INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

RESERVE SIGNAL DETECTOR FOR TC AND KR CARRIER

Description	Style
Panel mounted for 48 or 125 volt D.C. KR or TC Carrier	470D167G02
Panel mounted for 250 volt D.C. TC Carrier only	470D167G03
Rack mounted for 48 or 125 volt D.C. KR or TC Carrier	408C484G01
Rack mounted for 250 volt D.C. TC Carrier only	408C484G03

APPLICATION

The reserve signal detector is a device used to detect changes in received signal level on a power-line carrier channel. The relaying receiver output current is saturated at normal received signal levels. Thus, even a substantial reduction in the received signal may not give a corresponding drop in receiver output current. The reserve signal detector makes it possible to detect such changes in signal level before the signal drops to a low enough value to cause an incorrect relay operation.

CONSTRUCTION

The reserve signal detector is available in two different mechanical designs; one for switchboard mounting, and one for rack mounting (19" panel). The unit for switchboard mounting is shown in Figure 1 which includes outline dimensions and schematic wiring. Figure 2 shows the outline of the rack-mounting unit, and Figure 3 is the internal schematic for this design. Electrically both units consist of a fixed resistor, a variable resistor, and a normally open pushbutton connected in series.

OPERATION

The resistors and pushbutton of the reserve signal detector are connected into the transmitter carrier-start circuit, effectively functioning as a separate transmitter output control. This control is obtained by varying the d-c voltage to the amplifier stage following the crystal oscillator in either the KR or TC transmitter. With the TC set, the output will not drop appreciably until sufficient resistance has been inserted to drop the voltage across zener diode CR101 below its 20-volt breakdown. The adjustable resistor is effective over a 25-db range of transmitter output. If a fault occurs while a reserve signal test is being made (with reduced transmitter output), operation of any carrier-start protective relay will instantly restore full output as long as required for the relaying function. The connections of the reserve signal detector into the carrier-start circuit are shown on the overall schematic which applies to a particular order.

ADJUSTMENT

Because of differences in transmitter output, supply voltage, and service conditions, it is not practical to have a calibrated dial for this unit. However, calibration may be made at installation by recording output (either db or volts) at various knob settings of R1. Then, by depressing pushbutton S1 and adjusting the R1 dial so as to obtain one-half the normal saturated receiver output current (on a clear dry day), any increase in line attenuation at a later time may be noted as the difference between the original setting, and that required to obtain the one-half maximum receiver output current at the time of checking. The normal procedure for this test is to start with the knob full counterclockwise, and rotate slowly until the remote receiver output drops to half its maximum value.

NOTE: The nominal "one-half maximum" value for the TC set is 100 ma, and for the KR set, 10 ma. Since these values are half way up a steep curve, it may be rather difficult to adjust to exactly 10 or 100 ma. If the receiver output current is within ± 20 per cent of the nominal 10 or 100 ma figure, any attenuation figures will be correct within one db.

If communication between stations on a line section makes the foregoing periodic adjustment procedure inconvenient, there is a second method of us-

SUPERSEDES I.L. 41-944.6F, dated May 1972
✪ Denotes change from superseded issue.
Also supersedes Addendum, dated August 1976

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ing the reserve signal detector. First, set the receiver sensitivity to the desired margin for deterioration of signal. Depending on power company standards, this will usually be somewhere between 6 and 15 db. Now on a clear dry day, close S1 and increase R1 setting until the remote receiver output current drops 20 per cent. Leave the control at this point. At another time when a reserve signal test is to be made, it is necessary only to close the S1 pushbutton and have the remote operator note the receiver output current. If it does not drop more than 20 per cent or so, the desirable receiver margin still exists. If the receiver output drops to a low value or to zero, it indicates that the original margin no longer exists. This could mean increased line loss, reduced transmitter output, reduced receiver sensitivity, or a combination of these factors.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, replacement parts can be furnished, in most cases, to customers who are equiped for doing repair work. When ordering parts, always give the complete nameplate data as well as the part identification as given in the Parts List.

