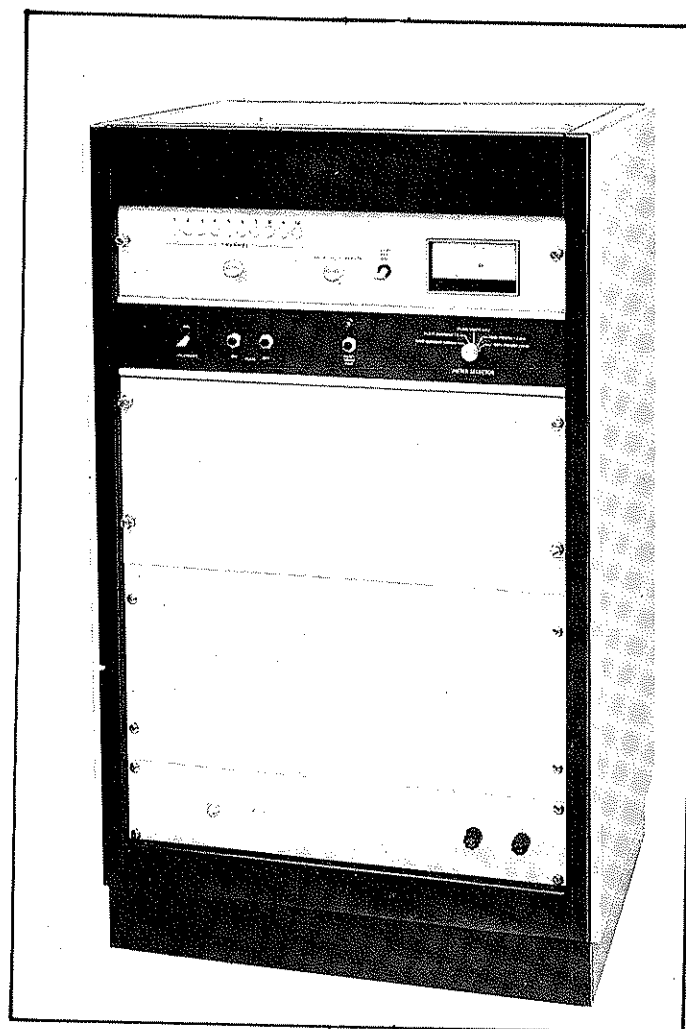




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**OPERATION AND
MAINTENANCE MANUAL
1000 WATT
LINEAR POWER
AMPLIFIER
GSL - 1000**

1st EDITION, 1 MAY, 1974
MANUAL PART NUMBER 5025-0005

GSL-1000
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W A R N I N G

OPERATING VOLTAGES AS HIGH AS 4000 VOLTS D.C. ARE
PRESENT IN THE POWER SUPPLY AND RF UNITS. THE INTERLOCK
SWITCH ON THE REAR DOOR PREVENTS APPLICATION OF VOLTAGE
WHEN THE DOOR IS OPEN, UNLESS IT IS "CHEATED".
SHORT ALL HIGH VOLTAGE COMPONENTS TO GROUND WITH A
GROUNDING STICK BEFORE ATTEMPTING TO WORK INSIDE THE
POWER AMPLIFIER.

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SECTION 1

GENERAL INFORMATION

1.1 Purpose of Instruction Book

This instruction book describes the GSL-1000 Linear Power Amplifier and includes installation details, operating instructions, and maintenance procedures. Information in this instruction book applies to all equipment configurations unless otherwise stated in the text or illustrations.

1.1.1 Purpose of Equipment

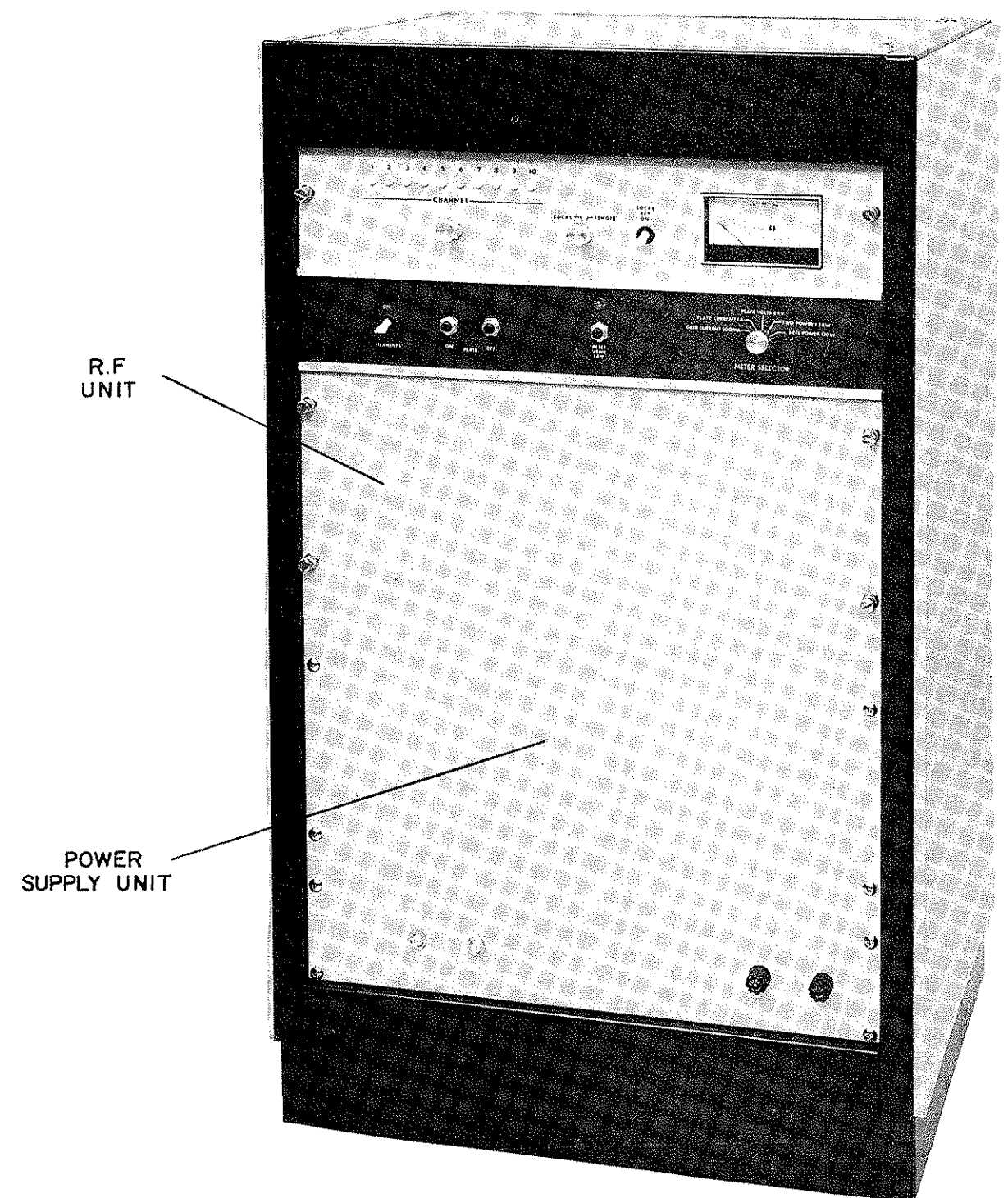
The purpose of the GSL-1000 Linear Power Amplifier is to amplify the low-level rf output of a separate exciter to produce 1.0 kw \pm 1.0 db peak envelope power (pep.) or average power with a maximum rf input signal level of 100 watts. The GSL-1000 has ten pre-tuned channels within the 1.6 to 30 mhz frequency range. It is intended for continuous duty, unattended operation in fixed station ground radio communications systems.

1.2 General Description

1.2.1 Physical Description

Outline and mounting dimensions for the GSL-1000 are given in Figure 2-1. Control, power, and rf connections to the equipment are made at the rear, top and bottom of the cabinet. An rf amplifier control panel provides local control and monitoring functions for the GSL-1000.

The RF unit, shown in Figure 1-1, consists of a single chassis with a standard E.I.A. mounting configuration. Optional slide mounting is available for easier access to the unit for maintenance purposes. Rapid access to the power amplifier is provided at the rear of the unit by a panel which is secured with 1/4 turn captive fasteners. The RF output connector is at the top rear of the chassis. Two fans are employed for cooling the power amplifier tubes and RF output network. Air exhaust is through a perforated cover panel on top of the unit.



GSL-1000
FRONT VIEW
FIGURE 1-1

The power supply unit contains the high voltage, filament and control supplies that provide all the internal operating voltages required in the equipment. In addition, control and AC primary voltages are available for use in an antenna coupler, if used. Exciter and antenna coupler control interface connections are made to barrier-type terminal strips located in the power supply.

1.2.2 Electrical Description

The GSL-1000 is a single stage, 10 channel, linear power amplifier. The RF power amplifier includes a tuned cathode input circuit, a pair of 3-500Z/8802 zero bias triode power amplifier tubes, and a "Pi" output network. One of ten pre-set channels may be selected within the 1.6 to 30.0 MHz frequency range. Channel selection may be accomplished locally from the power amplifier control panel or remotely from a companion exciter channel switching function.

The purpose of the Pi-network circuit at the exciter input to the cathodes is to provide an even multiple of 90° electrical line length between the exciter RF output and the power amplifier cathodes. This minimizes non-linear loading of the exciter output stage, and provides a path for the RF plate current pulse which otherwise would travel through the coaxial cable to the exciter output capacitor.

Control circuit functions operate on 24 volts D.C. High voltage for the power amplifier is 2500 volts nominal and D.C. plate current overload relay provides protection for the high voltage power supply. Fuses and circuit breakers provide AC primary power protection. A VSWR trip circuit with an adjustable trip level is used to prevent operation into high VSWR loads and a VSWR fault indicator and reset switch is provided. A door actuated interlock switch removes high voltage from the equipment when the rear door is opened.

An RF transfer relay is provided to connect the exciter directly to the antenna terminal when the power amplifier is un-keyed or when the plate voltage is switched off, or primary power removed.

1.3 Electrical Specifications

RF Output Power:	1KW PEP \pm 1.0 DB with two or more equal amplitude input tones. or 300 ⁺ to 400W AM. 1KW AVE \pm 1.0 DB with one input tone.
RF Input Power:	60 watts nominal, 100 watts maximum.
Frequency Range:	1.6 to 30.0 MHz.
Frequency Selection:	Ten pre-set channels
Channeling Time:	6 seconds nominal
Type of Emission:	AM,SSB,CW or any other type within the bandwidth and power capabilities of the amplifier.
Input Impedance:	50 ohms, unbalanced with a 1.3:1 VSWR max.
Output Impedance:	50 ohms, unbalanced. Tolerable VSWR to 2:1 provided 1000 watts plate dissipation is not exceeded.
Intermodulation Distortion:	Third and higher order distortion products are at least 30db below either tone of a two-tone signal producing rated output.
Harmonic Output:	2nd harmonic at least 40DB below PEP.
AC Power Input:	115/230 volts, 50 to 60 Hz. 10% taps provided.
Power Consumption:	1800VA for 1KW PEP 2-tone input, 2350VA for 1KW AVE output.
Physical Size & Weight:	Dimensions: 92.7Hx 55.2W x 47D (CM) 36.5Hx 21.75Wx 18.5D (inches) Weight: 113KG (250 lbs)
1.3.1 Environmental	
Ambient Temperature:	-30°C to +50°C
Humidity:	to 95% at 50°C
Altitude:	to 5000 feet
Shock & Vibration:	As encountered in normal shipping. (Vacuum tubes shipped in separate container)

1.4 Equipment Supplied:

	<u>Part Number</u>
Kilowatt Linear Power Amplifier, Type GSL-1000 with 10 foot power cord	5025-0000

1.5 Equipment Required, Not Supplied:

1. External a-c power connector	
2. Transceiver, GSB-300, 115/230 VAC	97892
3. Coaxial Cable	58864
4. Coaxial Connectors, (2 Rqd)	74219
5. GSB-300/GSL-1000 interface cables	98023
6. Antenna, fixed base, 50 ohms nom.	

1.6 Optional Equipment:

1. KW Antenna Coupler, GCU-1100	5026-0000
2. 35 Foot vertical fiberglass antenna	71585
3. 75 Foot long-wire antenna kit	99920
4. 150 Foot long-wire antenna kit	99921
5. Caster Set (4), for GSL-1000	98014
6. PA Chassis Slide Mounting Kit	98018
7. GSL-1000 Running spare parts kit	98015
8. GSL-1000 Depot spare parts kit	98016
9. GCU-1100 Depot spare parts kit	98017



SECTION 2

INSTALLATION

2.1 Unpacking and Inspection of Equipment

The GSL-1000 linear power amplifier is packed in a crate using "Triwall" construction. The two amplifier vacuum tubes are packed and shipped in a separate container. The crating and packing material should be removed carefully and the contents inspected for physical damage. Any claims for shipping damage should be filed promptly with the transportation company. If it is found necessary to file such a claim, retain all packing material.

If possible, uncrate the linear amplifier as close as possible to the actual installation location. This will facilitate handling and reduce the possibility of damage while moving the cabinet into place.

Do not accept a shipment where there are visible signs of damage to the shipping container until a complete inspection is made. If there is a shortage or evidence of damage is noted, insist on a notation to that effect on the shipping papers before signing the receipt from the carrier. A full report should also be forwarded to Sunair.

Include the following:

- (a) Order number
- (b) Model and serial number
- (c) Name of transportation agency

When this information is received by Sunair, arrangements will be made for repair or replacement.

2.2 Return of Equipment to Factory:

The shipping crate for the GSL-1000 has been carefully designed to protect the equipment during shipment. The container and its associated packing materials should be used to reship the unit.

When returning subassemblies or components for repair or replacement, be sure to pack each unit separately, using suitable cushioning material where necessary.

Shipment should be AIR PARCEL POST consigned to:

SUNAIR ELECTRONICS, INC.
3101 SW Third Avenue
Fort 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

Mark all sides of the package:

FRAGILE - ELECTRONIC EQUIPMENT

2.3 Installation Procedure:

2.3.1 Station Layout:

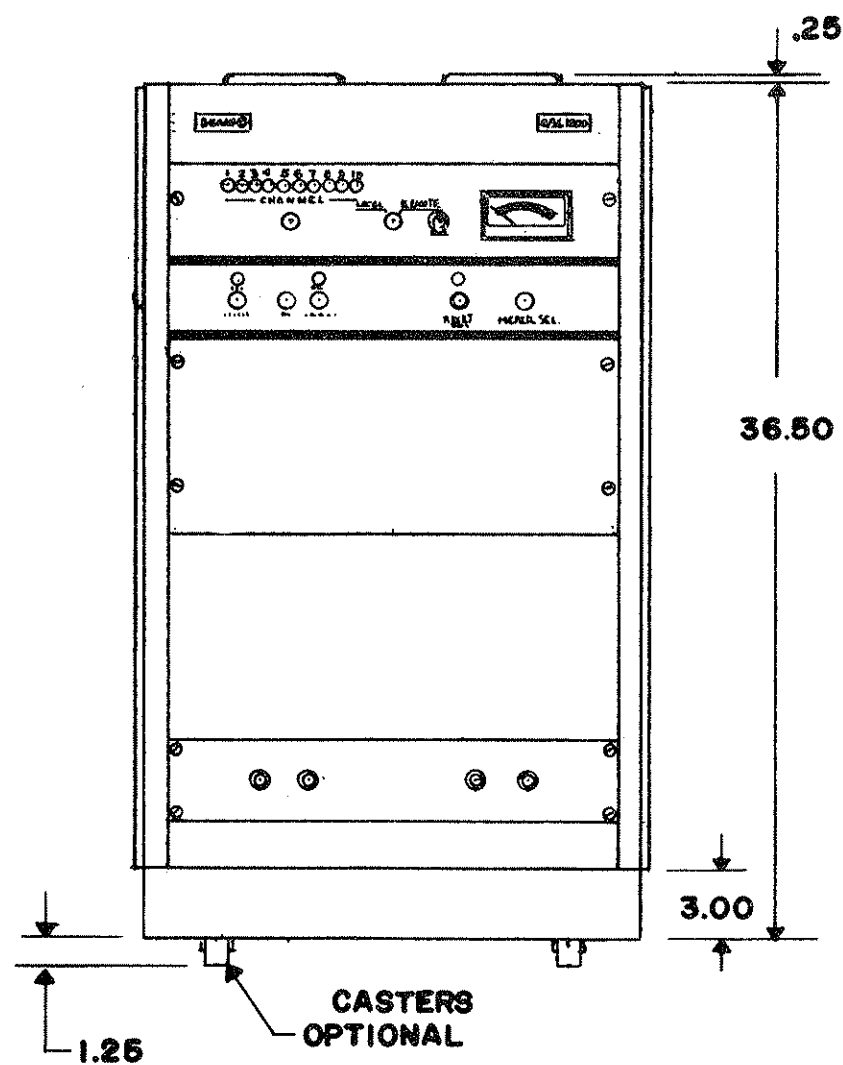
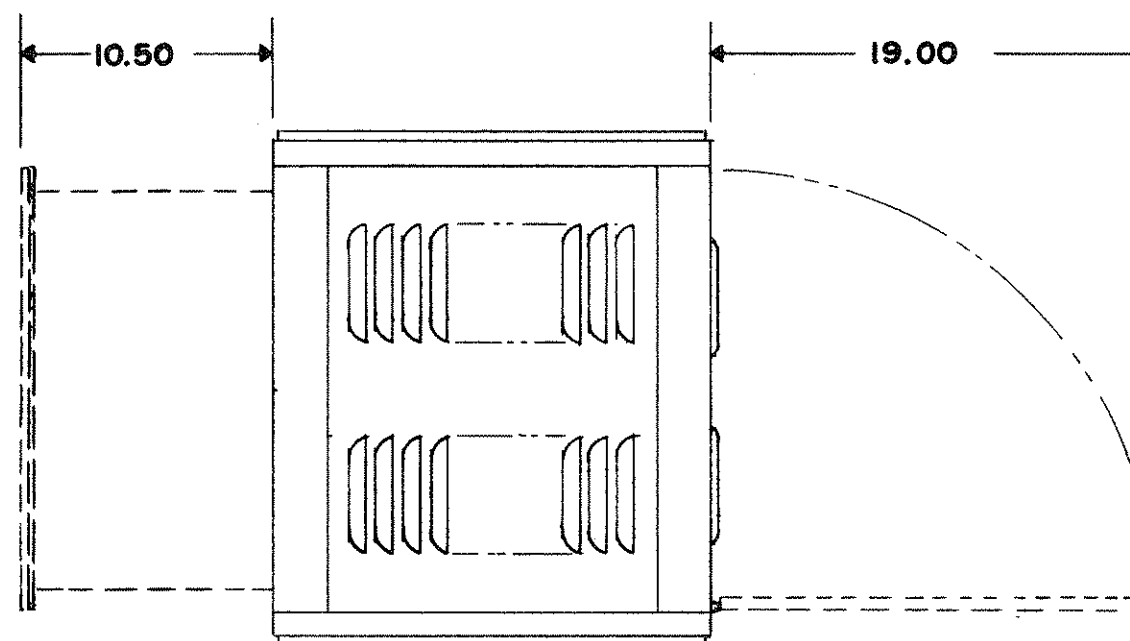
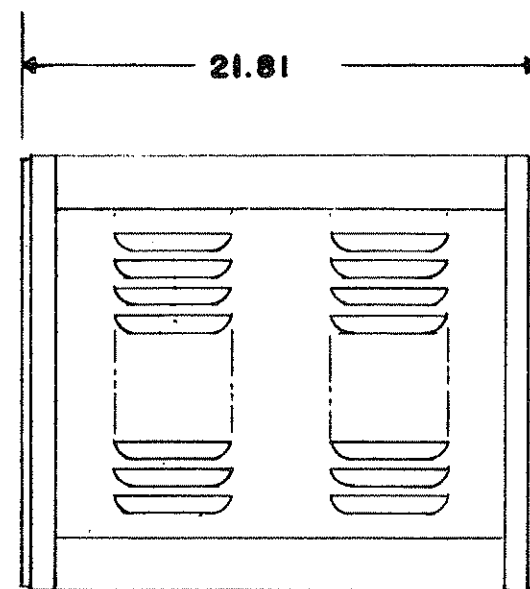
The GSL-1000 must be installed in a structure which provides protection from the weather. Ambient temperature must be maintained between -30°C. (-22°F.) and 50°C. (122°F.).

