CARRIER CURRENT

TYPE CS-26-B

TRANSMITTER-RECEIVER EQUIPMENT FOR SOLID STATE PHASE OR DIRECTIONAL COMPARISON PILOT RELAYING (125 VDC, 10-WATTS, WITH VOICE)

LBI-18288

TELECOMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

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

GENERAL

DESCRIPTION OF UNITS

ELEMENTARY - INTERCONNECTION DIAGRAM

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

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

DESCRIPTION OF EQUIPMENT
TYPE CS-26B

The combination number on the equipment nameplate is a description of what the equipment contains. A key to the significance of the digits in the combination number is given in Figure 1.

Those equipments in which the twelfth digit is "1" are supplied with a 1500 Hz bandwidth receiver filter. If the twelfth digit is "2", a 1000 Hz (higher selectivity) receiver filter is supplied.

NOMENCLATURE KEY

To facilitate understanding the many options possible with the Type CS-26B transmitter-receiver equipment, meaning has been assigned to each digit of the Model No. as shown below.

4CS26B 1 F 04 M 1 N 0950 Typical Model No.

- 0950 — Operating frequency (in 1/2 kHz steps starting at 50 kHz).
- N — N-Without Voice Modulator; V-With Voice Modulator
- 1 — 1.-Receiver bandpass of 1500 Hz; 2.-Receiver bandpass of 1000 Hz
- M — M-10-Watt transmitter output; H-100-Watt transmitter output
- 04 — 04-48-Volt DC input; 12-125-Volt DC input; 25-250-Volt DC input
- F — F-Wiring harness for GE fixed-rack cabinet (or open rack with terminal-board side panel); 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
- 1 — 1.-Standard keying. Requires external circuit-opening contact to start carrier. Receiver outputs are:
  - a. Phase or directional-comparison relaying. The CS-26B transmitter keying and receiver outputs are coordinated with GE solid-state relaying equipment.
  - b. Supervisory control (and/or telemetering). A separate keying circuit in the CS-26B transmitter provides for keying by Purchaser's contact. Likewise, the receiver has a separate 30-ma DC output for operation of Purchaser's 250-ohm relay.
- 4CS26B — Solid-state transmitter-receiver assembly for phase-or directional-comparison relaying and/or supervisory control.

Figure 1 Combination Number Code

The Transmitter-Receiver Unit may be modified for use with a 48V battery by moving jumpers A thru K to different points on TB20, TB21 and FL35 as follows:

Jumper	Move From	Move To
A	TB20-2	TB20-1
B	TB20-4	TB20-3
C	TB20-6	TB20-5
D	TB20-8	TB20-7
E	TB20-10	TB20-9
F	TB21-2	TB21-1
G	TB21-4	TB21-3
H	TB21-6	TB21-5
I	TB21-8	TB21-7
J	FL35-1	FL35-2
K	FL35-5	FL35-4
Also, add jumper from RA-18 to RA-19.		

If this is done, the dotted connections shown on the Elementary Diagram will apply. The nominal current drain will change to 0.54 A on standby and to 1.32 A on transmit.

NOMINAL OPERATING CHARACTERISTICS

Frequency Range

Fixed frequency operation in 1/2 kHz intervals on specified frequency in band of ..... 50-250 kHz

Keying Requirements

1. Burden on solid state relaying equipment to hold transmitter OFF .... 0.02 Amp
2. Contact burden for keying auxiliary functions at nominal supply voltage ..... 0.02 Amp

Power Supply Requirements

125 Volt battery (60 cell) ..... 104-140 Volts

Standby drain ..... 0.30 Amp

Transmit drain ..... 0.68 Amp

Receiver Outputs

1. Blocking voltage into static relaying equipment ..... 5 VDC
2. To external 200 ohm signal alarm relay coil ..... 65 ma DC min.
3. To external 250 ohm supervisory relay coil ..... 30 ma DC min.
4. To external 5000 ohms/Volt meter for reserve signal indication ..... 0-5 VDC

Receiver Sensitivity

Sensitivity on 50 ohm coaxial cable, (noise free line) ..... 0.125 Volt

Normal minimum signal ..... 0.225 Volt

Power Output

Power output into 50 ohm resistive load (RG-8/U cable) ..... 10 Watts max.

Voice

Suitable for maintenance or emergency voice communication.

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 operation 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.

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GENERAL ELECTRIC COMPANY
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DESCRIPTION

TRANSMITTER-RECEIVER UNIT
PL-19D404770-G5

GENERAL

The Transmitter-Receiver Unit is used for the transmission and reception of carrier current high speed signals over high voltage power lines for solid state phase and directional comparison pilot relaying and supervisory control.

Transmission of supervisory control or telemetering information is obtained by keying the transmitter ON and OFF in accordance with the supervisory or telemetering code. This is accomplished by means of the supervisory or telemetering send relay contacts. At the receiver, the supervisory control or telemetering receive relay is energized when the supervisory control or telemetering signals are received.

Equipment List

This unit includes the following items:

1. Main Chassis
2. Oscillator-Keying Module-PL-19C305448-G1
3. Driver Module ----------PL-19C305850-G1
4. Carrier Receiver Module -PL-19C318259-G1
5. Output Module ----------PL-19C305847-G1
6. Output Filter ----------FL-35
7. Receive Filter ----------FL-36 or FL-37
8. Hybrid Module ----------PL-19C305442-G3

> NOTE
>
> Items 2, 6 and 7 contain frequency determining elements and must be coordinated with the channel frequency. The receiver filter will be FL-36 for narrow-band applications, and will be FL-37 for wide-band applications. Refer to the combination number on the nameplate for the channel frequency and the receiver filter supplied with the unit.

DESCRIPTION OF CIRCUITS AND MODULES

Main Chassis

The front panel of the chassis contains the following test point jacks:

J31 --- Emit Q31	J35 --- Neg.
J32 --- Emit Q32	J36 --- Pos Input
J33 --- Coll Q33	J37 --- +33
J34 --- Coll Q34	J38 --- RF IN

Relay current measuring jacks J41 and J42, Input Attenuator AT31, Carrier Test Switch S32, and Power ON-OFF Switch S31 are also located on the front panel.

The circuitry on the main chassis provides three separate functions: (1) power supply, (2) power amplifier, and (3) receiver relay driver.

The power supply circuit works from the station battery. The circuit is fused by two 5-ampere fuses F31 and F32, and is separated from the battery input at J40-6 (NEG) and J40-3 (POS) by power switch S31. Reactors L31 and L32 and capacitors C33 thru C36 and C39 act as a DC filter to reduce battery surges and other interference entering on the battery leads, and also keeps RF off of the battery leads. The filtered battery voltage is routed out of the unit at J40-9 (NEG) and J40-8 (POS) for power for relays, control circuits, and other functions. The negative lead is the COMMON for the transmitter-receiver circuits.

The supply current re-enters at J40-12. Zener diode VR32, resistor R33, and capacitors C31 and C32 work from this voltage to provide a filtered +33 VDC supply for all of the modules in the unit.

The +125 VDC at J40-12 is connected externally to J40-16 either directly or through a "Carrier ON Indicator" (25 ohm max.) to supply the power amplifier.

The power amplifier consists of transformer T33, transistors Q32 and Q33, and associated circuitry, in conjunction with filter FL-35. The amplifier operates Class B and amplifies the signal from the driver module to provide the 10-Watt output level.

Transistor Q33 is turned ON by a signal from the Output Module when the received RF input level exceeds the receiver sensitivity. This energizes the supervisory relay via J40-14 and the signal alarm relay via J40-15. Resistors R38, R39 and R40 determine the relay currents.

Oscillator-Keying Module, PL-19C305448-G1

The oscillator-keying module is used to generate the channel frequency. This module has the following test point jacks:

J101 --- Coll Q101
J102 --- Coll Q102
J103 --- Coll Q103
J104 --- Coll Q104

Also, front panel adjustments are available for the oscillator tuning capacitors, C101 and C102.

The module contains two common collector (emitter-follower) oscillators consisting of transistors Q101 and Q102 and associated circuitry. The Q101 oscillator operates at a frequency of 2000 kHz, determined by crystal Y101, and adjustable to some degree by C101. The Q102 oscillator operates at a

frequency of 2000 kHz plus the channel frequency, determined by crystal Y102, and adjustable C102.

The outputs of the oscillators are injected into the base of transmitter Q103. This transistor mixes the two frequencies to produce a signal of channel frequency at the output of transformer T101. This signal is filtered by C115, L101, and C116 to remove harmonics, then amplified by A104. The signal then passes out of terminal TB101-7 to the driver module.

The crystals used in this module come as "matched pairs"; that is, they have been tested to insure that they have very similar temperature characteristics. Both crystals have the same serial number stamped on their metal envelopes. Also, crystal Y101 (2000 kHz) is stamped with the letter "A" and Y102 (2000 kHz plus the channel frequency) is stamped with the letter "B". If it is desired to change channel frequency, the two crystals must be replaced by a new "matched pair" of the new frequency.

Driver Module, P1-19C305850-G1

The driver module is used for control and the amplification of the carrier signal to drive the power amplifier. This module has the following test point jacks:

J151 --- Coll Q151
J152 --- Coll Q152
J153 --- Coll Q153
J154 --- Emit Q154

The front panel also contains the RF Gain Control, R165, and the Reduced RF Out Control, R161.

The transistors used in this module have the following functions:

Q151, Q153, Q157, Q158-Carrier Control
Q152 ----------Switched Amplifier
Q154 ----------RF Amplifier and Driver
Q155 ----------Modulation Control
Q156 ----------Reduced Power Control

NOTE

Transistor Q155 performs no function unless a modulator unit is used with this unit. The function of Q155 is discussed in LBI-18205, the instruction of the Modulator Unit, PL-19C318286-G1.

The driver module has four modes of operation in addition to the function of Q155: (1) Carrier OFF, (2) Full power, (3) Reduced power and (4) Auxiliary stop.

Carrier OFF

Under Carrier OFF conditions, the driver module is receiving a signal from the Oscillator-Keying Module through TB151-1 but no carrier signal is being transmitted. This is because positive voltage is on TB151-3, turning transistor Q151 ON. This turns Q157 OFF which produces back-bias on Q152 and turns it OFF. With Q152 OFF, the signal is not amplified; hence, no transmitter output. In this condition, Q155, Q156, Q153 and Q158 remain OFF.

