M 28345

POWER LINE CARRIER
DUAL CHANNEL
TRANSFER TRIP RELAYING EQUIPMENT

TRANSMITTER TERMINAL
MODEL 4CT51B1F04M1A, OPTION 00X12

RECEIVER TERMINAL
MODEL 4CR51B1F04R7N, OPTION 00X13

LUGO - VICTORVILLE.

LBI-28006

TELECOMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

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The diagrams included in this book may in some cases vary in minor details from the equipment which is supplied. However, in all cases, the approved diagrams supplied by the Data Bureau and identified with the particular requisition involved will be correct in all details.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired, or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

This book contains the following detailed installation, adjustment, operation and maintenance instructions and diagrams:

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MISCELLANEOUS

DESCRIPTION

DUAL CHANNEL
TRANSFER TRIP RELAYING EQUIPMENT
TYPE 51B

This Dual Channel Transfer Trip Relaying Equipment consists of two Model 4CT51B1F04M1A Transmitter Equipment, two Model 4CR51B1F04R7N Receiver Equipments, a Transformer Hybrid, Model 4CL12RS1, and an RF Skewed Hybrid, Model 4CL12RA2. This equipment is mounted in a 90-inch open rack. The equipment provides a 1 Watt/10 Watt output and operates from a 48 VDC power source.

The Option Numbers 00X12 and 00X13 are used to show dual channel operation, associated hybrids, and special interconnections between these equipments.

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POWER LINE CARRIER
TRANSFER TRIP RELAYING EQUIPMENT
TRANSMITTER TERMINAL

MODEL 4CT51B1*04M1A

LBI-19420B

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This book contains the following detailed installation, adjustment, operation and maintenance instructions and diagrams:

POWER AUXILIARY

DIAGRAMS

CARRIER CURRENT
TRANSFER TRIP
RECEIVER EQUIPMENT

MODEL 4CR51B1*04R7N
MODEL 4CR51B1*04R3N

LBI-19137B

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This section contains the following detailed installation, adjustment, operation, and maintenance instructions and diagrams:

DISCRIMINATOR

DIAGRAMS

PARTS LIST NOTES

The Parts List for each unit or module includes all principal replacement parts. The symbol numbers used are the same as those appearing on elementary and other related diagrams.

The manufacturer's type numbers, when shown, are not necessarily direct replacements for the corresponding GE Part No.

When ordering a replacement part, please include description, symbol designation, and reference number of the part and ML- and PL- number of the unit or module. When reordering crystals and filters, also include the frequency. Orders may be sent to the nearest General Electric Apparatus Sales Division District Office, or direct to Service Parts, Telecommunication Products Dept., General Electric Company, Lynchburg, Virginia 24502.

The following is an explanation of the reference marks used in the parts lists:

Carrier Current equipment marked with a letter on or adjacent to the nameplate has had changes incorporated. The symbol * on the parts list indicates that this part or entry has been either added, deleted or changed according to production changes or alteration notices. The symbol ® on the parts list will indicate "Registered U.S. Patent Office".

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INSTRUCTIONS

RECOMMENDED CUSTOMER TEST EQUIPMENT

The following test equipment (or equivalent) is recommended for initial adjustment, trouble-shooting and maintenance of General Electric Power Line Carrier Current Equipment.

1.* AC Vacuum Tube Voltmeter

Hewlett-Packard Model 400 E

Used for: Checking input and output levels, noise levels.

2.* Cathode Ray Oscilloscope

Tektronix Type 5103N/D10 Main Frame
Type 5A15N Vertical Amplifier
Type 5B10N Time Base
Type 016-0195-00 Blank Panel
Type P6006 10X Probe

The above basic package may be expanded to meet present or future individual requirements requiring a DC to 2 MHz device.

Used for: observing wave shapes.

3. Electronic (Frequency) Counter

Hewlett-Packard Model 5216 A

Used for: Checking oscillator and other frequencies.

4.* Frequency Selective Voltmeter (Wave Analyzer)

Sierra Model 125 A or Rycom Model 3135 (transistorized). (Carrying case #3063 is available for this meter).

** Hewlett-Packard Model 302 A

Used for: Checking levels.

5.* Test Oscillator

Hewlett-Packard Model 200 CD (160 mW output) or Model 204 C (10 mW output). Note: Model 204 C is a solid-state type and is available with a rechargeable battery pack.

6.* VOM-VTVM

Triplett Model 631 or GE Model 4CX5A2 Meter Analyzer Unit.

Used for: General trouble-shooting.

7.* Extender Test Kit

Various Extenders are available for different models. See the General Instructions for the specific unit required.

*** General Electric Company

Used for: Testing modules electrically in a system, but physically removed from their position in the Shelf Unit.

The above items of test equipment are not supplied as part of the system equipment. This list is offered as an aid to the customer in determining what items of test equipment he may require.

* Minimum recommended list for efficient maintenance. (Recommend one per maintenance crew or section.)

The frequency counter is considered optional but desirable for more comprehensive maintenance. It is generally required during installation, and for some specialized tests. (Recommend one per system or major maintenance division.)

** The Hewlett-Packard Wave Analyzer has a narrower bandwidth and is very useful when a system has a number of closely spaced tones. Note: The upper frequency limit of this instrument is 50 kHz.

*** The Part Number needed will depend on the equipment function. Supply full Model No. of equipment with which it is to be used.

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LYNCHBURG, VIRGINIA 24502

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INSTRUCTIONS
INSTALLATION AND MAINTENANCE

SAFETY CONSIDERATIONS

Since the use of high voltages, both transmission line voltages and AC and DC supply voltages, is necessary for the successful operation of much of the Carrier Current Equipment, certain reasonable precautions must be carefully observed by the operating personnel during the installation, operation and maintenance of the equipment.

Although practical safety measures have been incorporated in these equipments, the following general rule should be observed:

WARNING

Under no circumstances should any person be permitted to handle any portion of the equipment that is supplied with high voltage, or to connect any external apparatus to the equipment, while the equipment is supplied with power, unless that person is thoroughly familiar with the hazards involved.

Individual unit or equipment instructions contain some safety references which should be followed - read the instructions completely before using a piece of equipment.

These safety references are in addition to the normal safety practices which have been established by the customer and should in no way be construed to modify or limit the customers safety procedures.

GENERAL

This Power Line Carrier Current Equipment is supplied to the customer in two ways: (1) As un-mounted separate units (for open-rack installation) and, (2) As mounted units in a cabinet (either a fixed-rack or a swing-rack cabinet).

LOCATION

A number of factors should be considered in selecting a suitable location for this equipment:

1. The location should be free from excessive humidity, dust and vibration.
2. The equipment should not be installed in a battery room or where corrosive fumes are present.
3. The equipment should be easily accessible for maintenance.

An indoor installation is recommended, since it simplified the installation and maintenance of the equipment and normally does not require the blowers, heaters and thermostatic controls usually necessary in outdoor installations.

For an indoor installation, the carrier current lead-in connection between the outdoor line equipment and the Power Line Carrier Current Equipment should be made with coaxial cable or other lead-in cable, depending on the application.

LEAD-IN CONDUCTORS

GENERAL

Carrier-current lead-ins refer to those conductors used for the interconnection between coupling capacitors, line-tuning units and transmitter-receiver assemblies. The two types of conductors that have been specially developed for these interconnections are:

1. Carrier-current single conductor consisting of: Single-conductor, No. 8 AWG, 19 strands, rubber insulation, neoprene sheath; 0.480-inch diameter. (GE Dwg. No. 7146185-P1).

2. Carrier-current coaxial cable, RG-8/U, consisting of: Single-conductor, No. 12AWG, 7 strands of No. 21 copper, polyethylene insulation, copper shielding braid, and black vinyl plastic jacket to a nominal outside diameter of 0.405 inch.

Each of these two types of conductor has its own field of application as dictated by the details of each specific installation. Application and installation details are as follows:

SINGLE CONDUCTOR

One length of this type of lead-in is generally used between each coupling capacitor and the outdoor transmitter-receiver assembly or outdoor line-tuning unit. Overhead, open construction must be used with this type of lead-in.

Since this conductor is at the high impedance point of the tuned circuit formed by the coupling capacitor and the line-tuning units, stray capacity to ground and leakage current affect the overall coupling circuit performance. The stray capacity causes a loss in bandwidth and the leakage resistance results in loss of carrier power. Both effects are more pronounced if the line voltage is high and the frequency low since both of these conditions make for a high coupling capacitor reactance. To minimize capacity and leakage losses it is desirable to support this lead on insulators,

using as few as possible and making the run as direct as possible. Avoid the use of a bare wire for overhead lead-ins as this makes each insulator a direct leakage path to ground, and hence cannot be recommended. The recommended use of neoprene insulated single-conductor for this type of lead-ins adds the leakage path along the surface of the insulators. In order that this extra length of leakage path may be as long as possible, the neoprene insulation should be unbroken as far as possible from each insulator and care should be taken in clamping the conductor to prevent any breaking of the insulation. In addition, this insulated single conductor should be carried through the bushing of the outdoor cabinet to a dry connection inside in order to add this length of dry insulation to the leakage path over the surface of the entrance bushing to ground.

Coaxial cable should not be used for the lead from the coupling capacitor to the tuning unit since the high capacity to ground introduced by the cable will narrow the frequency bandwidth of the overall tuning equipment, and will cause shunt loss to ground.

For the entrance to the outdoor assemblies, run the lead-in wire through the entrance bushing in the cabinet to the internal connection which is always dry. A "drip loop" should always be provided outside of the cabinet bushing.

NOTE

All customer connections to the base housing, or other outdoor connections, should be made waterproof, such as by using a GE silicone-rubber sealing compound.

Minimum bending diameter is six times the diameter of the cable. Minimum bending temperature is 0 F.

COAXIAL CABLE

Lead-ins of this type are used for the low-impedance interconnections between line-tuning units, between line tuning units and indoor mounted transmitter-receiver assemblies, and between coupling capacitors and indoor-mounted transmitter-receiver assemblies.

In the latter case an impedance-matching transformer is usually mounted in the base of the coupling capacitor.

Specific installation details are as follows:

1. The usual practice in installing this coaxial cable is either to bury it directly in earth, or to install it in underground conduit, alone or with other cables. The cable should be run in the most direct manner to keep the total conductor length, and therefore the carrier loss, to a minimum.

2. If the coaxial cable is to be connected directly to the coupling capacitor, the cable (or cable and conduit) can enter the coupling capacitor base, either through the bottom which is open in some assemblies or through the opening in the side of the base which will accommodate standard conduit. Refer to the coupling-capacitor outline drawing for dimensions.

3. The copper braid which forms the outer conductor of the cable should be securely grounded at the carrier equipment end only. At the tuning unit end the braid should be connected to the ground (GND) terminal of the impedance-matching transformer or wide band filter without directly grounding this terminal at this point. It was previously our recommendation that both ends of this cable be grounded. However, it was found in certain cases that momentary ground fault currents flowing through the cable could cause saturation of the impedance matching transformer and subsequent failure of the carrier channel. This is especially important in the case of pilot relay channels since these must operate during a fault. The outer jacket of the cable should be cut back so that the braid is well insulated against high surge voltages that may be produced between ground and the braid during line faults. Install both ends so as to assure a permanently dry surface of two to three inches between the exposed copper braid and the inner central conductor.

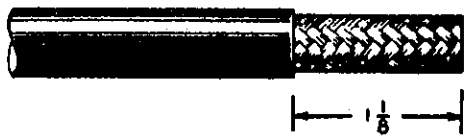
4. Minimum bending diameter is six times the diameter of the cable. Minimum bending temperature is 0 F.

5. The characteristic impedance of RG-8/U cable is 52 ohms. The capacitance is 29.5 picofarads per foot.

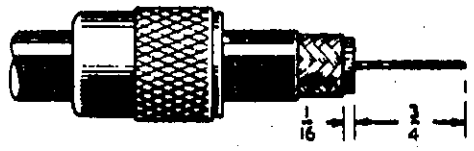
6. Cable Termination Diagram A-4032543, Figure 1, shows a method of attaching a connector to RG-8/U cable.

NOTICE

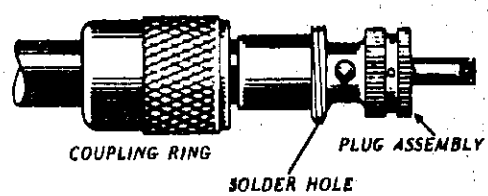
The carrier lead-in from the coupling capacitor should never be disconnected without first grounding the low potential end of the capacitor. Failure to keep a power-frequency ground on this end of the capacitor will allow dangerous static voltages to be built up at this point. Normally this ground is provided by a drainage coil located in the base of the coupling capacitor or in the cabinet housing the carrier equipment. To be safe, always close the grounding switch on the capacitor base, or ground the bottom terminal of the capacitor before disconnecting the lead-in conductor.



Cut end of cable even.
Remove vinyl jacket 1 ⅛"—*don't nick braid.*



Bare ¾" of center conductor—*don't nick conductor.*
Trim braided shield 1/16" and trim.
Slide coupling ring on cable.



Screw the plug assembly on cable.
Solder assembly to braid thru solder holes.
Solder conductor to contact sleeve.

Screw coupling ring on assembly.

(A-4032543, Rev. 0)

Figure 1 Installation Diagram RG 8/U Cable & Connector Assembly

CONNECTIONS, COUPLING

The Line Tuning Equipment, when used, should be connected to this equipment. Refer to separately furnished Line Tuning instruction books for details of this operation.

The power connections must be of the correct voltage and polarity. Incorrect polarity will result in an increase in the amount of current flowing through the dropping resistors and the load.

CAUTION

Avoid the installation of ground loops.

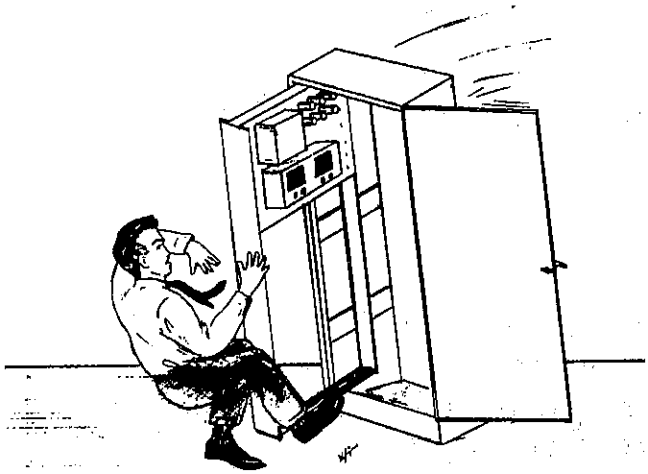
INSTALLATION

MOUNTING

The units in this equipment are mounted on a standard 19 inch wide rack. They will be mounted and interconnected according to the Elementary and Interconnection Diagrams furnished. However, external connections (shown by dotted lines on the Elementary and Interconnection Diagrams) are to be made by the purchaser.

The cabinet will be either a fixed-rack or a swing-rack type. Fasten indoor cabinets firmly to the floor with suitable bolts or lag-screws. This must be done before opening the rack if the cabinet is

of the swing-rack type.



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BOLT IT DOWN - BEFORE OPENING!

OPEN-RACK MOUNTING

When open-rack mounting is to be used, or when the customer is planning to use his existing racks or cabinets, the units in the equipment will be shipped separately. Each unit has a specific location in the rack and each unit must be correctly located for proper system operation. Reference should be made to either the typical installation arrangement diagrams or to special installation arrangement diagrams which will be supplied.

MAINTENANCE

Observe the following general instructions and also refer to the Trouble-Shooting aids section of each module instruction for specific information.

SERVICE HINTS FOR TRANSISTOR AND DIODE CIRCUITS

Servicing transistor equipment requires some special techniques which can be easily acquired. The following hints are intended as a guide in developing these techniques.

Transistor circuits require essentially the same troubleshooting techniques as conventional vacuum-tube circuits. The usual order for locating troubles is still:

1. Use of symptoms discovered by eye and ear, simple realignment, and test jack readings to localize trouble.
2. Substitution of plug-in components in suspected stages.
3. Use of voltage readings, resistance readings, signal injection, realignment, sensitivity measurements, and gain measurements to further identify faulty components.
4. Replacement of suspected component.
5. Check out and adjustment of affected circuits.

Equipment using transistors and diodes soldered directly to terminals require special treatment. Care must be taken to avoid overheating the transistor or diode while soldering. Even other transistors and/or diodes near the one being soldered can be damaged.

Use a heat-sink (such as an alligator clip) on any transistor or diode lead being soldered.

Always check the circuit for defects which could damage the new transistor or diode being placed into the circuit.

A heavy duty soldering iron should not be used. Make certain that the iron to be used does not have current leakage. An isolation transformer can be used to prevent current leakage.

A transistor or diode should never be removed or replaced while power is on, as a surge of current may damage them.

If the leads from a transistor are disconnected, make sure that each wire is reconnected to the proper place. Otherwise, voltages of reversed polarity may be applied across a transistor which may damage it.

To replace transistors and diodes which are mounted on heat sinks, first remove the heat sink and bracket from the chassis by loosening the captive nuts which hold them.

When replacing transistors using a heat sink, make certain that the transistor and the heat sink make firm and secure contack in order to provide good heat dissipation. A very light coating of DC4 (Dow-Corning 4 Compound Silicon Lubricant) is recommended for use with both transistors and diodes which use heat sinks.

TEST EQUIPMENT

Equipment used to test transistor circuits is of the same type used for checking conventional circuits. Certain precautions are necessary, however, to prevent damage to transistors.

Signal generators, VTVM's and signal tracers should be of the transformer type which isolates the equipment from the power line. Use an isolation transformer whenever the test equipment uses a transformerless power supply.

Use a common ground between the transistor equipment and the chassis of the test equipment.

Use multimeters having a sensitivity of at least 20,000 ohms-per-volt. High currents from a meter of low sensitivity can damage transistors.

Do not use an ohmmeter capable of causing the transistor curcuit under test to draw more than one milliampere of current.

Take care when metering transistor circuits so as to avoid accidental short circuits which could damage transistors. A base-to-collector short while a transistor is operating can ruin the transistor.

NOTE

Careful attention to the polarity of the meter leads should be given when testing transistors and diodes. In some meters, in the "OHMS" position, the internal battery is connected into the metering circuit so that its polarity is opposite to that indicated for voltage readings made with the meter leads. That is, with a meter of this sort, when measuring the forward resistance of a diode, instead of putting the positive lead on the anode and the negative lead on the cathode, the proper application would be to put the lead marked "negative" on the anode and the lead marked "positive" on the cathode. The GE Type 4CX5A Meter Analyzer Unit is not of this type -- it has the same polarity in both voltage and resistance reading positions.

CAUTION

Inserting test prods into either the insulated holes of a connector plug or into the two-pronged blade terminals of a connector jack will cause damage.

To prevent damage to the connector terminals, a spare mating plug or jack should be inserted into the connector. Terminal numbers are now visible and test prods will not damage these (solder side) terminals.

Care of Relay Contacts

CAUTION

Before cleaning the contacts, the power switch should be opened.

Relay covers should always be kept on the relays except when removed for inspection. Relay contacts will require only a small amount of care because, when in regular use, they are self-cleaning.

Unnecessary cleaning of relay contacts should be avoided.

Never oil relay bearings; the oiled bearings will collect dust and grit. This will cause the bearing to wear more rapidly than a non-lubricated bearing and may cause binding.

Should cleaning be required, exercise caution to avoid bending or deforming any part of the relay. Do not work on relays or contacts which may become unexpectedly energized.

If ordinary dust is present, carefully remove it with a suitable brush, such as a clean pipe cleaner.

If contacts are covered by a greasy substance which cannot be removed by dry brushing, they may be cleaned as follows:

1. Dip a clean pipe cleaner in chemically pure (C.P.) ethylene trichloride or ethylene tetrachloride (perchlorethylene), shake off excess, and brush contacts. The contacts should then be further cleaned using a fresh pipe cleaner dipped in alcohol or ether (INFLAMMABLE). Care should be taken to avoid contamination of the fluids. Use small separate bottles and change fluid frequently.

CAUTION

Do not use carbon tetrachloride. Recent studies have shown it to be much more toxic than previously supposed. The ethylene solvents listed are commonly used by dry-cleaners; however, since individual tolerance to organic compounds varies, care and adequate ventilation should attend their use. Ether, while an excellent solvent, is highly inflammable, both in liquid and vapor form.

2. Allow spring assembly to dry for approximately five minutes, then brush with a clean dry pipe cleaner or piece of clean chamois.

If contacts have become coated with a non-conducting oxide, they may be carefully burnished with a piece of smooth clock-spring steel. Commercial relay burnishing tools, such as Automatic Electric's H-47386-1, C.P. Clare's RP1067, or equivalent, may be used.

If the contacts have become pitted,

the relay should be replaced. The same care can also be taken with switch contacts.

Mercury Relays

Relays containing mercury should be mounted vertically (within 30 degrees). If it should be moved out of this position, allow the excess mercury to drain off the contacts (about 30 seconds after restoring to a vertical position).

Arc Suppression

For most applications, it is recommended

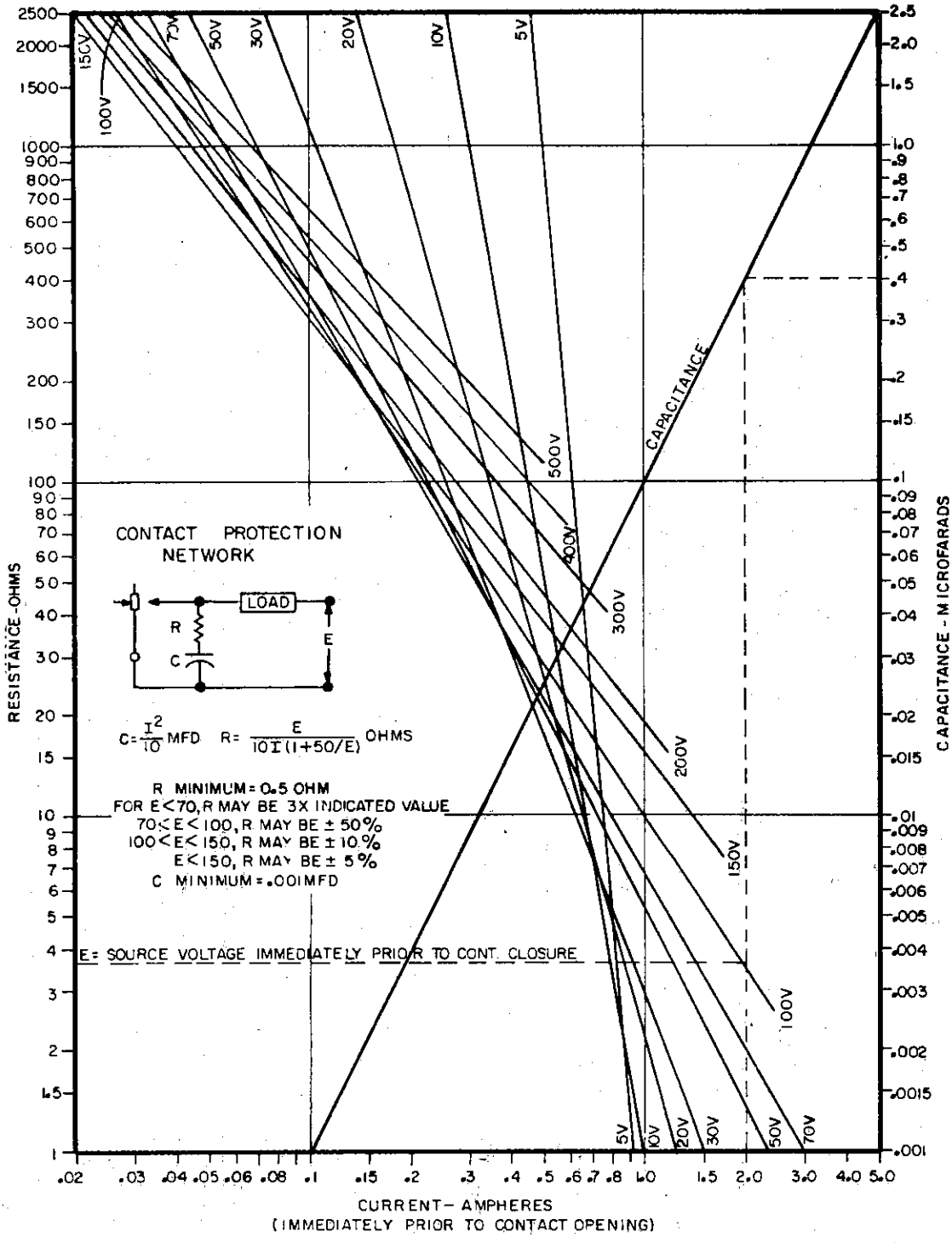

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Figure 2 Calculation Chart for Contact-Protection Network

that a spark suppression or contact protection network, consisting of a capacitor and a resistor in series, be used with the relay. The capacitor and resistor values to be applied by the customer for this network may be found by using the chart shown in Figure 2.

Dotted lines indicate a typical calculation. To use the chart, the value of load current is first found on the horizontal scale. Then reading directly up to the sloping capacitance line, the value of capacitance is determined from the right-hand scale. To find resistance, read directly up from the load current value to its intersection with the appropriate load voltage line. The value of resistance is then read from the left-hand scale.

Printed Circuit Boards

When repairing or replacing components on a printed circuit board, do not overheat. A low-wattage soldering iron must be used (consider 60-watts the absolute maximum).

An easy way to remove molten solder from the holes in the board is to use a "solder-sucker". One type is called SOLDAPULLT and is made by EDYSN, INC. of Van Nuys, California, U.S.A.

A multi-lead component, such as an integrated circuit, should be removed from a printed circuit board by cutting all of its leads first, and then removing individually each piece of lead from its hole. This will prevent overheating of the board. In some cases, a broad-tip soldering iron can be used, if the number of leads is small - generally seven or less if closely spaced.

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EXTENDER TEST BOARD
PL-19C318404-G1

The Extender Test Board, PL-19C318404-G1, provides extended connections for testing all modules in either the Transmitter Shelf Unit, or in the Receiver Shelf Unit; thus, the module will be in the system electrically, yet be removed physically for trouble-shooting or maintenance.

The Extender Test Board consists of a printed circuit card which will mate with the printed circuit-type connectors (15-contacts, one-part printed wiring; sim Elco Corp. Cat. No. 00-6021-015-955-004) mounted on the shelf unit. By turning the handle to a right angle, a similar connector is exposed into which the module to be tested can be inserted. Note that the board is keyed, so one must read the instructions on the side of the board which says, "This edge up for transmitter use" or, on the opposite side, "This edge up for receiver use".

This Extender Test Board may also be used in certain combiner Shelf Units. The key position will be the same as for receiver use.

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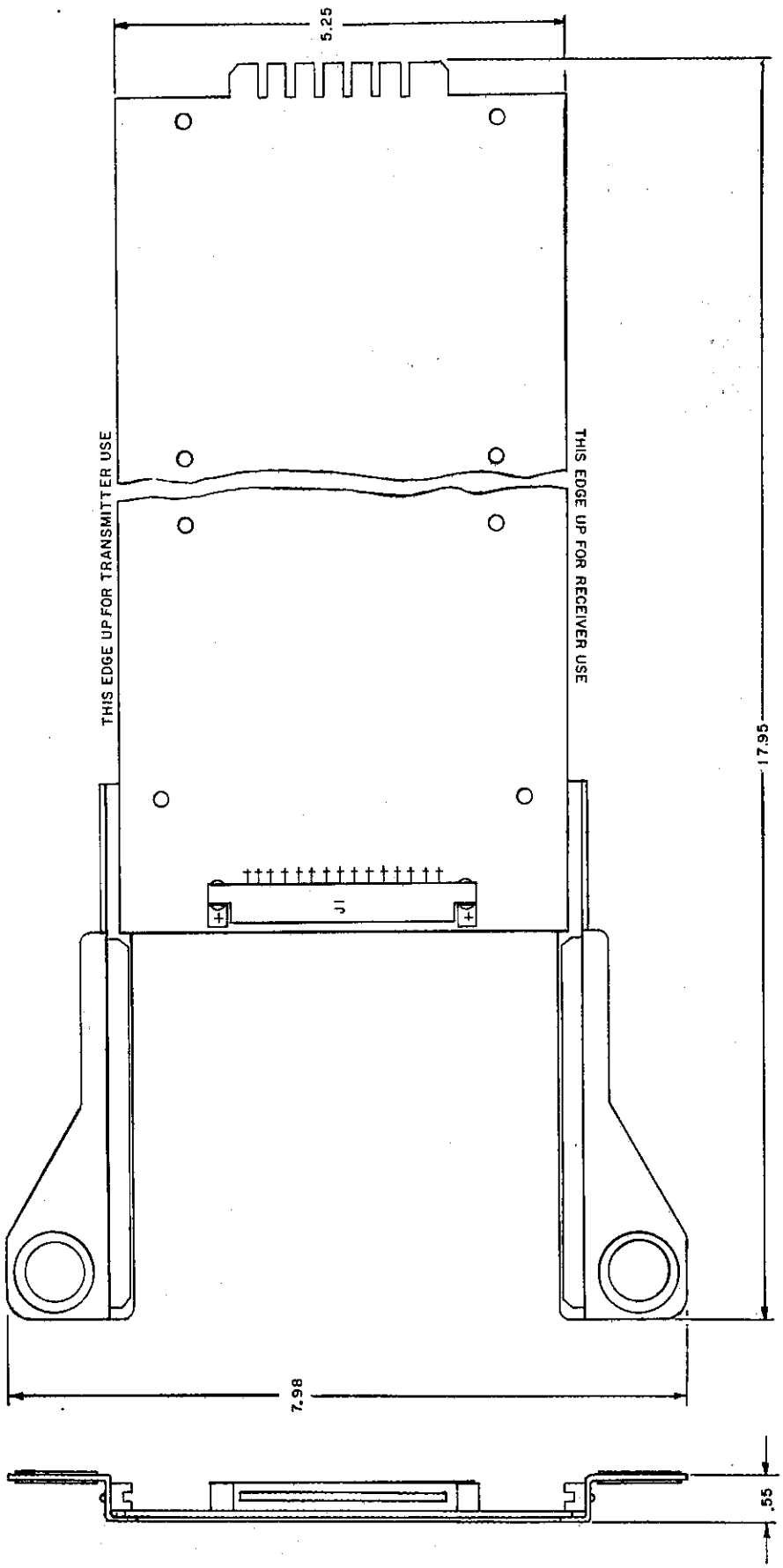


Outline Diagram

EXTENDER TEST BOARD
PL-19C318404-G1

(19C318407, Rev. 2)

GENERAL INSTRUCTIONS

MODEL 4CT51B1*04 L 1 A _ _ _ _
12 M 2 E
25 H

General

This Transfer-Trip Frequency Shift Transmitter Equipment operates from either 48, 125, or 250 VDC power sources and has an RF output of 1 to 10 Watts, maximum.

The associated model number for a given transmitter is located on the front of the Shelf Unit in the upper left hand corner.

The last four digits of the number gives the transmitter frequency (in kHz) multiplied by ten. The asterisk * denotes any one of the six wiring harnesses.

Table 1 shows the nomenclature system used to describe a particular transmitter.

TABLE I

NOMENCLATURE KEY

To facilitate understanding the many options possible with the Type CT-51B transmitter equipment, meaning has been assigned to each digit of the Model No. as shown below.

4CT51B 1 F 04 M 1 A 1605 Typical Model No.

1605 — Frequency (line frequency x 10) example: 160.5 kHz = 1605

A — Transmitter Keying
A — Contact, dry or contact keying from positive bus
B — Contact, isolated voltage (same magnitude as supply voltage)
C — Solid state, 5V at 0.02 amp
E — Contact keying from negative bus

1 — Supervision
1. — none
2. — Loss of DC power and frequency shift alarm

M — Output
H — 10-Watt GUARD, 10-Watt TRIP (non-exalt)
M — 1 Watt GUARD, 10-Watt TRIP (exalt-raised power on trip frequency)
L — 1-Watt GUARD, 1-Watt TRIP (non-exalt)

04 — Supply
04 — 48-Volt DC input
12 — 125-Volt DC input
25 — 250-Volt DC input

F — Wiring harness for GE fixed-rack cabinet or open rack
S — Wiring harness for GE swing-rack cabinet
R — Wiring harness (6-ft long) for customers existing cabinet
T — Wiring harness (10-ft long) for customers existing cabinet
X — Special wiring harness
N — No wiring harness

1 — Channel
1. — Two frequency

Transmitter Equipment, 200 Hz shift (±100 Hz)

With reference to the model numbers and Table 1, it will be seen that this instruction will cover power sources of 48 VDC (04), 125 VDC (12), and 250 VDC (25); power outputs of 1 Watt/1 Watt (L), 1 Watt/10 Watt (M) and 10 Watt/10 Watt (H) operations. Also included is the supervision option with (2) or without (1) alarm, and dry contact keying from a positive bus (A) or contact keying from the negative bus (E).

Note: Option (24) supply voltage per GE apparatus Handbook Section 6444 applies only to 250 Volt, 1 Watt/1 Watt applications.

For 1 Watt/1 Watt operation, the RF power output of the GUARD (high-shift) frequency and TRIP (low-shift) frequency is always higher than the Guard frequency (10 Watt maximum).

For 1 Watt/10 Watt operation, the RF power output of the GUARD (high-shift) frequency is variable from 1 Watt to approximately 5 Watts, but the RF power output of the TRIP (low-shift) frequency is always higher than the Guard Frequency (10 Watt maximum).

For 10 Watt/10 Watt operation, the RF power output is variable from 1 Watt to 10 Watts (on both GUARD and TRIP frequencies).

Mechanical Package

The transmitter consists of five plug-in printed circuit modules which are interconnected in a 4 rack unit (IRU=1.75 in.) Shelf Unit designed for mounting in a standard 19-inch rack or cabinet. The five modules are described in individual instructions following this general instruction. Module circuitry and interconnections are shown on the composite diagrams, Figures 1, 2, and 3, included in the diagram section of the Model Instructions Book.

Safety Considerations

Since the use of high voltages, both transmission line voltages and DC supply voltages, is necessary for the successful operation of much of the Carrier Current Equipment, certain reasonable precautions must be carefully observed by the operating personnel during the installation, operation and maintenance of the equipment.

Any person working on this equipment should keep in mind that the equipment common is connected directly to the negative terminal of the DC power source, which, in most cases, will be the station battery. This implies that there will be a voltage difference between equipment common and station ground which equals one-half of the battery voltage. For this reason, one should be very careful while doing work on this equipment.

Although practical safety measures have been incorporated in these equipments, the following general rule should be observed:

WARNING

Under no circumstances should any person be permitted to handle any portion of the equipment that is supplied with high voltage, or to connect any external apparatus to the equipment, while the equipment is supplied with power, unless that person is thoroughly familiar with the hazards involved.

Individual unit or equipment instructions contain some safety references which should be followed - read the instructions completely before using a piece of equipment.

These safety references are in addition to the normal safety practices which have been established by the customer and should in no way be construed to modify or limit the customers safety procedures.

Nominal Operating Characteristics

Frequency Range	30 kHz to 300 kHz (0.5 kHz increments, See Table 2)
Frequency Shift	
Guard	+100 Hz
Trip	-100 Hz
Power Output	
Guard	1 Watt or 10 Watts
Trip	1 Watt or 10 Watts - into 50 ohm resistive load.

Power Supply

Nominal	Cells	Range
48 VDC	24	42-56 VDC
125 VDC	60	104-140 VDC
250 VDC	120	210-280 VDC

Current Drain (excluding keying input current)

1 Watt output at	48 VDC	375 mA
1 Watt output at	125 VDC	200 mA
1 Watt output at	250 VDC	250 mA
10 Watt output at	48 VDC	800 mA
10 Watt output at	125 VDC	400 mA
10 Watt output at	250 VDC	450 mA

Keying Input Current

100 mA at	48 VDC
60 mA at	125 VDC
60 mA at	250 VDC

Alarm Relays (Contact Rating)	100 VA max., into resistive load with proper arc suppression.

TABLE 2

FILTER PART NUMBER VERSUS FREQUENCY (GROUP NO = 2F - 59)		
GE PART NO.	GROUP NO.	FREQUENCY
PL-19C304694-	G1	30.0 kHz
PL-19C304694-	G2	30.5 kHz
PL-19C304694-	G3	31.0 kHz
PL-19C304694-	G21	40.0 kHz
PL-19C304694-	G22	40.5 kHz
PL-19C304694-	G141	100.0 kHz
PL-19C304694-	G142	100.5 kHz
PL-19C304694-	G300	179.5 kHz
PL-19C304694-	G301	180.0 kHz
PL-19C304694-	G452	255.5 kHz
PL-19C304694-	G453	256.0 kHz
PL-19C304694-	G540	299.5 kHz
PL-19C304694-	G541	300.0 kHz

Principles of Operation (Refer to Figure A, Page 7)

The basic transmitter is capable of operating from either a 48 VDC or a 125 VDC station battery. With an additional unit, called a 250 Volt Regulator Unit, the transmitter will operate from a 250 VDC station battery.

The 250 Volt Regulator Unit is used to supply regulated 125 Volts from a 250 Volt station battery. The Power Auxiliary Module (PWR. AUX) converts the 125 V voltage to a regulated 48 VDC, which supplies the Power Amplifier and the 36 V Regulator; the latter is used as a supply for the associated Oscillator-Driver Module and the Keying Module.

The signal is generated in the Oscillator-Driver Module by means of mixing two oscillator outputs and filtering out all signals except the difference between the two frequencies, which will be used as the channel frequency. The driver stage amplifies the adjusted signal to drive the Power Amplifier Module. The signal path then leads to the bandpass filter, a broadband harmonic filter in the Transmitter Filter Module, the output of which is connected to the associated Line Coupling Equipment.

The Keying Module serves two purposes: one, to supply 6 VDC to the Oscillator-Driver Module to shift frequency on a fault condition, and two, to provide 36 Volts to the driver stage of the Oscillator-Driver Module when the exalt function is required. These two functions occur simultaneously when the external keying contact is closed. (Refer to Figure A for input keying principles and interconnections within the transmitter equipment.)

The keying contact is applied to Terminal Board TA-5 and TA-6 for dry, dedicated contact keying; between TA-6 and positive battery bus for positive keying, and between TA-7 and negative battery bus for negative keying.

In case the transmitter is equipped with the two alarm relays (for supervision), they are located physically on the Keying Module and function as a power supply alarm and as a transmitter shift condition indicator.

ADJUSTMENTS

Factory Adjustments

The following adjustments have been made at the factory before shipment to the customer.

1. Transmitter frequencies
2. Transmitter output level
3. 36 V supply voltage
4. 48 V supply voltage (if applicable)

Installation Adjustments

There are normally no adjustments to make at the time of installation. Nevertheless, an alignment procedure is given below in case the customer would like to check the transmitter before putting it into system operation.

Alignment Instruction

The test instruments recommended in LBI-18319, included in the model book, should be used - or their equivalent. All

modules should be plugged into the Transmitter Shelf Unit, unless otherwise specified.

Testing should proceed in the following manner:

A. Transmitter RF output must be terminated into a 50 ohm, 10 Watt, resistive load.

B. Check and adjust the supply voltages.

C. Check and adjust frequencies, including the keying operation.

D. Check and adjust the output levels.

A. Supply Voltages

1. When operating from 250 VDC source

a. Turn switch S1 on Regulator OFF. Turn switch S1 on Transmitter OFF.

b. Check connections from station battery to terminal board TA, including station ground for correct wiring and polarity. Ascertain that NO jumper exists between TA-3 and TA-4.

c. Pull the Power Auxiliary, Oscillator-Driver, Keying, and Filter Modules from the Transmitter Shelf.

130-Volt Test

d. Turn switch S1 on the Regulator ON. Measure the voltage between TA-2 (NEG) and TA-4 (POS). Should be approximately 130 Volts.

e. Turn switch S1 on the Regulator OFF.

f. Check the Power Auxiliary jumper arrangement. Jumper A should be connected to post E3, and jumper B to post E2.

g. Check the jumper arrangement on the Keying Module per following chart

JUMPER CHART

Keying Voltage	Keying Bus	Jumper		
		A to	B to	C to
48	POS	E2	E4	E3
48	NEG	E2	E5	E3
125	POS	E3	E4	E6
125	NEG	E3	E5	E6
250	POS	E1	E4	E6
250	NEG	E1	E5	E6

h. Reinsert the Power Auxiliary Module into Transmitter Shelf.

i. Turn 250 V Regulator and Transmitter switches ON.

j. Check the voltage across NEG battery (negative lead) and POS battery (positive lead) on the Power Auxiliary Module (PWR. AUX). Measurement reading should be approximately 130 Volts.

48 Volt Test

k. Measure the voltage across COM (negative lead) and +48 (positive lead) on the Power Auxiliary (PWR AUX) with a VOM. Voltage reading should be approximately 48 Volts. Reinsert all modules into the Transmitter Shelf. Adjust the voltage to 48 Volts with potentiometer R18 (+48 ADJ).

36 Volt Test

l. Measure the voltage across COM (negative lead) and +36 (positive lead) on the Power Amplifier/Regulator Module (PWR AMPL/REG) with a VOM. Adjust the voltage to 36 Volts with potentiometer R6 (+36 ADJ).

m. Check the same voltage across COM and +36 on the Keying Module and on the Oscillator-Driver Module (OSC DRV). The power ON lamp on the front panel should be illuminated.

n. The voltage test is now complete.

2. When operating from 125 VDC source.

a. Turn switch S1 on Transmitter OFF.

b. Check connections from station battery to terminal board TA, including station ground, for correct wiring and polarity. Ascertain that there is a jumper between TA-3 and TA-4.

c. Pull the Power Auxiliary, Oscillator-Driver, Keying, and Filter Modules from the Transmitter Shelf.

d. Check the Power Auxiliary jumper arrangement. Jumper A should be connected to post E3 and jumper B to post E2.

e. Check the jumper arrangement on the Keying Module per the Jumper chart previously given in section A1-g.

f. Reinsert the Power Auxiliary Module into the Transmitter Shelf.

g. Turn switch S1 ON.

h. Complete testing per sections A1-j,k,l, and m.

3. When operating from a 48 VDC source.

a. Turn switch S1 on the Transmitter OFF,

b. Check connections from station battery to terminal board TA, including station ground, for correct wiring and polarity. Ascertain that there is a jumper between TA-3 and TA-4.

c. Pull the Power Auxiliary and Keying Modules from the Transmitter Shelf.

d. Check the Power Auxiliary jumper arrangement. Jumper A should be connected to post E4 and jumper B to post E1.

e. Check the jumper arrangement on the Keying Module per the Jumper Chart in section A1-g.

f. Reinsert all modules into Transmitter Shelf.

g. Complete testing per section A1-l and m.

B. Frequency

1. Keying Module - Dry contact or Keying from Positive Bus.

a. Apply normally open, dry dedicated contact between terminal board terminals TA-5 and TA-6 for dry contact keying or between TA-6 and remote positive battery bus for positive keying. Note: Determine that no jumper exists between TA-5 and TA-6.

b. Switch the unit ON.

c. Connect a VOM across COM (negative lead) and EXALT (positive lead).

d. With contact open, the reading should be about 6 Volts.

e. Close the contact; the reading should be about 36 Volts.

2. Keying Module - Negative Bus Keying

a. Apply normally open, contact between terminal board terminal TA-7 and remote negative battery bus. Note: Determine that there is a jumper connected between TA-5 and TA-6.

b. Switch the unit ON.

c. Connect a VOM across COM (negative lead) and EXALT (positive lead).

d. With contact open, the reading should be about 6 Volts.

e. Close the contact; the reading should be about 36 Volts.

3. Oscillator-Driver Module.

a. Switch the unit OFF.

b. Connect a counter to J22 or J23.

c. Pull the Oscillator-Driver Module out of the Shelf and connect it to the Printed Circuit Board Extender Unit.

d. Make sure the correct pair of matched crystals is plugged in. Crystal socket XY1 holds the crystal with the frequency of 2000 kHz plus channel frequency, and XY2 holds the 2000.000 kHz crystal. The nominal frequency is the difference between the two crystal frequencies.

e. Check the Filter Module for the corresponding filter frequency; the nameplate shows the nominal frequency of the filter.

f. Turn the unit ON.

g. Set the transmitter on GUARD (high-shift) frequency (open contacts).

h. Use a tuning wand, from the accessory kit, to tune capacitor C3 until the exact frequency, 100 ± 3 Hz above nominal frequency is obtained. An increase in capacitance decreases the frequency.

i. Set the transmitter on TRIP (low-shift) frequency (closed contacts).

j. Tune capacitor C21 until the exact frequency, 100 ± 3 Hz below nominal frequency is obtained. An increase in capacitance decreases the frequency.

k. Check to see if the high-shift frequency is still correct - re-adjust if necessary.

C. Output Level

The output current may be monitored by placing an RF ammeter between J24A and J24B located on the front panel of the Shelf Unit.

1. Non-Exalt Operation

a. Switch transmitter OFF.

b. If the Oscillator-Driver Module was shipped from the factory with jumper A, connect it to post E2.

c. Connect a VTVM (ungrounded) across the 50 ohm, 10 Watt dummy load.

d. Switch transmitter ON.

e. Shift the transmitter to the high-shift frequency (open keying contact).

f. Adjust the output level with potentiometer R45 (LEVEL) on the OSC. DRV. Module. Turn clockwise for an increase in level. Use the following formula for determining output power:

$$P = V^2 \times 0.02$$

Where:
P=Power in Watts
V=VTVM reading in Volts
0.02 considers 50 ohm load.

A common output power level is from 1 to 10 Watts. One Watt corresponds to 7.1 VRMS and ten Watts corresponds to 22.5 VRMS.

g. Close the keying contact to shift the transmitter to the low-shift frequency.

h. The level reading should be approximately the same as for the high-shift condition.

2. Exalt Operation

a. Switch transmitter OFF.

b. Connect jumper A to post E1 on the OSC.DRV Module for exalt operation.

c. Proceed as for non-exalt operation, paragraphs 1.c - 1.g preceeding.

d. Adjust the output level with potentiometer R42 (EXALT) on the OSC.DRV. Module. Turn clockwise for an increase in level. The maximum output power is 10 Watts.

D. Conversion Adjustments

If it should become necessary to change the battery supply voltage or the channel frequency, the following instructions should be followed.

1. Change of Battery Voltage from 250V to 125V or 48V

a. Switch Transmitter and 250V Regulator OFF.

b. Refer to composite diagram 19D415899 in Model Instruction Book. Add jumper between TA-3 and TA-4.

c. Power Auxiliary Module: Refer to Jumper Chart on composite diagram 19D415899, Figure 2, Note 21.

d. Keying Module: Refer to notes on composite diagram 19D415899, Figure 1.

e. Always keep switch S1 on the 250V Regulator OFF when making these changes.

f. Test the unit as per the 48 Volt and 36 Volt Tests given previously in Section A2 and A3.

2. Change of Battery Voltage from 125V to 48V (or vice versa).

a. Turn Transmitter OFF.

b. Refer to notes on composite diagram 19D415899; change fuses.

c. Power Auxiliary Module: Refer to Jumper Chart on composite diagram 19D415899, Figure 1.

d. Keying Module: Refer to notes on composite diagram 19D415899, Figure 1.

e. Test the unit per the 36 Volt Tests given previously in Section A3.

3. Change in Channel Frequency.

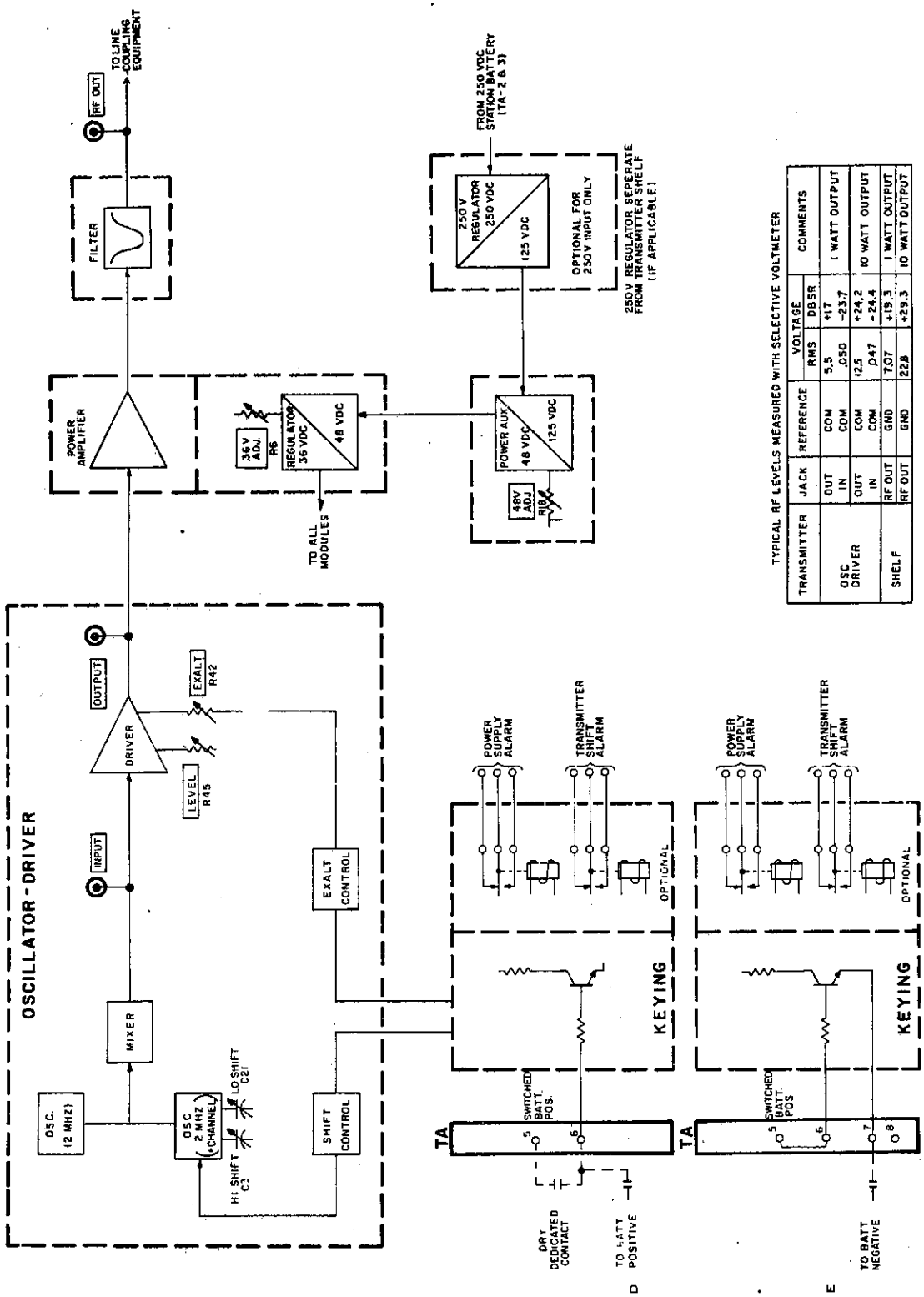
a. Refer back to the Frequency Section B-3a-c.

b. Exchange the matched pair of crystals in the OSC.DRV. Module with new ones of the desired frequency.

c. Exchange the bandpass filter in the Transmitter Filter Module with a new one for the corresponding frequency.

d. Test per referenced Frequency Section B-3f thru B-3k.

e. Re-adjust levels per referenced Output Level Section C1 or C2.