Reference to Figure 2-1 will provide the necessary outline dimensions required for installation. Floor load is 250 pounds. Allow free circulation of air around the cabinet, and at least six inches air space between the back of the unit and a wall or partition. The companion exciter may be placed on top of the GSL-1000 for voice or cw modes of communications, but should be located on an adjacent table or desk for afsk and other modes requiring a full kilowatt of average R-F output power. If an exciter other than the GSB-300 is placed on top of the unit, be sure that it does not block the air exhaust from the power amplifier. The GSB-300 has mounting feet which provide sufficient clearance.

2.3.2 External Connections:

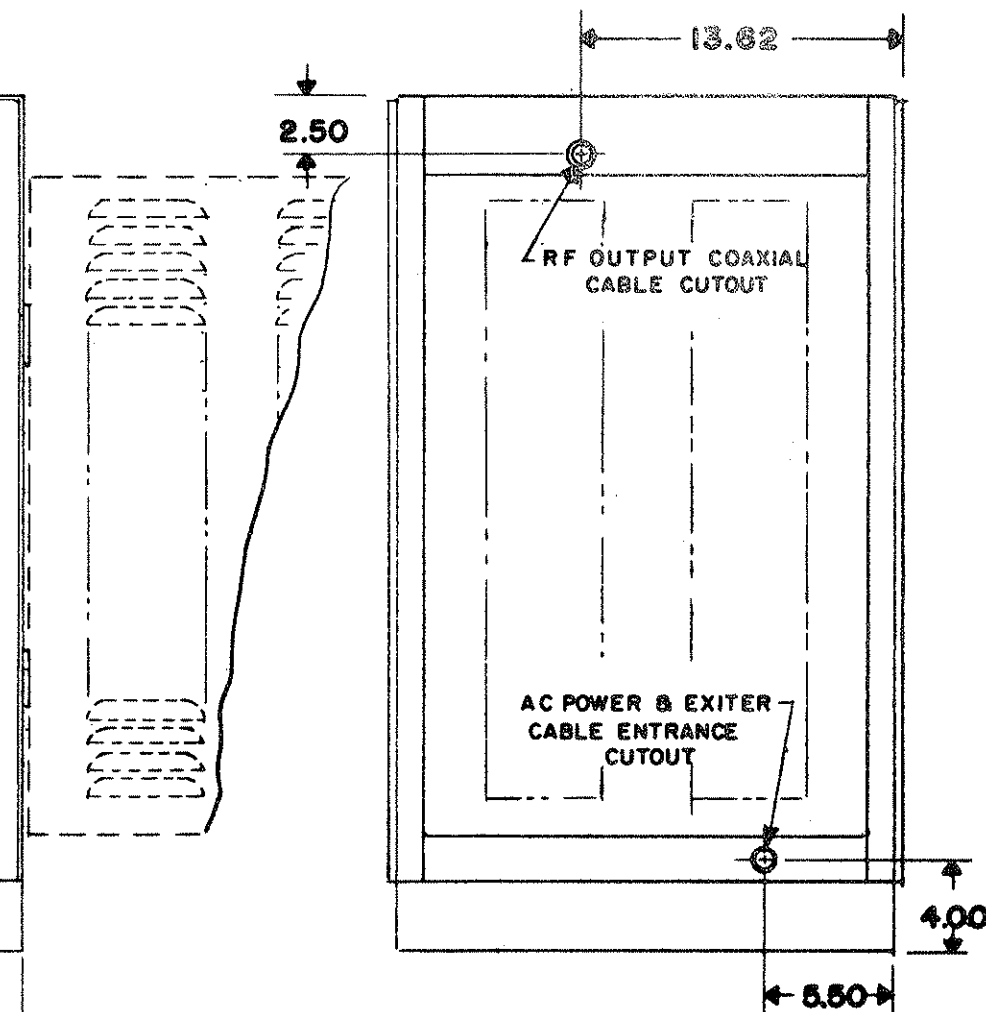
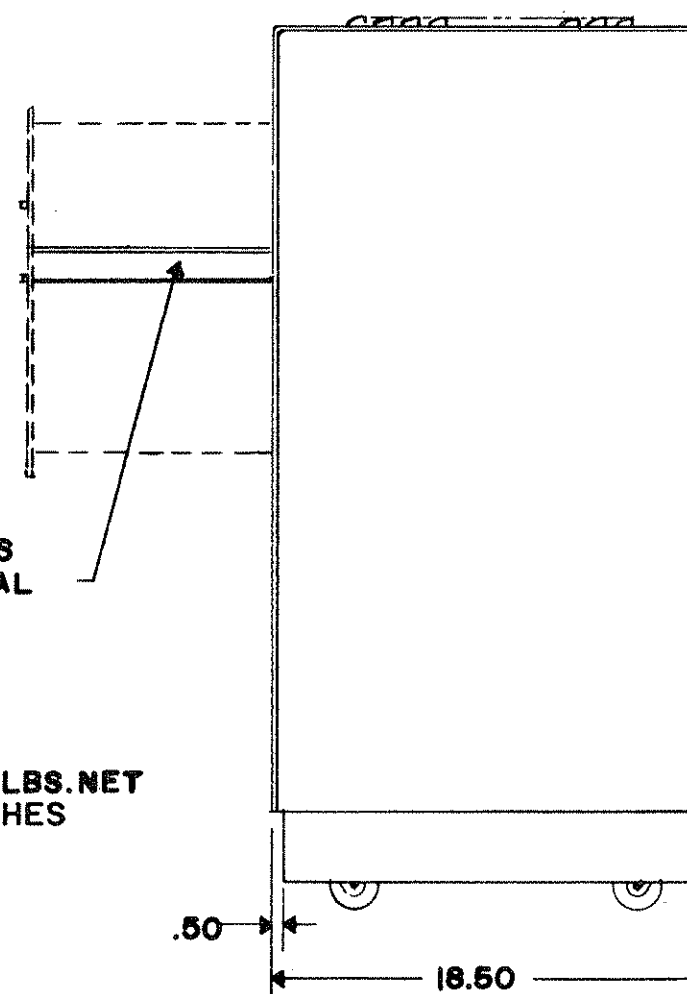
2.3.2.1 Primary Power Connections:

The GSL-1000 requires a primary power source that can provide up to 3.0 kilowatts at 85% power-factor. Whenever possible, the primary power source should be connected to the amplifier through a double-pole, 30 ampere capacity, manual disconnect switch. An arrangement of this type will insure that all power has been removed from the unit prior to entrance for servicing. Two #10 AWG cables

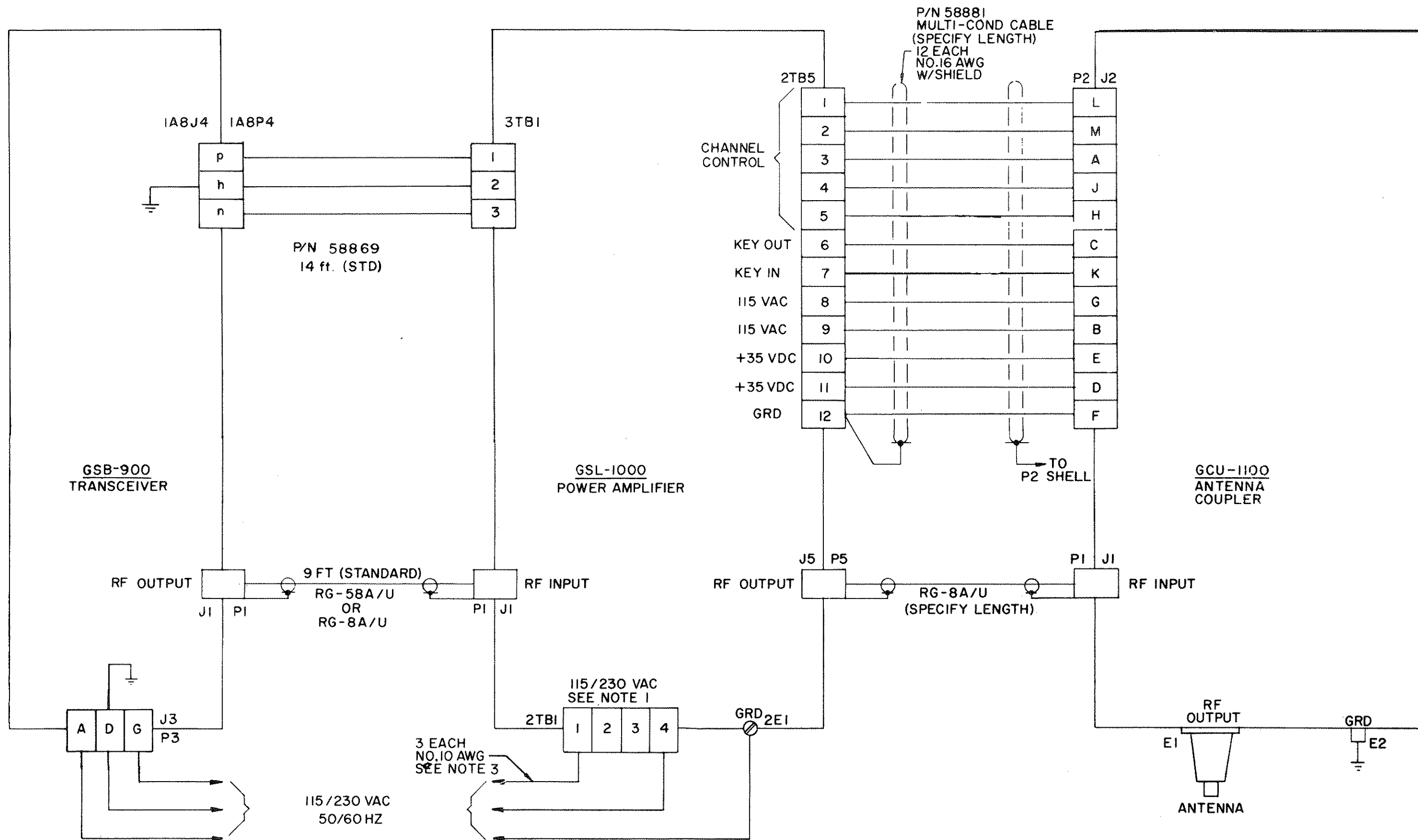


SLIDES
OPTIONAL

FLOOR LOAD: 247 LBS.NET
DIMENSIONS IN INCHES



GSL 1000
OUTLINE DRAWING
KILOWATT LINEAR POWER AMPLIFIER
10 CHANNEL



NOTES:

1. 115 VAC-JUMPER 2TB1-1 TO 2TB1-2 & 2TB1-3 TO 2TB1-4.
230 VAC-JUMPER 2TB1-2 TO 2TB1-3.
2. AUDIO CONNECTIONS, SEE GSB-900 INST. BOOK.
3. TEN FEET OF 3 COND. NO. 10 AWG FURNISHED WITH EQUIPMENT
USE NO. 8 AWG FOR RUNS LONGER THAN 10 FEET.
4. ALL CONNECTORS EXCEPT COAXIAL TYPES FURNISHED
WITH EQUIPMENT.

GSB-900 / GSL-1000
SYSTEM INTERCONNECT DIAGRAM
FIGURE 2-2 A

are needed for the input power connections. (MIL-W-16878 Type D or equivalent wire). Connect the power leads to the terminal strip, 2TB1. Route the wires through the entrance hole at the lower rear of the cabinet. A connection from the station ground system, should also be made at this time. Connect to the 8-32 ground stud, 2E1 located next to 2TB1. Refer to Figure 2-2 for additional details.

2.3.2.2 Exciter Connections:

Unless otherwise specified, the normal rf cable used between the exciter and the power amplifier input is 9 feet long. The cable type should be RG-58A/U terminated on both ends with a type PL-259 plug and UG-175/U adapter. The cable should be routed through the same entrance hole as the primary power cables. Connect to the UHF connector, J1 and allow sufficient slack cable to permit full forward travel of the amplifier, if the chassis slide option is in use. Avoid sharp bends in the cable, and insure that the cable is clear of high voltage components.

A 12 conductor control cable, PN 58881, is used for the channel selection and keying functions from the exciter to the GSL-1000. The cable route is the same as previously used, and connection is made at 2TB4 in the power supply. Route the cable directly to the front of the unit from the grommet, cross the front using the channel between the base plate and the Fuse & Circuit Breaker panel. Proceed directly to 2TB4. The cable termination at the exciter end uses a Jones Plug which mates with a chassis connector near the rf output jack. Connections should be made as shown on the cabling diagram of Figure 2-2.

2.3.2.3 RF Output Connections:

The RF output cable is type RG-8A/U or its equivalent. It is terminated on both ends with a type PL-259 UHF plug. If an antenna coupler is not used, insure that the load termination is 50 ohms nominal. If the type GCU-1100 antenna coupler is used, refer to its instruction manual for inter-connection details. If an antenna coupler is not used, install a jumper from 2TB5-6 to 2TB5-7 to complete the keyline interlock circuit.

2.3.2.4 Power Tube Installation

2.4 Preliminary Checks and Adjustments

2.4.1 Mechanical Checks

Visually inspect the linear amplifier for broken components. Use a vacuum cleaner attachment to clean the interior of the cabinet, if necessary. Remove all shipping tie-down and packing materials. Check the door-actuated high voltage interlock switch for proper adjustment when the door is closed. Loosen the mounting screws and align, if needed.

2.4.2 Electrical Checks

2.4.2.1 Line Voltage Compensation

Primary line voltage taps are provided on the power transformers to permit adjustment 10% above and below the nominal rated line voltages of 115 and 230 volts. Jumpers are provided on the power input terminal board, 2TB1 to accommodate 115 or 230 volt power source. No changes are required on the transformers to connect either of the two primary line voltages.

2.4.2.2 Key Line Interlocks

Key line interlocks are provided when the amplifier is used with an exciter and GCU-1100 antenna coupler. Prior to operating the amplifier refer to Section IV, paragraph 4.3 for interlock details.

