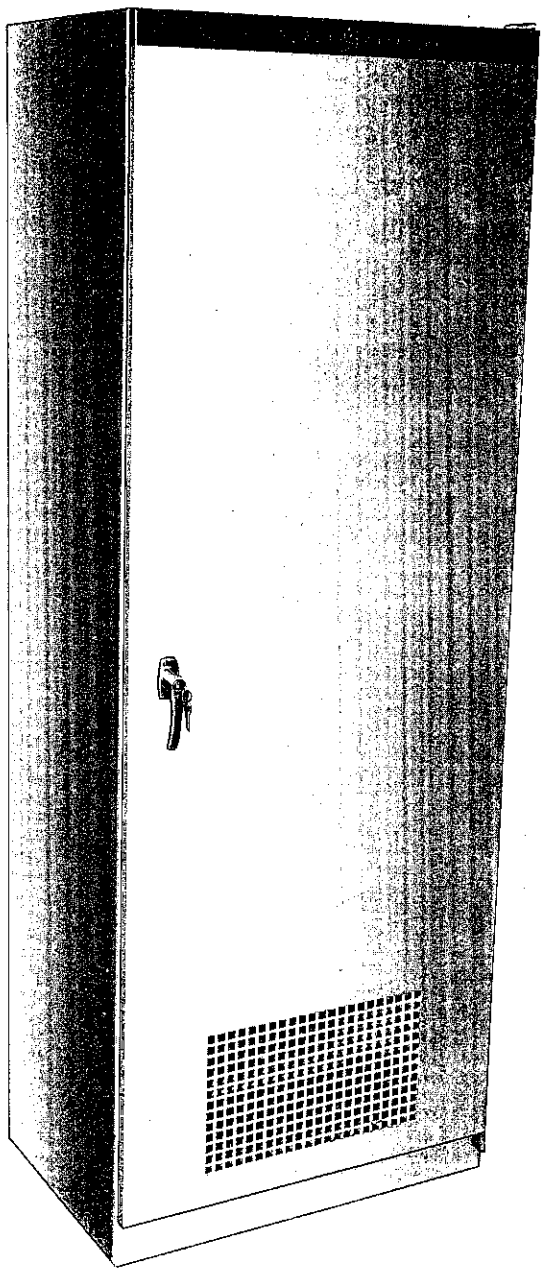
POWER SYSTEM COMMUNICATIONS

POWER-LINE CARRIER COMMUNICATION



INSTRUCTION MANUAL

TRANSMITTER EQUIPMENT
MODEL 4CT71A1*04M1A

LBI-19571B

GENERAL ELECTRIC

ECC-222

WARRANTY

THE WARRANTY PERIOD FOR THIS EQUIPMENT IS FOR ONE YEAR FROM THE DATE OF SHIPMENT, UNLESS OTHERWISE SPECIFIED IN THE CONTRACT.

FOR ADDITIONAL DETAILS, CONTACT THE NEAREST GENERAL ELECTRIC POWER TRANSMISSION AND DISTRIBUTION SALES OFFICE.

POWER LINE CARRIER OPERATION
MOBILE RADIO PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

INSTRUCTION MANUAL

FOR

TRANSMITTER EQUIPMENT

MODEL 4CT71A1*04M1A

CONTENTS

TABLE OF CONTENTS

Module Description Tab

GENERAL DESCRIPTION

TYPE 4CT71A TRANSMITTER

INTRODUCTION This publication contains instructions for installing, operating and servicing the General Electric Transferred Trip Relaying Transmitter Type 4CT71A. These instructions are divided into four major sections as follows:

- GENERAL
- INSTALLATION
- SYSTEM ALIGNMENT
- MODULE DESCRIPTIONS

This first major section (GENERAL) deals primarily with overall equipment function, physical arrangement, model number nomenclature key and specifications of the Type 4CT71A equipment family.

The full equipment model number, which identifies the specific hardware supplied, and its corresponding instruction manual number will be found on both the equipment front panel nameplate and on the front cover of this manual.

While some of the information found in this manual is common to many models, specific instructions for a particular Type 4CT71A model will be found clearly identified in the subsequent sections. In particular, only instructions for equipment described by the specific model number on the front of this manual will be found in the section MODULE DESCRIPTIONS.

Production changes (if any), incorporated after the basic issue of this publication, are identified in the write-up of each module of equipment found in the fourth section, MODULE DESCRIPTIONS.

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

GENERAL The General Electric Type 4CT71A Transmitter equipment is a frequency shift (FSK) transmitter for signal transmission over high voltage power lines. It provides the transmitting end of a communication channel used for transferred trip relaying applications.

The Transmitter is supplied in one of the following operational modes:

4CT71A1...A or E	Two frequency type with 1000 Hertz total shift, using dry contact keying or contact keying from a positive buss (A); or contact keying from a negative buss (E).
4CT71A1...B	Two frequency type with 1000 Hertz total shift, using isolated voltage keying (voltage same magnitude as supply voltage).
4CT71A1...C	Two frequency type with 1000 Hertz total shift, using solid state, 5V at 0.02A keying.
4CT71A2...D	Three frequency type with +500 Hertz shift from center frequency using solid-state, 5V at 0.02A keying.

Transmitter carrier channel frequencies are from 50 kHz to 300 kHz at 0.5 kHz increments.

The above equipment is available with several options shown in nomenclature key (see Table 1). This table describes the meaning of the particular model number which is found stamped on the equipment nameplate. Three power supply options, three power output options and two supervisory options are identified specifically. In addition, six wiring harnesses are available to accomodate the various mounting and rack-up arrangements available.

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.

TABLE 1

NOMENCLATURE KEY FOR MODEL NUMBERS

To facilitate understanding the many options possible with the Type CT-71A transmitter equipment, meaning has been assigned to each digit of the Model No. as shown below.

4CT71A 1 F 04 M 1 A 1605 Typical Model No.

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

Transmitter Keying
- A --- Contact, dry or contact keying from positive buss
- B --- Contact, isolated voltage (same magnitude as supply voltage)
- C --- Solid state, 5V at 0.02 amp (4CT71A1---)
- D --- Solid state, 5V at 0.02 amp (4CT71A2---)
- E --- Contact keying from negative buss

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

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)

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 (1000 Hz total frequency shift)
2. --- Three frequency (±500 Hz frequency shift)

Transmitter Equipment.

NOTE: Whenever equipment is supplied that cannot be described by the above nomenclature table, it is customary to identify the equipment by an additional designation in the option pad on the nameplate, as well as on the front of the instruction manual. In addition, a description of such equipment, together with the necessary instructional information will be supplied in a major manual section SPECIALS.

MECHANICAL DESCRIPTION

The Type 4CT71A Transmitter consists of a Shelf Assembly (4 RU) (1 RU = 1.75-in or 44.5mm) with five plug-in Modules and is designed to mount in a standard 19" (482.6mm) rack or cabinet. Referring to Figure 1, these modules are from left to right: Filter module, Power Amplifier/Regulator module, Power Auxiliary module, Blank panel, Oscillator Driver module and Keying module. All have self aligning plugs and are retained in place by locking knobs located in lower left corner of each module front panel.

(Detailed descriptions and servicing aids on each are found in the section on MODULE DESCRIPTIONS). Input power and interconnections to the transmitter are made at the rear through conveniently located and marked terminal boards. (Refer to Figure 2.) Power control, indicator lamp and fuses are front panel mounted, as well as module adjustments and test points. For 250 Volt DC operation, an additional unit, 250 Volt Regulator (2 RU high), is mounted directly above the Type 4CT71A Transmitter and provides 130 Volt DC to the Power Auxiliary module via a cable.

NOMINAL OPERATING CHARACTERISTICS

(NOTE: For latest information, refer to GE Apparatus Handbook, Section 6444.)

ELECTRICAL

Frequency Range: 50 kHz to 300 kHz (0.5 kHz increments)

Frequency Shift

Guard	+500 Hz
Trip	-500 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

120 mA at 48, 125 and 250 VDC	Isolated voltage keying
100 mA at 48 VDC 60 mA at 125 VDC 60 mA at 250 VDC	Contact keying
20 mA at 5 VDC	Solid state keying

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

---

SPECIFICATIONS

PHYSICAL:

Transmitter:

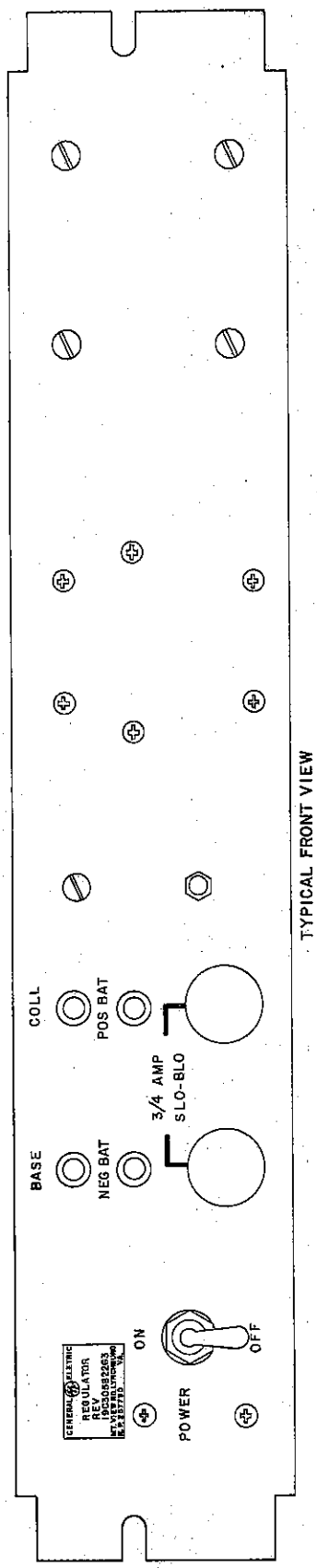
Size	19-in (482.6 mm) wide, 7-in (177.8 mm) high, (4RU), and 17.5-in (445 mm) deep.
Weight	26 pounds, 11.79 Kg

250 V Regulator

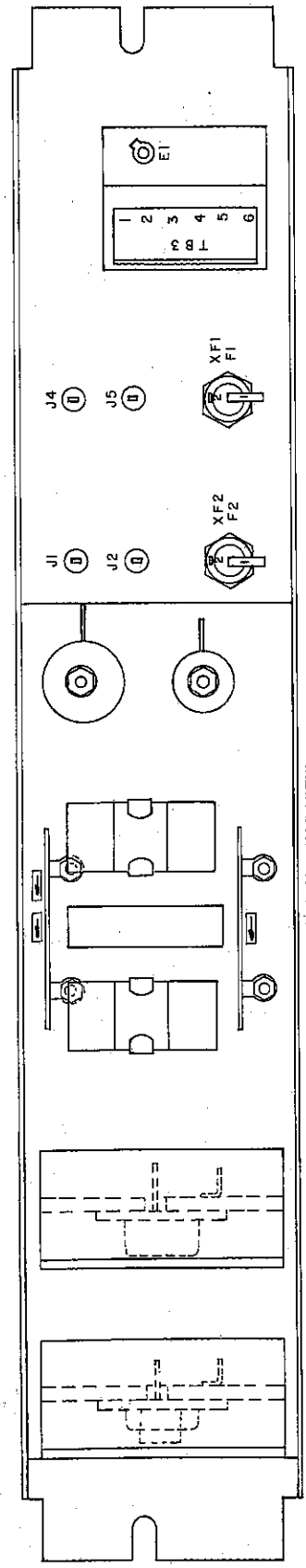
Size	19-in (482.6 mm) wide, 3.5-in (88.9 mm) high, (2RU), and 6.25-in (158.75 mm) deep.
Weight	5 pounds, 2.27 Kg.

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.



TYPICAL FRONT VIEW



TYPICAL REAR VIEW

250V REGULATOR

FIG. 3

(19C323706, Sheet 3, Rev. 1)

INSTALLATION

TYPE 4CT51B, TYPE 4CT61A AND TYPE 4CT71A TRANSMITTER

RECEIVING, HANDLING AND STORAGE

This equipment, when not included as part of a rack or cabinet, will be shipped in cartons designed to protect them against damage.

Immediately upon receipt of equipment, examine it for any damage sustained in transit. If injury or damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Power Transmission and Distribution Sales Office.

Reasonable care should be exercised in unpacking the equipment in order that none of the parts are injured, lost, or the adjustment disturbed.

If the equipment is not to be installed immediately, it should be stored in their original cartons, racks, or cabinets in a place that is free from moisture, dust, or metallic chips. Foreign matter collected on the ouside of the equipment may find its way inside and cause trouble in its operation.

CONNECTIONS AND CHECK OUT

Before applying power to the equipment, refer to the following two applicable diagrams:

• Equipment Arrangement	19C318444
• Interconnection Diagram (48 VDC or 125 VDC)	19C318330, Sheet 1
or Interconnection Diagram (250 VDC)	19C318329, Sheet 1

These diagrams will be found at the end of this section of the manual. These diagrams include instructions for various power, keying and cabling arrangements. Before applying power, establish proper battery polarity (or station power) and provide adequate grounding of equipment. In particular, observe the instructions for termination and grounding shielded cables. Other installation details and procedures will be found in LBI-18318 which immedaitely follows these paragraphs on CONNECTIONS & CHECK OUT.

Complete tests and inspection are conducted at the factory, including the following four principal adjustments:

- Transmitter output level.
- Transmitter output frequency.
- 36 Volt DC supply voltage (+36 ADJ).
- 48 Volt DC supply voltage (+48 ADJ), if applicable.

Normally, there are no adjustments to be made at the time of installation. However, the following two checks should precede power "turn-on".

1. Transmitter RF output connection must be terminated into an applicable 50 ohm load such as a properly terminated Hybrid, Filter, or Line Tuning Equipment. For test purposes, a 10-Watt resistive load can be used.
2. Supply voltage to the equipment from station battery or power source must be correct for equipment supplied, including proper polarity and voltage for the keying circuit (see nameplate).

If diagnosis is necessary at check out time, complete alignment and testing procedures for the equipment will be found in this manual under section SYSTEM ALIGNMENT. Also, detailed servicing information on each module, including parts lists, elementary, and repair & return information will be found in the section on MODULE DESCRIPTIONS.

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

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.

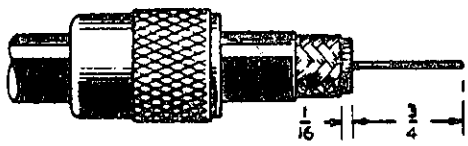
5. The characteristic impedance of RG-8/U cable is 52 ohms. The capacitance is 29.5 picofarads per foot.

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

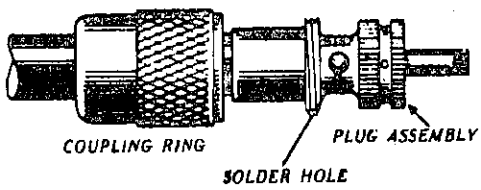
NOTICE

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.