TYPICAL RF LEVELS MEASURED WITH SELECTIVE VOLTMETER

TRANSMITTER	JACK	REFERENCE	VOLTAGE RMS	VOLTAGE DBSR	COMMENTS
OSC DRIVER	OUT	COM	5.5	+17	1 WATT OUTPUT
	IN	COM	.050	-23.7	
	OUT	COM	12.5	+24.2	10 WATT OUTPUT
	IN	COM	.047	-24.4	
SHELF	RF OUT	GND	7.07	+19.3	1 WATT OUTPUT
	RF OUT	GND	22.8	+29.3	10 WATT OUTPUT

Figure A Simplified Block Diagram of Transmitter Equipment

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DESCRIPTION

TRANSMITTER SHELF UNIT
PL-19D415186-G1 and -G2

Introduction

The Transmitter Shelf Units, PL-19D415186-G1 and -G2 are a four rack unit (1 RU = 1 - 3/4 in.) shelf designed for mounting the various transmitter modules in a standard 19-inch wide rack or cabinet, and is 14.5 inches deep. Provisions are made for RF connections to be made from either the front or rear of the shelf. The shelf contains connectors for mounting five printed circuit type modules.

The -G1 Shelf is used with a 10-Watt Transmitter Equipment, and the -G2 Shelf is used with a 1-Watt Transmitter Equipment.

Description

The basic shelf unit contains connectors and interconnection wiring for the five transmitter modules. A "front panel" at the top front of the shelf is used to mount power switch S1, power ON lamp I1, fuses F1 and F2, RF coaxial connector J23 (BNC type), and output current monitoring jacks J24A and J24B. A "rear panel" at the top rear of the shelf is used to mount RF coaxial connector J22 (UHF type), 24-pin connector J21, and 8-pin connector J25. Printed wiring connectors (15-contacts) J1 thru J3 and J7 and J8 are covered at the rear of the shelf by a metal plate for protection of the wire-wrap terminals.

Connector J25 is used only when solid-state relays are mounted in the same rack as the transmitter. For this mode of operation, the transmitter keying circuits are brought through J25.

Fuses F1 and F2 are removable from the front of the unit. For 48 VDC operation, 1.0 ampere slow-blowing fuses should be used; for 125 VDC operation, 0.75 ampere slow-blowing fuses should be used.

The Shelf is key-slotted to restrict each module position and the modules are fitted with a lock to maintain position and contact with the Shelf connectors. The Shelf weighs approximately 14 pounds, 2 ounces empty, and approximately 26 pounds, 1 ounce with the modules inserted.

PARTS LIST

TRANSMITTER SHELF UNIT
PL-19D415186-G1 and G2

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - - - FUSE - - - - - - - - - - - - - - -
F1 & F2	7487942-P4 or 7487942-P5	Cartridge, slow-blowing; 250 V, 3/4 A; sim Bussmann MDL 3/4 (-P4 for 125 VDC operation) or 250 V, 1A; sim Bussmann MDL 1 (for 48 VDC operation (-P5))
		- - - - - - - - - - - - - INDICATOR - - - - - - - - - - - - -
I1*	19C307037-P25	Lamp, incandescent; 55 V; 3 W; bulb size, T-3-1/4 sim GE Cat No. 1835
		- - - - - - - - - - - - - CONNECTORS - - - - - - - - - - - - -
J1 thru J3 & J7 & J8	19A116497-P1	15-contacts, one-part printed wiring; sim Elco Corp. Cat. No. 00-6021-015-955-004
J21	7775345-P53	24-contacts; sim Elco Corp. Cat. No. 01-2224-115-004-XXX
J22	2R22-P3	Coaxial; sim Signal Corps 50-239 or Amphenol 83-1R
J23	7776570-P17	Coaxial, bulkhead receptacle; Mil. No. UG-1094/U
J24A & J24B	4029842-P3	Binding post; sim Superior Electric Cat. No. DF30B, non-captive nut.
J25	7775345-P27	8-contacts; sim Elco Corp. Cat. No. 01-1108-106-004-100

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - PLUGS - - - - - - - - - - - - -
P21	7775345-P18	24-contacts; sim Elco Corp. Cat. No. 01-4224-105-001-100
P22	2R22-P1	Coaxial; sim Signal Corps PL-259 or Amphenol 83-1SP
P23	7776570-P1	Coaxial, cable; Mil. No. UG-88C/U or UG-88D/U
		- - - - - - - - - - - - - SWITCH - - - - - - - - - - - - -
S1	5492177-P2	Toggle; DPST; sim Arrow-Hart & Hedgeman 82143-VLS; 6A at 250 V
		- - - - - - - - - - - - FUSE HOLDER - - - - - - - - - - - -
XF1 &	19B209005-P1	Post type; 15A at 250 V; sim to Littlefuse 342012
		- - - - - - - - - - - - LAMP HOLDER - - - - - - - - - - - -
XI1*	7141855-P15	Black phenolic; sim Dialight Co. Piece No. 95-0410-09-102, with Dialight Co. Piece No. 95-0931 white lens.

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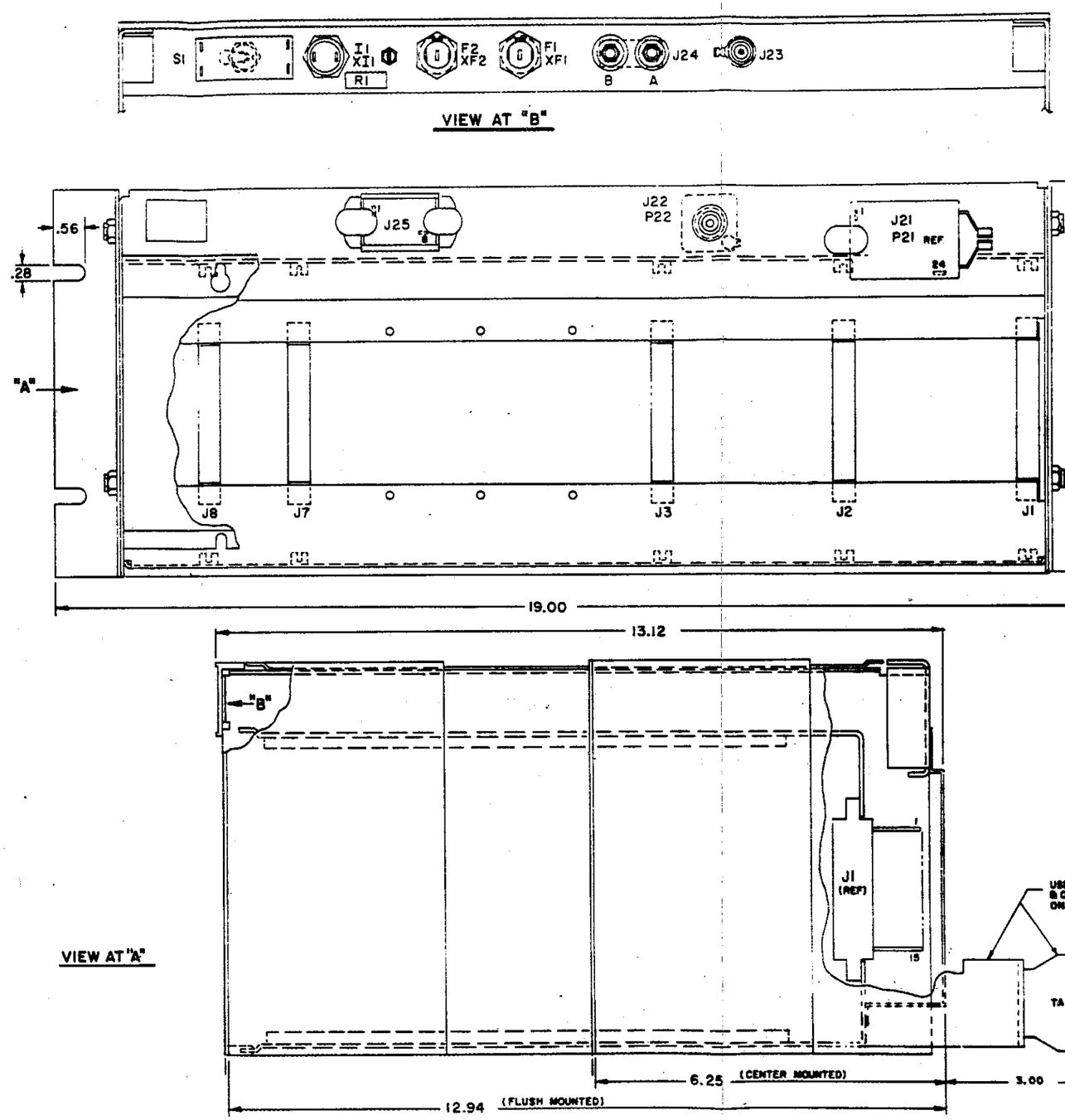
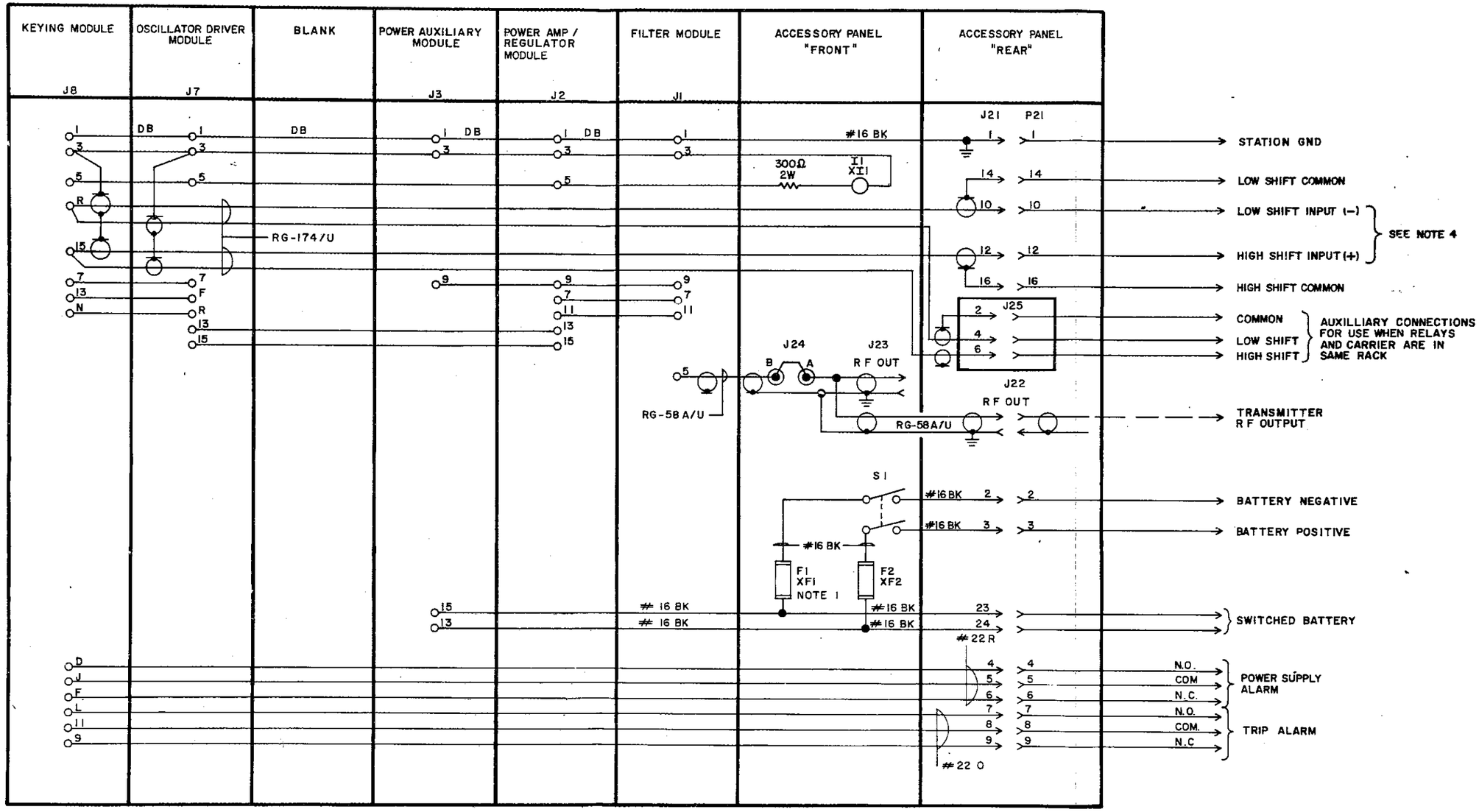


Pictorial/Outline

TRANSMITTER SHELF UNIT
PL-19D415186 -G1

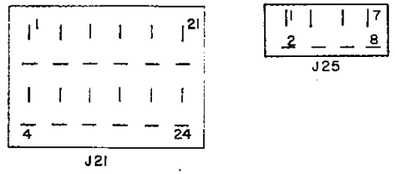
(19D415230, Rev. 1)



NOTES:

1. F1 & F2 CURRENT RATINGS ARE AS FOLLOWS:
   125 VDC BATTERY SOURCE, F1 & F2 ARE 0.75 AMP
   48 VDC BATTERY SOURCE, F1 & F2 ARE 1.0 AMP
2. ALL FACTORY WIRING TO BE #22 WHITE AWG, UNLESS OTHERWISE SPECIFIED.
3. DOTTED CONNECTIONS TO BE MADE BY PURCHASER.
4. POLARITIES APPLY FOR 48V OR 125V KEYING.
5. FOR CONNECTOR PIN LAYOUT AS SEEN FROM REAR SEE DETAIL "A".
6. MODULE ARRANGEMENT AS SEEN FROM REAR.

DETAIL "A"



Interconnection Diagram

TRANSMITTER SHELF
PL-19D415186-G1

(19D415142, Rev. 1)

TRANSMITTER FILTER MODULE
PL-19D415015-G1

INTRODUCTION

The Transmitter Filter Module is used to suppress harmonics of the transmitter output signal. In addition, the filter input transformer serves as the output transformer for the Class "B" power amplifier.

The module consists of a printed circuit board, and its components, which plugs into a 15-pin connector mounted in the Transmitter Shelf Unit.

DESCRIPTION

The module contains a power filter with screw-type connections to facilitate transmitter frequency changes. In addition to the power filter, there are three capacitors and an inductor that are used to decouple the transmitter DC power from the Class "B" power amplifier distortion products. Two diodes are also provided to prevent reflected voltages at the filter from reaching the associated power amplifier transistors. A surge protector is used to limit voltage spikes on the transmitter output to approximately 90V, thereby protecting the filter.

Should it be desired to change transmitter frequencies, refer to the System Alignment and Test Procedure instruction, included in the model book, for the section on filter nomenclature versus frequency.

TROUBLE-SHOOTING AIDS

Refer to the transmitter composite drawing for the electrical connections on this module. Should a filter module be suspected of being faulty, the following filter check can be made by using the suggested test circuit shown in Figure 1.

When driving the normal transmitter frequency into terminals 3 and 4 on the filter, as shown in Figure 1, the meter reading on M2 should be approximately 6dB lower than the reading on meter M1. Connecting the input to terminals 2 and 3 should produce approximately the same signal level reading on M2 as measured previously.

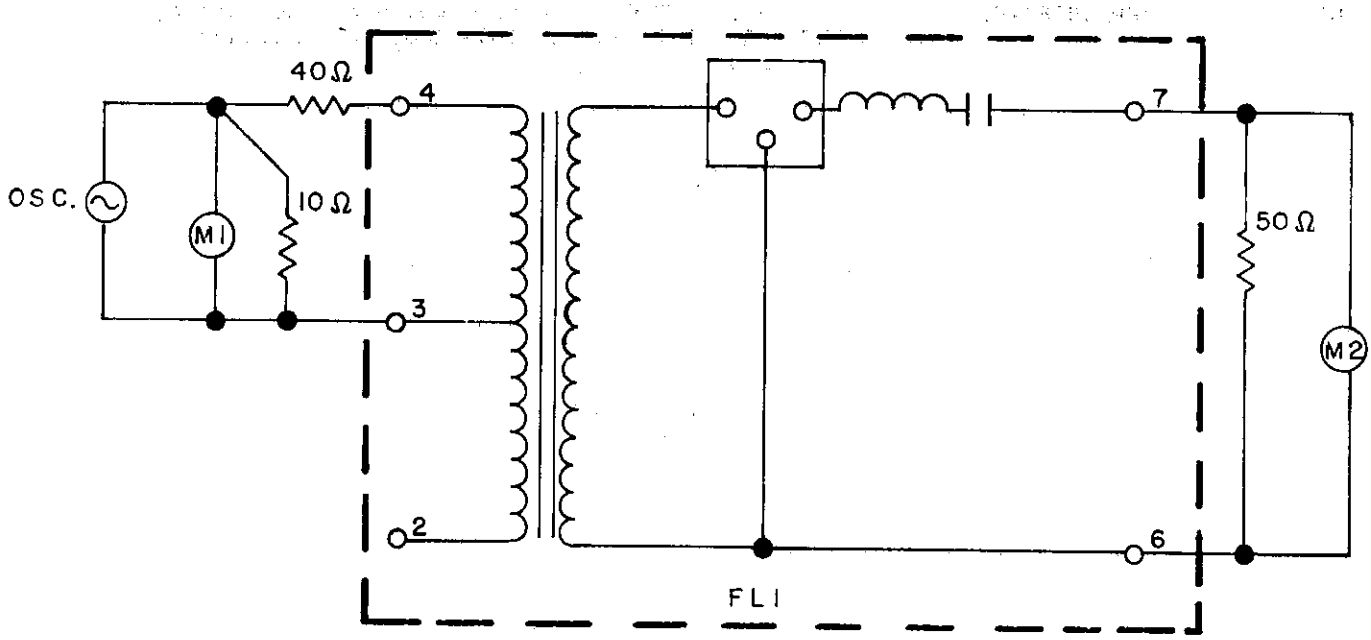


Figure 1 Transmitter Filter Test Circuit

PARTS LIST

TRANSMITTER FILTER MODULE
PL-19D415015-G1

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - CAPACITORS - - - - - - - - - - - - -
C1 & C2	7489162-P35	Silver mica: 220 μμf ±5%, 500 VDCW; sim Electromotive DM-15
C3	19B200230-P20	Metallized polyester: 5 μf ±20%, 200 VDCW; sim Good-All type X663FR.
		- - - - - - - - - - - - - - DIODES - - - - - - - - - - - - - -
CR1 & CR2	19A116565-P2	Silicon, rectifier, hermetically sealed; sim Sem-Tech SC6 or Type IN4005
		- - - - - - - - - - - - - PROTECTOR - - - - - - - - - - - - -
E1	19A115751-P2	Telephone; sim Siemens and Halske Code No. B1-F90
		- - - - - - - - - - - - - - FILTER - - - - - - - - - - - - - -
FL1*	19C304694	Transmitter, power
		- - - - - - - - - - - - - - INDUCTOR - - - - - - - - - - - - - -
L1	19B209166-P1	Reactor; 50 VDC, operating voltage; inductance, IMH ±10% at 1 KHz and 0.5 VRMS; DC resistance, 0.5 ohms max.

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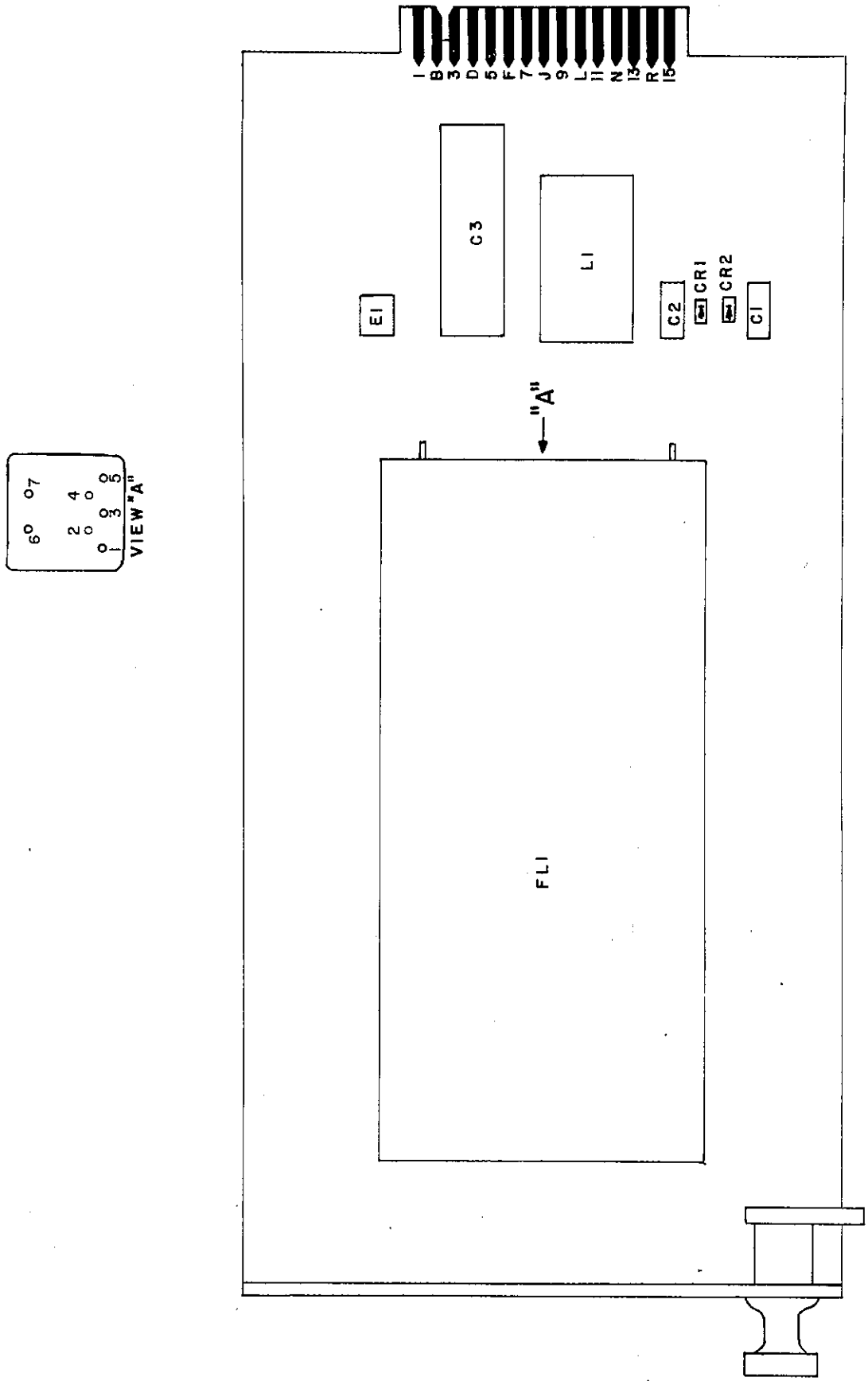

Parts Layout Diagram

FILTER MODULE
PL-19D415015 -G1

(19C318388, Rev. 1)

DESCRIPTION

POWER AMPLIFIER/REGULATOR MODULE
PL-19D415144-G1 and -G2

Introduction

The Power Amplifier/Regulator Module, PL-19D415144-G1, and -G2 serves as the source of 36 VDC voltage for the associated Oscillator-Driver and Keying Modules. The -G1 module also accommodates a 10-Watt RF power amplifier and the -G2 module contains a 1-Watt amplifier. The printed circuit board module plugs into a 15-pin connector in the Transmitter Shelf Unit.

Operation

The Power amplifier transistors Q1 and Q2 form a Class "B" Power Amplifier, when connected to the associated Transmitter Filter Module.

A series regulator circuit, consisting of transistors Q3 and Q4, voltage regulating Zener diode VR1, and resistors R3 through R9, converts the unregulated 48 VDC input (in 48 volt battery applications), or the Power Auxiliary Module 48 VDC output, to a regulated +36 VDC. Reactor L1 and capacitor C1 provide filtering of the 48 volt ripple voltage. Capacitors C2 and C3 provide additional filtering and surge protection for the +36 VDC circuits. Potentiometer R6 provides a limited level control of the +36 VDC output from the front panel of the module.

Trouble-Shooting Aids

Refer to the transmitter composite drawing (figure 2), included in the model book, for the electrical connections on this module. Should a Power Amplifier/Regulator Module be suspected of being faulty, the module may be inserted into an Extender Card (part of the optional Extender Test Kit) and the test voltages listed in Table 1 may be monitored to assist in isolating the problem. All DC voltages should be measured on a meter having at least a 20,000 ohms per volt input impedance. DC voltages should be checked on transistors Q3 and Q4, if the 36 VDC regulated voltage is abnormal. Problems involving the power amplifier output may require checking the DC bias on transistors Q1 and Q2.

To measure the values given in Table 1, remove crystals Y1 and Y2 from the associated Oscillator-Driver Module. This will remove the amplifier drive and will present a static DC condition to transistors Q1 and Q2. Under normal 10-watt (-G1) or 1-watt (-G2) output drive conditions, the AC voltage across resistors R1 and R2 should be equal and should be approximately 1.4 VRMS when measured on a VTVM.

TABLE 1

(All DC voltages referenced to J3 (com. neg.))

Transistor	Base VDC	Collector VDC	Emitter VDC
Q1	0	48 (-G1), 36 (-G2)	0
Q2	0	48 (-G1), 36 (-G2)	0
Q3	36.5	48	36
Q4	15.5	36.5	15

Nominal Operating Characteristics

DC Inputs

Regulator (-G1) Power Amplifier	48VDC @ 400 mA 48VDC @ 300 mA (max)
(-G2) Power Amplifier	36VDC @ 250 mA (max)

DC Output

Regulator	36VDC @ 380 mA

PARTS LIST

POWER AMPLIFIER/REGULATOR MODULE
PL-19D415144-G1
PL-19D415144-G2, REV. B

Symbol	GE Part No.	Description
		- - - - - - - - - -CAPACITORS - - - - - - - - - -
C1 & C2	7491930-P13	Mylar: 1 µf ±20%, 100 VDCW; sim GE Type 61F
C3	19A115680-P6	Electrolytic: 50 µf -10% +150%; 50 VDCW; sim Mallory TTX
C4* & C5	7489162-P27	Silver Mica; 100 pfd ±5%, 500 VDCW Used in -G2 only

Symbol	GE Part No.	Description
		- - - - - - - - - - -DIODES - - - - - - - - - - -
CR1 & CR2	19A116565-P2	Silicon, rectifier; sim Sem-Tech SC-6 or Type 1N4005
		- - - - - - - - - - - JACKS - - - - - - - - - - -
J1 & J3	7150763-P4	Test point; sim Alden 110 BC1-green
J2 & J4	7150763-P2	Test point; sim Alden 110 BC1-red
		- - - - - - - - - - -REACTOR - - - - - - - - - - -
L1	19B209345-P1	DC resistance, 0.5 ohms max; operating voltage, 15 VDC; inductance, 20 mH at 0.73 amp DC.
		- - - - - - - - - -TRANSISTORS - - - - - - - - - -
Q1 & Q2	19A115924-P1	Silicon, NPN; sim Delco DTS-413 or Type 2N3902. Used in -G1 only.
Q1* & Q2*	19A115527-P2	Silicon, NPN; sim Type 2N3879. Used in -G2 only.
Q3 *	19A116315-P1	Silicon, High speed switch, NPN; sim Type 2N4347.
Q4	19A115783-P1	Silicon, NPN; sim Type 2N4240
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1 & R2	19B209022-P32	Wirewound: 5.1 ohms ±5%, 2 W; sim 1RC Type BWH Used in -G1 only
R1* & R2*	3R78-P200J	Composition; 20 ohms ±5%, 1 W. Used in -G2 only.
R3	19A116278-P245	Metal film: 2.87 K ohms ±2%, 1/2 W; sim Corning Stype C5M
R4	19A116278-P253	Metal film: 3.48 K ohms ±2%, 1/2 W; sim Corning Style C5M
R5	19A116278-P237	Metal film; 2.37 K ohms ±2%, 1/2 W; sim Corning Style C5M
R6	19A116430-P7	Variable, Cermet; 5 K ohms ±10%, 0.75 W; sim Helitrim Model 79P
R7	3R77-P472-J	Fixed composition: 4.7 K ohms ±5%, 1/2 W
R8	19B209022-P107	Wirewound: 0.47 ohms ±10%, 2 W; sim 1RC Type BWH
R9	3R78-P821J	Fixed composition: 820 ohms ±5%, 1 W
		- - - - - - - - VOLTAGE REGULATOR - - - - - - - -
VR1	19A115528-P6	Diode, Zener; sim Type 1N3025A
VR2* & VR3*	19A115468-P1	Diode, Zener; sim Type 1N1372. Used in -G2 only.

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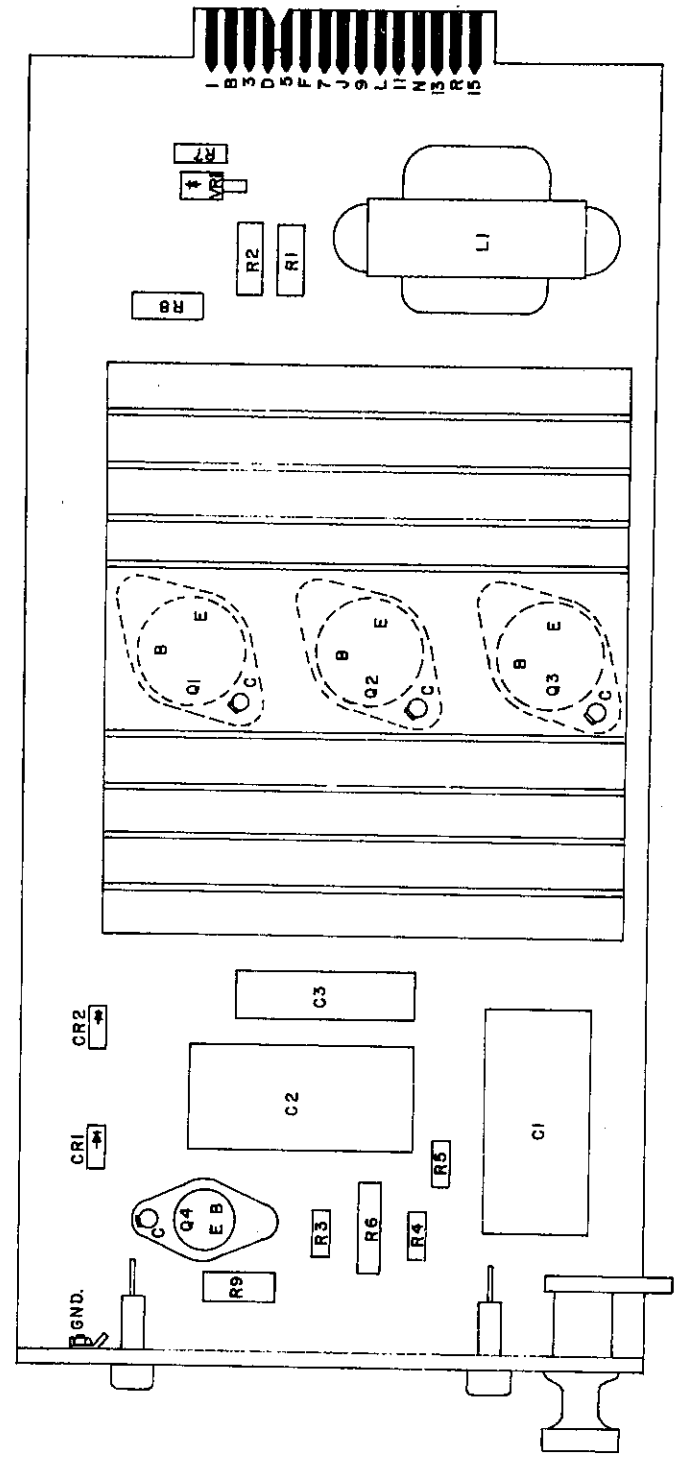

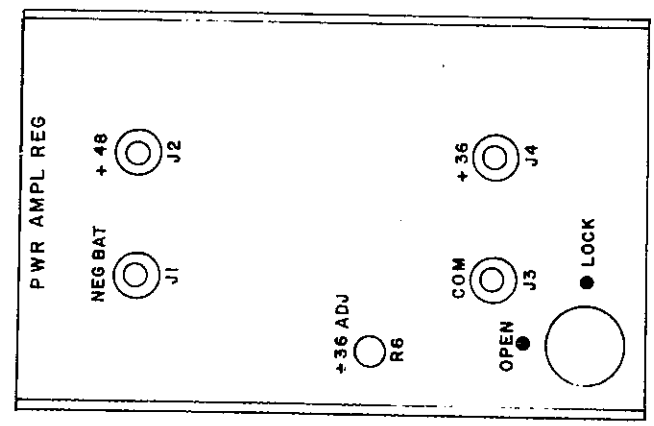

Parts Layout Diagram

POWER AMPLIFIER REGULATOR MODULE
PL-19D415144-G1

(19C318389, Rev. 0)

PRODUCTION CHANGES

POWER AMPLIFIER/REGULATOR MODULE
PL-19D415144

The revisions listed below can be identified by the revision letter appearing on the equipment nameplate.

PL-19D415144-G2, Rev. A

Purpose: To improve electrical contact to the power transistors.

Part Changed	Was	Changed To:
---	---	The mounting of Q1, Q2, and Q3 was changed.

PL-19D415144-G2, Rev. B

Purpose: To prevent spurious oscillation.

Part Changed	Was	Changed To:
C4 & C5	---	Add capacitor C4 across Zener diode VR2 and C5 across VR3. GE Part No. 7489162-P27; Silver mica, 100 pfd ±5%, 500 VDCW.

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GENERAL ELECTRIC COMPANY
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DESCRIPTION

OSCILLATOR-DRIVER MODULE
PL-19D415172-G5 and -G10

Introduction

The Oscillator-Driver Modules (OSC-DRV), PL-19D415172-G5 and -G10, are used in a 2-frequency shift transmitter, such as the Type CT-51B. Each module consists of two parts, the Oscillator Subassembly, PL-19D415162-G5, and the driver section. The Oscillator Subassembly generates the channel frequency which can be shifted ±100 Hz by means of an associated Keying Module. The driver section is capable of amplifying the oscillator signal which, in turn, drives an associated Power Amplifier.

In the -G5 module, the gain can be exalted at the same time as the frequency is shifted to 100 Hz below nominal frequency by the associated Keying Module.

In the -G10 module, this level exalting feature is not available. In -G5, jumper "A" is connected to electrical contact E1 for exalt or to E2 for non-exalt operation.

The modules are printed circuit cards which are plugged into a 15-pin connector mounted on a Shelf Unit.

Operation

Refer to the Elementary Diagram as shown in Figure 1 which is included in the Model Instruction Book.

The Oscillator Subassembly consists of two identical transistor stages, a diode mixer stage and a low-pass filter. Each transistor stage consists of a transistor, crystal, and associated components.

The stage containing transistor Q2 generates an oscillation whose frequency of 2 MHz plus channel frequency is determined by crystal Y2 and capacitors C12 and C13.

The stage containing transistor Q1 generates a signal whose frequency is 2 MHz, which is determined by crystal Y1 and capacitors C2 and C3.

Both signals (2 MHz and 2 MHz + channel frequency) are injected into the forward biased diode CR1 which serves as a mixer. The low-pass filters consisting of capacitors C10, and C15 and Coil L1, has a roll-off frequency of about 400 kHz; consequently, the higher frequencies, in particular the 2 MHz oscillation, are cut off. Thus the resulting frequency is 100 Hz above the nominal or channel frequency (can be accurately tuned with capacitor C3). Since the capacitance of C2 and C3 takes part in determining the frequency, it is therefore possible to get a frequency-shift by paralleling capacitance, as is being done in this circuit.

If +6V is applied to terminal 1 (C18), the diode CR2 becomes conductive and forms a path through capacitors C20 and C21 to common negative (COM). Capacitor C21 then allows fine tuning of the frequency to 100 Hz below the channel frequency. (Note that the appropriate DC voltages are applied through the associated Keying Module.) Since the amplitude of the transistor Q1 stage may be varying with frequency shifting, the amplitude is kept much greater than the amplitude from the transistor Q2 stage. After mixing the two signals, the smaller signal dominates. Thus the output signal level is kept fairly constant while shifting the signal. The coil L2 presents a very high impedance at 2 MHz to keep the frequency from being impaired from the Keying Module.

The variable capacitors and crystals can be reached by pulling out the printed circuit card or module from the Shelf Unit. Note that the crystals come as matched pairs. Crystal Y1 will be stamped "A" 2000.000 kHz. Crystal Y2 will be stamped "B" 2 ---, --- kHz (2 MHz plus channel frequency, as specified by the customer).

The driver section is divided into two parts; first, a DC-coupled 2-stage amplifier, and, second, two transistor stages. The DC-coupled 2-stage amplifier, consisting of transistors Q41 and Q42, with variable gain, increases the low voltage signal from the Oscillator Subassembly. The gain can be adjusted with potentiometer R45 (LEVEL). If as in -G5, jumper "A" is connected to electrical contact E1 and the associated Keying Module applies +36 VDC on pin 7 (which will be the case at low-shift frequency), transistor Q43 is turned ON, thus making potentiometer R42 (EXALT) operative. Hence, the gain is now adjustable by potentiometer R42.

Following the amplifier are the two transistor stages. Transistor Q45 matches the impedances between transistors Q42 and Q44. Transistor Q44 is a medium power type and drives with its collector lead into transformer T1. The feedback in the emitter lead limits DC as well as AC collector current. The transformer secondary side, with center tap to common negative is used to drive the push-pull power amplifier. Both potentiometers, R42 and R45, are adjusted through an opening on the front panel. Jumper "A", can be reached by pulling out the printed circuit card from the Shelf Unit.

Trouble-Shooting Aids

All DC voltages given in Table 1 below are measured with a VOM (20K ohms/V) and with reference to common negative.

All AC voltages given in Table 2 below are measured with a VTVM having at lease 1M ohm input impedance and with reference to common negative. The values given should be considered as typical only.

All tests should be made with the module interconnected to the associate modules; therefore, an Extender Unit is recommended.

TABLE 1

OSCILLATOR SUBASSEMBLY - with crystals removed

Condition	Circuit Component	Emitter VDC	Base VDC	Collector VDC	Cathode VDC	Anode VDC
at High-Shift Frequency	Q1	11.0	11.3	22.0	-	-
	Q2	5.5	5.9	12.0	-	-
	VR1	-	-	-	36.0	21.2
	CR1	-	-	-	0.45	0.7
	CR2	-	-	-	33.0	21.3
at Low-Shift Frequency	CR2	-	-	-	21.0	21.5
			DRIVER SECTION			
at High-Shift Frequency	Q41	5.6	6.0	7.5	-	-
	Q42	6.8	7.5	15.2	-	-
	Q43	6.6	0	0	-	-
	Q44	7.7	8.2	36.0	-	-
	Q45	14.5	15.2	36.0	-	-
at Low- Shift Frequency	Q43	6.6	7.2	6.6	-	-
at any Frequency	VR41	-	-	-	6.6	0

TABLE 11

AC VOLTAGES - with crystals plugged in

Condition	Circuit Component	Emitter VRMS	Base VRMS	Collector VRMS
at High-Shift Freq. with R42 and R45 fully Counterclockwise	Q1	620 mV	670 mV	5 mV
	Q2	980 mV	1.4	7 mV
	Q41	46 mV	46 mV	1.7 mV
	Q42	-	1.7 mV	290 mV
	Q44	280 mV	290 mV	2.03
	Q45	290 mV	290 mV	2.03
at High-Shift Freq. with R45 fully clockwise	Q42	-	830 mV	6.0
	Q44	3.4	4.9	22.5

Nominal Operating Characteristics

Supply Voltage -	+36 VDC
Oscillator only -	+36 VDC
Current Drain -	100 mA
Oscillator only -	13 mA
Input Impedance (into driver stage Q41 with R42 and R45 fully counter-clockwise) -	25K ohms
Load Impedance (across Pin 13 to Pin 15) approx. -	150 ohms

PARTS LIST
OSCILLATOR-DRIVER MODULE
PL-19D415172-G5
PL-19D415172-G10, Rev. A

Symbol	GE Part No.	Description
		CAPACITORS
C41 *	19A116080-P11	Polyester; 0.47 µf ±20%, 50 VDCW. Used in -G5 only
C42	19A116080-P9	Polyester; 0.22 µf ±20%, 50 VDCW
C43 thru C45	19A116080-P11	Polyester; 0.47 µf ±20%, 50 VDCW (C44 used in -G5 only)
C46	5490008-P35	Silver mica; 220 pf ±5%, 500 VDCW
C47	4029003-P4	Silver mica; 680 µµf ±5%, 500 VDCW
C48	19A116080-P1	Polyester; 0.01 µf ±20%, 50 VDCW
C49	19A116080-P9	Polyester; 0.22 µf ±20%, 50 VDCW
C50 & C51	19A116080-P11	Polyester; 0.47 µf ±20%, 50 VDCW
		JACKS
J41	7150763-P6	Test point; sim Alden 110BC1-blue
J42	7150763-P8	Test point, sim Alden 110BC1-orange
J43	7150763-P2	Test point; sim Alden 110BC1-red
J44	7150763-P4	Test point; sim Alden 110BC1-green
		TRANSISTORS
Q41 thru Q43 *	19A115300-P1	Silicon, NPN; sim Type 2N3053 (Q43 used in -G5 only)
Q44 *	19A115527-P2	Silicon, NPN; sim Type RCA40250
Q45	19A115300-P1	Silicon, NPN; sim Type 2N3053
		RESISTORS
R41 *	19A1162780P273	Metal film; 5.62K ohms ±2%, 1/2 W Used in -G5 only.
R42 *	7475398-P73	Variable, composition; 4.7K ohms ±20%, 1.13 W; sim Allen Bradley Type J. Used in -G5 only

Symbol	GE Part No.	Description
R43	19A116278-P329	Metal film; 19.6K ohms ±2%, 1/2 W
R44	19A116278-P245	Metal film; 2.87K ohms ±2%, 1/2 W
R45	7475398-P73	Variable, composition; 4.7K ohms ±20%, 1.13 W; sim Allen Bradley Type J
R46	19A116278-P225	Metal film; 1.78K ohms ±2%, 1/2 W
R47	19A116278-P309	Metal film, 12.1K ohms ±2%, 1/2 W
R48	19A116278-P301	Metal film; 10.0K ohms ±2%, 1/2 W
R49	19A116278-P341	Metal film; 26.1K ohms ±2%, 1/2 W
R50	19A116278-P229	Metal film; 1.96K ohms ±2%, 1/2 W
R51	19A116278-P33	Metal film; 21.5 ohms ±2%, 1/2 W
R52	19A116278-P205	Metal film; 1.1K ohms ±2%, 1/2 W
R53	19A116278-P101	Metal film; 100 ohms ±2%, 1/2 W
R54	19A116278-P121	Metal film; 162 ohms ±2%, 1/2 W
R55 & R56	19A116278-P93	Metal film; 90.9 ohms ±2%, 1/2 W
R57 *	19A116278-P393	Metal film; 90.9K ohms ±2%, 1/2 W; Used in -G5 only
R58	19A1162780P229	Metal film; 1.96K ohms ±2%, 1/2 W
R59	19A116278-P169	Metal film; 511 ohms ±2%, 1/2 W
R60	19A116278-P101	Metal film; 100 ohms ±2%, 1/2 W
R61	19A116278-P121	Metal film; 162 ohms ±2%, 1/2 W
R62	19A116278-P309	Metal film; 12.1K ohms ±2%, 1/2 W
R63	19A116278-P193	Metal film; 909 ohms ±2%, 1/2 W
		- - - - - - - - - - - - - TRANSFORMER - - - - - - - - - - - - -
T1	PL-19B207872-G3	Center tapped secondary; input impedance, primary, 500 ohms; output impedance, secondary, 100 ohms; insertion loss, less than 0.5 dB; max, input signal, +15 dBm
		- - - - - - - - - - - - VOLTAGE REGULATOR - - - - - - - - - - - -
VR41*	4036887-P6	Silicon, Zener diode; sim Type 1N753A. Used in -G5 only

OSCILLATOR SUBASSEMBLY
PL-19D415162-G5

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - CAPACITORS - - - - - - - - - - - - -
C1	19A116080-P8	Polyester; 0.15 µf ±20%, 50 VDCW
C2	5490008-P8	Silver mica; 15 pf ±5%, 500 VDCW
C3	5491271-P103	Variable, air, sub-miniature; 1.7 pf min and 8.3 pf max at 1 MHz; peak voltage, 750 V; air gap, 0.010 in.; sim EF Johnson 189-503-5 or Erie 542-001

Symbol	GE Part No.	Description
C4	4029003-P20	Silver mica; 3300 pf ±5%, 500 VDCW
C5	5490008-P29	Silver mica; 120 pf ±5%, 500 VDCW
C6	19A116080-P1	Polyester; 0.01 µf ±20%, 50 VDCW
C7	5490008-P27	Silver mica; 100 pf ±5%, 500 VDCW
C8 & C9	19A116080-P1	Polyester; 0.01 µf ±20%, 50 VDCW
C10	5490008-P41	Silver mica; 390 pf ±5%, 500 VDCW
C11	4029003-P16	Silver mica; 2200 µµf ±5%, 500 VDCW
C12	5490008-P8	Silver mica; 15 pf ±5%, 500 VDCW
C13	5490008-P11	Silver mica; 22 pf ±5%, 500 VDCW
C14	19A116080-P8	Polyester; 0.15 µf ±20%, 50 VDCW
C15	5490008-P41	Silver mica; 390 pf ±5%, 500 VDCW
C16 thru C18	5493392-P7	Ceramic; 1000 µµf -0%, +100%, 500 VDCW; sim Allen Bradley Type FA5C
C19	19A116080-P1	Polyester; 0.01 µf ±20%, 50 VDCW
C20	5490008-P11	Silver mica; 22 pf ±5%, 500 VDCW
C21	5491271-P108	Variable, air, sub-miniature; 2.4 pf min. and 17.4 pf max. at 1 MHz; peak voltage, 750 V; air gap 0.010 in.; sim E.F. Johnson 189-507-5 or Erie 546-001
		- - - - - - - - - - - - - - - DIODES - - - - - - - - - - - - -
CR1 & CR2	19A115250-P1	Silicon, fast recovery; sim Type 1N4305 or GE Type SSD-753
		- - - - - - - - - - - - - - - COILS - - - - - - - - - - - - - -
L1	7491382-P107	RF; 1000 µH ±10%, 185 ma; 14 ohms max resistance, sim Delevan 3500 series
L2	7491382-P107	RF; 1000 µH ±10%, 185 ma; 14 ohms max. resistance; sim Delevan 3500 series
		- - - - - - - - - - - - - - - TRANSISTORS - - - - - - - - - - - -
Q1 & Q2	19C300114-P2	Silicon, NPN; sim Type 2N706
		- - - - - - - - - - - - - - - RESISTORS - - - - - - - - - - - -
R1	19A116278-P257	Metal film; 3.83K ohms ±2%, 1/2 W

Symbol	GE Part No.	Description
R2 & R3	19A116278-P309	Metal film; 3.83K ohms ±2%, 1/2 W
R4	19A116278-P257	Metal film; 3.83K ohms ±2%, 1/2 W
R5	19A116278-P201	Metal film; 1K ohms ±2%, 1/2 W
R6	3R77-P154J	Fixed composition; 150K ohms ±5%, 1/2 W
R7	19A116278-P229	Metal film; 1.96K ohms ±2%, 1/2 W
R8	19A116278-P269	Metal film; 5.11K ohms ±2%, 1/2 W
R9	19A116278-P257	Metal film; 3.83K ohms ±2%, 1/2 W
R10 & R11	19A116278-P309	Metal film; 12.1K ohms ±2%, 1/2 W
R12	19A116278-P229	Metal film; 1.96K ohms ±2%, 1/2 W
R13	19A116278-P309	Metal film; 12.1K ohms ±2%, 1/2 W
R14	19A116278-P257	Metal film; 3.83K ohms ±2%, 1/2 W
R15	19A116278-P237	Metal film; 2.37K ohms ±2%, 1/2 W
R16	19A116278-P393	Metal film; 90.9K ohms ±2%, 1/2 W
		- - - - - - - - - - VOLTAGE REGULATOR - - - - - - - - - -
VR1	4036887-P12	Silicon, Zener; sim Type 1N5245B
		- - - - - - - - - - - - - - SOCKETS - - - - - - - - - - - - - -
XY1 & XY2	19B201742-P1	Crystal; vertical mounting; sim Augat 8000-AG6-1
		- - - - - - - - - - - - - - CRYSTALS - - - - - - - - - - - - - -
Y1 & Y2	4031095-P1	Quartz, matched pair; Y2 will be 2000 kHz plus the channel frequency. Customer must specify the channel frequency, and the envelope will be stamped with the letter "B"; Y1 will be 2000 kHz and the envelope will be stamped with the letter "A". Each matched pair will have the same serial number.

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PRODUCTION CHANGES

OSCILLATOR DRIVER MODULE
PL-19D415172-G1 thru -G10

The revisions listed below can be identified by the revision letter appearing on the equipment nameplate.