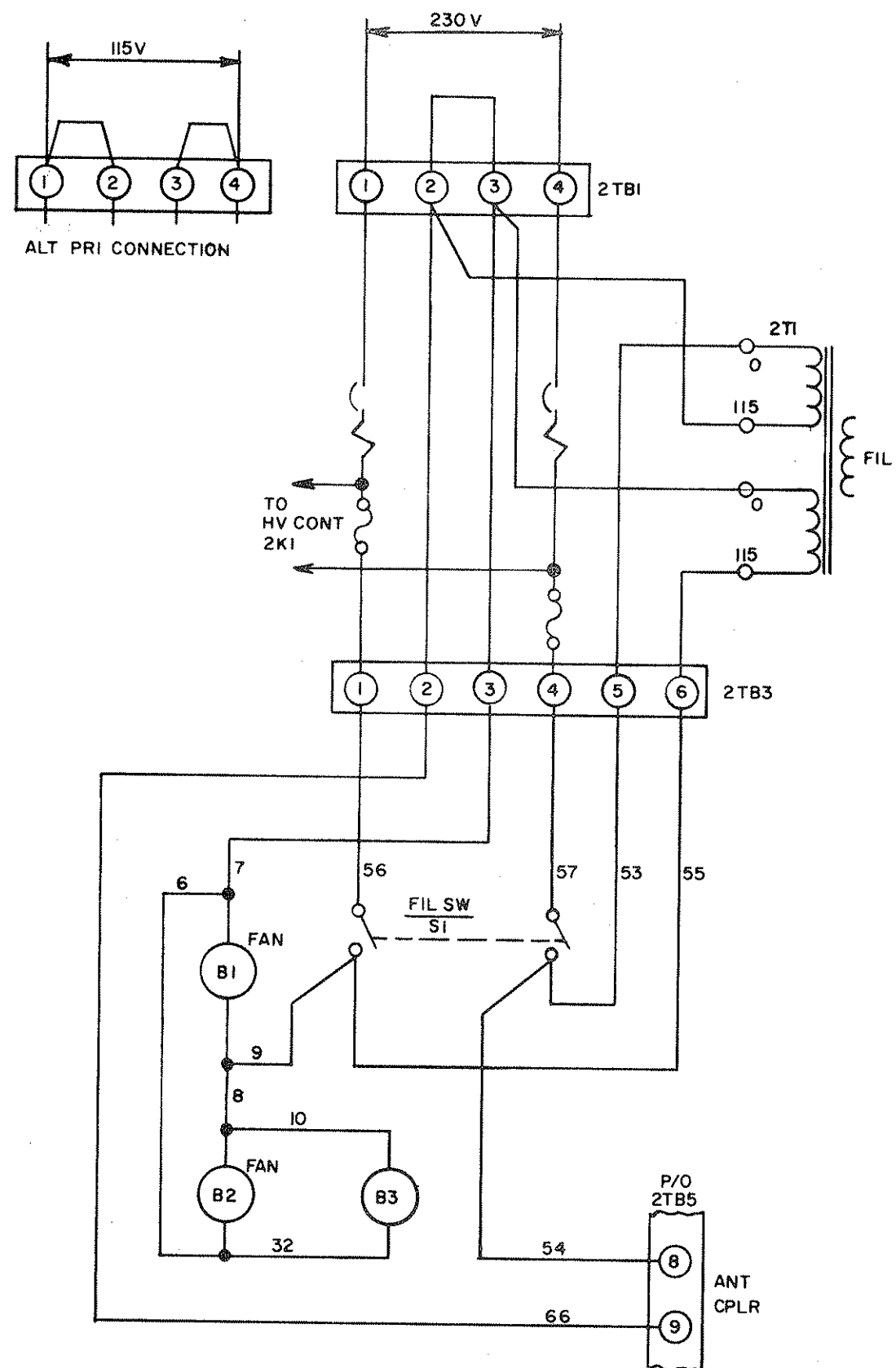


FIGURE 2-3

GSL-1000
10 CHAN. KW LPA
AC DISTRIBUTION
SIMPLIFIED

SECTION 3

OPERATION

3.1 General

All of the controls used in normal operation of the GSL-1000 linear amplifier are located on the front panel.

3.2 Function and Location of Controls and Indicators

Table 3-1 lists the controls and indicators along with their functions. Location is shown on Figure 3-1.

Table 3-1
Control and Indicator Functions

Control or Indicator	Function
Filaments	A toggle switch that supplies filament, control and blower power.
Plate Start	A pushbutton switch which applies plate operating voltage.
Plate Stop	A pushbutton switch which removes all amplifier plate voltage.
Test Meter/Switch	A five position rotary switch used with the multimeter to read any of the following: PA cathode current, PA grid current, PA plate voltage and forward and reflected RF power output.
Filaments	A green pilot lamp which lights when filament voltage is applied.
Plate	A red lamp which lights when the plate contactor is closed.
VSWR Trip	An amber lamp which lights when the VSWR trip circuit is energized.

(Table 3-1 Cont'd)

Channel Status	Ten white lamps numbered 1 thru 10 which indicate the position of the channel switch when lighted.
VSWR Reset	A push button switch which releases the VSWR trip relay when activated.
Local/Remote	A two position switch which selects the remote or local keying and channel selector functions.
Local Key	A toggle switch to locally key the PA.
Channel Selector	A ten position switch for local channel section.

Table 3-2

TYPICAL METER READINGS

Power Output - 1000 Watts CW (Key-Down):

FREQ	I GRID	I PLATE	E PLATE	PWR INPUT		PLATE DISS.
				FWD	REFL	
2182 kHz	246 MA	650 MA	2.7 KV	68W	2W	755W
4421	200	700	2.7	53	2	890
6540	200	660	2.7	63	2	782
8796	188	620	2.7	53	2	674
13356	215	720	2.68	72	2	929
17321	200	620	2.7	58	2	674
22674	230	710	2.7	55	2	917
27000	210	700	2.76	76	3	932

Power Output - 1000 Watts PEP (2-Tone)

FREQ	I GRID	I PLATE	E PLATE	*PWR INPUT		PLATE DISS.
				FWD	REFL	
2182	110 MA	410 MA	2.6 KV	54W	2.5W	499W
4421	115	460	2.56	59	2.5	677
6540	105	425	2.54	59	2.5	579
8796	115	435	2.5	59	2.5	587
13356	122	440	2.44	64	2.5	573
17321	125	490	2.46	76	2.5	705
22674	145	510	2.48	67	5	764
27000	150	525	2.44	69	5	781

*PEP

3.3 Operating Procedure

3.3.1 Operation

In the GSL-1000 tuning scheme, a channel selector switch is used to connect discrete inductor taps and padder capacitors according to the assigned frequency of operation. A motor with a series of cams, one for each channel, is used to tune the output network input and output variable capacitors to resonance. The channel selector motor switches the input tuned cathode network.

It is assumed that the GSL-1000 and its associated equipment have been properly installed according to the instructions in Section II. In most cases, the amplifier will have been tuned at the factory to the channel frequencies previously specified by the customer. Key line interlock wiring must be correct before the unit can be keyed. Refer to Section IV.

Insure that a properly adjusted antenna system is connected to the power amplifier. Never attempt to operate into an unknown antenna load.

Place the exciter mode selector in the AM position and key the exciter. Plate current should be 400 to 500 MZ and power output from 250 to 300 watts. Check each channel.

WARNING

ALWAYS UNKEY THE EXCITER BEFORE CHANGING CHANNELS TO AVOID DAMAGE TO THE CHANNEL SELECTOR SWITCH CONTACTS.

If the CW option has been installed in the exciter, place the mode selector switch in the CW position, and the channel selector to the lowest channel frequency. Close the key and adjust the exciter power output control potentiometer for 1000 watts output from the PA. See the exciter instruction book for procedure and location of this control. Check each channel and compare the plate and grid currents with those given in Figure 3-1. If a particular channel output is higher than the lowest frequency, reduce that channel to 1000 watts.

For USB or LSB voice operation, adjust the microphone gain to produce 1000 watt peaks. Do not over-drive the power amplifier, the wattmeter is a peak reading type, over-drive will cause distortion and intelligibility will suffer.

The GSL-1000 has a nominal power gain of 15. For voice communications, the microphone gain control at the exciter should be adjusted so that voice peaks reach only 1000 watts. For CW operation, the rf input should also be adjusted as outlined in paragraph 3.3, to insure that the GSL-1000 is not over-driven.

After the level adjustments have been made operation is simple, and requires only the following steps:

1. Turn on the exciter and power amplifier primary power. Turn on the power amplifier filaments and plate voltage. Allow at least 3 minutes for the filament temperature to stabilize. Place local/remote switch in remote position.
2. Select the desired channel on the GSB-300 selector switch. Wait until the GSL-1000 tuning motor stops before proceeding.
3. Select the desired mode of transmission at the GSB-300 mode selector switch. The system is now ready for use.

Note: If the GCU-1100 Antenna Coupler is used, an internal timing circuit will open the keyline while the unit is changing channels.

Remember that overdriving the power amplifier will probably impair communications, and result in distortion, splatter, and high plate dissipation.

3.3.2 Channel Switching:

The GSL-1000 may be channeled remotely from its associated exciter, provided it has a compatible 5 wire switching scheme, or locally from the front panel channel selector control. The Local-Remote switch must be placed in the Local position for local operation.

Each time a channel change is made, the operator should listen for the sound of the tuning motor operating. The tuning cycle should require 4 or 5 seconds to complete. If the motor does not run for this time period, move the channel selector switch to one of its adjacent channels and back again to the desired channel to assure that the motor is started.

SECTION 4

THEORY OF OPERATION

4.1 Introduction.

The GSL-1000 is a single-stage, linear power amplifier. The power amplifier stage, input and output rf circuits, wattmeter and control panel are contained in a single chassis which is mounted in a standard 19 inch E.I.A. rack cabinet. The RF amplifier chassis may be mounted on slides for easier access, if desired. (Option).

The remainder of the cabinet, which has 28 inches of panel mounting space, consists of the power supply. Components located in the power supply area are designated with a unit 2 prefix. The heavier iron-core components are mounted on a floor panel, while the lighter components such as resistors and relays are mounted on two side panels. The lower front panel is 3½ inches wide and is used for mounting the fuse holders and circuit breakers.

4.2 R-F Power Amplifier Circuits:

4.2.1 General

Refer to Figure 4-1, Functional Block Diagram

The power amplifier consists of two 3-500Z, zero-bias triodes connected in parallel to provide a power gain of approximately 15. The drive signal is applied to the filament circuit. This is commonly called a grid-separation or grounded-grid connection. Both the input and output rf networks are the "Pi" type. The input circuit improves the power amplifier plate efficiency and intermodulation distortion is reduced. In addition, a substantially lower vswr is presented to the exciter. The Pi network in the rf output provides a fixed transformation ratio from the tube plates to a nominal 50 ohm load. Harmonic rejection is approximately 45db below PEP.

4.2.2 R-F Input Circuit:

The basic function of the input circuit is to provide a low impedance path for the plate current pulse, which would otherwise have to travel through the coaxial cable to the exciter output capacitor and back through the shield ground connection to complete the cathode return path. In addition, since the class of operation is AB₂,

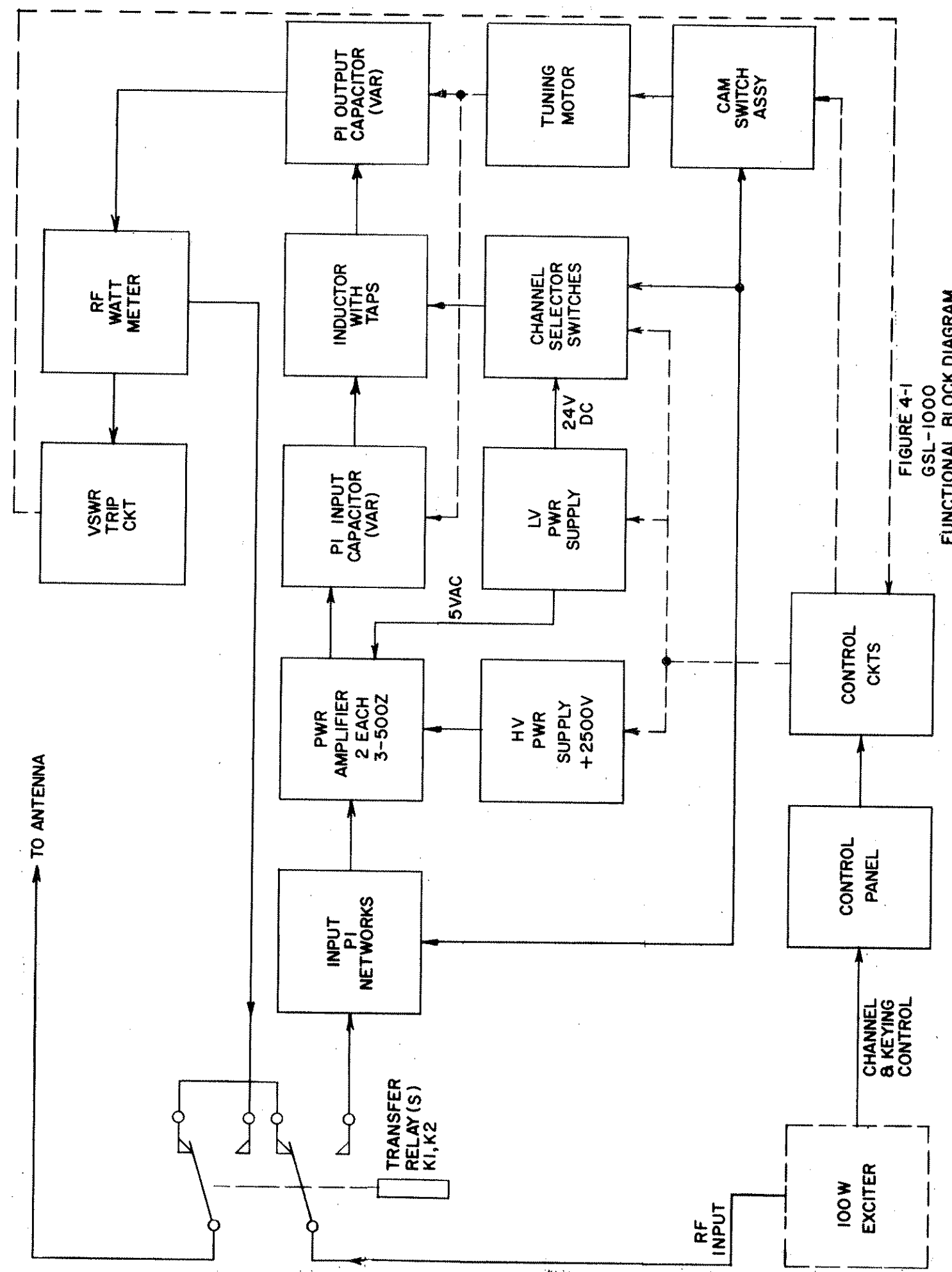


FIGURE 4-1
GSL-1000
FUNCTIONAL BLOCK DIAGRAM

the plate current pulse provides a low impedance load to the exciter and a high impedance when the tube is cut-off during the remaining portion of the rf cycle. The use of a low-Q input circuit, because of its inherent fly-wheel effect, solves this difficulty. It should also be noted that an un-tuned input circuit can also cause RFI problems when the outer shield of the coaxial cable is used as the return path for the rf pulse.

A separate input network is used for each channel, and is composed of separate input and output capacitors and a series inductor which is tapped as required for each channel frequency. Two switch sections ganged to the channel selector are used to place the proper network into the input circuit as needed.

4.2.3 Power Amplifier

The two 3-500Z triodes used in the power amplifier are designed for zero-bias operation, which eliminates the usual requirement for a bias supply. The class of operation is AB2 for linear service. Grounded-grid operation permits connecting the grids directly to rf chassis ground at the tube socket, and the excellent input to output isolation which results, eliminates the requirement for neutralization. The use of grounded-grid also provides 6db of negative feed-back which results in the same amount of I.M. improvement.

4.2.4 R-F Output Network

The GSL-1000 uses a low-pass Pi network to match the tube load to the antenna. The Pi series inductor is tapped according to the frequency requirements for each channel. The proper tap is selected by another switch wafer ganged to the channel selector function. The input and output capacitors are air variable types with associated padders switched in parallel in the range of 1.6 to approximately 4 mhz. Indexing the tuning to a particular channel frequency is accomplished by ten separate cam wheels with a flat on one side, ganged to a motor which also drives the tuning and loading capacitors. Ten microswitches, with roller type actuators, ride on each cam wheel. The system is then indexed so that when the particular channel tuning is correct, the flat portion of the wheel is just under the switch, which opens and the motor stops. Tuning is simple, the motor is run to the cam stop and then the set-screw holding the cam wheel for the channel being tuned, is loosened. The

network is tuned by turning the drive gear while holding the cam wheel in place. The cam wheel screw is then tightened, assuring that in this particular channel, it will always stop at this pre-set tuning position. Another wafer on the channel selector function is used to connect the ten cam switches, one for each channel in use.

A second wafer near the inductor tap selector is used to connect a loading padder capacitor, when required by the frequency in use. In addition, this wafer is used to connect a short circuit across the un-used portion of the Pi inductor when the channel frequency is above 20 mhz and there is a possibility of the un-used turns becoming self-resonant at the operating frequency.

The cam switch is also used to provide voltage to a solenoid actuated rf switch which selects the padder for the input tuning capacitor, when needed. When the cam wheel reaches its detent and stops, the switch opens and transfers the motor voltage to the solenoid circuit, causing it to close.