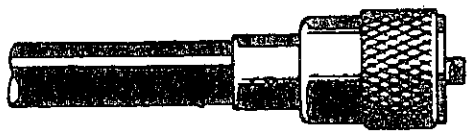
Cut end of cable even.
Remove vinyl jacket 1 ⅛"—*don't nick braid.*



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.

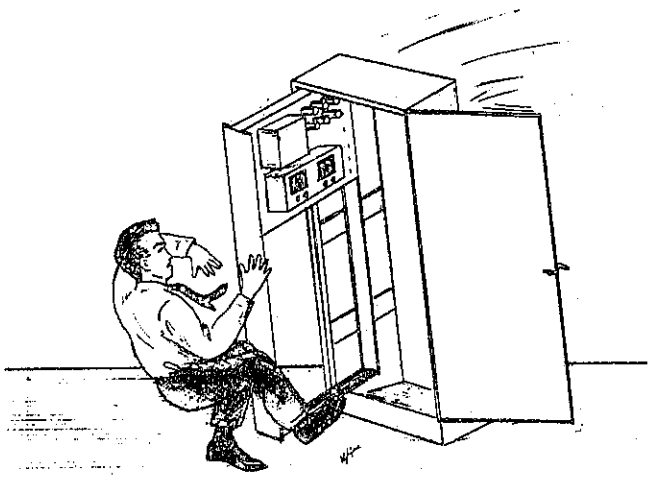
INSTALLATION

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.



(CC-20)

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,

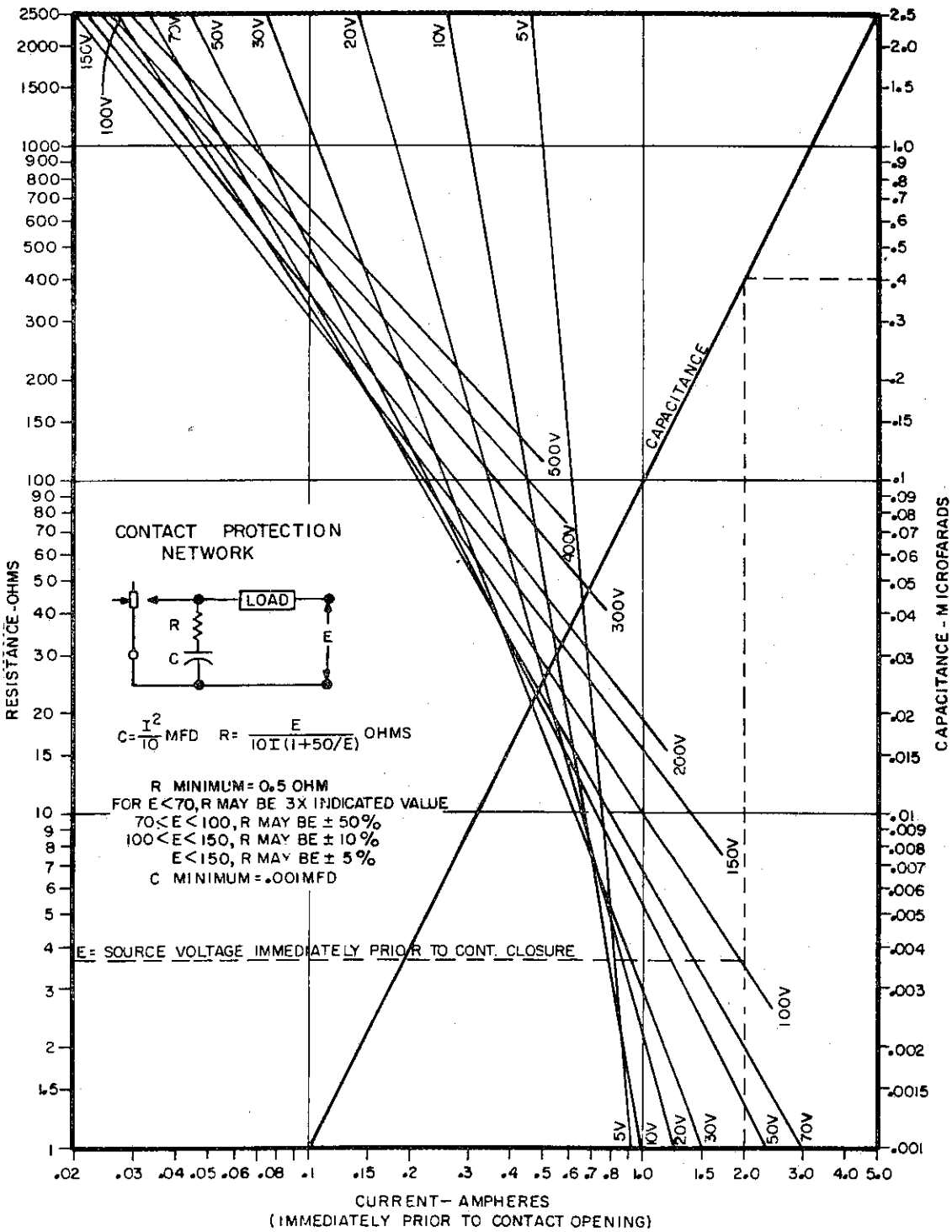
the relay should be replaced. The same care can also be taken with switch contacts.

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



(CC-16)

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

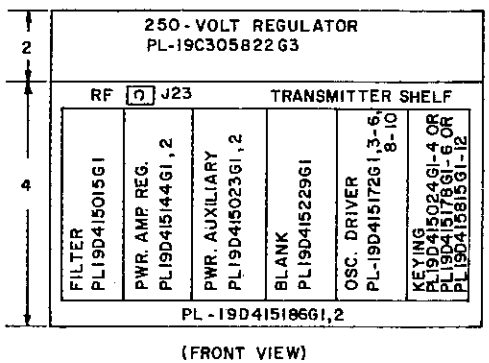
When repairing or replacing components on a printed circuit board, do not overheat. A low-wattage soldering iron must be used (consider 60-watts the absolute maximum).

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.

POWER LINE CARRIER PRODUCT SECTION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

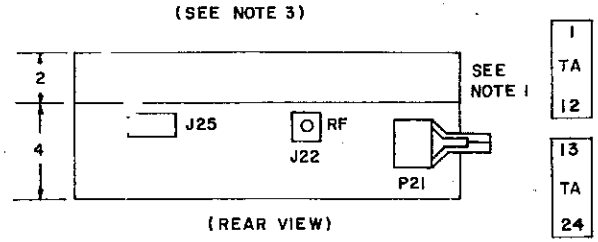


(FRONT VIEW)

SEE NOTE 1

CUSTOMER CONNECTIONS

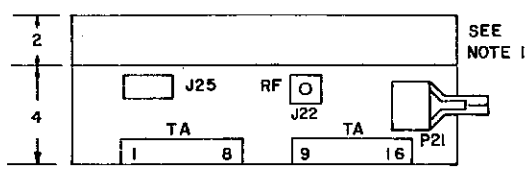
6' OR 10' LONG WIRING HARNESS - INDEX TYPE "R" & "T".
(SEE NOTE 3)



(REAR VIEW)

CUSTOMER CONNECTIONS

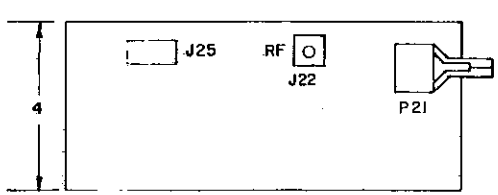
FIXED & OPEN RACK WIRING HARNESS - INDEX TYPE "F"
(SEE NOTE 4)



(REAR VIEW)

CUSTOMER CONNECTIONS

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

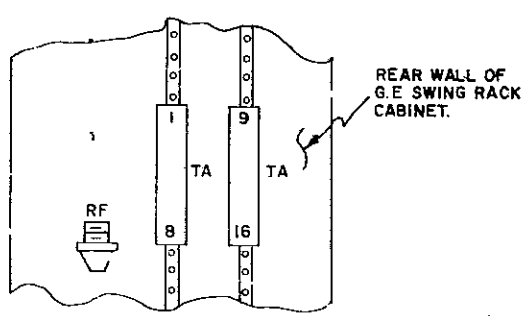


(REAR VIEW)

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 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 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)



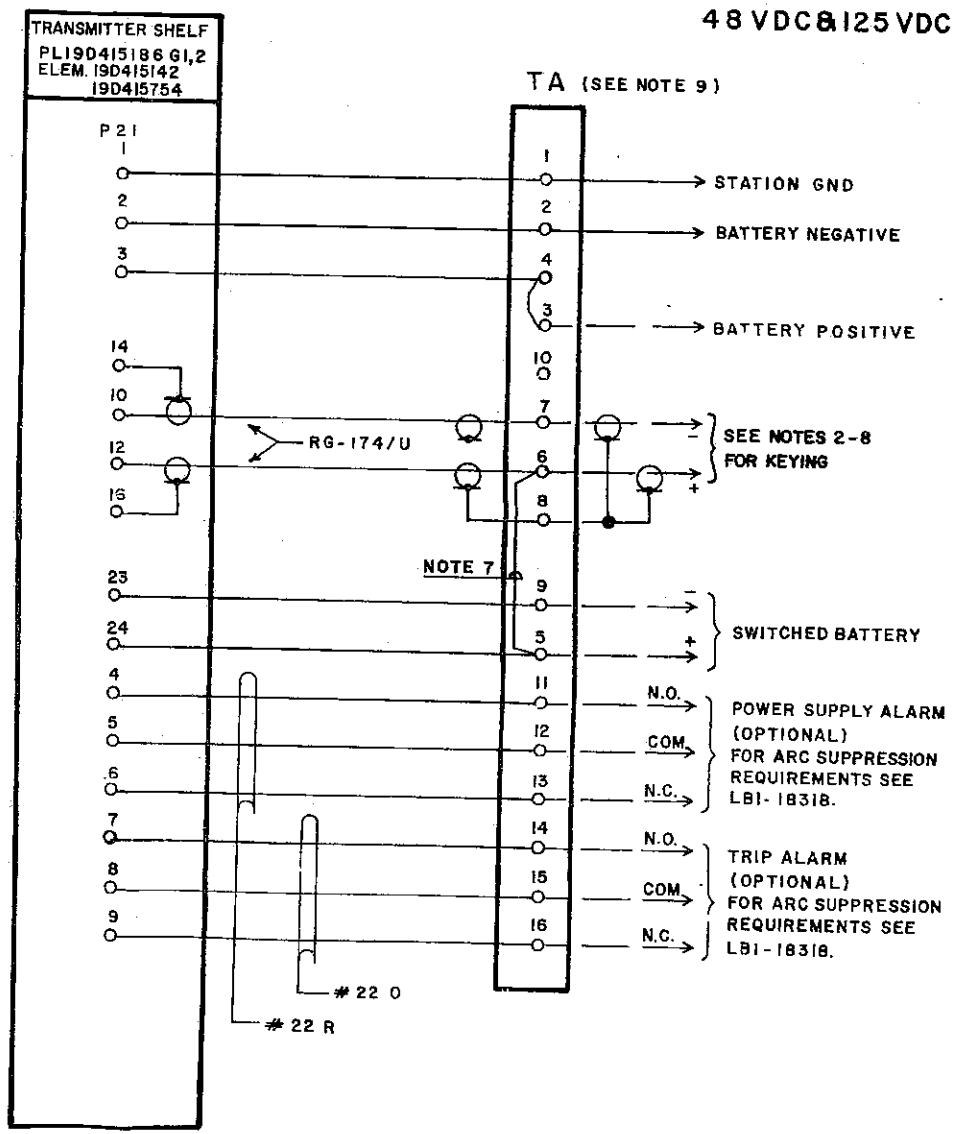
(VIEW FROM INSIDE)

Typical Equipment Arrangement

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

(19C318444, Rev. 3)

CT 51B/61A/71A CABLE
PL-19A113488G1 - REV. A
G3 - REV. A
G5 - REV. B
G7 - REV. B
G9 - REV. A
G11 - REV. A
G13 - REV. A
G15 - REV. A



NOTES:

1. ALL WIRING TO BE V16 BLACK UNLESS OTHERWISE SPECIFIED.
2. FOR 5V-20 MA KEYING, 3 FREQ. OPERATION APPLY +5VDC TO "TA" TERMINAL 7 FOR LOW SHIFT AND TO TERMINAL 6 FOR HIGH SHIFT, USING TERMINAL 8 AS SHIELD TERMINATION. REMOTE END OF SHIELD MUST NOT BE TIED TO BATTERY.
3. FOR 5V-20 MA KEYING, 2 FREQ. OPERATION APPLY +5VDC TO "TA" TERMINAL 7 FOR "TRIP," USING TERMINAL 8 AS SHIELD. REMOTE END OF SHIELD MUST NOT BE TIED TO BATTERY.
4. FOR 48 VOLT, 125 VOLT OR 250 VOLT ISOLATED VOLTAGE KEYING, APPLY VOLTAGE ACROSS "TA" TERMINALS 6 & 7 USING POLARITY AS INDICATED. (2-FREQ. OPERATION ONLY)
5. FOR DRY CONTACT KEYING, 2-FREQ. OPTIONS APPLY NORMALLY OPEN CONTACT BETWEEN TERMINALS 5 & 6 TO SHIFT TRANSMITTER.
6. FOR CONTACT KEYING FROM POSITIVE BUS APPLY N.O. CONTACT BETWEEN TA-6 AND REMOTE POSITIVE BATTERY BUS.
7. FOR CONTACT KEYING FROM NEGATIVE BUS APPLY N.O. CONTACT BETWEEN TA-7 AND REMOTE NEGATIVE BATTERY BUS AND USE JUMPER FROM TA-5 TO TA-6 (CABLE GROUPS 1, 5, 9, 13).
8. FOR DRY CONTACT KEYING, 3-FREQ. OPTIONS APPLY NORMALLY OPEN CONTACT BETWEEN TERMINALS 5 & 6 FOR LOW SHIFT AND BETWEEN TERMINALS 5 & 7 FOR HIGH SHIFT
9. STANDARD 6 AND 10 FEET CABLE (G9-G16) SUPPLIED WITH 24 TERMINALS.

Interconnection Diagram
TRANSMITTER EQUIPMENT CABLE
(19C318330, Sheet 1, Rev. 9)

OPERATION AND ALIGNMENT

TYPE 4CT71A TRANSMITTER

DESCRIPTION Figure 1, found at the rear of this section, provides a functional block diagram of the Type 4CT71A Transmitters. In general, the several models differ principally in the keying options supplied, and all are shown on Figure 1.

ALL MODELS The signal is generated in the Oscillator-Driver (OSC DRV) 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 (PWR AMPL) Module. The signal path then leads to the bandpass filter, a broadband harmonic filter in the Filter Module, the output of which is connected to the associated RF combiner, or Line Tuning Equipment.

The Keying (Keying) Module serves two purposes: one, to supply 6 VDC to the Oscillator-Driver (OSC DRV) Module to shift frequency, and two, to provide 36 Volts to the driver stage of the Oscillator-Driver (OSC DRV) Module when the exalt function is required. These two functions occur simultaneously when the external keying contact is closed or keying voltage is applied. (Refer to Figure 1 for input keying principles and interconnections within the transmitter equipment.)