PL-19D415172-G1 thru -G10, Rev. A

Purpose: A. To delete unused parts in -G6 thru -G10
B. To change transistor lead length in -G1 thru -G10

	Part Changed	Was	Changed To
A.	C41	19A116080-P11	Delete
	C44	19A116080-P11	Delete
	Q43	19A115300-P1	Delete
	R41	19A116278-P273	Delete
	R42	7475398-P73	Delete
	R57	19A116278-P393	Delete
	VR41	4036887-P6	Delete
B.	Q44	19A115527-P1	19A115527-P2

PL-19D415172-G5 and -G10, Rev. B

Purpose: To insure tuning range

Part Changed	Was	Changed To
Oscillator	PL-19D415162-G5	PL-19D415162-G5, Rev.A
C2	5490008-P8	5490008-P1 (5pf)
C10	5490008-P41	5490008-P43 (470pf)
C12	5490008-P8	5490008-P1 (5pf)
C15	5490008-P41	5490008-P43 (470pf)
C20	5490008-P11	5490008-P8 (15pf)
C22	----------	Add 5490008-P2 (Silver mica, 6pf ±5%, 500 VDCW)
L1	7491382-P107	7491382-P106 (680μH ±10%, 12 ohms, 205 mA)
R1	19A116278-P257	19A116278-P249 (3.16K ohms)
R6	3R77-P154J	19A116278-P373 (Metal film, 56.2K ohms ±2%, 1/2 W)
R7	19A116278-P229	19A116278-P201 (1.0K ohms)

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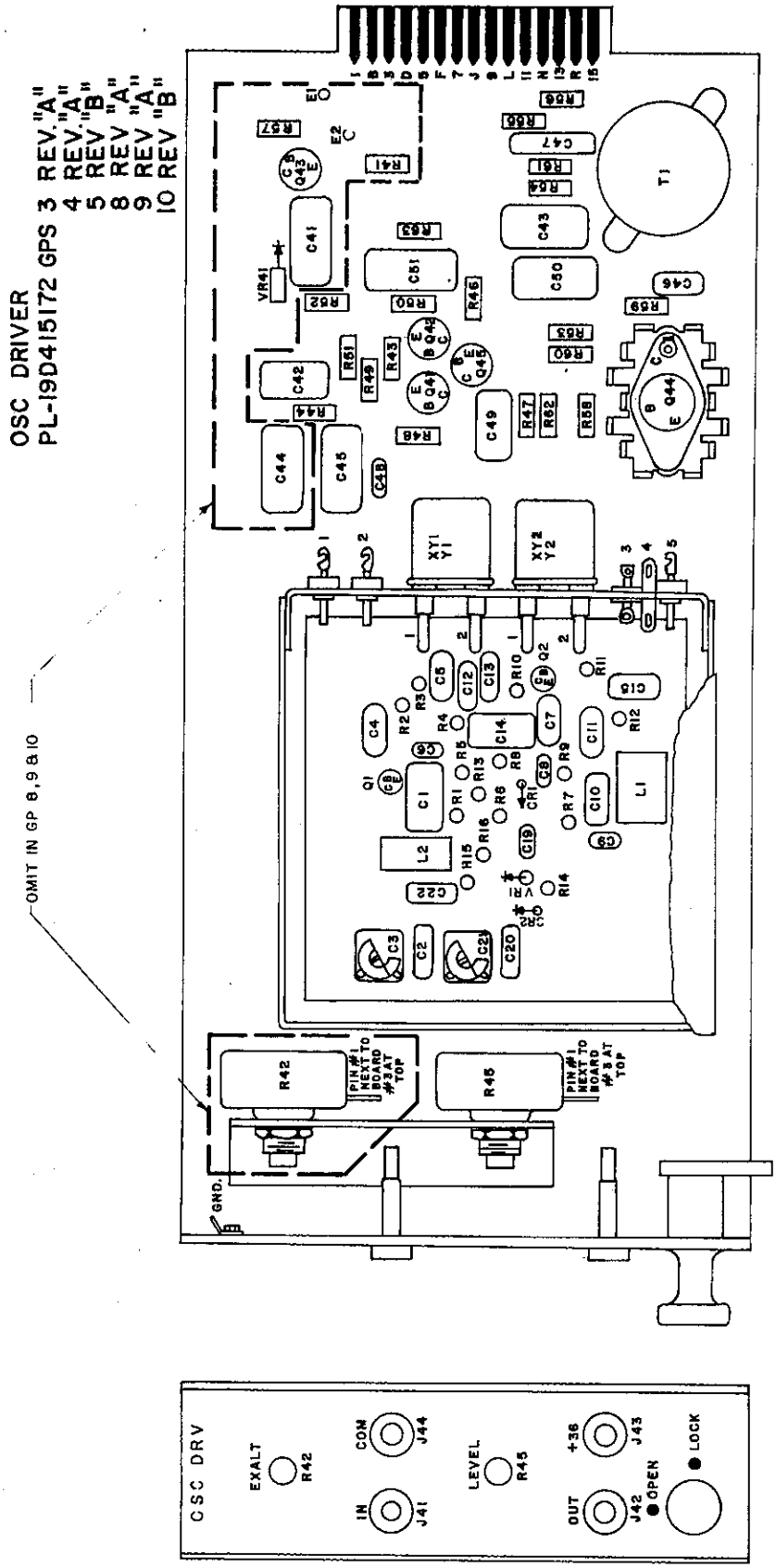

Parts Layout Diagram

OSCILATOR-DRIVER MODULE
PL-19D415172-G3, -G4, -G5,
-G8, -G9 & -G10

(19C318395, Rev. 2)

DESCRIPTION

KEYING MODULE
PL-19D415815-G1 thru -G12

Introduction

The Keying Modules, PL-19D415815-G1 through -G12 are used in a 2-frequency-shift transmitter. Their purpose is to detect the input shift signal and to derive from it the appropriate keying voltages for the frequency-shift oscillator and the exalt circuit. The modules are printed circuit cards which are plugged into a redundant 15-pin connector mounted in the rear of the Shelf Unit.

The modules are designed to work from 48, 125, or 250 VDC and from a positive or negative bus, dependant upon jumper positions. Two alarm relay circuits (trip alarm and loss of power alarm) are present in the even numbered groups (-G2, -G4, -G6, -G8, -G10 and -G12).

Modules can be converted from a particular keying voltage and polarity to the other voltage and polarity functions by changing jumper positions. The exception is that a 48 or 125 volt unit cannot be converted for 250 volt keying because of the additional resistors which are required.

Table 1 shows the functions and jumper positions per group designations.

TABLE 1

Group Number	Keying Voltage	Keying Bus	Jumper Positions		
			A to	B to	C to
1 or 2	48	Positive	E2	E4	E3
3 or 4	250	Positive	E1	E4	E6
5 or 6	48	Negative	E2	E5	E3
7 or 8	125	Positive	E3	E4	E6
9 or 10	125	Negative	E3	E5	E6
11 or 12	250	Negative	E1	E5	E6

Operation

Refer to the Elementary Diagram as shown in Figure 1 which is included in the Model Instruction Book.

The proper keying voltage is applied between pin 15 (+) and pin 3 (-) for positive bus keying or between pin 15 (+) and pin R (-) for negative bus keying. The keying voltage is divided through the correct series resistor combination to the base-emitter jumction of transistor Q1. When Q1 is turned ON, Q2 is biased OFF. With Q2 OFF, Q3 is allowed to be biased ON. Turning ON transistor Q3 causes the crystal oscillator, located on the Oscillator-Driver Module, to shift to TRIP frequency. In addition, alarm relay K1 is picked up in the applicable groups. This relay provides form C contacts for TRIP indications. Transistor Q4 is biased ON, as a result of Q3 conducting, which provides +36 VDC as an output for the exalt circuit which is located on the Oscillator-Driver Module.

Zener diode VR2 forms, together with resistors R7 and R8 and transistor Q1, a threshold detector. That is, the shift input voltage has to rise above a certain minimum level before Zener diode VR2 starts to conduct, which turns ON transistor Q1. This threshold detector, in conjunction with capacitor C1, makes the keying circuit highly secure against false keying due to surge voltages which might be applied to the shift input.

Zener diode VR1 protects the input circuit against accidentally applied overvoltages.

Relay K2, which is used in -G2, -G4, -G6, -G8, -G10 and -G12, serves as a power supply alarm indicator. Relay K2 stays picked-up as long as the 36 V power supply is operating. Zener diode VR3 is used to insure that relay K2 will drop out when the supply voltage drops below 13 V (approx.).

Trouble-Shooting Aids

The voltages given in Table 2 are typical readings, as measured with a 20 K ohms per volt DC meter. Reference Q1 to jumper C connection and reference Q2, Q3, and Q4 to common negative. The voltages are of positive polarity and were measured with the module plugged into the Shelf Unit

If the module has to be tested separately, outside the Shelf, connect a 6.2 K ohm, 1/2 Watt resistor from pin 7 to common negative, and a 5.1 K ohm, 1/2 Watt resistor from pin N to the +36 V supply.

TABLE 2

Condition	Transistor	Emitter VDC	Base VDC	Collector VDC
No keying voltage applied	Q1	0	0	11
	Q2	0	0.7	0
	Q3	0	0	36
	Q4	36	36	0
With applicable keying voltage applied	Q1	0	0.7	0
	Q2	0	0	0.7
	Q3	0	0.7	0.1
	Q4	36	35.5	36

Nominal Operating Characteristics

Supply Voltage	+36 VDC		
Current Drain	20 mA, max.		
Shift Input Voltage	48 VDC	125 VDC	250 VDC
Current	100 mA	60 mA	60 mA

PARTS LIST

KEYING MODULE
PL-19D415815-G1 thru -G12

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C1	19A116080-P7	Polyester; 0.1 µF ±20%, 50 VDCW
C2 thru C9	5490825-P4	Ceramic, disc; 6000 pF ±10%, 2000 VDC. Note: C4 thru C9 used in -G2, -G4, -G6, -G8, -G10, and -G12 only.
		- - - - - - - - - - DIODES - - - - - - - - - -
CR1	19A116565-P2	Silicon, rectifier; sim Type 1N4005 or Sem Tech SC6.
CR2	19A115250-P1	Silicon, fast recovery; sim Type 1N4305 or GE Type SSD-753. Used in -G2, -G4, -G6, -G8, -G10, and -G12 only.
		- - - - - - - - - - - - JACKS - - - - - - - - - -
J1	7150763-P5	Test point, sim Alden 110BC1-yellow.
J2	7150763-P4	Test point, sim Alden 110BC1-green.
J3	7150763-P2	Test point, sim Alden 110BC1-red.
J4 & J5	7150763-P6	Test point, sim Alden 110BC1-blue.
		- - - - - - - - - - RELAYS - - - - - - - - - -
K1 & K2	19B209439-P1	Reed, mercury-wetted; 48 VDC, 1.75 W max.; 6100 ohms ±10%; full-in, 20 VDC; drop-out, 3.1 VDC; 1 form C contact; sim CP Clare HGSR61211V01. Used in -G2, -G4, -G6, -G8, -G10, and -G12 only.
		- - - - - - - - - - INDUCTOR - - - - - - - - - -
L1 & L2	7491382-P107	Coil, RF; 1000 µH ±10%; max. DC resistance, 14 ohms; max. current, 185 mA; sim Delevan 3500 series.

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - TRANSISTORS - - - - - - - - -
Q1 thru Q3	19A115300-P2	Silicon, NPN; sim Type 2N3053.
Q4	19A115562-P2	Silicon, PNP, switch; sim Type 2N2800
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1 thru R3	7478740-P29	Wirewound; 630 ohms ±5%, 10 W.
R4 & R5	19A116278-P181	Metal film; 681 ohms ±2%, 1/2 W.
R7	19A116278-P117	Metal film; 147 ohms ±2%, 1/2 W.
R8	19A116278-P81	Metal film; 68.1 ohms ±2%, 1/2 W.
R9	3R77-P303J	Composition; 30 K ohms ±5%, 1/2 W.
R10	3R77-P202J	Composition; 2 K ohms ±5%, 1/2 W.
R11	3R77-P303J	Composition; 30 K ohms ±5%, 1/2 W.
R12	3R77-P512J	Composition; 5.1 K ohms ±5%, 1/2 W.
R13	3R77-P202J	Composition; 2 K ohms ±5%, 1/2 W.
R14	3R77-P303J	Composition; 30 K ohms ±5%, 1/2 W.
R15 & R16	7478740-P37	Wirewound; 4 K ohms ±5%, 10 W. Used in -G3, -G4, -G11, and -G12 only.
		- - - - - - - VOLTAGE REGULATORS - - - - - -
VR1	19A115528-P4	Silicon, Zener; 12 V; sim Type 1N3022A.
VR2	4036887-P6	Silicon, Zener; 6.2 V; sim Type 1N5234.
VR3	4036887-P8	Silicon, Zener; 11 V; sim Type 1N5241.
VR4	4036887-P6	Silicon, Zener; 6.2 V; sim Type 1N5234.
VR5	4036887-P8	Silicon, Zener; 11 V; sim Type 1N5241. Used in -G2, -G4, -G6, -G8, -G10, and -G12 only.

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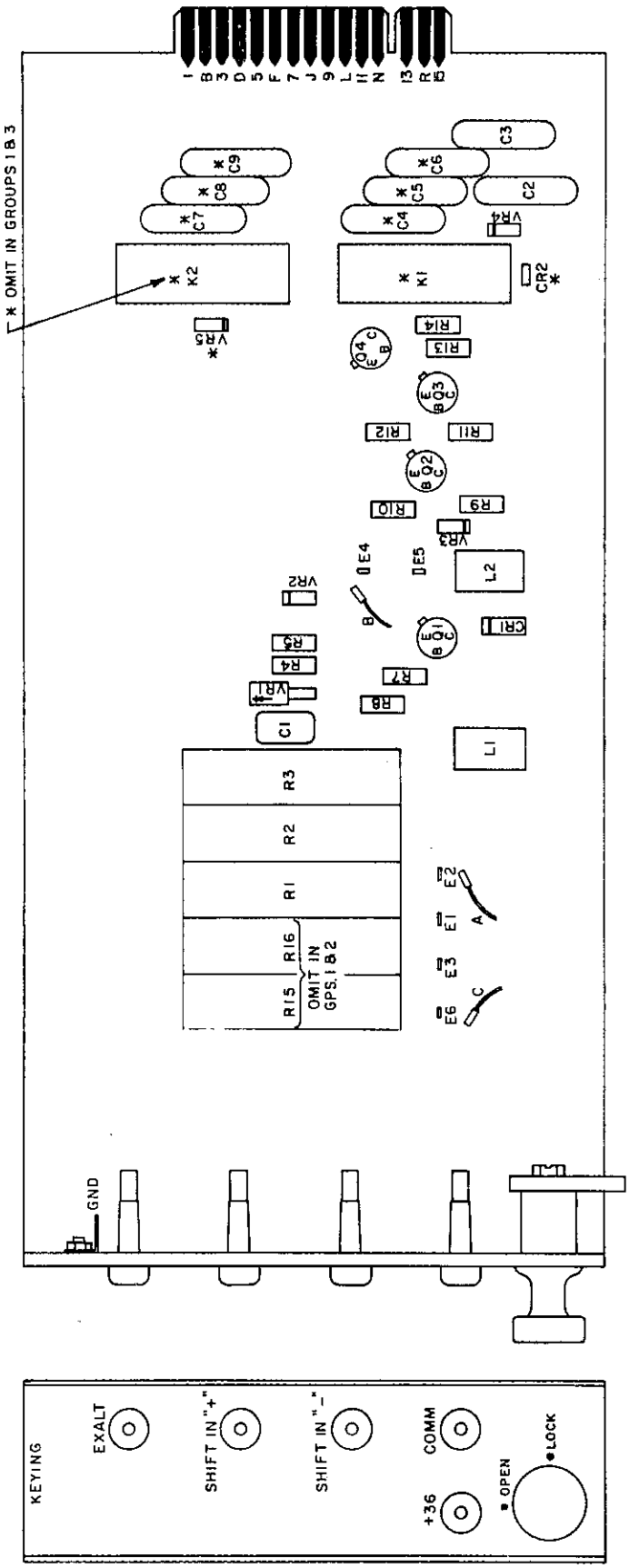

JUMPER CHART

GROUP NO.	JUMPER A TO	JUMPER B TO	JUMPER C TO	KEYING VOLTAGE	KEYING BUS
1 OR 2	E2	E4	E3	48	POS
3 OR 4	E1	E4	E6	250	POS
5 OR 6	E2	E5	E3	48	NEG
7 OR 8	E3	E4	E6	125	POS
9 OR 10	E3	E5	E6	125	NEG
11 OR 12	E1	E5	E6	250	NEG

Parts Layout Diagram

KEYING MODULE
PL-19D415815-G1 thru -G12

(19C323052, Rev. 0)

DESCRIPTION

POWER AUXILIARY MODULE
PL-19D415023-G1 and -G2

Introduction

The Power Auxiliary Module, PL-19D415023-G1 serves primarily as a 125 VDC to 48 VDC converter, and PL-19D415023-G2 as a battery filter circuit for the lower voltage circuitry in the transmitter. The module is applied in both 125 VDC and 48 VDC applications to permit field conversion from either 125 VDC or 48 VDC, or vice-versa, power sources, and, in addition, serves as a filter for high-energy transient voltages which are commonly present on battery leads. Jumpers "A" and "B" are used to perform this conversion.

Operation

With jumper "A" connected to terminal E3 and jumper "B" connected to terminal E2 (-G1 connections), the module serves as a highly efficient convertor to provide a regulated 48 VDC voltage for the associated power amplifier circuit and the 36 VDC regulator circuit. Transistor Q1 turns ON and OFF at a rate which keeps output capacitors C8 and C9 charged-up to the nominal 48 VDC output. Inductor L3 serves as a current source for capacitors C8 and C9 during periods in which transistor Q1 is turned OFF. Transistors Q5 and Q6 form a very sensitive differential amplifier which senses the voltage level across capacitors C8 and C9. A drop in this voltage is sensed and used to activate the Schmitt trigger formed by transistors Q3 and Q4. A drop in the output voltage quickly switches transistor Q3 ON, thereby turning transistors Q2 and Q1 ON, producing a surge of charging current through capacitors C8 and C9. This action is continuous and a series of very steep pulses may be seen at approximately a 5 kHz rate by monitoring the collector voltage at transistor Q3 on an oscilloscope.

Diode CR3 serves as a current path for the inductor current when transistor Q1 is in the OFF state, and limits the transient voltage applied to the emitter of transistor Q1. Diode CR2 is used for protection against short-circuit load conditions and removes the bias from transistor Q3 under a short circuit condition, thereby turning transistor Q1 OFF. Potentiometer R18 is accessible from the front of the module to adjust the 48 VDC output level.

In 48V battery applications, jumper "A" is connected to terminal E4 and jumper "B" is connected to terminal E1 (-G2 connections). In this application, inductors L1 and L2 and capacitors C1 through C3 provide an input filter for protection of the 48 VDC to 36 VDC regulator from transient voltages appearing on the battery leads.

Trouble-Shooting Aids

Refer to the composite drawing Figure 2 included in the model book for the electrical connections on this module. Should difficulty be encountered in obtaining the 36 VDC regulated shelf voltage or the 48 VDC power auxiliary output voltage, the following checks should be made. Insert the Power Auxiliary Module into the Extender Unit (optionally supplied in the Extender Test Kit) and then insert the Extender Unit into the shelf connector. When set up for -G1 operation (125 VDC input), the 48 VDC output level should be adjustable (using R18) from 43 VDC to 51 VDC. The various transistor voltages obtained should be similar to those shown in Table 1, when using a high impedance VTVM and common negative reference.

TABLE 1 (-G1 only)

(Reference: common negative)

Transistors	Base VDC	Collector VDC	Emitter VDC
Q1	48.5	125	48
Q2	125	48.5	125.5
Q3	-0.12*	72	3.7
Q4	3.8	13	3.6
Q5	2.9	8.8	2.3
Q6	2.9	9.3	2.3

* Negative value results from shape of voltage waveform.

Nominal Operating Characteristics

Group 1

DC input voltage	129 VDC, nominal
Input voltage range	104-140 VDC
Input current (for 800 mA output)	400 mA @ 129 VDC
Output voltage range	43-51 VDC (adjustable)

Group 2 (Filter only)

DC input voltage	48 VDC, nominal
Input voltage range	42-56 VDC
Input current	800 mA
Output voltage	48 VDC, nominal (42-56 VDC, follows input)

PARTS LIST

POWER AUXILIARY MODULE
PL-19D415023-G1 & G2

Symbol	GE Part No.	Description
		---------- CAPACITORS ----------
C1 & C2	3R121-P19	Paper-Askarel: 0.25µf ±10%, 1500 VDCW; sim GE Cat. No. 23F963
C3	5493132-P12	Electrolytic: 50 µf -10%, +50%, 250 VDCW; sim Sprague Type 39D
C4	4029003-P12	Silver mica: 1500µµf ±5%, 500 VDCW; sim Electromotive Type DM-20
C5	19A115028-P108	Polyester: 0.015µf ±20%, 200 VDCW
C6	4029003-P20	Silver mica: 3300µµf ±5%, 500 VDCW; sim Electromotive Type DM-20
C7	5496267-P19	Tantalum: 22µv ±20%, 35 VDCW; sim Sprague Type 150D
C8 & C9	19B200230-P20	Metallized polyester: 5µf ±20%, 200 VDCW; sim Good-All Type X663FR
C10	19A115028-P111	Polyester: 0.047 µf ±20%, 200 VDCW
		---------- DIODES ----------
CR1 thru CR3	19A116565-P2	Silicon rectifier: sim Sem Tech SC-6 or Type IN4005
		----------JACK TIP----------
J1 & J3	7150763-P4	Test point; sim to Alden 110BC1-green
J2 & J4	7150763-P2	Test point; sim to Alden 110BC1-red
		---------- REACTORS AND COIL ----------
L1 & L2	19B209345-P1	Reactor; DC resistance, 0.5 ohms max; operating voltage, 15 VDC; inductance, 20 mH at 0.73 amp DC
L3	19B209146-P1	Reactor; DC resistance, 2.5 ohms max; operating voltage, 14 VDC; inductance, 100 mH at 0.85 amp DC

Symbol	GE Part No.	Description
L4	PL-19B213869-G1	Coil; Inductance, 294-306 mH at 1kHz
		---------- TRANSISTORS ----------
Q1	19A115924-P1	Silicon, NPN; sim to Delco DTS-413 or Type 2N3902
Q2	19A116330-P1	Silicon, PNP; sim to Type 2N3636
Q3 *	19A115783-P2	Silicon, NPN; sim to Type 2N4240
Q4	19A115300-P4	Silicon, NPN; sim to Type 2N3053
Q5 & Q6	19A115720-P1	Silicon, NPN; sim RCA-40232 or Type 2N3227
		---------- RESISTORS ----------
R1	19A116278-P61	Metal film; 42.2 ohms ±2%, 1/2 W; Corning C5M
R2	3R77-P511J	Fixed composition: 510 ohms ±5%, 1/2 W.
R3	19A116278-P333	Metal film; 21.5 K ohms ±2%, 1/2 W; Corning C5M
R4	19A116278-P157	Metal film; 383 ohms ±2%, 1/2 W; Corning C5M
R5	19A116278-P317	Metal film; 14.7 K ohms ±2%, 1/2 W; Corning C5M
R6	19A116278-P201	Metal film; 1 K ohms ±2%, 1/2 W; Corning C5M
R7	19A116278-P317	Metal film; 14.7 K ohms ±2%, 1/2 W; Corning C5M
R8	3R79-P153J	Fixed composition: 15 K ohms ±5%, 2 W
R9	19A116278-P273	Metal film; 5.62 K ohms ±2%, 1/2 W; Corning C5M
R10	19A116278-P301	Metal film; 10 K ohms ±2%, 1/2 W; Corning C5M
R11	3R77-P242J	Fixed composition: 2.4 K ohms ±5%, 1/2 W
R12	19A116278-P265	Metal film; 4.75 K ohms ±2%, 1/2 W; Corning C5M
R13	19A116278-P169	Metal film; 511 ohms ±2%, 1/2 W; Corning C5M
R14	3R79-P152J	Fixed composition: 1.5 K ohms ±5%, 2 W
R15	3R77-P302J	Fixed composition: 3 K ohms ±5%, 1/2 W
R16	3R77-P103J	Fixed composition: 10 K ohms ±5%, 1/2 W
R17	19A116278-P229	Metal film; 1.96 K ohms ±2%, 1/2 W; Corning C5M
R18	19A116430-P7	Variable; cermet; 5 K ohms ±10%, 0.75 W; sim Helitrim Model 79 P
R19	19A116278-P153	Metal film; 348 ohms ±2%, 1/2 W; Corning C5M
R20 & R21	19A116278-P290	Metal film; 8.45 K ohms ±2%, 1/2 W; Corning C5M
		---------- VOLTAGE REGULATOR ----------
VR1	4036887-P2	Silicon, Zener; sim to Type IN5224B
VR2	4036887-P17	Silicon, Zener; sim to Type IN5250B

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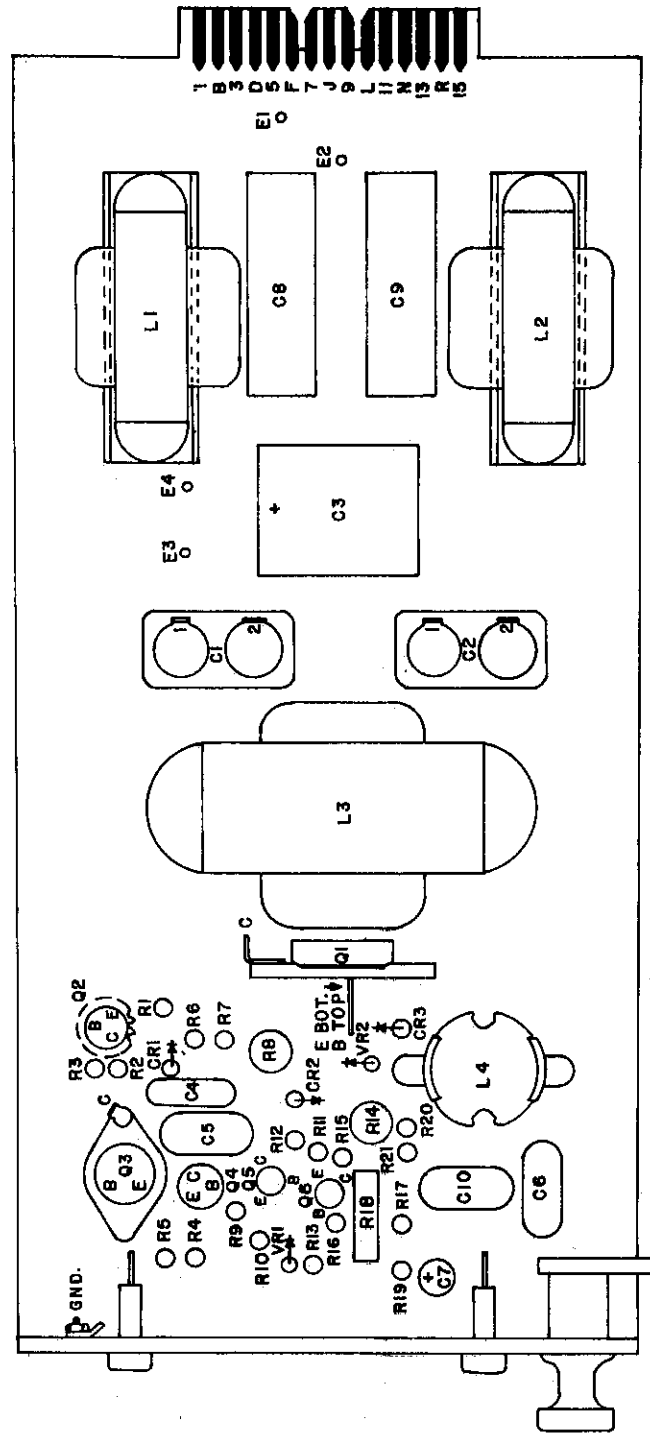
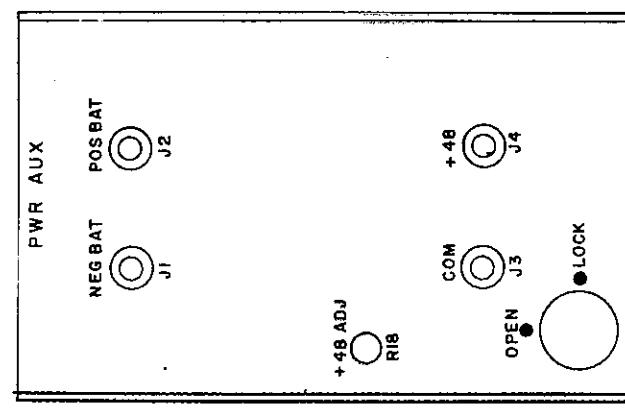
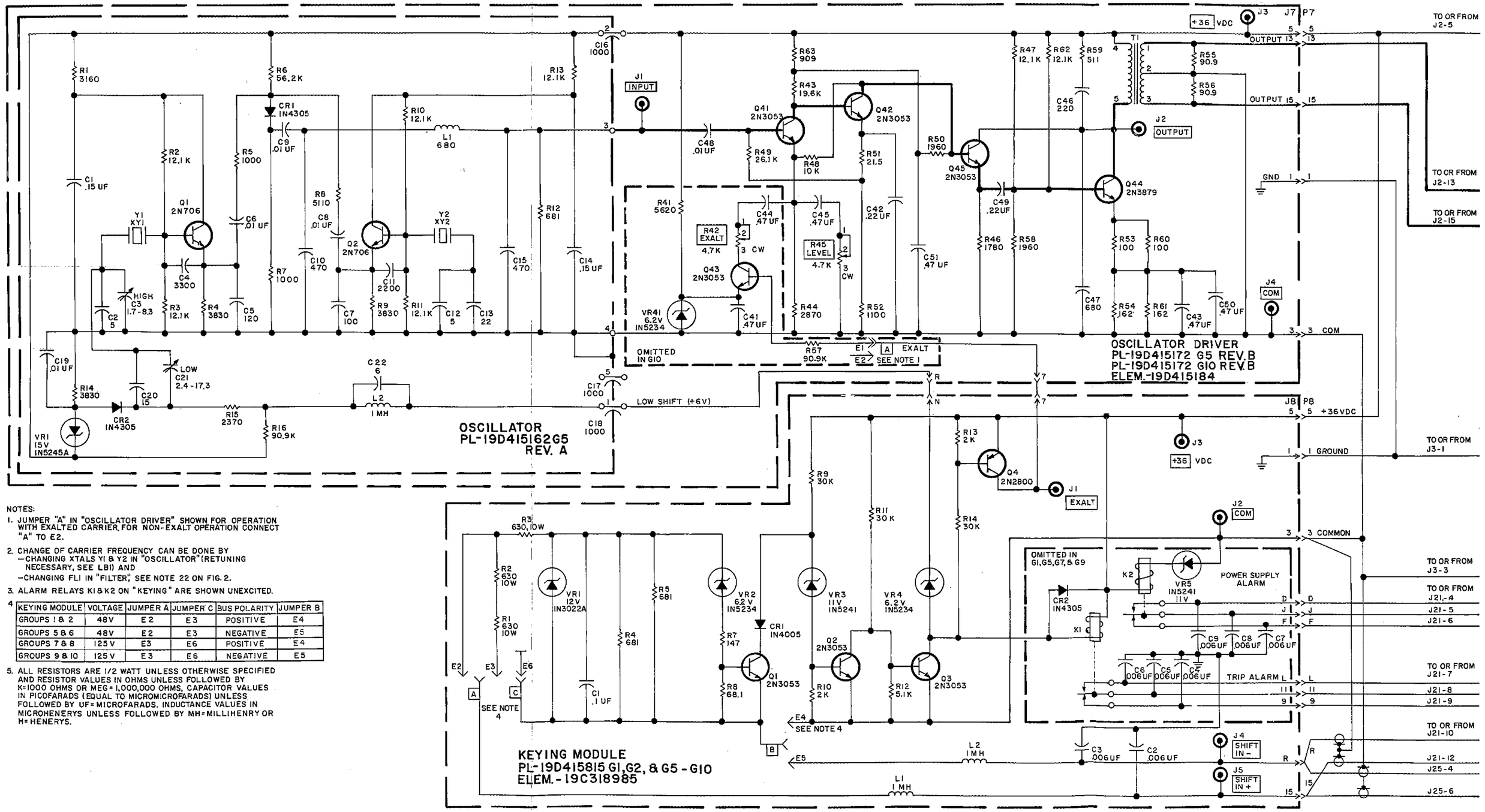




Parts Layout Diagram

POWER AUXILIARY MODULE
PL-19D415023-G1

(19C318390, Rev. 1)



NOTES:

1. JUMPER "A" IN "OSCILLATOR DRIVER" SHOWN FOR OPERATION WITH EXALTED CARRIER. FOR NON-EXALT OPERATION CONNECT "A" TO E2.
2. CHANGE OF CARRIER FREQUENCY CAN BE DONE BY
   —CHANGING XTALS Y1 & Y2 IN "OSCILLATOR" (RETUNING NECESSARY, SEE LB1) AND
   —CHANGING FL1 IN "FILTER," SEE NOTE 22 ON FIG. 2.
3. ALARM RELAYS K1 & K2 ON "KEYING" ARE SHOWN UNEXCITED.
4.

KEYING MODULE	VOLTAGE	JUMPER A	JUMPER C	BUS POLARITY	JUMPER B
GROUPS 1 & 2	48V	E2	E3	POSITIVE	E4
GROUPS 5 & 6	48V	E2	E3	NEGATIVE	E5
GROUPS 7 & 8	125V	E3	E6	POSITIVE	E4
GROUPS 9 & 10	125V	E3	E6	NEGATIVE	E5

5. ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS, CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF=MICROFARADS. INDUCTANCE VALUES IN MICROHENERYS UNLESS FOLLOWED BY MH=MILLIHENRY OR H=HENERYS.

Elementary Diagram

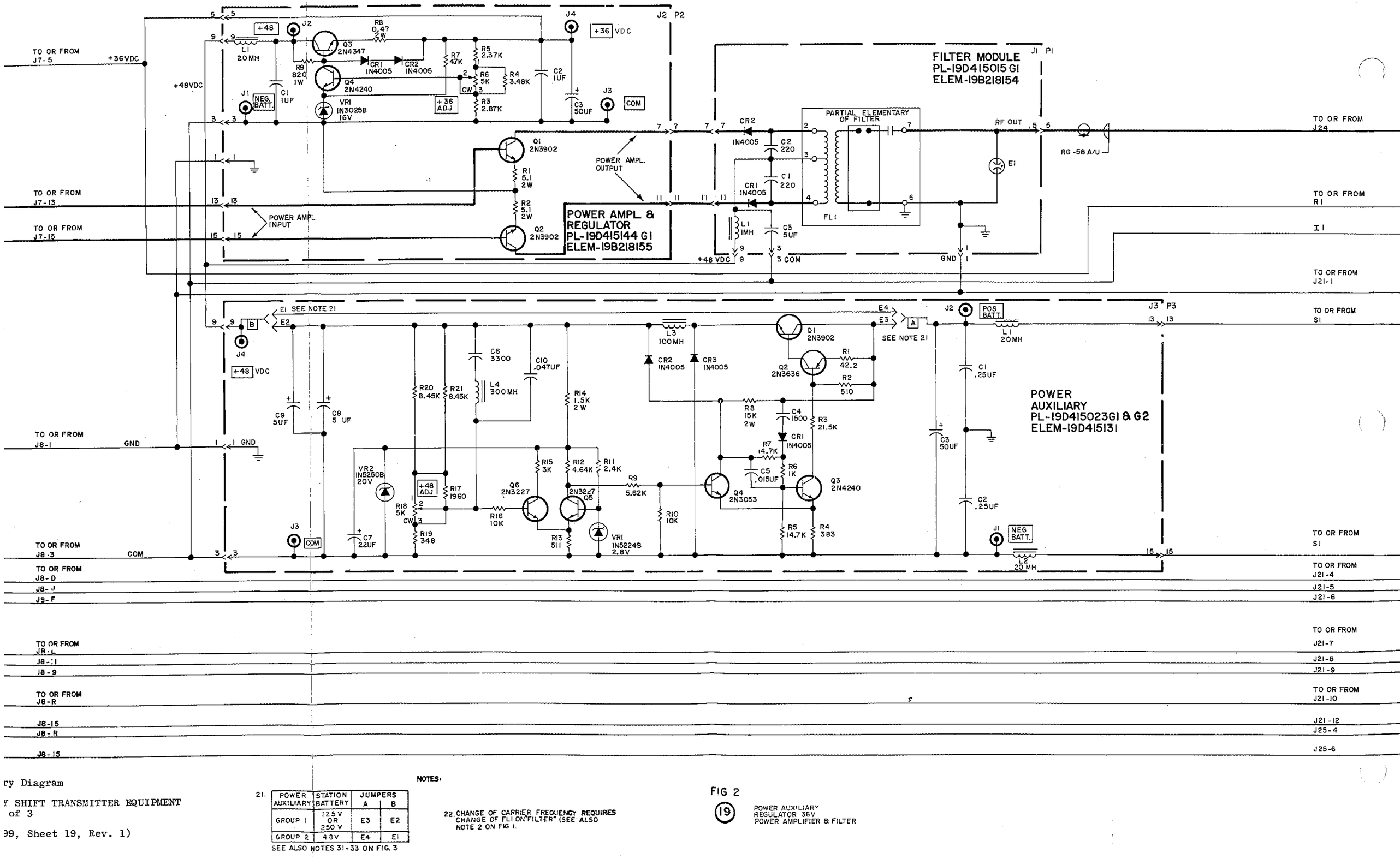
FREQUENCY-SHIFT TRANSMITTER EQUIPMENT
FIGURE 1 of 3

(19D415899, Sheet 2, Rev. 1)

FIG. 1

(2) 4CT51B

2 FREQ. 200 HZ SHIFT, DRY CONTACT OR POSITIVE/NEGATIVE BUS KEYING, 48V/125V



ry Diagram

Y SHIFT TRANSMITTER EQUIPMENT
of 3

99, Sheet 19, Rev. 1)

NOTES:

21.

POWER AUXILIARY	STATION BATTERY	JUMPERS A	JUMPERS B
GROUP 1	125 V OR 250 V	E3	E2
GROUP 2	48V	E4	E1

SEE ALSO NOTES 31-33 ON FIG. 3

22. CHANGE OF CARRIER FREQUENCY REQUIRES CHANGE OF FLI ON "FILTER" (SEE ALSO NOTE 2 ON FIG 1.

FIG 2

19 POWER AUXILIARY REGULATOR 36V POWER AMPLIFIER & FILTER

NOTES:

31 FUSES F1 & F2 ON "ACCESSORY PANEL FRONT" ARE .75 AMP/SLOW BLOW FOR 125 OR 250 VDC BATTERY OR 1 AMP/SLOW BLOW FOR 48 VDC BATTERY.

32 NOT APPLICABLE

33 TO CONVERT FROM 125V TO 48V BATTERY
- CHANGE FUSES (SEE NOTE 31, FIG 3)
- SEE NOTE 21 ON FIG. 2.
SEE NOTE #4 ON FIG. 1.

34. DOTTED CONNECTION TO BE MADE BY PURCHASER.

35. FOR DEDICATED CONTACT KEYING FUNCTION APPLY NORMALLY OPEN, DEDICATED CONTACT BETWEEN "TA" TERMINALS 6 & 5. CLOSE CONTACT TO SHIFT TRANSMITTER (TRIP).

36. WHEN MORE THAN ONE TRANSFER TRIP TRANSMITTER IS CONTAINED IN THE CABINET, DUPLICATED CONNECTIONS WILL BE MADE AT BOARDS MARKED "TB", "TC" ETC.

37. STANDARD TERMINAL BOARDS AND CABLE AS SHOWN, NOT PROVIDED WITH WIRING HARNESS OPTION "N" (SEE NOMENCLATURE KEY).

38. FOR CONTACT KEYING FROM POSITIVE BUS APPLY N.O CONTACT BETWEEN TA-6 AND REMOTE POSITIVE BATTERY BUS. CLOSE CONTACT TO SHIFT TRANSMITTER (TRIP).

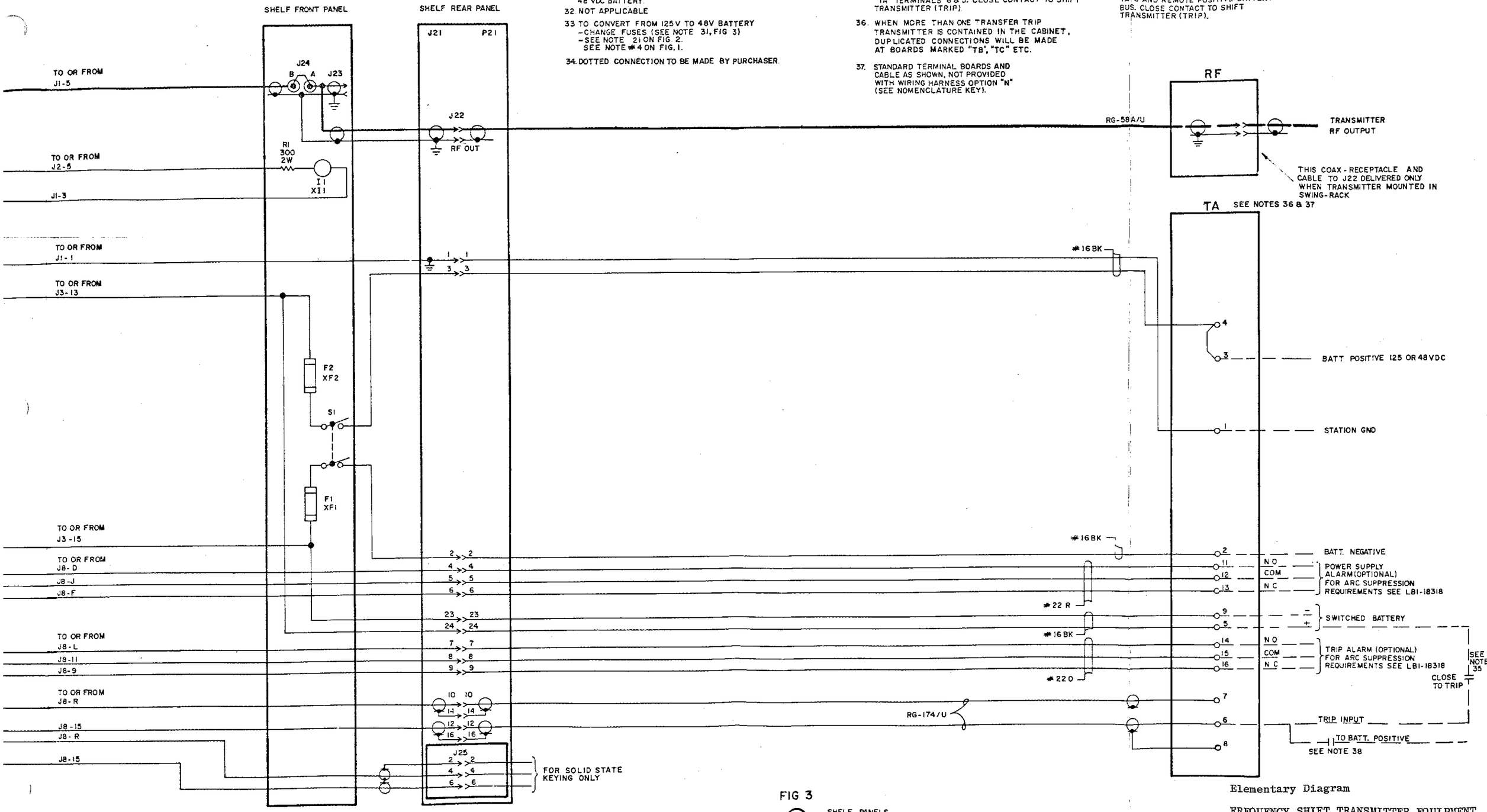


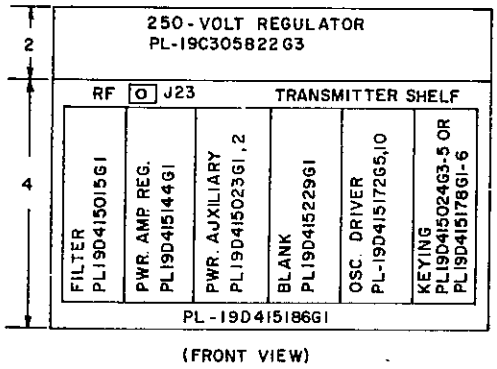
FIG 3

(26) SHELF PANELS CUSTOMER CONNECTIONS

Elementary Diagram

FREQUENCY SHIFT TRANSMITTER EQUIPMENT
FIGURE 3 of 3

(19D415899, Sheet 26, Rev. 0)

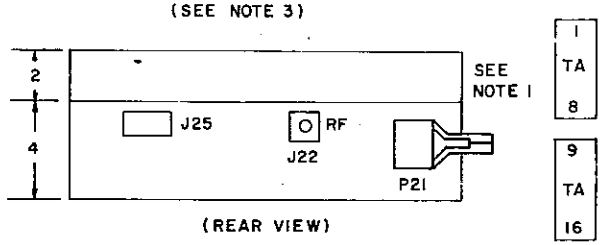


(FRONT VIEW)

SEE NOTE 1

CUSTOMER CONNECTIONS

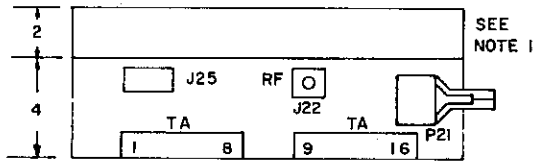
6' OR 10' LONG WIRING HARNESS - INDEX TYPE "R" & "T".
(SEE NOTE 3)



(REAR VIEW)

CUSTOMER CONNECTIONS

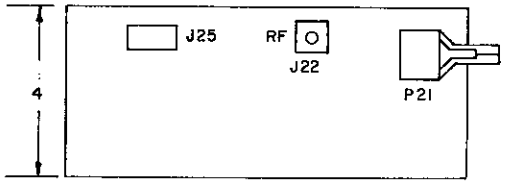
FIXED & OPEN RACK WIRING HARNESS - INDEX TYPE "F"
(SEE NOTE 4)



(REAR VIEW)

CUSTOMER CONNECTIONS

NO HARNESS - INDEX TYPE "N"
(SEE NOTE 6)

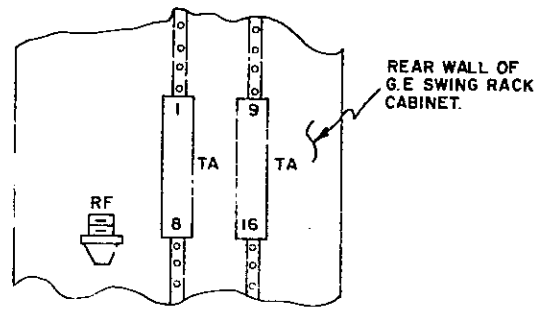


(REAR VIEW)

NOTES:

1. A SEPARATE 250-VOLT REGULATOR AS SHOWN IS REQUIRED ONLY WHEN THE SUPPLY VOLTAGE IS 250 VOLTS.
2. ALL VERTICAL DIMENSIONS ARE IN RACK UNITS OF 1.75" EACH
3. THE CUSTOMER CONNECTION FOR THE 6' OR 10'- LONG WIRING HARNESS IS PROVIDED BY TWO TERMINAL BOARDS AT THE END OF THE HARNESS HAVING #10 SCREWS FOR THE CONNECTIONS AND ONE FEMALE UHF COAXIAL CONNECTOR WITH 5/8-24 EXTERNAL THREADS MOUNTED ON THE REAR OF THE TRANSMITTER. THE MOUNTING LOCATION AND POSITION OF THE BOARDS ARE TO BE AT THE DISCRETION OF THE CUSTOMER.
4. THE CUSTOMER CONNECTION FOR THE FIXED OR OPEN RACK WIRING HARNESS IS PROVIDED BY TWO TERMINAL BOARDS HAVING #10 SCREWS FOR THE CONNECTIONS AND ONE FEMALE UHF COAXIAL CONNECTOR WITH 5/8-24 EXTERNAL THREADS ALL UNITS MOUNTED ON THE REAR OF THE TRANSMITTER.
5. THE CUSTOMER CONNECTION FOR THE SWING BACK WIRING HARNESS IS PROVIDED BY TWO TERMINAL BOARDS HAVING #10 SCREWS FOR THE CONNECTIONS AND ONE FEMALE UHF COAXIAL CONNECTOR WITH 5/8-24 EXTERNAL THREADS, ALL MOUNTED ON THE REAR WALL OF THE SWING RACK CABINET.
6. IN THE EVENT NO WIRING HARNESS IS DESIRED, THE CUSTOMER CONNECTION IS MADE DIRECTLY TO THE REAR OF THE TRANSMITTER SHELF ASSEMBLY ATTACHING TO ONE FEMALE UHF COAXIAL CONNECTOR WITH 5/8-24 EXTERNAL THREADS AND TO A 24-PIN RECEPTACLE BY WIRING TO THE SIDE-ENTRY MATING PLUG PROVIDED, USING A WIRE SIZE APPROXIMATION AWG NO. 22.
7. A PARALLEL CONNECTED FEMALE BNC CONNECTOR IS MOUNTED ON THE FRONT OF THE TRANSMITTER SHELF & IS AN EXTENSION OF THE UHF CONNECTOR ON THE REAR.
8. CONNECTOR J25 IS PROVIDED WITH ALL TRANSMITTERS BUT USED ONLY FOR SOLID STATE KEYING REQUIREMENTS. MATING PLUG TO BE PROVIDED BY THE CUSTOMER.

CUSTOMER CONNECTIONS
SWING RACK WIRING HARNESS INDEX TYPE "S"
(SEE NOTE 5)



(VIEW FROM INSIDE)

Typical Equipment Arrangement

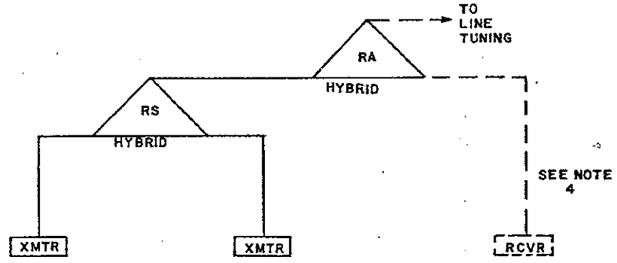
TRANSFER TRIP TRANSMITTER EQUIPMENT
TYPE CT51B, TYPE CT61A, TYPE CT71A

(19C318444, Rev. 2)

DUAL CHANNEL TRANSFERRED TRIP

OUTPUT 1W/10W TRIP & GUARD
48 VDC SUPPLY
INSTRUCTION BOOK - SEE NOTE 7.