If two channel frequencies are close together, it would be possible for both of their associated cam wheel detents to over-lap. Thus when switching from one channel to the other, the tuning motor would not run, and the amplifier would be off-tune. The forcing relay of PC1-K5 and its associated circuitry are used to force the tuning motor out of its detent position each time a channel switching function is performed. Each time a ground is applied to the channel selector solenoid motor, B4, a sample of the ground pulse is applied to the emitter of PC1-Q3 through an isolation diode, PC1-CR12. The pulse turns on Q3 which in turn energizes its collector circuit relay, PC1-K5. The circuit is then latched in through a set of normally open contacts. In addition, an associated timer circuit, composed of a unijunction transistor, PC1-Q4, is also provided with a circuit ground, starting the timing sequence. After a nominal period of approximately 3 seconds, the unijunction transistor is fired by the timing capacitor, PC1-C29 which is charged by a voltage fed through resistors, R13 and R17. The base voltage of Q3 is then driven to ground, shutting off Q3 which in turn drops out K5 and the cycle is complete. While K5 is in the energized condition, a second set of normally open contacts apply 115 VAC to the tuning motor, B3, in parallel with its associated channel switch feed. This forces the motor to run for a sufficient period of time to clear any closely indexed channel wheel detents and

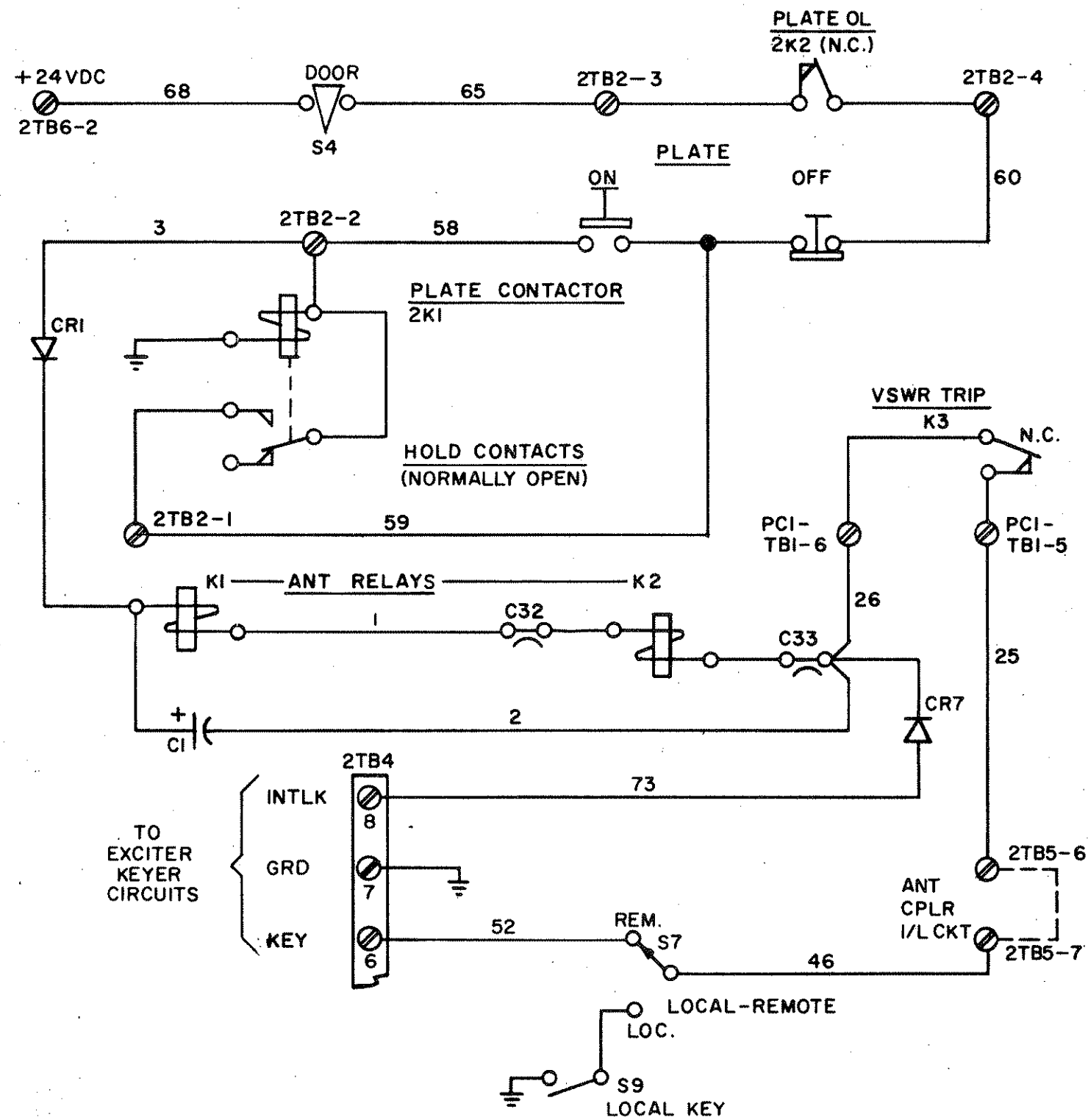


FIGURE 4-3
GSL-1000
PLATE VOLTAGE CONTROL
& KEYING CIRCUITS

dropping out the relay. The key-line is completed through normally closed contacts on the trip relay, K3. When both of the above circuits are complete, and the local-remote selector switch, S7 on the control panel is in the remote position the power amplifier may be keyed by any of the normal exciter keying functions. If the local-remote switch is in the local position, the local key switch, S9 must be closed to key the power amplifier.

When the GSL-1000 plate voltage is not present, the R-F signal from the exciter is routed around the power amplifier to the antenna (rf output) terminal by the rf transfer relays, K1 & K2. These relays receive their supply voltage from the power amplifier plate control circuit, and consequently are not activated by the key-line closure when there is no plate voltage. When plate voltage is present, keying the unit will activate the transfer relays which will connect the rf signal to the power amplifier input circuit and the output network will be transferred to the antenna terminal. The input transfer relay, K1 has a second set of contacts which are used to short-circuit the cathode bias resistor, R1, when the unit is keyed. The power amplifier tubes will then draw normal zero-bias static current and will operate in the linear mode when driven by a suitable rf signal.

As described previously, the VSWR trip circuit will open the key-line when activated. The trip level is adjustable, (potentiometer PC1-R9), and is normally set to trip when the rf wattmeter indicates a reflected power level of approximately 60 watts which is slightly higher than a 1.5:1 VSWR. When the key-line is opened by an VSWR overload, both the power amplifier and the exciter are un-keyed. The reason for the high VSWR on the output transmission line should be determined, and the fault cleared before pressing the re-set button to restore operation.

4.4 Power Supplies

4.4.1 Primary Power Circuits

Primary A-C power enters the unit through the input connector, 2TB1, terminals 1 & 4, for either of the rated nominal line voltages of 115 or 230 volts. Jumpers are used to alter the primary circuit for each of the two input conditions. The transformer connections are changed by the jumper configuration. Only the 10% voltage taps on the transformer need be adjusted, when the nominal line voltage is high or low. The two ac circuit breakers, 2CB1 & 2 control the entire primary feed to the unit. These breakers are the push-to-reset type and cannot be manually tripped. Fuses 2F1 & 2 are used to protect the filament/control

transformer, fans, wiring, tuning motor, rf switch solenoid, and antenna coupler ac feed.

4.4.2 Control Circuits

Front panel plate voltage control of the GSL-1000 uses a conventional latching type 24 VDC circuit for the high voltage contactor. Depressing the plate-on switch, S2, will activate the plate contactor, 2K1, and its auxiliary holding contacts will keep the contactor energized until the plate-off switch, S3, is pressed.

4.4.3 D-C Power Supplies

Two d-c power supplies are used in the GSL-1000. The first supplies the low voltage for control circuits. The output of a standard capacitor input full-wave bridge rectifier is fed directly to the channel selector rotary solenoid, B4, and to the antenna coupler for its solenoid and servo system. The unregulated output is approximately 35 volts. A zener regulator circuit provides a nominal 24VDC for the remainder of the control circuits.

The high voltage power supply is also a full-wave bridge circuit, but the ripple filter is a choke input L section. A transient suppressor is connected across the rectifier output. The suppressor consists of a capacitor, 2C2, and a resistor, 2R2. A high voltage bleeder resistor network is connected across the filter section output to discharge the filter capacitor, 2C3, when the high voltage is turned off.

4.5 Metering & Overload Protection Circuits:

4.5.1 Metering Circuits

Five important amplifier functions are monitored; amplifier grid, plate current, and plate voltage, and forward and reflected rf output power. The rf wattmeter was described in par. 4.2.5. The grid and plate current meter shunts are located in the high voltage return for safety reasons. An additional resistor, 2R14, is connected across the shunts to ground to preclude developing high voltage in the meter circuit if one of the shunts should open. The high voltage metering multipliers are conventional types with low thermal drift. All of the above metering components are 1% tolerance types. The basic meter accuracy is 2% which results in an overall accuracy of 3% without calibration.

4.5.2 Overload Protection Circuits

4.5.2.1 A-C & D-C Overload Circuits

A-C overload protection is provided by the fuses and circuit breakers described in par. 4.4.1. D-C protection for the high voltage power supply is provided by the dc overload relay, 2K2. A trip threshold is provided by the potentiometer, 2R13. A dc current which exceeds the relay threshold setting will activate the relay whose normally closed contacts will open the control circuit to the high voltage contactor.

4.5.2.2 R-F Overload Circuits

An excessive rf input signal level will result in an increase in dc plate current, tripping the dc overload relay if the level is high enough to stress amplifier components. Likewise, an off-frequency input signal will result in a dc overload condition. The VSWR trip circuit was described in par. 4.3. This is the primary rf protection circuit for the GSL-1000.

SECTION 5

MAINTENANCE AND REPAIR

WARNING

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES (3000 VOLTS) WHICH ARE DANGEROUS TO LIFE. OBSERVE SAFETY REGULATIONS AT ALL TIMES. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH HIGH VOLTAGE ON. DO NOT DEPEND ON DOOR INTERLOCKS FOR PROTECTION. TO AVOID INJURY DISCONNECT UNIT FROM AC MAINS AND ALWAYS GROUND CIRCUITS BEFORE TOUCHING THEM. DO NOT SERVICE ALONE.

5.1 Preventative Maintenance.

In the normal service life of any piece of equipment, faults and breakdowns will develop. In order that the necessary repairs may be carried out in a reasonably short time, a logical testing routine must be followed. The maintenance technician should familiarize himself with the circuitry and the physical layout of the equipment prior to the occurrence of trouble.

When repairs are necessary, it is recommended that this servicing be done whenever possible by competent radio technicians, supplied with suitable tools and test equipment.

5.1.1 Periodic Inspections

Linear power amplifier GSL-1000 should be inspected regularly. Table 5-1 is a recommended inspection schedule. Unusually severe environmental conditions may require more frequent inspections.

TABLE 5-1

- | |
|--|
| 1. Inspect the unit for dust accumulation, loose electrical connections, evidence of overheating or arcing, and proper operation of motors, fans, switches, etc.
Interval: Weekly |
| 2. Use forced dry air to eliminate dust collection inside the equipment.
Interval: 3 months |

TABLE 5-1 cont'd

3.	Inspect contacts of all relays and the plate contactor for excessive burning and pitting. Refer to par. 5.1.3 for maintenance instructions. Interval: 6 months
4.	Check tuning belt and idler. Clean and adjust tension and lubricate, if necessary. Interval: Annually

5.1.2 Lubrication

The cooling fans used in the GSL-1000 have sealed bearings. No lubrication is necessary. A few drops of light machine oil should be applied to the cam motor tuning shaft bearings at 6 month intervals. Clean up all excess oil. Do not lubricate variable capacitor bearings.

5.1.3 Relay Maintenance

Relay failure is usually caused by dirty or irregular contact surfaces. Dust or dirt which collects on the contacts causes high contact resistance, sticking or sluggish operation. Pits or metal spikes formed by arcing or overloading cause high contact resistance and possibly locked or bridged contacts. If periodic inspections of relay contacts reveal dirty or irregular surfaces, burnish the contact surface with a piece of crocus cloth or very fine sandpaper. Be careful not to remove excess metal. Burnish break-contacts while exerting their normal pressure, and burnish make-contacts while the relay armature is hand operated. Always clean relay contacts after burnishing.

5.2 Corrective Maintenance

5.2.1 Fuse & Lamp Replacement

The CM22 "Peanut-Lites" used in this equipment are rated by the manufacturer to have an average life of 25,000 hours at 28 volts. In this instance, 24 volts (regulated), is used, or 86% of rated voltage. The manufacturers' data gives a life multiplying factor of 5 times for this percentage, or 125,000 hours. It is apparent that the average lamp will never need replacement over the life of the equipment. If replacement should be necessary, unsolder the two lamp leads and release the tinnerman nut from the polycarbonate shell.

The circuit breakers may be re-set after an overload, by pushing the plunger straight-in when the fault has been cleared.

Two 1½ ampere medium time delay fuses are used to protect the low voltage power supplies and cooling fans. Replace only with the same type.

5.2.2 D.C. Overload Adjustment

Connect a 24 volt, 1 amp power supply, positive terminal to 2TB2-7 and negative to B- (negative lead of 2C3). Switch the test meter to "Plate Current" and adjust the power supply output voltage for an indication of 800 ma on the meter. Now adjust 2R13, located below the four high voltage meter multiplier resistors in the power supply, until the overload relay, 2K2 pulls in. Recheck the adjustment several times to insure a nominal trip setting of 800ma.

5.2.3 VSWR Trip Adjustment

The VSWR trip level has been set at the factory to trip when the reflected power is between 40 and 50 watts. (1.5:1 VSWR nominal). To check the trip setting, short circuit the RF output at the output connector, J5. Connect an audio generator to the exciter AF input and slowly raise its output, starting at zero until 40 to 50 watts is indicated on the test meter with the selector in the reflected power position. Note that full scale deflection is 120 watts. The trip circuit should activate, opening the keyline. The yellow "VSWR Trip" pilot lamp should also light.

CAUTION

Be sure that the GSL-1000 plate voltage has been turned on for this test to protect the exciter RF output from working into the short circuit.

If the trip level is not correct, adjust the trip level potentiometer, PC1-R9 for the proper trip setting. Be sure that this adjustment is made on a single-tone (CW) signal only.

5.2.4 Test Meter Functions Calibration

Grid and plate current, and plate voltage indications are derived from 1% tolerance resistor shunts and

multipliers, which in conjunction with a 2% meter movement, provides an accuracy of 3% of full scale with no adjustments required.

Forward and reflected power calibrations should only be made if the factory adjustment has been tampered with, and then, only if a suitable dummy load and wattmeter are available. An accurate RMS reading RF VTVM may be used if the dummy load is 50 ohms resistive at the calibration frequency. Calibrate with single-tone signal only. The forward power is adjusted at 1000 watts using PC1-R8. (If a voltmeter is used 223.6 volts RMS)

To adjust the reflected power metering circuit, adjust PC1-R7 using the exciter only connected to J5 (PA output) with the 50 ohm load at J4 (PA input) (BNC). Calibrate at 100 watts, (70.7 volts RMS).

5.3 Channel Frequency Change

The procedure for performing periodic checks of channel tuning is given in par. 3.3. If it is necessary to change or add channel frequencies, the input cathode tuned circuit and output pi network must be changed by following the procedures in this section.

5.3.1 Channel Frequency Change and Set-Up Procedure:

Preliminary: The station exciter frequency should be changed prior to starting adjustments on the GSL-1000. Follow the procedure outlined in the instruction book and complete all tuning into a suitable 50 ohm dummy load before proceeding.

When at all possible, the following adjustments should be made with the RF output terminated with a 50 ohm nonreactive load capable of dissipating the required power output. If it is necessary to tune into an antenna or coupler impedance, insure that the reflected power has been minimized, before proceeding.

5.3.1.1 Test Equipment Required:

The following test equipment or their equivalent is required to perform the specified tests which follow. Equipment marked with an asterisk (*), is not necessary, but is recommended to improve tuning accuracy. Connect equipment as shown in Figure 5-1.

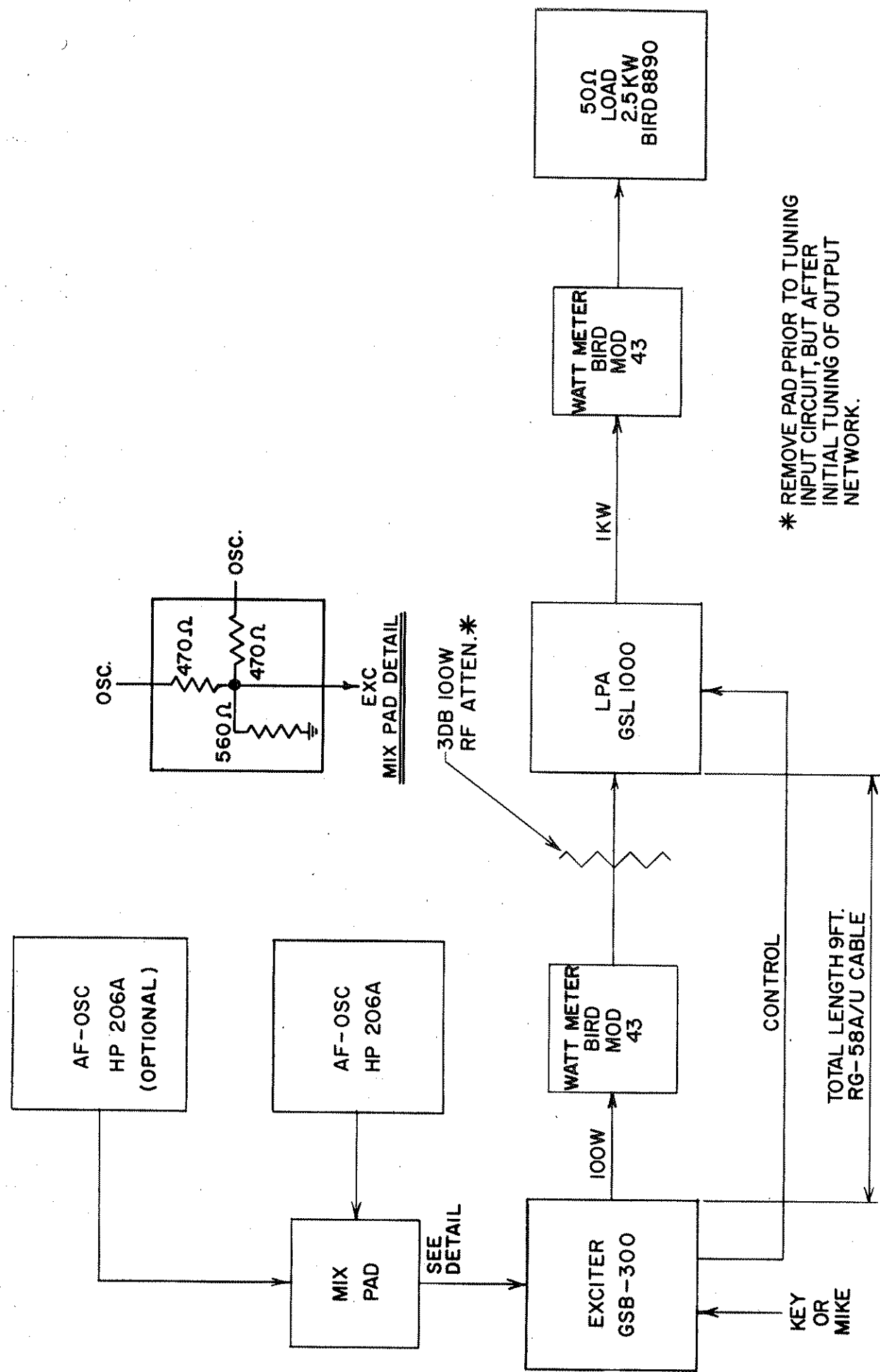


FIGURE 5-1
GSL-1000
TEST SET-UP

1. VOM Triplet Model 630
2. RF Wattmeter, Bird Thruline Model 43
with 100 watt 2-30 mhz element. (50 ohms)
3. RF Wattmeter*, Bird Thruline Model 43
with 1000 watt 2-30 mhz element. (50 ohms)
4. Coaxial resistor*, 1000 watts, 50 ohms,
Bird Model 8833.
5. Vector Impedance Meter*, Hewlett-Packard
Model 4815A.
6. Frequency Counter*, Systron Donner Model
6050.
7. Oscilloscope*, Tektronix Model 465.
8. Audio Signal Generator, Hewlett-Packard
Model 206A.
9. 3DB 100 watt Attenuator*, 2-30 mhz.
10. High Voltage Grounding Stick.