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

MODEL 4CT71A1 --- A AND E

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.

MODEL 4CT71A1 --- B

For isolated voltage contact keying, either the battery used for the transmitter or a separate battery can be applied. The keying source is applied across terminal board TA-6 & 7 through a normally open contact. Refer to the keying module elementary diagram for correct strapping with respect to the keying battery voltage.

MODEL 4CT71A1 --- C

The 5 Volt, 20 mA keying source is applied to terminal board TA 7 & 8. Caution should be applied ascertaining that +5 Volts is connected to TA 7 and the shield to TA 8 and that remote end of shield is not tied to battery.

MODEL 4CT71A2 --- D

The 5 Volt, 20 mA keying source is (alternately) applied to either terminal board TA-6 or TA-7 with the common or shield connected to TA-8. Note that the remote end of the shield must not be tied to battery.

POWER SUPPLIES (Refer to Figure 1). The basic transmitter operates from either a 48 VDC or 125 VDC station battery. With the addition of a 250 Volt Regulator Unit, the transmitter will operate from a 250 VDC station battery. The 250 V Regulator Unit supplies regulated 130 VDC from 250 VDC. In this case, the Power Auxiliary module (PWR AUX) converts the 130 VDC to a regulated +48 VDC.

For 48 VDC or 125 VDC Sources, only the Power Auxiliary module (PWR AUX) is used, which converts the 125 VDC to a regulated +48 VDC, and supplies the Power Amplifier and the 36 V Regulator. The 36 V supplies power to the associated OSCILLATOR DRIVER module, and the KEYING module.

ALIGNMENT INSTRUCTIONS

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 Equipment, certain reasonable precautions must be carefully observed by the operating personnel during the installation, operation and maintenance of the equipment.

All persons 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 careful while doing work.

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

ALIGNMENT INSTRUCTIONS (CONTD)

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 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 customer's safety procedures.

ADJUSTMENTS

Factory Adjustments

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

1. Transmitter output level
2. Transmitter frequencies
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.

The test instruments recommended in LBI-18319 (or their equivalent), included in this section of the instruction book, should be used. All modules should be plugged into the Transmitter Shelf Unit, unless otherwise specified.

Testing should proceed in the following manner:

1. Transmitter RF Output must be terminated into a 50 ohm, 10 Watt, resistive load.
2. Check and adjust the supply voltages. (See "A" below).
3. Check and adjust the output levels. (See "B" below).
4. Check and adjust frequencies, including the keying operation. (See "C" below).

A. SUPPLY VOLTAGE ADJUSTMENTS

48 VDC 125 VDC

When operating from either a 48 VDC or a 125 VDC power source:

1. Turn POWER switch on Transmitter OFF:
2. 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.
3. Check the Power Auxiliary (PWR AUX) jumper arrangement.
   a. For 48 VDC operation
   Jumper A should be connected to Post E4 and Jumper B to Post E1.
   b. For 125 VDC operation
   Jumper A should be connected to Post E3 and Jumper B to Post E2.
4. For Model 4CT71A1---A,B, and E only.

   Check the jumper arrangement on the KEYING module per the following applicable model chart.

MODEL 4CT71A1---A

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

MODEL 4CT71A1---B

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

MODEL 4CT71A1---B

Supply Voltage	Keying Voltage	Jumper A to
48 VDC	48 VDC	E2
125 VDC	125 VDC	E3
250 VDC	250 VDC	E1

SUPPLY VOLTAGE ADJUSTMENTS (CONTD)

5. Re-insert all modules into the Transmitter Shelf.

6. Turn POWER switch ON. (For 48 V operation, continue with Step 8).

7. For 125 VDC Operation only

   a. Power Auxiliary Output Test (48 V) Measure the voltage across COM (negative lead) and +48 (positive lead) on the Power Auxiliary (PWR AUX) with a VOM. Adjust it to 48 Volts with potentiometer R18 (+48 ADJ).

8. Regulator Output Test (36 V)

   a. 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).

   b. Check the same voltage across COM and +36 on the Keying Module (KEYING) and on the OSCILLATOR-DRIVER module (OSC DRV). The POWER lamp on the front panel should be illuminated, indicating presence of 36 V.

   c. The voltage test is now complete.

250 VDC When operating from a 250 VDC power source:

1. Turn POWER switch on 250 V Regulator OFF. Turn POWER switch on Transmitter OFF.

2. 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.

3. 250 V Regulator Output Voltage Test (130V)

   a. Turn POWER switch on the 250 V Regulator ON. Measure the voltage between TA-2 (NEG) and TA-4 (POS). Should be approximately 130 Volts.

   b. Check the Power Auxiliary (PWR AUX) jumper arrangement. Jumper A should be connected to post E3, and jumper B to post E2.

   c. For Model 4CT71A1---A, B, and E only

      Check the jumper arrangement on the KEYING module per the applicable jumper chart given previously, in Step 4 for 48 V/125 V operation.

   d. Re-insert all modules into the Transmitter Shelf.

   e. Turn POWER switch of Transmitter ON.

   f. Check the voltage across negative battery (NEG BAT) and positive battery (POS BAT) on the Power Auxiliary (PWR AUX) module. The measurement reading should be approximately 130 Volts.

   g. Complete testing per Steps 7 and 8 given previously for 48 V/125 V operation.

B. POWER LEVEL OUTPUT

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

1. PRELIMINARY PROCEDURES
   a. All Models, 4CT71A1 and 4CT71A2
      1. Switch Transmitter OFF.
      2. Connect a VTVM (ungrounded) across the 50 ohm, 10 Watt dummy load.

   b. Model 4CT71A1---A
      Keying Module - Dry contact, keying from Positive Bus.
      1. 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.
      2. Continue with Step B1e.

   c. Model 4CT71A1---B
      Keying Module-Voltage Keying
      1. Applying keying voltage through normally open contact to TA-6 (positive) and TA-7 (negative).
      2. Continue with Step B1e.

   d. Model 4CT71A---E
      Keying Module - Negative Bus Keying
      1. 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.
      2. Continue with Step B1e.

e. All Models, 4CT71A---A, B, and E
1. Switch the unit ON.

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

3. With contact open, the reading should be approximately 0 Volts.

4. Close the contact, the reading should be approximately 36 Volts.

f. Model 4CT71A1---C
Keying Module - Solid State
Two Frequency

1. Check to make sure that the leads from the static relay are connected to TA-7 (positive 5V) and to TA-8 (shield). Ascertain that the shield at the remote end is not tied to a battery source. Refer to Simplified Block Diagram, Figure 1.

2. Switch the unit ON.

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

4. With no voltage applied from static relay, the reading should be about 2 volts.

5. Close static relay applying 5 V; the reading should be about 36 volts.

g. Model 4CT71A2
Keying Module - Solid State
Three Frequency

1. Check connections per functional Diagram, Figure 1.

2. Switch unit ON.

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

4. With no keying voltage applied, the reading should be about 2 VDC.

5. With either voltage applied, the reading should be about 36 VDC.

2. Level Adjustment
A. Model 4CT71A1 or 2---L or H---(non-exalt operation)
1. If OSC DRV is supplied with jumper A, connect it to E2.

2. Transmit GUARD frequency (--A1) or CENTER frequency (--AZ) (open contacts or remove 5V keying voltage).

3. 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:

$$P = \frac{V^2}{R}$$

Where: P = Power in Watts
V = VTVM reading in Volts (RMS)
R = Resistive load

The maximum output power and voltages into a nominal load of 50 ohms (resistive) is shown in following table.

POWER OPTION FROM COMBINATION NUMBER	POWER WATTS	VOLTAGE VRMS
L	1	7.1
H	10	22.4

4. Close the keying contact or apply 5V keying voltage to shift the transmitter to the TRIP (low-shift) frequency (--A1) or either HIGH or LOW shift (--AZ).

5. The level reading should be approximately the same as for Step 2A3 above.

B. Model 4CT71A1---M---(exalt operation)

1. Verify that jumper A is connected to post E1 on the OSC DRV module.

2. Proceed per Step 2 a2 and 3 above, adjusting the output power to 1 W (nominal) or up to 5 W (max.).

3. Close the keying contact or apply 5 V keying voltage to shift the transmitter to TRIP (low-shift) frequency.

4. 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.

C. FREQUENCY ADJUSTMENT MODEL 4CT71A1 ------

1. 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 XY2 holds the crystal with the frequency of 6000 kHz minus channel frequency, and XY1 holds the 6000.000 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. For Model 4CT71A1

      Set the transmitter on GUARD (high-shift) frequency (open contact or OV).

   h. Use a tuning wand, from the accessory kit, to tune capacitor C3 until the exact frequency, 500±3 Hz above nominal frequency is obtained. An increase in capacitance decreases the frequency.

   i. Set the transmitter on TRIP (low-shift) frequency (closed contact or 5V).

   j. Tune capacitor C21 until the exact frequency, 500 ±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.

   l. Check power output levels; re-adjust if necessary.

      For Model 4CT71A2

   m. Set the transmitter to HIGH shift.

   n. Use a tuning wand, from the Accessory Kit, to tune capacitor C3 until the exact frequency of 500 +3 Hz above nominal frequency is obtained. An increase in capacitance decreases the frequency.

   o. Set the transmitter on CENTER shift.

   p. Tune capacitor C25 until the exact nominal frequency ±3 Hz is obtained.

   q. Set the transmitter on LOW shift.

   r. Tune capacitor C21 until the exact frequency of 500 +3 Hz below nominal frequency is obtained.

   s. Re-check Steps m-r and re-adjust if necessary.

   t. Check the power output levels and re-adjust if necessary.

D. CONVERSION PROCEDURES

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

1. CHANGE FROM 125 VDC TO 48 VDC (OR VICE-VERSA).

   a. Turn Transmitter power switch OFF.

   b. Change fuses (See Note on Fig. 1).

   c. Power Auxiliary Module:
   Refer to jumper notes on Elementary Diagram.

   d. For Model 4CT71A1---A,B, and E only

      Keying Module (See Notes on Elementary)

   e. Test the unit per the Regulator Output Test (36V) given previously.

2. CHANGE FROM 250 VDC TO 125 VDC OR 48 VDC

   a. Switch Transmitter POWER and 250 V Regulator POWER switch OFF.

   b. Refer to Elementary Diagrams in model instruction book and to Figure 1.

   c. Power Auxiliary Module:
   Refer to jumper notes on Elementary Diagram.

   d. For Model 4CT71A1---A,B, or E only

      Keying Module (See Notes on Elementary)

   e. Always keep POWER switch on the 250 V Regulator OFF after making these changes.

   f. Test the unit as per the Power Aux Output Test (48 V) and Regulator Output Test (36 V) given previously.

3. CHANGE IN CHANNEL FREQUENCY

a. Refer back to the Frequency Adjustment Section.

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, per Table 1 given below.

d. Re-adjust levels per referenced Power Output Level Section.

e. Test per referenced Frequency Adjustment Section.

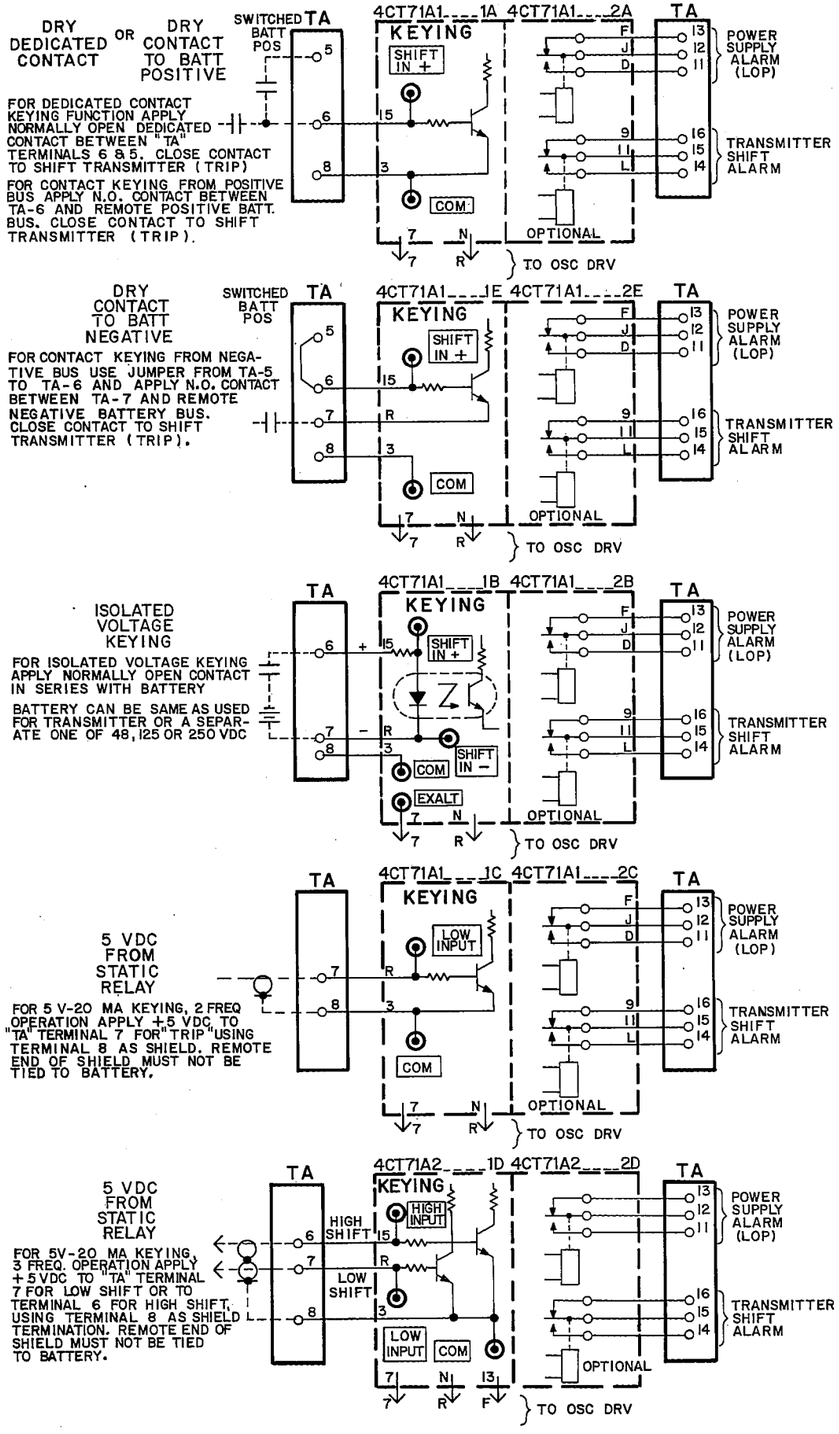
TABLE 1

FILTER PART NUMBER VERSUS FREQUENCY
(GROUP NO = 2F - 59)