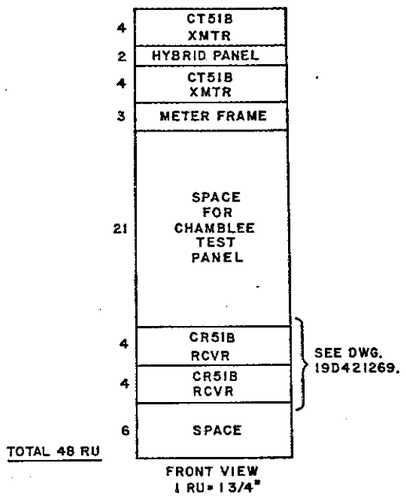
SIMPLIFIED RF CONNECTIONS

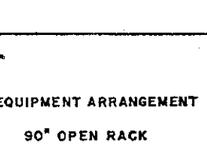


NOTES:
1. DOTTED CONNECTIONS TO BE MADE BY PURCHASER.
2. USE #16 AWG BK. WIRE UNLESS OTHERWISE MARKED.
3. FACTORY CO-AX CONNECTIONS RG-58 C/U.
4. FACTORY TO PROVIDE THIS INTERCONNECTION WHEN RECEIVERS ORDERED AND MOUNTED IN EQUIPMENT AT FACTORY.
5. CONNECTIONS SHOWN TERMINATED AT TA AND TB BOARDS ON DRAWING 19D415899 SH. 26 ARE TYPICAL FOR SINGLE TRANSMITTERS. FOR DUAL OPERATION CABLES ARE CONNECTED AS SHOWN ON THIS DRAWING.
6. SECOND TRANSMITTER MARKED "TB"
7. INSTRUCTIONS - LBI-28006 FOR ALL EQUIPMENT IN RACK.

EQUIPMENT ARRANGEMENT

90" OPEN RACK
CB48R

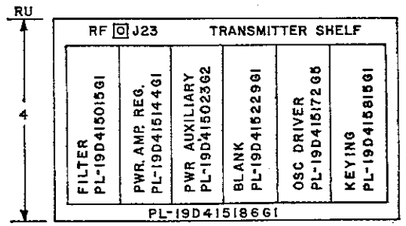


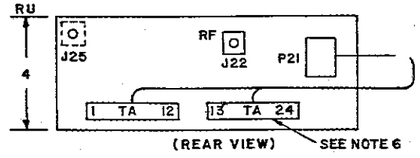


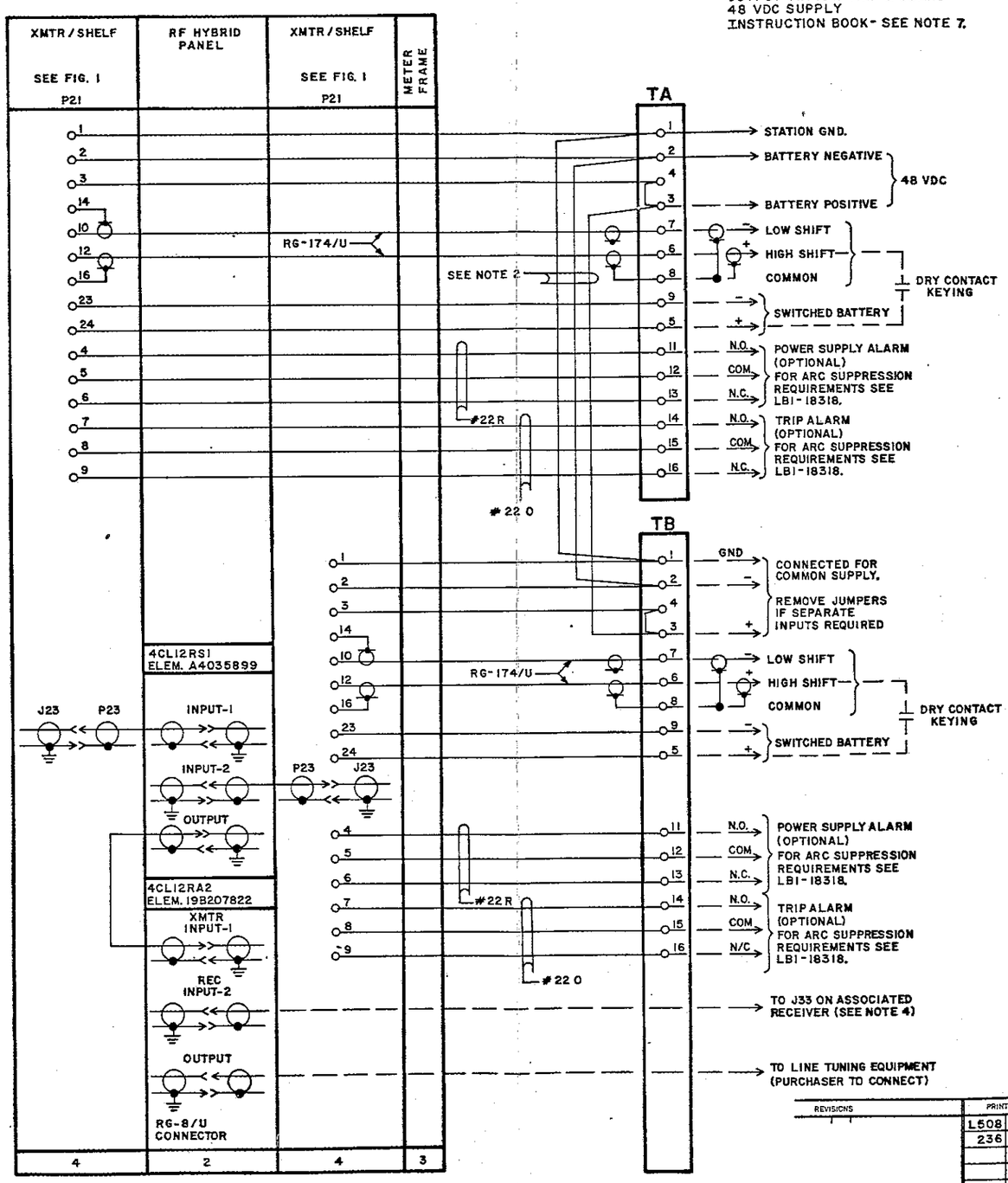
FRONT VIEW OF P21

FIG. 1

COMBINATION
4CT51B1F04M1A
OPTION-00X12
ELEM. DIAG. - 19D415899 SH. 2-19, 26







REVISIONS

PRINTS TO
L508
236 15

GENERAL INSTRUCTIONS
RECEIVER EQUIPMENT
MODEL 4CR51B1*04 R 3N_ _ _ _

12
25

4
5
6
7
8

Introduction

This Receiver Equipment provides a receiving terminal for one end of a carrier-current transfer-trip relaying channel over high-voltage power lines.

General

This General Instruction Book will cover all model number combinations as listed above. The asterisk * in the above model number is used in place of any of the six types of wiring harness available in Table 1.

Table 1 shows the nomenclature system used to describe a particular receiver. The associated model number for a given receiver is located on the front of the Shelf Unit in the upper left-hand corner. The last four digits of the number gives the receiver frequency (in kHz) multiplied by ten.

TABLE I

NOMENCLATURE KEY

To facilitate understanding the many options possible with the Type CR51B equipment, meaning, has been assigned to each digit of the Model No. as shown below.

CR51B 1 F 04 R 8 N 1605 Typical Model No.

Frequency (Line frequency x 10) example:
160.5 kHz = 1605

LOGIC
N — None

CHANNEL ANALYSIS
3 -- Carrier Level Monitor with CLM Meter and Alarm Relay
4 -- Loss of Power Alarm and Carrier Level Monitor with CLM Meter and Alarm Relay
5 — None
6 — Loss-of-Power Alarm
7 — Carrier Level Monitor with Alarm Relay
8 -- Loss of Power Alarm & Carrier Level Monitor with Alarm relay

RECEIVER OUTPUT
R — Trip Relay & Guard Relay

SUPPLY
04 — 48-Volt DC input
12 — 125-Volt DC input
25 — 250-Volt DC input

F — Wiring harness for GE fixed-rack cabinet or open rack
S — Wiring harness for GE swing-rack cabinet
R — Wiring harness (6-ft long) for customers existing cabinet
T — Wiring harness (10-ft long) for customers existing cabinet
X — Special wiring harness
N — No wiring harness

CHANNEL
1.— Two frequency

Receiver Equipment, 200 Hz shift (±100 Hz)

For the purpose of these instructions this Transfer-Trip Receiver Equipment will operate from either a 48 VDC, 125 VDC or 250 VDC power source and includes a carrier level monitor circuit.

Notice should be taken that the unit or module instructions sometimes includes more than one unit or module description. The customer should examine the Table of Contents of the Model Instruction Book to determine exactly which group number applies to his unit or module.

The customer should also note that if an instruction has been revised, the revision letter following the LBI number on the first page will apply throughout the instruction.

Safety Considerations

Any person working with this equipment should keep in mind that the equipment common is connected directly to the negative terminal of the DC power source, which, in most cases, will be the station battery. This implies that there will be a voltage difference between equipment common and station ground which equals one-half of the battery voltage. For this reason, one should be very careful while doing work on this equipment.

From the above, it is obvious that only ungrounded test equipment should be used. Also, for the same reason, the output leads of the Carrier Level Monitor circuit, where an external mA-meter is connected, should never be grounded.

NOMINAL OPERATING CHARACTERISTICS

Power Supply Voltage	250 V (Range 210V - 280 VDC) 125 V (Range 104V - 140V) 48 V (Range 42V - 56 VDC)
Current Drain	0.4A (at 48 V operation) 0.23A (at 125 V operation) 0.25A (at 250V operation)
Frequency Range	30 kHz to 300 kHz (in 0.5 kHz increments)
Modulation Frequency Shift	GUARD, +100 Hz TRIP, -100 Hz
Selectivity RF Input Filter	±100 Hz down 6 dB ±500 Hz down 55 dB
IF Filter	10 ±2 kHz down 3 dB 10 ±4 kHz down 40 dB
Sensitivity Noise Free Channel	5 mV (can be adjusted to 15 mV)
Input Impedance Optional (shipped from factory as 1.5 K ohms)	70 ohms or 1.5 K ohms minimum
Outputs - Guard and Trip Relay Contact Rating - Trip circuit	30A make and carry for 100 ms at 10s interval
- Alarm Contacts	100VA (2A max, 280 VDC max.) into a resistive load.
Channel Time Delay Transmitter-Receiver, Back-to-Back	32 ms (adjustable, 25 ms to 90 ms)
Carrier Level Monitor Current output for remote indication of relative receive level	0-3 mA
Alarm Relays DC - Supply Alarm Relay	1 form C contact
Carrier level Alarm Relay	2 form C contacts
Contact rating same as alarm contacts with proper arc suppression	

Environment	
Temperature Range	
Air around chassis	-20 C to +60 C
Humidity	up to 95% at 40 C
Altitude	up to 10,000 feet

TABLE 2

Filter Part Number Versus Frequency
(Group Number = 2f - 59)

GE Part No.	Group No.	Frequency
PL-19C304798	-G1	30.0 kHz
PL-19C304798	-G2	30.5 kHz
PL-19C304798	-G3	31.0 kHz
PL-19C304798	-G81	70.0 kHz
PL-19C304798	-G82	70.5 kHz
PL-19C304798	-G300	179.5 kHz
PL-19C304798	-G301	180.0 kHz
PL-19C304798	-G540	299.5 kHz
PL-19C304798	-G541	300.0 kHz

Mechanical Package

The Receiver Equipment consists of a Shelf Unit containing five (5) plug-in type printed circuit modules. The shelf can be mounted in a standard 19-inch rack or cabinet, and it occupies four rack units of space (1 RU = 1.75 in.). The shelf without harness, including all five modules, weighs 27 pounds.

If the Receiver Equipment is a single unit, a cable and terminal board will be furnished with it, and all external connections will be shown on the composite diagrams in this book. If the Receiver Equipment is part of a system entirely furnished by the General Electric Company, then a special system interconnection cable will be used, and all external connections will be shown on a special system interconnection diagram which will be furnished.

Two coaxial connectors are available for connection of the RF input. One is a BNC connector, mounted on the shelf front panel; and the other is a UHF connector, mounted on the rear panel of the shelf.

Principles of Operation

The 250 V Regulator Unit reduces the battery voltage (250 VDC) to a regulated 125 VDC. The Power Auxiliary Module (PWR. AUX.) converts the 125 VDC to a regulated 48 VDC. A series regulator circuit located in the Filter Module reduces the 48 VDC to 36 VDC, which is used as the supply voltage for all transistor circuits.

Refer to the Receiver Block Diagram shown in Figure 1.

The receiver RF signal is fed into the Filter Module where it is adjusted to the proper level with the input attenuator "RF IN ADJ". Depending on the input level, the signal is passed directly to the filter or to the filter through a 20 dB pad. If the input signal is above +12 VRMS, the 20 dB resistive pad is inserted by connecting jumper A to terminal E9 and jumper B to terminal E8.

There are two input impedance options available. The input impedance is 1.5 K ohms if jumper C, located on the Filter Module, is connected to terminal E1, or it is 70 ohms if jumper C is connected to terminal E2.

After the RF signal has passed through the input filter, it is then amplified.

The RF signal is now fed into the Local Oscillator-Mixer Module. Here, a frequency conversion from line frequency to an IF frequency of 10 kHz is performed.

A crystal oscillator, with associated driver stages, provides the local signal necessary to drive the mixer. The output

of the mixer is passed through an IF band pass filter with a center frequency of 10 kHz. This IF signal is now amplified and fed to the Discriminator Module and the Carrier Level Monitor. In the Discriminator Module, the IF signal is first passed through a limiter circuit and then fed to the frequency discriminator circuit. The discriminator produces either a GUARD or a TRIP output voltage (refer to Figure 2) depending on whether a TRIP or GUARD frequency is received. In order to favor the GUARD side of the discriminator under high noise conditions, the center of the discriminator is off-set toward the TRIP frequency. That is, the GUARD side has a larger frequency spectrum available than the TRIP side. Reference to Figure 2 will show a superposition of the characteristics of the input filter, IF filter and discriminator.

The typical discriminator curve shown is for an input signal level adequate to produce full limiting in the receiver.

The discriminator guard or trip output voltages are amplified in two different DC-amplifier-switch combinations, which produce a 5 V output. The outputs of these two DC-amplifier-switch combinations are fed into the output module, where they drive the output relays.

The Carrier Level Monitor (CLM) produces a DC output current which is proportional to the receive level. The output current changes approximately 0.1 mA per 1 dB change in receive level. An external DC mA meter, with 3 mA full scale deflection, should be connected to the CLM output unless Analysis Option 3 or 4 is chosen. A potentiometer, CLM ADJ, is provided to adjust the DC output current. The CLM also contains a relay which drops out when the IF level drops below a certain point. This relay can be used for an alarm indication when the receive level drops below a certain value.

ADJUSTMENTS

Factory Adjustments

The following adjustments have been made at the factory before shipment to the customer:

1. Local Oscillator Frequency
2. Discriminator Zero
3. 36 V Supply Voltage
4. 48 V Supply Voltage
5. Receiver Sensitivity

Installation Adjustments

Three adjustments have to be made at the time of installation. These are:

1. Input level adjustment.
2. Carrier Level Monitor Adjustment.
3. Oscillator frequency and discriminator zero -- these parameters should be checked to insure that the factory setting has not shifted during shipment.

An alignment procedure is given below for the customers convenience which covers all possible adjustments.

Alignment Instruction

For recommended test instruments refer to LBI-18319 which is included in the Model Instruction Book. All modules should be plugged into the Receiver Shelf, unless otherwise specified. The testing should proceed in the same sequence as shown below:

A. Supply Voltages

1. 125V Test (Applicable for 250 VDC Operation)

   a. Switch both the receiver OFF with switch S1, and also the 250 Volt Regulator Unit OFF with its switch S1.

   b. Check connections from 250 V station battery to terminal board TA, including station ground, for correct wiring and polarity. Be sure that there is no jumper 13-3 on terminal board TA.

   c. Pull Power Auxiliary Module out of the Shelf and make sure that jumper A is connected to post E3, and jumper B to post E2. Reinsert module into Shelf.

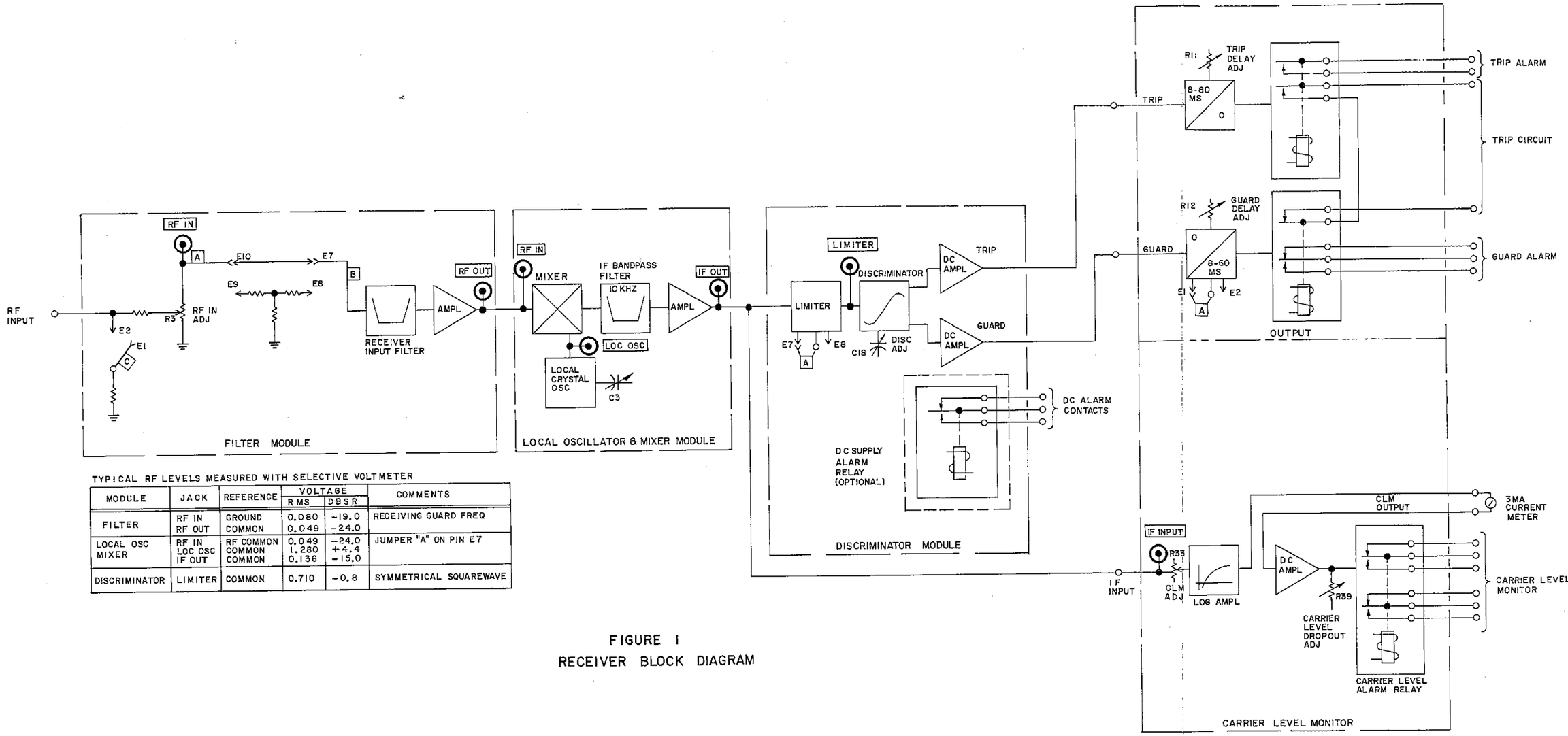
   d. Check the voltage across neg. batt. and pos. batt. on the Power Auxiliary Module. It should be 125 VDC.

2. 48 V Test (Applicable for 125 VDC & 250 VDC Operation Only)

   a. Measure the voltage between the test jacks +48 and COM on the Power Auxiliary Module with a VOM. Adjust this voltage to 48 V with potentiometer R18, +48 ADJ, on the Power Auxiliary Module.

3. 36 V Test

   a. Measure the voltage between the test jacks +36 and COM on the Filter Module with a VOM. Adjust this voltage to 36 V with potentiometer R19, +36 ADJ, on the Filter Module.



TYPICAL RF LEVELS MEASURED WITH SELECTIVE VOLTMETER

MODULE	JACK	REFERENCE	VOLTAGE RMS	VOLTAGE DBSR	COMMENTS
FILTER	RF IN	GROUND	0.080	-19.0	RECEIVING GUARD FREQ
	RF OUT	COMMON	0.049	-24.0	
LOCAL OSC MIXER	RF IN	RF COMMON	0.049	-24.0	JUMPER "A" ON PIN E7
	LOC OSC	COMMON	1.260	+4.4	
	IF OUT	COMMON	0.136	-15.0	
DISCRIMINATOR	LIMITER	COMMON	0.710	-0.8	SYMMETRICAL SQUAREWAVE

FIGURE 1
RECEIVER BLOCK DIAGRAM

Figure 1

RECEIVER BLOCK DIAGRAM

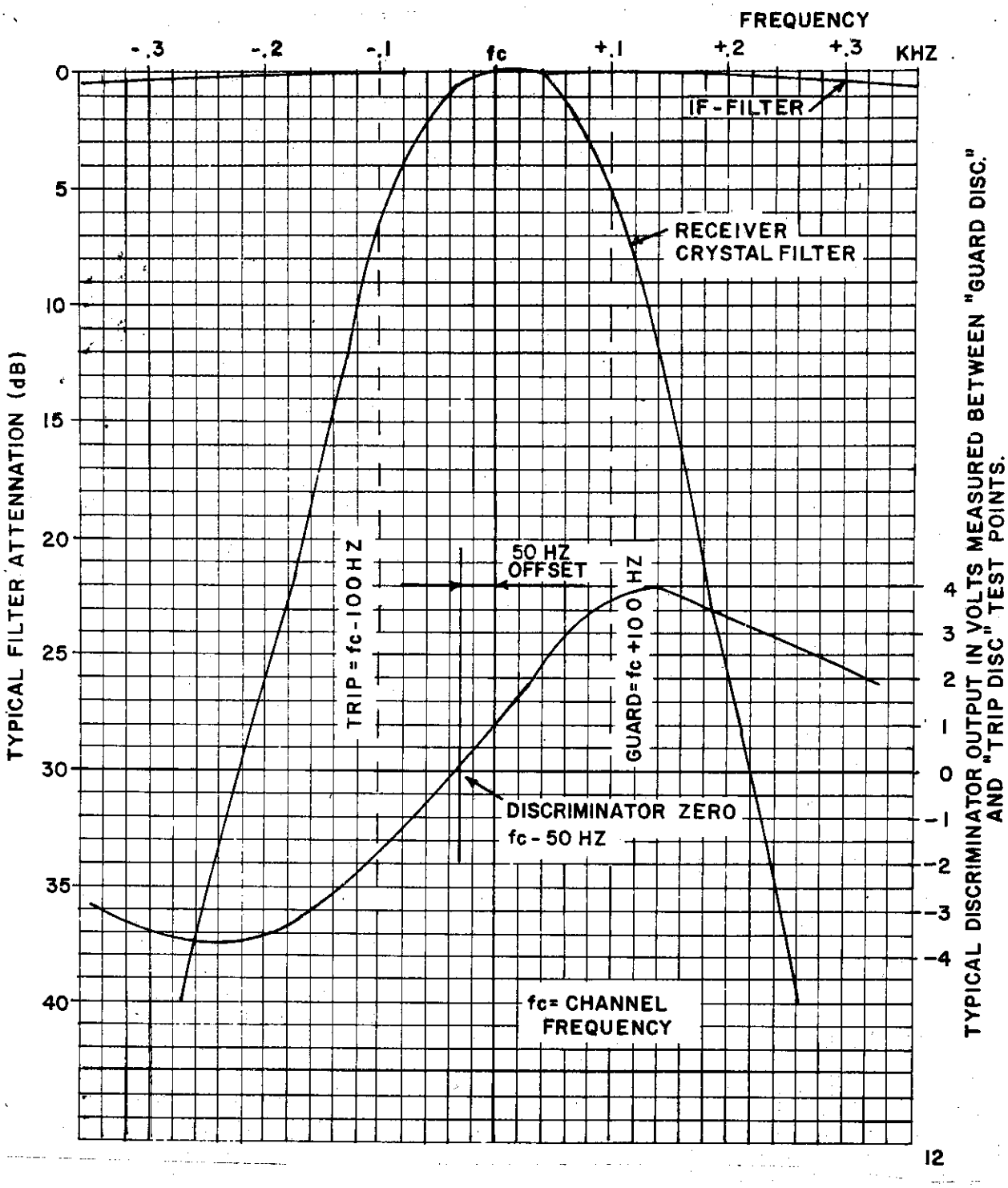


Figure 2 - Typical Filter and Discriminator Characteristics Type CR51B

B. Local Oscillator Frequency

a. Connect the Extender Test Board, PL-19C318404-G1, to the Local Oscillator and Mixer Module. Plug the Extender Test Board "Receive Side Up" as noted, into the shelf.

b. Connect an ungrounded frequency counter to the test jacks LOCAL OSC and COM on the Local Oscillator and Mixer Module.

c. The frequency should be equal to the channel frequency +10,000 Hz. It can be adjusted with variable capacitor C3 (inside the oscillator on the Local Oscillator and Mixer Module) and should be within ±2 Hz of the nominal value.

C. Discriminator

This adjustment should only be made if the discriminator is suspected of being out of adjustment.

a. Disconnect the RF input coaxial cable.

b. Connect an ungrounded oscillator to the test jacks IF OUT and COM, located on the Local Oscillator and Mixer Module. Adjust the oscillator frequency for 10,050 ±3 Hz and the level for -25 dBsr.

c. Connect a VOM between test jacks GUARD DISC and TRIP DISC, located on the Discriminator Module. Use a meter with a range of 3V or less with full scale deflection. Adjust variable capacitor C18, DISC ADJ (located on Discriminator Module) for a zero Volt reading on the VOM. If the range of C18 is not large enough for a zero adjustment, a different combination of the capacitors C19 through C22 can be strapped in to extend this range.

D. RF Input Level Adjustment

Before making the RF input level adjustment, make sure that the transmitter at the remote end of the line is set up properly and that it is transmitting the GUARD signal. Determine if Jumper A on the Discriminator Module is connected to E7 for the 5 mV sensitivity or E8 for the recommended 15 mV receiver sensitivity.

1. First Method

a. Connect an ungrounded VTVM between test jacks IF OUT and COM, located on the Local Oscillator and Mixer Module.

b. Adjust potentiometer R3. RF in ADJ, for a VTVM reading of -15 dBsr for the 15 mV sensitivity or -25 dBsr for the 5 mV receiver sensitivity. If the RF receive level is so high that R3 cannot be adjusted to give above mentioned dBsr reading (RF receive level above +12 VRMS, then the gain in the Filter Module can be reduced by connecting jumper A from terminals E10 to E9 and jumper B from terminals E7 to E8 to connect a 20 dB resistive pad.

2. Second Method

a. Connect a selective voltmeter between the test jacks RF IN and GND on the Filter Module. The voltmeter can be grounded.

b. Adjust potentiometer R3, RF IN ADJ, located on the Filter Module for a meter reading of -33 dBsr for the 5 mV receiver sensitivity or -23 dBsr for a 15 mV receiver sensitivity. (Refer to jumper connections shown in Figure 1.)

By adjusting the receiver input potentiometer R3 according to method 1 or 2, above, the receiver margin for guard frequency is approximately 25 dB. The receiver margin at trip frequency is approximately 20 dB, if the trip signal is not exalted above the normal guard level. The receiver margin on guard frequency is larger because an off-set discriminator is used, which favors guard frequency. If the transmitter output level is exalted by 10 dB when trip frequency is sent, then the receiver margin for the trip frequency is 30 dB.

3. Third Method

The receiver margin can be measured in the following way:

1. Guard Frequency Receiver Margin

a. Verify that the transmitter at the far end of the line is sending guard frequency.

b. Connect a VOM between the test jacks GUARD OUT and COM on the Discriminator Module. Connect a selective voltmeter between the test jacks RF IN and GND on the filter module.

c. Turn the potentiometer R3, RF IN ADJ, maximum counterclockwise. The VOM will now read OV.

d. Turn R3 clockwise until the VOM reading changes fromOV to about 5 V. Measure the guard signal level at test jack RF IN with the selective voltmeter.

e. Set R3 back to its normal position and measure the guard signal level at test jack RF IN with the selective voltmeter.

f. The receiver margin for guard frequency is the difference in dB between the two readings on the selective voltmeter taken in steps d and e.

2. Trip Frequency Receiver Margin

a. For this test, the transmitter has to send trip frequency. This can be accomplished by applying the appropriate keying voltage to the transmitter keying input.

b. Follow the same procedure as for the guard frequency receiver margin, except that the VOM should be connected between TRIP OUT and COM, and the selective voltmeter should be tuned for the trip frequency.

E. Carrier Level Monitor (CLM)

Figure 3 shows a plot of the CLM input level, as measured at IF OUT jack, versus meter current in the external receiver level indicator.

For proper connection of the CLM meter, see the notes on Figure 2 of the composite diagrams included in the Model Instruction Book

The carrier level alarm relay drops out for a meter current of 0.4-1.2 mA. This corresponds to a drop in IF level of 8 - 15 dB from the recommended setting and is adjustable with potentiometer R39.

Adjustment

The receiver input potentiometer R3 should be adjusted before the CLM is adjusted. The level at the IF OUT test jack will then be approximately -25 dBsr or -15 dBsr respectively.

Adjust R33, CLM ADJ, for a meter reading of 2.0 mA. Then adjust the IF level to the dropout point and set R39, the carrier level dropout adjust, to pickup the alarm relay for this IF level.

F. Conversion Adjustments

At times, it may become necessary to make other adjustments to the unit. If a basic change is made, such as in battery supply voltage, or in channel frequency, the following instructions should be followed:

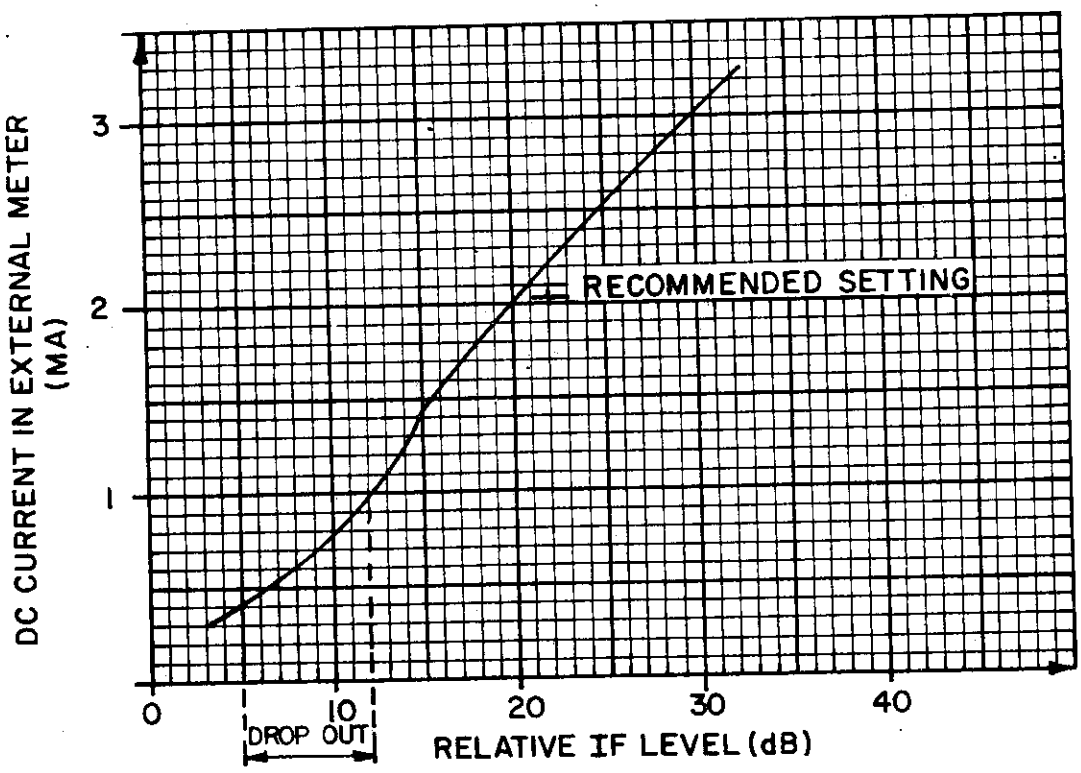


Figure 3 - Carrier Level Monitor Characteristic

1. Change of Battery Voltage from 250 V to 125 VDC or 48 VDC

   a. Switch Receiver and 250 Volt Regulator OFF.

   b. Reference terminal connections on Composite Diagram, 19E501457, Figure 2. Add jumper between SA-3 and SA-13.

   c. Power Auxiliary Module: Reference jumper chart on Composite Diagram, 19E501457, Figure 2, Note 24.

   d. Always keep switch S1 on the 250 Volt Regulator OFF when making these changes.

   e. Test the unit as per the 48 Volt and 36 Volt test given previously in Steps A2 and A3.

2. Change of Battery Voltage from 125 VDC to 48 VDC (or vice-versa)

   a. Turn Receiver OFF.

   b. Reference Interconnection Cable Drawing 19C318330

   c. Power Auxiliary Module: Reference jumper chart on Composite Diagram 19E501457, Figure 2, Note 24.

   d. Test the unit per the 48 Volt and 36 Volt test given previously in Steps A2 and A3.

G. Change of Channel Frequency

In order to change channel frequency, a new pair of matched crystals and a new receiver filter must be ordered. The procedure is as follows:

a. Insert the new pair of crystals in the Local Oscillator and Mixer Module. Crystal Y1 has a frequency of 2010 kHz plus channel frequency. Crystal Y2 has a frequency of 2,000.000 kHz. The difference between the two crystal frequencies is equal to the channel frequency plus 10.000 kHz.

b. Replace the band pass filter in the Filter Module with the new one. Reference to Table 2 gives a cross reference between the GE Part No. printed on the filter can and the channel frequency.

c. Adjust the local oscillator frequency according to Section B of the alignment instruction given previously.

d. Adjust the RF input level according to Section D of the alignment instruction given previously.

TELECOMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

DESCRIPTION

RECEIVER SHELF UNIT
PL-19D415194-G1 thru -G8

Introduction

The Receiver Shelf Unit, PL-19D415194-G1, is a four rack unit (1 RU = 1-3/4 in.) shelf designed for mounting the various special Type CR61A and Type CR71A receiver modules in a standard 19-inch wide rack or cabinet.

The Receiver Shelf Unit, PL-19D415194-G2, is also a four rack unit shelf and was designed for mounting some standard Type CR61A and Type CR71A receiver modules in a standard 19-inch wide rack or cabinet. The -G1 and -G2 shelves contain connectors for mounting seven printed circuit type modules.

The Receiver Shelf Unit, PL-19D415194-G3 is also a four rack unit shelf and was designed for mounting the various standard Type CR51B receiver modules in a standard 19-inch wide cabinet or rack. The -G3 shelf contains connectors for mounting five printed circuit type modules.

The Receiver Shelf Unit, PL-19D415194-G4 is also a four rack unit shelf and was designed for mounting the various standard Type CR71A (and, in some instances, Type CR61A) receiver modules in a standard 19-inch wide rack or cabinet. The -G4 shelf contains connectors for mounting seven of these printed circuit type modules.

The Receiver Shelf Unit, PL-19D415194-G5, is also a four rack unit shelf and was designed for mounting special Type CR71A receiver modules in a standard 19-inch wide cabinet or rack. The -G5 shelf contains connectors for mounting six printed circuit type modules.

The Receiver Shelf Units, PL-19D415194--G7 and -G8 are the same as the -G3 and -G4 respectively, except that each contains a DCmA panel meter.

Provisions are made on each shelf for RF connections to be made from either the front or the rear of the shelf.

Description

The basic shelf unit (-G6) contains connectors and interconnection wiring for the five or seven receiver modules. A "front panel" at the top front of the shelf is used to mount power switch S1, power ON lamp DS1, fuses F1 and F2, and RF coaxial connector J33 (BNC type). A "rear panel" at the top rear of the shelf is used to mount RF coaxial connector J32 (UHF type), 24-pin connector J31, and in -G1, -G2, -G4, -G5 and -G8 only, 8-pin connector J35. The printed wiring connectors (15-contacts) are covered at the rear of the shelf by a metal plate for protection of the wire-wrap terminals. NOTE: Refer to the parts list for a listing of these connectors and the group they are used in.

Connector J35 is used only when the trip relay is mounted in the same rack as the receiver, or when it is desired to sense the discriminator TRIP and GUARD outputs. Channel failure indication from the logic module is also accessible from this plug. NOTE: This connector is used in -G1, -G2, -G4, -G5 and -G8 only.

Fuses F1 and F2 are removable from the front of the unit. To replace the lamp bulb, DS1, unscrew the lens.

Reference should be made to Interconnection Diagram 19D415245 and to Parts Layout Diagram 19D415294 for the -G1 shelf.

Reference should be made to Interconnection Diagram 19D415590 and to Pars Layout Diagram 19D415614 for the -G2 shelf.

Reference should be made to Interconnection Diagram 19D415589 and Parts Layout Diagram 19D415615 for the -G3 and -G7 shelf.

Reference should be made to Interconnection Diagram 19D415632 and Parts Layout Diagram 19D415633 for the -G4 and -G8 shelf.

Reference should be made to Interconnection Diagram 19D415839 and Parts Layout Diagram 19D415614 for the -G5 shelf.

PARTS LIST

RECEIVER SHELF UNIT
PL-19D415194-G1 thru -G8

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - - FUSES - - - - - - - - - - - - - -
F1 and F2	7487942-P3	Cartridge, slow-blowing; 250V, 1/2 A; sim Bussman MDL-1/2. (See shelf front for rating to use)

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - - - FUSES - - - - - - - - - - - - - - -
F1 and F2	7487942-P4	Cartridge, slow-blowing; 250V, 3/4 A; sim Bussman MDL-3/4 (see shelf front for rating to use).
		- - - - - - - - - - - - - - - INDICATOR - - - - - - - - - - - - - - -
DS1	19C307037-P25	Lamp, 55V, 0.05 A; bulb, T 3-1/4; sim GE Cat. No. 1835.
		- - - - - - - - - - - CONNECTORS AND PLUGS - - - - - - - - - - -
J1 thru J10	19A116497-P1	Connector, printed wiring, one part: sim Elco 00-6021-015-955-004. J2 used in -G1 only. J4 used in -G1 only. J5 used in -G2, -G3, -G4, -G5, -G7 and -G8 only. J6 used in -G1, -G2, -G4, -G5 and -G8 only. J7 used in -G1 only. J9 used in -G2, -G3, -G4, -G5, -G7 and -G8 only. J9A used in -G3, -G4, -G7 and -G8 only. J10 used in -G2, -G4 and -G8 only.
J31	7775345-P53	Receptacle, 24-male contacts; sim Elco 01-2224-115-004-XXX.
J32	2R22-P3	Connector, Coaxial, receptacle; sim Signal Corps SO-239 or Amphenal 83-1R.
J33	7776570-P17	Connector, coaxial, BNC series, bulkhead receptacle; Mil. No. UG-1094/U.
J35	7775345-P27	Connector, 8-contacts; sim Elco 01-1108-121-004-100. NOTE: Used in -G1, -G2, -G4, -G5 and -G8 only.
P31	7775345-P18	Plug, 24-contacts; sim Elco 01-4224-105-001-100.
P32	2R22-P1	Plug, coaxial; sim Signal Corps No. PL-259 or Amphenal Cat. No. 83-1SP.
P33	7776570-P1	Cable Plug, coaxial, BNC series; Mil. No. UG-88C/U or UG-88D/U. (For use with RG58A/U cable).
P35	7775345-P54	Plug, 8-contacts; sim Elco 01-3108-105-004-100 NOTE: Used in -G1, -G2, -G4, -G5 and -G8 only.
	2R22-P2	Coaxial, right angle adapter; sim Signal Corps No. M-359 or Amphenol Cat. 83-1AP.
		- - - - - - - - - - - - - - METER - - - - - - - - - - - - - -
M1*	19A116982-P1	Panel; 0-3 DCmA ±2% of full scale reading; sim GE Cat. 50-185111FXFX1JTD used in -G7 and -G8 only.
		- - - - - - - - - - - - - RESISTOR - - - - - - - - - - - - -
R1	3R79-P301J	Composition, 300 ohms ±5%, 2 W.
		- - - - - - - - - - - - - -SWITCH - - - - - - - - - - - - -
S1	5492177-P2	Toggle, DPST; sim A-HH Cat. No. 82143-VSL; 6A 250V.
		- - - - - - - - - - - - - -HOLDERS - - - - - - - - - - - - -
XF1 and XF2	19B209005-P1	Fuse, post type; sim Littelfuse No. 342012.
XDS1	7141855-P15	Incandescent, indicator light; without lens cap; sim Dialight Piece No. 95-0410-09-102. Plastic lens cap, transluscent white, sim Dialight Piece No. 135-1475 (GE Part No. 7141855-P30).

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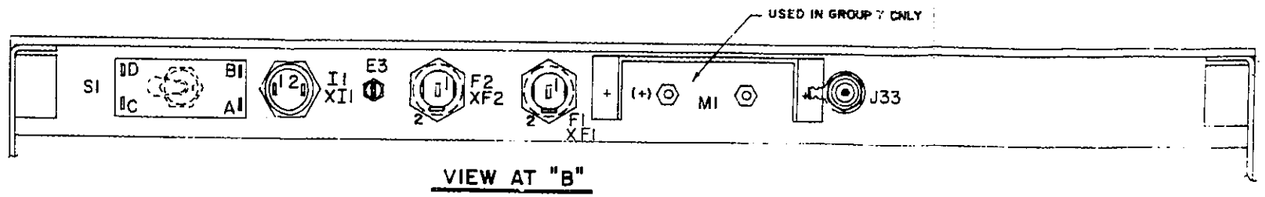
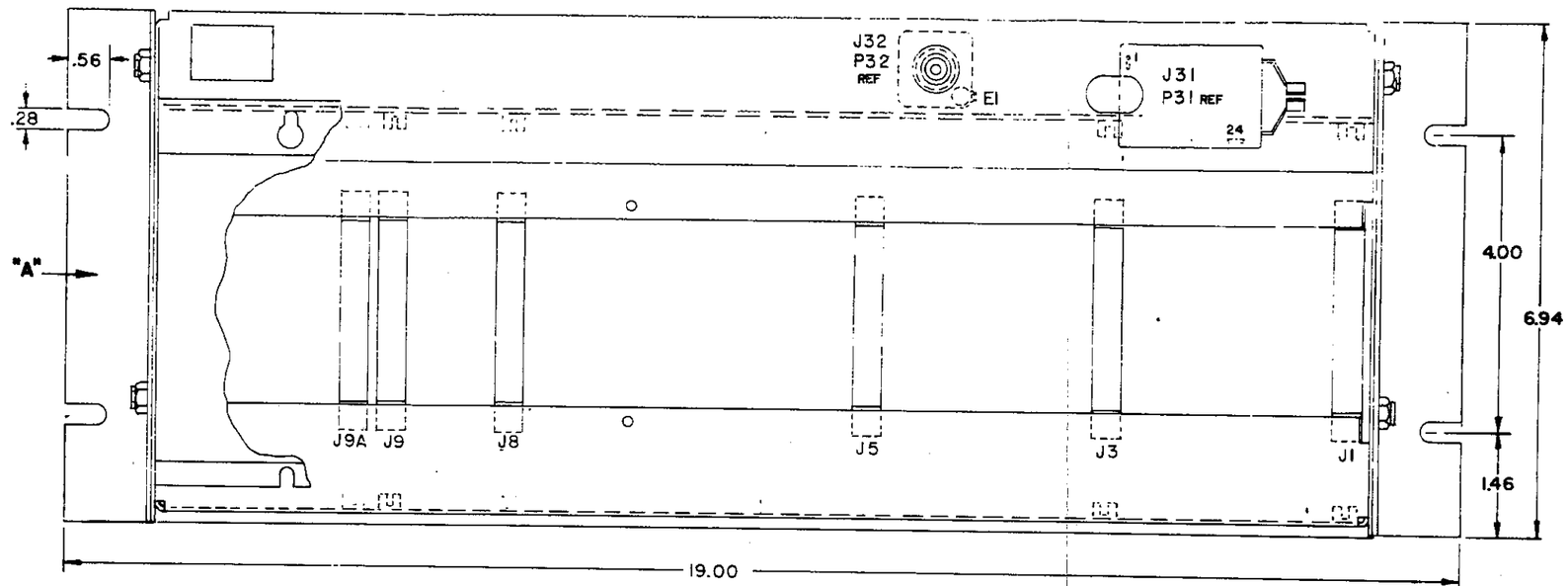
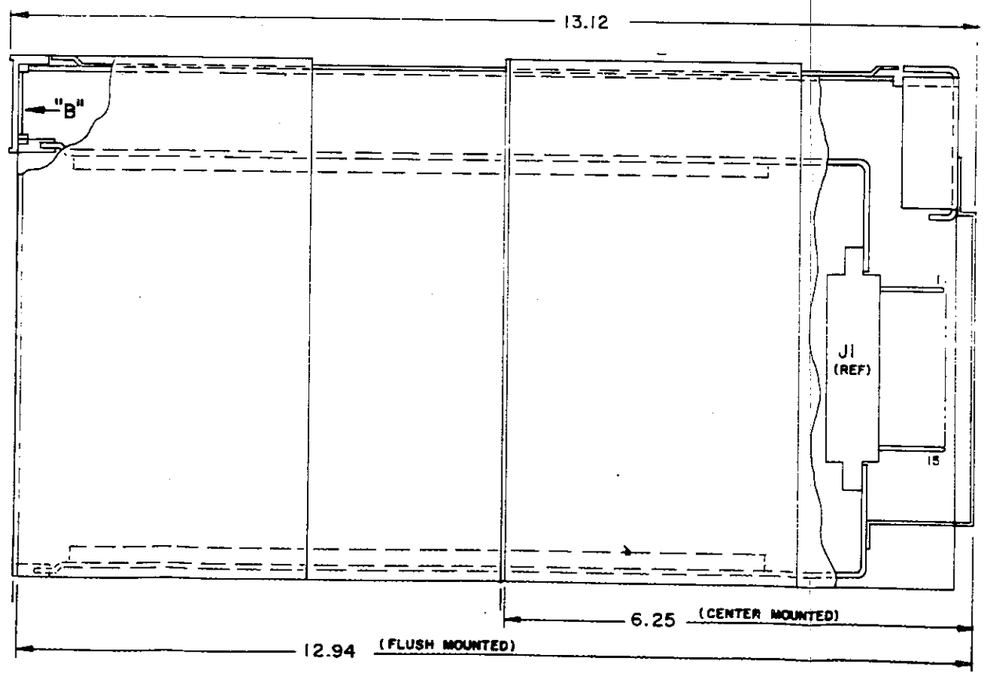


VIEW AT "B"



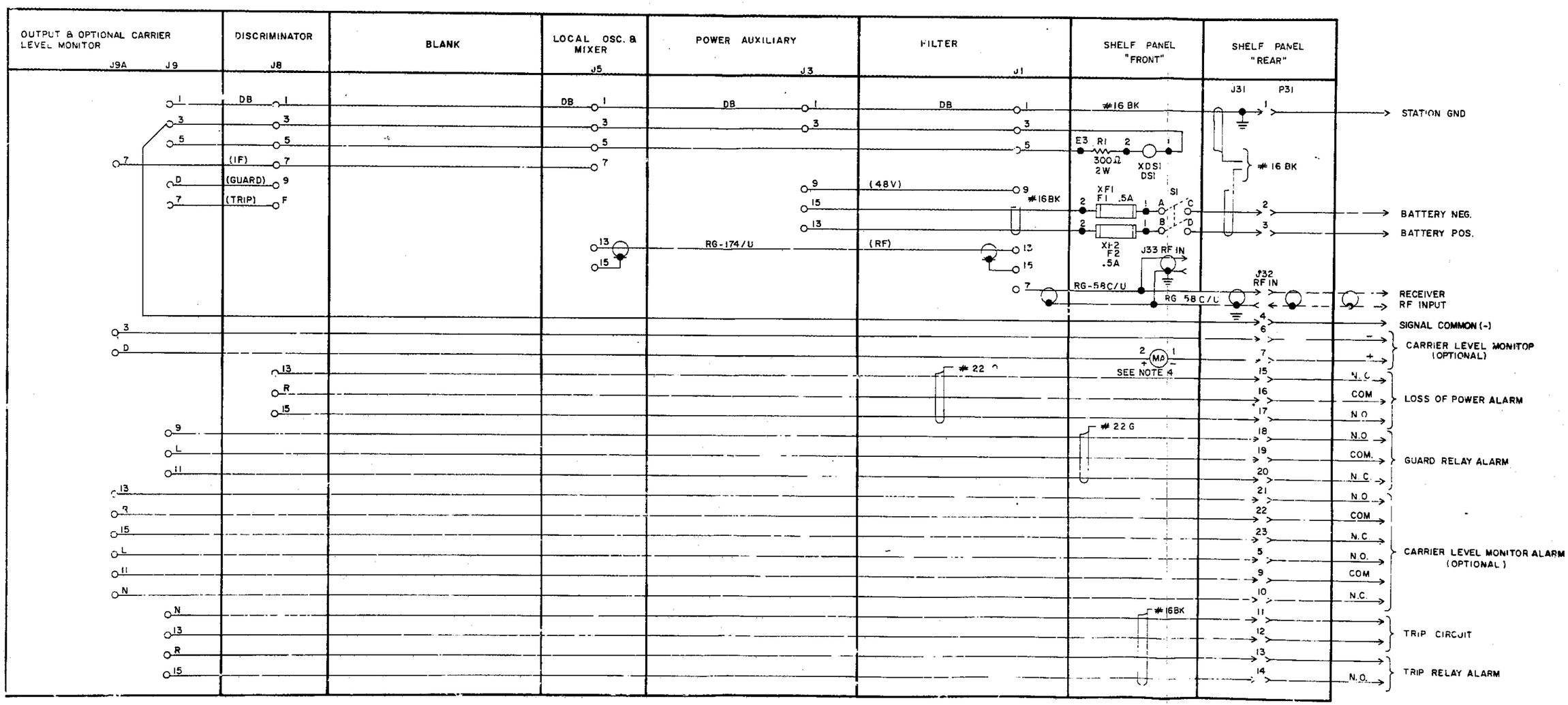


VIEW AT "A"

Parts Layout/Outline Diagram

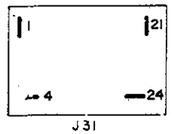
RECEIVER SHELF
PL-19D415194-G3 and -G7

(19D415615, Rev. 1)



NOTES:

1. ALL FACTORY WIRING TO BE #22 WHITE UNLESS OTHERWISE SPECIFIED
2. CONNECTOR PIN LAYOUT IS AS FOLLOWS:



J31 CONNECTOR AS SEEN FROM REAR OF SHELF

3. MODULE ARRANGEMENT AS SEEN FROM REAR.
4. CLM METER IN GROUP 7 ONLY.

PL-19D415194G3 REV. "A"
G7 REV. "A"

G3 WITHOUT CLM METER
G7 WITH CLM METER

Elementary-Interconnection Diagram

RECEIVER SHELF
PL-19D415194-G3

(19D415589, Rev. 4)

DESCRIPTION

RECEIVER FILTER MODULE PL-19D415161-G1 and -G2

Introduction

This module is used in relaying receivers and provides a very selective crystal filter for selection of only the desired channel frequencies. A voltage regulator circuit in the module provides the regulated 36 VDC for the entire Receiver Shelf.

