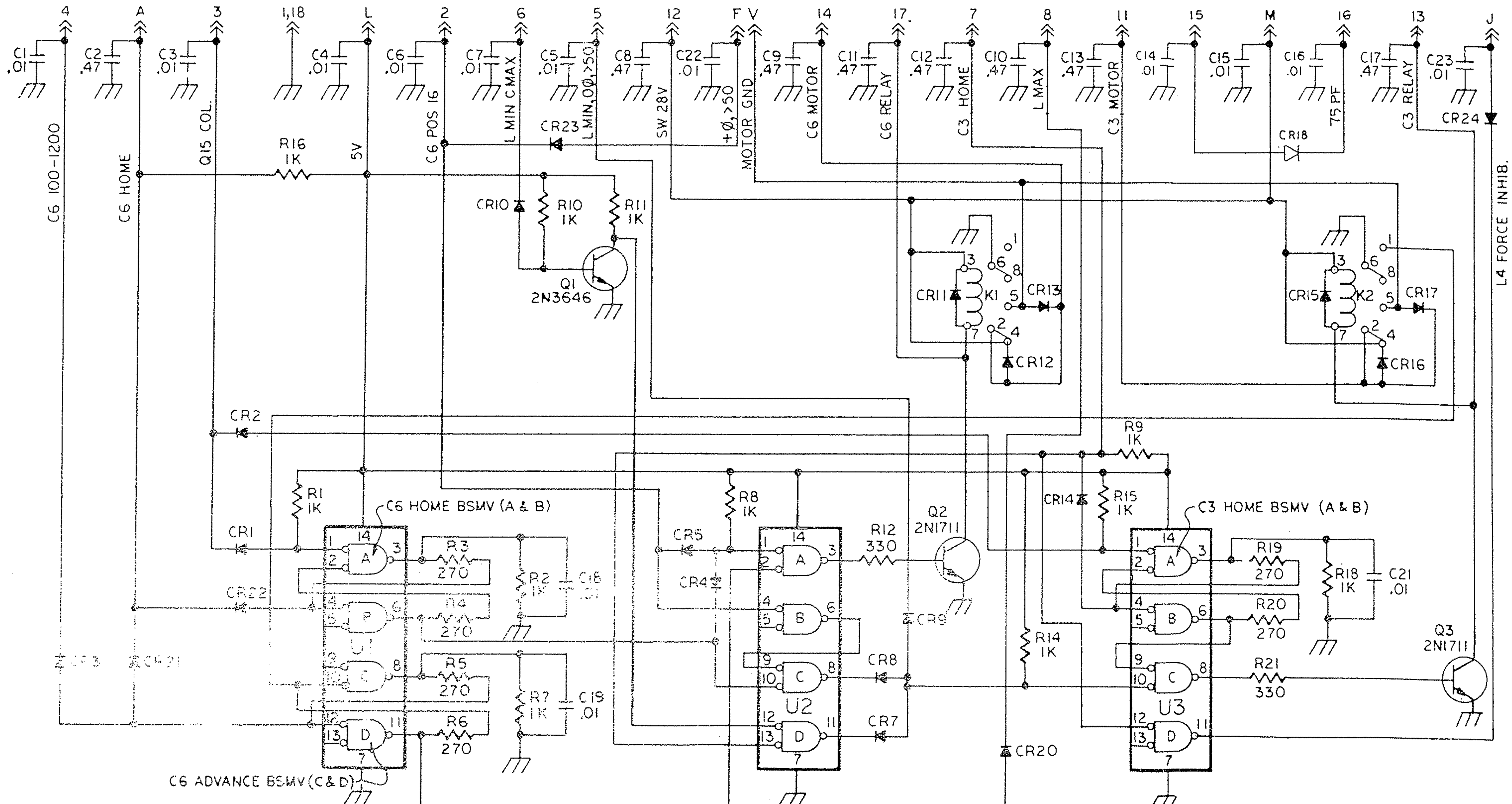
Figure 5.4 Phase and Amplitude Control (3A3) Schematic

PARTS LIST, C3 & C6 CONTROL (3A4)

REF SYMBOL	DESCRIPTION	SUNAIR PART NO.
	C3 and C6 Control	8033340096
C1,3-7, 14-16,18, 19,21-23	Capacitor, 0.01 UF, 100V	0273210009
C2,8-13, 17	Capacitor, 0.47 UF, 20%, 50V	0283370009
CR1-5, 7-9,14, 20-22,24	Diode, Signal, IN914	0442900007
CR10,23	Diode, Signal, IN270	0405510004
CR11-13, 15-18	Diode, Rectifier, IN4004	0405180004
K1,2	Relay, DPDT, 24V	0661630005
Q1	Transistor, NPN, 2N3646	0442520000
Q2,3	Transistor, NPN, 2N1711	0448380005
R1,2,7-11, 14-16,18	Resistor, 1K, 10%, 1/4W	0171560001
R3-6,19, 20	Resistor, 270 ohm, 10%, 1/4W	0178450006
R12,21	Resistor, 330 ohm, 5%, 1/4W	0170910008
U1-3	IC, Digital, SN7400N	0448070006