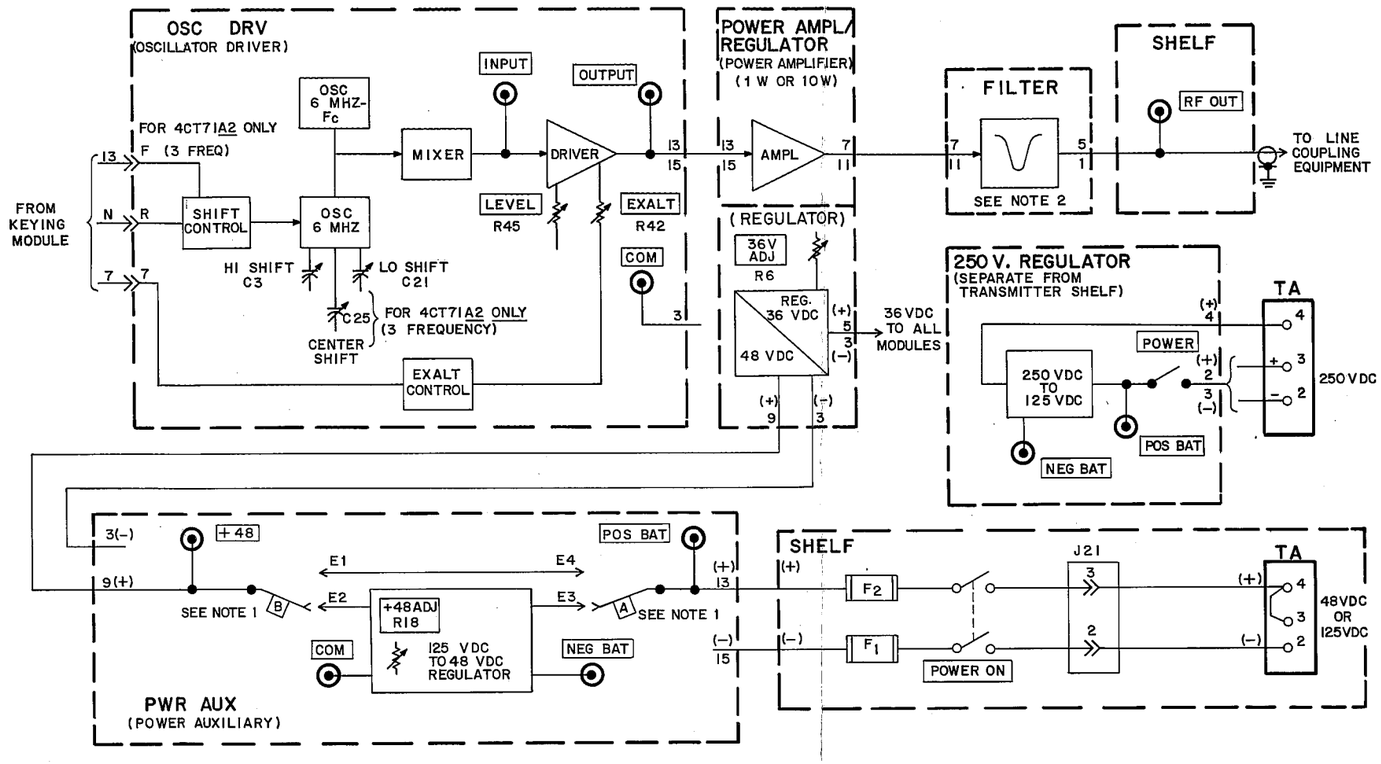
GE PART NO.	GROUP NO.	FREQUENCY
PL-19C304694-	G41	50.0 kHz
PL-19C304694-	G42	50.5 kHz
PL-19C304694-	G43	51.0 kHz
PL-19C304694-	G61	60.0 kHz
PL-19C304694-	G62	60.5 kHz
PL-19C304604-	G141	100.0 kHz
PL-19C304694-	G142	100.5 kHz
PL-19C304694-	G300	179.5 kHz
PL-19C304694-	G301	180.0 kHz
PL-19C304694-	G452	255.5 kHz
PL-19C304694-	G453	256.0 kHz
PL-19C304694-	G540	299.5 kHz
PL-19C304694-	G541	300.0 kHz

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.



4CT71A_____H__ (10 WG / 10 WT)
4CT71A_____M__ (1 WG / 10 WT)
4CT71A_____L__ (1 WG / 1 WT)



NOTES:

1.

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

2. CHANGE OF CARRIER FREQUENCY REQUIRES CHANGE OF FL1 ON FILTER.
3. CHANGE OF CARRIER FREQUENCY CAN BE DONE BY CHANGING CRYSTALS Y1 & Y2 IN OSCILLATOR (RETUNING NECESSARY SEE LB1.)
4. ALARM RELAYS K1 & K2 ON KEYING ARE SHOWN DE-ENERGIZED.
5. FUSES F1 & F2 ON "SHELF PANEL FRONT" ARE .75 AMP/SLOW BLOW FOR 125 OR 250 VDC BATTERY OR 1 AMP/SLOW BLOW FOR 48 VDC BATTERY.
6. TO CONVERT FROM 250V TO 125V BATTERY
   - SWITCH "REGULATOR 250" OFF AND
   - CONNECT "BATTERY POSITIVE" TO 4 ON "TA"

   TO CONVERT FROM 250V TO 48V BATTERY
   - SWITCH "REGULATOR 250V OFF.
   - CONNECT "BATTERY POSITIVE" TO 4 ON "TA".
   - CHANGE FUSES

FIGURE 1

TYPICAL RF LEVELS MEASURED WITH SELECTIVE VOLTMETER

TRANSMITTER	JACK	REFERENCE	VOLTAGE 1W/1W EQUIP VRMS	1W/1W EQUIP DBSR	1W/10W EQUIP VRMS	1W/10W EQUIP DBSR	10W/10W EQUIP VRMS	10W/10W EQUIP DBSR	COMMENTS
OSC DRIVER	OUT	COM	17	+26.8	5.8	17.5			1 WATT OUTPUT
	IN	COM	.042	−25.6	.042	−25.6			
	OUT	COM			13.9	+25.0	13.0	24.3	10 WATT OUTPUT
	IN	COM			.030	−29.0	.030	−29.0	
SHELF	RF OUT	GND	7.07	+19.3	7.07	+19.3			1 WATT OUTPUT
	RF OUT	GND			22.8	+29.3	22.8	+29.3	10 WATT OUTPUT

NOTE : ODBSR ≙ 0.78 VRMS

Figure 1

FUNCTIONAL DIAGRAM
TYPE 4CT71A TRANSMITTER EQUIPMENT

(19D425628, Rev. 0)

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 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 5300 A Main Frame with Model 5304 A Counter Module.

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 630-A or GE Model 4CX5A2 Meter Analyzer Unit.

Used for: General trouble-shooting.

7. Data Analyzer

Hewlett-Packard Model 1645A.
Used with Type 52 Equipment for analyzing data distortion and errors.

8.* 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.

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

EXTENDER TEST BOARD
PL-19C318404-G1

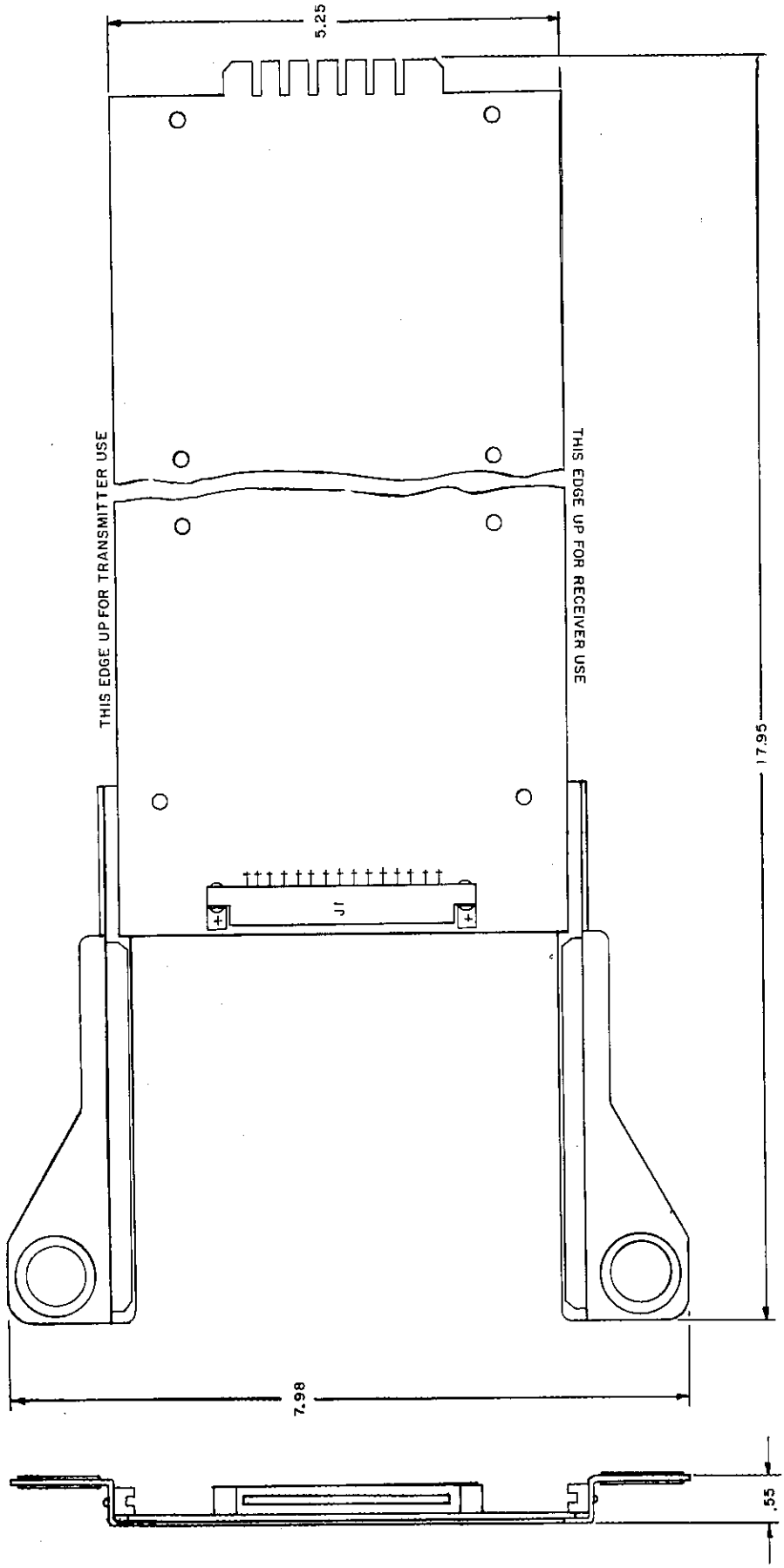
The Extender Test Board, PL-19C318404-G1, provides extended connections for testing all modules in either the Transmitter Shelf Unit, or in the Receiver Shelf Unit; thus, the module will be in the system electrically, yet be removed physically for trouble-shooting or maintenance.

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.

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.



Outline Diagram

EXTENDER TEST BOARD
PL-19C318404-G1

(19C318407, Rev. 2)

MODULE DESCRIPTION

GENERAL This Module Description section of the instruction book contains complete information on each module used in a particular Equipment Model; namely, Description, Parts List, Production Change Sheet (if applicable), and a Parts Layout Diagram. (See the nameplate on the equipment for exact model number.) If a module description covers more than one group (-G1, -G2, etc.) of a particular module Type, reference should be made to the Table of Contents (MODULE DESCRIPTION section) of this instruction book, where the specific module group number will be identified for the particular equipment supplied. Additionally, reference to the Interconnection or Arrangement Diagrams will also identify the specific module group involved.

Note that the Elementary Diagrams may be found in one of two places - either with the module description text or, in the case of composite drawings, in the tabbed section labeled DIAGRAMS.

The module description text describes the electrical operation of that module, and further contains a "Trouble-Shooting Aids" section for servicing the module, consisting of typical voltage readings and nominal operating characteristics.

REPAIR & RETURN

The General Electric Co. will repair and return a faulty module, if the customer so desires. If so, contact the nearest General Electric Power Transmission and Distribution Sales Office for authorization.

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 Power Transmission and Distribution Sales Office.

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

Power Line Carrier 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".

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

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

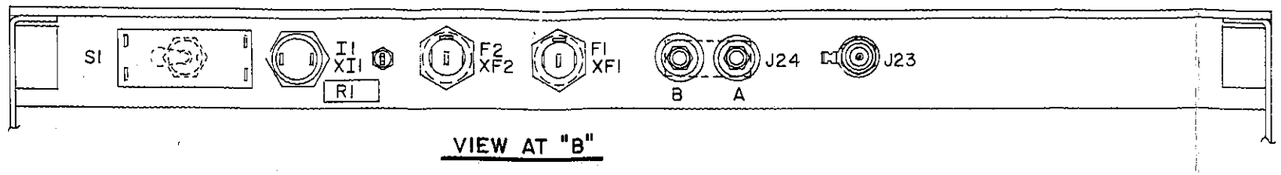
Symbol	GE Part No.	Description
		- - - - - - - - - - - FUSE - - - - - - - - - - -
F1 & F2	7487942-P4 or 7487942-P5	Cartridge, slow-blowing; 250 V, 3/4 A; sim Bussman MDL 3/4 (-P4 for 125 VDC operation) or 250 V, 1A; sim Bussman MDL 1 (for 48 VDC operation (-P5))
		- - - - - - - - - - INDICATOR - - - - - - - - - -
I1*	19C307037-P25	Lamp, incandescent; 55 V; 3W; 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