Full Power-Transmitter ON (10-Watt RF Output)

Full power output is obtained either by removing voltage from the Start lead or by closing the Carrier Test Switch, S32, or the external Supervisory Control contact. When voltage is removed from the Start lead, Q151 turns OFF, which turns Q157 ON. This applies forward bias to Q152, thereby allowing Q152 and Q154 to amplify the RF signal and pass it to the power amplifier on the main chassis. R165 is adjusted to set the RF power output at 10 Watts. Closure of an external contact (supervisory send relay contact or full power test switch) between terminals CB-7 and CA-9 energizes relay K32. This, or depressing S32 on the front of the main chassis, applies voltage to TB151-8 and turns Q153 ON. This forward biases Q152 and allows amplification as above. Transistors Q155, Q156 and Q158 remain OFF.

Reduced Power - Transmitter ON

When voltage is applied to the Reduced Power Send lead, relay K31 is energized via J40-23. Contacts 6-7 of the relay close and apply voltage to TB151-11, turning transistors Q153 and Q156 ON. Part of the input RF signal is shunted through R161 when Q156 turns ON, which reduces the amount of signal applied to Q153. When Q153 turns ON it allows Q152 and Q154 to amplify this reduced signal. The amount of power reduction is set by adjustment of R161. Transistors Q155 and Q158 remain OFF.

Auxiliary Stop

When voltage is applied to the auxiliary Stop lead (TB151-2), transistor Q158 turns ON. This reduces the voltage used for keying transistors Q153, Q155 and Q156 to nearly zero and prevents them from turning ON. The RF power out is then either zero or 10 watts depending only on whether or not voltage is on the start lead (TB151-3).

Hybrid Module, PL-19C305442-G3

The Hybrid Module is an RF Skewed Hybrid which is used for separating a transmitter from a receiver operating on closely spaced frequencies, or on the same frequency, and which are connected to a common tuned output circuit.

This module has the following test point jacks:

J202 --- OUT
J203 --- XMIT
J204 --- REC
J205 --- GND

The RF current may be measured between J206, A and B. Note that jumper "A" must be connected for optimum line impedance matching.

The Hybrid Module consists of a multi-tap impedance matching transformer on the transmit path, and a one-to-one ratio transformer on the receive path. The receive path is coupled to the line through the action of a third winding on each transformer, which also provides isolation between the transmit and receive paths by flux cancellation. A spark arrestor protection circuit has also been included.

This hybrid differs from a conventional RF hybrid in that the transmitter loss is reduced to less than 1.0 dB, as opposed to the 4.0 dB loss in the conventional RF hybrid. This is accomplished at the expense of added attenuation in the receive path of the RF hybrid; but, this is of little concern, as both signal and noise are attenuated to the same degree.

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

Carrier Receiver Module, PL-19C318259-G1

The Carrier Receiver Module is a carrier detector and detects the presence or absence of channel signal for relaying operations.

This module contains the following test point jacks:

J251 --- Coll 251
J252 --- Coll 252
J253 --- Coll 253
J254 --- REC POS

The front panel also contains Gain Control R256 and Reserve Signal Adj. R258.

The transistor amplifier consisting of Q251 and associated circuitry is driven by the output of the bandpass receiver filter FL-36 or FL-37. The Gain Control, R256, is used to set the receiver sensitivity.

The output of Q251 takes two paths, one to the input of Q253, and the other through resistor R257 and potentiometer R258 (Reserve Signal Level Adj.) to the input of Q252. The signal is amplified by Q253 to drive (through TB251-12) the transistor switch in the output module. The signal is also amplified by Q252 to drive (through TB251-11) the reserve signal indicator circuit in the output module. The adjustment of R258 is explained in the adjustment section.

Output Module, PL-19C305847-G1

The output module contains a reserve signal indicator circuit, provides a voltage output for the solid-state relaying equipment, and provides drive for Q33. This module has the following test point jacks:

J301 --- COLL Q301
J302 --- COLL Q302
J303 --- BASE Q33

The amplified carrier signal enters the output module at TB301-6 where it is rectified to provide a DC voltage proportional to the received signal level. This DC voltage is applied to the base of Q301. When it reaches a sufficient level, Q301 turns ON and turns Q302 ON. This causes Q303 to turn OFF, producing a loss of voltage at J43-3. When Q302 turns ON, voltage is applied, via TB301-10, to the base of Q33 causing it to turn ON and pick up the Supervisory and Signal Alarm relays.

The applied signal for Reserve Signal Level Indication enters the Output Module at TB301-5, where it is also rectified and filtered. The DC voltage is then applied through TB301-9 to a 0-5 volt, 5000 ohms/Volt external Reserve Signal Level Indicator.

ADJUSTMENTS

Factory Adjustments

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

1. Transmitter frequency
2. Transmitter output level
3. Receiver sensitivity

NOTE

When two units are to be operated on the same frequency at opposite ends of a line, one of the units shall be off-set on the high side by 150 Hz. When three units are to be operated on the same frequency and on the same line, one of the units shall be operated on frequency, one shall be off-set plus 150 Hz, and the third unit shall be off-set minus 150 Hz. This will be done at the factory if the requisitions for all terminals are received at the same time and each is identified as being part of a common 2-terminal or 3-terminal (or more) channel.

Installation Adjustments

The following adjustments are normally made at the time of installation of the unit.

NOTE

The scale marking for the AT31 attenuator provides a fairly accurate indication of the dB change in attenuation caused by adjustment of AT31. More accurate indication of the input voltage attenuation can be obtained by observing a selective VTVM connected between J34, "RF IN", and ground.

Operating Margin

For reliable operation, a 20 dB operating margin should be established. This provides for up to 15 dB increased attenuation for foul weather plus 5 dB margin to assure adequate response time. The 5 dB for adequate response time is mandatory for phase comparison relaying, but maybe omitted in a directional comparison scheme if the relaying is adjusted for a 1.5 millisecond longer channel response time. If the narrow band filter (FL-36) is being used, the relaying scheme should be adjusted for an increased channel response time (refer to Philadelphia instructions).

Establish a margin of 20 dB in the receiver as follows:

1. With the Receiver Gain Control (R256) set as received from the factory (0.125V sensitivity) and the Receiver Input Attenuator (AT31) set on "zero", turn the remote transmitter ON.

2. Connect the 10 VDC meter scale of the Meter Analyzer Unit to TB301-2 (NEG) and TB301-7 (POS).

3. Turn the Receive Input Attenuator, AT31, in a counterclockwise direction until the current in J41 is at the "knee" of the curve, in Figure 1. The output voltage will not increase further if the Input Attenuator is moved beyond this point. The knee of the curve will normally be reached at an Input Attenuator scale reading of 20 dB or more. Turn the Receiver Input Attenuator 20 dB from this point in a clockwise direction. This establishes a 20 dB operating margin, which means that the RF input signal may decrease 20 dB before the relay current starts to decrease.

4. NOTE: The above adjustments are assumed to be made with all equipment operating normally, and with normal line attenuation.

5. If the normal line attenuation is very high, the knee of the curve may not be reached at a Receiver Input Attenuator scale reading of 20 dB or more. In this case, turn the Gain Control (R256) a small amount in a clockwise direction and repeat Step 3.

CAUTION

Turning the Gain Control clockwise beyond its normal 125 mv sensitivity setting will cause the receiver to operate on less than the standard 125 mv RF input. In general, a sensitivity greater than the standard 125 mv sensitivity should not be used because it may cause the receiver to be falsely operated by line noises.

6. There is a possibility, due to high line loss, that the 20 dB operating margin desired cannot be obtained, even with the Receiver Gain Control turned fully clockwise. The operating margin, in this case, may only be 16 or 18 dB. If a lower margin is noted, check the transmitter and line to be sure that the remote transmitter is performing as intended and that unnecessary losses have not been inserted in the line.

Reserve Signal Level Indication

The Reserve Signal Level Indicator is adjusted as follows:

1. With normal line attenuation, and the operating margin set as explained above, turn the remote transmitter ON at full power.

2. Turn the Reserve Signal Adjust (R258) to approximately full scale deflection of the 0-5 volt indicating meter. This point corresponds to "zero" dB change in the input RF signal level.

3. NOTE: If this adjustment is made during conditions of higher than normal line attenuation, the meter should be adjusted