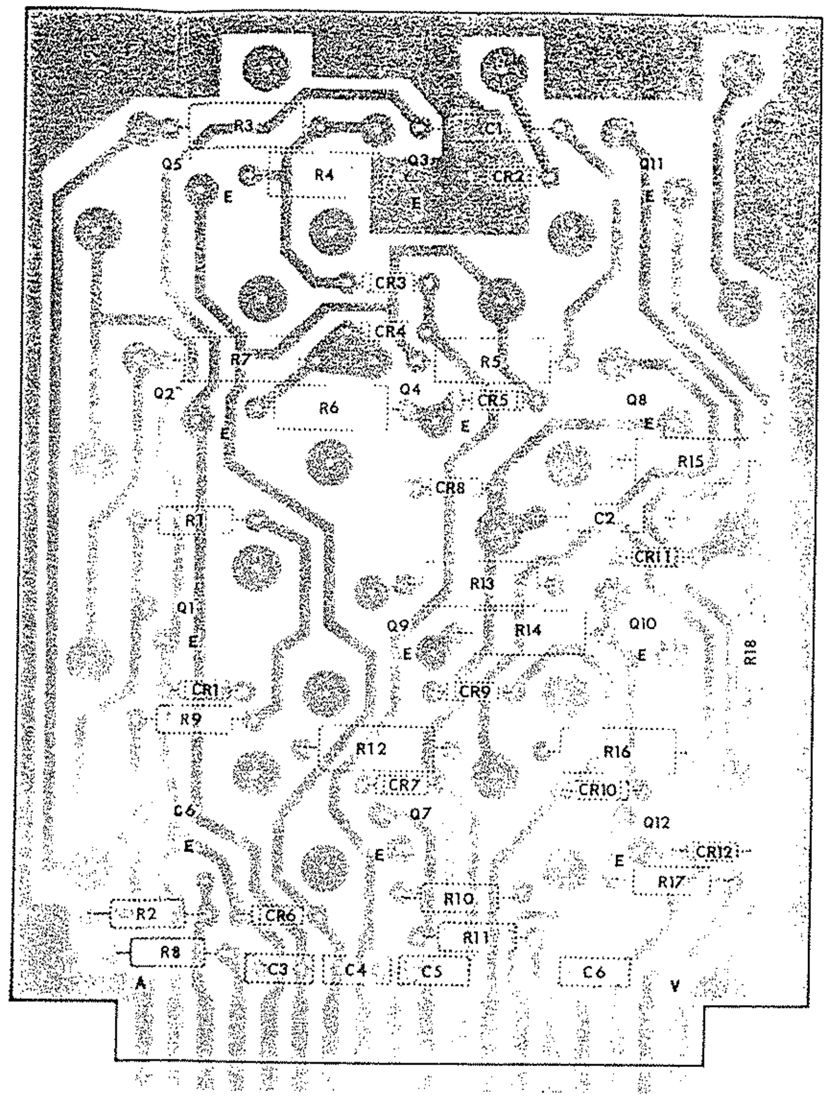


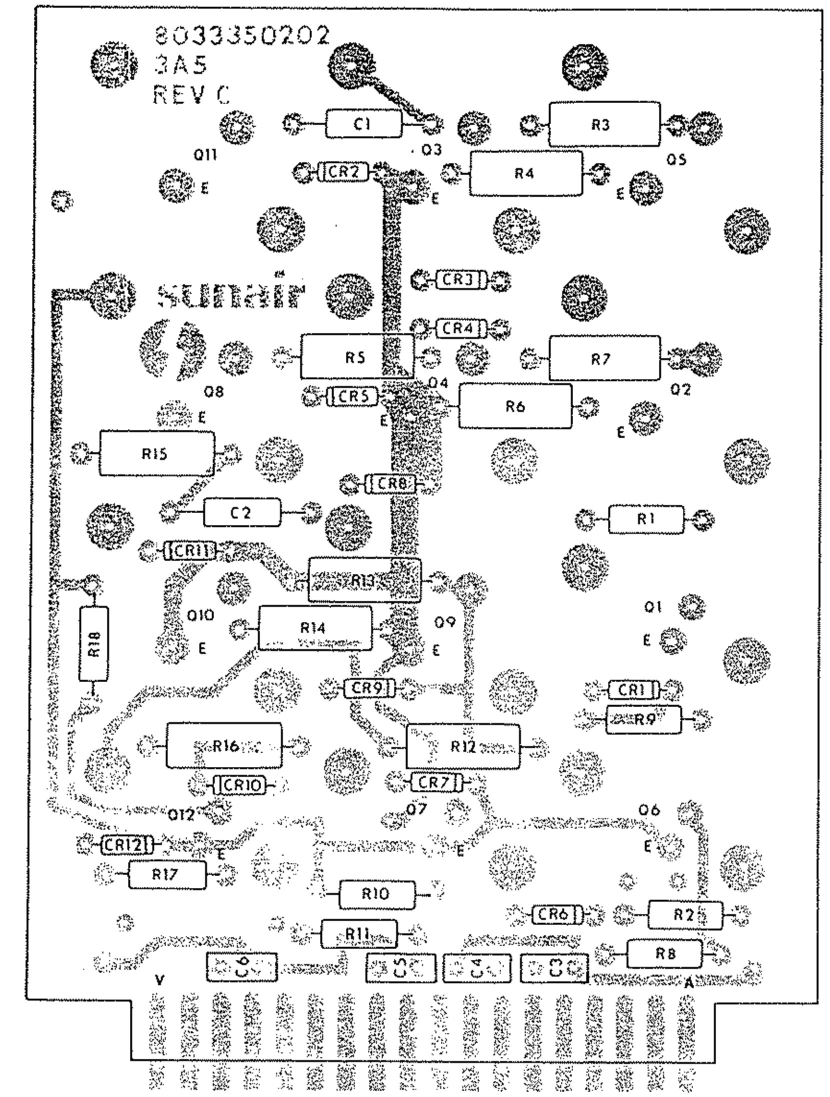


NOTES:

1) UNLESS OTHERWISE SPECIFIED:
ALL RESISTOR VALUES ARE IN OHMS, ±10%, 1/4 WATT.
ALL CAPACITOR VALUES ARE IN MICROFARADS, ±10%.

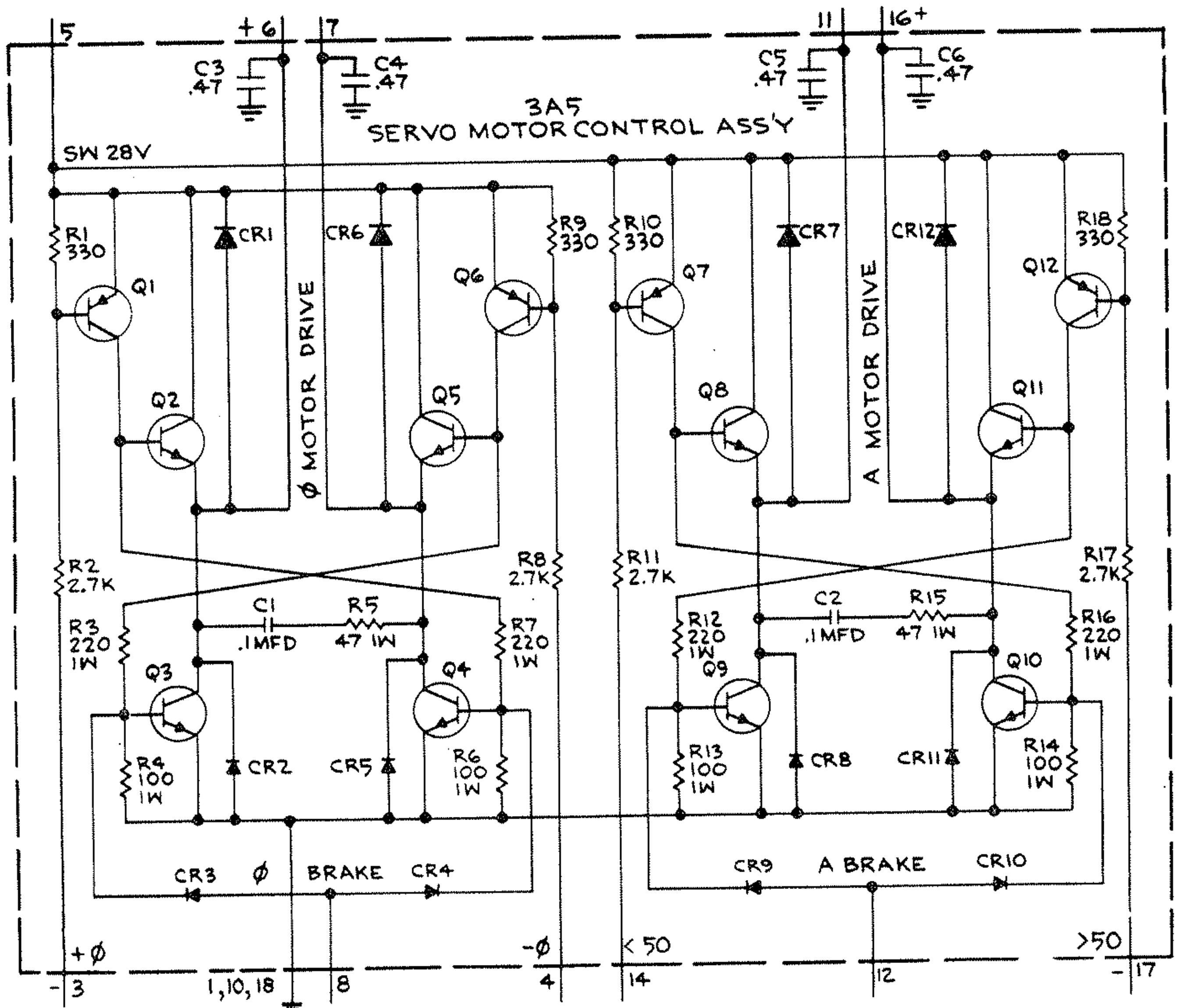
Figure 5.5 C3 and C6 Control (3A4) Schematic