PARTS LIST

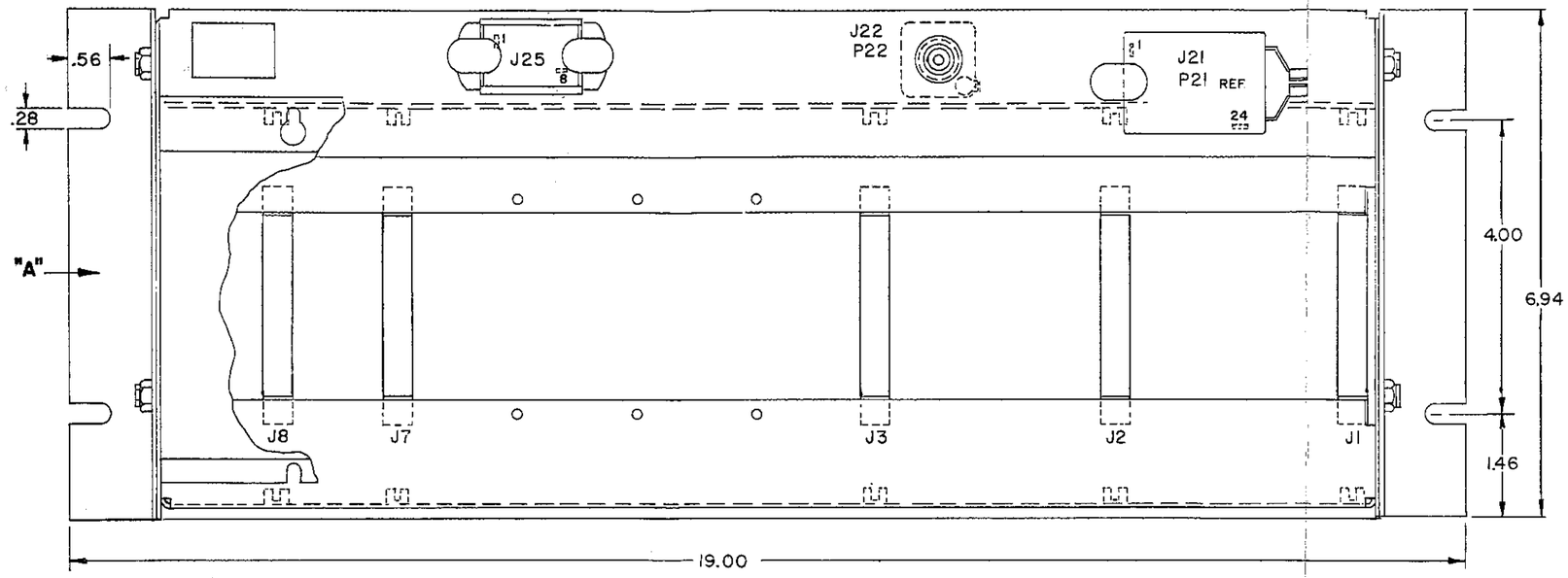
Symbol	GE Part No.	Description
P21	7775345-P18	24-contacts; sim Elco Corp. Cat. No. 01-4224-105-001-100
P22	2R22-P1	Coaxial; sim Signal Corps PL-259 or Amphenol 83-1SP
P23	7776570-P1	Coaxial, cable; Mil. No. UG-88C/U or UG-88D/U
		- - - - - - - - - - - SWITCH - - - - - - - - - - -
S1	5492177-P2	Toggle; DPST; sim Arrow-Hart & Hedgeman 82143-VLS; 6A at 250 V
		- - - - - - - - - - FUSE HOLDER - - - - - - - - - -
XF1 & XF2	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

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

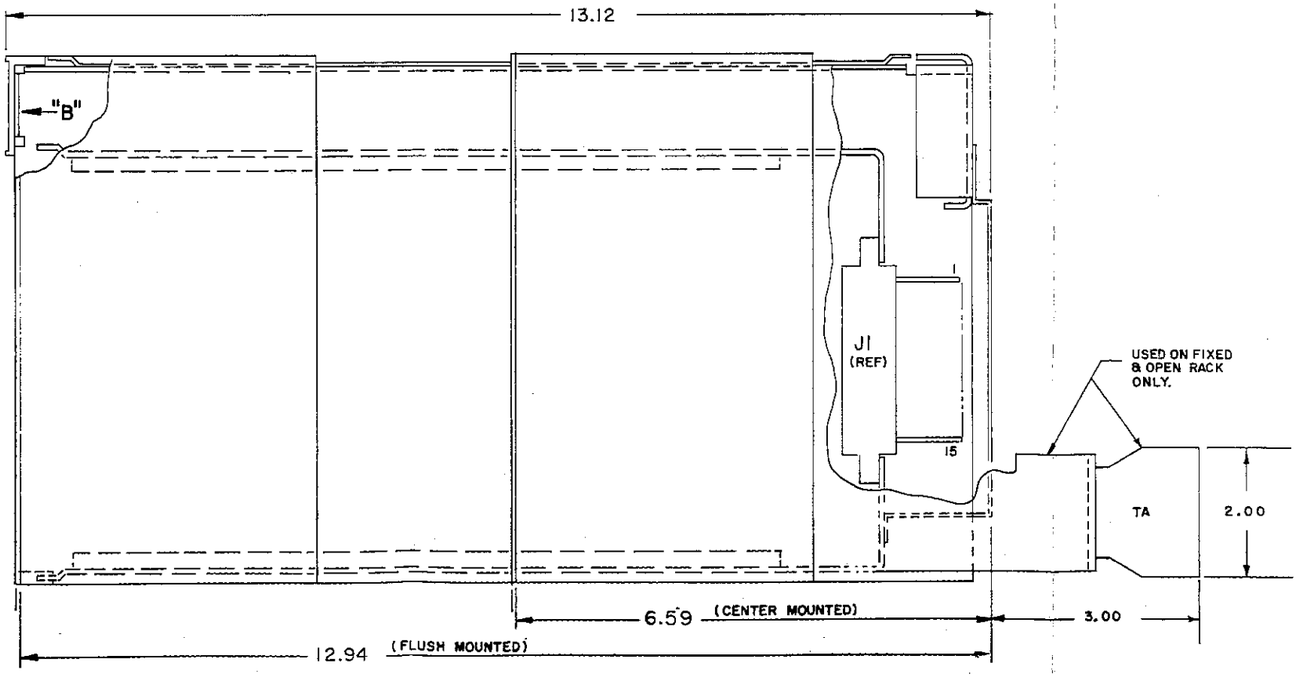
Printed in U.S.A.



VIEW AT "B"



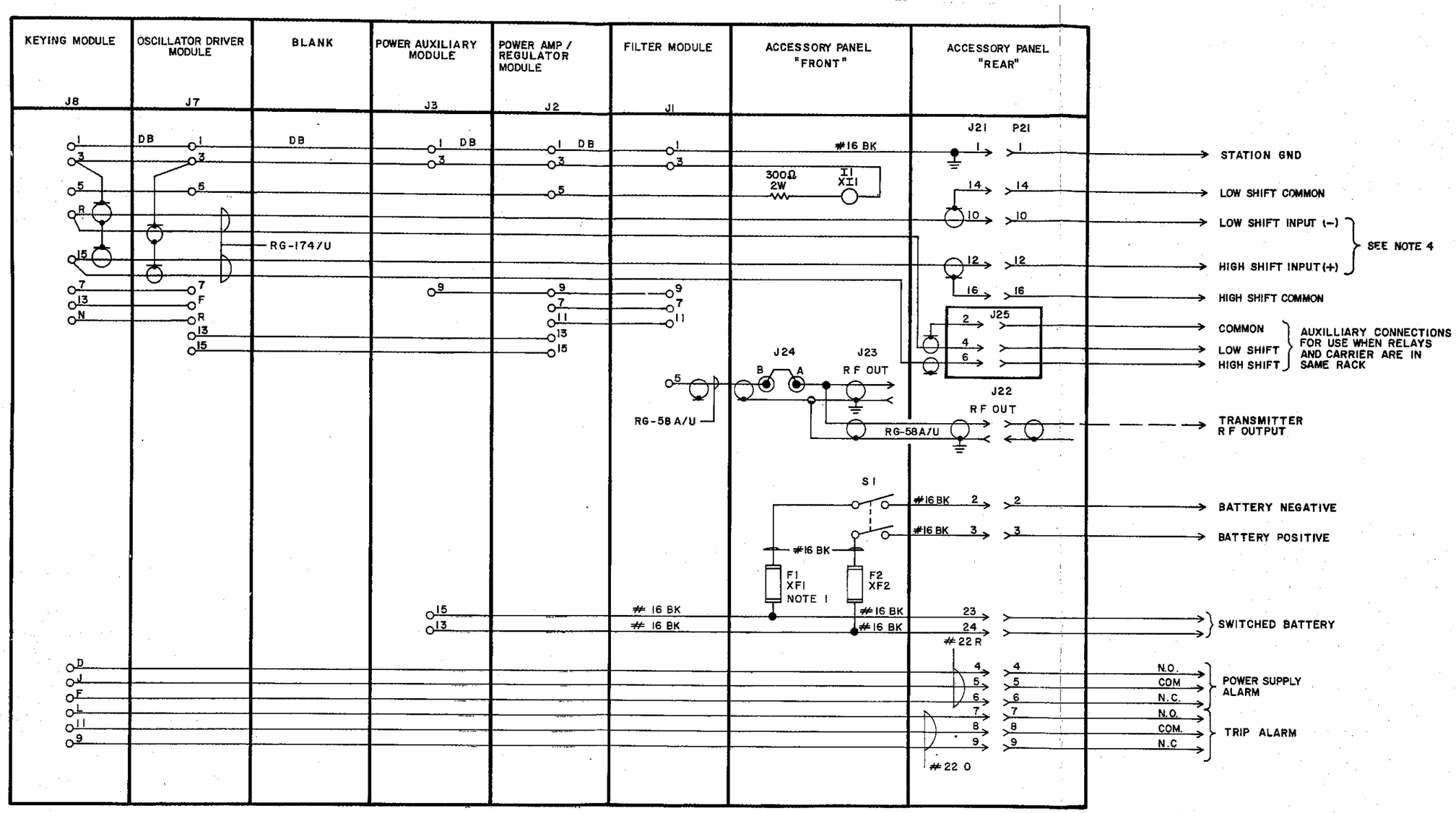
VIEW AT "A"



Pictorial/Outline

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

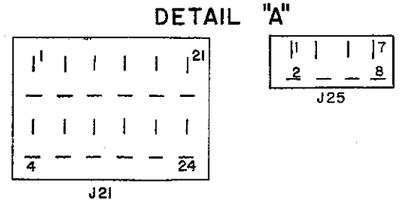
(19D415230, Rev. 2)



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 or 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 approximagely 6 dB 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.

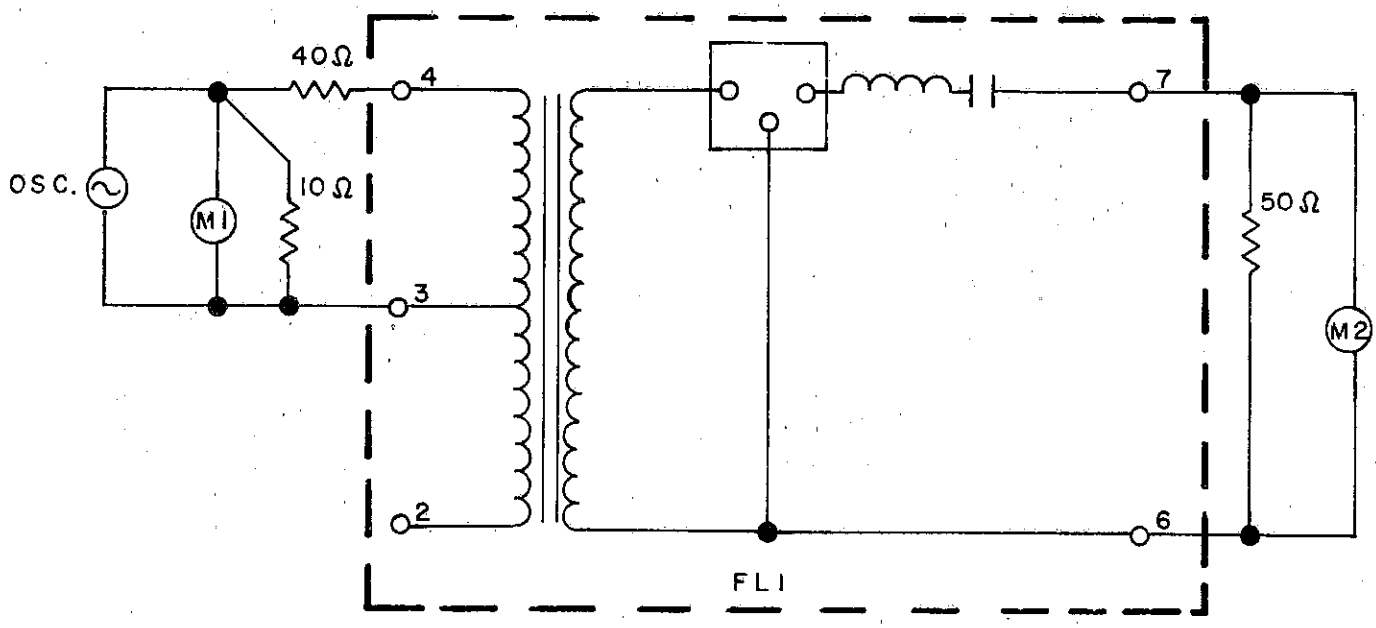


Figure 1 - Transmitter Filter Test Circuit

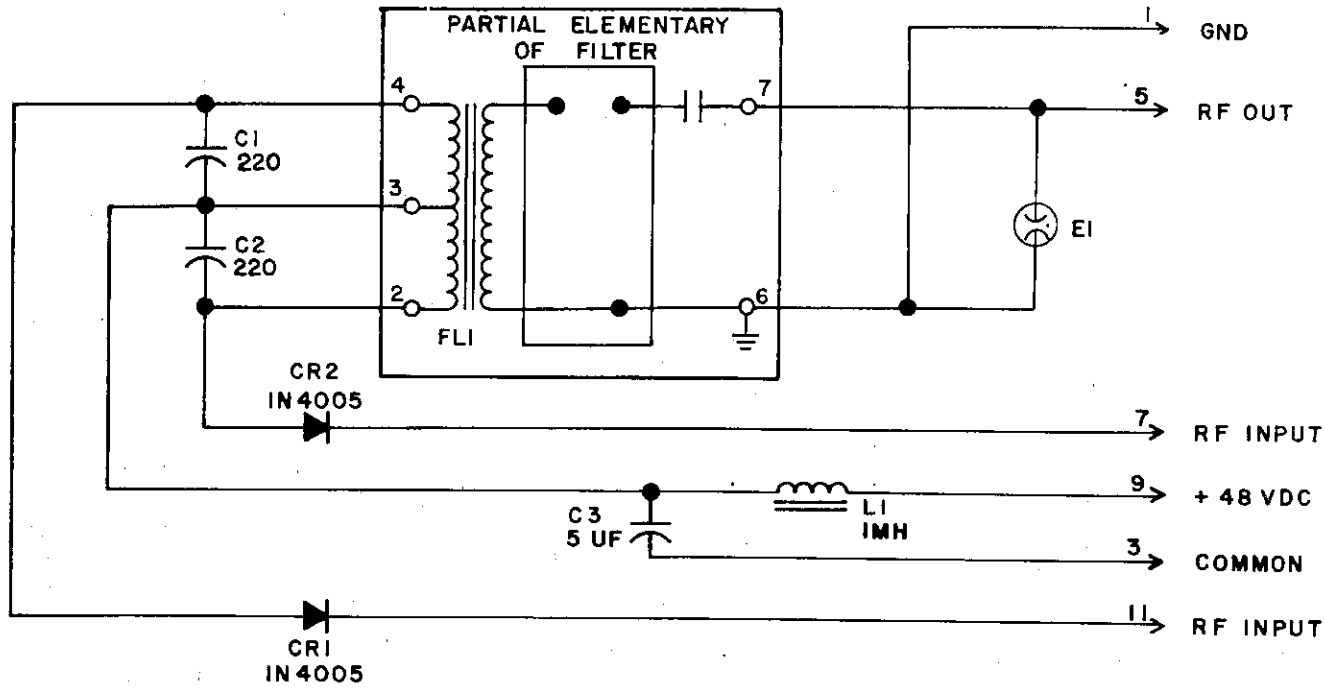
PARTS LIST

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.