PARTS LIST

Symbol	Description	Style
R1	200-K Pot.	185A086H27
R1	200-K Pot.	185A067H14
R2	2000-ohm resistor	1267296
	8000-ohm resistor	1205219
S1	Pushbutton Switch	879A860H01

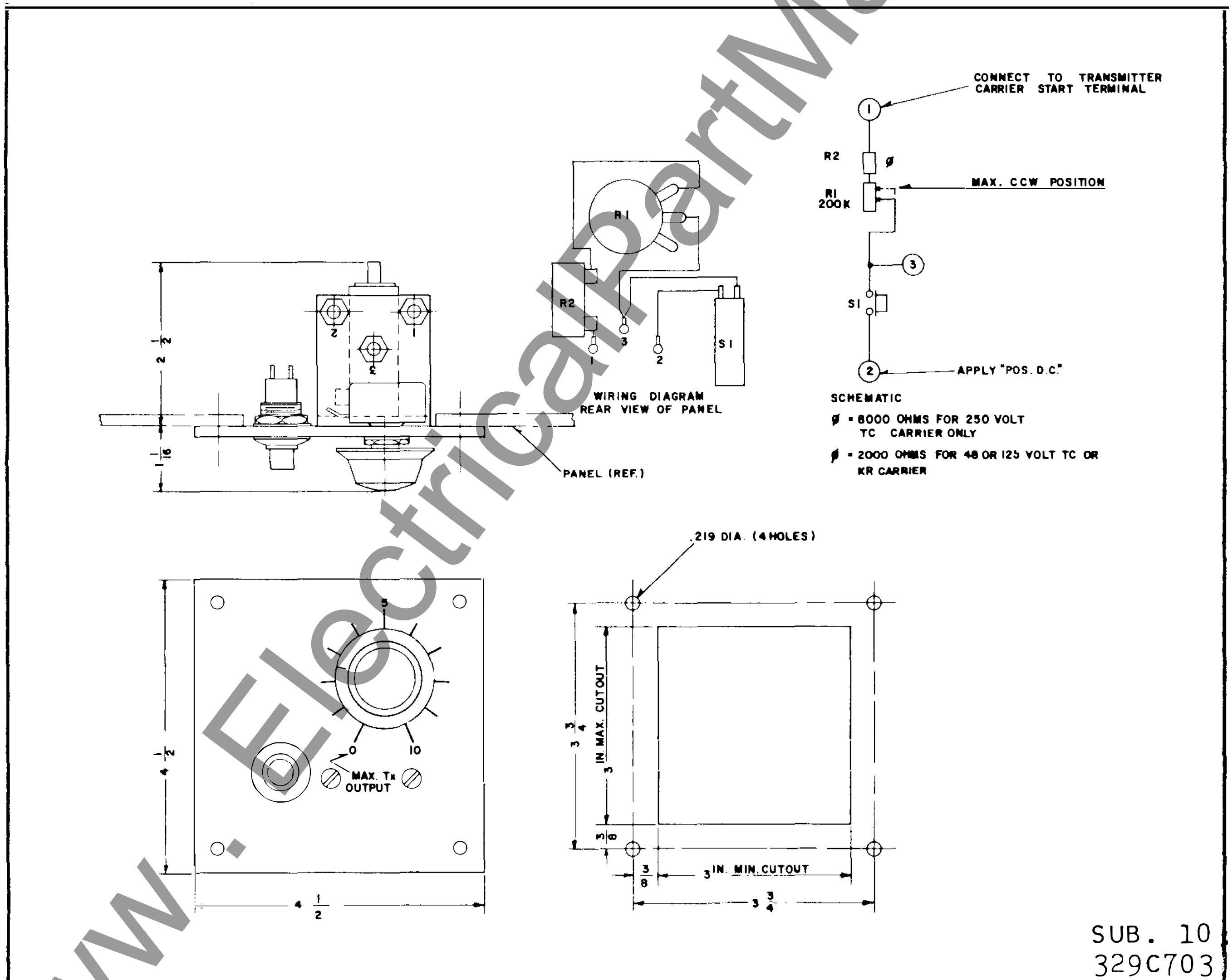

Fig. 1. Reserve Signal Detector for Panel Mounting.