TABLE 5-2

OUTPUT NETWORK TUNING DATA

<u>FREQ.</u>	<u>INDUCTOR TAP</u>	<u>RL</u>	<u>QL</u>	<u>C1 PAD</u>	<u>C2 PAD</u>
1600 KHZ	22 Turns	2100 Ohms	15.7	In	1410 PF
1700	21	2000	14.4	"	"
1800	20	1950	13.7	"	"
1900	19	1900	13.3	"	"
2000	18	1800	12.7	"	"
2100	17	1750	12.1	"	"
2200	16	1850	13.9	"	"
2300	15	1800	12.8	"	"
2400	14	1700	12.3	"	"
2400	14	2200	17.1	"	1880 PF
2500	13	2100	17.1	"	"
2600	12	1950	16.9	"	"
2700	11	1850	17	"	"
2800	10	1900	19.7	"	"
2900	10	2000	19.3	"	"
3000	9	1850	20.5	"	"
3100	9	1900	20.5	"	"
3200	8	1750	21.8	"	"
3300	8	1850	22.1	"	"
3400	8	1850	21.3	"	"
3500	7	1750	22.8	"	"
3500	12	1800	10.9	OUT	OUT
3500	13	2150	13.2	"	"
3500	14	1900	13	"	"
3600	14	1800	10.7	"	"
3.6 MHZ	13	1850	10.5	"	"
3.7	13	1900	10.4	"	"
3.8	13	1950	10.5	"	"
3.9	12	2000	10.5	"	"
4.0	10	2000	12.8	"	"

TABLE 5-2

OUTPUT NETWORK TUNING DATA (CONT.)

<u>FREQ.</u>	<u>INDUCTOR TAP</u>	<u>RL</u>	<u>QL</u>	<u>C1 PAD</u>	<u>C2 PAD</u>
5	8	1750	12.5	OUT	OUT
6	7	1800	12.5	"	"
7	6 1/3	1800	13.5	"	"
8	6	2000	14.0	"	"
9	5 1/4	1850	14.8	"	"
10	5	2100	14.8	"	"
11	4 1/3	1950	16.9	"	"
12	4	2000	16.8	"	"
13	4	2000	14.8	"	"
14	3 1/3	2000	19	"	"
15	3 1/3	2000	17.6	"	"
16	3	1800	17.8	"	"
17	2 1/3	1850	25.3	"	"
18	2 1/3	2000	22.2	"	"
19	2 1/4	1950	24	"	"
20	2	1900	25	"	"
21	1 7/8	1850	25	"	"
22	1 3/4	1800	24.7	"	"
23	1 5/8	1800	29.6	"	"
24	1 1/2	1750	28.5	"	"
25	1 3/8	1700	30	"	"
26	1 1/4	1700	35	"	"
27	1 1/8	1750	42	"	"
28	1	1700	47	"	"
29	7/8	1700	51	"	"
30	3/4	1700	53	"	"

NOTES, TABLE 5-2:

1. Inductor tap settings indicate active turns. (See Figure 5-7)
2. RL is tube resonant load impedance.
3. QL is operating (loaded) circuit "Q".
4. C1 is pi-network input pad, switched.
5. C2 is pi-network output pad, switched.
1410 PF is 3 each 470PF, Mica
1880 PF is 4 each 470PF, Mica
200PF consisting of 2 each 100PF, ceramic capacitors is permanently connected to output at all frequencies.

5.3.1.2 Preliminary Adjustments:

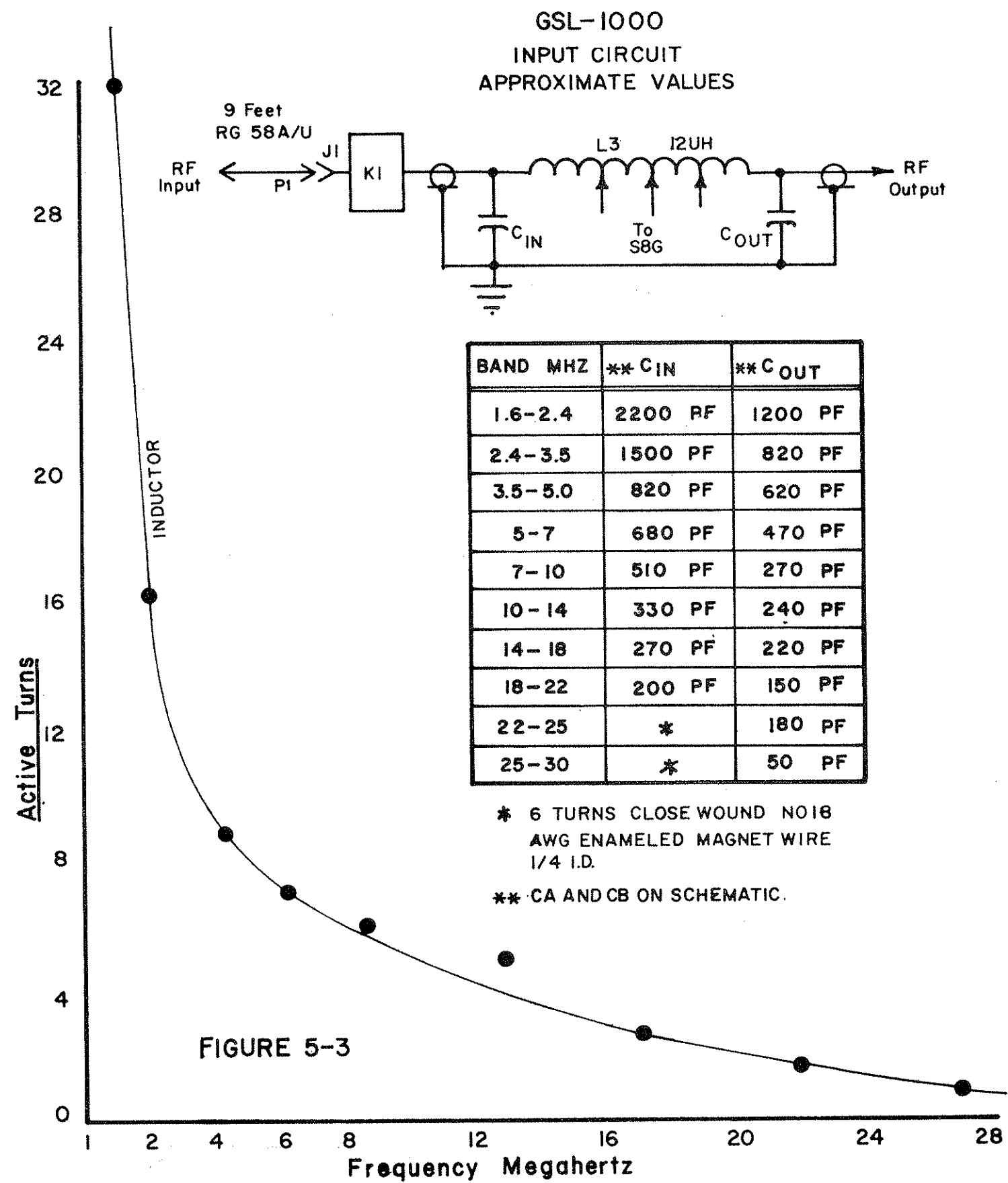
Figures 5-3 thru 5-7 and Table 5-2 provide the necessary data for inductor and capacitor padder values over the operating frequency range.

In addition to the adjustment of the input and output Pi-network inductor taps for each channel frequency, the following connections must be made for operation in the frequency ranges given below:

OUTPUT PI NETWORK	
<u>1.6-2.4 mhz</u>	Input and output padders, output is 3 each, 470 pf in parallel. Input C16,17;Output C22-24
<u>2.4-3.5 mhz</u>	Input and output padders, output is 4 each, 470 pf in parallel. Input C16,17;Output C11,C22-C24
<u>3.5-14.0 mhz</u>	None required.
<u>14-30 mhz</u>	Back turn short, connects 12 turns from 50 ohm end of inductor, L4, to required channel position of S8D.

Note: $\frac{1}{2}$ of S8E & S8D are connected in parallel and used for inductor tap selection. Either of the remaining sections may be used for the auxillary connections.

Typical output pi network connections for 5 frequency assignments which require all of the above connections are shown schematically in Figure 5-2. The circuit is shown with the switches in the channel 1 position. Assume that the channel selector is moved to channel 1, the cam switch actuator wheel rides on the rounded portion of the channel 1 cam wheel. Tuning motor, B3 is then activated through the contacts of the cam switch, S12 and the channel selector wafer S8C. The motor runs until the cam wheel flat is reached, and S12 opens. When S12 opens, the voltage from S8C is transferred to the RF switch solenoid, K4, engaging the input padder. The paralleled sections of S8E & S8D select 20 active turns of inductor, L4. In this case, the remaining section of S8D is used to connect the output padders to the circuit.



GSL-1000

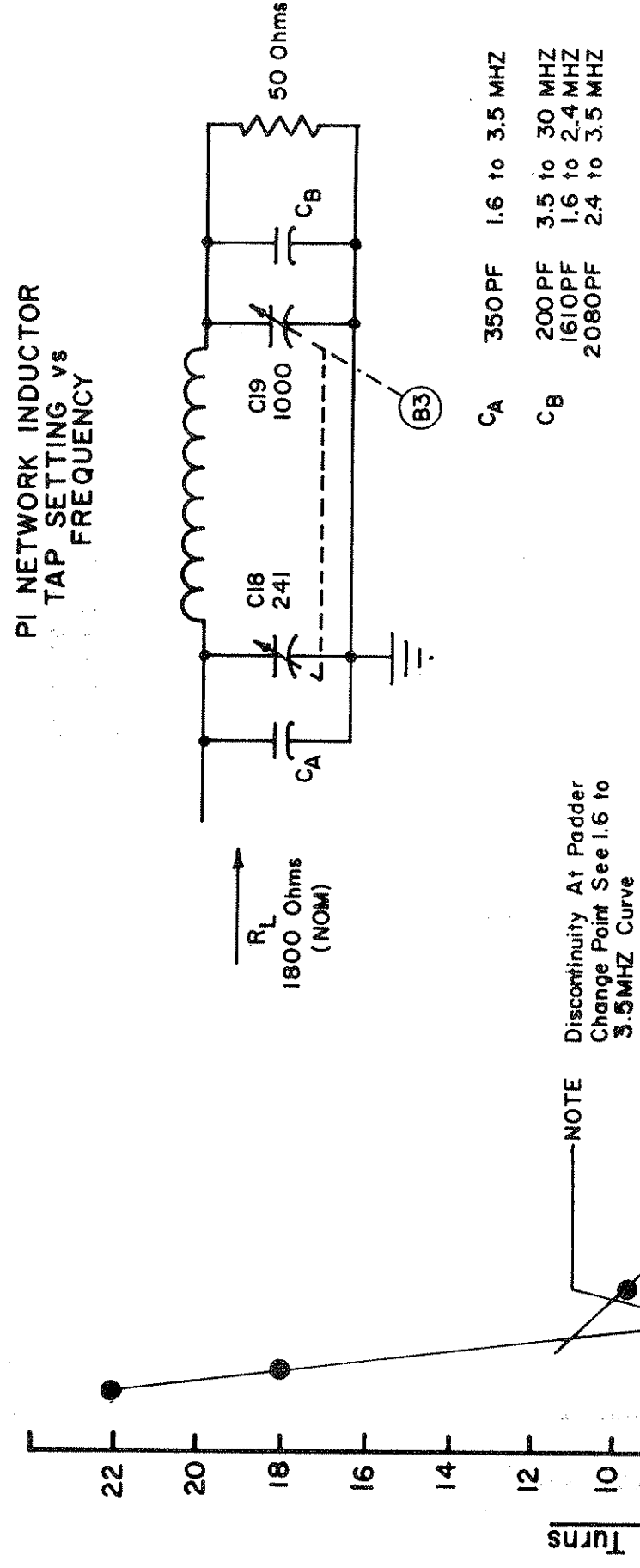


FIGURE 5-4

GSL-1000

PI-NETWORK INDUCTOR
TAP SETTING
VS
FREQUENCY
1.6 to 2.8 MHZ.