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

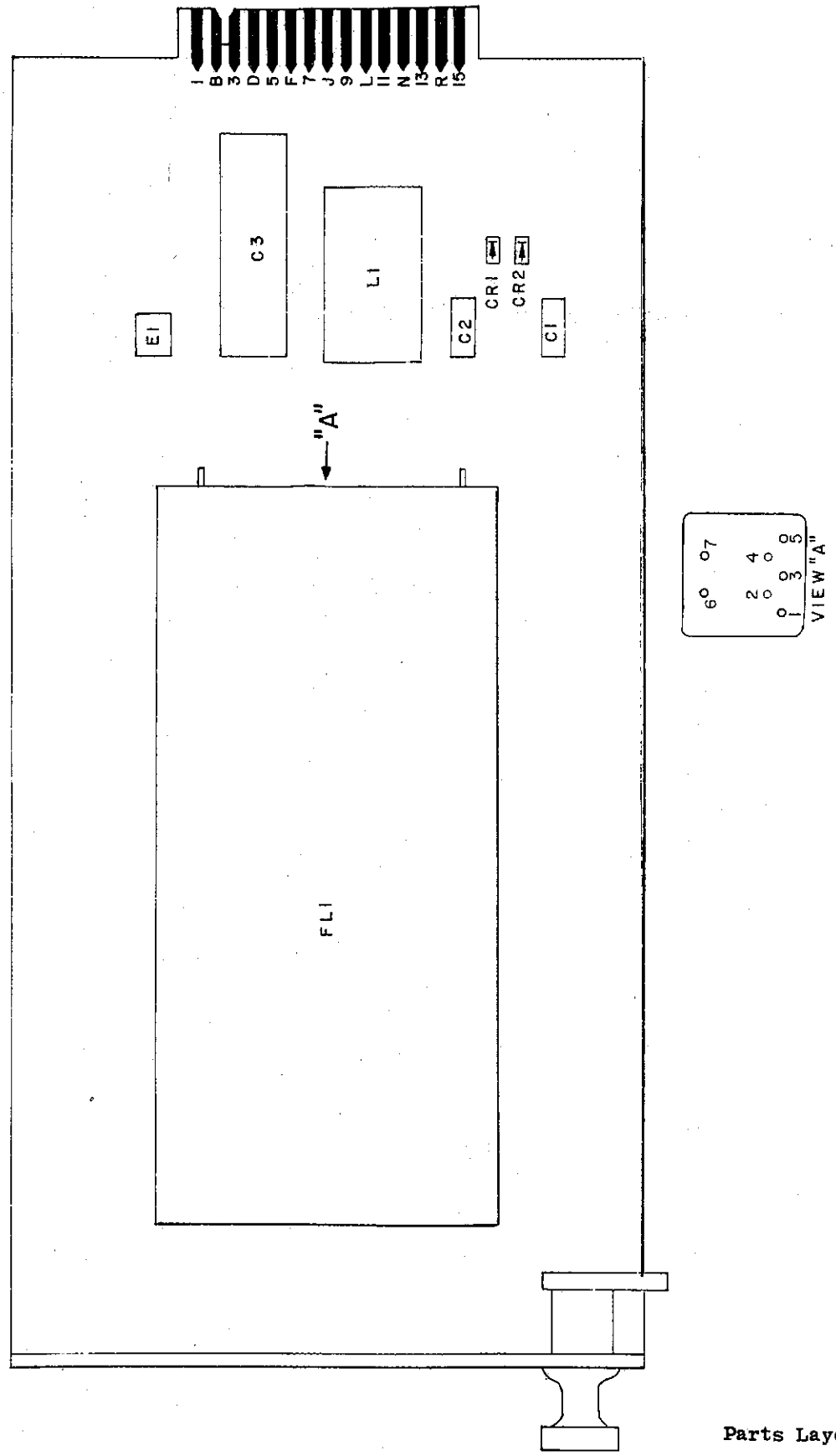


ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF=MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH=MILLIHENRYS OR H=HENRYS.

Elementary Diagram

TRANSMITTER FILTER MODULE
PL-19D415015-G1

(19B218154, Rev. 2)



Parts Layout Diagram

FILTER MODULE
PL-19D415015-G1

(19C318388, Rev. 3)

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 (max)
(-G2) Power Amplifier	36VDC @ 250 mA (max)

DC Output

Regulator	36VDC @ 380 mA

PARTS LIST

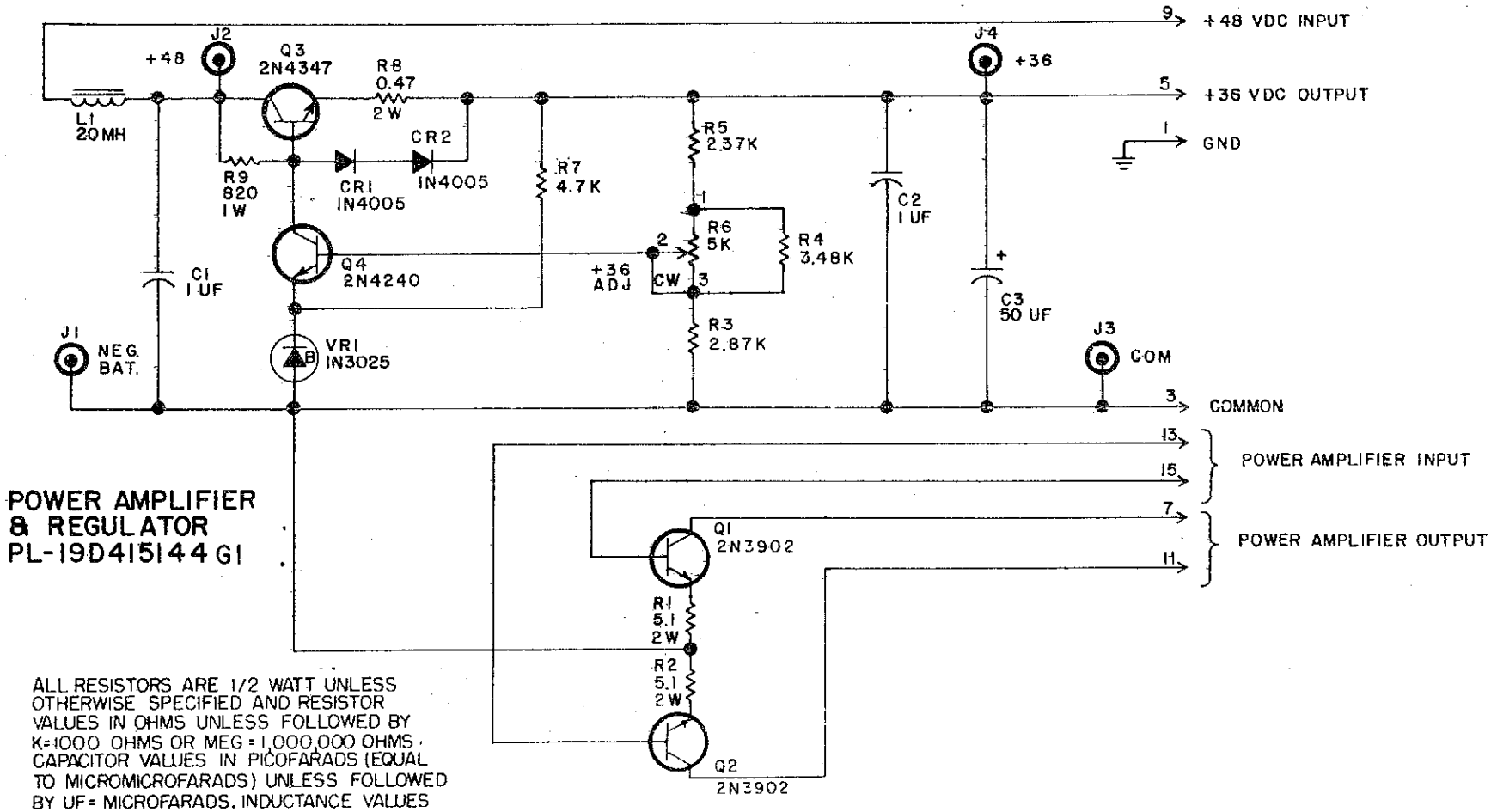
POWER AMPLIFIER/REGULATOR MODULE
PL-19D415144-G1
PL-19D415144-G2, REV. B

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.

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.



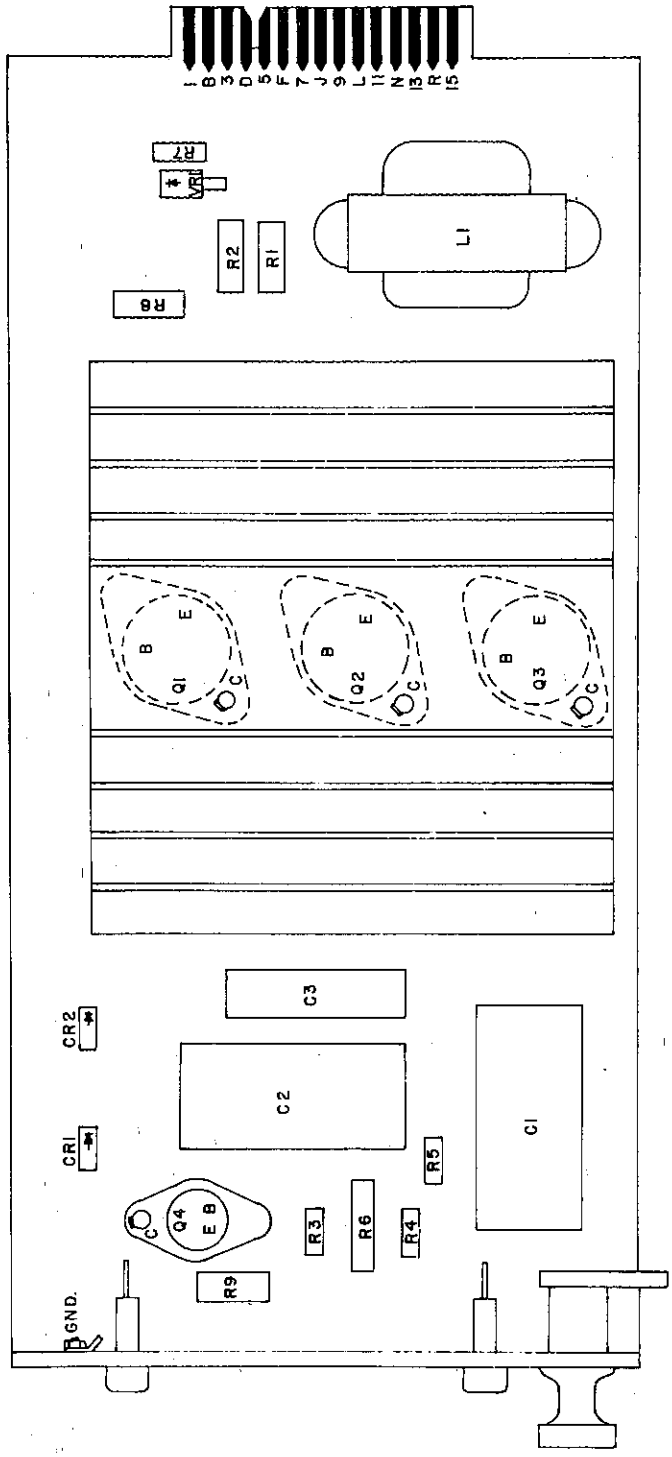
POWER AMPLIFIER
& REGULATOR
PL-19D415144 G1

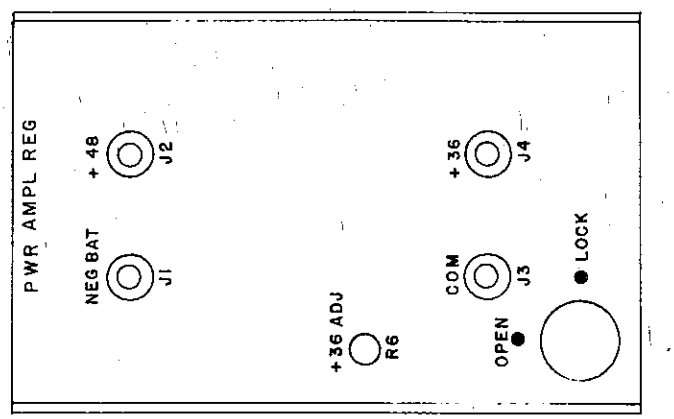
ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG = 1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS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

Elementary Diagram

POWER AMPLIFIER AND
REGULATOR MODULE
PL-19D415144 -G1

(19B218155, Rev. 0)





Parts Layout Diagram

POWER AMPLIFIER REGULATOR MODULE
PL-19D415144-G1

(19C318389, 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, 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, REV. A

Symbol	GE Part No.	Description
		- - - - - - - - -CAPACITORS - - - - - - - - -
C1 & C2	3R121-P19	Paper-Askarel: 0.25 µf ±10%, 1500 VDCW; sim GE Cat. No. 23F963
C3	5493132-P12	Electrolytic: 50 µf -10%, +50%, 250 VDCW
C4*	19A115028-P108	Polyester: 0.01 µf ±20%, 200 VDCW
C5	19A115028-P108	Polyester: 0.015 µf ±20%, 200 VDCW
C6	4029003-P20	Silver mica: 3300 µµf ±5%, 500 VDCW
C7	5496267-P19	Tantalum: 22 µv ±20%, 35 VDCW
C8 & C9	19B200230-P20	Metallized Polyester: 5 µf ±20%, 200 VDCW
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 1N4005
		- - - - - - - - - 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
L4	PL-19B213869-G1	Coil; Inductance, 294-306 mH at 1 kHz
		- - - - - - - - - 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
R2	3R77-P511J	Composition: 510 ohms ±5%, 1/2 W
R3	19A116278-P333	Metal film; 21.5 K ohms ±2%, 1/2 W

Symbol	GE Part No.	Description
		- - - - - - -RESISTORS (CONTD)- - - - - - -
R4	19A116278-P157	Metal film; 383 ohms ±2%, 1/2 W
R5	19A116278-P317	Metal film; 14.7 K ohms ±2%, 1/2 W
R6	19A116278-P201	Metal film; 1 K ohms ±2%, 1/2 W
R7	19A116278-P317	Metal film; 14.7 K ohms ±2%, 1/2 W
R8	3R79-P153J	Composition: 15 K ohms ±5%, 2 W
R9	19A116278-P273	Metal film; 5.62 K ohms ±2%, 1/2 W
R10	19A116278-P301	Metal film; 10 K ohms ±2%, 1/2 W
R11	3R77-P242J	Composition: 2.4 K ohms ±5%, 1/2 W
R12	19A116278-P265	Metal film; 4.75 K ohms ±2%, 1/2 W
R13	19A116278-P169	Metal film; 511 ohms ±2%, 1/2 W
R14	3R79-P152J	Composition: 1.5 K ohms ±5%, 2 W
R15	3R77-P302J	Composition: 3 K ohms ±5%, 1/2 W
R16	3R77-P103J	Composition: 10 K ohms ±5%, 1/2 W
R17	19A116278-P229	Metal film; 1.96 K ohms ±2%, 1/2 W
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
R20 & R21	19A116278-P290	Metal film; 8.45 K ohms ±2%, 1/2 W
R22 *	3R77-P105J	Composition: 1 megohm ±5%, 1/2 W
		- - - - - - -VOLTAGE REGULATOR - - - - - -
VR1	4036887-P2	Silicon, Zener; sim to Type 1N5224B
VR2	4036887-P17	Silicon, Zener; sim to Type 1N5250B