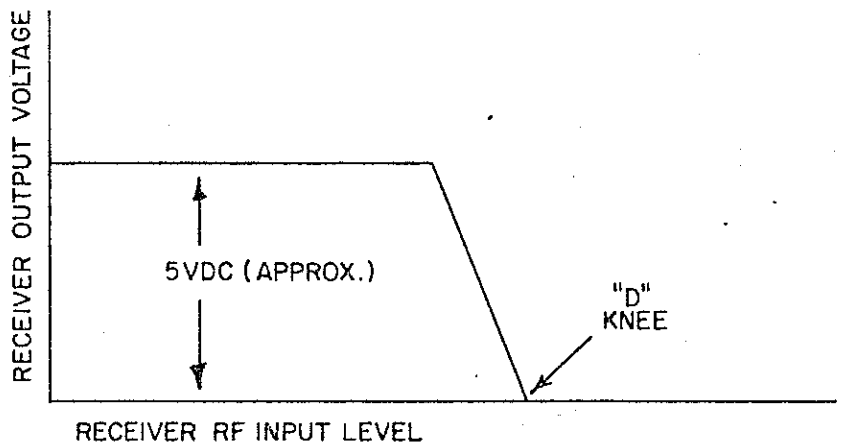
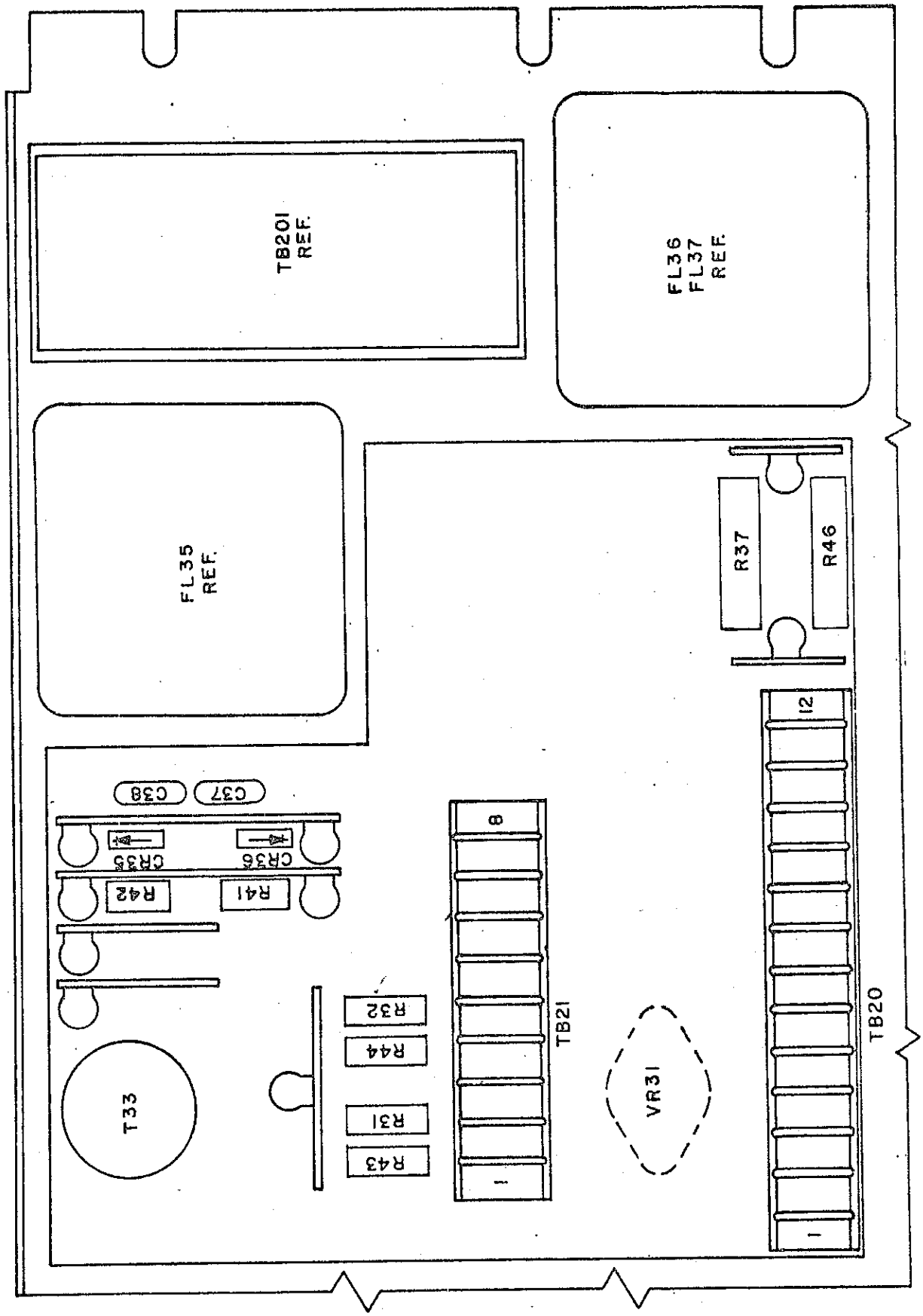


Figure 1 - Receiver Output Voltage vs Input Level

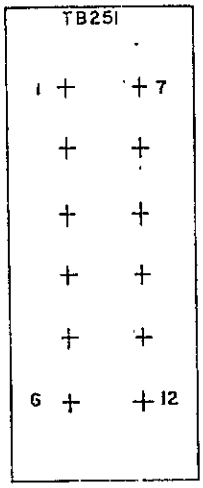
Symbol	GE Part No.	Description
FL36	PL-19C304750	Receiver input filter (1000 hertz bandwidth). State frequency required.
FL37	PL-19C304745	Receiver input filter (1500 hertz bandwidth). State frequency required.
		----------INDICATOR----------
I32	19C307037-P25	Incandescent lamp; sim to GE Lamp Dept. Cat. No. 1835. 55 V; Bulb size T-3 1/4; current, 0.05 ±15 amps.
		----------JACKS AND CONNECTORS ----------
J31 & J32	7150763-P3	Test point, sim to Alden 110BC1-brown
J33	7150763-P8	Test point, sim to Alden 110BC1-orange
J34	7150763-P5	Test point, sim to Alden 110BC1-yellow
J35	7150763-P4	Test point, sim to Alden 110BC1-green
J36	7150763-P2	Test point, sim to Alden 110BC1-red
J38	7150763-P2	Test point, sim to Alden 110BC1-red
J40	7775345-P21	Connector, receptacle; 24-contacts; sim to Elco Corp. 01-2224-121-004-100
J41 & J42	7489006-P4	Telephone; sim to Mallory Type 3B or Switchcraft Type 4J-1196
J43	7775345-P27	Connector, receptacle; 8-contacts; sim to Elco Corp. 01-1108-106-004-100
P40	7775345-P24	Connector, plug; 24-contacts; sim to Elco Corp. 01-4224-104-001-109
P43	7775345-P11	Connector, plug; 8-contacts; sim to Elco Corp. 01-3108-104-001-103
		----------RELAY----------
K31 & K32	5491595-P2	Armature; resistance, 2500 ohms ±15%; pickup, 38 VDC min; dropout, 2 mA DC max.; operate time, 17.8 ms at 48 VDC; release time, 2 ms. sim to Allied Control Piece No. T154X87
		----------COILS----------
L31 & L32	19A115392-P1	Coil, RF; DC resistance; 0.020 ohm max.; max. DC voltage, 35 V; inductance, 50 µh ±10% at 1kHz
		----------TRANSISTORS----------
Q31 thru Q33	19A115924-P1	Silicon, NPN; sim to Delco Type DTS-413 or Type 2N3902
		----------RESISTORS----------
R31 & R32	3R79-P100J	Composition: 10 ohms ±5%, 2 W.
R33	2R17-P98	Wirewound; 500 ohms ±5%, 50 W.

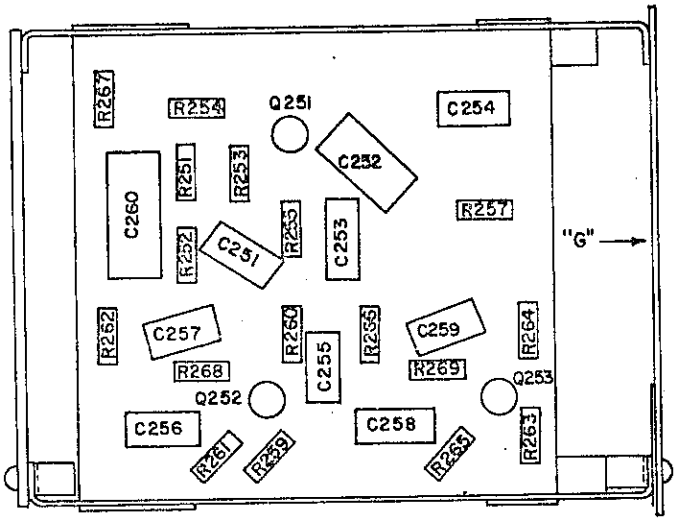


Parts Layout Diagram

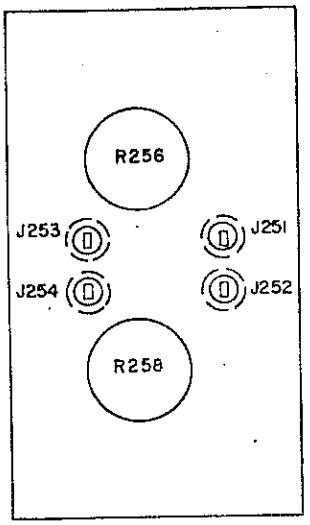
TRANSMITTER-RECEIVER UNIT
PL-19D404770-G5 thru -G8

(19D415430, Sheet 4, Rev. 0)

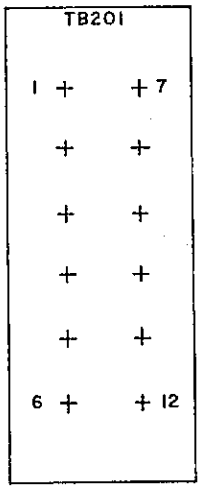


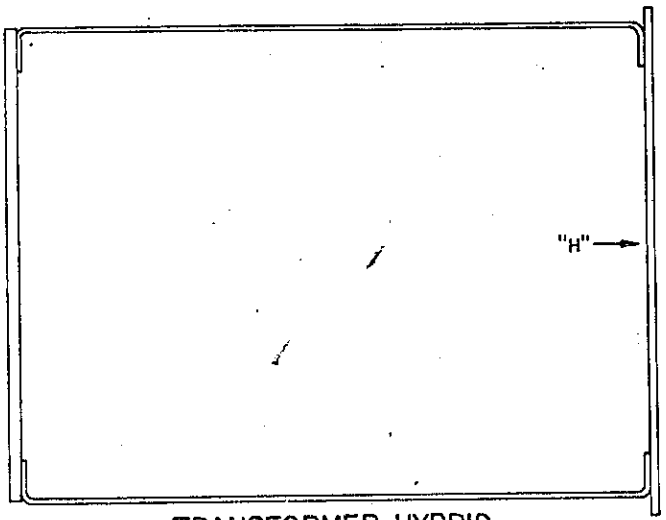


CARRIER RECEIVER
PL-19C318259G1

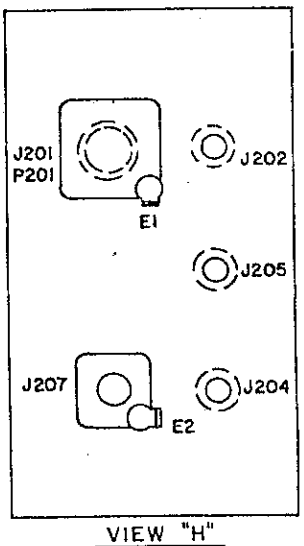


VIEW "G"





TRANSFORMER HYBRID
PL-19C305442G2



VIEW "H"

Parts Layout Diagram

TRANSMITTER-RECEIVER UNIT
PL-19D404770-G5 thru -G8

(19D415430, Sheet 3, Rev. 0)