- OUTPUT PAD 1610PF
 - OUTPUT PAD 2080PF
- INPUT PAD 350PF
1.6 TO 3.5 MHZ

R_L 1800 Ohms NOMINAL

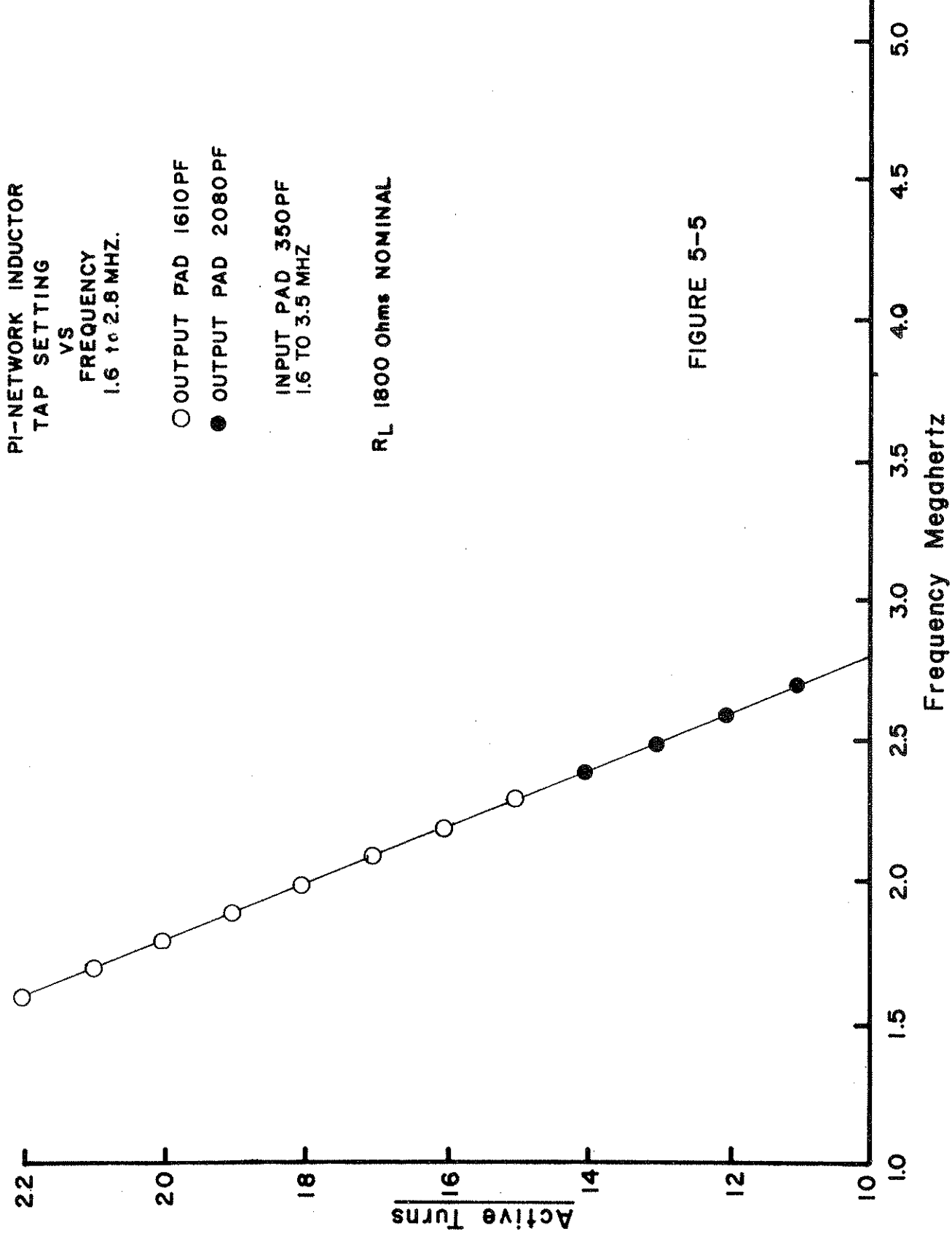


FIGURE 5-5

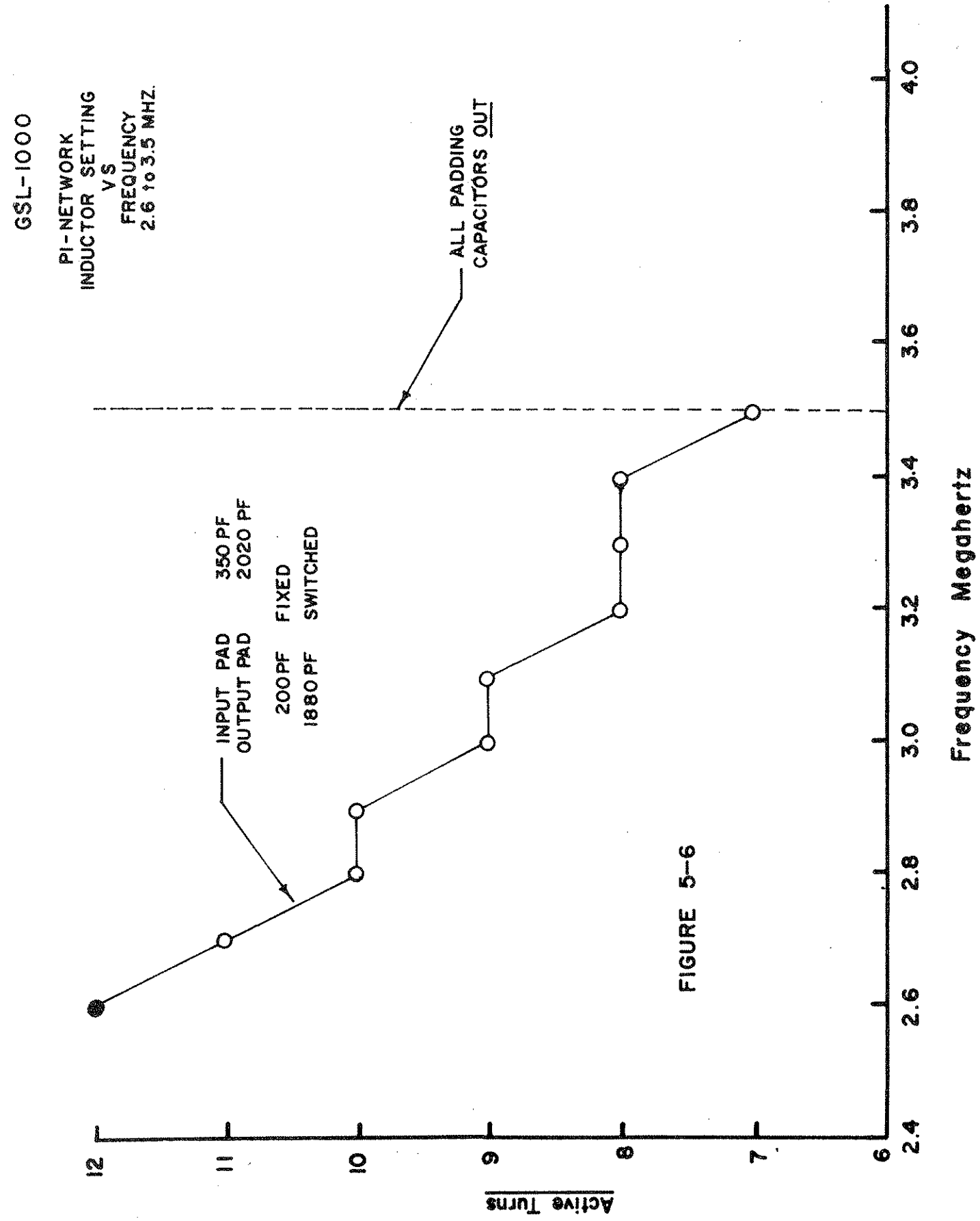


FIGURE 5-6

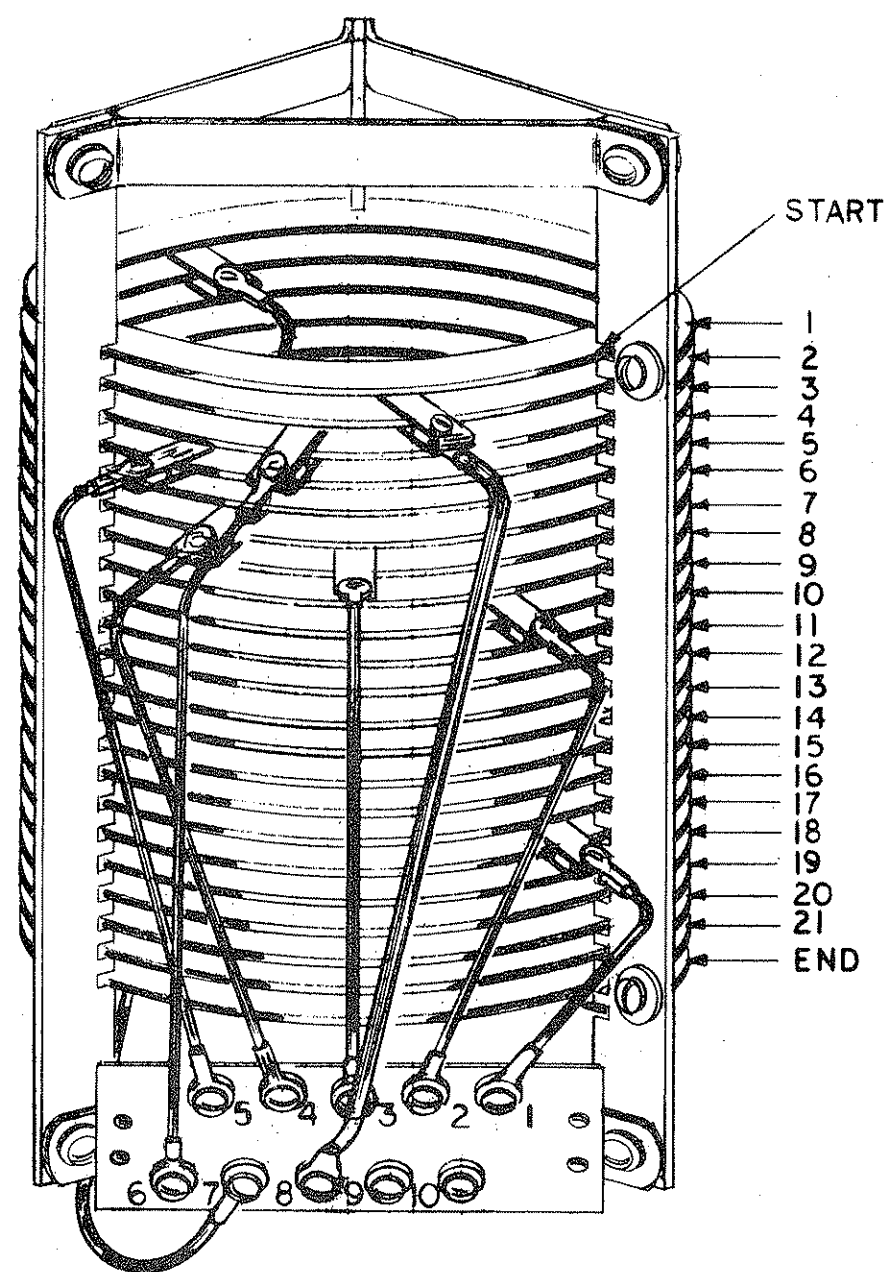


FIGURE 5-7
INDUCTOR TAP LOCATIONS

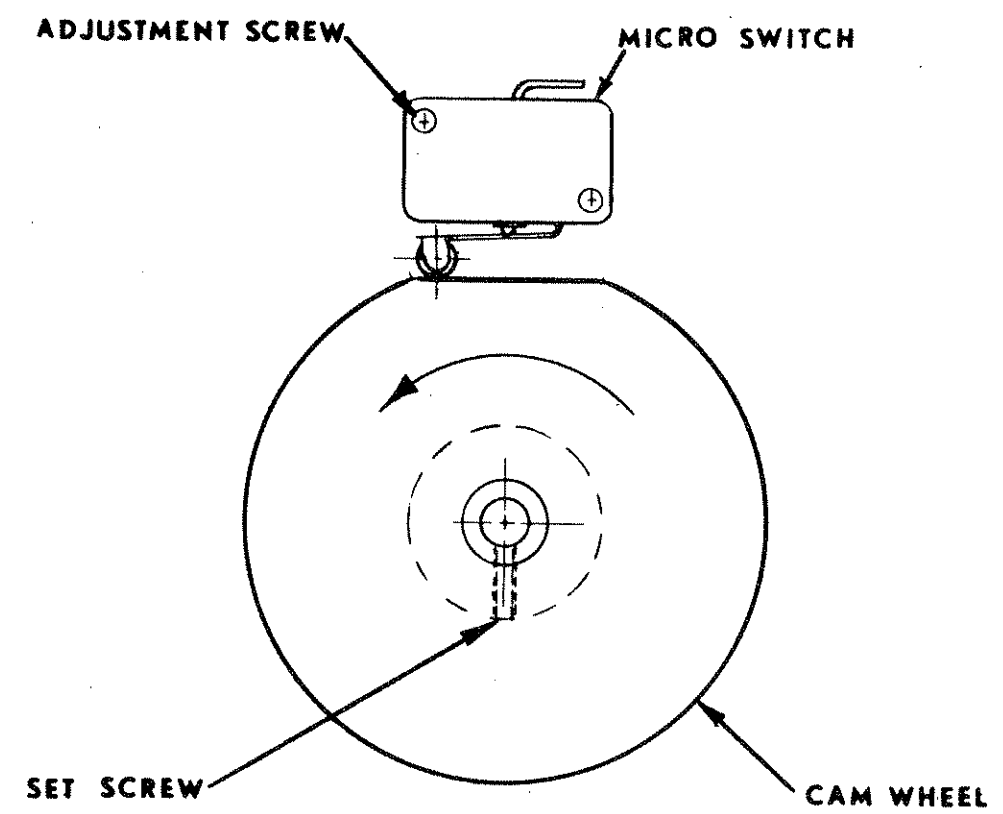


FIGURE 5-8
CHANNEL CAM WHEELS

Connect the GSB-300 (or other suitable exciter) control cable. Connect the exciter RF output to the GSL-1000 RF input connector using a 9 foot length of type RG-58A/U coaxial cable. Other cable lengths can be used, refer to the exciter instruction book for cable data. (RG-8A/U should be used for longer runs to avoid excessive power dissipation in the cable.

5.3.1.3 Coarse Settings Input Circuit

Figure 5.3 is a graph of inductor tap settings for the input circuit. These data were plotted with a 9 foot length of cable in the circuit. Other cable lengths will result in different tap settings, but the coarse setting should be selected from the graph for any cable length. The inductor leads are color coded from 1 to 10. Connect as required by channel frequencies, using short leads above 20 mhz. Connect capacitors from the common ground bus wire to the channel switch terminal according to the required frequency scheme. (If the padder has already been used for another channel, connect the two channel switch terminals together.

5.3.1.4 Preliminary Adjustments, Output Network Using the Vector Impedance Meter:

Note: If the Vector Impedance meter is not available, skip this paragraph and follow the procedure of par. 5.3.1.5.

Connect the auxillary padder components as needed. (Refer to par. 5.3.1.2).

Setup Procedure:

Connect a 50 ohm coaxial load directly to the Pi-network output connector, P3. (The power rating of the load is unimportant while the Vector Impedance Meter is in use). Connect the HP 4815A Vector Impedance Meter between the junction of the tube parasitic suppressors and RF chassis ground. Use short low inductance strap type leads and the BNC connector on the probe. Connect the frequency counter to the impedance meter RF output jack and set the meter to the desired channel frequency. Turn on the GSL-1000 filaments and switch to the

desired channel. After channeling the PA turn off all voltage to the unit.

CAUTION

Do not apply a drive signal or D.C. plate voltage to the GSL-1000 while the Vector Impedance Meter is being used.

Refer to Figures 5-4, 5, 6 & 7 for inductor tap data. Connect a clip lead 6 to 8 inches long between the desired channel terminal on the inductor tap board and the inductor turn listed for the operating frequency. Comprehensive tuning data is shown in Table 5-2.

Fine Tuning:

Hold the cam wheel corresponding to the channel in use with the fingers of one hand and loosen its set screw while firmly retaining the cam in position. Now turn the motor drive gear to rotate the variable capacitors until 0° phase angle is indicated on the vector impedance meter. The plate load impedance should be between 1800 and 2100 ohms. If it is not, slide the clip lead along the inductor turn and re-resonate (turn motor drive gear while holding cam) until the proper load impedance is found.

Operating Q Check:

The adjustment must now be examined to insure that the circuit Q is within the tolerances listed below:

1.6 to 16 MHz	Q= 10 to 20
16 to 24 MHz	Q= 15 to 30
24 to 30 MHz	As low as possible, but not over 50

To determine circuit Q using the vector impedance meter, move the frequency setting of the meter above and below the operating frequency and read the two frequencies noted when the meter indicates $\pm 45^\circ$.

Circuit Q is then:

$$Q = \frac{f_o}{f_2 - f_1} = \frac{f_o}{BW} \text{ (3DB)}$$

Where: f_o = resonant operating frequency
 f_2 = -45° frequency
 f_1 = $+45^\circ$ frequency

If the resonant load impedance and circuit Q do not fall within tolerance, readjust the inductor tap until they do.

NOTE: The ganging of the variable tuning and loading capacitors, C18 and C19 have been set so that when the tuning capacitor is at minimum, the loading capacitor (output) is meshed 10° or approximately 85Pf. This action has been taken to improve tracking over the frequency range. It is apparent then, that two tuning points are possible, one with the 85Pf adding to the total effective loading capacity, and another with it subtracting. Generally, the subtracting action results in a much lower load impedance than the adding case. However, the tuning at the lower frequencies can be improved by using the subtracting mesh. Both positions should be checked before moving the tap from the initial setting, to insure the circuit actually is tuned to the highest impedance. In general, 1800 ohms yields best I.M. distortion and 2100 ohms gives best CW efficiency.

RF Tuning:

Before proceeding, install the final jumper connector between the coil tap and its terminal. Use No. 10 AWG enameled wire for circuit Q of 10 to 22 and 3/16" O.D. copper tubing for those above 22. Be sure that the 6-32 screw is nickel plated brass, (furnished with the terminals with lockwasher) and is tight. Repeat procedure for the remaining channel frequencies.

Check all channels, and note load impedance and phase. Touch up tuning where necessary.

Remove all test equipment and connect the GSB-300 and GSL-1000 as shown in Figure 3. Install all the covers on the equipment. The system is now ready for RF test. Turn

on filament & plate voltages. Select either the USB or LSB mode on the GSB-300 and feed a single audio tone until output is noted. Advance the AF input until the RF output is 300 to 500 watts. Carefully recheck resonance. (Loosen cam wheel set screw and tune as described previously). Check each channel & retune if necessary. Check for repeatability.

Remove the 3DB pad at the input. Check the RF input reflected power when the power amplifier is driven to 1000 watts.

Note: If the reflected power is high, do not increase power until the network is adjusted. Readjust the input inductor tap for minimum reflected power. Adjacent turns may be shorted with a small screwdriver to determine if more or less inductance is needed. At frequencies to 15 mhz the reflected power should reduce to zero and to a minimum of at least 2 watts at higher frequencies when the PA is driven to 1000 watts.

5.3.1.5 R-F Output Network Adjustment Without Special Test Equipment:

Connect auxillary components as outlined in paragraph 5.3.1.2. Connect a 50 ohm load, or an antenna adjusted to 50 ohms to the RF output jack, J5.

Refer to Figures 5-4, 5, 6, & 7 for inductor tap data. Connect the jumper from the channel tap board to the inductor turn specified. Use No. 10 AWG enameled wire for frequencies to 22 mhz, and 3/16" O.D. copper tubing for frequencies above this. Connect the jumper using as direct a route as possible, keep clearance to coil body and other jumpers from 3/4" to 1".

Install covers and apply operating voltages. Slowly advance the AF input level to the exciter until a noticeable increase in plate current and some RF output is obtained. Hold the cam wheel corresponding to the channel in use with the fingers of one hand and loosen its set screw while firmly retaining the cam in position. Now turn the motor drive gear to rotate the variable capacitor gang until a peak in the RF forward power output, or a

plate current dip is found. If the operating frequency is above 20 mhz, shut down the equipment and check the position of the plate variable capacitor, C18. Mesh should be 1/2" or less. If it is not, move the inductor tap to increase the effective inductance and repeat the above steps.

To determine if the plate impedance (loading) is correct it will be necessary to check the ratio of plate current to grid current and the plate efficiency. Since the input tuned circuit has a marked effect on the magnitude of the grid current as well as plate efficiency, the input-network should be tuned at this time.

Remove the 3 DB pad at the input if one was used. Advance the exciter output and note the reflected power at the input to the GSL-1000. Adjust the input inductor tap for minimum VSWR. It should be possible to obtain zero reflected power at frequencies to 15 mhz, and less than 2 watts above 15 mhz. If the reflective power is high, do not increase the power input until the network is adjusted. Adjacent turns may be shorted with a small screwdriver to determine if more or less inductance is required.

Replace all covers and drive the power amplifier to rated output. The ratio of plate to grid current should be approximately 3:1 or slightly higher. Refer to Table 3-1 for typical meter indications at various frequencies across the band. Single-tone (CW) efficiency should be from 55 to 60% at all frequencies except the high end of the band where plate circuit losses will drop efficiency as low as 50%. If the plate to grid current ratio and efficiency are not as noted above, or if the tuning is abnormally critical, indicating an excessively high operating circuit Q, readjust the output network tap until the above criteria has been satisfied. Recycle the channel selector several times to insure repeatability of the tuning function.

Plate Efficiency may be calculated from the following:

$$\text{Efficiency (\%)} = \frac{\text{Power Output (Ave. watts)} \times 100}{\text{Plate Current (amps)} \times \text{Plate Voltage (volts)}}$$

5.4 Tube Maintenance & Replacement:

CAUTION - GLASS IMPLOSION

The 3-500Z is pumped to a very high vacuum, which is contained by a glass envelope. When handling a glass tube, remember that glass is a relatively fragile material, and accidental breakage can result at any time. Breakage will result in flying glass fragments, so safety glasses, heavy clothing, and leather gloves are recommended for protection.