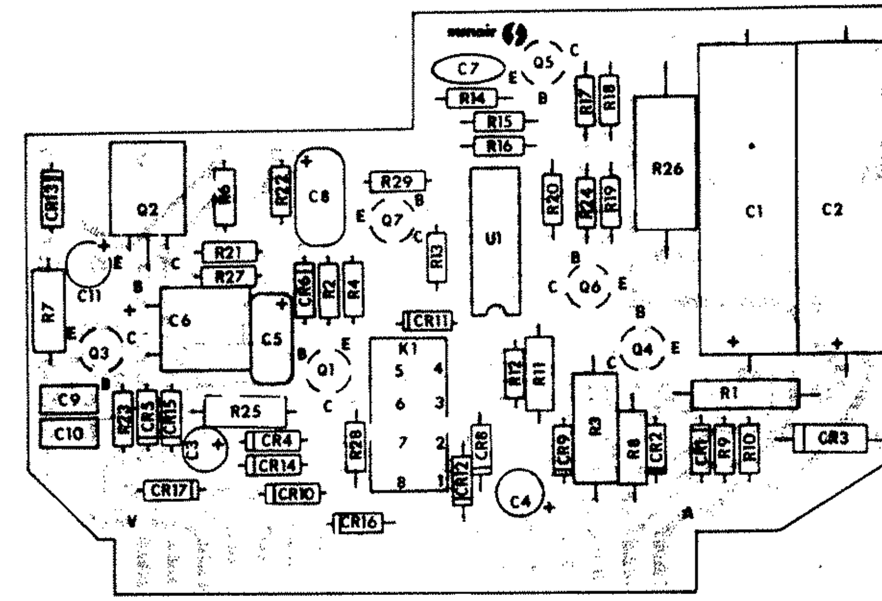
PARTS LIST, SERVO MOTOR CONTROL (3A5)

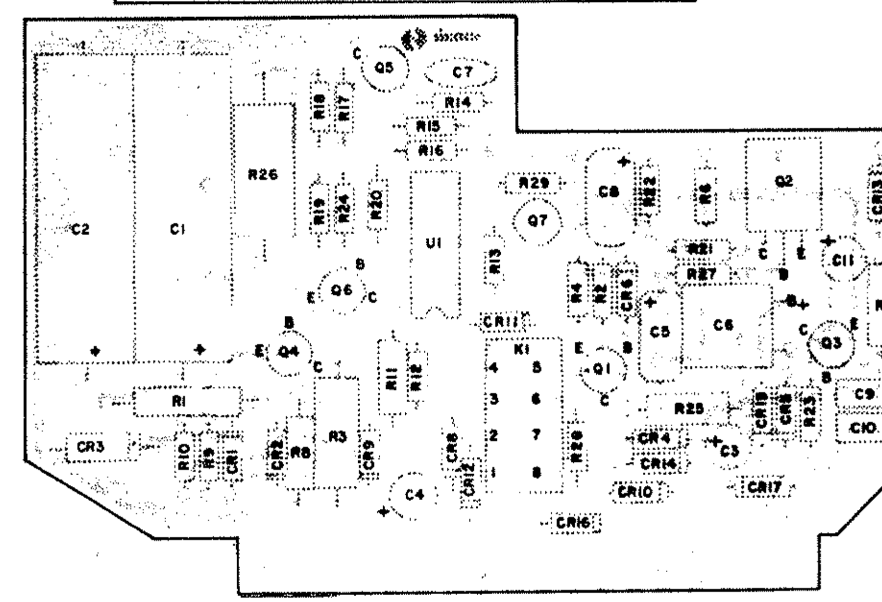
REF SYMBOL	DESCRIPTION	SUNAIR PART NO.
	Servo Motor Control Ass'y	8033350091
C1,2	Capacitor, Mylar, 0.10 UF, 100V	0272160008
C3-6	Capacitor, 0.47 UF, 20%, 50V	0283370009
CR1-12	Diode, Rectifier, IN4004	0405180004
Q1,6,7,12	Transistor, PNP, 2N3741	0448360004
Q2-5,8-11	Transistor, NPN, 2N3772	0448370000
R1,9,10,18	Resistor, 330 ohm, 10%, 1/2W	0173380000
R2,8,11,17	Resistor, 2.7K, 10%, 1/2W	0165780002
R3,7,12,16	Resistor, 220 ohm, 10%, 1W	0197190006
R4,6,13,14	Resistor, 100 ohm, 10%, 1W	0165540001
R5,15	Resistor, 47 ohm, 10%, 1W	0164990003
	Jack, PCB, Press-in	0754100006
	Jack, PCB, Press-in	0754380009



RESISTORS 1/2 W ± 10% UNLESS OTHERWISE SPECIFIED

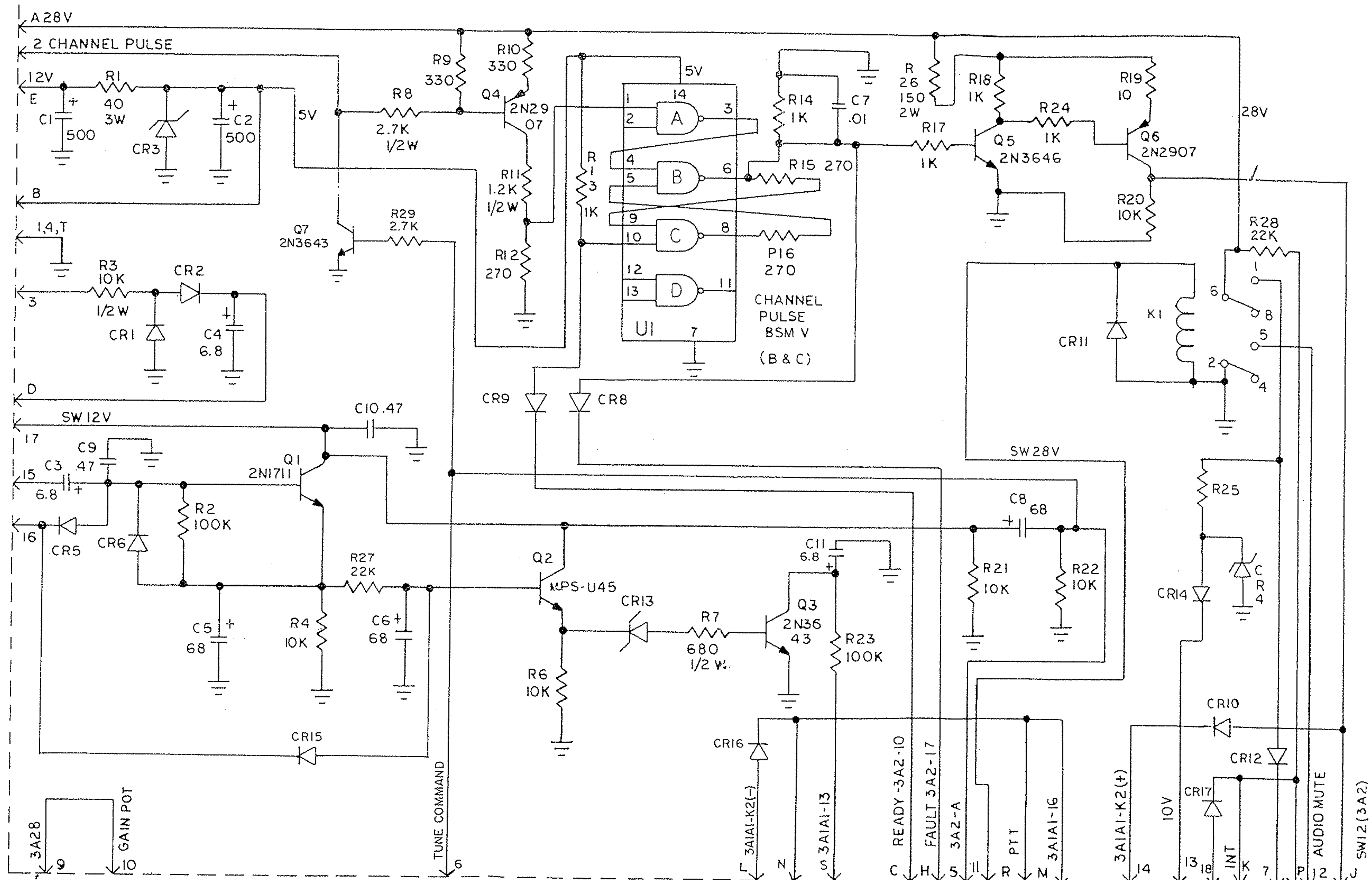
Figure 5.6 Servo Motor Control (3A5) Schematic