The -G1 module is used in the Type CR61A and Type CR71A Receiver Equipment.

The -G2 module is used in the Type CR51B Receiver Equipment.

The module is a printed circuit card which is plugged into a 15-pin connector mounted on the Receiver Shelf Unit.

Operation

Refer to the composite drawing, Figure 1, included in the Model Instruction Book.

An RF signal from the Coupling Equipment is passed to the Receiver Shelf coaxial connector and to terminal 7 of plug P1. This input signal is passed through a variable loss network to crystal filter FL1. The filter input has the common side connected to station ground.

The filtered output is passed from a balanced output (2500 VDC insulation to ground) to a 2-stage amplifier which provides the proper drive level for the mixer circuit located in the Local Oscillator Mixer Module. Potentiometer R3 (RF IN ADJ) provides front panel adjustment of the mixer input level. (See the receiver alignment section for proper level settings.)

The normally high input impedance of the module may be converted to 68 ohms by terminating jumper "C" at terminal E2, if so desired. For very short lines (or receiver input levels above +14 dBsr (5 VRMS), an attenuation path can be inserted by terminating jumper "B" at terminal E8 and jumper "A" at terminal E9.

A series of voltage regulator circuit, composed of transistors Q3 and Q4 and voltage regulator Zener diode VR1, provides regulated 36 VDC for the amplifier and the rest of the receiver circuitry. Output voltage changes are sensed at the base of transistor Q3, turning Q3 ON or OFF as required to hold a constant 36 VDC emitter voltage at the emitter of transistor Q4. Potentiometer R19 provides front panel control of this 36 VDC level; reactor L1 and capacitor C5 provide filtering of the unregulated 48 VDC input voltage.

Trouble-Shooting Aids

The RF gain of the attenuator-filter-amplifier combination actually appears as a loss of approximately 4 dB with the input attenuator set at minimum attenuation. This is true for an input signal at center frequency and with the output terminated by the mixer circuit. Variations in filter insertion loss with frequency will cause this value to change by ±2 dB from unit to unit.

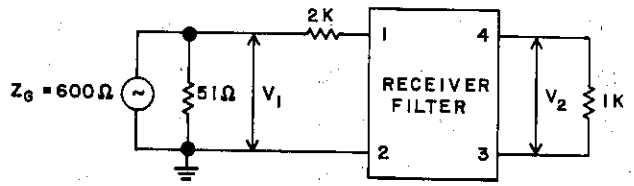
Values of all transistor DC voltage levels are given in Table 1. The values were measured with reference to negative common with the module plugged into the Shelf Unit, using a 20,000 ohms per volt test instrument and with 48 VDC applied to terminal 9.

TABLE 1

Typical DC Voltages with Reference to Negative Common

Transistor	Emitter VDC	Base VDC	Collector VDC
Q1	1.1	1.65	5.5
Q2	0.4	1.05	5.5
Q3	15.5	16.2	36.8
Q4	36.1	36.8	48

FILTER TROUBLESHOOTING AID



TYPICAL READING AT CENTER FREQUENCY

V_1 = -5 DBSR = 0.430VMRS
V_2 = -18 DBSR = 0.090 VRMS (-G1)
V_2 = -21 DBSR = 0.070 VRMS (-G2)

For more information, refer to the selectivity characteristic under Nominal Operating Characteristics in the General Instructions for a particular receiver model.

Nominal Operating Characteristics

Input Voltage	42-56 VDC
Input Current	(-G1) 470mA; (-G2) 400mA
Output Voltage	36 VDC
Output Current	(-G1) 450mA; (-G2) 380mA
RF Input Frequency Range	30-300 kHz
Adjusted for max. attenuation	+32 dBsr max. (30 VRMS)

PARTS LIST

RECEIVER FILTER MODULE
PL-19D415161-G1 and -G2

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - -CAPACITORS - - - - - - - - - - - - -
C1	19A116080-P7	Polyester; 0.1 µf ±20%, 50 VDCW
C2	19A116080-P111	Polyester; 0.47 µf ±10%, 50 VDCW
C3	19B200230-P16	Polyester; 1.0 µf ±20%, 200 VDCW
C4	19A115680-P6	Electrolytic; 50 µf -10%, +150%, 50 VDCW
C5	19B200230-P16	Polyester; 1.0 µf ±20%, 200 VDCW
C6	19A116080-P111	Polyester; 0.47 µf ±10%, 50 VDCW
		- - - - - - - - - - - - - -DIODES - - - - - - - - - - - - -
CR1 & CR2	19A116565-P1	Silicon, rectifier; sim Sem-Tech SC4 or Type 1N4004
		- - - - - - - - - - - - - -FILTER - - - - - - - - - - - - -
FL1 *	19C304798	Type CR51B Bandpass; customer must specify frequency
FL1 *	19C304747	Type CR61A Bandpass; customer must specify frequency
FL1	19C304676	Type CR71A Bandpass; customer must specify frequency
		- - - - - - - - - - - - - -JACKS - - - - - - - - - - - - -
J1	7150763-P1	Test point, sim Alden 110BC1-black
J2	7150763-P2	Test point, sim Alden 110BC1-red
J3	7150763-P8	Test point, sim Alden 110BC1-orange
J4	7150763-P6	Test point, sim Alden 110BC1-blue
J5	7150763-P2	Test point, sim Alden 110BC1-red
J6	7150763-P4	Test point, sim Alden 110BC1-green
		- - - - - - - - - - - - - -INDUCTOR - - - - - - - - - - - - -
L1	19B209345-P1	Reactor, inductance, 20 mH at 0.7A; resistance, 0.5 ohms, max.; operating voltage, 15 VDC
		- - - - - - - - - - - - - TRANSISTORS - - - - - - - - - - - - -
Q1	19C300114-P1	Silicon, NPN; sim Type 2N706
Q2	19A115300-P2	Silicon, NPN; sim Type 2N3053
Q3	19A115783-P1	Silicon, NPN; sim Type 2N4240
Q4	19A116315-P1	Silicon, NPN, switch; sim Type 2N4347
		- - - - - - - - - - - - - -RESISTORS - - - - - - - - - - - - -
R1*	3R79-P152J	Composition; 1.5K ohms ±5%, 2 W
R2 *	19A116278-P229	Metal film; 1.96K ohms ±2%, 1/2 W. Used in -G1 only.
R2 *	19A116278-P205	Metal film; 1.1K ohms ±2%, 1/2 W. Used in -G2 only.
R3 *	2R74-P10	Variable, composition; 2500 ohms ±20%, 1-1/8 W, 500 VDC max.

Symbol	GE Part No.	Description
R4	19A116278-P265	Metal film; 4.64K ohms ±2%, 1/2 W. Used in -G1 only.
R4 *	19A116278-P285	Metal film; 7.5K ohms ±2%, 1/2 W. Used in -G2 only.
R5 *	19A116278-P205	Metal film; 1.1 K ohms ±2%, 1/2 W. Used in -G1 only.
R5 *	19A116278-P201	Metal film; 1 K ohms ±2%, 1/2 W. Used in -G2 only.
R6 *	19A116278-P145	Metal film; 287 ohms ±2%, 1/2 W
R7	3R79-P561J	Composition; 560 ohms ±5%, 2 W
R8 *	3R78-P621J	Composition; 620 ohms ±5%, 1 W
R9	19A116278-P317	Metal film; 14.7K ohms ±2%, 1/2 W
R10	19A116278-P209	Metal film; 1.21K ohms ±2%, 1/2 W
R11	19A116278-P317	Metal film; 14.7K ohms ±2%, 1/2 W
R12 *	19A116278-P1	Metal film; 10 ohms ±2%, 1/2 W
R13 *	3R79-P511J	Composition; 510 ohms ±5%, 2 W. Used in -G1 only.
R13 *	3R79-P621J	Composition; 620 ohms ±5%, 2 W. Used in -G2 only.
R14	19B209022-P107	Wirewound; 0.47 ohms ±10%, 2 W
R15	3R77-P472J	Composition; 4.7K ohms ±5%, 1/2 W
R16	19A116278-P237	Metal film; 2.37K ohms ±2%, 1/2 W
R17	19A116278-P253	Metal film; 3.48K ohms ±2%, 1/2 W
R18	19A116278-P245	Metal film; 2.87K ohms ±2%, 1/2 W
R19 *	19A116430-P7	Variable, Cermet; 5K ohms ±10%, 3/4 W
R20	3R79-P680J	Composition; 68 ohms ±5%, 2 W
R21 *	19A116278-P233	Metal film; 2.15K ohms ±2%, 1/2 W. Used in -G1 only.
R21 *	19A116278-P237	Metal film; 2.37 K ohms ±2%, 1/2 W. Used in -G2 only.
		- - - - - - - - - - VOLTAGE REGULATOR - - - - - - - - - -
VR1 thru VR3	19A115528-P6	Silicon, Zener diode; sim Type 1N3025A or GE Type Z4XL16.

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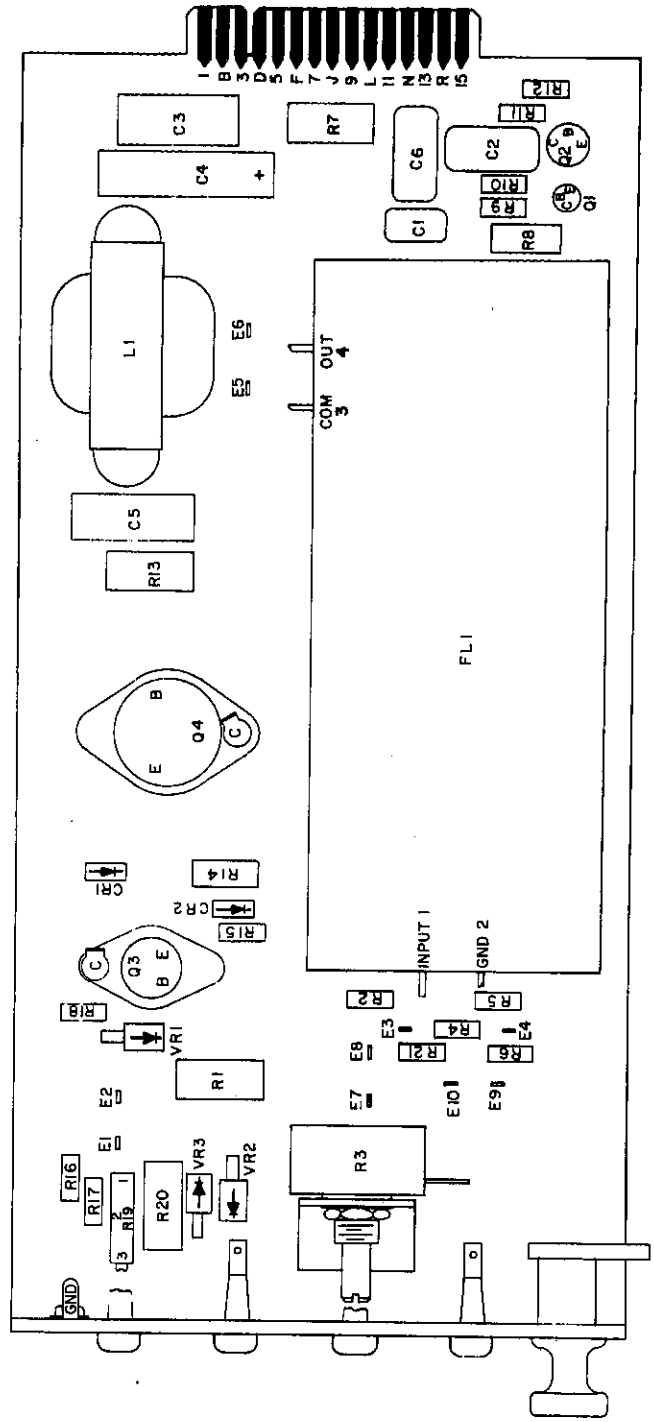

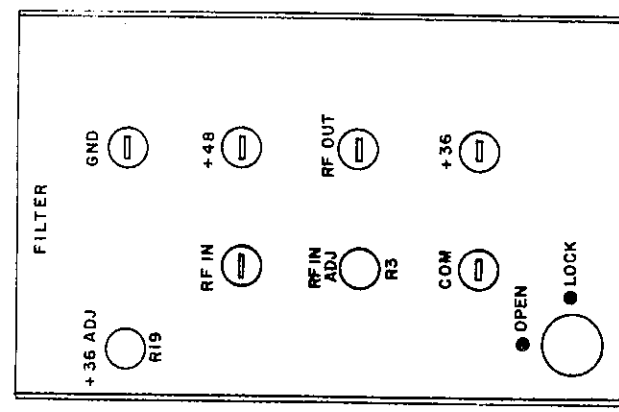

Parts Layout Diagram

FILTER MODULE
PL-19D415161 -G1 and -G2

(19C318423, Rev. 2)

DESCRIPTION

POWER AUXILIARY MODULE
PL-19D415023-G1 and -G2

Introduction

The Power Auxiliary Module, PL-19D415023-G1 serves primarily as a 125 VDC to 48 VDC converter, and PL-19D415023-G2 as a battery filter circuit for the lower voltage circuitry in the transmitter. The module is applied in both 125 VDC and 48 VDC applications to permit field conversion from either 125 VDC or 48 VDC, or vice-versa, power sources, and, in addition, serves as a filter for high-energy transient voltages which are commonly present on battery leads. Jumpers "A" and "B" are used to perform this conversion.

Operation

With jumper "A" connected to terminal E3 and jumper "B" connected to terminal E2 (-G1 connections), the module serves as a highly efficient convertor to provide a regulated 48 VDC voltage for the associated power amplifier circuit and the 36 VDC regulator circuit. Transistor Q1 turns ON and OFF at a rate which keeps output capacitors C8 and C9 charged-up to the nominal 48 VDC output. Inductor L3 serves as a current source for capacitors C8 and C9 during periods in which transistor Q1 is turned OFF. Transistors Q5 and Q6 form a very sensitive differential amplifier which senses the voltage level across capacitors C8 and C9. A drop in this voltage is sensed and used to activate the Schmitt trigger formed by transistors Q3 and Q4. A drop in the output voltage quickly switches transistor Q3 ON, thereby turning transistors Q2 and Q1 ON, producing a surge of charging current through capacitors C8 and C9. This action is continuous and a series of very steep pulses may be seen at approximately a 5 kHz rate by monitoring the collector voltage at transistor Q3 on an oscilloscope.

Diode CR3 serves as a current path for the inductor current when transistor Q1 is in the OFF state, and limits the transient voltage applied to the emitter of transistor Q1. Diode CR2 is used for protection against short-circuit load conditions and removes the bias from transistor Q3 under a short circuit condition, thereby turning transistor Q1 OFF. Potentiometer R18 is accessible from the front of the module to adjust the 48 VDC output level.

In 48V battery applications, jumper "A" is connected to terminal E4 and jumper "B" is connected to terminal E1 (-G2 connections). In this application, inductors L1 and L2 and capacitors C1 through C3 provide an input filter for protection of the 48 VDC to 36 VDC regulator from transient voltages appearing on the battery leads.

Trouble-Shooting Aids

Refer to the composite drawing Figure 2 included in the model book for the electrical connections on this module. Should difficulty be encountered in obtaining the 36 VDC regulated shelf voltage or the 48 VDC power auxiliary output voltage, the following checks should be made. Insert the Power Auxiliary Module into the Extender Unit (optionally supplied in the Extender Test Kit) and then insert the Extender Unit into the shelf connector. When set up for -G1 operation (125 VDC input), the 48 VDC output level should be adjustable (using R18) from 43 VDC to 51 VDC. The various transistor voltages obtained should be similar to those shown in Table 1, when using a high impedance VTVM and common negative reference.

TABLE 1 (-G1 only)

(Reference: common negative)

Transistors	Base VDC	Collector VDC	Emitter VDC
Q1	48.5	125	48
Q2	125	48.5	125.5
Q3	-0.12*	72	3.7
Q4	3.8	13	3.6
Q5	2.9	8.8	2.3
Q6	2.9	9.3	2.3

* Negative value results from shape of voltage waveform.

Nominal Operating Characteristics

Group 1

DC input voltage	129 VDC, nominal
Input voltage range	104-140 VDC
Input current (for 800 mA output)	400 mA @ 129 VDC
Output voltage range	43-51 VDC (adjustable)

Group 2 (Filter only)

DC input voltage	48 VDC, nominal
Input voltage range	42-56 VDC
Input current	800 mA
Output voltage	48 VDC, nominal (42-56 VDC, follows input)

PARTS LIST

POWER AUXILIARY MODULE
PL-19D415023-G1 & G2

Symbol	GE Part No.	Description
		---------- CAPACITORS ----------
C1 & C2	3R121-P19	Paper-Askarel: 0.25µf ±10%, 1500 VDCW; sim GE Cat. No. 23F963
C3	5493132-P12	Electrolytic: 50 µf -10%, +50%, 250 VDCW; sim Sprague Type 39D
C4	4029003-P12	Silver mica: 1500µµf ±5%, 500 VDCW; sim Electromotive Type DM-20
C5	19A115028-P108	Polyester: 0.015µf ±20%, 200 VDCW
C6	4029003-P20	Silver mica: 3300µµf ±5%, 500 VDCW; sim Electromotive Type DM-20
C7	5496267-P19	Tantalum: 22µv ±20%, 35 VDCW; sim Sprague Type 150D
C8 & C9	19B200230-P20	Metallized polyester: 5µf ±20%, 200 VDCW; sim Good-All Type X663FR
C10	19A115028-P111	Polyester: 0.047 µf ±20%, 200 VDCW
		---------- DIODES ----------
CR1 thru CR3	19A116565-P2	Silicon rectifier: sim Sem Tech SC-6 or Type IN4005
		----------JACK TIP----------
J1 & J3	7150763-P4	Test point; sim to Alden 110BC1-green
J2 & J4	7150763-P2	Test point; sim to Alden 110BC1-red
		---------- REACTORS AND COIL ----------
L1 & L2	19B209345-P1	Reactor; DC resistance, 0.5 ohms max; operating voltage, 15 VDC; inductance, 20 mH at 0.73 amp DC
L3	19B209146-P1	Reactor; DC resistance, 2.5 ohms max; operating voltage, 14 VDC; inductance, 100 mH at 0.85 amp DC

Symbol	GE Part No.	Description
L4	PL-19B213869-G1	Coil; Inductance, 294-306 mH at 1kHz
		---------- TRANSISTORS ----------
Q1	19A115924-P1	Silicon, NPN; sim to Delco DTS-413 or Type 2N3902
Q2	19A116330-P1	Silicon, PNP; sim to Type 2N3636
Q3 *	19A115783-P2	Silicon, NPN; sim to Type 2N4240
Q4	19A115300-P4	Silicon, NPN; sim to Type 2N3053
Q5 & Q6	19A115720-P1	Silicon, NPN; sim RCA-40232 or Type 2N3227
		---------- RESISTORS ----------
R1	19A116278-P61	Metal film; 42.2 ohms ±2%, 1/2 W; Corning C5M
R2	3R77-P511J	Fixed composition: 510 ohms ±5%, 1/2 W.
R3	19A116278-P333	Metal film; 21.5 K ohms ±2%, 1/2 W; Corning C5M
R4	19A116278-P157	Metal film; 383 ohms ±2%, 1/2 W; Corning C5M
R5	19A116278-P317	Metal film; 14.7 K ohms ±2%, 1/2 W; Corning C5M
R6	19A116278-P201	Metal film; 1 K ohms ±2%, 1/2 W; Corning C5M
R7	19A116278-P317	Metal film; 14.7 K ohms ±2%, 1/2 W; Corning C5M
R8	3R79-P153J	Fixed composition: 15 K ohms ±5%, 2 W
R9	19A116278-P273	Metal film; 5.62 K ohms ±2%, 1/2 W; Corning C5M
R10	19A116278-P301	Metal film; 10 K ohms ±2%, 1/2 W; Corning C5M
R11	3R77-P242J	Fixed composition: 2.4 K ohms ±5%, 1/2 W
R12	19A116278-P265	Metal film; 4.75 K ohms ±2%, 1/2 W; Corning C5M
R13	19A116278-P169	Metal film; 511 ohms ±2%, 1/2 W; Corning C5M
R14	3R79-P152J	Fixed composition: 1.5 K ohms ±5%, 2 W
R15	3R77-P302J	Fixed composition: 3 K ohms ±5%, 1/2 W
R16	3R77-P103J	Fixed composition: 10 K ohms ±5%, 1/2 W
R17	19A116278-P229	Metal film; 1.96 K ohms ±2%, 1/2 W; Corning C5M
R18	19A116430-P7	Variable; cermet; 5 K ohms ±10%, 0.75 W; sim Helitrim Model 79 P
R19	19A116278-P153	Metal film; 348 ohms ±2%, 1/2 W; Corning C5M
R20 & R21	19A116278-P290	Metal film; 8.45 K ohms ±2%, 1/2 W; Corning C5M
		---------- VOLTAGE REGULATOR ----------
VR1	4036887-P2	Silicon, Zener; sim to Type IN5224B
VR2	4036887-P17	Silicon, Zener; sim to Type IN5250B

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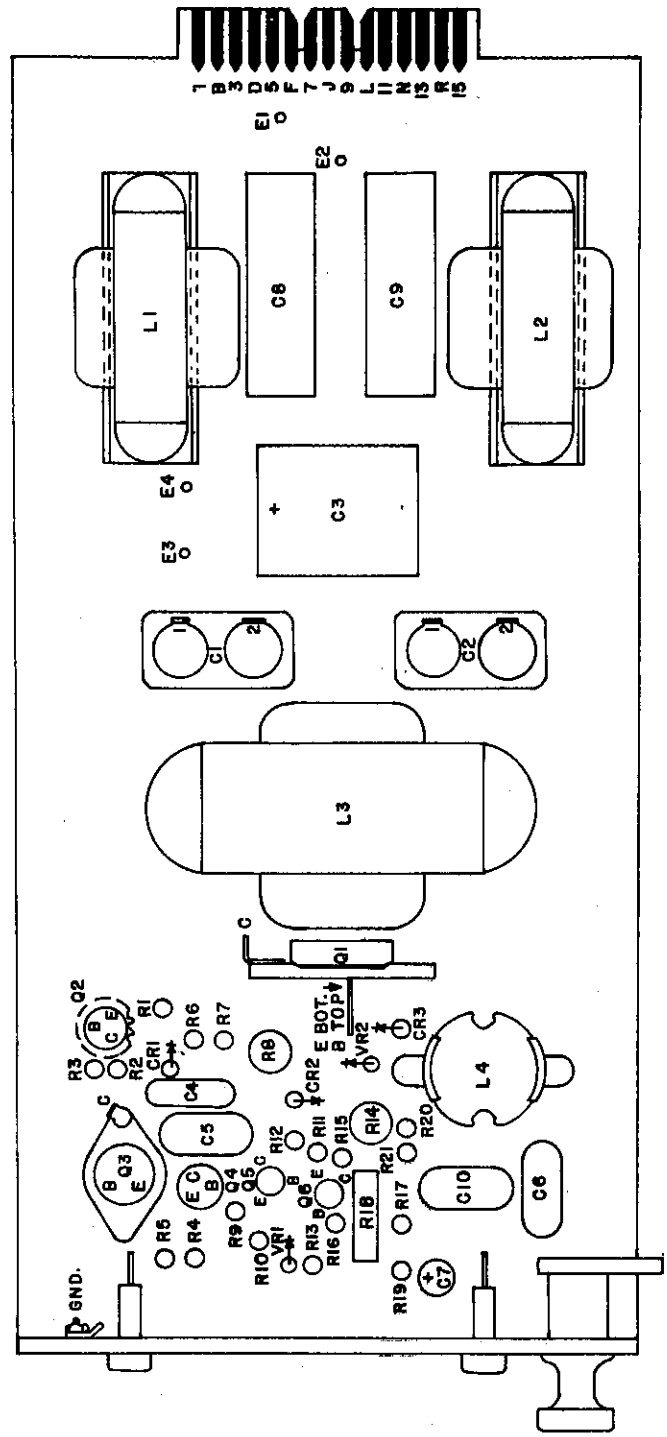

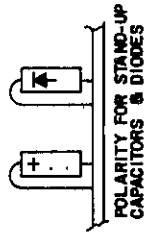

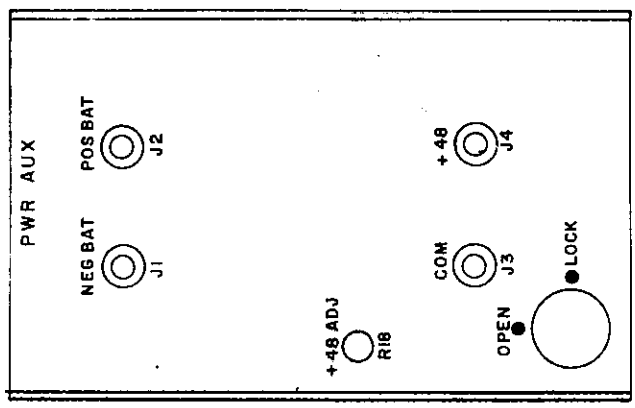

Parts Layout Diagram

POWER AUXILIARY MODULE
PL-19D415023-G1

(19C318390, Rev. 1)

DESCRIPTION

LOCAL OSCILLATOR AND MIXER MODULE PL-19D415190-G1 and -G2

Introduction

The Local Oscillator and Mixer Module consists of two parts, the local oscillator subassembly circuit and the mixer circuit. It is used to translate the frequency of the receive signal to an intermediate frequency (IF) of 29 KHz in -G1 or to 10 KHz in -G2. The local oscillator subassembly circuit generates the local carrier frequency which, after being amplified, drives the mixer circuit.

The module is a printed circuit card which is plugged into a 15-pin connector mounted on a Shelf Unit.

Principles of Operation

Refer to the Elementary Diagram as shown in Figure 1 which is included in the Model Instruction Book.

The local Oscillator Subassembly consists of two identical transistor stages, a diode mixer stage and a low-pass filter. Each transistor stage consists of a transistor, crystal, and associated components.

The stage containing transistor Q2 generates an oscillation whose frequency of 2 MHz is determined by crystal Y2 and capacitors C12 and C13.

The stage containing transistor Q1 generates a signal whose frequency is 2.029 MHz plus channel frequency for -G1 (2.010 MHz for -G2) which is determined by crystals Y1 and capacitors C2 and C3.

Both signals (2 MHz and 2.029 MHz, or 2.010 MHz, + channel frequency) are injected into the forward biased diode CR1 which serves as a mixer. The low-pass filter consisting of capacitors C10, and C15 and Coil L1, roll-off frequency of about 400 KHz; consequently, the higher frequencies, in particular the 2 MHz oscillations, are cut off. Thus, the resulting frequency is the difference between the two oscillator frequencies, which is 29 KHz plus channel frequency for -G1 or 10 KHz plus channel frequency for -G2.

This signal is amplified in a two stage amplifier, consisting of transistors Q41 and Q42, and is fed to the mixer circuit where it is used as the local carrier signal.

The operation of the mixer circuit can be understood from a study of Figure A.

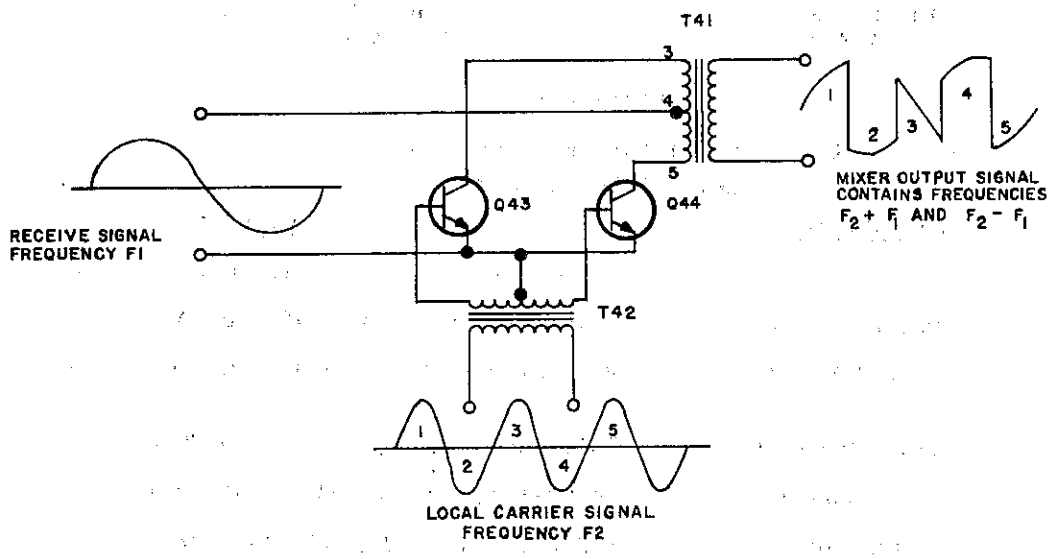

Figure A - Mixer Operation

During the positive half of the carrier cycle, transistor Q44 is conducting and transistor Q43 is turned OFF, which places pin 5 of transformer T41 to ground. During the negative half of the carrier cycle, transistor Q43 is conducting and transistor Q44 is turned OFF, which places pin 3 of transformer T41 to ground. Thus, when pin 5 is grounded, pin 3 is open and vice versa. The effect of this is to give an output wave that has frequency components in it that are equal to the sum and the difference between local carrier and receive signal.

In -G1, the mixer output is fed to a band pass filter with a center frequency of 29 KHz. In -G2, the mixer output is fed to a bandpass filter with a center frequency of 10 KHz. The filter passes only the difference frequency between local carrier and receive signal, which is called the intermediate frequency signal (IF signal).

A one-stage amplifier, transistor Q45, amplifies this IF signal.

Trouble-Shooting Aids

All DC voltages given in Table 1 are measured with a VOM (20K ohms/V) with reference to commom negative.

Table 1

Typical DC Voltages
(Common Negative Reference)

Transistor	Emitter	Base	Collector
Q1	5.5	6.0	12.0
Q2	5.5	6.0	12.0
Q41	5.7	6.1	28
Q42	6.2	6.6	16.5
Q43	0	0	0
Q44	0	0	0
Q45	6.4	6.8	22

For filter characteristics, refer to the parts list and to the nominal operating characteristics which follow.

Nominal Operating Characteristics

Supply Voltage		36 VDC
Current Drain		28 mA
Input Impedance Between pins 13 and 15		75 ohms
Output Load Between pins 7 and 3		less than 5K ohms
Bandpass Filter Characteristic		
For -G1:	29 ±2 KHz	down 3 dB
For -G1:	29 ±4 KHz	down 40 dB
For -G2:	10 ±2 KHz	down 3 dB
For -G2:	10 ±4 KHz	down 40 dB

PARTS LIST

Local Oscillator and Mixer Module
PL-19D415190-G1 and -G2

Symbol	GE Part No.	Description
		- - - - - - - - - CAPACITORS - - - - - - - - -
C41	19A116080-P11	Polyester; 0.47 µf ±20%, 50 VDCW.
C42 & C43	19A116080-P9	Polyester; 0.22 µf ±20%, 50 VDCW.
C44	19A116080-P11	Polyester; 0.47 µf ±20%, 50 VDCW.
C45	19A116080-P9	Polyester; 0.22 µf ±20%, 50 VDCW.
C46	5496267-P17	Tantalum; 1.0 µf ±20%, 35 VDCW.
C47 thru C50	19A116080-P9	Polyester; 0.22 µf ±20%, 50 VDCW. Note: C50 used in -G1 only for this value.

Symbol	GE Part No.	Description
C50*	5496267-P13	Tantelum; 2.2 µf ±20%, 20 VDCW (used in -G2 only)
C51*	19B200240-P9	Tantelum; 15 µf ±10%, 50 VDCW.
C52*	4029003-P12	Silver mica; 1500 pF ±5%, 500 VDCW; (used in -G1 only)
C52*	4029003-P24	Silver mica; 4700 pF ±5%, 300 VDCW; (used in -G2 only)
		- - - - - - - - - - - DIODES - - - - - - - - - -
CR41 & CR42	19A115250-P1	Silicon; fast recover; sim GE Type SSD-753 or Type 1N645.
		- - - - - - - - - - - FILTER - - - - - - - - - -
FL41	19C304697-G1	IF, band-pass; 29 kHz; input impedance, 1K ohms; output impedance, 1K ohms; insertion loss, 1 dB or less. Used in -G1 only.
FL41	19C304788-G1	IF, band-pass; 10 kHz; input impedance, 1K ohms; output impedance, 1K ohms; insertion loss, 1 dB or less. Used in -G2 only.
		- - - - - - - - - - - JACKS - - - - - - - - - -
J1	7150763-P6	Test-point; sim Alden 110BC1-blue.
J2	7150763-P4	Test-point; sim Alden 110BC1-green.
J3	7150763-P8	Test-point; sim Alden 110BC1-orange.
J4	7150763-P7	Test-point; sim Alden 110BC1-white.
J5	7150763-P4	Test-point; sim Alden 110BC1-green.
J6	7150763-P2	Test-point; sim Alden 110BC1-red.
		- - - - - - - - - - TRANSISTORS - - - - - - - - -
Q41 & Q42	19A115720-P1	Silicon, NPN; sim RCA-40232 or Type 2N3227.
Q43 & Q44	19A115300-P4	Silicon, NPN; sim to type 2N3053.
Q45	19A115720-P1	Silicon, NPN; sim RCA-40232 or Type 2N3227.
		- - - - - - - - - - - RESISTORS - - - - - - - - - -
R41	19A116278-P113	Metalfilm; 133 ohms ±2%, 1/2 W.
R42	19A116278-P373	Metalfilm; 56.2K ohms ±2%, 1/2 W.
R43	19A116278-P313	Metalfilm; 13.3K ohms ±2%, 1/2 W.
R44	19A116278-P117	Metalfilm; 147 ohms ±2%, 1/2 W.
R45	19A116278-P249	Metalfilm; 3.16K ohms ±2%, 1/2 W.
R46	19A116278-P69	Metalfilm; 51.1 ohms ±2%, 1/2 W.
R47	19A116278-P245	Metalfilm; 2.87K ohms %2%, 1/2 W.
R48	19A116278-P193	Metalfilm; 909 ohms ±2%, 1/2 W.
R49	19A116278-P365	Metalfilm; 46.5K ohms ±2%, 1/2 W.
R50	19A116278-P313	Metalfilm; 13.3K ohms ±2%, 1/2 W.

Symbol	GE Part No.	Description
R51	19A116278-P217	Metalfilm; 1.47K ohms ±2%, 1/2 W.
R52	19A116278-P69	Metalfilm; 51.1 ohms ±2%, 1/2 W.
R53	19A116278-P165	Metalfilm; 464 ohms ±2%, 1/2 W.
R54	19A116278-P217	Metalfilm; 1.47K ohms ±2%, 1/2 W.
R55	19A116278-P345	Metalfilm; 28.7K ohms ±2%, 1/2 W.
R56	19A116278-P289	Metalfilm; 8.25K ohms ±2%, 1/2 W.
R57	19A116278-P209	Metalfilm; 1.21K ohms ±2%, 1/2 W.
R58	19A116278-P101	Metalfilm; 100 ohms ±2%, 1/2 W.
R59	19A116278-P176	Metalfilm; 604 ohms ±2%, 1/2 W.
R60	19A116278-P153	Metalfilm; 348 ohms ±2%, 1/2 W.
		- - - - - - - - -TRANSFORMERS - - - - - - - - -
T41 & T42	5498875-P1	RF; Freq. range, 50 KHz to 500 KHz; DC current, none; insertion loss, 0.3 dB max.

PARTS LIST

Oscillator Circuit
PL-19D415162-G6

Symbol	GE Part No.	Description
		- - - - - - - - - CAPACITORS- - - - - - - - -
C1	19A116080-P8	Polyester; 0.15 μf ±20%, 50 VDCW.
C2	5490008-P11	Silver mica; 22 pf ±5%, 500 VDCW; sim Electromotive Type DM-15.
C3	5491271-P105	Variable, air, sub-miniature; 1.9 pf min. and 10.5 max. at 1 MHz; peak voltage 750 V; air gap, 0.010 inches; sim E.F. Johnson 189-504-4 or Erie 543-001.
C4	4029003-P12	Silver mica; 1500 μμf ±5%, 500 VDCW; sim Electromotive Type DM-20.
C5	5490008-P29	Silver mica; 120 pf ±5%, 500 VDCW; sim Electromotive Type DM-15.
C6	19A116080-P1	Polyester; 0.01 μf ±20%, 50 VDCW.
C7	5490008-P29	Silver mica; 120 pf ±5%, 500 VDCW; sim Electromotive Type DM-15.
C8 & C9	19A116080-P1	Polyester; 0.01 μf ±20%, 50 VDCW.
C10	5490008-P41	Silver mica; 390 pf ±5%, 500 VDCW; sim Electromotive Type DM-15.
C11	4029003-P12	Silver mica; 1500 μμf ±5%, 500 VDCW; sim Electromotive Type DM-20.
C12	5490008-P8	Silver mica; 15 pf ±5%, 500 VDCW; sim Electromotive Type DM-15.

Symbol	GE Part No.	Description
C13	5490008-P9	Silver mica; 18 pf ±5%, 500 VDCW; sim Electromotive Type DM-15.
C14	19A116080-P8	Polyester; 0.15 µf ±20%, 50 VDCW.
C15	5490008-P41	Silver mica; 390 pf ±5%, 500 VDCW; sim Electromotive Type DM-15.
C16 thru C18	5493392-P7	Ceramic; 1000 µµf -0%, +100%, 500 VDCW; sim Allen Bradley Type FA5C.
		- - - - - - - - - - -DIODE - - - - - - - - - -
CR1	19A115250-P1	Silicon, fast recovery; sim Type 1N645 or GE Type SSD-753.
		- - - - - - - - - - -COIL - - - - - - - - - -
L1	7491382-P107	RF, 1000 µH ±10% 185 mA; 14 ohms max. resistance; sim Delevan 3500 series.
		- - - - - - - - - TRANSISTORS - - - - - - - - -
Q1 & Q2	19C300114-P2	Silicon, NPN; sim Type 2N706
		- - - - - - - - - -RESISTORS - - - - - - - - -
R1 thru R3	19A116278-P309	Metalfilm; 12.1K ohms ±2%, 1/2 W.
R4	19A116278-P257	Metalfilm; 3.83K ohms ±2%, 1/2 W.
R5	19A116278-P201	Metalfilm; 1K ohms ±2%, 1/2 W.
R6	3R77-P154J	Composition; 150K ohms ±5%, 1/2 W.
R7	19A116278-P229	Metalfilm; 1.96K ohms ±2%, 1/2 W.
R8	19A116278-P269	Metalfilm; 5.11K ohms ±2%, 1/2 W.
R9	19A116278-P257	Metalfilm; 3.83K ohms ±2%, 1/2 W.
R10 & R11	19A116278-P309	Metalfilm; 12.1K ohms ±2%, 1/2 W.
R12	19A116278-P229	Metalfilm; 1.96Kohms ±2%, 1/2 W.
R13	19A116278-P309	Metalfilm; 12.1K ohms ±2%, 1/2 W.
		- - - - - - - - - - SOCKETS - - - - - - - - - -
XY1 & XY2	19B201742-P1	Crystal, vertical mounting; sim Augat 8000-AG6-1.
		- - - - - - - - - - CRYSTALS - - - - - - - - -
Y1 & Y2	4031095-P1	Quartz, matched pair; one stamped "A" will be at 2000 KHz and the other stamped "B" will be at 2029 KHz plus channel frequency for -G1 or at 2010 KHz plus channel frequency for -G2. Customer must specify channel frequency. Both crystals of a pair will bear the same serial number.

TELECOMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

PRODUCTION CHANGES

LOCAL OSCILLATOR AND MIXER MODULE
PL-19D415190-G1 and -G2

The revisions listed below can be identified by the revision letter appearing on the equipment nameplate.

PL-19D415190-G1, Rev. A
PL-19D415190-G2, Rev. A

Purpose: To eliminate power supply interference.

Part Changed	Was	Changed To
C51	19A116080-P11	19B200240-P9; Capacitor, Tantalum; 15 µF ±10%, 50 VDCW.

PL-19D415190-G1, Rev. B
PL-19D415190-G2, Rev. B

Purpose: To reduce harmonic output

Part Changed	Was	Changed To
C39	---	Add capacitor C39 between the collector of Q41 and Common. GE Part No. 7147203-P8; Capacitor, silver mica; 0.001 µF ±5%, 500 VDCW.

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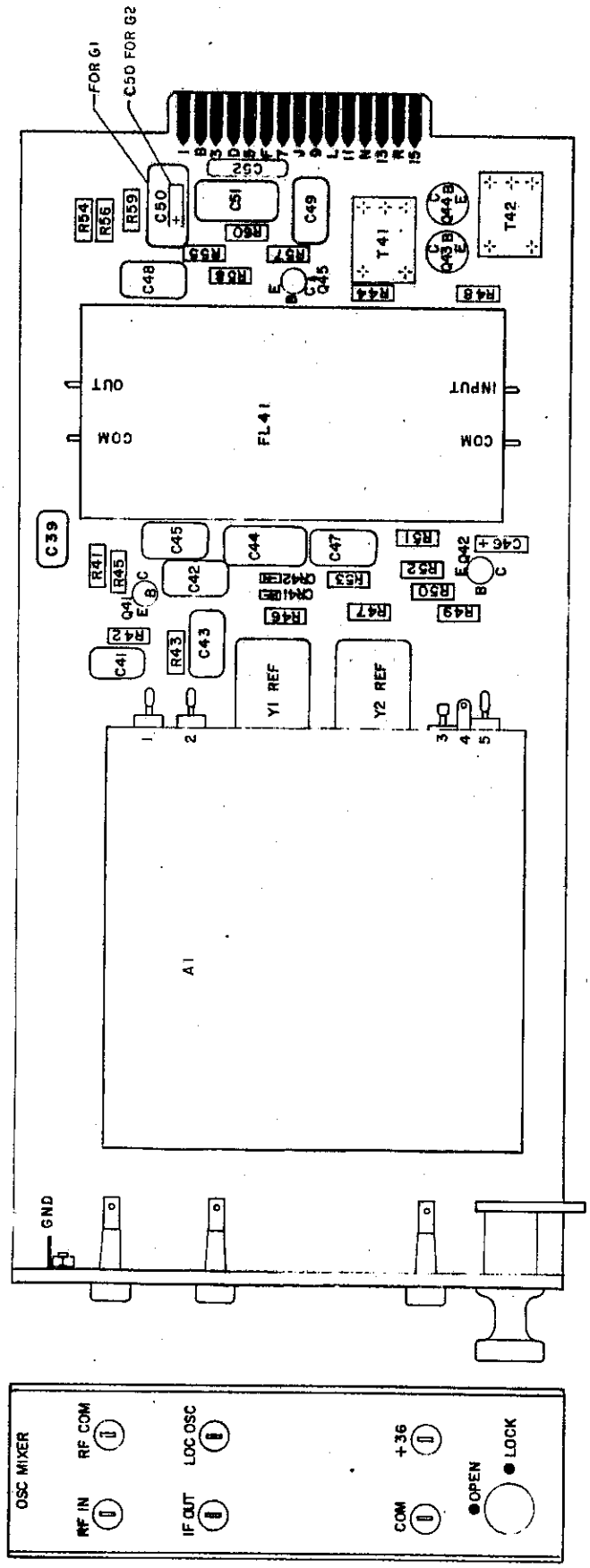

Parts Layout Diagram

LOCAL OSCILLATOR AND MIXER MODULE
PL-19D415190-G1 and -G2

(19C318416, Rev. 4)

DESCRIPTION

OUTPUT/CARRIER LEVEL MONITOR MODULE PL-19D415693-G1

Introduction

The Output/Carrier Level Monitor Module, PL-19D415693-G1, consists of two major circuits, a carrier level monitor circuit and an output circuit.

The Carrier Level Monitor (CLM) portion produces a DC output current for an external mA meter which is proportional to the receiver input level. The meter current changes approximately 0.1 mA per dB input level change. The carrier level alarm relay drop-out point can be adjusted. The DC output current can be monitored on a telephone-type jack mounted on the front panel. This test jack is connected in series with the external mA meter.

The Output portionof the module has three output circuits and is used to indicate the presence of a Guard or Trip signal and energize the customer's relays or trip coils.

This latter trip circuit is formed by a normally closed Guard relay contact and a normally open Trip relay contact. The Trip relay pick-up time and the Guard relay drop-out time can be adjusted for Guard delay times between 5-15 ms, jumper A is connected to E1; for delay times between 10-85 ms, connect to E2.

The module is a printed circuit card which plugs into a 15-pin connector mounted on the Shelf Unit.

Principles of Operation

Output

A Guard input signal of +5 VDC on terminal D turns transistors Q4, Q5, and Q3 ON. Transistor Q5 energizes relay K2. Capacitor C1 or C2 charges through resistor R7, the instant Q3 turns ON. When Q3 is turned OFF, C1 or C2 discharges through potentiometer R12 and the base-emitter junction of Q4, thus keeping Q4 in conduction and the Guard relay energized for a time that depends on the C1 or C2 - R12 time constant.

Transistor Q1 is used as a switch and conducts upon application of a Trip signal of +5 VDC at terminal 7 which, in turn, starts charging capacitor C3 through potentiometer R11. The time constant of C3-R11, and the time required for the voltage across C3 to reach the break-down rating of voltage regulator VR1, determines the Trip delay. When VR1 conducts, transistor Q2 turns ON and energizes Trip relay K1.

Carrier Level Monitor

The IF signal coming in through pin 7 is fed into a gain stage. Transistors Q6 and Q7 and their associated bias circuitry form this high-gain amplifier. Transistor Q8 and diodes CR7 and CR8 rectify the amplified IF signal to an output current that is proportional to the receiver input level, measured in dB. The collector current in Q8 flows through test jack J8 and to the external mA meter. This current can be adjusted by potentiometer R33 (CARR. LVL ADJ) which is accessible through an opening in the front panel. The carrier level relay alarm K3 is operated by transistor Q9. This transistor turns OFF when the current flow through the mA meter drops below a pre-set level. Potentiometer R39 varies the level at which the relay alarm operates.

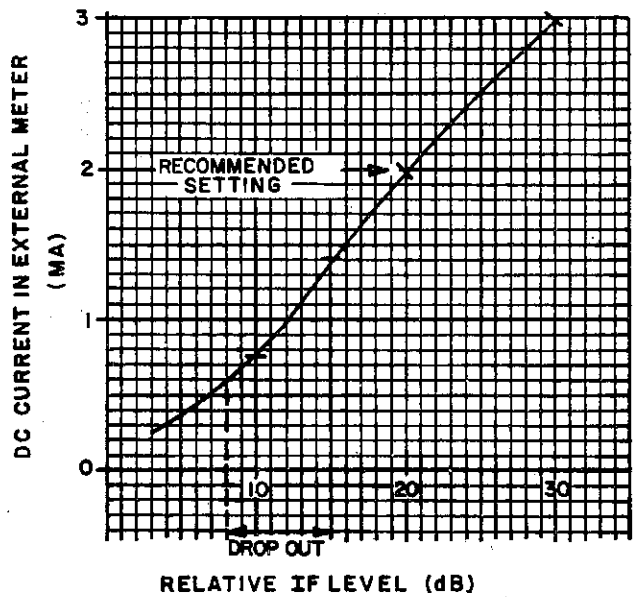

Figure 1 - CLM Characteristics

Trouble-Shooting Aids

Output

All DC voltages given in Table 1 are measured with a VOM (20 K ohms per Volt) with reference to common negative.

TABLE 1

Typical DC Voltages
(Common Negative Reference)

	TRANSISTOR	EMITTER	BASE	COLLECTOR
Guard ON, Trip OFF R11 & R12 Fully CW	Q1	0.0	0.0	35.5
	Q2	36.0	35.5	36.0
	Q3	2.75	3.3	35.5
	Q4	0.0	0.62	0.13
	Q5	30.4	29.7	30.2
Guard ON, Trip OFF R11 & R12 Fully CCW	Q1	0.0	0.0	35.5
	Q2	36.0	35.5	36.0
	Q3	2.45	3.1	2.55
	Q4	0.0	0.74	.025
	Q5	30.4	29.7	30.2
Guard OFF, Trip ON	Q1	0.0	0.77	0.075
	Q2	36.0	35.1	34.2
	Q3	0.0	0.0	35.9
	Q4	0.0	0.0	35.7
	Q5	35.9	35.8	0.0

Carrier Level Monitor

The DC voltages given in Table 2 are measured with reference to common and with a 10 kHz signal at a level of -25 dBsr applied to test jack IF IN CLM Adjust. R33, is set for 2 mA output current and R25 is set to drop the carrier level alarm relay K3 at -35 dBsr.