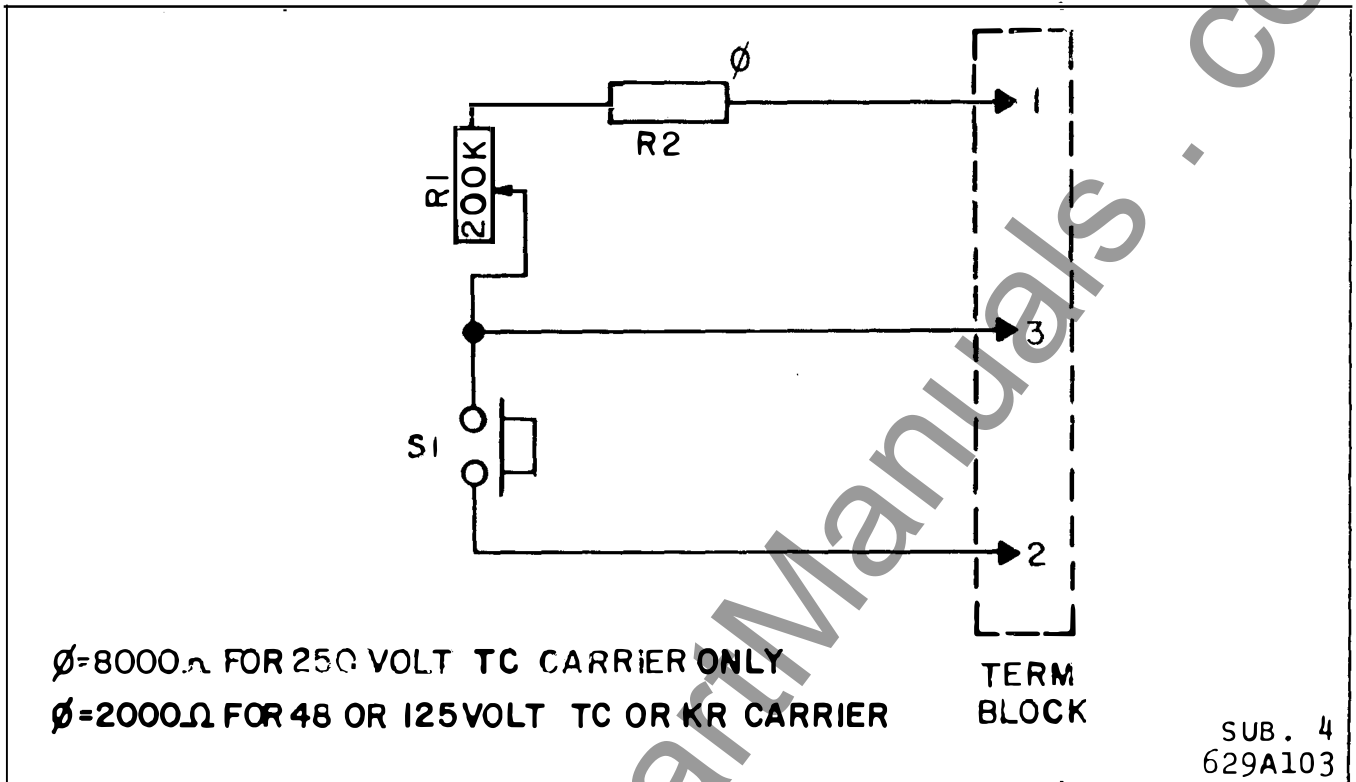

Fig. 2. Reserve Signal Detector for 19-inch Rack Mounting.