Symbol	GE Part No.	Description
CR303 & CR304	19A116565-P1	Silicon, rectifier; sim to Sem-Tech Type SC-4 or Type 1N4004
CR305* & CR306*	19A115250-P1	Silicon; fast recovery; sim to GE Type SSD-753 or Type 1N645
CR307	19A116565-P1	Silicon, rectifier; sim to Sem-Tech Type SC-4 or Type 1N4004
		---------- JACKS ----------
J301 & J302	7150763-P8	Test point, sim to Alden 110BC1-orange
J303	7150763-P6	Test point, sim to Alden 110BC1-blue
		----------TRANSISTORS----------
Q301*	19A115300-P1	Silicon, NPN; sim to Type 2N3053
Q302 & Q303	19A115562-P1	Silicon, PNP, switch; sim to Type 2N2800
		----------RESISTORS----------
R301	3R77-P102J	Composition: 1000 ohms ±5%, 1/2 W.
R302*	3R77-P302J	Composition: 3000 ohms ±5%, 1/2 W.
R303	3R77-P822J	Composition: 8200 ohms ±5%, 1/2 W.
R304	3R77-P202J	Composition: 2000 ohms ±5%, 1/2 W.
R305*	3R79-P152J	Composition: 1500 ohms ±5%, 2 W.
R306	3R77-P202J	Composition: 2000 ohms ±5%, 1/2 W.
R307*	3R77-P362J	Composition: 3600 ohms ±5%, 1/2 W.
R308*	3R77-P102J	Composition: 1000 ohms ±5%, 1/2 W.
R309*	3R77-P272J	Composition: 2700 ohms ±5%, 1/2 W.
R311* & R312*	3R79-P152J	Composition: 1500 ohms ±5%, 2 W.
		----------VOLTAGE REGULATOR----------
VR301*	4036887-P5	Silicon, diode, Zener; sim to Hoffman Type HR5.4

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Symbol	GE Part No.	Description
		----------TRANSISTORS----------
Q251 thru Q253	19A115720-P1	Silicon, NPN; sim to RCA-40232 or Type 2N3227
		----------RESISTORS----------
R251	3R77-P563J	Composition: 56,000 ohms ±5%, 1/2 W.
R252	3R77-P163J	Composition: 16,000 ohms ±5%, 1/2 W.
R253	3R77-P122J	Composition: 1200 ohms ±5%, 1/2 W.
R254	3R77-P752J	Composition: 7500 ohms ±5%, 1/2 W.
R255*	3R77-P470J	Composition: 47 ohms ±5%, 1/2 W.
R256	7475398-P112	Variable, composition: 3300 ohms ±20%, 1.13 W; locking; sim to Allen Bradley Type J
R257	3R77-P302J	Composition: 3000 ohms ±5%, 1/2 W.
R258	2R75-P10	Variable, carbon film; 2500 ohms ±20%, 1/2 W; linear taper, screwdriver slot; sim to CTS series 45
R259	3R77-P223J	Composition: 22,000 ohms ±5%, 1/2 W.
R260	3R77-P622J	Composition: 6200 ohms ±5%, 1/2 W.
R261	3R77-P472J	Composition: 4700 ohms ±5%, 1/2 W.
R262	3R77-P202J	Composition: 2000 ohms ±5%, 1/2 W.
R263	3R77-P223J	Composition: 22,000 ohms ±5%, 1/2 W.
R264	3R77-P622J	Composition: 6200 ohms ±5%, 1/2 W.
R265	3R77-P472J	Composition: 4700 ohms ±5%, 1/2 W.
R266	3R77-P202J	Composition: 2000 ohms ±5%, 1/2 W.
R267	3R77-P152J	Composition: 1500 ohms ±5%, 1/2 W.
R268 & R269	3R77-P101J	Composition: 100 ohms ±5%, 1/2 W.

OUTPUT MODULE
PL-19C305847-G1, Rev. A

Symbol	GE Part No.	Description
		----------CAPACITORS----------
C301	7491930-P10	Mylar®; 0.022 µf ±20%, 100 VDCW; sim to GE Type 61F
C302	7491930-P13	Mylar®; 1.0 µf ±20%, 100 VDCW; sim to GE Type 61F
C303	7491930-P11	Mylar®; 0.33 µf ±20%, 100 VDCW; sim to GE Type 61F
		---------- DIODES ----------
CR301* & CR302*	19A115250-P1	Silicon; fast recovery; sim to SSD-753 or Type 1N645

TRANSFORMER HYBRID MODULE
PL-19C305442-G3

Symbol	GE Part No.	Description
		---------- SPARK ARRESTER ----------
E201	19A115751-P2	Telephone protector; sim to Siemans & Halske Code No. B1-F90
		---------- CONNECTORS & JACKS ----------
J201	2R22-P3	Connector, Coaxial; sim to Signal Corps SO-239 or Amphenol 83-1R
J202	7150763-P7	Test point, sim to Alden 110BC1-white
J203 & J204	7150763-P5	Test point, sim to Alden 110BC1-yellow
J205	7150763-P1	Test point, sim to Alden 110BC1-black
J206A & J206B	4029842-P3	Binding post non-captive, black; sim to Superior Elect. Co. Type DF 30 BC
P201	2R22-P1	Connector, Coaxial; sim Signal Corps PL-259 or Amphenol 83-1SP
		----------RESISTORS ----------
R201 thru R204	3R79-P201J	Composition: 200 ohms ±5%, 2 W.
		---------- TRANSFORMERS ----------
T201	PL-19B207380-G1	RF hybrid
T202	PL-19B207381-G1	RF hybrid

CARRIER RECEIVER MODULE
PL-19C318259-G1

Symbol	GE Part No.	Description
		----------CAPACITORS ----------
C251	19B209243-P9	Polyester; 0.22 µf ±20%, 50 VDCW
C252	7491930-P11	Mylar®; 0.33 µf ±20%, 100 VDCW; sim to GE Type 61F
C254 thru C259	19B209243-P9	Polyester; 0.22 µf ±20%, 50 VDCW
C260	7491930-P11	Mylar®; 0.33 µf ±20%, 100 VDCW; sim to GE Type 61F
		----------JACKS----------
J251 thru J253	7150763-P8	Test point, sim to Alden 110BC1-orange
J254	7150763-P2	Test point, sim to Alden 110BC1-red

Symbol	GE Part No.	Description
R162	3R77-P300J	Composition: 30 ohms ±5%, 1/2 W.
R163	3R77-P103J	Composition: 10,000 ohms ±5%, 1/2 W.
R164	3R77-P303J	Composition: 30,000 ohms ±5%, 1/2 W.
R165	2R25-P112	Potentiometer, 5000 ohms ±20%, 1.5 W; linear taper; sim to Allen Bradley Type J, locking
R166	3R77-P203J	Composition: 20,000 ohms ±5%, 1/2 W.
R167	3R77-P331J	Composition: 330 ohms ±5%, 1/2 W.
R168	3R77-P681J	Composition: 680 ohms ±5%, 1/2 W.
R169	3R77-P912J	Composition: 9100 ohms ±5%, 1/2 W.
R170	3R77-P302J	Composition: 3000 ohms ±5%, 1/2 W.
R171	3R77-P510J	Composition: 51 ohms ±5%, 1/2 W.
R172	3R77-P151J	Composition: 150 ohms ±5%, 1/2 W.
R173	3R78-P302J	Composition: 3000 ohms ±5%, 1 W.
R174	3R77-P153J	Composition: 15,000 ohms ±5%, 1/2 W.
R175	3R77-P680J	Composition: 68 ohms ±5%, 1/2 W.
R176	3R77-P472J	Composition: 4700 ohms ±5%, 1/2 W.
R177	3R77-P103J	Composition: 10,000 ohms ±5%, 1/2 W.
R178	3R77-P272J	Composition: 2700 ohms ±5%, 1/2 W.
R179 & R180	3R77-P101J	Composition: 100 ohms ±5%, 1/2 W.
		----------THERMISTOR----------
RT151	5490828-P28	Thermal resistor; 8750 ohms ±5%, 1 W; sim to Globar Type 723-F2

Symbol	GE Part No.	Description
C157	7147203-P1	Silver mica; 510 μμf ±5%, 500 VDCW; sim to Electromotive Type DM 20
C158	19B209370-P1	Polyester; 0.01 μf ±20%, 50 VDCW; sim to TRW Type 601 PE
C159	7489162-P39	Silver mica; 330 μμf ±5%, 500 VDCW; sim to Electromotive Type DM 15
C160 & C161	19B209370-P1	Polyester; 0.01 μf ±20%, 50 VDCW; sim to TRW Type 601 PE
		----------DIODES----------
CR151 thru CR153	19A116565-P1	Silicon, rectifier; sim to Sem-Tech Type SC-4 or Type 1N4004
		----------JACKS----------
J151 thru J153	7150763-P8	Test point, sim to Alden 110BC1-orange
J154*	7150763-P3	Test point, sim to Alden 110BC1-brown
		----------TRANSISTORS----------
Q151*	19A115720-P1	Silicon, NPN; sim to RCA-40232 or Type 2N3227
Q152	19A115300-P1	Silicon, NPN; sim to Type 2N3053
Q153*	19A115720-P1	Silicon, NPN; sim to RCA-40232 or Type 2N3227
Q154	19A115527-P2	Silicon, NPN; sim to RCA-40250
Q155*	19A116504-P1	Field effect, N Type; sim to Type 2N3823
Q156* & Q157*	19A115720-P1	Silicon, NPN; sim to RCA-40232 or Type 2N3227
Q158*	19A115300-P3	Silicon, NPN; sim to Type 2N3053
		---------- RESISTORS ----------
R151	3R77-P153J	Composition: 15,000 ohms ±5%, 1/2 W.
R152	3R77-P302J	Composition: 3000 ohms ±5%, 1/2 W.
R153	3R77-P680J	Composition: 68 ohms ±5%, 1/2 W.
R154	3R79-P302J	Composition: 3000 ohms ±5%, 1/2 W.
R155	3R77-P203J	Composition: 20,000 ohms ±5%, 1/2 W.
R156	3R77-P103J	Composition: 10,000 ohms ±5%, 1/2 W.
R157	3R77-P822J	Composition: 8200 ohms ±5%, 1/2 W.
R158	3R77-P333J	Composition: 33,000 ohms ±5%, 1/2 W.
R159	3R77-P392J	Composition: 3900 ohms ±5%, 1/2 W.
R160	3R77-P433J	Composition: 43,000 ohms ±5%, 1/2 W.
R161	2R25-P92	Potentiometer, 3300 ohms ±20%, 1.5 W; linear taper; sim to Allen Bradley Type J, locking

Symbol	GE Part No.	Description
R104	3R77-P101J	Composition: 100 ohms ±5%, 1/2 W.
R105	3R77-P622J	Composition: 6200 ohms ±5%, 1/2 W.
R106 & R107	3R77-P103J	Composition: 10,000 ohms ±5%, 1/2 W.
R108	3R77-P392J	Composition: 3900 ohms ±5%, 1/2 W.
R109	3R77-P101J	Composition: 100 ohms ±5%, 1/2 W.
R110	3R77-P622J	Composition: 6200 ohms ±5%, 1/2 W.
R111	3R77-P133J	Composition: 13,000 ohms ±5%, 1/2 W.
R112	3R77-P333J	Composition: 33,333 ohms ±5%, 1/2 W.
R113 & R114	3R77-P103J	Composition: 10,000 ohms ±5%, 1/2 W.
R115	3R77-P102J	Composition: 1000 ohms ±5%, 1/2 W.
R116	3R77-P203J	Composition: 20,000 ohms ±5%, 1/2 W.
R117	3R77-P472J	Composition: 4700 ohms ±5%, 1/2 W.
R118	3R78-P302J	Composition: 3000 ohms ±5%, 1 W.
R119	3R77-P102J	Composition: 1000 ohms ±5%, 1/2 W.
R120	3R78-P242J	Composition: 2500 ohms ±5%, 1 W.
		----------TRANSFORMER----------
T101	19B207832-G2	Frequency range, 30 kHz to 250 kHz; primary impedance, 5 k ohms with secondary terminated in 5 k ohms
		----------SOCKET----------
XY101 & XY102	19B201742-P1	Crystal socket; sim to Augat Part No. 8000-AG6-1
		----------CRYSTAL----------
Y101 & Y102	4031095	Quartz, matched pair (A = 2000 kHz, B = 2000 kHz plus channel frequency). Each pair will have same serial number.