TABLE 2
Typical DC Voltages
(Common Reference)

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q6	7.0	7.4	9.2
Q7	8.6	9.2	19.0
Q8	6.6	7.0	23.5
Q9	4.0	4.6	4.0
Q10	30.9	30.0	25.5

Nominal Operating Characteristics - Output

Supply Voltage	+36 VDC
Current Drain, Max.	100 mA
Shift Input Voltage Guard or Trip	+5 VDC
Shift Input Current, Max.	20 mA
Trip Pickup Delay Time	5-85 ms
Guard Dropout Delay Time	5-85 ms
Guard & Trip Relay Rating Contact	30A make and carry for 17 ms or 3A at 115 VAC or 48 VDC continuous into resistive load.

Nominal Operating Characteristics - Carrier Level Monitor

Supply Voltage	+36 VDC
Current Drain, Max.	100 mA
IF Level for 2 mA Output Current	-35 dBsr to +5 dBsr

Recommended External Meter	DC - mA with 3 mA full scale deflection
Carrier Level Alarm Relay Dropout Point from Nominal Setting (2 mA Output Current)	6-14 dB
Contacts	2 form C
Rating	100 VA (2 AMP Max. 280 VDC Max. into a resistive load)

PARTS LIST

OUTPUT/CARRIER LEVEL MONITOR MODULE
PL-19D415693-G1, REV. A

Symbol	GE Part No.	Description
		- - - - - - - - - - CAPACITORS - - - - - - - - - - -
C1*	5496267-P217	Tantalum; 1.0 µf ±10%, 35 VDCW
C2	5496267-P218	Tantalum; 6.8 µf ±10%, 35 VDCW
C3*	5496267-P210	Tantalum; 22 µf ±10%, 15 VDCW
C4 & C5	19A115680-P15	Electrolytic; 12 µf -10% +100%, 150 VDCW
C6 thru C12	5490825-P4	Ceramic; 6,000 pf ±10%, 2000 VDCW
C13 & C14	19A116080-P107	Polyester; 0.1 µf ±10%, 50 VDCW
C15	19A116080-P111	Polyester; 0.47 µf ±10%, 50 VDCW
C16	19A116080-P107	Polyester; 0.1 µf ±10%, 50 VDCW
C17	19A116080-P109	Polyester; 0.22 µf ±10%, 50 VDCW
C18	5496267-P17	Tantalum; 1.0 µf ±20%, 35 VDCW
C19	5496267-P20	Tantalum; 47 µf ±20%, 35 VDCW
C20	5496267-P17	Tantalum; 1.0 µf ±20%, 35 VDCW
C21 thru C26	5490825-P4	Ceramic; 6000 pf ±10%, 2000 VDCW
		- - - - - - - - - - DIODES - - - - - - - - - - -
CR1 thru CR10	19A116565-P1	Silicon, rectifier; sim Type 1N4004 or Sem-Tech Type SC4.
		- - - - - - - - - - JACKS - - - - - - - - - - -
J1	7150763-P5	Test point; sim Alden 110BC1-yellow
J2	7489006-P4	Telephone; sim Mallory 3B or Switchcraft 4J-1196
J3	7150763-P6	Test point; sim Alden 110BC1-blue
J4	7150763-P5	Test point; sim Alden 110BC1-yellow
J5	7489006-P4	Telephone; sim Mallory 3B or Switchcraft 4J-1196

Symbol	GE Part No.	Description
J6 & J7	7150763-P6	Test point, sim Alden 110BC1-blue
J8	7489006-P4	Telephone; sim Mallory 3B or Switchcraft 4J-1196
J9	7150763-P2	Test point; sim Alden 110BC1-red
J10	7150763-P4	Test point; sim Alden 110BC1-green
		- - - - - - - - - - - - RELAYS- - - - - - - - - - - -
K1	19B209300-P1	Enclosed; 30 VDC; 12 W. max. 2 W continuous; 75 ohms ±10%; pull-in current, 60 mA; drop-out current, hold to 40 mA; 2 form A contacts; operate speed, 4 ms max; sim Magnecraft No. 33CPX-26A
K2	19B209300-P9	Enclosed; 30 VDC; 12 W max. 2 W continuous; 75 ohms ±10%; pull-in current, 60 mA; drop-out current, hold to 40 mA; 1 form B contact and 1 form C contact; operate speed, 6 ms max. sim Magnecraft No. 33CPX-52.
K3	19B209240-P5	Open; 12 VDC; 2 W max; 100 ohms ±10%; pull-in voltage, 9.6 VDC max; 3 form C contacts; sim Magnecraft No. 88X-156.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q1	19A115300-P2	Silicon, NPN; sim Type 2N3053
Q2	19A116330-P1	Silicon, PNP; sim Type 2N3636
Q3	19A115300-P2	Silicon, NPN; sim Type 2N3053
Q4	19A115300-P4	Silicon, NPN; sim Type 2N3053
Q5	19A116330-P1	Silicon, PNP; sim Type 2N3636
Q6 & Q7	19A115300-P4	Silicon, NPN; sim Type 2N3053
Q8 & Q9	19A115300-P2	Silicon, NPN; sim Type 2N3053
Q10*	19A115562-P1	Silicon, PNP; sim Type 2N2904A
		- - - - - - - - - - RESISTORS- - - - - - - - - -
R1*	3R77-P131J	Composition; 130 ohms ±5%, 1/2 W.
R2	3R77-P222J	Composition; 2.2 K ohms ±5%, 1/2 W.
R3	3R77-P201J	Composition; 200 ohms ±5%, 1/2 W.
R4	3R77-P560J	Composition; 56 ohms ±5%, 1/2 W.
R5*	3R77-P151J	Composition; 150 ohms ±5%, 1/2 W.
R6	3R77-P183J	Composition; 18 K ohms ±5%, 1/2 W.
R7	3R77-P101J	Composition; 100 ohms ±5%, 1/2 W.
R8	3R79-P471J	Composition; 470 ohms ±5%, 2 W.
R9	3R79-P361J	Composition; 360 ohms ±5%, 2 W.
R10	3R79-P331J	Composition; 330 ohms ±5%, 2 W.

Symbol	GE Part No.	Description
		- - - - - - - - - - RESISTORS (contd) - - - - - -
R11 & R12	19A116559-P106	Variable, cermet, 200 ohms 10K ohms ±20%, 1/2 W. linear taper.
R13	19A116278-P245	Metal film; 2.87 K ohms ±2%, 1/2 W.
R14	3R77-P103J	Composition; 10 Kohms ±5%, 1/2 W.
R15	19A116278-P257	Metal film; 3.83 K ohms ±2%, 1/2 W.
R16	7478711-P28	Wirewound; 500 ohms ±5%, 7 W.
R17	3R78-P820J	Composition; 82 ohms ±5%, 1 W.
R18	3R78-P470J	Composition; 47 ohms ±5%, 1 W.
R19	7478711-P28	Wirewound; 500 ohms ±5%, 7 W.
R20	3R77-P752J	Composition; 7.5 K ohms ±5%, 1/2 W.
R21	19A116278-P341	Metal film; 26.1 K ohms ±2%, 1/2 W.
R22	19A116278-P329	Metal film; 19.6 K ohms ±2%, 1/2 W.
R23	19A116278-P141	Metal film; 261 ohms ±2%, 1/2 W.
R24	19A116278-P241	Metal film; 2.61 K ohms ±2%, 1/2 W.
R25	19A116278-P301	Metal film; 10.0 K ohms ±2%, 1/2 W.
R26	19A116278-P229	Metal film; 1.96 K ohms ±2%, 1/2 W.
R27	19A116278-P33	Metal film; 21.5 ohms ±2%, 1/2 W.
R28	19A116278-P205	Metal film; 1.1 K ohms ±2%, 1/2 W.
R29	3R77-P243J	Composition; 240 K ohms ±5%, 1/2 W.
R30	3R77-P622J	Composition; 6.2 K ohms ±5%, 1/2 W.
R31	3R77-P202J	Composition; 2 K ohms ±5%, 1/2 W.
R32	19A116278-P201	Metal film; 1.0 K ohms ±2%, 1/2 W.
R33	19A122939-P1	Variable, cermet; 25 K ohms ±20%, 0.75 W. Linear taper.
R34	3R77-P750J	Composition; 75 ohms ±5%, 1/2 W.
R35*	3R78-P100J	Composition; 10 ohms ±5%, 1 W.
R36*	3R77-P103J	Composition; 10 K ohms, ±5%, 1/2 W.
R37*	3R77-P103J	Composition; 10 K ohms ±5%, 1/2 W.
R38*	19A116278-P245	Metal film; 2.87 K ohms ±2%, 1/2 W.
R39*	19A116559-P108	Variable, cermet; 500 ohms - 50 K ohms ±20%, 1/2 W, linear taper
R40*	5493035-P5	Wirewound; 240 ohms ±5%, 5 W;

Symbol	GE Part No.	Description
		- - - - - - - - - VOLTAGE REGULATOR - - - - - - - - -
VR1	4036887-P4	Silicon, Zener diode; sim Type 1N5229B
VR2 & VR3	4036887-P29	Silicon, Zener diode; sim Type 1N5265B
VR4	4036887-P4	Silicon, Zener diode; sim Type 1N5229B
		- - - - - - - - - - - - SOCKETS - - - - - - - - - - - -
XK1 & XK2	1R14-P26	Relay, tube; 8 octal contacts; sim Amphenal 77-M1P8T

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PRODUCTION CHANGES

OUTPUT AND CLM MODULE
PL-19D415693-G1 thru -G5

The revisions listed below can be identified by the revision letter appearing on the equipment nameplate.

PL-19D415693-G1 thru -G5, Rev. A

Purpose: -G2, -G3: To change polarity of current test jacks; -G1, -G4, and -G5; to insure polarity compatibility of current test jacks and improve reproducibility of CLM relay dropout.

Part Changed	Was	Changed To
J8		Delete in -G2.
R38	19A116278-P265 (4.64 K ohms)	19A116278-P245, 2.87 K ohms in -G1, -G4, and -G5 only
R39	19A116559-P107 (500 ohms to 25 K ohms)	19A116559-P108, 500 ohms to 50 K ohms in -G1, -G4 and -G5 only
R41	3R77-P202J (2 Kohms)	19A116278-P241, 2.61 K ohms in -G4 only
R43	19A116278-P165 (464 ohms)	19A116278-P176, 604 ohms in -G4 only
Leads		Change leads to J2, J5, and J8 in -G1 thru -G5, except No. J8 in -G2 and -3

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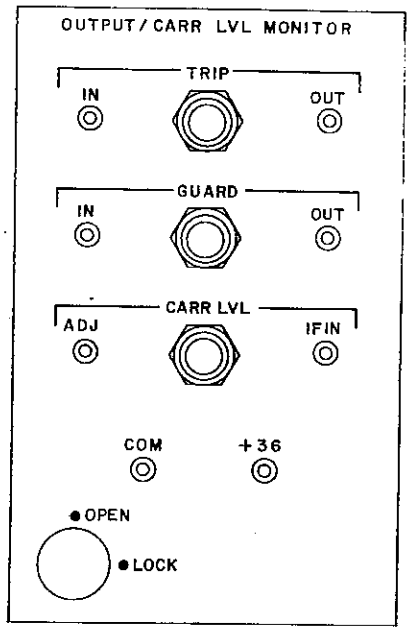
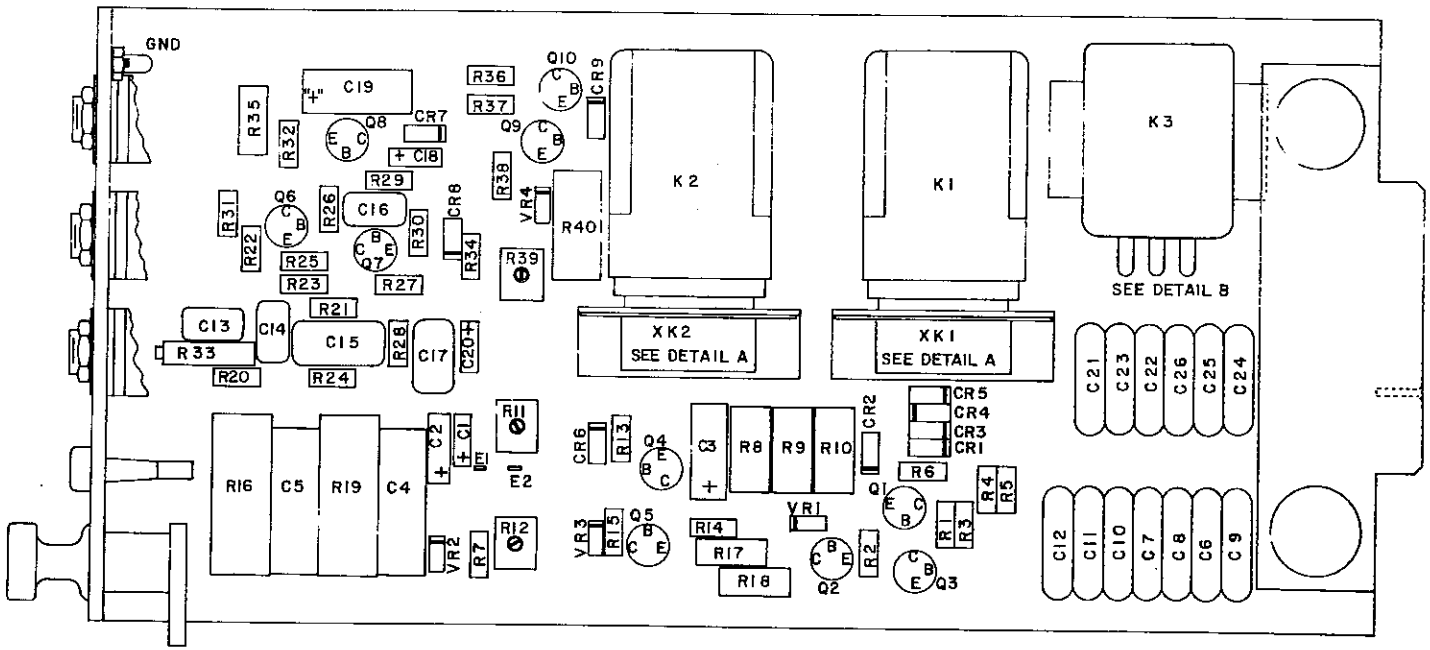
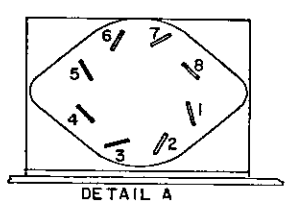
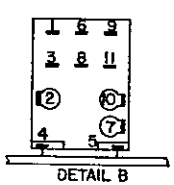




OUTPUT/ CLM
PL-19D415693 G1 REV A





Parts Layout Diagram
OUTPUT/CLM MODULE
PL-19D415693-G1
(19C318890, Rev. 1)

DESCRIPTION

DISCRIMINATOR MODULE
PL-19D415222-G7 and -G8

Introduction

The Discriminator Modules, PL-19D415222-G7 and -G8 are used in Type CR51 Receiver Equipment for relaying applications which require both minimum channel time and the security offered by an offset discriminator. The function of the discriminator module is to convert a frequency-shift RF input signal to a DC output voltage. A discriminator bandwidth of 200 Hz and a zero offset of 50 Hz toward the trip side are used. An alarm relay is used to indicate a low DC voltage condition (-G7 only).

The Discriminator Module is a printed circuit card which plugs into a 15-pin connector mounted on the Receiver Shelf Unit.

Operation

Refer to the composite drawing shown as Figure 1 in the model instruction book. An RF input signal from the Local Oscillator Mixer Module is passed to a three-stage amplifier consisting of transistors Q1, Q2, and Q3. This RF signal is amplified sufficiently to cause diodes CR2 and CR3 to conduct, thereby producing a constant level signal which is further amplified and applied to the discriminator FL1. Jumper A provides for an adjustable gain in the limiter-amplifier. Changing the jumper connection from E8 to E7 increases the gain by 10 dB. For a 9.9 kHz input frequency (GUARD), a DC output voltage is produced between J3 and J4 which produces a forward bias on the transistor Q6 base-emitter junction. This, in turn, produces an output of approximately +5 VDC. Shifting the input frequency to 10.1 kHz (TRIP) reverses the polarity of the voltage between J3 and J4 and forward biases transistor Q7, thereby producing a +5 VDC output at J2.

Capacitors C18 through C22 are used to set the discriminator zero voltage point. Capacitors C19 through C22 are factory selected for an approximate zero setting and capacitor C18 is adjusted for an exact zero setting. For a properly adjusted companion transmitter and local IF oscillator, this zero frequency into the discriminator module should be 10,050 Hz.

Transistors Q6, Q8, Q10, Q12, and Q14 form a threshold detector and output timer which provides a fast pickup, slow release guard output characteristic. Similarly, transistors Q7, Q9, Q11, Q13 and Q15 form a threshold detector and output timer for the trip circuit. The trip output has a slow (5 ms) pickup and fast (less than 0.1 ms) release characteristic. The times quoted here are for the output timer only and do not include input filter delay.

Relay K1 in series with voltage regulator VR8 forms a power supply voltage monitoring circuit. Whenever the regulated DC voltage drops below approximately 14 VDC, relay K1 drops out -- providing a power supply alarm (-G7 only).

Capacitors C34 through C36 provide suppression of transient voltages present on the external wiring (-G7 only).

Trouble-Shooting Aids

Refer to the composite drawing, Figure 1, included in the model instruction book, for the electrical connections on this module. Should a Discriminator Module be suspected of being faulty, the module may be inserted into an Extender Card (GE Part No. 19C318404) and the test voltages shown in Table 1 may be monitored to assist in isolating the problem. All DC voltages should be measured on a meter having at least a 20K ohm per volt input impedance. All readings are measured using negative common as reference.

Nominal Operating Characteristics

Supply Voltage	36 VDC
Current Drain	75 mA
Guard Frequency	9.9 kHz
Trip Frequency	10.1 kHz
Discriminator Offset	50 Hz
Output Characteristic	5 V at 20 mA
IF Input Level to Produce Limiting	-35 dBsr (Jumper A to E8)
	-45 dBsr (Jumper A to E7)

TABLE 1

Input Frequency	Transistor	Emitter VDC	Base VDC	Collector VDC
GUARD	Q1	7.2	7.6	32.0
	Q2	6.5	7.0	13.8
or	Q3	4.0	4.5	15.5
	Q4	8.0	8.5	34.5
TRIP	Q5	7.5	8.0	20.5
GUARD	Q6	0.3	1.0	0.35
	Q7	0.4	0	21.0
	Q8	0	0.2	6.9
	Q9	1.3	2.0	1.4
	Q10	0	0.7	0
	Q11	0	0	7.0
	Q12	0	0	5.3
	Q13	0	0.7	0.1
	Q14	4.6	5.3	6.0
	Q15	0	0	30.0
TRIP	Q6	0	0	21.0
	Q7	0.4	1.0	0.4
	Q8	1.2	1.8	1.4
	Q9	0	0.2	7.0
	Q10	0	0	7.0
	Q11	0	0.7	0
	Q12	0	0.6	0.1
	Q13	0	0	6.6
	Q14	0	0	36.0
	Q15	4.8	5.4	5.0

PARTS LIST

DISCRIMINATOR MODULE
PL-19D415222-G7 and -G8

Symbol	GE Part No.	Description
		- - - - - - - - - - - - CAPACITORS - - - - - - - - - - - -
C1	19A115028-P114	Polyester; 0.1 µf ±20%, 200 VDCW.
C2	19A115680-P6	Electrolytic; 50 µf -10% +150%, 50 VDCW.
C3	19A115028-P114	Polyester; 0.1 µf ±20%, 200 VDCW.
C4 & C5	19A116080-P9	Electrolytic; 120 µf -10% +150%, 26 VDCW.
C6	19A115028-P114	Polyester; 0.1 µf ±20%, 200 VDCW.
C8	19A115028-P114	Polyester; 0.1 µf ±20%, 200 VDCW.

Symbol	GE Part No.	Description
C9	19A115028-P102	Polyester; 0.0022 µf ±20%, 200 VDCW.
C10	19A115680-P6	Electrolytic; 50 µf -10% +150%, 50 VDCW.
C11	5496267-P10	Tantalum; 22 µf ±20%, 15 VDCW.
C12	19A115028-P116	Polyester; 0.22 µf ±20%, 200 VDCW.
C15	5490008-P35	Silver mica; 220 pf ±5%, 500 VDCW.
C18	19B209328-P10	Variable, air; 2.62 pf min., 30.6 pf max.; 650 VDCW; air gap, 0.010; sim E.F. Johnson 193-10-2.
C19	5490008-P13	Silver mica; 27 pf ±5%, 500 VDCW.
C20	5490008-P19	Silver mica; 47 pf ±5%, 500 VDCW.
C22	5490008-P27	Silver mica; 100 pf ±5%, 500 VDCW.
C25 thru C29	19A116080-P7	Polyester; 0.1 µf ±20%, 50 VDCW.
C32	19A116080-P211	Polyester; 0.47 µf ±5%, 50 VDCW.
C34 thru C36	5490825-P3	Ceramic, disc; 10,000 µµf -20% +100%, 2000 VDCW. Used in -G7 only.
C37	7489483-P11	Electrolytic; 20 µf -10%, +75%, 50 VDCW.
C38	19A116080-P211	Polyester; 0.47 µf ±5%, 50 VDCW.
		- - - - - - - - - - - - DIODES - - - - - - - - - - - -
CR1	5494922-P3	Silicon; sim Type 1N458 (Hughes)
CR2 thru CR11	19A115250-P1	Silicon, fast recovery; sim Type 1N645 or GE Type SSD-753.
		- - - - - - - - - - - - FILTERS - - - - - - - - - - - -
FL1E	PL-19C304778-G1	Resonator network
		- - - - - - - - - - - - JACKS - - - - - - - - - - - -
J1 & J2	7150763-P3	Test point; sim Alden 110BC1 - brown.
J3 & J4	7150763-P6	Test point; sim Alden 110BC1 - blue.
J5	7150763-P8	Test point; sim Alden 110BC1 - orange.
J6	7150763-P4	Test point; sim Alden 110BC1 - green.
J7	7150763-P2	Test point; sim Alden 110BC1 - red.
		- - - - - - - - - - - - RELAY - - - - - - - - - - - -
K1	19B209439-P1	Reed, mercury-wetted; 48 VDC, 1.75 W; 6100 ohms ±10%; pull-in, 20.1 VDC; drop-out, 3.15 VDC, 1 form C contact (break before make) sim C. P. Clare HGSR61211V01. Used in -G7 only.

DESCRIPTION

Symbol	GE Part No.	Description
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q1 thru Q4	19A115300-P2	Silicon; NPN; sim Type 2N3053.
Q5	19A115783-P1	Silicon; NPN; sim Type 2N4240.
Q6 thru Q13	19A115720-P2	Silicon; NPN; sim Type 2N3227 or RCA-40237.
Q14 & Q15	19A115300-P2	Silicon; NPN; sim Type 2N3053.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1	19A116278-P333	Metal film; 21.5 K ohms ±2%, 1/2 W.
R2	19A116278-P281	Metal film; 6.81 K ohms ±2%, 1/2 W.
R3	3R77-P103J	Composition; 10 K ohms ±5%, 1/2 W.
R4	3R77-P202J	Composition; 2 K ohms ±5%, 1/2 W.
R5	3R77-P103J	Composition; 10 K ohms ±5%, 1/2 W.
R6	19A116278-P153	Metal film; 348 ohms ±2%, 1/2 W.
R7	3R77-P302J	Composition; 3 K ohms ±5%, 1/2 W.
R8	3R77-P513J	Composition; 51 K ohms ±5%, 1/2 W.
R9	3R77-P103J	Composition; 10 K ohms ±5%, 1/2 W.
R10	3R77-P472J	Composition; 4.72 K ohms ±5%, 1/2 W.
R11	19A116278-P85	Metal film; 75 ohms ±2%, 1/2 W
R12	3R77-P102J	Composition; 1 K ohms ±5%, 1/2 W.
R13	3R77-P392J	Composition; 3.9 K ohms ±5%, 1/2 W.
R14	3R77-P623J	Composition; 62 K ohms ±5%, 1/2 W.
R15	3R77-P243J	Composition; 24 K ohms ±5%, 1/2 W.
R16	3R77-P301J	Composition; 300 ohms ±5%, 1/2 W.
R17	3R77-P472J	Composition; 4.7 K ohms ±5%, 1/2 W.
R18	3R79-P561J	Composition; 560 ohms ±5%, 2 W.
R19	3R77-P150J	Composition; 15 ohms ±5%, 1/2 W.
R20	3R78-P271J	Composition; 270 ohms ±5%, 1 W.
R21	3R77-P300J	Composition; 30 ohms ±5%, 1/2 W.
R22	3R77-P331J	Composition; 330 ohms ±5%, 1/2 W.
R23 & R24	19A116278-P269	Metal film; 5.11 K ohms ±2%, 1/2 W.
R25 & R26	19A116278-P353	Metal film; 34.8 K ohms ±2%, 1/2 W.
R27	19A116278-P317	Metal film; 14.7 K ohms ±2%, 1/2 W.

Symbol	GE Part No.	Description
		- - - - - - - - - - - RESISTORS - - - - - - - - - - -
R28	19A116278-P109	Metal film; 121 ohms ±2%, 1/2 W.
R29 & R30	3R77-P473J	Composition; 47 K ohms ±2%, 1/2 W.
R31	19A116278-P361	Metal film; 42.2K ohms ±2%, 1/2 W.
R32	19A116278-P369	Metal film; 51.1K ohms ±2%, 1/2 W.
R33 & R34		
R35	19A116278-P277	Metal film; 6.19 K ohms ±2%, 1/2 W.
R36	19A116278-P257	Metal film; 3.83 K ohms ±2%, 1/2 W.
R37	3R79-P821J	Composition; 820 ohms ±5%, 2 W.
R38 & R39	3R77-P102J	Composition; 1 K ohms ±5%, 1/2 W.
R40	3R79-P681J	Composition; 680 ohms ±5%, 2 W.
R41	19A116278-P249	Metal film; 3.16 K ohms ±2%, 1/2 W.
R42	3R77-P202J	Composition; 2K ohms ±5%, 1/2 W.
R43	19A116278-P229	Metal film; 1.96 K ohms ±2%, 1/2 W.
R44 & R45	3R77-P103J	Composition; 10 K ohms ±5%, 1/2 W.
		- - - - - - - - - - -THERMISTOR - - - - - - - - - - -
RT1	5490828-P9	Thermal resistor; 10 K ±10%, 1/4 W; sim Carborundum 551J-8
		- - - - - - - - -VOLTAGE REGULATOR - - - - - - - - -
VR1	403687-P5	Silicon, Zener diode; sim 1N5232B
VR2 thru VR7	4036887-P6	Silicon, Zener diode; sim 1N753.
VR8	4036887-P8	Silicon, Zener diode; sim 1N962B. Used in -G7 only.

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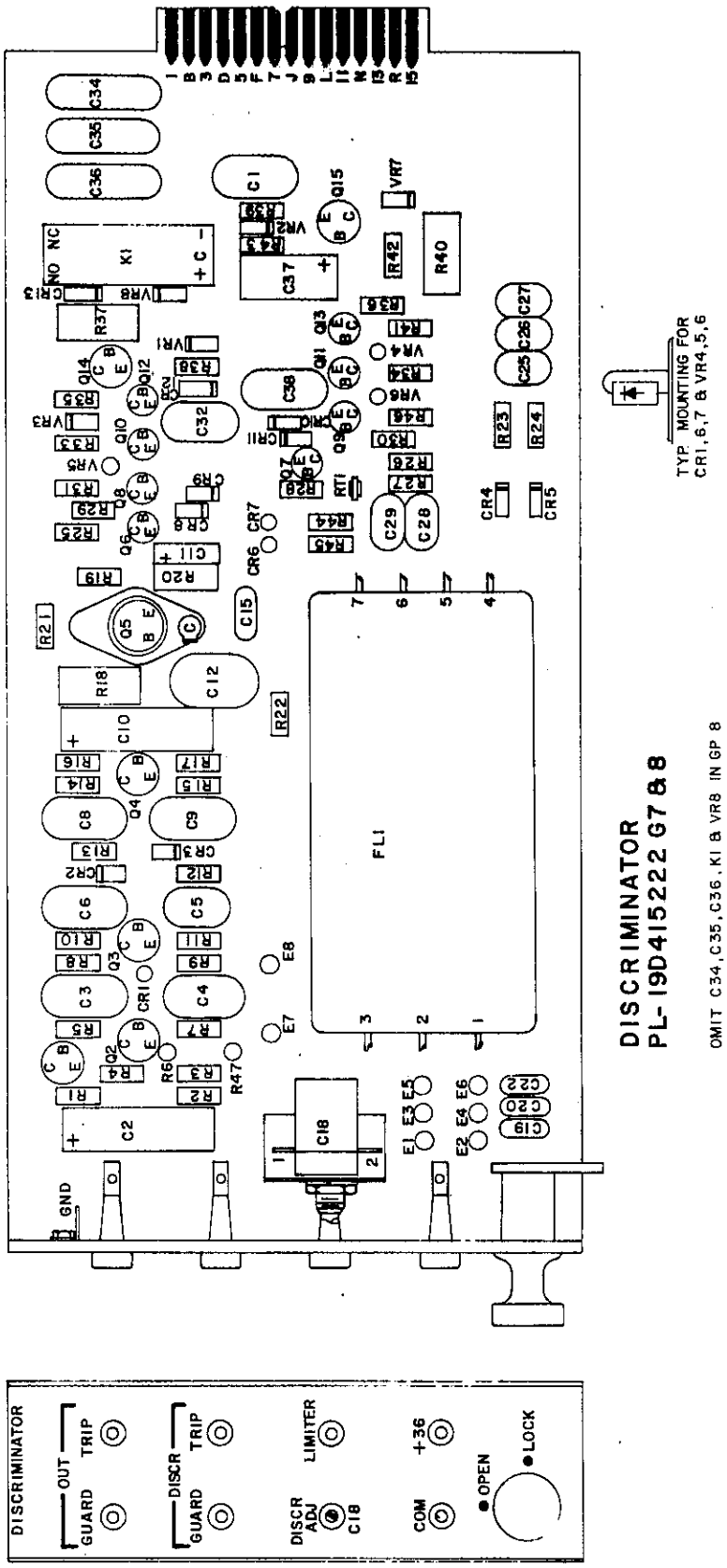
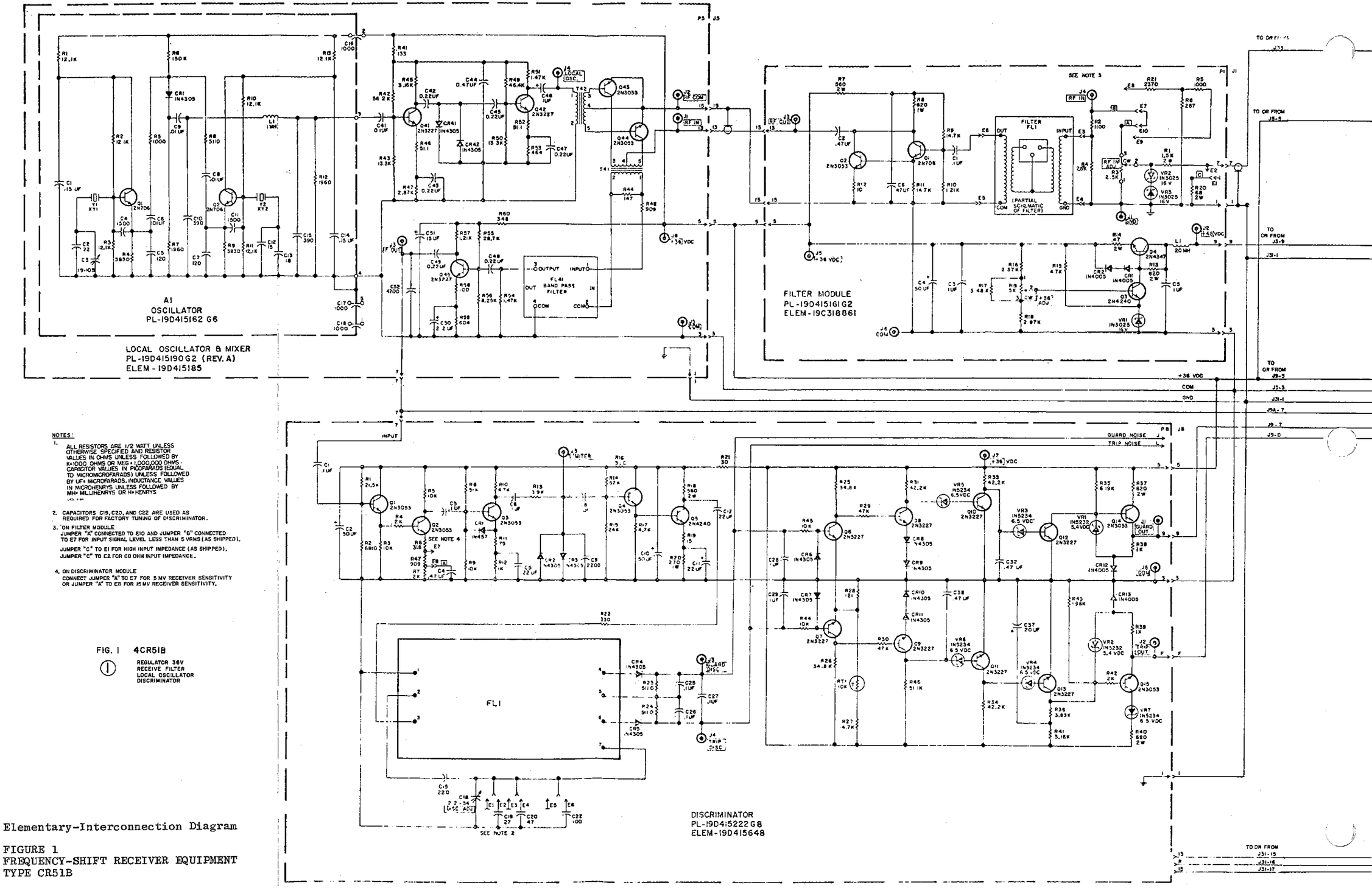


Parts Layout Diagram

DISCRIMINATOR MODULE
PL-19D415222-G7 and -G8

(19C318412, Sheet 3, Rev. 0)



NOTES:

1. ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS OR H=HENRYS
2. CAPACITORS C19, C20, AND C22 ARE USED AS REQUIRED FOR FACTORY TUNING OF DISCRIMINATOR.
3. ON FILTER MODULE
   JUMPER "A" CONNECTED TO E10 AND JUMPER "B" CONNECTED TO E7 FOR INPUT SIGNAL LEVEL LESS THAN 5 VRMS (AS SHIPPED).
   JUMPER "C" TO E1 FOR HIGH INPUT IMPEDANCE (AS SHIPPED).
   JUMPER "C" TO E2 FOR 68 OHM INPUT IMPEDANCE.
4. ON DISCRIMINATOR MODULE
   CONNECT JUMPER "A" TO E7 FOR 5 MV RECEIVER SENSITIVITY OR JUMPER "A" TO E8 FOR 15 MV RECEIVER SENSITIVITY.

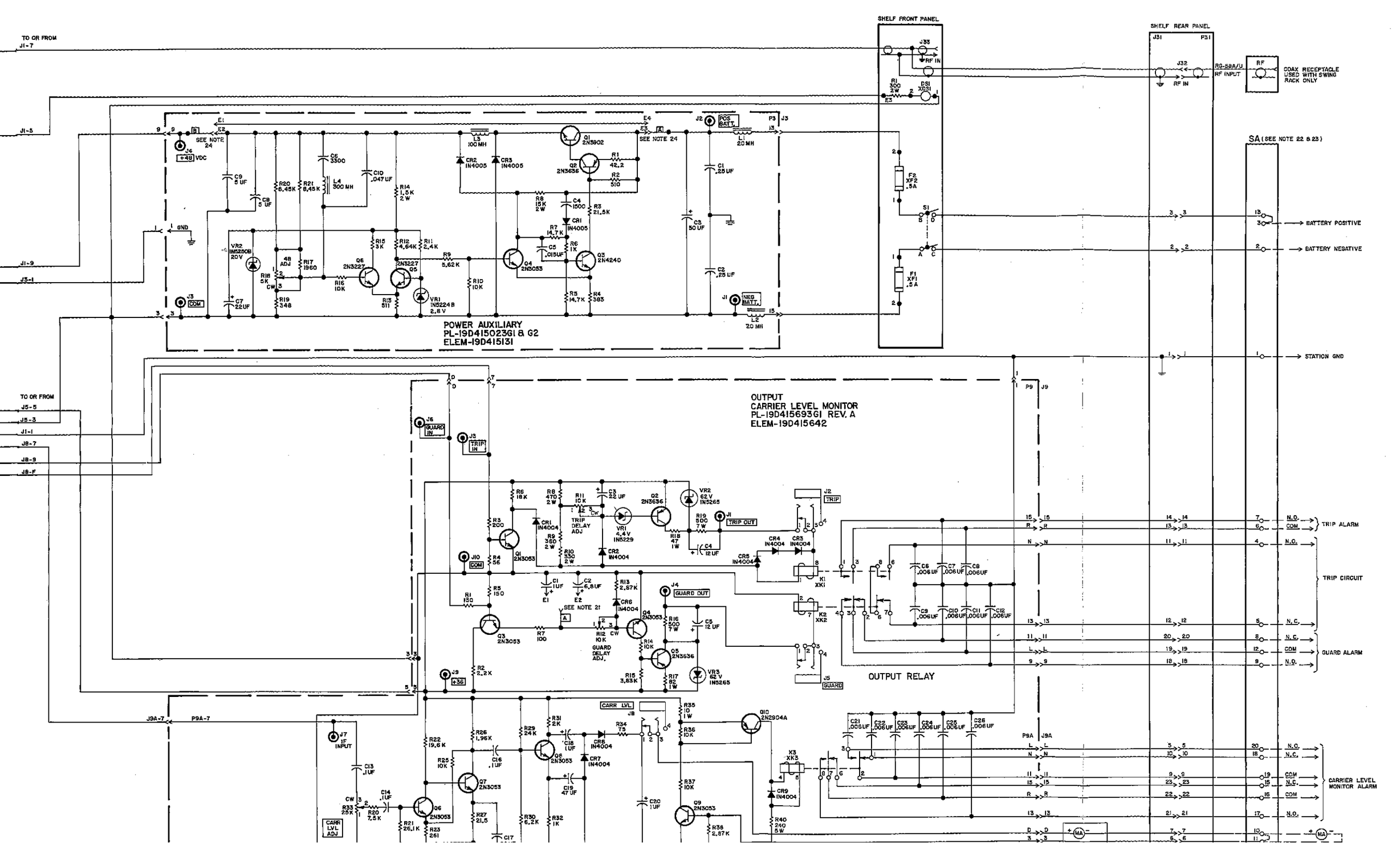
FIG. 1 **4CR51B**

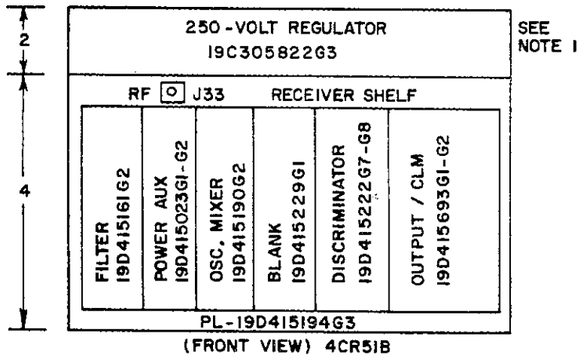
① REGULATOR 36V
RECEIVE FILTER
LOCAL OSCILLATOR
DISCRIMINATOR

Elementary-Interconnection Diagram

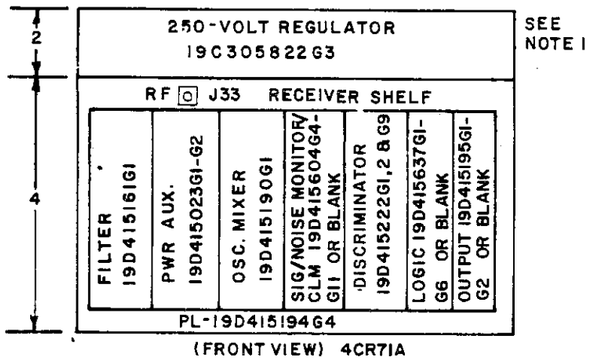
FIGURE 1
FREQUENCY-SHIFT RECEIVER EQUIPMENT
TYPE CR51B

(19E501457, Sheet 2, Rev. 1)

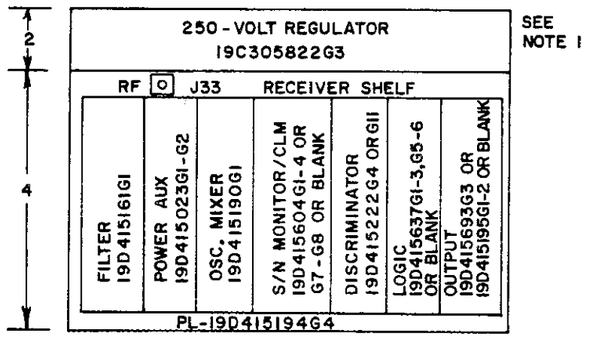

SHELF FRONT PANEL
SHELF REAR PANEL
J31
P31
J32
RF IN
RG-58A/U
RF INPUT
RF
COAX RECEPTACLE USED WITH SWING RACK ONLY
SA (SEE NOTE 22 & 23)
TO OR FROM J1-7
J1-5
J1-9
J3-1
SEE NOTE 24
+48 VDC
GND
COM
POS BATT.
NEG BATT.
L3 100 MH
L1 20 MH
L2 20 MH
Q1 2N3902
Q2 2N3636
Q3 2N4240
Q4 2N3053
Q5 2N3227
Q6 2N3227
CR1 IN4005
CR2 IN4005
CR3 IN4005
VR1 1N5224B 2.8 V
VR2 1N5250B 20V
F1 XF1 .5A
F2 XF2 .5A
S1
POWER AUXILIARY
PL-19D415023G1 & G2
ELEM-19D415131
BATTERY POSITIVE
BATTERY NEGATIVE
STATION GND
TO OR FROM J5-5
J5-3
J1-1
J8-7
J8-9
J8-F
OUTPUT
CARRIER LEVEL MONITOR
PL-19D415693G1 REV. A
ELEM-19D415642
GUARD IN
TRIP IN
TRIP OUT
GUARD OUT
TRIP
GUARD
TRIP DELAY ADJ
GUARD DELAY ADJ.
SEE NOTE 21
OUTPUT RELAY
K1 XK1
K2 XK2
K3 XK3
TRIP ALARM
TRIP CIRCUIT
GUARD ALARM
CARRIER LEVEL MONITOR ALARM
N.O.
N.C.
COM
J9A-7
P9A-7
IF INPUT
CARR LVL
CARR LVL ADJ
Q10 2N2904A



(FRONT VIEW) 4CR51B



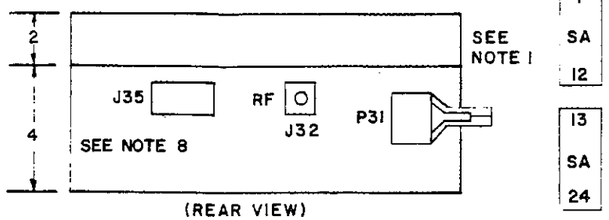
(FRONT VIEW) 4CR71A



(FRONT VIEW) 4CR61A

CUSTOMER CONNECTIONS

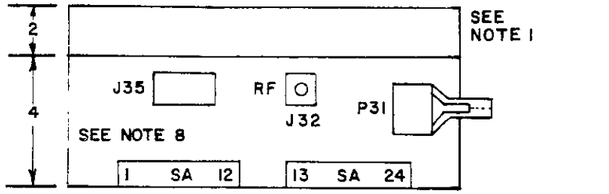
6' OR 10' LONG WIRING HARNESS - INDEX TYPE "R" & "T"
(SEE NOTE 3)



(REAR VIEW)

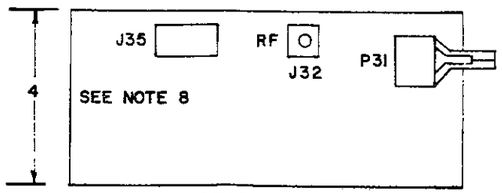
CUSTOMER CONNECTIONS

FIXED & OPEN RACK WIRING HARNESS - INDEX TYPE "F"
(SEE NOTE 4)



CUSTOMER CONNECTIONS

NO HARNESS - INDEX TYPE "N"
(SEE NOTE 6)



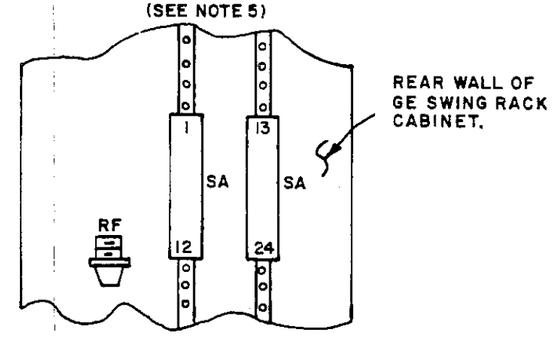
(REAR VIEW)

NOTES:

1. A SEPARATE 250-VOLT REGULATOR AS SHOWN IS REQUIRED ONLY WHEN THE SUPPLY VOLTAGE IS 250 VOLTS.
2. ALL VERTICAL DIMENSIONS ARE IN RACK UNITS OF 1.75" EACH.
3. THE CUSTOMER CONNECTION FOR THE 6' OR 10'-LONG WIRING HARNESS IS PROVIDED BY TWO TERMINAL BOARDS AT THE END OF THE HARNESS HAVING #10 SCREWS FOR THE CONNECTIONS AND ONE FEMALE UHF COAXIAL CONNECTOR WITH 5/8-24 EXTERNAL THREADS MOUNTED ON THE REAR OF THE RECEIVER. THE MOUNTING LOCATION AND POSITION OF THE BOARDS ARE TO BE AT THE DISCRETION OF THE CUSTOMER.
4. THE CUSTOMER CONNECTION FOR THE FIXED OR OPEN RACK WIRING HARNESS IS PROVIDED BY TWO TERMINAL BOARDS HAVING #10 SCREWS FOR THE CONNECTIONS AND ONE FEMALE UHF COAXIAL CONNECTOR WITH 5/8-24 EXTERNAL THREADS, ALL UNITS MOUNTED ON THE REAR OF THE RECEIVER.
5. THE CUSTOMER CONNECTION FOR THE SWING RACK WIRING HARNESS IS PROVIDED BY TWO TERMINAL BOARDS HAVING #10 SCREWS FOR THE CONNECTIONS AND ONE FEMALE UHF COAXIAL CONNECTOR WITH 5/8-24 EXTERNAL THREADS, ALL MOUNTED ON THE REAR WALL OF THE SWING RACK CABINET.
6. IN THE EVENT NO WIRING HARNESS IS DESIRED, THE CUSTOMER CONNECTION IS MADE DIRECTLY TO THE REAR OF THE RECEIVER SHELF ASSEMBLY ATTACHING TO ONE FEMALE UHF COAXIAL CONNECTOR WITH 5/8-24 EXTERNAL THREADS AND TO A 24-PIN RECEPTACLE BY WIRING TO THE SIDE-ENTRY MATING PLUG PROVIDED, USING A WIRE SIZE APPROXIMATING AWG. NO. 22.
7. A FEMALE BNC CONNECTOR IS MOUNTED ON THE FRONT OF THE RECEIVER SHELF & IS PARALLEL-CONNECTED WITH THE UHF CONNECTOR ON THE REAR.
8. CONNECTOR J35 IS PROVIDED WITH RECEIVERS CR61 & CR71 ONLY, AND USED ONLY FOR SOLID STATE KEYING REQUIREMENTS. MATING PLUG (C7775345P54) TO BE PROVIDED BY THE CUSTOMER.

CUSTOMER CONNECTIONS

SWING RACK WIRING HARNESS - INDEX TYPE "S"
(SEE NOTE 5)



(VIEW FROM INSIDE)

Equipment Arrangement

TRANSFER TRIP RECEIVER EQUIPMENT
TYPE CR51B, TYPE CR61A, AND TYPE CR71A

(19C318849, Rev. 1)

GENERAL ELECTRIC 19D421269

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING — APPLIED PRACTICES A-4029229 A-7118636

TITLE DIAG., INTR./EQPT. ARR.