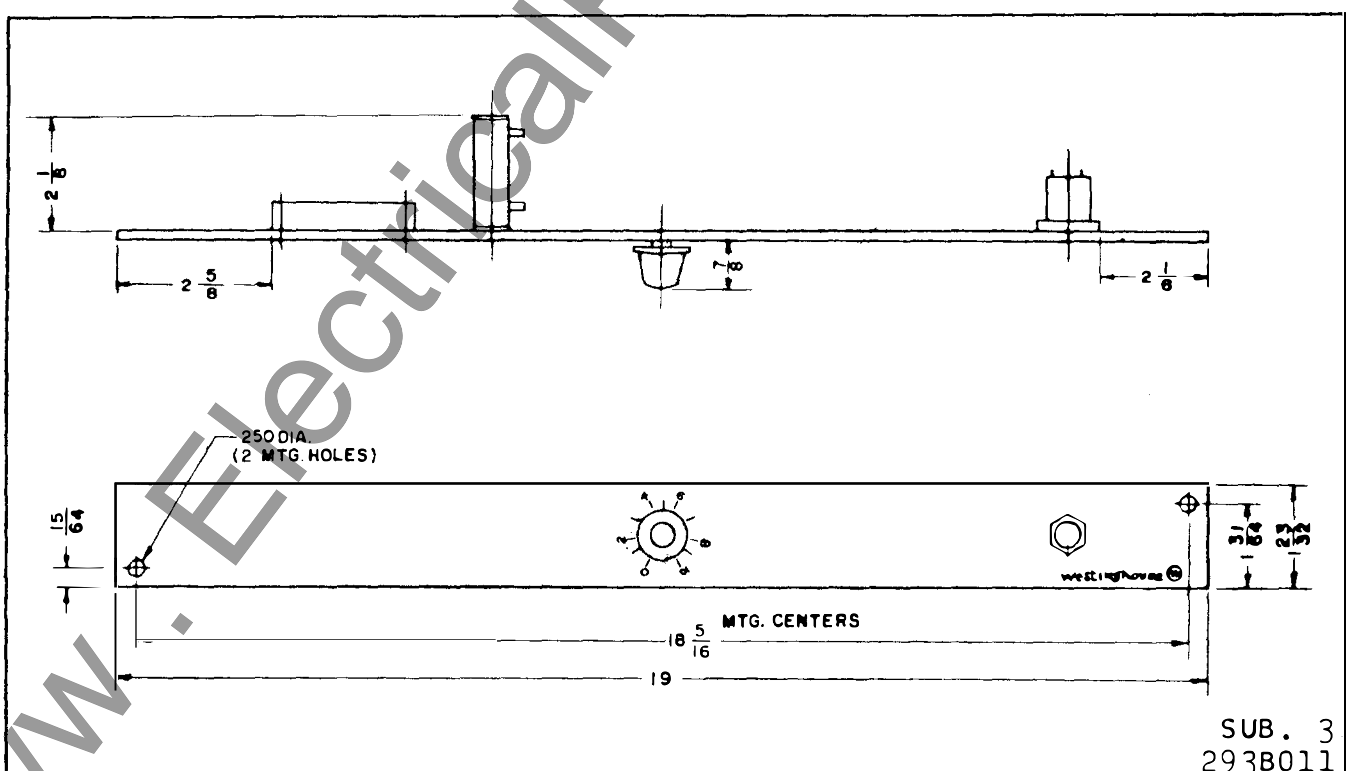

Fig. 3. Reserve Signal Detector for 19-inch Rack Mounting.

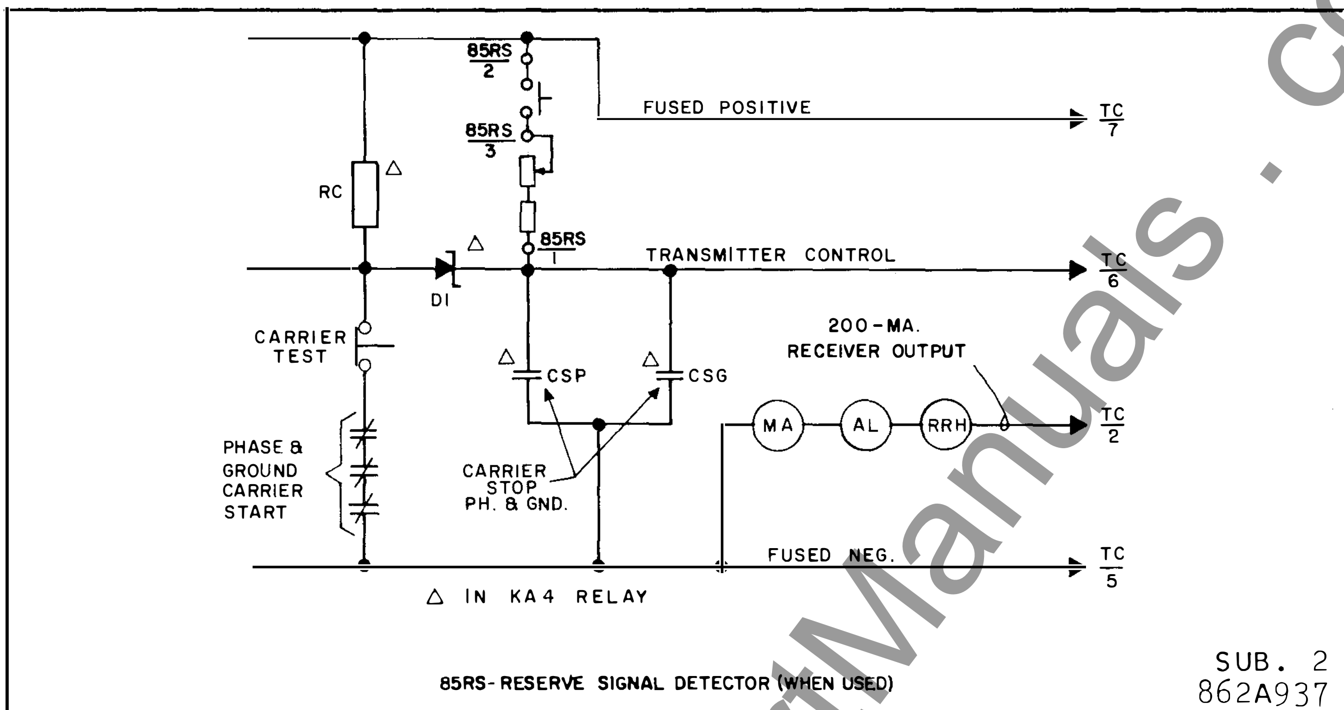

Fig. 4. Elementary K-Dar/TC Carrier Control Circuit.