DRIVER MODULE
PL-19C305850-G1, Rev. A

Symbol	GE Part No.	Description
		----------CAPACITORS ----------
C151	19B209370-P1	Polyester; 0.01 µf ±20%, 50 VDCW; sim to TRW Type 601 PE
C152	19B209370-P9	Polyester; 0.33 µf ±20%, 50 VDCW; sim to TRW Type 601 PE
C153	19B209370-P1	Polyester; 0.01 µf ±20%, 50 VDCW; sim to TRW Type 601 PE
C154 thru C156	19B209370-P9	Polyester; 0.33 µf ±20%, 50 VDCW; sim to TRW Type 601 PE

Symbol	GE Part No.	Description
C103	7489162-P27	Silver mica; 100 μμf ±5%, 500 VDCW; sim to Electromotive Type DM-15
C104	7147203-P12	Silver mica; 1500 μμf ±5%, 500 VDCW; sim to Electromotive Type DM-20
C105	7147203-P1	Silver mica; 510 μμf ±5%, 500 VDCW; sim to Electromotive Type DM-20
C106	5491189-P5	Mylar®; 0.068 μf ±20%, 50 VDCW; sim to Good-All Type 601 PE
C107 & C108	7591189-P9	Mylar®; 0.33 μf ±20%, 50 VDCW; sim to Good-All Type 601 PE
C109	7147203-P12	Silver mica; 1500 μμf ±5%, 500 VDCW; sim to Electromotive Type DM-20
C110	7489162-P27	Silver mica; 100 μμf ±5%, 500 VDCW; sim to Electromotive Type DM-15
C111	5491189-P5	Mylar®; 0.068 μf ±20%, 50 VDCW; sim to Good-All Type 601 PE
C112	7491930-P9	Mylar®; 0.1 μf ±20%, 100 VDCW; sim to GE Type 61 F
C113	7491930-P11	Mylar®; 0.33 μf ±20%, 100 VDCW; sim to GE Type 61 F
C114	7491930-P7	Mylar®; 0.033 μf ±20%, 100 VDCW; sim to GE Type 61 F
C115 & C116	7489162-P27	Silver mica; 100 μμf ±5%, 500 VDCW; sim to Electromotive Type DM-15
C117 & C118	7491930-P2	Mylar®; 0.0022 μf ±20%, 100 VDCW; sim to GE Type 61 F
		----------DIODES----------
CR101	19A116565-P1	Silicon, rectifier; sim to Sem-Tech Type SC-4 or Type 1N4004
		----------JACKS----------
J101 thru	7150763-P8	Test point, sim to Alden 110BC1-orange
		----------COIL----------
L101	7491382-P109	RF; 2500 μh ±10%; DC resistance, max. 35 ohms; sim to Delevan Co. 3500 series
		---------- TRANSISTORS ----------
Q101 thru Q103	19C300114-P3	Silicon, NPN; sim to Type 2N706
Q104	19A115300-P1	Silicon, NPN; sim to Type 2N3053
		----------RESISTORS----------
R101 & R102	3R77-P103J	Composition: 10,000 ohms ±5%, 1/2 W.
R103	3R77-P392J	Composition: 3900 ohms ±5%, 1/2 W.

Symbol	GE Part No.	Description
R35	2R14-P27	Wirewound; 400 ohms ±5%, 25 W.
R36	2R14-P31	Wirewound; 1000 ohms ±5%, 25 W.
R37	7478711-P37	Wirewound; 4000 ohms ±5%, 5 W.
R40	2R14-P36	Wirewound; 3100 ohms ±5%, 25 W.
R41 & R42	3R77-P301J	Composition: 300 ohms ±5%, 1/2 W.
R43 & R44	19B209022-P22	Wirewound; 1.2 ohms ±5% 2 W.
R45	2R17-P87	Wirewound; 40 ohms ±5%, 50 W.
R46	7478711-P37	Wirewound; 4000 ohms ±5%, 7 W.
R47	2R14-P30	Wirewound; 800 ohms ±5%, 25 W.
R48	3R79-P271J	Composition; 270 ohms ±5%, 2 W.
R52	2R14-P32	Wirewound; 1200 ohms ±5%, 25 W.
		----------SWITCHES----------
S31	5492177-P2	Toggle, DPST; 6A, 250 V, 12A, 125 V; sim to Arrow-Hart and Hedgeman Cat. No. 82143-VSL
S32	7107835-P11	Push; non-locking; sim to P.R. Mallory Cat. No. 2006
		----------TRANSFORMERS----------
T33	PL-19B207872-G4	Input impedance, 400 ohms; output impedance 100 ohms; max. input signal, +15 dBm; insertion loss, less than 0.5 dB
		----------VOLTAGE REGULATOR----------
VR31	4037398-P3	Silicon, Zener diode, sim Type 1N1824B
VR32	4038569-P3	Silicon, Zener diode; sim Type 1N1825A
		----------SOCKETS----------
XF31 & XF32	19B209265-P2	Fuseholder; 20A, 250 V; sim to Littelfuse Cat. No. 342025
X132	7141855-P15	Indicator, incandescent light; Dialight Co. Piece No. 95-0410-09-102. Lens; GE Part No. 19A115040-P8, white color, plain finish; sim to Dialight Cat. No. 81-435
XK31 & XK32	5491595-P4	Relay socket and ground wire; sim to Allied Control Co. Cat. No. 30054-1

OSCILLATOR KEYING MODULE
PL-19C305448-G1

Symbol	GE Part No.	Description
		----------CAPACITORS----------
C101 & C102	5491554-P4	Variable, air; 3.2 μμf min to 50.0 μμf max; tolerance, min. ±10%, -25%; max. +15%, -5%; 600 VDCW; sim to Hammarlund Type MAPC-50

TRANSMITTER-RECEIVER UNIT
PL-19D404770-G5

This list includes all principal replacement parts. The symbol numbers used are the same as those appearing on Elementary and other 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- or PL- number of the unit. When reordering crystals and filters, also please include the frequency. Orders may be sent to the nearest General Electric Apparatus Sales Division District Office, or direct to Service Parts, Telecommunication Products Department, General Electric Company, Lynchburg, Virginia 24502.

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

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

Symbol	GE Part No.	Description
		----------ATTENUATOR----------
AT31	7772843-P4	Variable, audio, T-pad; 50 ohms impedance; sim to Mallory Type T50
		----------CAPACITORS----------
C31	7491930-P13	Mylar®; 1.0 µf ±20%, 100 VDCW; sim to GE 61F
C32	7774786-P16	Electrolytic; 50 µf -10%, +100%, 150 VDCW; sim to P.R. Mallory TC49
C33 & C34	3R88-P10	Fixed paper, Pyranol; 1 µf ±10%, 1500 VDCW; sim to GE 23F955
C35	7772471-P19	Electrolytic; 200 µf, -10%, +100%, 350 VDCW; sim to P.R. Mallory Type FP
C36	7774786-P24	Electrolytic; 20 µf, -10%, +100%, 250 VDCW; sim to P.R. Mallory TC55
C37 & C38	7489162-P35	Silver mica; 220 µµf ±5%, 500 VDCW; sim to Electromotive Type DM-15
C39	5491656-P39	Polyester, 1.0 µf, -10%, +30%; 600 VDCW; sim to GE Type 61F
		----------DIODES----------
CR31 thru CR36	19A116565-P1	Silicon, rectifier; sim to Sem-Tech Type SC-4 or Type 1N4004
		----------FUSES----------
F31 & F32	1R16-P8	Cartridge, quick-blowing; 5A; sim to Littelfuse Cat. No. 312005 or Bussmann Cat. No. MTH5
		---------- FILTERS----------
FL35	PL-19C304694	Transmitter filter (200/1200 ohms). State specific frequency required.

D. The output voltage, measured across terminals 6 and 7, must be greater than 0.020 V (-32 dBm).

E. An alternative method can be used to test the transmitter output filter while the filter is installed in the Type CS-26B equipment by following these steps.

(a) Turn the transmitter ON at full power. Do not set R165 to produce more than 10-Watts output into a 50-ohm load.

(b) With an ungrounded VTVM, measure the output voltage of the filter (terminal 7 to terminal 6) and note the dB reading corresponding to this output voltage.

(c) With the same ungrounded VTVM, measure the input voltage (terminal 1 to terminal 5 for 125 V battery or terminal 2 to terminal 4 for 48 V battery) and note the dB reading corresponding to the input voltage.

(d) The dB reading noted in "c" above should be greater than that noted in "b" above.

(e) Subtract the two dB readings. The difference should not be greater than 16 dB for 125 V battery or 8 dB for 48 V battery.

(f) If the difference noted is less than that given in "e", the filter should be considered to be in proper working condition. If the difference noted is greater than that given in "e" above, the filter should be considered defective and should be replaced.

Receiver Filter Check

A. Remove receiver input filter and check filter for excessive loss at the channel frequency. Use setup and input voltage shown in section below. If filter is operating properly, reinstall it. If not, call your nearest GE Installation and Service Engineering Representative. Do not attempt to repair filter.

B. Using a 600 ohm internal impedance signal generator, connect receiver filter into the circuit shown in Figure 4. Be sure that carbon resistors only are used, as the coils in wire-wound resistors introduce an inductive voltage and the readings will be incorrect.