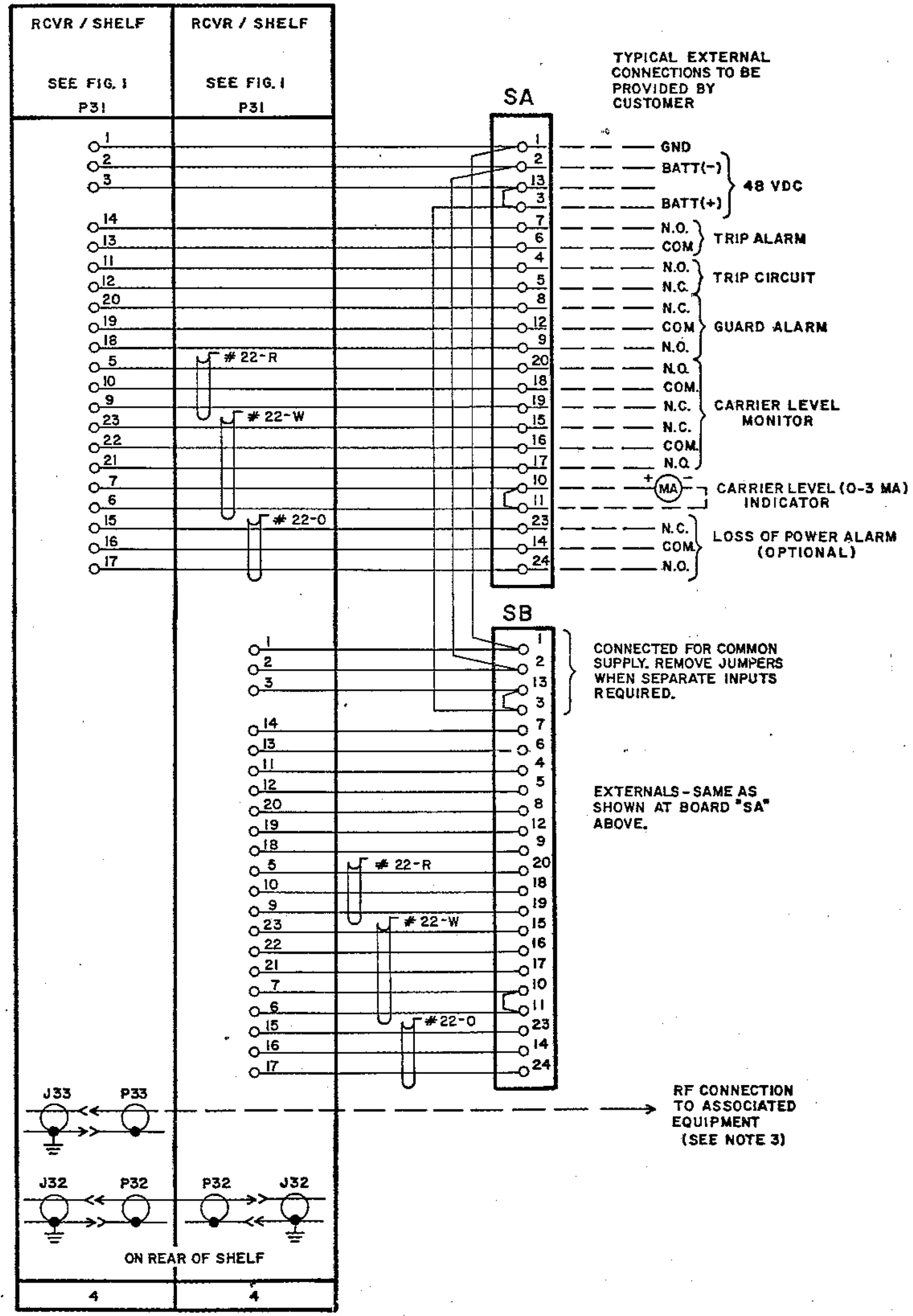
RECEIVER EQUIPMENT

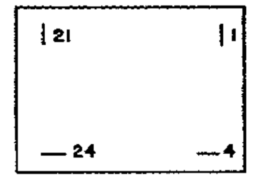
FIRST MADE FOR P.L.C.O. COMB. 4CR51B1F04R7N

F.C.F.O. (19-250280) OPTION 00X13

DUAL CHANNEL TRANSFERRED TRIP

48 VDC SUPPLY
INSTRUCTION BOOK - SEE NOTE 4.

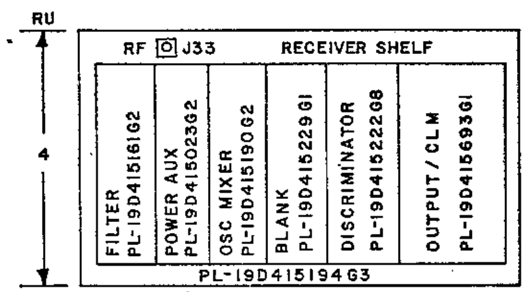




FRONT VIEW OF P31

FIG. 1

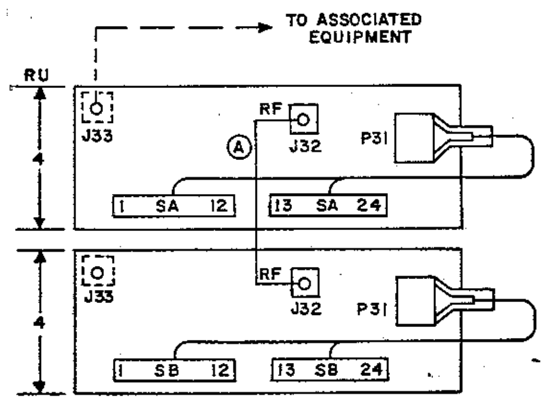
COMBINATION
4CR51B1F04R7N.
OPTION-00X13
ELEM. DIAG. - 19E501457 SH.2 - 4



(FRONT VIEW)

TWO IDENTICAL SHELVES FURNISHED FOR THIS MODEL OF EQUIPMENT.

DETAILS RF CONNECTIONS

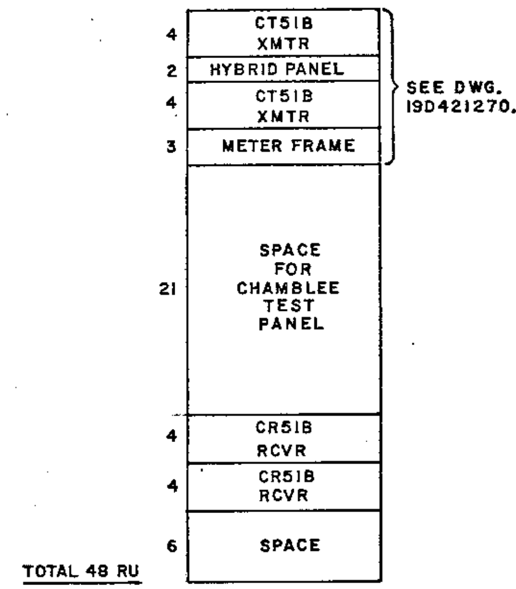


(REAR VIEW)

NOTE:
NO RF CONNECTION REQUIRED AT LOWER RECEIVER J33 WHEN JUMPER (A) INSTALLED.

EQUIPMENT ARRANGEMENT

90" OPEN RACK
CB48R



FRONT VIEW
1 RU = 1 3/4"

NOTES:

1. DOTTED CONNECTIONS TO BE MADE BY PURCHASER.
2. UNLESS OTHERWISE MARKED ALL FACTORY CABLES USE #16 BK. WIRE, RF CONNECTIONS RG-58 C/U CO-AX CABLE.
3. FACTORY TO PROVIDE THIS INTERCONNECTION WHEN ASSOCIATED TRANSMITTERS ORDERED AND MOUNTED IN COMMON CABINET, WITH HYBRIDS.
4. INSTRUCTIONS - LBI-28006 FOR ALL EQUIPMENT IN RACK.

REVISIONS	PRINTS TO
	L508
	236 15

MADE BY 5 MARCH 1973 — ISSUED 8 MARCH 1973 — APPROVED Mar 8 '73 — T.P.D. — LYNCHBURG — 19D421269 — 10 — EC-5

CARRIER FREQUENCY TRANSFORMER HYBRIDS

MODELS 4CL12X1, 4CL12RS1, AND 4CL12RD1

GENERAL

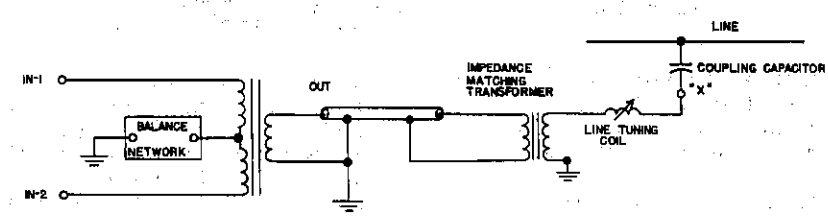
These hybrids are used for connecting two or more carrier transmitters and/or receivers, operating on closely spaced carrier frequencies, to a common tuned output circuit. They greatly attenuate (reject) the signal which each transmitter impresses (a) on adjacent receivers -- thus improving the overall channel operating ranges and (b) on adjacent transmitters -- thus reducing intermodulation products. This is accomplished at the expense of a power loss of approximately 3 dB multiplied by the number of hybrids through which a transmitter signal passes to reach the output circuit.

In general, N-1 hybrids are required to combine N functions. Reference to Figure 1-C shows a typical interconnection of transmitters through hybrids.

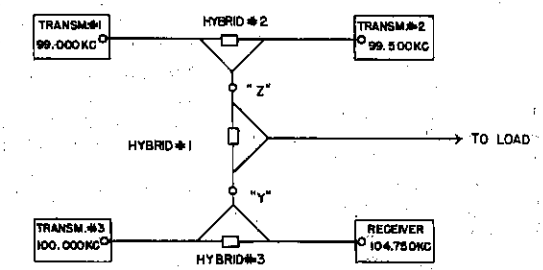
DESCRIPTION

The Model 4CL12X1 Transformer Hybrid has provision for matching and tuning and is used as the first hybrid since it permits the 50-70 ohm coaxial cable impedance level of the line tuning (or wide band coupling filter) equipment to be tuned and matched at one frequency for optimum hybrid balance. The Elementary Diagram is shown in Figure 2.

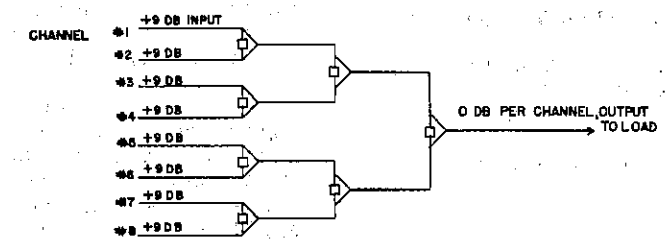
The Model CL12RS1 Transformer Hybrid is the same as the Model 4CL12X1 except that it does not have provision for matching and tuning. The Model 4CL12RS1 Transformer Hybrid consists of one hybrid subunit Model 4CL12R1 mounted in a case.



A. EQUIVALENT CIRCUIT OF HYBRID AND LOAD



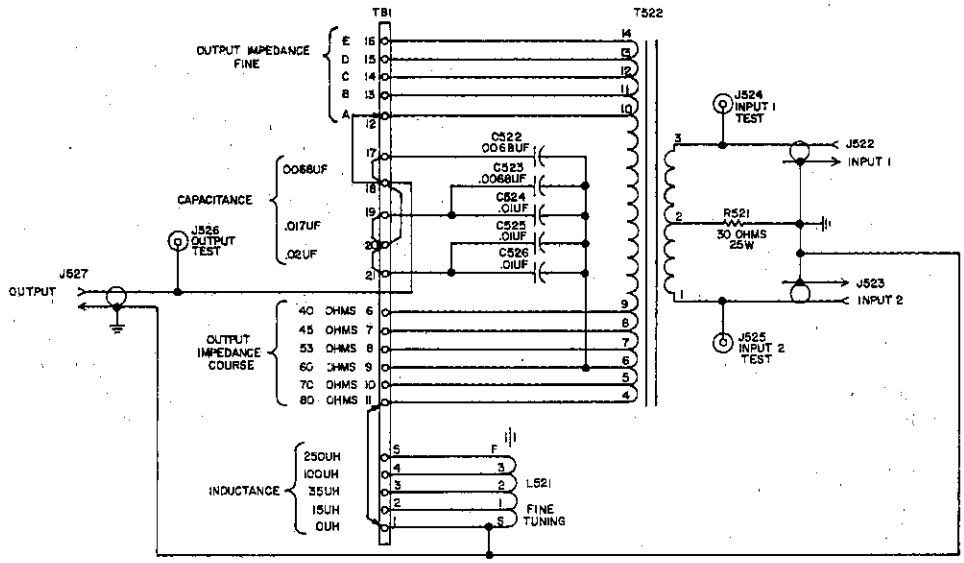
B. TYPICAL FREQUENCY SPACING OF THREE TRANSMITTERS AND ONE RECEIVER



C. 8 TRANSMITTER CHANNELS SHOWING ATTENUATION

(C-7977661, Rev. 4)

Figure 1 Hybrid Applications

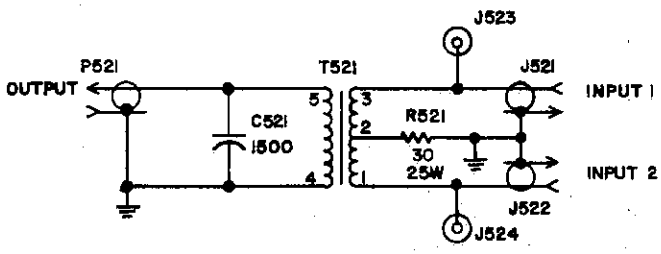


(B-5492665, Rev. 0)

Figure 2 Elementary Diagram of Transformer Hybrid, with Tuning and Matching, Model 4CL12X1

The Model 4CL12RD1 Transformer Hybrid consists of two hybrid subunits Model 4CL12R1 mounted in the same case. The Elementary Diagram is shown in Figure 3.

Either or both of these models, Model 4CL12RS1 and Model 4CL12RD1, are used as succeeding hybrids in a hybrid chain if Model 4CL12X1 is the first hybrid.



(A-4035899, Rev. 1)

Figure 3 Elementary Diagram of Transformer Hybrid, Subunit Model 4CL12R1
(one of these in a case compose Model 4CL12RS1)
(two of these in the same case compose Model 4CL12RD1)

HYBRID BALANCE

These hybrids are balanced when their output is terminated in the impedance which gives the maximum rejection (attenuation) between the pair of input terminals. Exact balance occurs when the output impedance reflected through transformer T521 looking into transformer terminals 1 and 2 or 2 and 3 is a 30 ohm resistance exactly matching R521. The impedance looking into either input is then 60 ohms.

For Model 4CL12R1, exact balance occurs when the hybrid output impedance is a 60 ohm resistance. This resistance can be provided by connecting the output of one hybrid to the input of the next hybrid and thus building up a chain of hybrids. All hybrids in the chain simultaneously balance when the hybrid nearest the common output tuning circuit is balanced.

For Model 4CL12X1, exact balance can be achieved over an adjustable range of output impedance. Even when the output circuit is already provided with tuning and matching (line tuning equipment), this hybrid provides a more exact and a more convenient means of obtaining hybrid balance.

Unlike filters, hybrids provide maximum rejection at minimum frequency spacing. Largely due to bandwidth limitations of the tuned output circuit, the rejection falls off at wide spacings. Hybrids are usually applied so that the bandwidth of the transmitted frequencies do not exceed 6% of the highest transmitted frequency.

A rejection of approximately 20 dB is maintained over this bandwidth range with relatively wide deviations of line impedance

from that value existing at the time of adjustment. It is advisable to readjust both the line tuning and the hybrid balance, if permanent changes are made in the high voltage power system of a nature that would change the line impedance.

ELECTRICAL SPECIFICATIONS

	MODEL 4CL12X1	MODEL 4CL12R1
Frequency Range, kHz	30-200	30-200
Max. Power, each input, Watts	15	15
Output Impedance, Resistance Load ohms	40-85	60
adjustment steps	3.2%	none
Input Impedance, ohms	60	60
Attenuation, dB (with exact impedance matching at output and inputs)		
Input to Output	3.5 max.	3.5 max.
Output to Input	3.5 max.	3.5 max.
Rejection, dB (each input to other input with exact matching at outputs and inputs)		
For any one frequency	40 min.	30 min.
For all frequencies	30 min.	30 min.

ADJUSTMENT

1. In general, the hybrid adjustment is the last adjustment made on the overall carrier installation. Check to see that all of the following adjustments have been completed (if they apply) in accordance with the instructions furnished with the equipment.

   (A) Line traps used on the carrier channels associated with the hybrid equipment should be tuned to the correct frequency or frequencies.

   (B) Adjust transmitter PA tank circuits, transmitter auxiliary tuning units or series L/C units for resonance.

   (C) Correctly set link on wide band coupling filter, if one is used.

   (D) Adjust line tuning equipment.

   Open the output circuit at the output terminals of the first hybrid (Model 4CL12X1). Normally, the signal used for adjustment will be obtained from the transmitter selected in (2) by opening its output circuit at the input terminals of its associated hybrid and then connecting the output circuit to feed directly into the coaxial cable to the line tuning equipment.

2. Select a transmitter to be used as a source of frequency for making the adjustments. This will be the transmitter if only a transmitter and receiver are involved or either transmitter if two transmitters are involved. If three or more transmitters are present, select the one whose frequency is nearest the center of the group of transmitter frequencies.

3. Restore all connections to normal, including any temporary connections made in (1). Turn on only the previously selected transmitter. Connect an electronic voltmeter to read the voltage across the other input of the hybrid to which the transmitter is directly connected. To avoid getting false readings from harmonic or intermodulation product signals, this voltmeter should preferably be a frequency selective voltmeter such as that made by Sierra Electronics or by Rycom.

4. Check to see that the first (Model 4CL12X1) hybrid strap connections are positioned so that L521 is 0 μh and C522 is 0 μf. Then adjust the tuning and matching adjustments in this hybrid unit for a minimum voltage reading on the voltmeter. This is accomplished as follows:

   (A) Adjust the coarse and fine impedance matching taps until a combination of the two is found which gives the lowest possible voltmeter reading.

   (B) Change the inductance tap from 0 to 15 μh. If the voltmeter reading decreases, continue to try other inductance taps and tuning slug positions until a combination of the two is found which gives the lowest possible reading and then proceed to (D). However, if the voltmeter reading increased on the 15 QH tap, this indicates that inductance is not required for exact hybrid balance. In this case, return the inductance tap to 0 and then proceed to (C).

   (C) Install link to obtain C522 equal to 0.0068 μf. If the voltmeter reading increases, indicating that capacity is not required, remove the link and complete the adjustment by following the procedure in (D). However, if the voltmeter reading decreases, try increasing values of C522 (values provided are 0.0068, 0.017, 0.02, 0.0238, 0.0268, 0.037, and 0.0438) until

the voltmeter reading passes through a minimum reading. Leave C522 connected for the first higher voltmeter reading after the minimum has been passed through. Change L521 tap and L521 slug position to obtain the combination giving the lowest possible voltmeter reading and proceed to (D).

(D) Repeat (A). At this point the voltage reading should be at least 40 dB down from the transmitter output level, assuming this input is terminated in a 60 ohm impedance. If terminated in a high impedance receiver, this value may be reduced to 34 dB. The voltmeter may not confirm this quality of performance unless it is of the frequency selective type. In unusual cases, it may not be possible to find any sharp balance point. For example, in adjusting impedance, inductance or capacity, the voltmeter may be decreasing at one end of the range but the minimum voltage point cannot be reached. This indicates that the line tuning equipment was not adjusted properly in (1D). This can usually be corrected by selecting another line tuning equipment impedance matching tap, if the hybrid impedance range is inadequate, or by a slight change in the line tuning equipment inductance setting, if the hybrid inductance or capacity range is inadequate -- followed by readjustment of the hybrid starting with (3).

(E) Verify that the system is operating correctly by turning on all transmitters and measuring the signal that each produces at the output of the first hybrid and at all hybrid inputs connected to transmitters or receivers.

PARTS LIST NOTES

This list includes all principal replacement parts. The symbol numbers used are the same as those appearing on elementary and other diagrams.

When ordering a replacement part, please include description, symbol designation, and reference number of the part and ML or PL number of the unit. When reordering crystals and filters, also please include the frequency. Orders may be sent to the nearest General Electric Apparatus Sales Division District Office.

The following is an explanation of the reference marks used in the parts lists:

Carrier Current equipment marked with a letter on or adjacent to the nameplate has had changes incorporated. The symbol * on the parts list indicates that this part has been either added, deleted or changed according to production changes.

PARTS LIST

TRANSFORMER HYBRID WITH TUNING & MATCHING

MODEL 4CL12X1

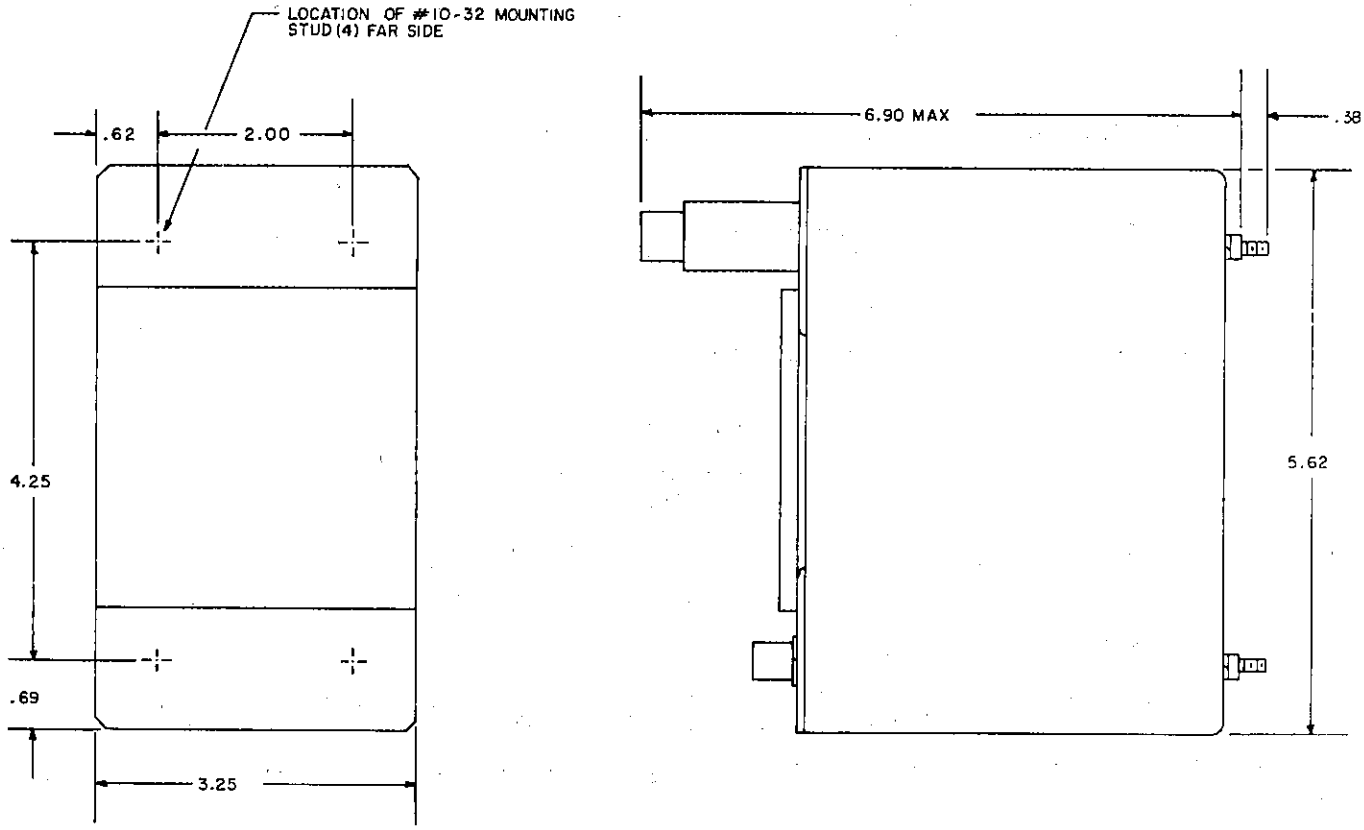
Symbol	GE Part No.	Description
		- - - - - - - - - - - - CAPACITORS - - - - - - - - - - - - - - -
C522 & C523	3R31-P64	Mica: 6800 pf ±10%, 1200 VDCW; sim to RETMA RCM50B682K.
C524 thru C526	3R31-P65	Mica: 10,000 pf ±10%, 1200 VDCW; sim to RETMA RCM50B103K.
		- - - - - - - - - - CONNECTORS & JACKS - - - - - - - - - - - - - -
J522 & J523	7776570-P17	Bulkhead receptacle: weather-proof bayonet-lock coupling, 500 V, 50 ohms; A/N Type Ug-1094/U.
J524 thru J526	7143959-P2	Test point jack: nylon -red; sim to E. F. Johnson 105-602-1.
J527	2R22-P3	Chassis receptacle, coaxial; sim to Amphenol 83-1R, Signal Corps SO-329.

Symbol	GE Part No.	Description
P527	2R22-P1	Straight plug, coaxial; sim to Amphenol 83-1SP, Signal Corp PL-259.
		- - - - - - - - - - - - - - COIL - - - - - - - - - - - - - - - -
L521	PL-5493744-G1	78 turn, 5 tap coil, 0 to 250 μh.
		- - - - - - - - - - - - - RESISTOR - - - - - - - - - - - - - - -
R521	5493550-P101	Wire-wound: non-inductive, non-magnetic Hardware, 30 ohms ±1%, 25 W; bolt mounted.
		- - - - - - - - - - - - - TRANSFORMER - - - - - - - - - - - - - -
T522	PL-5493741-G1	Transformer with 10 output imp taps.

PARTS LIST

TRANSFORMER HYBRID
MODEL 4CL12R1

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - CAPACITOR - - - - - - - - - - - - - - -
C521	5490825-P5	Disc: 1500 pf ±10%, sim to RMC JF.
J521 & J522	7776570-P17	Bulkhead receptacle: weather-proof bayonet-lock coupling, 500 V, 50 ohms, A/N Type UG-1094/U.
J523 & J524	7143959-P2	Test point jack: nylon - red; sim to E. F. Johnson 105-602-1.
P521	7776570-P1	Plug, BNC series: weather-proof bayonet-lock coupling, 500 V, 50 ohms; A/N Type UG-88C/U was A/N UG-88/U.
		- - - - - - - - - - - - RESISTOR - - - - - - - - - - - - - -
R521	5493550-P101	Wire-wound: non-inductive, non-magnetic hardware, 30 ohms ±1%, 25 W, bolt mounted.
		- - - - - - - - - - - - - TRANSFORMER - - - - - - - - - - - - - -
T521	PL-5493733-G1	Transformer with 5 taps.
		- - - - - - - - - - - - MISCELLANEOUS - - - - - - - - - - - - -
---	7776570-P1	Cable plug for connection to Hybrid Inputs (normally furnished with carrier system assembly). For RG-58 or RG-58A cable.



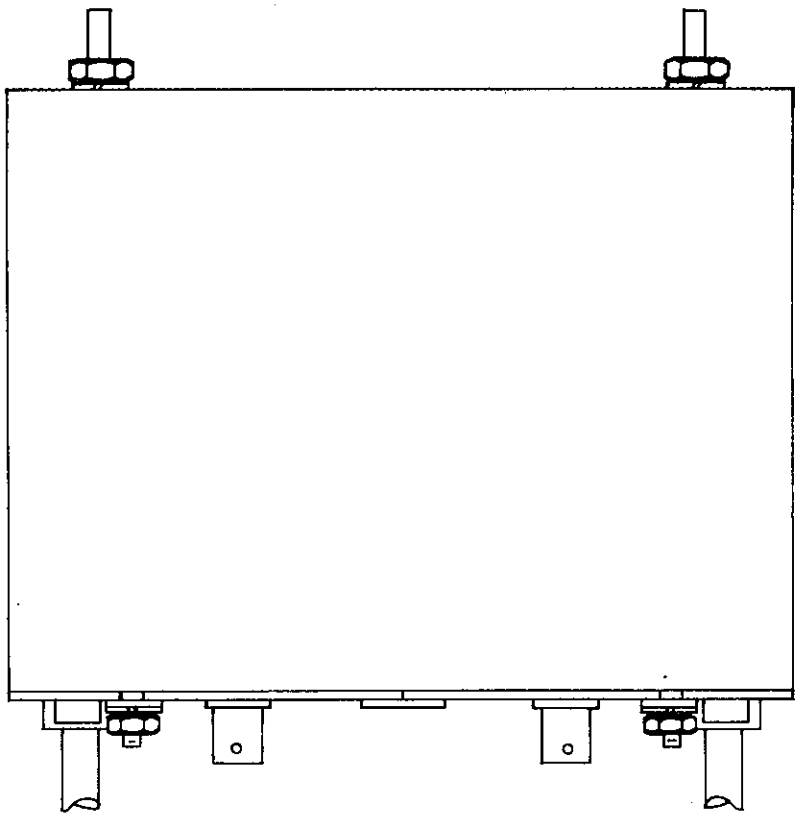
Outline Diagram

RF HYBRID UNIT
MODEL 4CL12X1

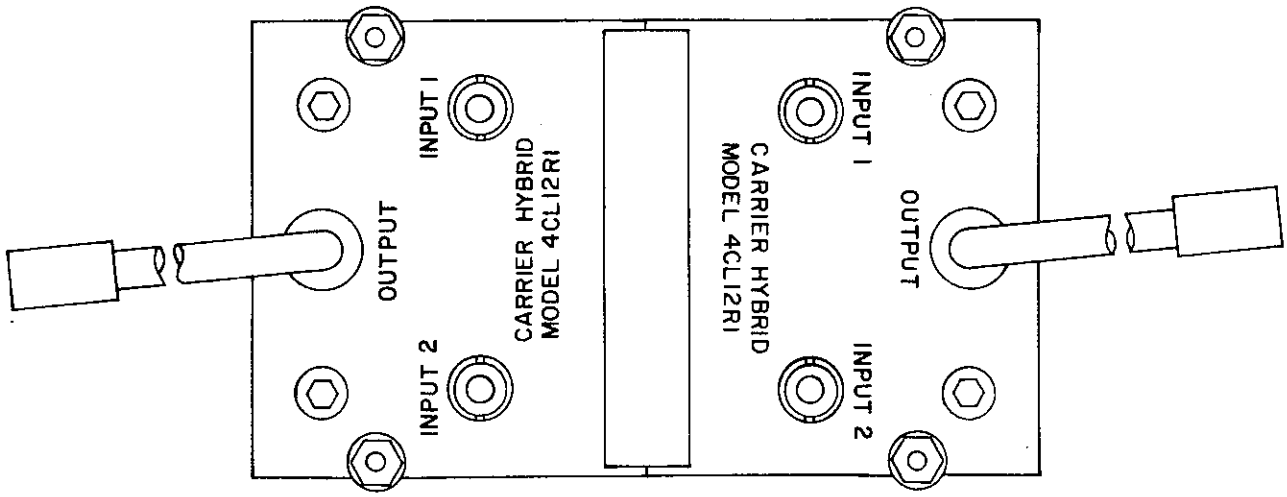
(19C305187, Rev. 0)

TELECOMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.



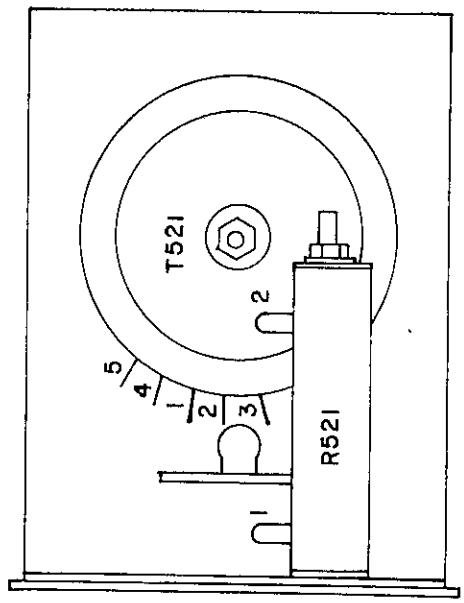
CARRIER HYBRID
ML-4CL12RD1

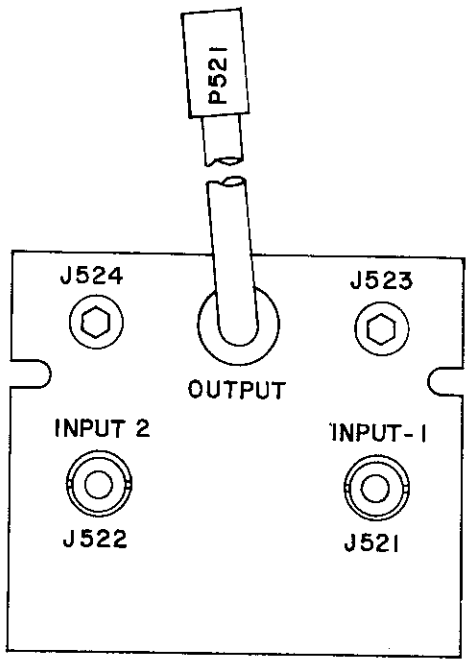


Parts Layout Diagram

CARRIER (TRANSFORMER) HYBRID
MODEL 4CL12RD1

(19B218540, Rev. 0)

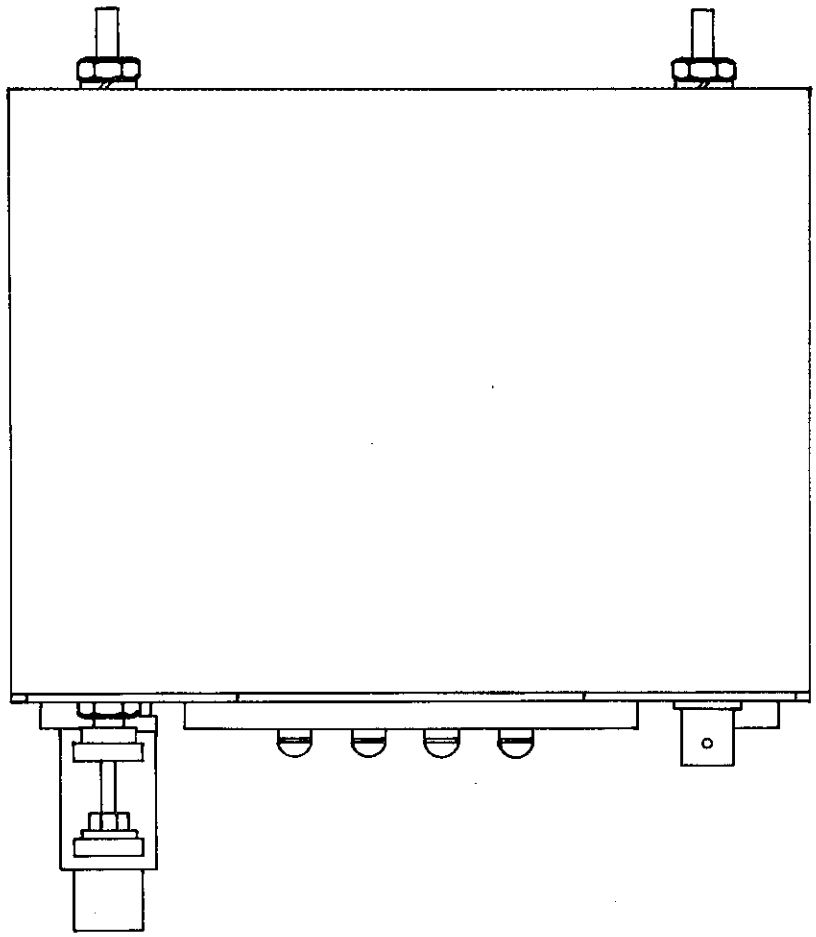


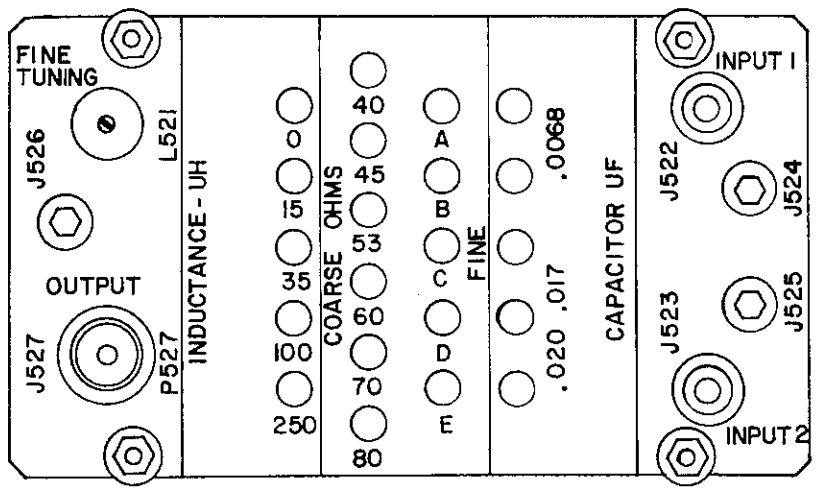


Parts Layout Diagram

TRANSFORMER HYBRID
MODEL 4CL12R1

(19B218541, Rev. 0)

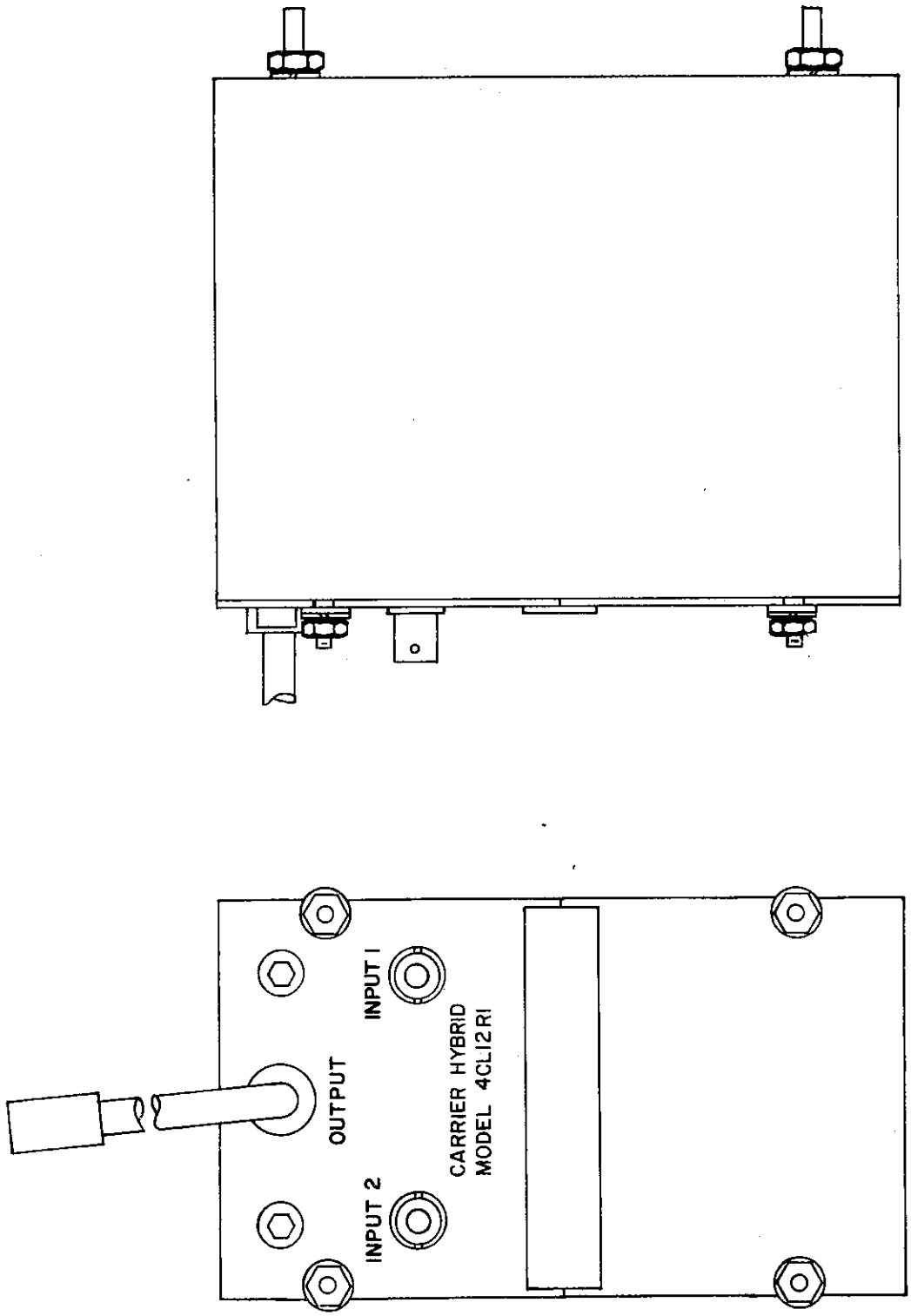




Parts Layout Diagram

TRANSFORMER HYBRID
MODEL 4CL12X1

(19B218542, Rev. 0)



Parts Layout Diagram

CARRIER (TRANSFORMER) HYBRID
MODEL 4CL12RS1

(19B218544, Rev. 0)

INSTRUCTIONS

HIGH-FREQUENCY RF SKEWED HYBRID
MODEL 4CL12RA1
MODEL 4CL12RA2

INTRODUCTION

The High-Frequency RF Skewed Hybrid Model 4CL12RA1, is a device which is used to connect a 4 wire transmitting-receiving system to a 2 wire line. The skewed hybrid is used only for separating a transmitter and receiver operating on closely spaced frequencies and which are connected to a common tuned output circuit. The RF Skewed Hybrid differs from a conventional RF Hybrid in that the transmitter loss is reduced to less than 1.0 dB as opposed to the 4.0 dB loss in the conventional hybrid. This is accomplished at the expense of added attenuation (12 dB instead of 4 dB) in the receiver path of the skewed hybrid; but, this is of little concern, as both signal and noise are attenuated to the same degree.

The RF Skewed Hybrid, Model 4CL12RA2 is similar to the model 4CL12RA1, except that resistor R202 has been added to provide proper termination impedance for terminal 2 when used with high impedance input devices.

GENERAL

The High-Frequency RF Skewed Hybrid consists of a multi-tap impedance matching transformer on the transmit path, and a one-to-one ratio transformer on the receive path.

The receive path of the 4 wire system is coupled to the line through the action of a third winding on each transformer, which also provides isolation between the transmit and receive paths by flux cancellation.

NOMINAL OPERATING CHARACTERISTICS

Frequency Range:	
Transmit Wattage Rating	Frequency Range
a) 20 Watts	8 kHz - 300 kHz
b) 80 Watts	40 kHz - 300 kHz
Maximum Power (Transmit)	20 Watts, 80 Watts (dependent on frequency)
Input Impedance	50 ohms (adjustable for line loading between 30-70 ohms)
Attenuation	
Transmit (Input 1) to Output	approx. 0.5 dB
Output to (Input 2) Receive	approx. 12.0 dB
Rejection (all frequencies)	
Transmit (Input 1) to (Input 2) Receive	30 dBm, min

CIRCUIT OPERATION

The operation of a Skewed Hybrid may be determined by a study of Figure 1. If, at some instant of time, the voltages induced in the two secondary windings of transformer T201 are as shown, it may be seen that if the fluxes set up in transformer T202 are to cancel each other, I_1 must equal NI_2, where N is the turns ratio of the secondary windings.

Since the fluxes in transformer T202 due to the currents from transformer T201 cancel, the impedance of the receiver side can vary without affecting the currents from T201 in any way. Since Z_L equals Z_B and has a current N times as large flowing through it, there must be N^2 times as much power dissipated in Z_L as in Z_B when a signal is received from the transmit side. When a signal is received from the receive side, N^2 times the power that is dissipated in Z_L will be dissipated in Z_B.

ADJUSTMENT

Maximum rejection of transmitter output to receiver input depends upon operating this skewed hybrid into as nearly a resistive load as possible. This means that any associated line tuning equipment must be adjusted as well as possible to tune out any reactive impedance in the load. This may require minor adjustments in the external

line tuning equipment (core position only) to maximize the rejection performance of this skewed hybrid.

Taps are provided for impedance matching of the line impedance from 30 to 70 ohms. The factory setting is for a line impedance of 50 ohms.

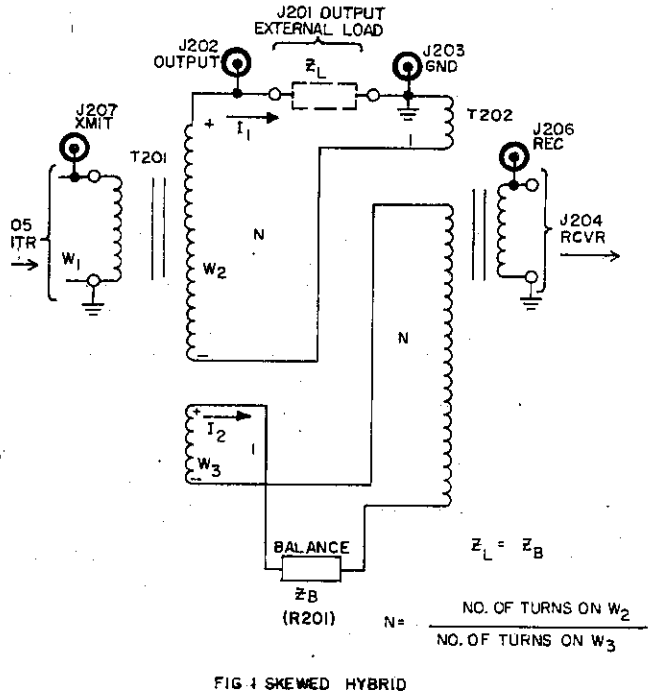


FIG 1 SKEWED HYBRID

CC-38

Figure 1 Skewed Hybrid

PARTS LIST

RF SKEWED HYBRID
MODEL 4CL12RA1
MODEL 4CL12RA2

Symbol	GE Part No.	Description
		- - - - - - - - - - - - CONNECTORS AND JACKS - - - - - - - - - -
J201	2R22-P3	Connector, Coaxial; sim to Signal Corps SO-239 or Amphenol 83-1R.
J202	7150763-P2	Test Point, stake-in; sim Alden 110BC1-red.
J203	7150763-P1	Test Point, stake-in; sim Alden 110BC1-black.
J204 & J205	7776570-P17	Connector, Coaxial, BNC type; bulkhead receptacle; Mil. No. UG-1094/U.
J206 & J207	7150763-P2	Test Point, stake-in; sim Alden 110BC1-red.
P201	2R22-P1	Connector, Coaxial, sim Signal Corps PL-259 or Amphenol 83-1SP.
		- - - - - - - - - - - - - - -RESISTORS - - - - - - - - - - - -
R201*	19A115927-P1	Wirewound, non-inductive: 50 ohms ±5%, 25 W.
R202*	3R79-P101J	Composition: 100 ohms ±5%, 2 W. (Used in Model 4CL12RA2 only)
		- - - - - - - - - - - - - -TRANSFORMERS - - - - - - - - - - -
T201	PL-19B207380-G1	RF Hybrid.
T202	PL-19B207381-G1	RF Hybrid.

PRODUCTION CHANGES

RF SKEWED HYBRID MODULE MODEL 4CL12RA1

The revisions listed below can be identified by the revision letter appearing on the equipment nameplate.

Model 4CL12RA1, Rev. A

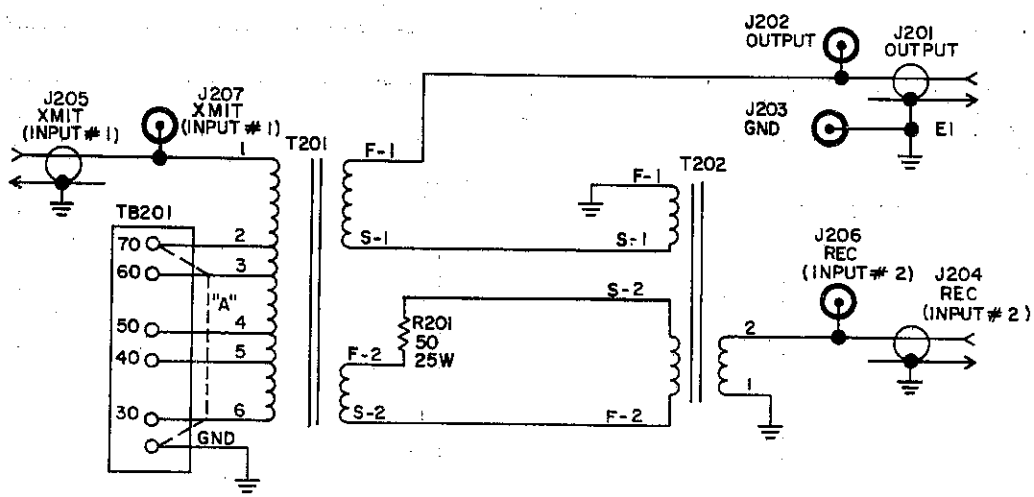
Purpose: To expand power operating range.

Part Changed	Was	Changed To
R201 thru R204	549548-P129	3R79-P201J; Composition: 200 ohms ±5%, 2 W.

Model 4CL12RA1, Rev. B

Purpose: To permit use with 100-Watt pilot relaying amplifiers.

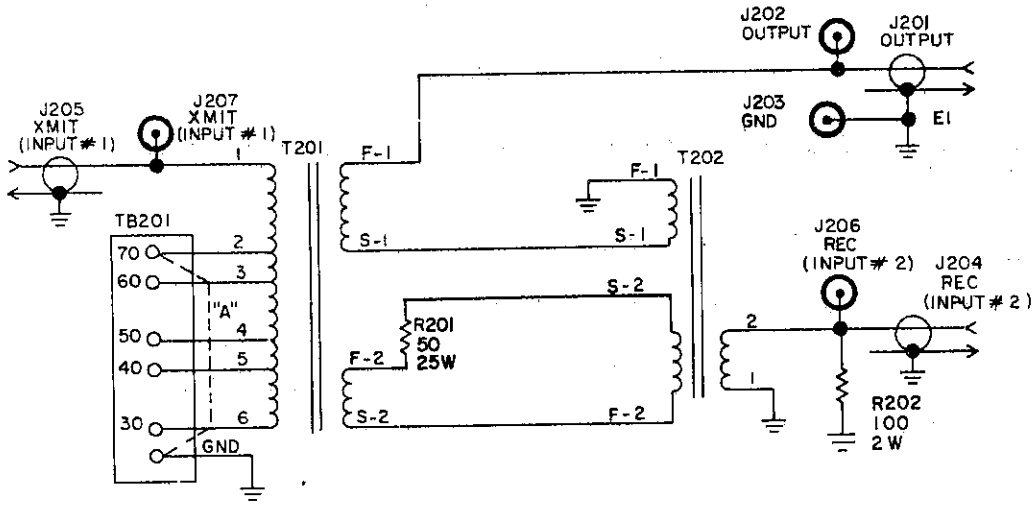
Part Changed	Was	Changed To
R201	3R79-P201J	19A115927-P1, wirewound; 50-ohm, ±5%, 25 W.
R202 thru R204	3R79-P201J	Delete.



JUMPER "A" PROVIDED FOR OPTIMUM IMPEDANCE MATCHING.
RESISTOR VALUES IN OHMS.