REF SYMBOL	DESCRIPTION	SUNAIR PART NO
	Filter Regulator Board	8042385099
C1	Capacitor, 500UF, 15V, BR	0273070002
C2	Capacitor, 500UF, 15V, BR	0273070002
C3	Capacitor, 6.8UF, 20V, T368	0296780006
C4	Capacitor, 6.8UF, 20V, T368	0296780006
C5	Capacitor, 68UF, 15V, T368	0296540005
C6	Capacitor, 68UF, 15V, T368	0296540005
C7	Capacitor, 0.01UF, 100V, Z5V	0273210009
C8	Capacitor, 68UF, 15V, T368	0296540005
C9	Capacitor, 0.47UF, 50V, X5V, 20%	0283370[illegible]
C10	Capacitor, 0.47UF, 50V, X5V, 20%	0283370[illegible]
C11	Capaciror, 6.8UF, 20V, T368	02967800[illegible]
CR1	Diode, Signal, Sil. 1N4454	0405270[illegible]
CR2	Diode, Signal, Sil. 1N4454	0405270[illegible]
CR3	Diode, Zener 1N5338B	0405[illegible]
CR4	Diode, Zener 1N5240B	040385000[illegible]
CR5	Diode, Rectifier 1N4004	0405180004
CR6	Diode, Signal, Si. 1N914	0442900007
CR7	Not used	
CR8	Diode, Signal, Si. 1N914	0442900007
CR9	Diode, Rectifier 1N4004	0405180004
CR10	Diode, Rectifier 1N4004	0405180004
CR11	Diode, Rectifier 1N4004	0405180004
CR12	Diode, Rectifier 1N4004	0405180004
CR13	Diode, Zener 1N5235B	04052000[illegible]
CR14	Diode, Rectifier 1N4004	0405180004
CR15	Diode, Rectifier 1N4004	04051800[illegible]
CR16	Diode, Rectifier 1N4004	0405[illegible]
CR17	Diode, Rectifier 1N4004	[illegible]
K1	Relay, DPDT, 24V, Crystal Con	[illegible]
Q1	Transistor, NPN, Si. 2N1711	[illegible]
Q2	Transistor, NPN, Si. MPSU45	[illegible]
Q3	Transistor, NPN, Si. 2N3643	[illegible]
Q4	Transistor, PNP, Si. 2N2907A	[illegible]

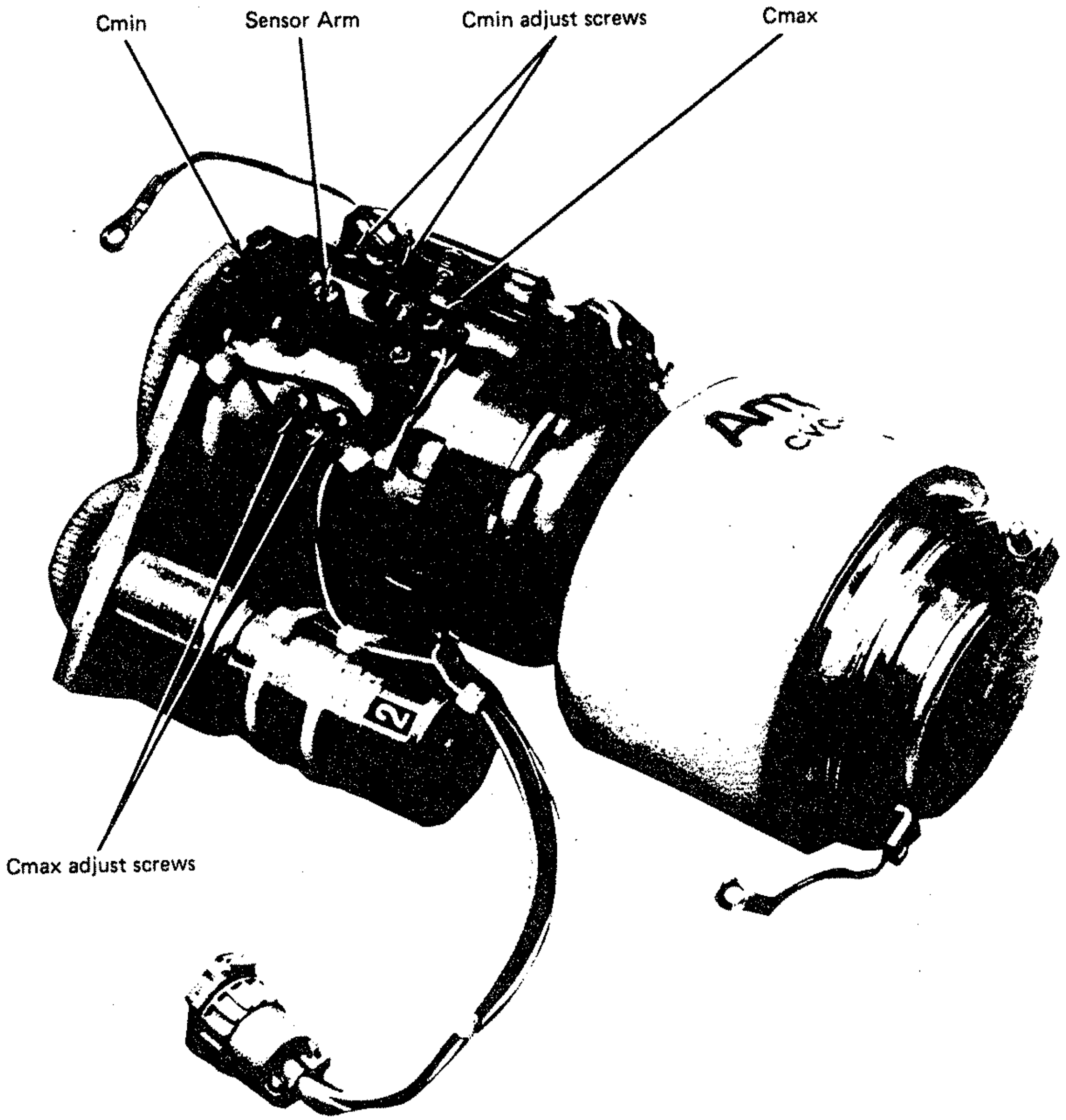
REF SYMBOL	DESCRIPTION	SUNAIR PART NO.
Q5	Transistor, NPN, Si. 2N3646	0442520000
Q6	Transistor, PNP, Si. 2N2907A	0448390001
Q7	Transistor, NPN, Si. 2N3643	0443310009
R1	Resistor, 40, 5%, 3W	0163100004
R2	Resistor, 100K, 10%, 1/4W	0170390004
R3	Resistor, 4.7K, 10%, 1W	1003090001
R4	Resistor, 10K, 10%, 1/4W	0170410005
R5	Not used	
R6	Resistor, 10K, 10%, 1/4W	0170410005
R7	Resistor, 680, 10%, 1/2W	0167500007
R8	Resistor, 2.7K, 10%, 1/2W	0165780002
R9	Resistor, 330, 5%, 1/4W	0170910008
R10	Resistor, 330, 5%, 1/4W	0170910008
R11	Resistor, 1.2K, 5%, 1/2W	0175960003
R12	Resistor, 270, 10%, 1/4W	0178450006
R13	Resistor, 1K, 10%, 1/4W	0171560001
R14	Resistor, 1K, 10%, 1/4W	0171560001
R15	Resistor, 270, 10%, 1/4W	0178450006
R16	Resistor, 270, 10%, 1/4W	0178450006
R17	Resistor, 1K, 10%, 1/4W	0171560001
R18	Resistor, 1K, 10%, 1/4W	0171560001
R19	Resistor, 10, 5%, 1/4W	0177160004
R20	Resistor, 10K, 10%, 1/4W	0170410005
R21	Resistor, 10K, 10%, 1/4W	0170410005
R22	Resistor, 10K, 10%, 1/4W	0170410005
R23	Resistor, 100K, 10%, 1/4W	0170390004
R24	Resistor, 1K, 10%, 1/4W	0171560[illegible]
R25	Resistor, 820, 10%, 1/2W	017560[illegible]
R26	Resistor, 150, 10%, 2W	017182[illegible]
R27	Resistor, 22K, 10%, 1/4W	0172230004
R28	Resistor, 22K, 10%, 1/4W	0172230004
R29	Resistor, 2.7K, 10%, 1/2W	0165780002
U1	I.C. Digital SN7400N	0448070006