C. Set the frequency of the signal generator to the center frequency of the filter. Set the output of the signal generator, measured across points A and B as shown in the diagram, Figure 4, at 0.24 V (-10 dBm) (1 mv, 600 ohms reference).

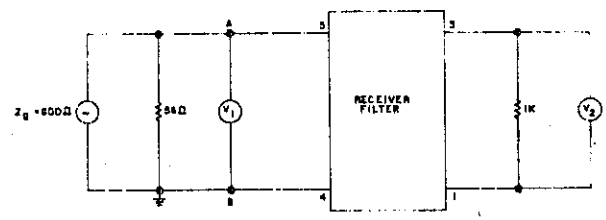

Figure 4 - Circuit for Testing Receiver Filter

D. (a) If the frequency of the filter is from 30 kHz to 99 kHz, the output voltage, measured across terminals 1 and 3, must be greater than 0.39 V (-6 dBm).

(b) If the frequency of the filter is from 100 kHz to 250 kHz, the output voltage, measured across terminals 1 and 3, must be greater than 0.218 V (-11 dBm).

TELECOMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

Printed in U.S.A.

Symptom	Probable Cause
	6. Defective filter.
	7. Defective hybrid.
	8. Defective transistors.
2. Transmitter keyed on continuously	1. Loose, shorted or open connections.
	2. Diode CR153 shorted.
	3. Carrier start contacts will not close.
	4. Carrier test switch open.
	5. Transistor Q152 defective.
3. Receiver outputs will not drop out	1. Loose, shorted or open connections.
	2. Transistors Q301, Q302, or Q303 defective.
	3. Transistor Q33 defective.
4. No receiver outputs	1. Loose, open or shorted connections.
	2. Defective filter.
	3. Diode CR302 shorted.
	4. Transistor Q33 defective.
	5. Diode CR301 open.
	6. Transistors Q251, Q253, Q301, Q302, or Q303 defective.
5. Reserve signal meter will not function	1. Loose, shorted or open connections.
	2. Defective diode CR303 or CR304.
	3. Defective receiver filter.
	4. Defective transistors Q251 or Q252.

Transmitter Filter Check

A. Remove transmitter output filter and check filter for excessive loss at the channel frequency. Use setup and input voltage shown in section on the following page. If filter is operating properly, reinstall it. If not, call your nearest GE Installation and Service Representative. Do not attempt to repair filters.

B. Using a signal generator whose internal impedance is 600 ohms, connect transmitter output filter into the circuit shown in Figure 3. Be sure that carbon resistors only are used, as the coils in wirewound resistors introduce an inductive voltage and the readings will be incorrect.

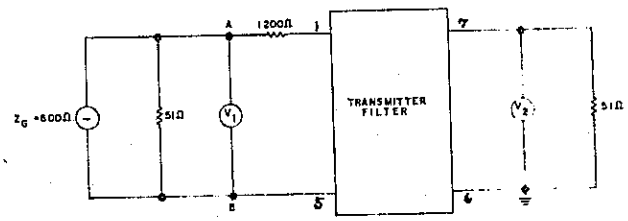

Figure 3 - Circuit for Testing Transmitter Filter

C. Set the frequency of the signal generator to the center frequency of the filter. Set the output of the signal generator, measured across points A and B as shown in the diagram at 0.24 V (-10 dBm) (1 mw, 600 ohms reference).

No attempt should be made to repair the filters. New ones should be ordered from the General Electric Company.

A module mounting bracket and extension cable assembly is furnished with each unit as part of the accessory kit. This is only to be used when it is desired to check a module while it is operating as part of the total circuit.

A module mounting bracket can be bolted to the rack frame at a convenient working height -- though in some cases its location may depend upon the cable length.

The module is removed from the chassis frame by taking out its four corner screws (see Figure 2) and removing the wires connected to the terminal board on the rear of the module.

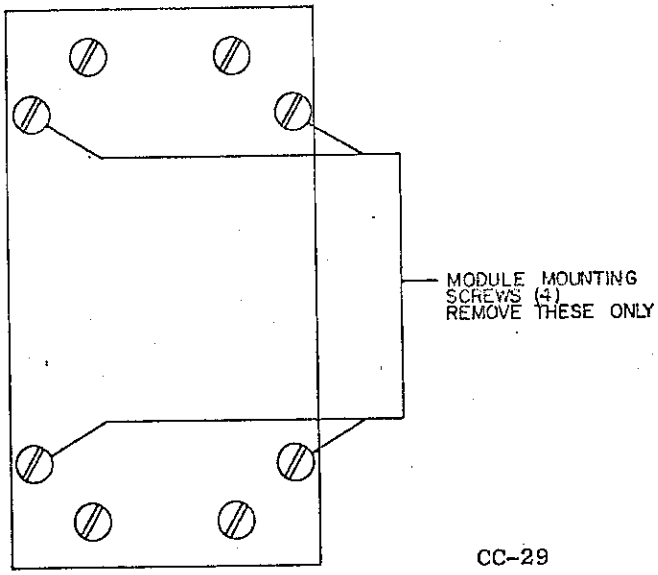

Figure 2 - Module Front Panel

To work on the components within the module, one side plate or cover must be removed. To determine which side, examine the narrow edge and locate the position of the slots which hold the component mounting boards in place. The plate to remove will be that one above the maximum free space. Remove the four screws holding this plate, thus exposing the mounted components.

Now, turn the module so that the exposed components face you and slip it into the mounting bracket. Secure it in place with two screws.

Note that the front jack plate and rear terminal board appear upside down. This is the correct orientation when using the mounting bracket.

Examine the extension cable assembly. This cable assembly consists of a bundle of twelve wires terminated at one end into twelve numbered terminal board.

The numbered spade lug leads match the module terminal board numbers and are thus connected to the terminal board on the module held in the mounting bracket.

The terminal board at the opposite end of the cable extension assembly is then connected to the unit leads previously connected directly to the module terminal board, using the matched numbers as a guide.

Make sure that the numbered connections match and are correct before applying power.

If a wire-wrapping air gun is available, replacement of components is easily made and the danger of solder splash, cold joints and overheating are eliminated.

TROUBLE-SHOOTING GUIDES

The first step, if trouble occurs, is to take measurements at the test jacks and compare them with the typical jack readings given on the Elementary-Interconnection Diagram, and a similar list which should have been prepared when the equipment was installed and operating correctly. These measurements, along with the following list of possible causes for the more probable symptoms, should aid in localizing the problem.

Symptom	Probable Cause
1. No transmitter output	1. Reduced supply voltage to transmitter-receiver or no supply voltage to transmitter-receiver.
	2. Loose connections on TB101, TB151, PA components or filter.
	3. Open connections TB101-7 to TB151-1, TB151-12 to T31.
	4. Carrier stop contacts are closed.
	5. Loose crystals in socket.

to less than full scale. This is to take into account the additional attenuation and to prevent "pegging" of the meter.

4. The meter may now be calibrated. Turn the Receiver Input Attenuator, in equal dB steps, in the counterclockwise direction. At each step record the meter scale reading and the total dB change on the Input Attenuator. When finished, return the Input Attenuator to its original scale setting.

5. It will be noticed that the meter response tends to be non-linear in the area of full scale deflection. Also at 15 dB attenuation, the meter reading approaches zero.

Reduced Power Output

The Reduced Power Level (for carrier test) is adjusted as follows:

1. Place the externally connected test switch (TS or, sometimes CTS) in the RS position.

2. Adjust R161, Reduced RF Out Adjust, for the desired reduced transmitter output level. This is measured with a VTVM at J202 and J205, or with an RF milliammeter at J206.

Other Adjustments

At times, it may become necessary to make other adjustments to the unit. If a basic change is made, such as in channel frequency, the Installation Adjustments given above should be made after completion of those which follow.

Transmitter Frequency

To initially adjust the transmitter frequency, set the screwdriver slots of capacitors C101 and C102, on the Oscillator Keying Module, to a horizontal orientation.

Apply operating power. Adjust C101 or C102 or both, as explained below, until the operating frequency is within ±5 Hz of the desired frequency.

1. To increase the channel frequency, lower the frequency of oscillation of Q101 by increasing the capacitance of C101 or increase the frequency of oscillation of Q102 by decreasing the capacitance of C102.

2. To decrease the channel frequency raise the frequency of oscillation of Q101 by decreasing the capacitance of C101 or decrease the frequency of oscillation of Q102 by increasing the capacitance of C102.

Transmitter Output Level

The transmitter normal output level is adjusted by means of the RF Gain Control, R165. This level should be adjusted for a maximum of 10-Watts into a 50 ohm load. If this level is exceeded, it will cause overloading of the transmitter output filter, with possible damage resulting.

The output current or current into the transmitter load is measured by inserting a suitable RF ammeter, such as the one used in GE Meter Analyzer Unit, Type 4CX5A, into the double plug just below J201 and removing the connecting link between the double plug terminals. The double plug is denoted as J206A and J206B on the elementary drawing. The output voltage or the voltage across the transmitter load is measured from either terminal on the double plug and the transmitter ground or chassis.

The rated 10 Watts output at 50 ohms (resistive) is approximately 0.45 ampere or, in terms of voltage, approximately 22-1/2 volts.

Receiver Sensitivity

The receiver is set for 0.125-Volt sensitivity. The procedure for setting the receiver at this sensitivity is as follows, if readjustment should become necessary.

1. Set the Input Attenuator Control at the minimum attenuation position (full clockwise).

2. Connect a signal generator, at channel frequency and a VTVM between the center conductor of J201 and ground. Adjust the output of the signal generator to 0.125 Volt.

3. Connect the 10 VDC meter scale of the Meter Analyzer Unit to TB301-2 (NEG) and TB301-7 (POS).

4. With a screwdriver, adjust the Receiver Gain Control for the "knee" (point "D") of the receiver output voltage curve. Refer to Figure 1.

MAINTENANCE

Preventive

Each customer should prepare a tabulation of jack reading for his particular unit after it has been installed and adjusted for his requirements. This list should be similar to those typical readings given in the tabulation shown on the elementary diagram. This will allow him to quickly spot any abnormal changes in the operating circuits if trouble develops.

Corrective

Modular and plug-in components have been used so that replacements or repairs can be quickly and easily made.

DESCRIPTION

MODULATOR UNIT
PL-19C318286-G1 and -G2

INTRODUCTION

Modulator Unit PL-19C318286-G1 and -G3 are designed for use with both Type CS-26-B and Type CS-27-B Carrier Current Relaying Equipment.