Under normal CW key-down operating conditions, the two 3-500Z Power Amplifier tube anodes will show a dull ruby red color. Should one tube appear to be brighter than the other, it is possible that the darker tube has begun to lose filament emission. When this condition exists, and it is no longer possible to obtain rated power output, the tubes should be replaced.

It is good engineering practice to keep a log of filament hours for each tube at the station, preferably by serial number, with a notation of the date of purchase or receipt at the station. This data will be valuable should a premature tube failure be experienced which requires the completion of the standard tube failure report supplied by the tube manufacturer. This report form also outlines the conditions which govern the tube manufacturers' warranty.

Spare tubes should be rotated periodically to preclude gas formation. New or used tubes that have been in storage for an extended period of time, should be operated with filament voltage only for at least fifteen minutes before applying plate voltage.

Typical Meter Readings, Static Conditions:
(Key-down, no RF Drive Signal)

Plate Voltage:	2640 volts
Plate Current:	0.3 amps
Grid Current:	45 milliamps

In any high voltage circuit, electrostatic fields will exist around the components, resulting in the accumulation of dust and dirt deposits at an accelerated rate. The glass envelope should be kept clean, wipe off all finger marks after handling. Special attention should be given the tube sockets and tube base seals during regular maintenance periods. Avoid over-tightening the set-screws on the heat dissipating tube plate caps to avoid damage to the plate seal and its solder connection.

5.5 High Voltage Power Supply Maintenance:

The normal failure mode for a high voltage power supply fault will result in tripping one or both of the primary AC line circuit breakers, 2CB1 & 2CB2. When such a fault occurs, the fault must be located and the defective components replaced before the circuit breaker is manually re-set and further operation is attempted. Repeated attempts to apply plate voltage under fault conditions can possibly result in further damage to the circuitry due to the high in-rush currents which will be present.

The following DC resistance measurements are given to assist in the rapid isolation of a failure in the high voltage power supply circuit:

1. Reactor, 2L1: 26.3 ohms
2. Plate transformer, 2T2: Primary H1-H2 0.068 ohms
 H5-H6 0.076 ohms
 Secondary X1-X2 40.91 ohms
3. High voltage terminal, 2E2:
 100K ohms to chassis ground (negative lead of the
 VOM to 2E2, positive to ground).
4. Rectifier stacks, 2CR1-4: Check for direct shorts
 only, typical measurements would depend on the
 type of instrument used for the data since the
 rectifier leg is composed of a multi-diode string
 in series.
5. Filter capacitor, 2C3: Should measure approximately
 100 megohms after a 30 second charging time.
 (measure with one terminal open).

Note: The above measurements are cold DC resistance at 25°C.
ambient temperature. If the equipment has been
operating some variation in readings will be encountered.

If a short circuit or low resistance is found at the high voltage terminal, 2E2, disconnect the silicone rubber high voltage wire leading to the RF Amplifier to determine if a fault is present in the power amplifier circuit. Resistance to chassis ground from the PA HV lead should be infinite.

Check all iron core components from windings to core and ground. Check the plate transformer for a primary to secondary or a primary winding one to primary two short. Check the transient suppressor capacitor, 2C2 for a short circuit. Examine all insulators and terminals for evidence of arcing to ground.

Normal operating voltages for the high voltage power supply are listed below for reference:

1. Transformer, 2T2, open circuit: 3000 VAC
2. HVDC, Key-up: 3500 volts approximately
3. HVDC, Key-down, no RF Drive: 2640 volts
4. HVDC, 1000 watts RF Output, CW: 2500 volts

WARNING

If it is necessary to make high voltage measurements, observe all safety precautions outlined on the warning in the front of this instruction book. Do not service alone, Remove primary AC power and discharge the filter capacitor, 2C3 directly at its terminals with a suitable insulated grounding stick.

TABLE 5-3
WIRE LIST

WIRE NO.	FROM	TO	LENGTH	SIZE & COLOR	DESCRIPTION
1	K1 Coil	C32		20 Brn/Wh	
2	C1	C33		20 Red/Wh	
3	CR1	2TB2-2		20 Orj/Wh	
4	K1 N.O.	2TB2-7		20 Yel/Wh	B-
5	R1	2T1-X4		20 Grn/Wh	(C.T.)
6	B1	B2		16 Red	
7	B1	2TB3-3		16 Red	
8	B1	B2		16 Black	
9	B1	S1		16 Black	
10	CR2/B3	B2		16 Bl/Wh	(A.C.)
11	S8C-1	DS4		24 Brn	Chan Lites
12	-2	DS5		24 Red	
13	-3	DS6		24 Org	
14	-4	DS7		24 Yel	
15	-5	DS8		24 Grn	
16	-6	DS9		24 Blue	
17	-7	DS10		24 Violet	
18	-8	DS11		24 Grey	
19	-9	DS12		24 White	
20	-10	DS13		24 Black	
21	C28	PC1-TB1-3		Shielded Pair Type BNSJ	Refl Pwr
22	C29	PC1-TB1-1		Black-Fwd White-Refl	Fwd Pwr
23	PC1-TB1-2	S6B-4		16 Vio/Wh	
24	PC1-TB1-4	S6B-5		16 Blue/Wh	
25	PC1-TB1-5	2TB5-6		20 Brn/Wh	Cplr TB
26	PC1-TB1-6	C33		20 Org/Wh	
27	PC1-TB1-7	E4		20 Red	Grd
28	PC1-TB1-8	DS3		20 Grn/Wh	Fault Lite
29	PC1-TB1-9	S5		20 Red/Wh	Reset

TABLE 5-3 CON'T.
WIRE LIST

WIRE NO.	FROM	TO	LENGTH	SIZE & COLOR	DESCRIPTION
30	PC1-TB1-10	2TB6-1		20 Red/Wh	+24V Reg
31	-11	S8A-F		20 Gray/Wh	
32	-12	B2		16 Grn	
33	-13	B3		16 Wh	AC Bus
34	E4	2TB2-9		20 Brn/Wh	P.S. Grd
35	S8B-E	2TB5-5		20 Brn	Cplr Cont
36	-D	2TB5-4		20 Red	
37	-C	2TB5-3		20 Org	
38	-B	2TB5-2		20 Yel	
39	-A	2TB5-1		20 Grn	
40	B4	2TB6-5		16 Org/Wh	+35V Ledex
41	S8A-E	S7		20 Brn/Wh	
42	-D	S7		20 Red/Wh	
43	-C	S7		20 Org/Wh	
44	-B	S7		20 Yel/Wh	
45	-A	S7		20 Grn/Wh	
46	S7	2TB5-7		20 Org/Wh	Cplr Key In
47	S7	2TB4-1		20 Brn	Rem Cont In
48	S7	2TB4-2		20 Red	"
49	S7	2TB4-3		20 Org	"
50	S7	2TB4-4		20 Yel	"
51	S7	2TB4-5		20 Grn	"
52	CR7/S7	2TB4-6		16 Bl/Wh	Rem Key
53	S1	2TB3-5		16 Wh	AC Fil Xfmr
54	S1	2TB5-8		16 Orange	AC Ant Cplr
55	S1	2TB3-6		16 Yel	AC Fil Xfmr
56	S1	2TB3-1		16 Brn	AC In
57	S1	2TB3-4		16 Grn	AC In
58	S2/DS1	2TB2-2		20 Yel/Wh	

TABLE 5-3 CON'T
WIRE LIST

WIRE NO.	FROM	TO	LENGTH	SIZE & COLOR	DESCRIPTION
59	S2/S3	2TB2-1		20 Red/Wh	
60	S3	2TB2-4		20 Black/wh	
61	S6B-3	2TB2-10		20 Viol/Wh	
62	R12/S6B	2TB2-6		20 Orange/Wh	
63	S6A-2	2TB2-5		20 Grn/Wh	
64	S6A-1	2TB2-8		20 Gray/Wh	
65	Not Used				
66	2TB3-2	2TB5-9		20 Grn/Wh	Cplr AC
67	2TB6-4	2TB5-10		16 Org	+35V
68	Not Used				
69	Not Used				
70	2TB6-3	DS3/DS4		16 White	+24V Reg
71	B2	S8C-Com		16 Bl/Wh	115VAC
72	2TB6-6	PC1-TB1-14		20 Blue/Wh	Grd
73	2TB4-8	CR7		20 White	