NOTES:

1. ALL RESISTOR 1/4W ± 10% UNLESS NOTED.
2. ALL CAPACITORS IN Mfd UNLESS NOTED.

Figure 5.7 Filter Regulator (3A8A2) for ACU-150A ( ) Schematic



PARTS LIST, C1 ASSEMBLY (3A9)

REF SYMBOL	DESCRIPTION	SUNAIR PART NO
	C1 Ass'y	8033316098
B1	Motor, Torque, 19 1 VDC	8033319500
C1	Capacitor, Var Vacuum	6035080707
P11	Connector, Power 5 PIN Round	0754850005
R1	Resistor, 1K 5% 5W	0190370009
S1,S2	Switch Micro SPDT	0345560001
T1	Transformer, 50-12 5 ohm	6035142001

Figure 5.9 C1 Assembly (3A9)

PARTS LIST, L4 ASSEMBLY (3A10)

REF SYMBOL	DESCRIPTION	SUNAIR PART NO.
	L4 Ass'y	8033319097
B1	Motor, Torque, 19.1 VDC	8033319500
L4	Inductor, Var, 0.2-18.0 UH	8033319607
P10	Connector, Power, 4 PIN Round	0754820009

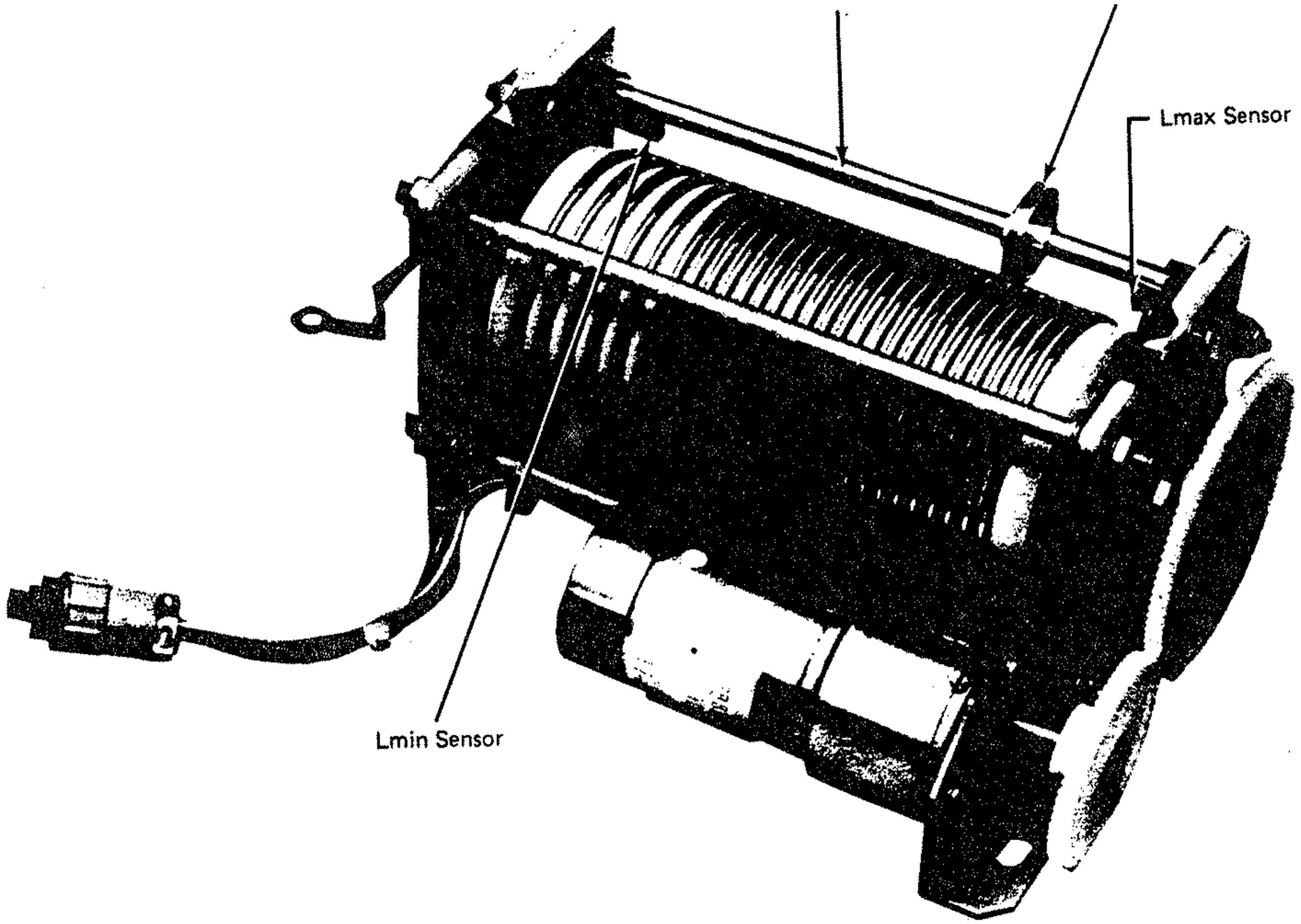
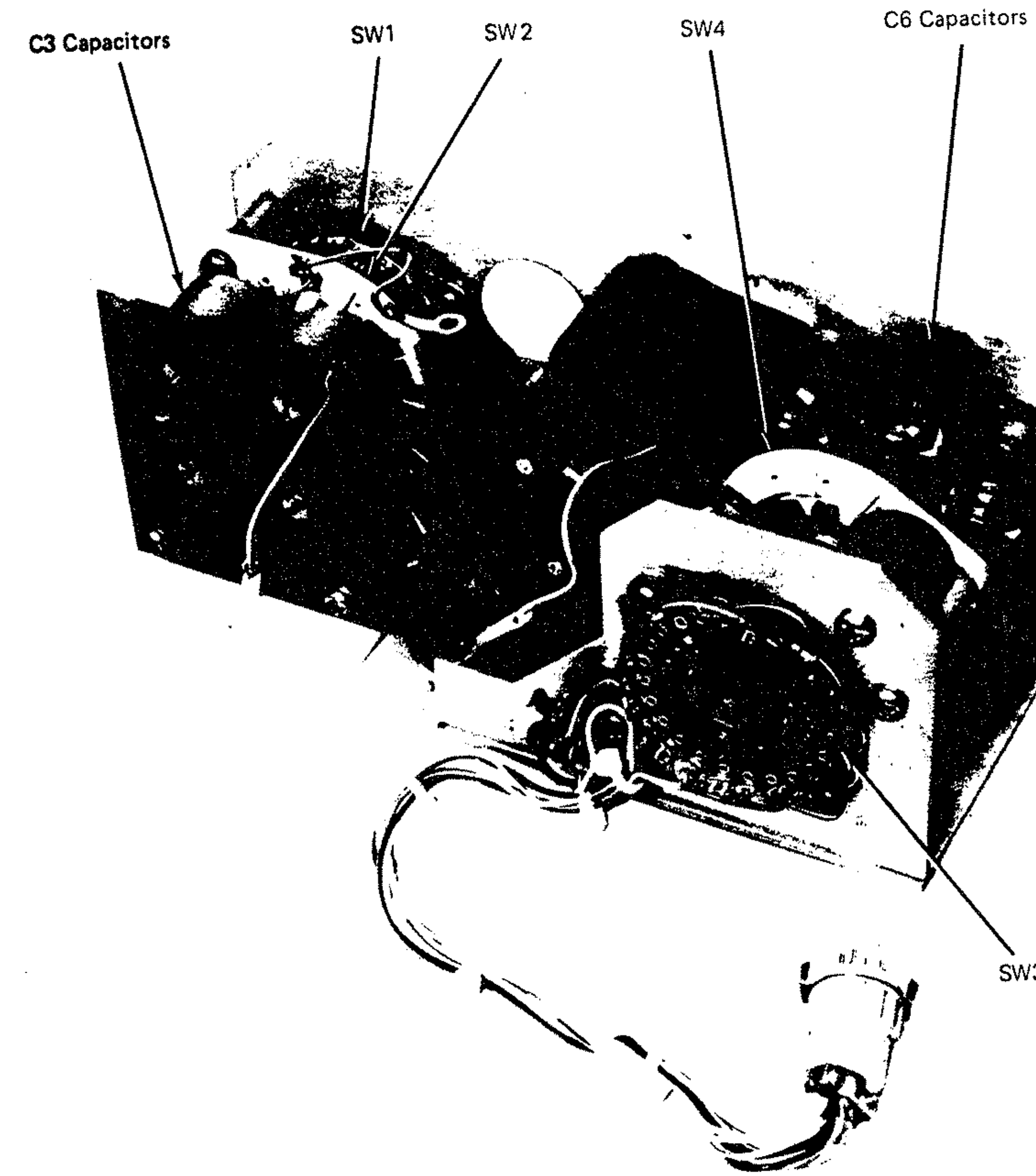


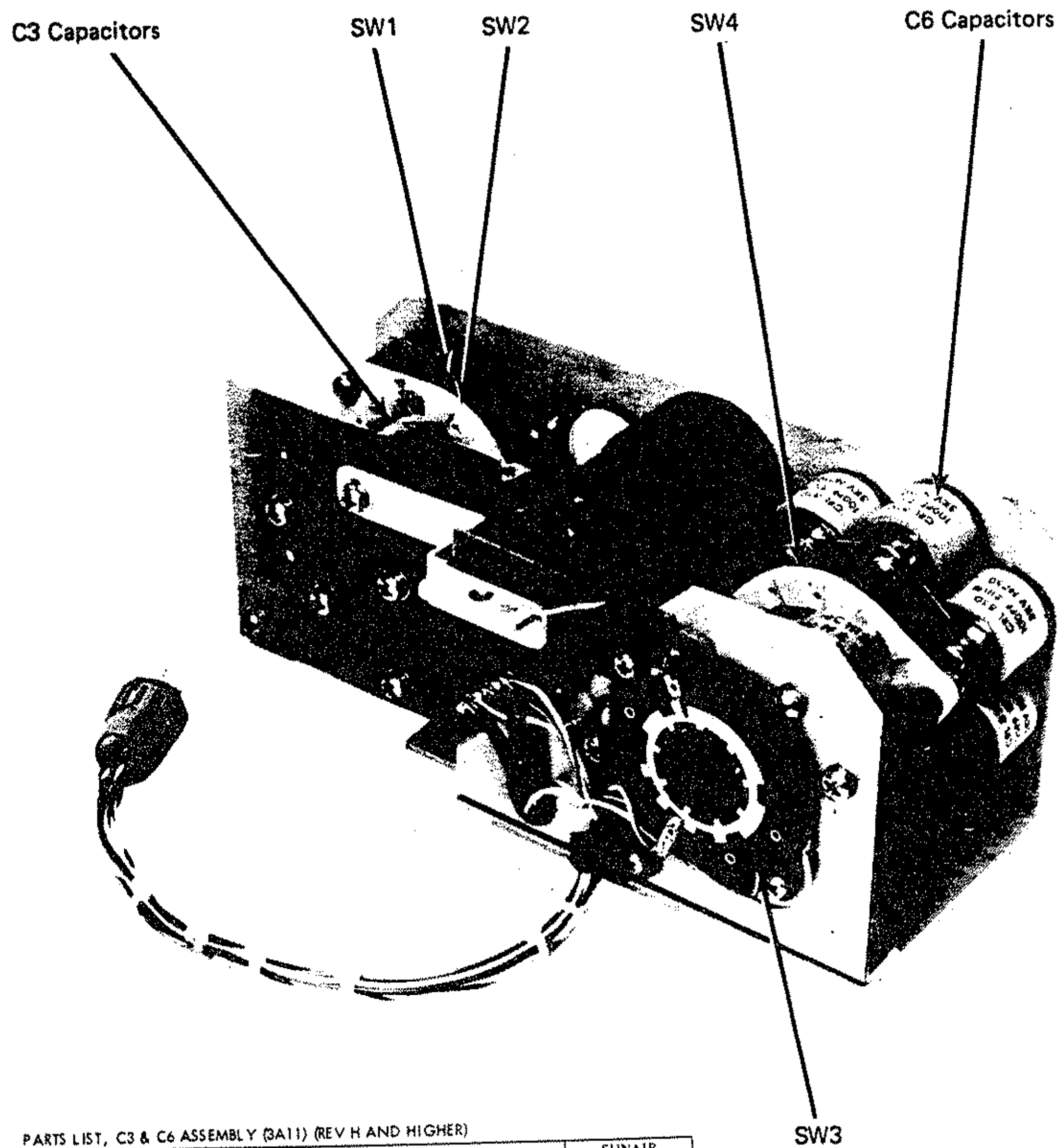
Figure 5.10 L4 Assembly (3A10)