The unit is used to provide emergency and maintenance telephone communications over the frequency range of 30-250 kHz. (Voice filter FL71 (in -G1) or FL72 (in -G2) must be changed when it is desired to change the operating frequency from that which was originally specified. Refer to the General Electric Co.). Amplitude modulation is employed and a single-frequency simplex, push-to-talk type telephone is provided over a 3-wire DC extension. An extra pair of wires is used for the alarm circuit.

CIRCUIT DESCRIPTION-VOICE OPERATION

GENERAL

Modulation Section

When the push-to-talk button on the telephone handset is depressed, relay K71 picks up. This applies + 33 VDC to terminal TB151-9 on the Driver Module in the Transmitter-Receiver Unit to allow the amplifier in that module to turn ON and amplify the RF signal. It also applies a DC bias, by way of terminal TB151-10, to the gate of transistor Q155 in the Driver Module. This causes Q155, a field effect transistor, to conduct slightly, thereby shunting off part of the RF signal from the Oscillator-Keying Module, in the Transmitter-Receiver Unit, and causing a reduction in the transmitter output. The transmitter output level during modulation is set by adjustment of the "RF Level" control, R75.

The audio from the handset microphone is applied to R74, "Modulation Adjust". It is then coupled by capacitor C72 to the gate of Q155, at TB151-10, in the Driver Module. The conduction of Q155 varies at the audio rate to shunt off more or less RF signal, thus causing modulation of the RF signal. Adjustment of R74 varies the percentage of modulation.

Demodulation Section

The signal enters the Demodulator Subassembly, through filter FL71 or FL72, to amplifier transistor Q401. Demodulation is accomplished by diode CR401 which acts as a signal detector. The RF portion of the signal is bypassed to ground through capacitor C402. The audio portion of the signal is coupled through capacitor C403 to a 2-stage audio amplifier, consisting of transistors Q402 and Q403 and their associated components, whose output is connected to the telephone receiver. Transformer T401 is used to isolate the RF components from the detector circuits.

Receive Level potentiometer R401 is used to adjust the telephone receive level to suit the user.

Alarm Circuit

The alarm bell circuit is in series with contacts of J72 and the bell circuit is opened when the telephone plug is inserted. The plug should, therefore, be removed from the jack upon completion of the conversation to restore the bell circuit so that other calls may be signaled.

A 3-wire extension telephone with another pair of wires used for the alarm circuit may be wired to perform the same function as a handset plugged into J72.

Operation of Voice Station

1. Plug the handset into the telephone jack.
2. Press the push-to-talk switch on the handset several times to signal the remote operator; then release the switch.
3. When the remote operator answers, conversation can begin.
4. Press the push-to-talk switch when talking; release the switch when listening.
5. Since only one person at a time can talk, do not try to interrupt while the other person is talking.
6. When the conversation is finished, remove the telephone plug from the jack.

If a test telephone hookswitch is employed to hold the telephone during periods of non-use, the hookswitch contacts effectively disconnect the telephone when it is hung up. Consequently, it is not necessary to plug the handset.

ADJUSTMENT

The modulator has been adjusted at the factory for approximately 30 percent

modulation with 14 V RMS RF output. These values may be changed by means of the front panel controls, R74 and R75.

Observe the transmitter RF output on an oscilloscope, and speak into the telephone handset at normal speaking level. Adjust R74 until both the peaks and the valleys of the modulated RF waveform are clipped. Adjust R75 so that the peaks and valleys are clipped the same amount. Reduce the percentage of modulation with R74 until no clipping of the waveform is observed. This procedure will result in the maximum modulation with the least distortion.

The maximum percentage of modulation attainable is dependent upon channel frequency and increases as the channel frequency is increased.

TABLE 1

TYPICAL DC VOLTAGE		
	J401 (Emit Q401)	J402 (Emit Q402)
Standby	1.25	28.0
Receive	1.25	28.0

PARTS LIST

MODULATOR UNIT
PL-19C318286-G1 and -G2

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - - CAPACITORS - - - - - - - - - - - - - -
C71	7491930-P13	Mylar ®: 1.0 µf ±20%, 100 VDCW; sim to GE Type 61F
C72	5491656-P44	Polyester: 2.2 µf +20% -0%, 200 VDCW; sim to GE Type 61F
		- - - - - - - - - - - - - - - - DIODES - - - - - - - - - - - -
CR71	4037822-P1	Silicon, rectifier: sim to Sem-Tech Type SC4
		- - - - - - - - - - - - - - - FILTER - - - - - - - - - - - - -
FL71	PL-19C304052	Voice, used in -G1 only
FL72*	PL-19C304741	Voice, used in -G2 only
		- - - - - - - - - - - CONNECTORS AND JACKS - - - - - - - - - -
J71	7775345-P42	16-contact; sim to Elco Corp. Cat. No. 01-2216-121-004-100
J72	4029578-P1	Telephone, lone frame type; sim to Mallory Cat. No. 6
P71	7775345-P41	16-contacts; sim to Elco Corp. Cat. No. 01-4216-104-001-100
		- - - - - - - - - - - - - - RELAY - - - - - - - - - - - - - - -
K71*	5495776-P28	Armature: coil resistance, 300 ohms ±10%; pick up, 33 mA max; drop out, 8 mA min; operate time, 10 ms at 28 VDC; release time, 95 ms at CVDC; sim to Auto. Elect. PG24099-L14
		- - - - - - - - - - - - - - RESISTORS - - - - - - - - - - - - -
R71	3R77-P153J	Fixed composition: 15,000 ohms ±5%, 1/2 W
R72	3R79-P102J	Fixed composition: 1000 ohms ±5%, 2 W
R73	2R12-P35	Wirewound: 2500 ohms ±5%, 10 W
R74	2R25-P91	Potentiometer, composition: 2200 ohms ±20%, linear taper, locking type 1.5 W; sim to Allen Bradley Type J
R75	7475398-P96	Variable, composition: 15,000 ohms ±20%, 1.13 W, locking type, non-linear tape (A), sim to Allen Bradley Type J

DEMODULATOR SUBASSEMBLY
PL-19C305806-G1

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - - CAPACITORS - - - - - - - - - - - - - -
C401	5491189-P9	Mylar®: 0.33 µf ±20%, 50 VDCW; sim to Good-All Type 601PE
C402	5491189-P8	Mylar®: 0.22 µf ±20%, 50 VDCW; sim to Good-All Type 601PE
C403	5496267-P18	Tantalum: 6.8 µf ±20%, 35 VDCW; sim to Sprague Type 150D
C404	7489483-P25	Electrolytic: 50 µf -10%, +75%, 50 VDCW; sim to Sprague Type 30D
C405	5491189-P8	Mylar®: 0.22 µf ±20%, 50 VDCW; sim to Good-All Type 601PE
C406 & C407	5496267-P15	Tantalum: 47 µf ±20%, 35 VDCW; sim to Sprague Type 150D
C408	5496267-P18	Tantalum: 6.8 µf ±20%, 35 VDCW; sim to Sprague Type 150D
		- - - - - - - - - - - - - - DIODES - - - - - - - - - - - - - -
CR401	19A115250-P1	Silicon, fast recovery; sim to Type SSD-753
		- - - - - - - - - - - - - - JACKS - - - - - - - - - - - - - -
J401 & J402	7150763-P3	Test point, stake-in; sim to Alden 110BC1-brown
		- - - - - - - - - - - - - - TRANSISTORS - - - - - - - - - - - -
Q401	19A115300-P1	Silicon, NPN; sim to Type 2N3053
Q402	19A115562-P1	Silicon, PNP, switch; sim to Type 2N2800
Q403	19A115910-P1	Silicon, NPN; sim to Type 2N3904
		- - - - - - - - - - - - - - RESISTORS - - - - - - - - - - - - - -
R401	2R25-P91	Potentiometer, composition; 470K ohms, ±20%, linear taper; 1.5 W.; sim to Bradley Type J
R402	3R77-P393J	Fixed composition: 39K ohms ±5%, 1/2 W
R403	3R77-P272J	Fixed composition: 2700 ohms ±5%, 1/2 W
R404	3R77-P301J	Fixed composition: 300 ohms ±5%, 1/2 W
R405	3R77-P304J	Fixed composition: 300K ohms ±5%, 1/2 W
R406	3R77-P512J	Fixed composition: 5100 ohms ±5%, 1/2 W
R407	3R77-P433J	Fixed composition: 43K ohms ±5%, 1/2 W
R408	3R77-P512J	Fixed composition: 5100 ohms ±5%, 1/2 W
R409	3R77-P103J	Fixed composition: 10K ohms ±5%, 1/2 W
R410	3R77-P330J	Fixed composition: 33 ohms ±5%, 1/2 W
R411	3R77-P102J	Fixed composition: 1000 ohms ±5%, 1/2 W
R412	3R77-P512J	Fixed composition: 5100 ohms ±5%, 1/2 W
R413	3R77-P433J	Fixed composition: 43K ohms ±5%, 1/2 W
R414	3R77-P512J	Fixed composition: 5100 ohms ±5%, 1/2 W

Symbol	GE Part No.	Description
		- - - - - - - - - - - - - RESISTORS (Cont'd) - - - - - - - - - - -
R415	3R77-P201J	Fixed composition: 200 ohms ±5%, 1/2 W
R416	3R77-P821J	Fixed composition: 820 ohms ±5%, 1/2 W
		- - - - - - - - - - - - - - TRANSFORMER - - - - - - - - - - - -
T401	19B207832-G3	Primary Z, 5K ohms with secondary terminated in 150 ohms. Max. input level, +5 dBm with 0.5 ma DC in primary.