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

PRODUCTION CHANGES

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

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

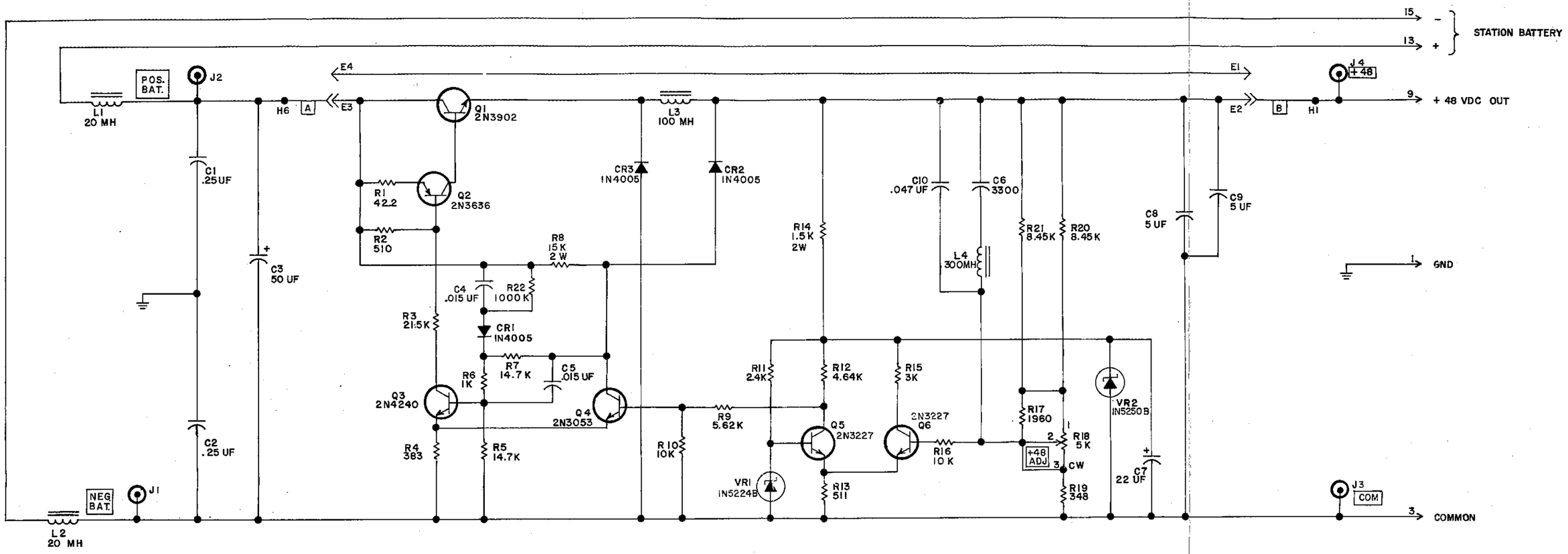
PL-19D415023-G1 and -G2, Rev. A

Purpose: To improve starting characteristics.

Part Changed	Was	Changed To
C4	4029003-P12 (1500μμF)	Polyester capacitor; 0.015μF ±20%, 200 VDCW. GE Part No. 19A115028-P108
R22	----------	Add resistor, composition 1 megohm ±5%, 1/2 w. GE Part No. 3R77-P105J. (Solder resistor to new C4 to make combination C-R)

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.



NOTES:

1. JUMPERS A & B AS SHOWN, 125 VDC BATTERY APPLICATIONS (G1).
2. JUMPER A CONNECTED BETWEEN H6 & E4 AND JUMPER B CONNECTED BETWEEN H1 & E1 IN 48 VDC APPLICATION (G2).

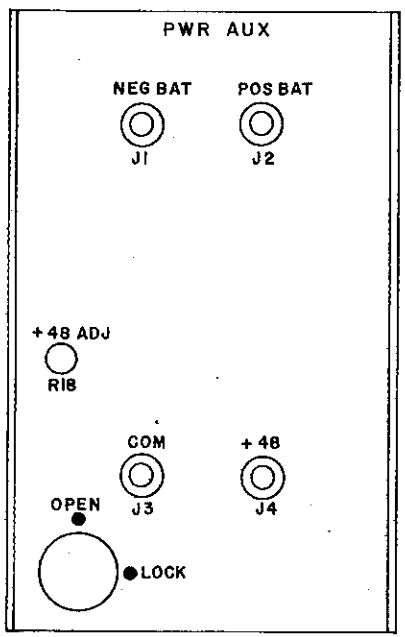
POWER AUXILIARY
PL-19D415023G1 REV. A (125 VDC INPUT) CAT. NO. CRP51B1A
PL-19D415023 G2 REV. A (48 VDC INPUT) CAT. NO. CRP51B1B

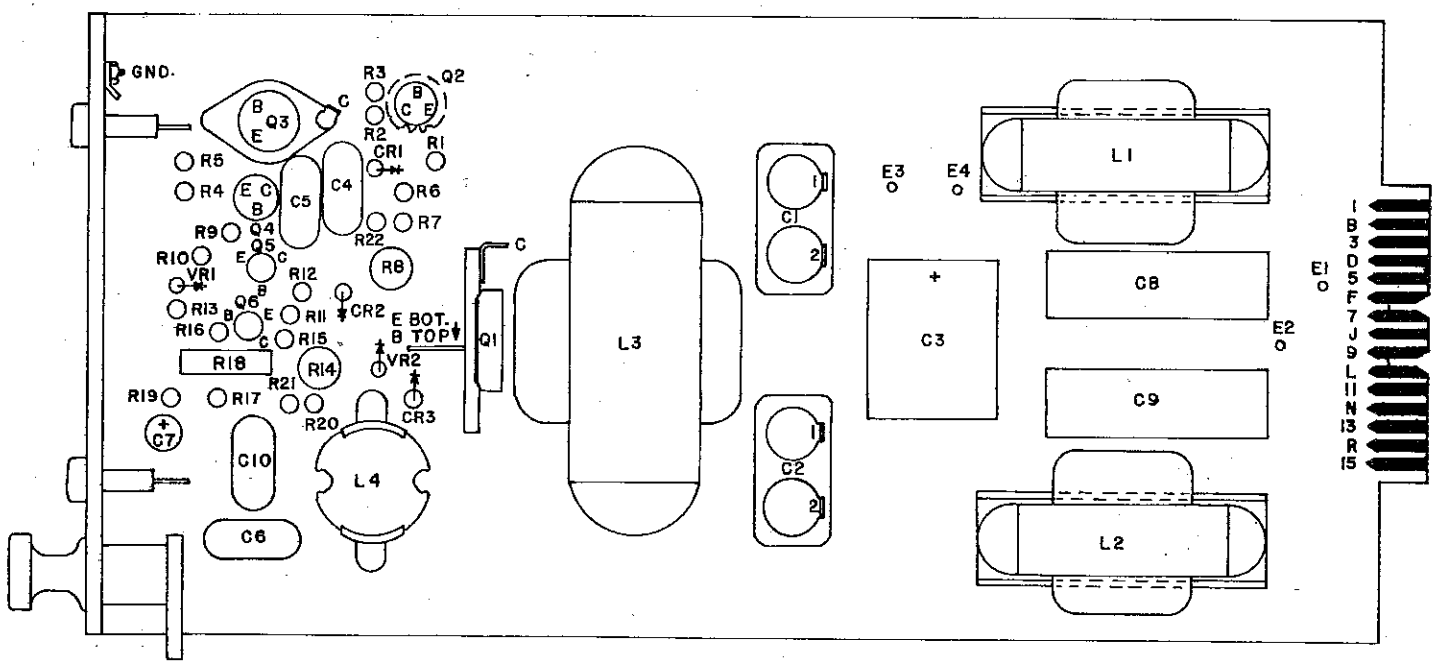
ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG = 1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS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

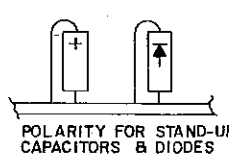
Elementary Diagram

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

(19D415131, Rev. 2)







POWER AUXILIARY
PL-19D415023 G1 REV. A
PL-19D415023 G2 REV. A

Parts Layout Diagram
POWER AUXILIARY MODULE
PL-19D415023-G1
(19C318390, Rev. 2)

OSCILLATOR-DRIVER MODULE
PL-19D415172-G3 and -G8, Rev. A

Introduction

The Oscillator-Driver Modules (OSC-DRV), PL-19D415172-G3 and -G8 are used in a 2-frequency-shift transmitter, such as the Type CT-71A. Each module consists of two parts, the Oscillator Subassembly, PL-19D415162-G3, and the driver section. The Oscillator Subassembly generates the channel frequency which can be shifted ±500 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 -G3 module, the gain can be exalted at the same time as the frequency is shifted to 500 Hz below nominal frequency by the associated Keying Module.

In the -G8 module, this level exalting feature is not available. In -G3, jumper "A" is connected to electrical contact E1 for exalt operation or to electrical contact 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 6 MHz minus the channel frequency is determined by crystal Y2 and capacitors C12 and C13.

The stage containing transistor Q1 generates a signal whose frequency is 6 MHz, which is determined by crystal Y1 and capacitors C2 and C3.

Both signals (6 MHz, and 6 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, has a roll-off frequency of about 400 kHz; consequently, the higher frequencies, in particular the 6 MHz oscillation, are cut off. Thus, the resulting frequency is 500 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 500 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 parallel circuits of capacitor C22 and coil L2 present a very high impedance at 6 MHz to isolate the oscillator 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 (both have the same serial number). Crystal Y1 will be stamped "A" 6000.000 kHz and crystal Y2 will be stamped "D" 5---,--- kHz (6 MHz minus 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 -G3, 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 high- or 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 associated 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 least 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 associated 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 Counter-clockwise	Q1	910 mV	1.3	12.0 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 clock-wise	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-G3 and -G8, Rev. A

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - - - CAPACITORS- - - - - - - - - - - -
C41 *	19A116080-P11	Polyester; 0.47 µf ±20%, 50 VDCW ; used in -G3 only
C42	19A116080-P9	Polyester; 0.22 µf ±20%, 50 VDCW
C43 thru C45	19A116080-P11	Polyester; 0.47 µf ±20%, 50 VDCW; NOTE: C44 used in -G3 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 ; NOTE: Q43 used in G3 only
Q44 *	19A115527-P2	Silicon, NPN; sim Type RCA40250
Q45	19A115300-P1	Silicon, NPN; sim Type 2N3053
		- - - - - - - - - - - - - - - - RESISTORS - - - - - - - - - - -
R41 *	19A116278-P273	Metal film; 5.62K ohms ±2%, 1/2 W; used in -G3 only
R42 *	7475398-P73	Variable, composition; 4.7K ohms ±20%, 1.13 W; sim Allen Bradley Type J; used in -G3 only
R43	19A116278-P329	Metal film; 19.6K ohms ±2%, 1/2 W;

Symbol	GE Part No.	Description
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 -G3 only
R58	19A116278-P229	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, 400 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 -G3 only

OSCILLATOR SUBASSEMBLY
PL-19D415162-G3

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - - - - CAPACITORS - - -- - - - - - - -
C1	19A116080-P8	Polyester; 0.15 µf ±20%, 50 VDCW
C2	5496219-P541	Ceramic disc, temperature compensating; 10 pf ±5%, 500 VDCW; -330 temp. coef.
C3	5491271-P102	Variable, air, sub-miniature; 1.6 pf min and 6.0 pf max at 1 MHz; peak voltage, 750 V; air gap, 0.010 in.; sim EF Johnson 189-502-5 or Erie 541-001
C4	5490008-P39	Silver mica; 330 pf ±5%, 500 VDCW

Symbol	GE Part No.	Description
C5	5490008-P33	Silver mica; 180 pf ±5%, 500 VDCW
C6	19A116080-P1	Polyester; 0.01 µf ±20%, 50 VDCW
C7	5490008-P33	Silver mica; 180 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	5490008-P39	Silver mica; 330 pf ±5%, 500 VDCW
C12	5490008-P6	Silver mica; 10 pf ±5%, 500 VDCW
C13	5490008-P9	Silver mica; 18 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-P10	Silver mica; 20 pf ±5%, 500 VDCW
C21	5491271-P102	Variable, air, sub-miniature; 1.6 pf min. and 6.0 pf max. at 1 MHz; peak voltage, 750 V; air gap 0.010 in.; sim E.F. Johnson 189-502-5 or Erie 541-001
C22	5490008-P1	Silver mica; 5 pf ±5%, 500 VDCW
		- - - - - - - - - - - - - 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-P101	RF; 100 µH ±10%, 300 ma; 4 ohms max. resistance; sim Delevan 3500 series
		- - - - - - - - - - - - - TRANSISTORS - - - - - - - - - - - - -
Q1 & Q2	19C300114-P2	Silicon, NPN; sim Type 2N706

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - - RESISTORS - - - - - - - - - - - -
R1	19A116278-P257	Metal film; 3.83K ohms ±2%, 1/2 W
R2 & R3	19A116278-P309	Metal film; 12.1K 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 &	19B201742-P1	Crystal; vertical mounting; sim Augat 8000-AG6-1
		- - - - - - - - - - - - - - CRYSTALS - - - - - - - - - - -
Y1	19B216664-P1	6000.000 kHz, stamped with letter "A". Part of matched pair.
Y2	19B216664-P4	6000.000 kHz minus channel frequency. Customer must specify channel frequency; stamped with letter "D". Both crystals of a matched pair will have the same serial number.