PARTS LIST, C3 & C6 ASSEMBLY (3A11)

REF SYMBOL	DESCRIPTION	SUNAIR PART NO
	C3 and C6 Ass'y	8033317094
B1,2	Motor, 28 VDC	5024204107
C3A	Capacitor, 100 PF 5KV, N750	0290440009
C3B,C	Capacitor, 50 PF 7.5KV NPO	0290200008
C3D	Capacitor, 25 PF 7.5KV NPO	0290320003
C6A-H, C6J-M	Capacitor, 100 PF 5KV, N750	0290440009
CR1	Diode Rectifier 1N4004	0405180004
P9	Connector Power 10 PIN Round	0754670006
SW1,3	Switch Wafer 22 Pos	0345840003
SW2,4	Switch, Progressive HV	5024204806

Figure 5.11 C3 and C6 Assembly (3A11)



PARTS LIST, C3 & C6 ASSEMBLY (3A11) (REV H AND HIGHER)

REF SYMBOL	DESCRIPTION	SUNAIR PART NO
	C3 and C6 Ass'y	8033317094
B1	Motor, 28 VDC	5024204107
B2	Motor, 28 VDC	5024204107
C3A	Capacitor, 100PF, 5KV, N750	0290440009
C3B	Capacitor, 50PF, 7.5KV, NPO	0290200008
C3C	Capacitor, 50PF, 7.5KV, NPO	0290200008
C3D	Capacitor, 25PF, 7.5KV, NPO	0290320003
C6A	Capacitor, 100 PF, 5KV, N750	0290440009
C6B	Capacitor, 100 PF, 5KV, N750	0290440009
C6C	Capacitor, 100 PF, 5KV, N750	0290440009
C6D	Capacitor, 100 PF, 5KV, N750	0290440009
C6E	Capacitor, 100 PF, 5KV, N750	0290440009
C6F	Capacitor, 100 PF, 5KV, N750	0290440009
C6G	Capacitor, 100 PF, 5KV, N750	0290440009
C6H	Capacitor, 100 PF, 5KV, N750	0290440009
C6J	Capacitor, 100 PF, 5KV, N750	0290440009
C6K	Capacitor, 100 PF, 5KV, N750	0290440009
C6L	Capacitor, 100 PF, 5KV, N750	0290440009
C6M	Capacitor, 100 PF, 5KV, N750	0290440009
CR1	Diode, Rectifier 1N4004	0405180004
P9	Connector, Power, 10 PIN Round	0754870006
SW1	Switch Wafer	1004870019
SW2	Switch, Progressive HV	5024204806
SW3	Switch, Wafer	1004640021
SW4	Switch, Progressive HV	5024204808

Figure 5.11A C3 and C6 Assembly (3A11) (Rev. H and higher)