TELECOMMUNICATION PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
LYNCHBURG, VIRGINIA 24502

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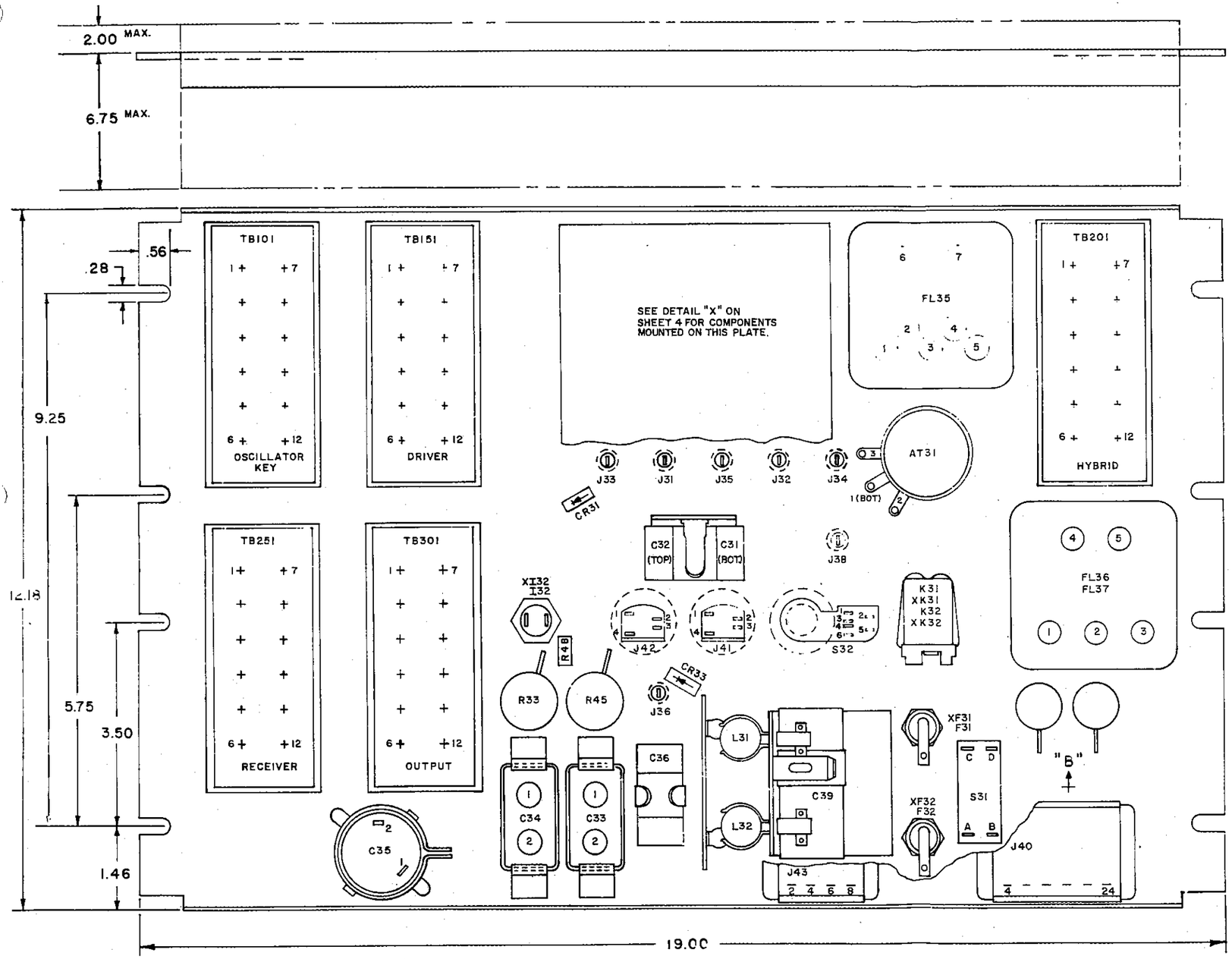

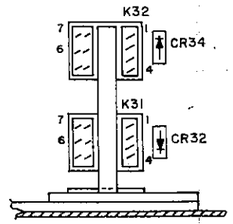

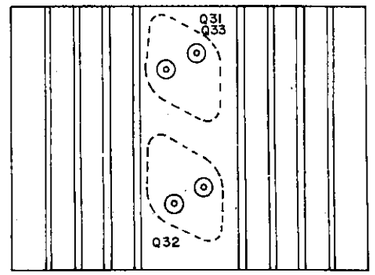

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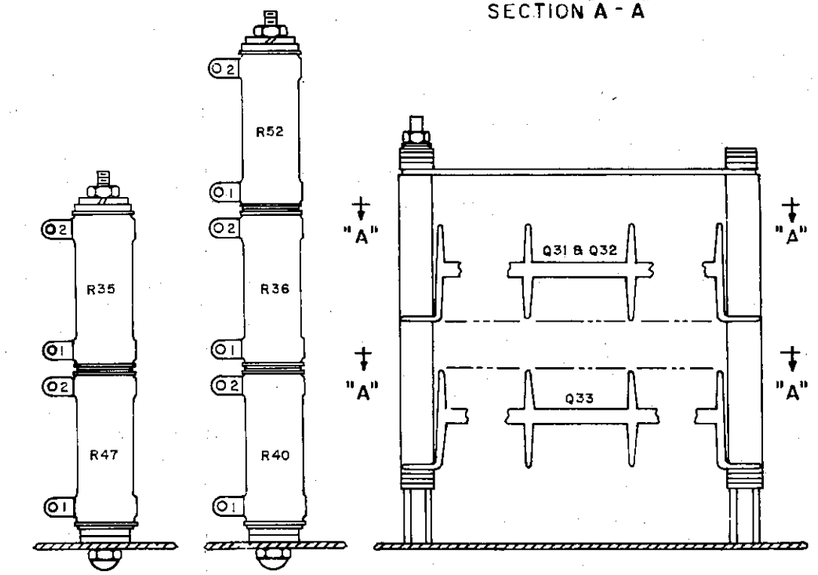
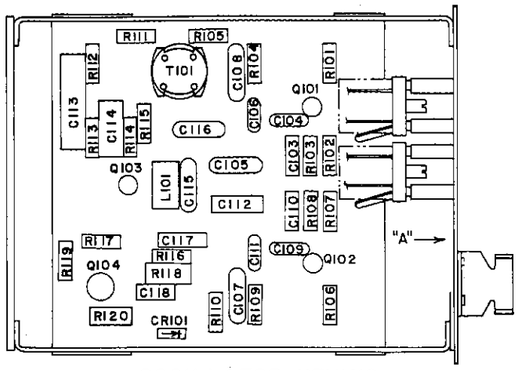


VIEW AT "B"

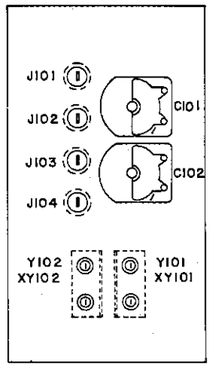
Parts Layout Diagram

TRANSMITTER-RECEIVER UNIT
PL-19D404770-G5 thru -G8

(19D415430, Sheet 1, Rev. 0)



OSCILLATOR KEYING
PL-19C305448G1



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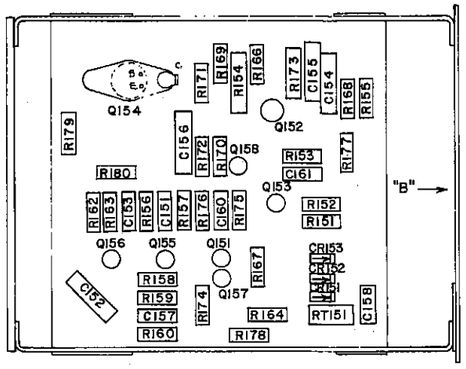
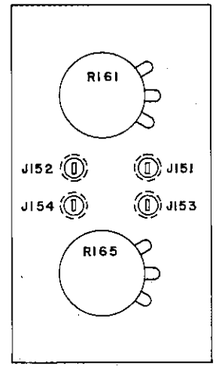


DRIVER
PL-19C305850G1 REV A.



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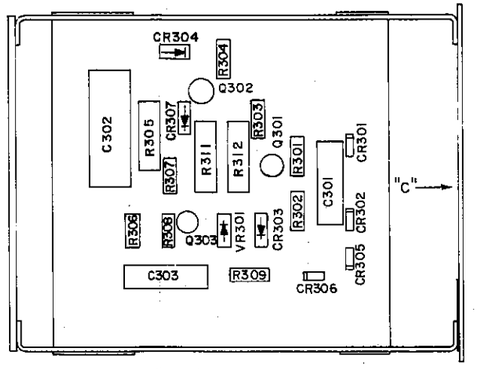
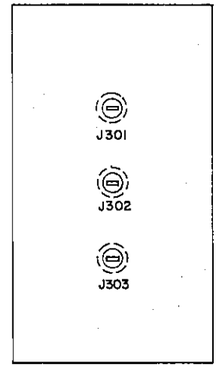


OUTPUT UNIT
PL-19C305847 G1 REV.A



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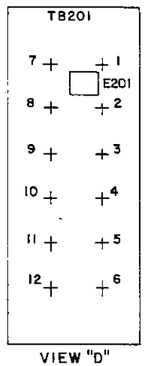

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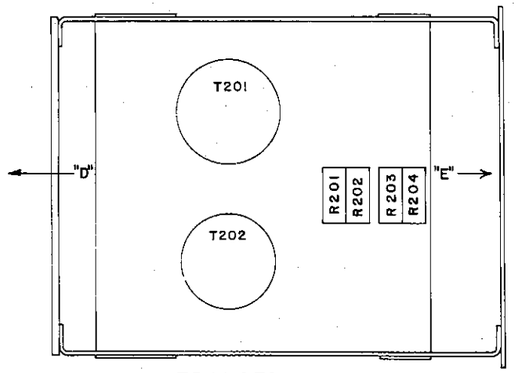
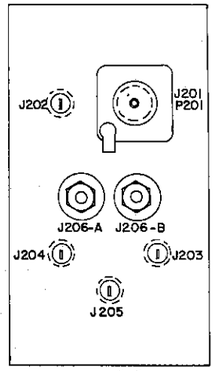


TRANSFORMER HYBRID
PL-19C305442 G1



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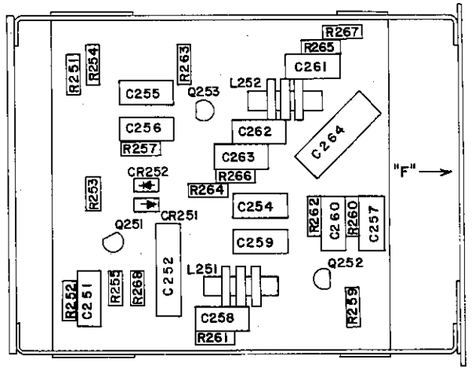
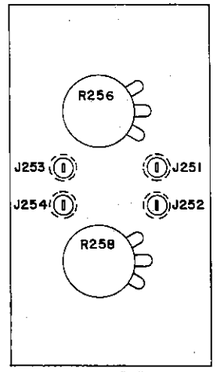


CARRIER RECEIVER
PL-19C305483G1



VIEW "F"

Parts Layout Diagram

TRANSMITTER-RECEIVER UNIT
PL-19D404770-G5 thru -G8

(19D415430, Sheet 2, Rev. 1)