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

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

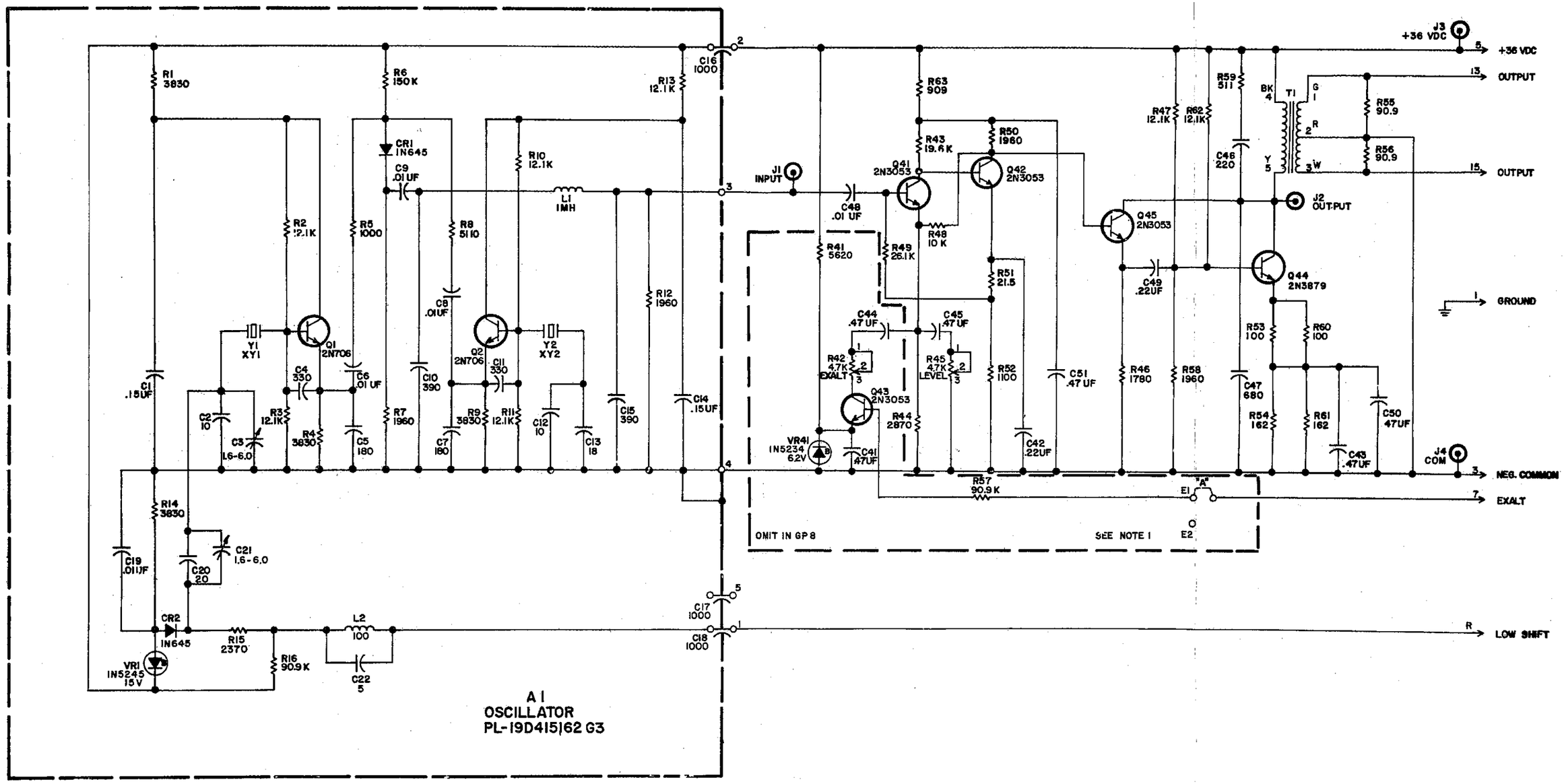
PL-19D415172-G5 and -G10, Rev. B

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)

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.



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.

NOTE:

1. "A" JUMPER TO E1 FOR OPERATION WITH EXALTED CARRIER.

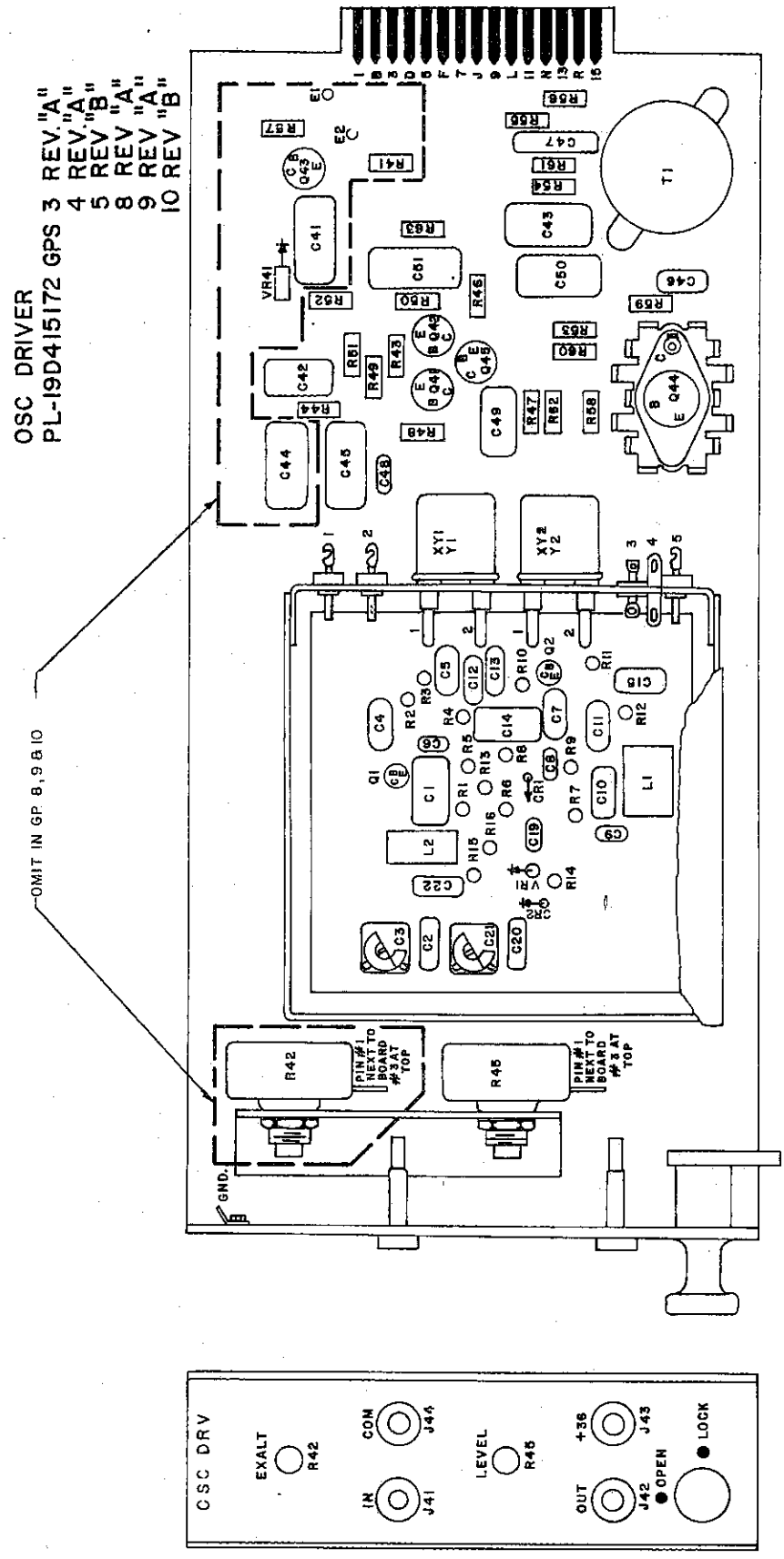
   "A" JUMPER TO E2 FOR OPERATION WITHOUT EXALTED CARRIER.

OSC DRIVER
PL-19D415172 G3 REV."A"
G8 REV."A"

Elementary Diagram

OSCILLATOR DRIVER MODULE
PL-19D415172 -G3 AND -G8

(19D415182, Rev. 3)



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

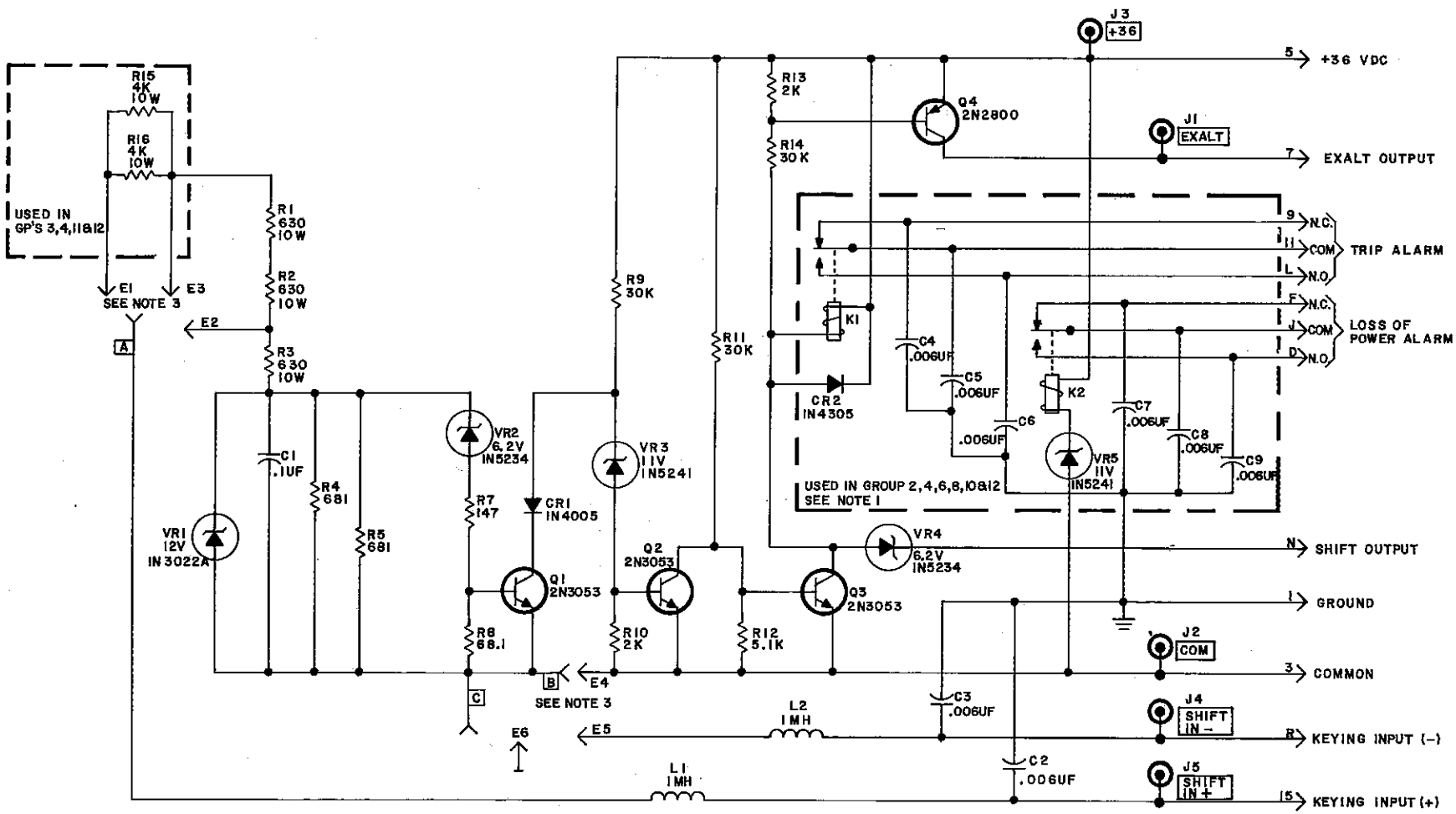
KEYING MODULE
PL-19D415815-G1 thru -G12

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.

POWER LINE CARRIER OPERATION
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.



KEYING
PL-19D415815 G1 - G12

NOTES:

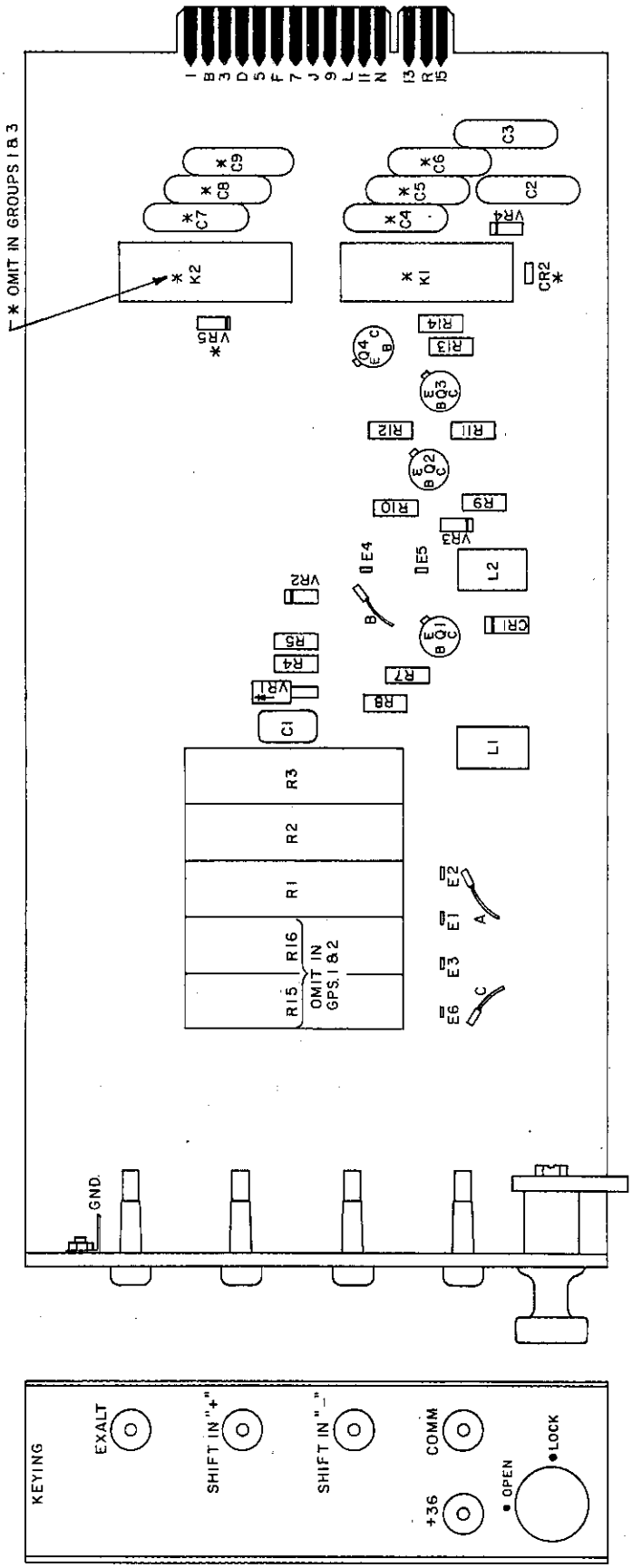
1. RELAYS SHOWN IN DE-ENERGIZED STATE.
2. ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS OR H=HENRYS.
3. JUMPER CHART

GROUP NO.	JUMPER			KEYING VOLTAGE	KEYING BUS
	A TO	B TO	C TO		
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

Elementary Diagram

KEYING MODULE
PL-19D415815-G1 THRU -G12

(19C318985, Rev. 0)



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)