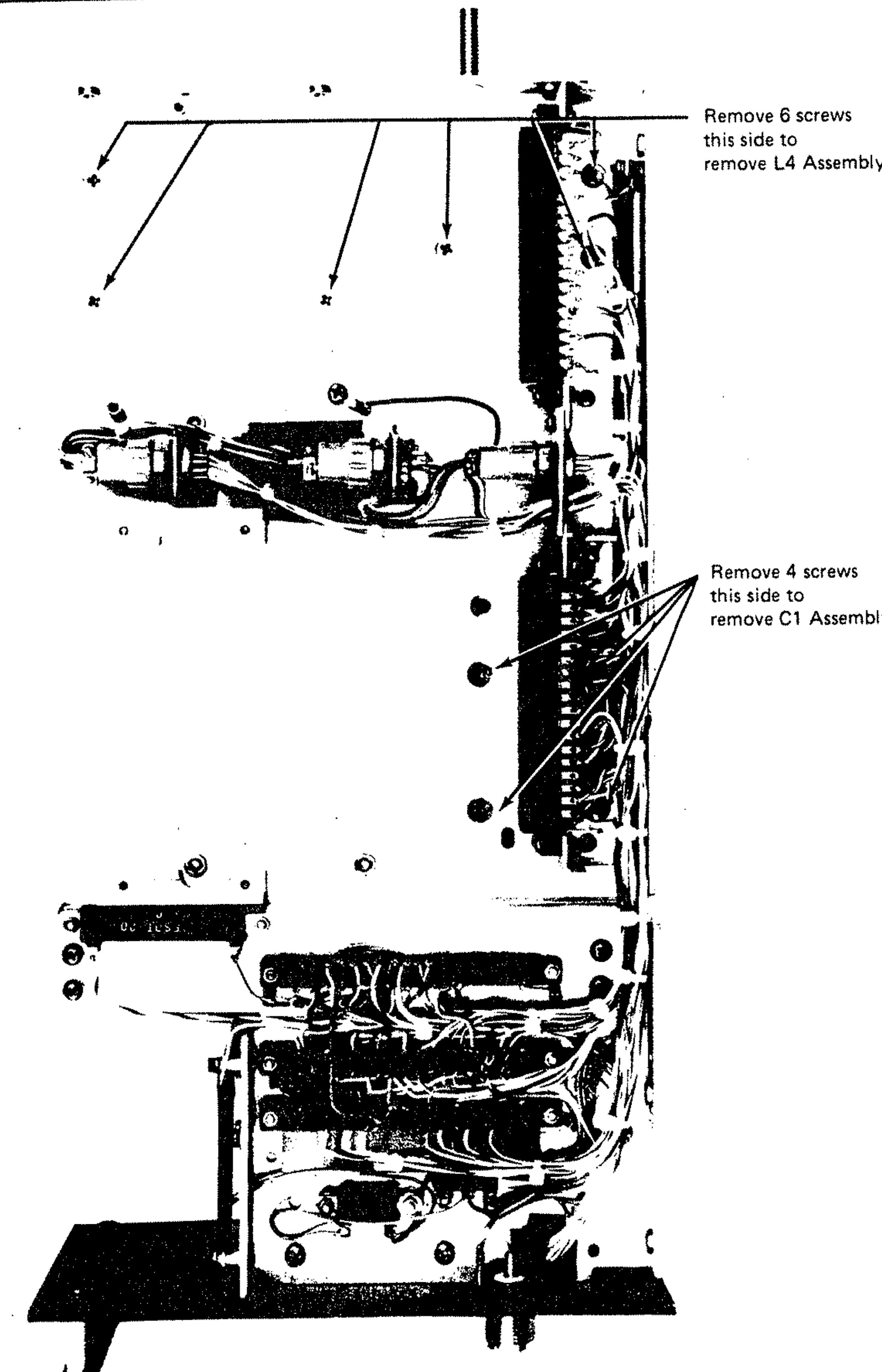


Figure 5.12 Antenna Coupler Chassis Right Side View

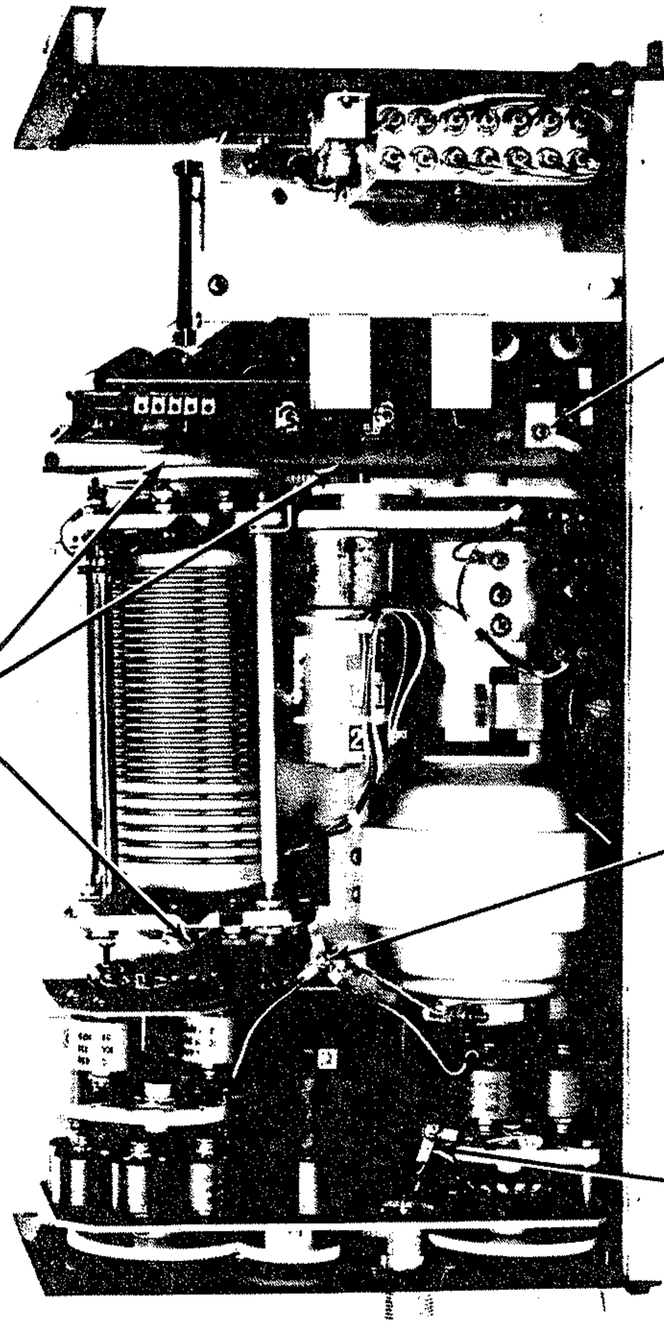


Figure 5.13 Antenna Coupler Chassis Left Side View

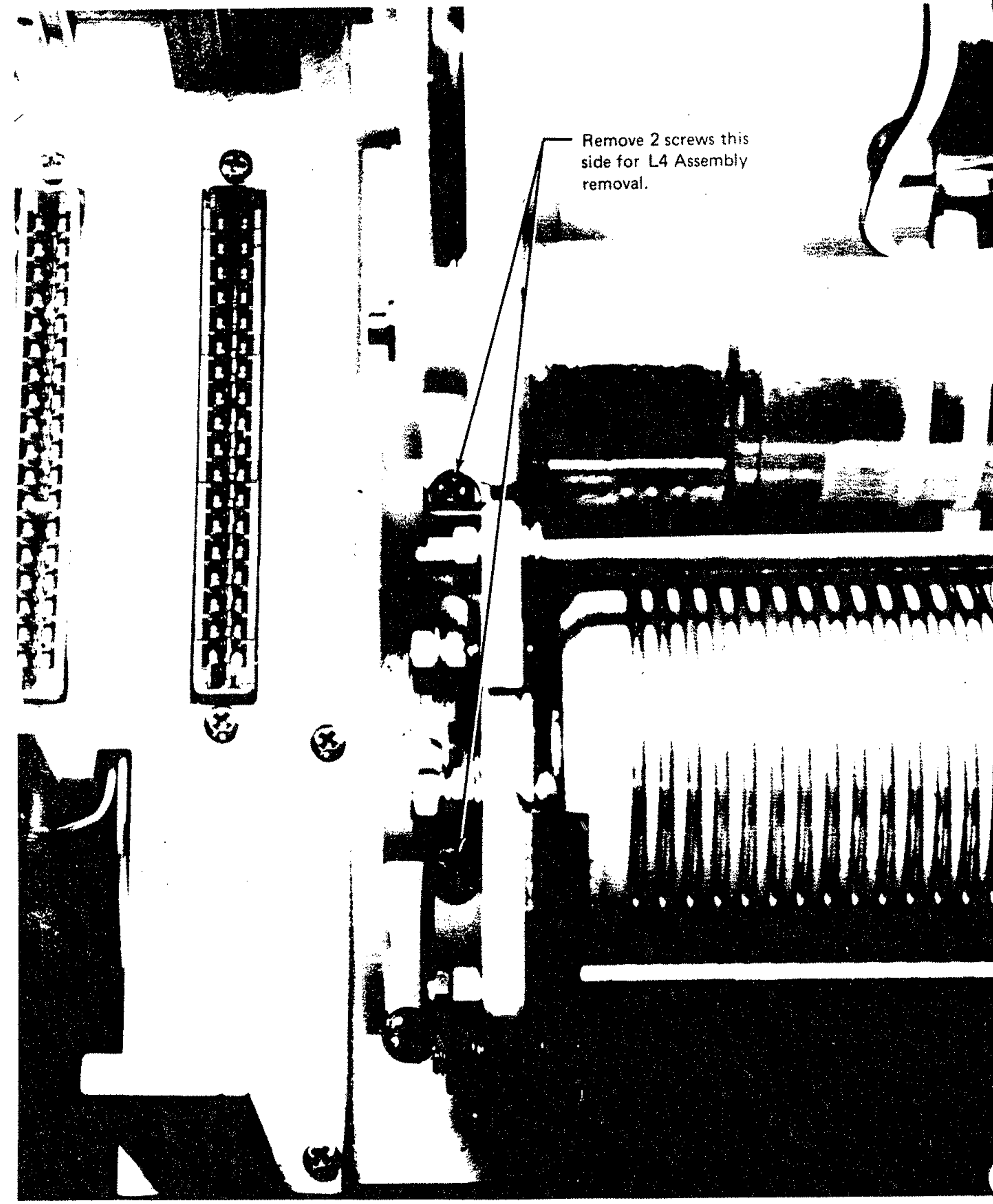


Figure 5.14 L4 Assembly, Top View

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