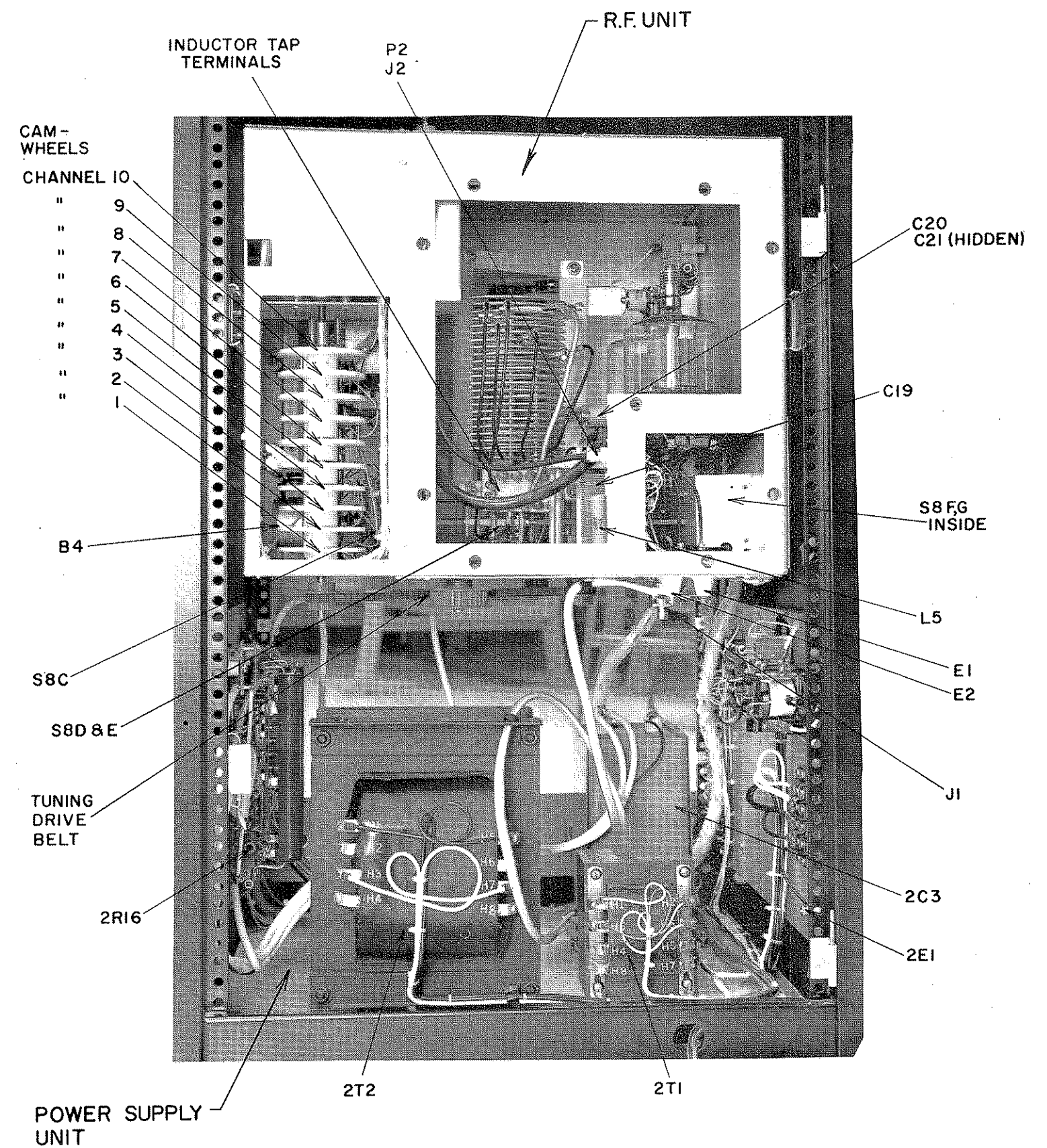


FIGURE 5-9
REAR VIEW



FIGURE 5-10
TOP VIEW R-F UNIT

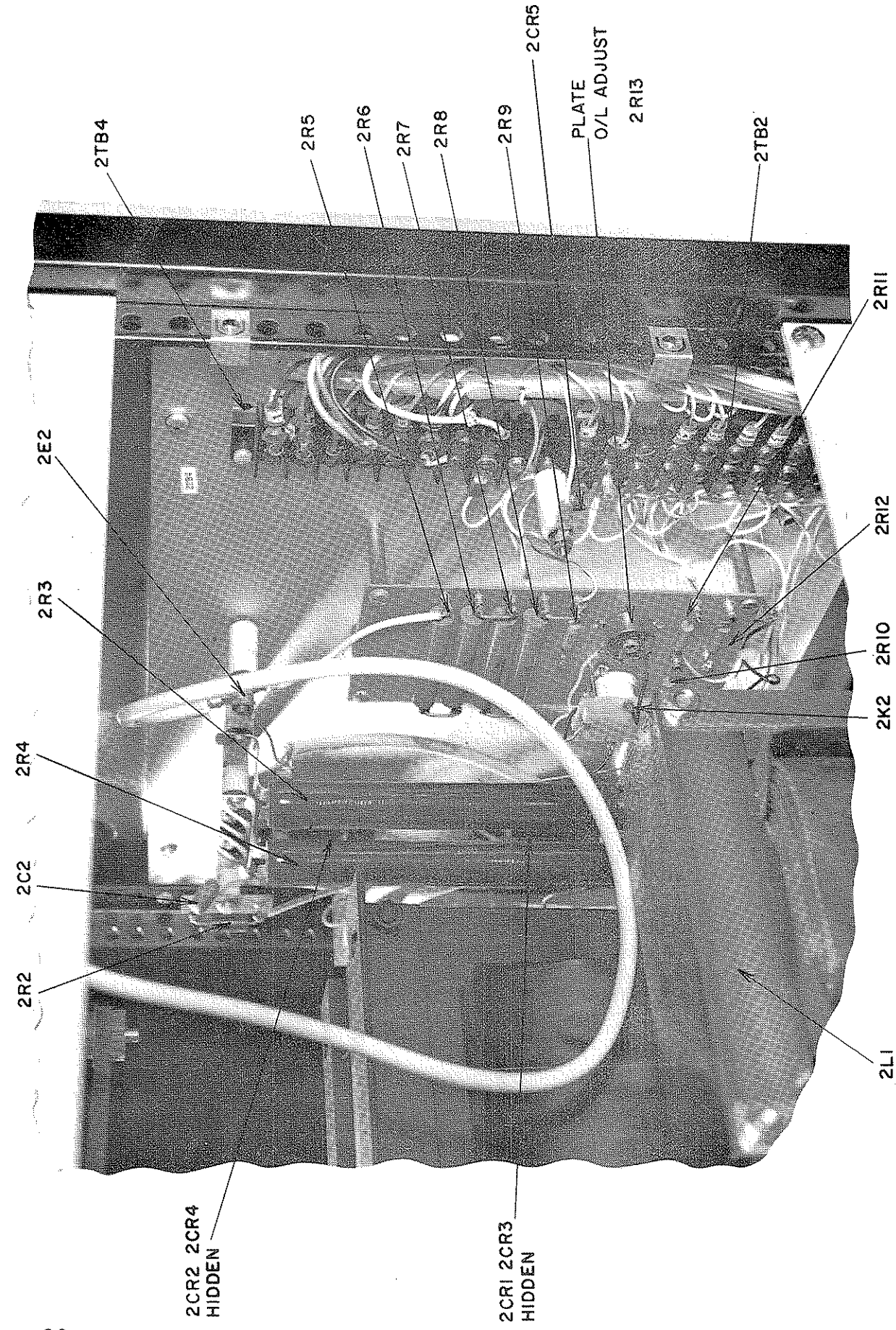


FIGURE 5-11
POWER SUPPLY REAR RIGHT VIEW

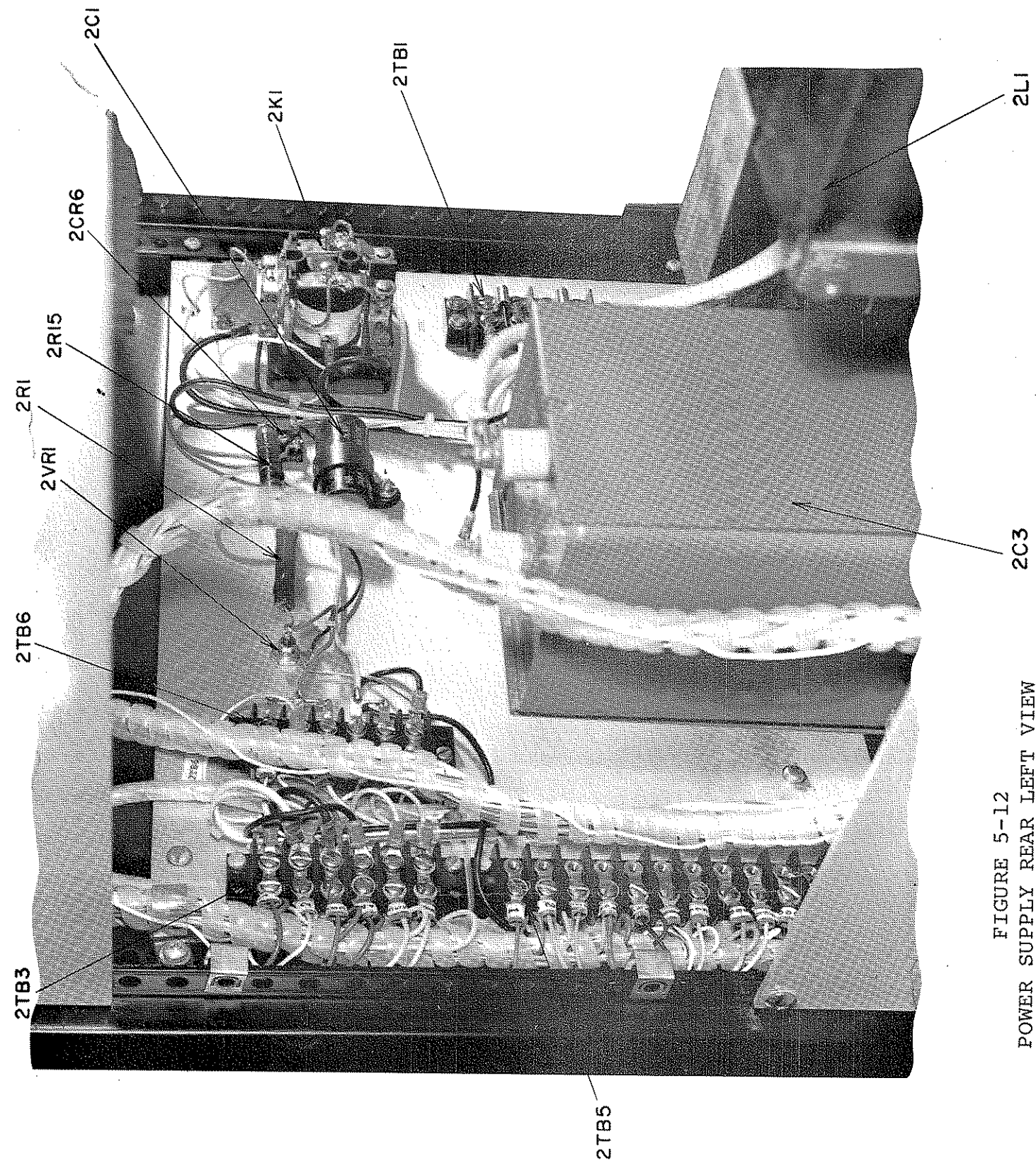


FIGURE 5-12
POWER SUPPLY REAR LEFT VIEW

SECTION 6

6.1 Parts List

6.1.1 Parts List Power Amplifier PARTS LIST

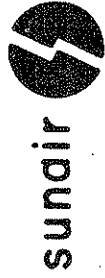
CKT. SYM.	PART NO.	DESCRIPTION	CKT. SYM.	PART NO.	DESCRIPTION
B1	71594	Fan 115VAC 50/60 Hz	C40	28153	Capacitor,Tant.33UF 10V
B2	71594	Fan 115VAC 50/60 Hz	C41	24355	Capacitor,Disc .01UF 500V
B3	71584	Motor 115VAC w/Clutch	C42	29501	Capacitor,Disc 1000PF 1KV
B4	34271	Rotary Solenoid, 28VDC	C43	27552	Capacitor,Elect. 50UF,150VDC
C1	28211	Capacitor,Alum 25UF, 50V	INPUT CIRCUIT		
C2	24355	Capacitor,Disc .01UF, 600V	CA		
C3	24355	Capacitor,Disc .01UF, 600V	BAND		
C4	24355	Capacitor,Disc .01UF, 600V	1	29965	Capacitor,Mica 2200PF
C5	24355	Capacitor,Disc .01UF, 600V	2	29848	Capacitor,Mica 1500
C6	24355	Capacitor,Disc .01UF, 600V	3	29757	Capacitor,Mica 910
C7	24355	Capacitor,Disc .01UF, 600V	4	28624	Capacitor,Mica 680
C8	25933	Capacitor,Disc 50PF, 3KV	5	28961	Capacitor,Mica 510
C9	25933	Capacitor,Disc 50PF, 3KV	6	29903	Capacitor,Mica 330
C10	28206	Capacitor,Ceramic,1000PF 5KV	7	29460	Capacitor,Mica 270
C11		Not Used	8	25804	Capacitor,Mica 200
C12	28911	Capacitor,Disc, 2000PF,6KV	9	29410	Capacitor,Mica 180
C13	28911	Capacitor,Disc, 2000PF,6KV	10	25933	Capacitor,Disc 50
C14	28911	Capacitor,Disc, 2000PF,6KV	CB		
C15	28911	Capacitor,Disc, 2000PF,6KV	BAND		
C16	29044	Capacitor,Ceramic,100PF,5KV	1	29977	Capacitor,Mica,1200PF
	--	(Assy of 3 Each)	2	28875	Capacitor,Mica, 820
C17	29020	Capacitor,Ceramic,50PF, 5KV	3	29915	Capacitor,Mica 620
C18	28207	Capacitor,Var.Air,32-241PF	4	29393	Capacitor,Mica 470
C19	28209	Capacitor,Var.Air,28-1000PF	5	29460	Capacitor,Mica 270
C20	29044	Capacitor,Ceramic,100PF, 5KV	6	29886	Capacitor,Mica 240
C21	29044	Capacitor,Ceramic,100PF, 5KV	7	29410	Capacitor,Mica 180
C22	28204	Capacitor,Mica,470PF 2.5KV	8	27498	Capacitor,Mica 150
C23	28204	Capacitor,Mica,470PF 2.5KV	9	25933	Capacitor,Disc 50
C24	28204	Capacitor,Mica,470PF 2.5KV	10	--	Capacitor,Disc 50
C25	28205	Capacitor,Ceramic,Var 0.5-4.5PF	CR1	40541	Diode, 1N645
C26	28205	Capacitor,Ceramic,Var 0.5-4.5PF	CR2	40542	Rect. FWB 2 Amp 400PIV
C27	25804	Capacitor,Mica,200PF,500V	CR3	40546	Diode, 1N3064
C28	25804	Capacitor,Mica,200PF,500V	CR4	40546	Diode, 1N3064
C29	27400	Capacitor,Tant. 15UF 35V	CR5	40541	Diode, 1N645
C30	29678	Capacitor,Tant. 6.8UF 15V	CR6	40541	Diode, 1N645
C31	24355	Capacitor,Disc,.01UF, 500V	CR7	40541	Diode, 1N645
C32	26901	Capacitor,Feedthru,1000PF,500V	CR8	--	Not Used
C33	26901	Capacitor,Feedthru,1000PF,500V	CR9	--	Not Used
C34	26901	Capacitor,Feedthru,1000PF,500V	CR10	40541	Diode 1N645
C35	26901	Capacitor,Feedthru,1000PF,500V	CR11	--	Not Used
C36	27230	Capacitor,Mylar,1UF, 100V	CR12	40165	Diode 1N2071 (IR 10D4)
C37	24355	Capacitor,Disc .01UF 500V	DS1	84101	Lamp,Red,28V, 40 MA
C38	24355	Capacitor,Disc .01UF 500V	DS2	84103	Lamp,Green,28V, 40MA
C39	24355	Capacitor,Disc .01UF 500V			

PARTS LIST

CKT. SYM.	PART NO.	DESCRIPTION	CKT. SYM.	PART NO.	DESCRIPTION
DS3	84102	Lamp, Amber, 28V, 40 MA	Q4	44834	Transistor, UJT 2N2646
DS4-	84104	Lamp, White, 28V, 40 MA	R1	19730	Resistor, 10K ohm 12W
DS13			R2	16994	Resistor, 22 ohm 2W
E1	71284	Insulator, Feedthru	R3	16994	Resistor, 22 ohm 2W
E2	71284	Insulator, Feedthru	R4	19477	Resistor, 1.0 ohm 1/2W
E3	50779	Insulator, Stand-off	R5		Not Used
			R6		Not Used
J1	74192	Connector, Chassis UHF	R7	31841	Potentiometer, 50K ohm 3/4W
J2	74374	Connector, Chassis BNC	R8	31841	Potentiometer, 50K ohm 3/4W
J3	74192	Connector, Chassis UHF	R9	34629	Potentiometer, 10K ohm 3/4W
J4	74374	Connector, Chassis BNC	R10	16607	Resistor, 15K ohm 1/2W
J5	74192	Connector, Chassis UHF	R11	17390	Resistor, 470 ohm 1/2W
			R12	17390	Resistor, 470 ohm 1/2W
K1	66731	Relay, RF DPDT, 12 VDC	R13	31841	Potentiometer, 50K ohm 3/4W
K2	66731	Relay, RF DPDT, 12 VDC	R14	16736	Resistor, 2.2K ohm 1/2W
K3	66743	Relay, DPDT, 24 VDC	R15	19731	Resistor, 17.4K ohm 1W
K4	66779	Solenoid, Cont. Duty, 115VDC	R16	16671	Resistor, 100K ohm 1/2W
K5	66743	Relay, DPDT, 24VDC	R17	16671	Resistor, 100K ohm 1/2W
			R18	18538	Resistor, 10 ohm 1/2W
L1	5025- 1111	Choke, RF Bifilar	S1	34627	Switch, Toggle DPST
L2	5025- 1110	Choke, RF 60 UH	S2	34622	Switch, Mom, N.O. SPST, Red
			S3	34623	Switch, Mom, N.C. SPST, Black
L3	62943	Inductor, Air Dux	S4	34628	Switch, Door I/L SPST
L4	55938	Inductor, 26UH, 15 Amp	S5	34623	Switch, Mom, N.C. SPST, Black
L5	55940	Choke, RF, 44 UH	S6	34624	Switch, Rotary, 2-5 Pos. 4 Pole
L6	65359	Choke, RF, 2000 UH, 99 MA	S7	34620	Switch, Rotary, 2-3 Pos. 6 Pole
L7	65359	Choke, RF, 2000 UH, 99 MA	S8A	--	Part of B2
XL4	52583	Coil Clip (10 ea reqd)	S8B	32209	Switch, Wafer, 15° Master
M1	5025- 1504	Meter, Special Scale	S8C	32314	Switch, Wafer, 10 Pos 2 Pole 15°
			S8D	34386	Switch, Wafer, 24 Pos, 2 Pole 15°
P1	90873	Connector, Plug w/adaptor UHF	S8E	34386	Switch, Wafer, 24 Pos, 2 Pole 15°
P2	74403	Connector, Plug, BNC	S8F	32314	Switch, Wafer, 10 Pos, 2 Pole 15°
P3	74219	Connector, Plug, UHF	S8G	32314	Switch, Wafer, 10 Pos, 2 Pole 15°
P4	74403	Connector, Plug, BNC	S9	34625	Switch, Toggle SPST
P5	74219	Connector, Plug, UHF	S10	33679	Switch, Wafer 30° Master
Q1	--	Not Used	XS10	5025- 1505	Index Assy 30°
Q2	44838	Transistor, NPN 2N1711			
Q3	44833	Transistor, NPN 2N697	S11	5025- 1505	Not Used
			S12	34619	Switch, Roller Actuator
			S21	34619	(10 Each Rqd)

PARTS LIST

CKT. SYM.	PART NO.	DESCRIPTION	CKT. SYM.	PART NO.	DESCRIPTION
T1	5025-1302	Transformer, RF	2K1	66158	Contactor, DPST w/Aux SPDT
			2K2	66767	Relay, SPDT, 12VDC
V1	76736	Tube, 3-500Z	2L1	5025-2104	Reactor, 8HY, 800MA
V2	76736	Tube, 3-500Z			
XV1	76748	Socket Tube	2R1	19725	Resistor, 2 ohm, 12W
XV2	76748	Socket Tube	2R2	16358	Resistor, 470 ohm, 2W
XXV1	75495	Connector, Plate Cap	2R3	19727	Resistor, 50K ohm, 100W
XXV2	75495	Connector, Plate Cap	2R4	19727	Resistor, 50K ohm, 100W
Z1	5025-1134	Suppressor, Parasitic	2R5	19728	Resistor, 1 meg ohm, 1%, 2W
			2R6	19728	Resistor, 1 meg ohm, 1%, 2W
Z2	5025-1134	Suppressor, Parasitic	2R7	19728	Resistor, 1 meg ohm, 1%, 2W
			2R8	19728	Resistor, 1 meg ohm, 1%, 2W
Z3	75500	Connector, Adapter 90° UHF	2R9	19723	Resistor, 133 ohm, 1%, 1W
			2R10	19724	Resistor, 1.0 ohm, 1%, 5W
6.1.2	PARTS LIST POWER SUPPLY		2R11	19724	Resistor, 1.0 ohm, 1%, 5W
2C1	28923	Capacitor, Elect. 500UF, 50V	2R12	19724	Resistor, 1.0 ohm, 1%, 5W
2C2	28911	Capacitor, Disc, 2000PF 6KV	2R13	31877	Potentiometer, 1K ohm, 1 1/2W
2C3	28203	Capacitor, Oil, 10UF, 4KV	2R14	19729	Resistor, 150 ohm, 12W
2C4	24355	Capacitor, Disc, .01UF 500V	2R15	16841	Resistor, 50 ohm, 12W
2XC3	52587	Capacitor Mtg. Bkts (Pair)	2R16	19192	Resistor, 10 ohm, 12W
2CB1	34617	Circuit Breaker, 15 Amp, 230V	2T1	5025-2102	Xfmr, 30V @2A & 5V @30A
2CB2	34617	Circuit Breaker, 15 Amp, 230V	2T2	5025-2103	Xfmr, 2900V @ .8A
2CR1	40439	Rectifier, Stack 1 amp 8KV	2TB1	75396	Connector, Barrier Type
2CR2	40439	Rectifier, Stack 1 amp 8KV	2TB2	75391	Connector, Barrier Type
2CR3	40439	Rectifier, Stack 1 amp 8KV	2TB3	75395	Connector, Barrier Type
2CR4	40439	Rectifier, Stack 1 amp 8KV	2TB4	75394	Connector, Barrier Type
2CR5	40541	Diode 1N645	2TB5	75393	Connector, Barrier Type
2CR6	40542	Rect. Assy FWB 2 amps 400PIV	2TB6	75395	Connector, Barrier Type
2F1	89645	Fuse, Slo-Blo 1.5 Amp 3AG	2VR1	40189	Diode, Zener, 1N2986B
2F2	89645	Fuse, Slo-Blo 1.5 Amp 3AG			MISC. MECHANICAL
2XF1	84903	Holder, Fuse, 3AG	MP1	84067	Pulley, 30 Groove
2XF2	84903	Holder, Fuse, 3AG	MP2	84069	Pulley, 15 Groove
			MP3	84079	Belt, 1/5 Pitch, 33 in. Long



RECOMMENDED SPARE PARTS LIST

Quantity Required To Support 3 to 5 Units For 2 To 4 Years			MODEL	GSL-1000	Description	Voltage	115/230V AC	Unit Price	Total Price
			SunAir	P/N					
		1	71594		Fan 115VAC				
		1	71584		Motor 115VAC w/Clutch				
		1	34271		Rotary Solenoid 28VDC				
		6	24355		Capacitor, .01uf				
		1	28206		Capacitor, 1000PF 5KV				
		2	28911		Capacitor,2000PF 6KV				
		2	29044		Capacitor,100PF 5KV				
		1	29020		Capacitor, 50PF 5KV				
		1	28207		Capacitor,Air Var 32-241 PF				
		1	28209		Capacitor,Air Var 28-1000PF				
		3	28204		Capacitor,Mica 470PF 2.5KV				
		3	40541		Diode 1N645				
		1	40542		Rect.FWB 2A 400PIV				
		1	66731		Relay,RF DPDT 12VDC				
		1	66743		Relay,DPDT, 24VDC				
		1	66799		Solenoid Cont Duty 115VDC				
		1	5025-1111-00		Choke,RF, Bifilar				
		1	5025-1110-00		Choke, RF 60UH				
		1	5025-1504-00		Meter, Special Scale				
		2	44838		Transistor, NPN				
		2	44833		Transistor, NPN				
		2	44834		Transistor, UJT				
		1	34627		Switch Toggle DPST				
		1	34622		Switch Mom N.O. Red				



RECOMMENDED SPARE PARTS LIST

Quantity Required To Support 3 to 5 Units For 2 To 4 Years				MODEL	GSL-1000	Voltage 115/230V AC	Total Price	
				SunAir P/N	Description	Unit Price	Total Price	
			1	34623	Switch Mom N.C. Black			
			1	34628	Switch Door I/L			
			1	34624	Switch 2-5 Pos 4 Pole			
			1	34620	Switch 2-3 Pos 6 Pole			
			2	34386	Switch 24 Pos 2 Pole			
			2	34619	Switch Micro Roller			
			4	76736	Tube, 3-500Z			
			1	76748	Socket, Tube			
			2	5025-1134-00	Suppressor, Parasitic			
			2	28911	Capacitor, 500 UF, 50V			
			1	28203	Capacitor, Oil 10UF 4KV			
			1	34617	Circuit Bkr 15 Amp			
			4	40439	Rect. Stack 1 Amp 8KV			
			10	89666	Fuse, 3.0 Amp Slo			
			1	66158	Contact, DPST w/Aux			
			1	66767	Relay, SPDT, 12VDC			
			1	5025-2104-00	Reactor, 8 HY 800 MA			
			2	19727	Resistor 50K ohm 100W			
			3	19724	Resistor, 1.0 ohm 1/2 5W			
			1	5025-2102-00	XFMR 30V@2A, 5V @30A			
			1	5025-2103-00	XFMR 2900V @ .8A			
			1	40189	Diode Zener 24V			

ADDENDUMS

Information contained in this section supplements the information contained in the manual. References to this section may be indicated where necessary in the manual.

SUNAIR ELECTRONICS, INC.
MANUAL: GSL-1000

ADDENDUM 1
DATE: 11-19-75

REFERENCE: Plate voltage control and keying circuits.

ECN: 5025-038

PURPOSE: Eliminate possibility of input keying relay
switching slightly before the output relay.

MANUAL REFERENCE: Schematic diagram, figure 4-3, page IV-7,
parts list, page VI-1.

TEXT: Connect negative lead of C1 to junction of
wire "1" and K1.
Remove wire "2".
Add diode CR13, 1N645, P/N 40541 across coil of
relay K2, cathode connected to C32, anode connected
to C33.