(19B207386, Rev. 4)

Elementary Diagram - RF SKEWED HYBRID MODULE MODEL 4CL12RA1, REV. B

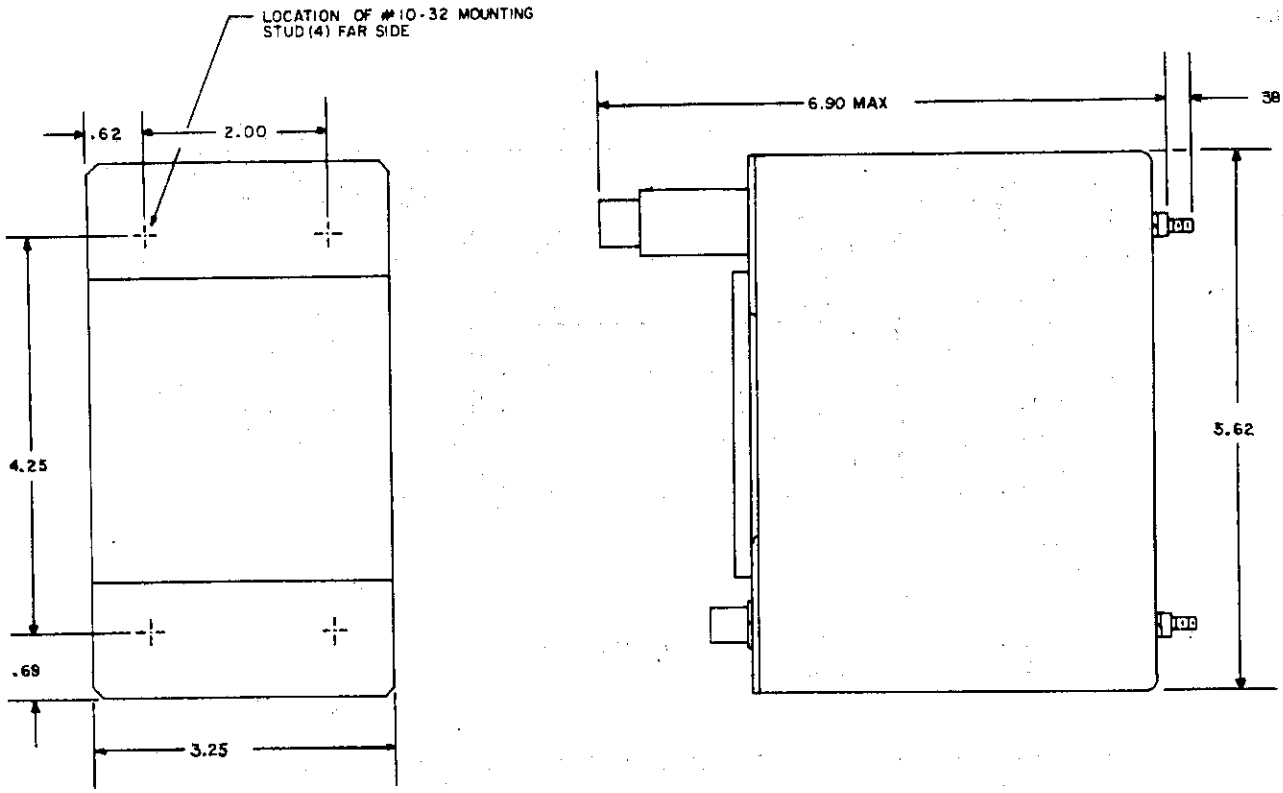


JUMPER "A" PROVIDED FOR OPTIMUM IMPEDANCE MATCHING.
RESISTOR VALUES IN OHMS

MODEL 4CL12RA2

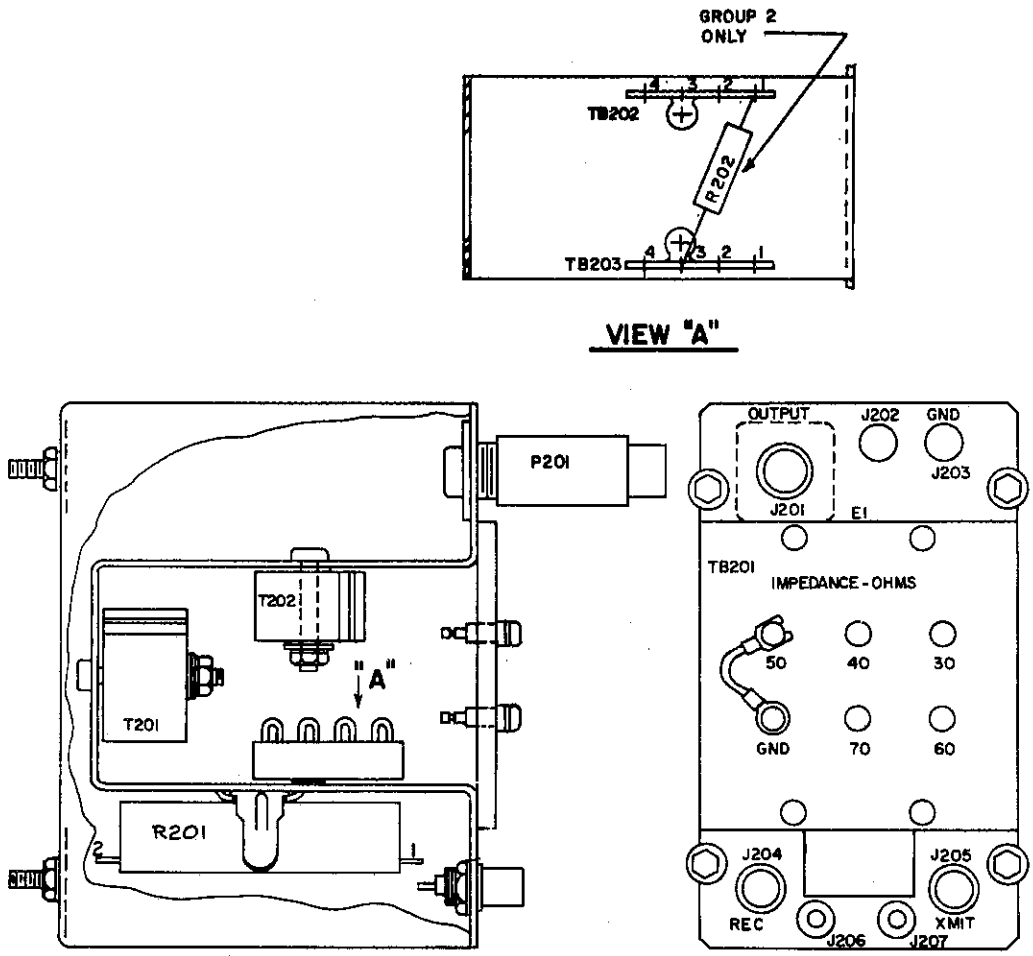
(19B207822, Rev. 0)

Elementary Diagram - RF SKEWED HYBRID MODULE MODEL 4CL12RA2



(19C305187, Rev. 1)

Outline Diagram - HYBRID UNIT OR MODULE



(19C305355, Rev. 4)

Parts Layout Diagram - RF SKEWED HYBRID MODULE MODEL 4CL12RA1 & MODEL 4CL12RA2

TELECOMMUNICATIONS PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

CARRIER CURRENT

METER-ANALYZER UNIT
MODEL 4CX5A2

INTRODUCTION

The General Electric Carrier Current Meter-Analyzer Unit, Model 4CX5A2, is a device to be used in checking carrier current equipment.

This unit is manufactured for the General Electric Company by the Triplett Electrical Instrument Company of Bluffton, Ohio. The Triplett warranty on this unit is for 12 months from the date of original purchase and covers defective material or workmanship, which, under normal use and service, discloses the defect to be the fault of the manufacturer. The complete wording of their standard warranty will apply, except that the time limit will be 12 months instead of 90 days.

It is suggested that for quick service on possible defective units or for replacement parts, the customer should either send the unit to, or order directly from, the Service Department, Triplett Electrical Instrument Company, Bluffton, Ohio.

A rack-mounting meter frame is used to hold the Meter-Analyzer Unit into which the unit can be inserted from either side. The meter unit panel contains two instruments, one to measure carrier-frequency current and the other to measure voltage (AC and DC), output level, resistance and current (DC). Switches are provided for function and range selection. External connections are made to appropriately labeled jacks. Leads and plugs are supplied with the unit, as well as batteries.

SPECIFICATIONS

Mechanical:

Height:	5-1/4" (3 RU) 1 RU = 1-3/4"
Width:	19" standard rack mounting
Depth:	3-1/8" (Meter Unit); 4-1/4" (Meter Frame)
Weight:	9-1/2 lbs. net; 13 lbs. shipping

Electrical:

Voltage Ranges: DC (at 20,000 ohms per Volt) and AC (at 5,000 ohms per Volt)

0-2.5-10-50-250-500-1000 Volts

NOTE

When RANGE Switch is in OFF position, meter is shunted for maximum damping.

Output Level Ranges: -10 to +10, +2 to +22, +16 to +36, +30 to +50, +36 to +56, +42 to +62 dB on 600 ohm line

Resistance Ranges: 0-1000-10,000-100,000-1 meg - 10 meg ohms at center scale: 5,50,500,5 K, 50 K ohms

CAUTION

High current drain on batteries on low ohm ranges. Replace weak batteries at once.

Current Ranges: DC (at 250 mV)

0-0.1-1.0-10-100-500 mA and 2.5 A

RF (at 12 mV)	RF (at 62 mV)
0-250-500 mA	0-1000 mA

Accuracy:

Scale	Tolerance
DCV	±3% of full scale
DCMA	±3% of full scale
ACV (60 cycle)	±5% of full scale
DBM	±5% of full scale
RFMA	±5% of full scale
R (check at 1/2 linear scale)	±3% of linear full scale

NOTE

ACV and DB ranges are flat from 35 cycles to 2000 cycles (dropping 0.1 DB at 10 kHz and gradually dropping to 0.6 DB at 100 kHz.

All measurements taken with meter face in vertical position, as mounted in rack frame.

DESCRIPTION

The panel for this instrument has been designed to provide simplicity of operation. Once the general operation of the Meter Analyzer Unit is understood, there is no necessity to refer to the instructions.

There are two electrically independent measuring instruments contained in the Meter-Analyzer Unit. These are: a thermocouple-type RF milliammeter, and a Volt-ohm-milli-ampere instrument. The RF milliammeter is located on the left-hand side of the panel. The Volt-ohm-milliampere instrument is located on the right-hand side of the panel.

There are two groups of jacks on the panel. One pair is below the RF milliam-meter and is labeled RFMA. The other group, consisting of three jacks, is located below the Volt-ohm-milliampere meter. Two of these jacks, labeled VOM and COMMON, are used for all VOM type measurements except for the 2.5 DC ampere range. For this range, the third jack, labeled 2.5 DC AMPS, is used.

Function and range selections are made by three switches. RF range selection is made with the left-hand switch, which also provides an OFF position in which it should be left at all times except when measure-ments are being made. The VOM function and range selections are made by the two right-hand switches. These switches are labeled FUNCTION AND RANGE.

Also on the panel, below and between the two meters, is a knob labeled OHMS ADJ used for ohms scale zero adjustment.

OPERATION

CAUTION

Before mounting the meter unit into the meter frame, remove the back cover and install the two batteries, supplied separately, into their holders, being sure that the positive terminals are matched to the red-plastic-marked-end of the battery holders.

DC VOLTAGE (20,000 ohms per Volt)

1. Turn FUNCTION switch to DCV.
2. Rotate RANGE switch to any one of six ranges desired. In choosing ranges, always start with the highest range if in doubt as to the approximate voltage.
3. Plug the red test lead into the red (+) jack marked VOM. Plug the black (-) jack marked COMMON.
4. Connect the test leads across the volt-age source. When polarity is difficult to determine, the meter may read back-wards. If this occurs, reverse the leads.
5. Take readings on the DC Volt scales, which are marked with the ranges of 0-10, 0-50, and 0-250.

NOTE

The instrument, when set to read DC volts, will drain 50 micro-amperes from the circuit under test at full scale deflection.

AC VOLTAGE (5000 ohms per Volt)

1. Turn FUNCTION switch to ACV.
2. Rotate RANGE switch to any one of six ranges desired. In choosing ranges, always start with the highest range if in doubt as to the approximate voltage.
3. Plug the red test lead into the red (+) jack marked VOM. Plug the black test lead into the black (-) jack marked COMMON.
4. Connect the leads across the voltage source. As there is no polarity on AC, the red and black leads may be interchanged without causing the meter to read backwards.

IMPORTANT

As there is no GROUND in the AC circuit, in order to take accurate measurements at high frequencies, the GROUND side of the circuit under test must be connected to the black (-) jack.

5. Take readings on the AC volt scales, marked with the ranges 0-10, 0-50, and 0-250. For the range 0-2.5 VAC, use the separate scale on the meter.

NOTE

The instrument, when set to read AC volts, will drain approximately 200 microamperes from the circuit under test at full scale deflection.

RIPPLE VOLTAGE (5000 ohms per Volt)

1. Turn the FUNCTION switch to DB.
2. Rotate RANGE switch to any one of six AC voltage ranges desired.
3. Plug the red test lead into the red (+) jack marked VOM. Plug the black test lead into the black (-) jack marked COMMON.
4. Take readings on the corresponding AC scale.

CAUTION

Ripple voltage measurements across voltages greater than 400 Volts DC must be avoided. This limit is imposed by the DC working voltage rating of the internally-connected 1.0 μf series capacitor.

AUDIO OUTPUT LEVEL OR DECIBELS

1. Turn the FUNCTION switch to DB.
2. Rotate RANGE switch to any one of six ranges desired.
3. Plug the red test lead into the red (+) jack marked VOM. Plug the black test lead into the black (-) jack marked COMMON.

IMPORTANT

In order to make accurate measurements at high frequencies, the GROUND side of the circuit under test must be connected to the black (-) jack.

4. Take all DB readings on the scale marked -10 to +10 DB. With the RANGE switch on the 0 DB position, the reading is taken directly; with the RANGE switch on any other position, the proper reading is obtained by adding algebraically the RANGE switch setting to the scale indication reading.

NOTE

Zero reference level is based on a one-milliwatt level in a 600 ohm line, which is equivalent to 0.775 Volts.

CAUTION

Audio output level or decibel measurements across voltages greater than 400 Volts DC must be avoided. This limit is imposed by the DC working voltage rating of the internally connected 1.0 μf series capacitor.

RESISTANCE

1. Turn FUNCTION switch to OHMS.
2. Rotate RANGE switch to any one of five range desired.
3. Plug the red test lead into the red (+) jack marked VOM. Plug the black test lead into the black (-) jack marked COMMON.
4. Short the test leads together and adjust the OHMS ADJ knob until the instrument reads zero ohms. (The zero for the ohms scale is at the extreme right side of the scale.)

NOTE

This check should be made each time an ohm range is changed.

5. Connect the test leads across the unknown resistance. If the component is wired into a circuit, disconnect one end before taking the reading.
6. Take readings on the OHMS scale, multiplying the scale indications by 1, 10, 100, 1 K (1000) or 10 K (10,000), depending upon the range selected.

CAUTION

It should be noted that in the measurement of resistance, a current is passed through a component. When the RANGE switch is set at RX1, the current drain on the batteries is quite large. It is, therefore, recommended that the readings be made as quickly as possible, especially when adjusting for zero ohms. It is more desirable that the RX10 or higher range be used for general continuity or circuit testing in order to extend battery life.

NOTE

The two lowest resistance ranges, RX1 and RX10, are protected by one-ampere fuse, F1, in the circuit. If no readings are obtained on any OHM Range setting, check the fuse.

DC CURRENT

1. Turn the FUNCTION switch DCMA.
2. Rotate the RANGE switch to any one of five ranges desired. In choosing ranges, always start with the highest range if in doubt as to the approximate current.
3. Plug the red test lead into the red (+) jack marked VOM. Plug the black test lead into the black (-) jack marked COMMON.
4. Connect the test leads in series with the circuit to be measured.

NOTE

Do not test directly across any potential circuits as this may burn out the instrument and shunt. Also note Item 6 below.

Where polarity is difficult to determine, the meter may read backwards. If this occurs, reverse the leads.

5. Take readings on the scales marked DC and AC with the ranges of 0-10 and 0-50.
6. To measure currents up to 2.5 amperes, plug the red test lead into the jack marked 2.5 DC AMPS. Plug the black test lead into the black (-) jack. Place the FUNCTION switch in the 2.5 DC AMPS position and the Range switch in any position. Take the reading on the 0-250 scale.

RF CURRENT

1. Turn the RF RANGE SELECTOR switch to the OFF position.
2. Connect the test leads into the pair of jacks marked RFMA.
3. Turn the RF RANGE SELECTOR switch clockwise to the highest range which will give a satisfactory scale indication. This is a precautionary measure to minimize the possibility of destructive overloads to the thermocouple.

IMPORTANT

It is recommended (if possible) that the current be reduced to zero before changing from one range to another. Switching ranges may cause the circuit to open.

4. Take readings on the scale corresponding to the RF RANGE SELECTOR switch setting.

NOTE

The RF RANGE SELECTOR switch should be left in the OFF position except when taking readings.

MAINTENANCE

Pointer Zero Adjustment

The pointed can be zero adjusted with the pointer zero adjustment screw located below the meter face.

Checking and Replacing Batteries

The batteries should be checked periodically and are satisfactory as long as the ranges can be adjusted to zero and the batteries do not leak or corrode.

Checking and Replacing Fuse

The fuse is located on the main mounting board beneath the back cover and is in the resistance testing circuit. If no scale indication is seen, check the fuse.

Cleaning Meter Windows

If the meter windows need cleaning, it should be done with cotton dipped in a weak solution of detergent and water. Allow to air dry and do not rinse with clear water.

PARTS LIST
METER-ANALYZER UNIT
MODEL 4CX5A2

Symbol	Manufacturer's Part Number	Description
		- - - - - - - - - - -BATTERY - - - - - - - - - -
B1 & B2	Burgess 2	1.5 V
		- - - - - - - - - -CAPACITORS - - - - - - - - -
C1	Aerovox P-82	1.0 mfd, 200 WVDC
C2	Centralab TTD-Hi-Q	0.01 mfd, 50 WVDC
		- - - - - - - - - - -DIODES - - - - - - - - - -
CR1 & CR2	Hughes HD1441	Type 1N295
		- - - - - - - - - - - FUSE - - - - - - - - - -
F1	Littelfuse 3AG	1.0 amp, 250 V
		- - - - - - - - - - -METERS - - - - - - - - - -
M1	Triplett 52-1594	50 µA, 250 mV; Model 420
M2	Triplett 52-1593	2 mA, 12 mV; Model 440
		- - - - - - - - - - - POSTS - - - - - - - - - -
J1 & J2	E.F. Johnson 111-103	Binding, black
J3	E.F. Johnson 111-102	Binding, red
J4	E.F. Johnson 111-103	Binding, black
J5	E.F. Johnson 111-102	Binding, red
		- - - - - - - - - - -PROBES - - - - - - - - - -
		Test leads - GE 5493306-P6
		These leads equipped with insulated banana plugs
		Test lead - twin. GE 5493306-P3. This lead equipped with Mallory 75 plug, and insulated banana plugs sim to H. H. Smith 295
		Test leads - red. GE 5493306-P4; black - GE 5493306-P5
		These leads equipped with insulated banana plugs sim to H. H. Smith 295; and solderless test prob sim to H. H. Smith 384
		- - - - - - - - - - RESISTORS - - - - - - - - -
R1 thru R3	Hi-Q CPL 1/2	5 megohms, ±1%, 1/2 W
R4	Hi-Q CP 1/2	4 megohm, ±1%, 1/2 W
R5	Hi-Q CP 1/2	800 K ohms, ±1%, 1/2 W
R6	Hi-Q CP 1/2	150 K ohms, ±1%, 1/2 W
R7	Hi-Q CP 1/2	45 K ohms, ±1%, 1/2 W

Symbol	Manufacturer's Part Number	Description
R8	Hi-Q CP 1/2	5 K ohms, ±1%, 1/2 W
R9	Triplett 15-2555	Wirewound: 263.2 ohms, ±1/2%
R10	Triplett 15-2850	Wirewound: 25.12 ohms, ±1%
R11	Triplett 15-3958	Wirewound: 2.48 ohms, ±1/2%
R12	Triplett 15-3959	Wirewound: 0.477 ohm, ±1/2%
R13	Triplett 90A-708	Shunt, DC: 2.5 amps, 50 mV; approx. 0.1 ohms
R14	Hi-Q CP 1/2	300 K ohms, ±1%, 1/2 W
R15	Hi-Q CP 1/2	5450 ohms, ±1%, 1/2 W
R16	Triplett 15-3665	Wirewound: 505 ohms, ±1%
R17	Triplett 15-1248	Wirewound: 50 ohms, ±1%
R18	Triplett 15-3666	Wirewound: 4.26 ohms, ±1%
R19	Hi-Q CP 1/2	37.5 K ohm, ±1%, 1/2 W
R20	Hi-Q CP 1/2	200 K ohms, ±1%, 1/2 W
R21	Hi-Q CP 1/2	1 megohm, ±1%, 1/2 W
R22	Hi-Q CP 1/2	1.25 megohm, ±1%, 1/2 W
R23	Hi-Q CP 1	2.5 megohm, ±1%, 1/2 W
R24	Hi-Q CP 1	8,100 ohms, ±1%, 1/2 W
R25 & R26	Hi-Q CP 1/2	5 K ohm, ±1%, 1/2 W
R27	Hi-Q CP 1/2	15 K ohms, ±1%, 1/2 W
R28	Centralab Model 2	Variable: 20 K ohms
R29	Hi-Q CP 1/2	2600 ohms, ±1%, 1/2 W
R30	Hi-Q CP 1/2	32 K ohms, ±1%, 1/2 W
R31	Triplett 15-3670	Wirewound: 0.364 ohms, ±1/2%
R32	Triplett 15-3671	Wirewound: 1.1 ohms, ±1/2%
R33 thru R35	Triplett 15-3945	Wirewound: 3.3 ohms, ±1/2%
		- - - - - - - - - SWITCHES - - - - - - - - -
S1	Grigsby Co.	Range, VOM: 12 pos, 4-deck
S2	Grigsby Co.	Range, RF, mA: 12 pos, 2-deck
S3	Grigsby Co.	Function, VOM: 12 pos, 4-deck
		- - - - - - - - - THERMOCOUPLE - - - - - - - - -
VT1	Amer. Thermo Elec. F-250	Vacuum, 250 mA

TELECOMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

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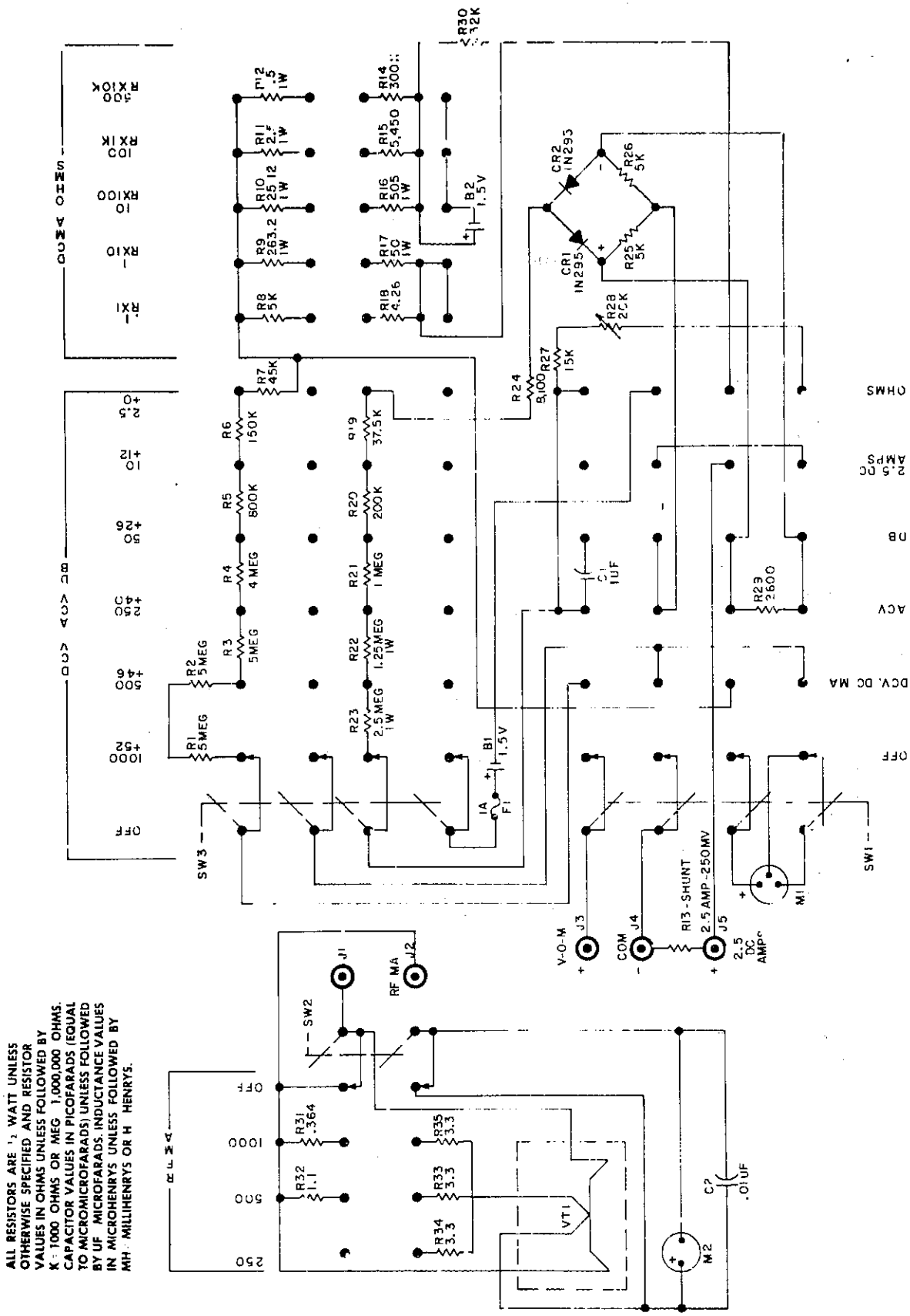
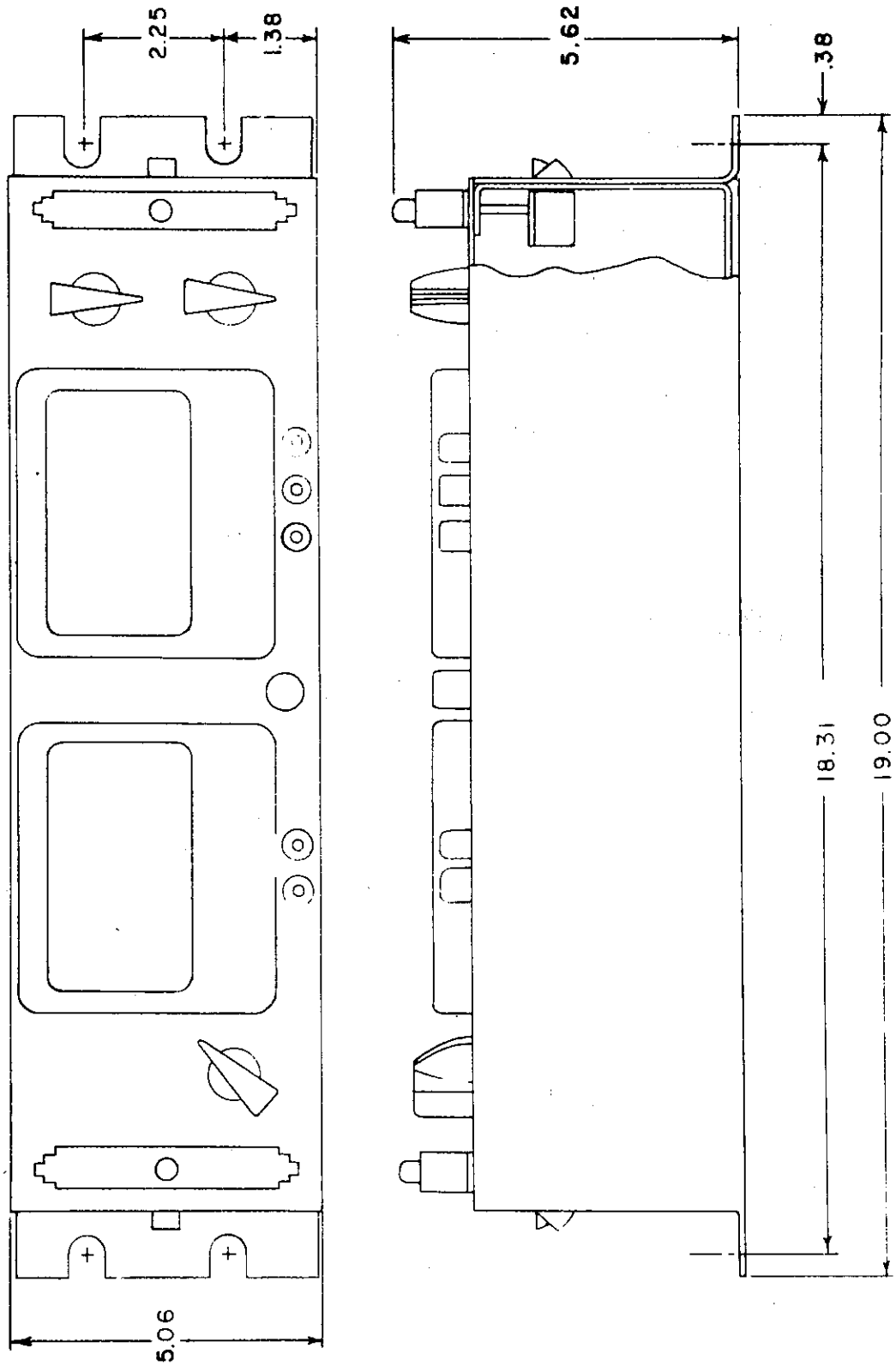


Elementary Diagram

CARRIER CURRENT
METER-ANALYZER UNIT
MODEL 4CX5A2

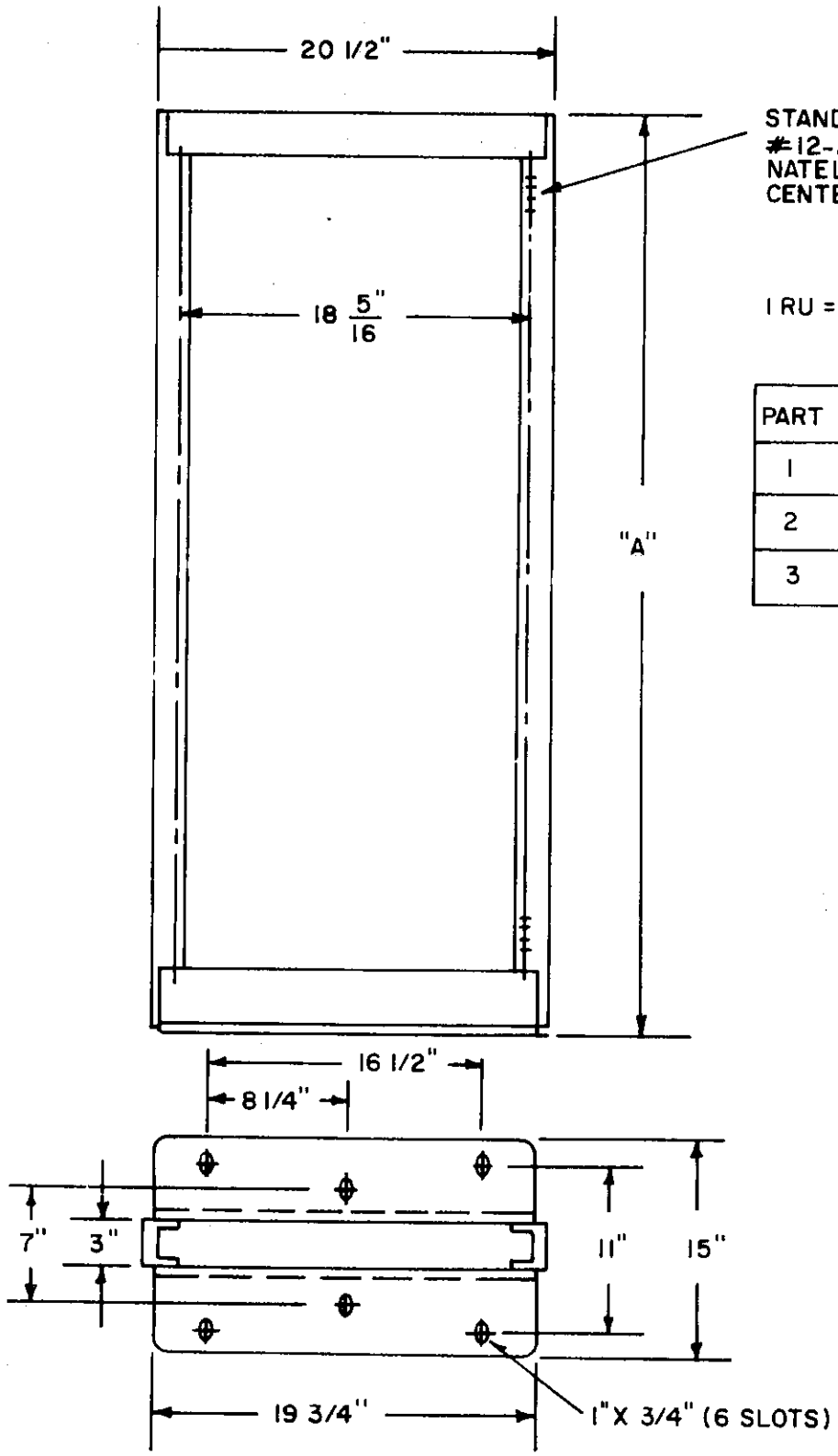
(19C305040, Rev. 4)



Outline Diagram

CARRIER CURRENT
METER-ANALYZER UNIT
MODEL 4CX5A2

(B-5490593, Rev. 1)



1 RU = 1 3/4"

PART	"A" DIM.	RACK UNITS
1	83 1/4	44
2	90	48
3	72	37

Outline Diagram

OPEN RACK
PL-C7774283

(A-4029835, Rev. 4)

LUGO - VICTORVILLE.

INSTRUCTIONS

HIGH-FREQUENCY RF SKEWED HYBRID
MODEL 4CL12RA1
MODEL 4CL12RA2

M 28358

INTRODUCTION

The High-Frequency RF Skewed Hybrid Model 4CL12RA1, is a device which is used to connect a 4 wire transmitting-receiving system to a 2 wire line. The skewed hybrid is used only for separating a transmitter and receiver operating on closely spaced frequencies and which are connected to a common tuned output circuit. The RF Skewed Hybrid differs from a conventional RF Hybrid in that the transmitter loss is reduced to less than 1.0 dB as opposed to the 4.0 dB loss in the conventional hybrid. This is accomplished at the expense of added attenuation (12 dB instead of 4 dB) in the receiver path of the skewed hybrid; but, this is of little concern, as both signal and noise are attenuated to the same degree.

The RF Skewed Hybrid, Model 4CL12RA2 is similar to the model 4CL12RA1, except that resistor R202 has been added to provide proper termination impedance for terminal 2 when used with high impedance input devices.

GENERAL

The High-Frequency RF Skewed Hybrid consists of a multi-tap impedance matching transformer on the transmit path, and a one-to-one ratio transformer on the receive path.

The receive path of the 4 wire system is coupled to the line through the action of a third winding on each transformer, which also provides isolation between the transmit and receive paths by flux cancellation.

NOMINAL OPERATING CHARACTERISTICS

Frequency Range:	
Transmit Wattage Rating	Frequency Range
a) 20 Watts	8 kHz - 300 kHz
b) 80 Watts	40 kHz - 300 kHz
Maximum Power (Transmit)	20 Watts, 80 Watts (dependent on frequency)
Input Impedance	50 ohms (adjustable for line loading between 30-70 ohms)
Attenuation	
Transmit (Input 1) to Output	approx. 0.5 dB
Output to (Input 2) Receive	approx. 12.0 dB
Rejection (all frequencies)	
Transmit (Input 1) to (Input 2) Receive	30 dBm, min

CIRCUIT OPERATION

The operation of a Skewed Hybrid may be determined by a study of Figure 1. If, at some instant of time, the voltages induced in the two secondary windings of transformer T201 are as shown, it may be seen that if the fluxes set up in transformer T202 are to cancel each other, I_1 must equal NI_2, where N is the turns ratio of the secondary windings.

Since the fluxes in transformer T202 due to the currents from transformer T201 cancel, the impedance of the receiver side can vary without affecting the currents from T201 in any way. Since Z_L equals Z_B and has a current N times as large flowing through it, there must be N^2 times as much power dissipated in Z_L as in Z_B when a signal is received from the transmit side. When a signal is received from the receive side, N^2 times the power that is dissipated in Z_L will be dissipated in Z_B.

ADJUSTMENT

Maximum rejection of transmitter output to receiver input depends upon operating this skewed hybrid into as nearly a resistive load as possible. This means that any associated line tuning equipment must be adjusted as well as possible to tune out any reactive impedance in the load. This may require minor adjustments in the external

line tuning equipment (core position only) to maximize the rejection performance of this skewed hybrid.

Taps are provided for impedance matching of the line impedance from 30 to 70 ohms. The factory setting is for a line impedance of 50 ohms.

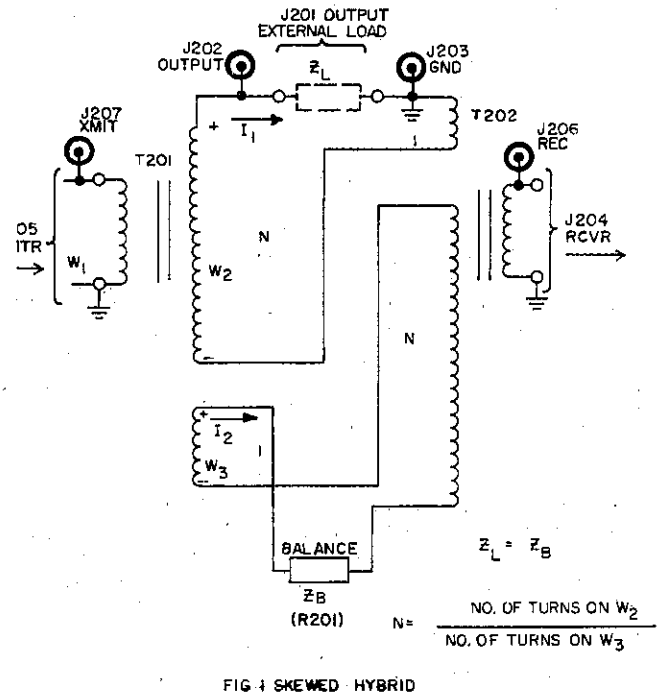


FIG 1 SKEWED HYBRID

CC-38

Figure 1 Skewed Hybrid

PARTS LIST

RF SKEWED HYBRID
MODEL 4CL12RA1
MODEL 4CL12RA2

Symbol	GE Part No.	Description
		- - - - - - - - - - - CONNECTORS AND JACKS - - - - - - - - - -
J201	2R22-P3	Connector, Coaxial; sim to Signal Corps SO-239 or Amphenol 83-1R.
J202	7150763-P2	Test Point, stake-in; sim Alden 110BC1-red.
J203	7150763-P1	Test Point, stake-in; sim Alden 110BC1-black.
J204 & J205	7776570-P17	Connector, Coaxial, BNC type; bulkhead receptacle; Mil. No. UG-1094/U.
J206 & J207	7150763-P2	Test Point, stake-in; sim Alden 110BC1-red.
P201	2R22-P1	Connector, Coaxial, sim Signal Corps PL-259 or Amphenol 83-1SP.
		- - - - - - - - - - - - - - -RESISTORS - - - - - - - - - - - - -
R201*	19A115927-P1	Wirewound, non-inductive: 50 ohms ±5%, 25 W.
R202*	3R79-P101J	Composition: 100 ohms ±5%, 2 W. (Used in Model 4CL12RA2 only)
		- - - - - - - - - - - - - -TRANSFORMERS - - - - - - - - - - - -
T201	PL-19B207380-G1	RF Hybrid.
T202	PL-19B207381-G1	RF Hybrid.

PRODUCTION CHANGES

RF SKEWED HYBRID MODULE MODEL 4CL12RA1

The revisions listed below can be identified by the revision letter appearing on the equipment nameplate.

Model 4CL12RA1, Rev. A

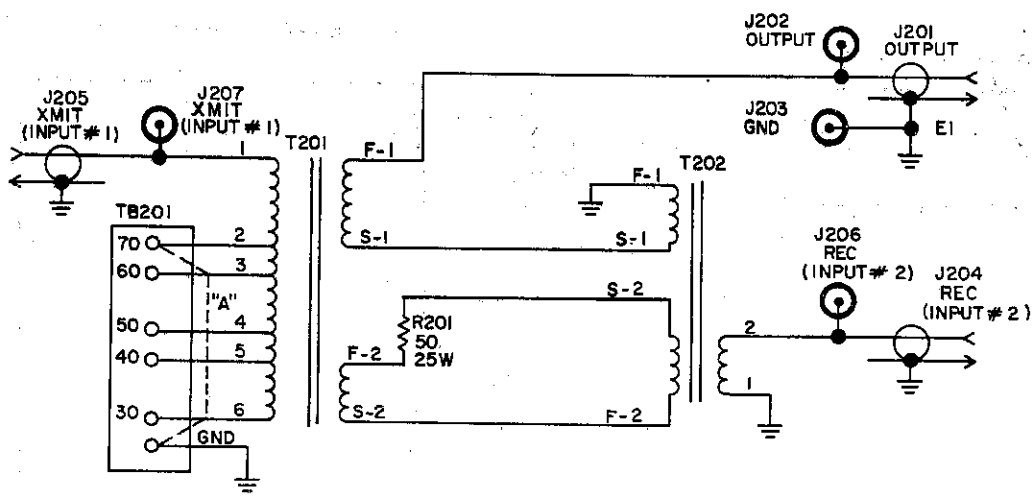
Purpose: To expand power operating range.

Part Changed	Was	Changed To
R201 thru R204	549548-P129	3R79-P201J; Composition: 200 ohms ±5%, 2 W.

Model 4CL12RA1, Rev. B

Purpose: To permit use with 100-Watt pilot relaying amplifiers.

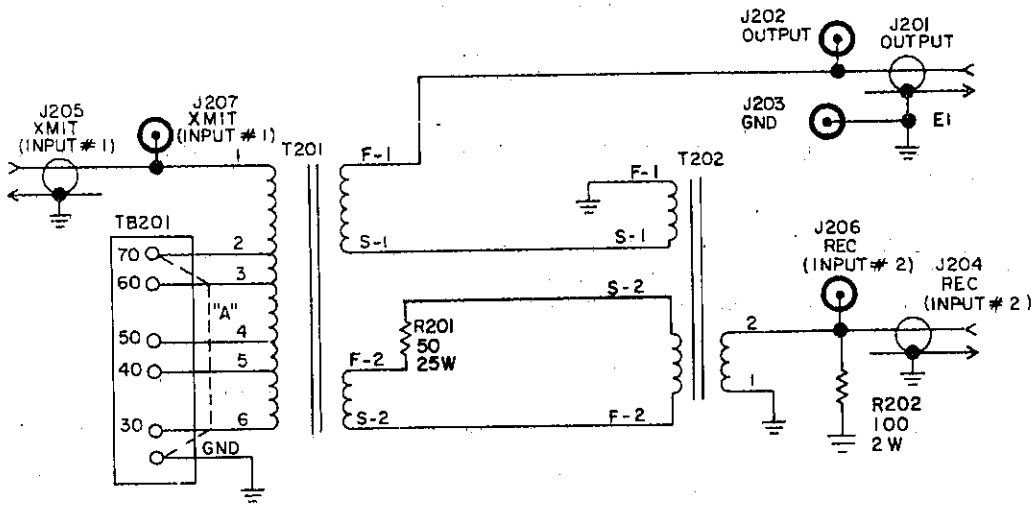
Part Changed	Was	Changed To
R201	3R79-P201J	19A115927-P1, wirewound; 50-ohm, ±5%, 25 W.
R202 thru R204	3R79-P201J	Delete.



JUMPER "A" PROVIDED FOR OPTIMUM IMPEDANCE MATCHING.
RESISTOR VALUES IN OHMS.

(19B207386, Rev. 4)

Elementary Diagram - RF SKEWED HYBRID MODULE MODEL 4CL12RA1, REV. B

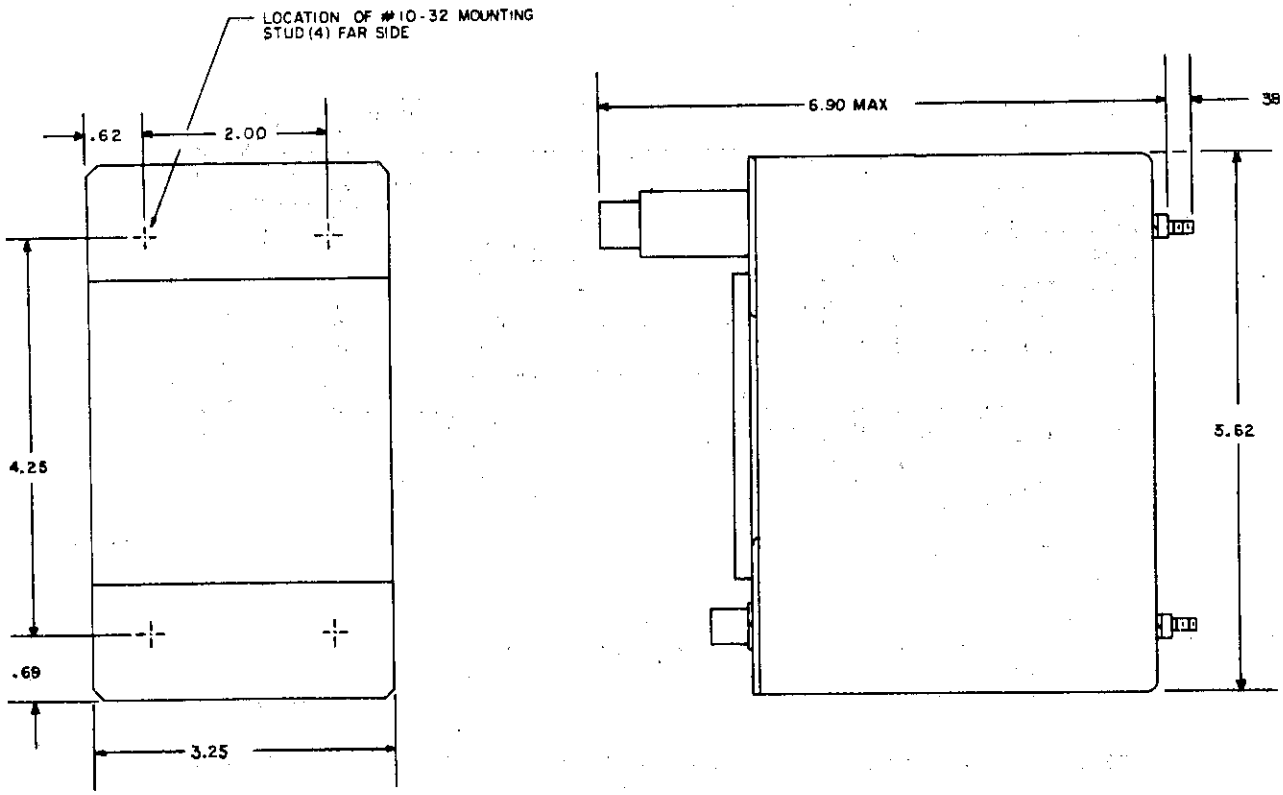


JUMPER "A" PROVIDED FOR OPTIMUM IMPEDANCE MATCHING.
RESISTOR VALUES IN OHMS

MODEL 4CL12RA2

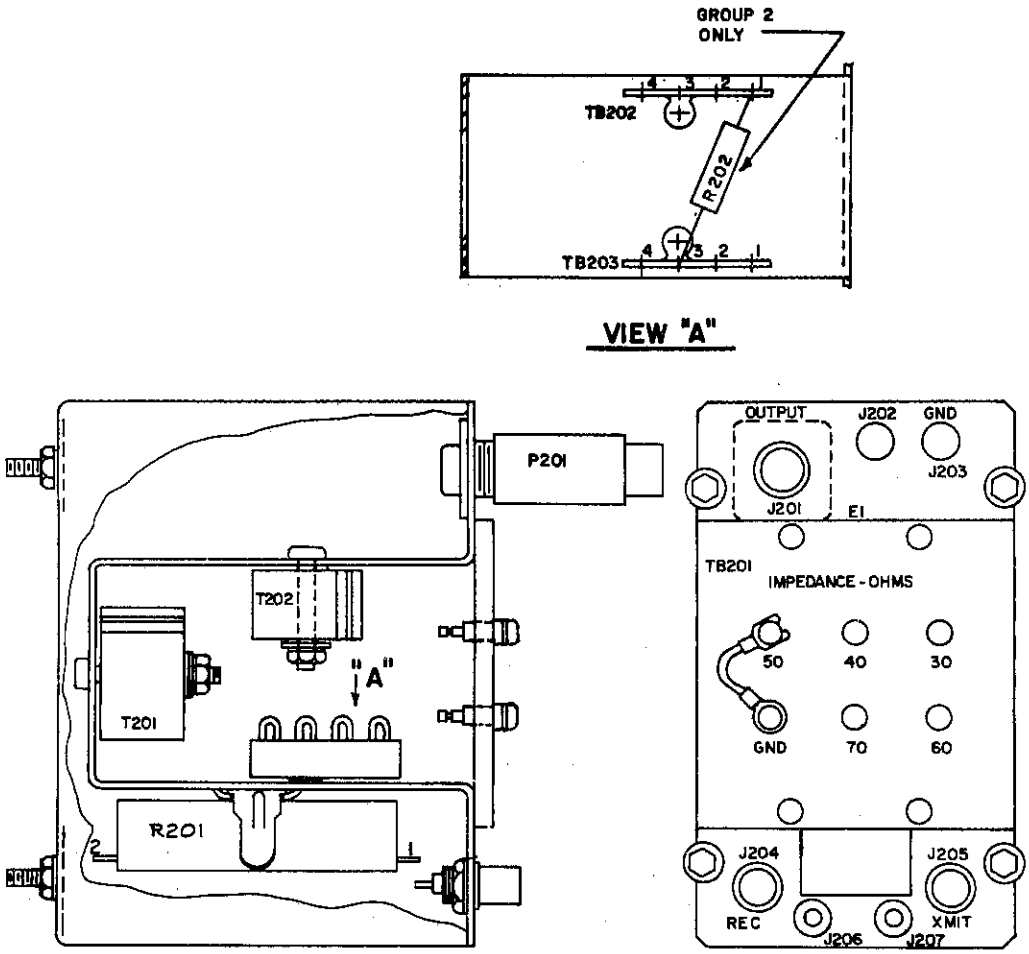
(19B207822, Rev. 0)

Elementary Diagram - RF SKEWED HYBRID MODULE MODEL 4CL12RA2



(19C305187, Rev. 1)

Outline Diagram - HYBRID UNIT OR MODULE



(19C305355, Rev. 4)

Parts Layout Diagram - RF SKEWED HYBRID MODULE MODEL 4CL12RA1 & MODEL 4CL12RA2

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