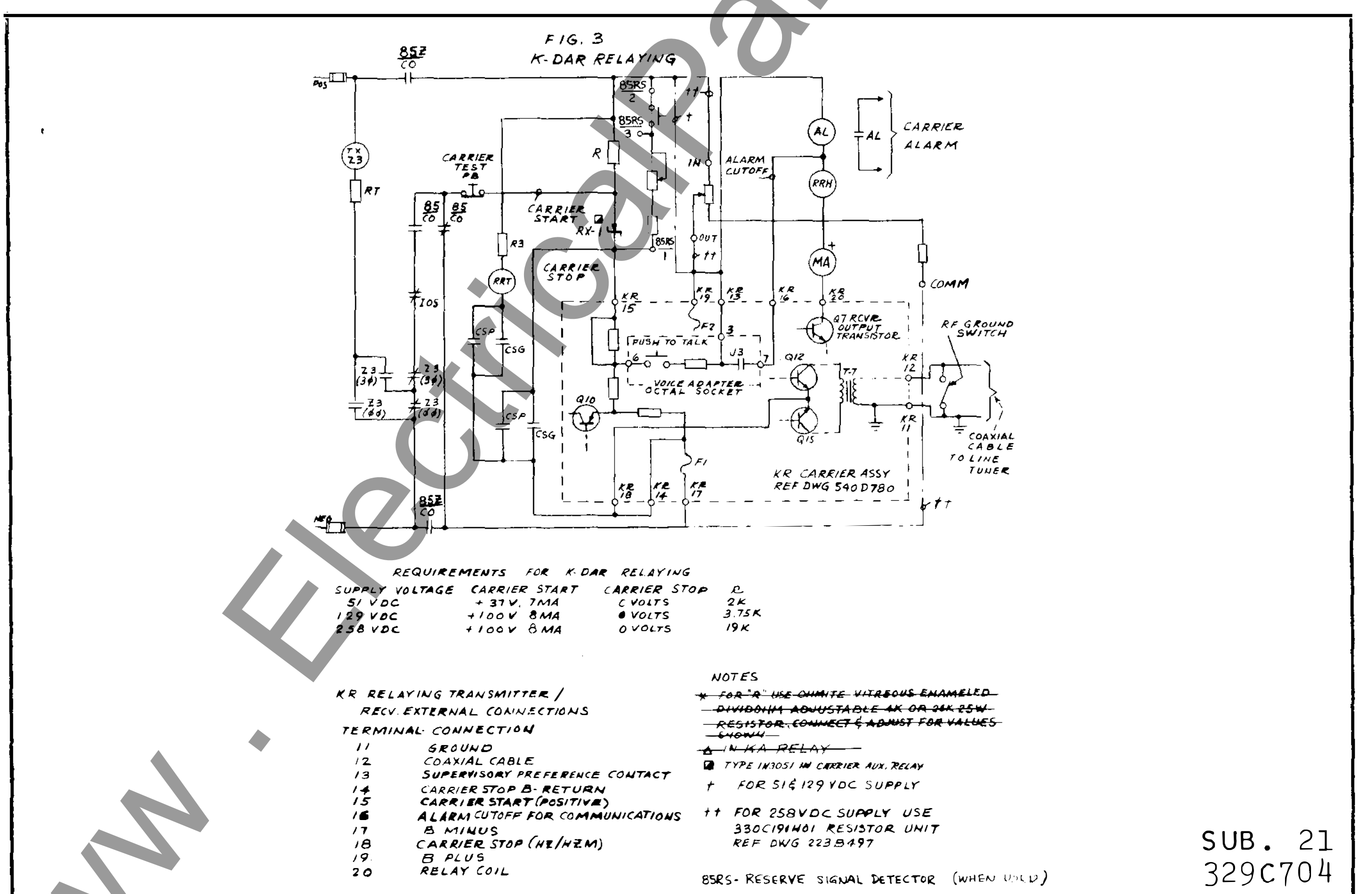

Fig. 5. Elementary K-Dar/KR Carrier Control Circuit.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TCU CONTROL UNIT FOR SKB OR HKB PHASE COMPARISON CARRIER RELAYING

CAUTION: It is recommended that the user of this equipment become thoroughly acquainted with the information in this instruction leaflet before energizing the carrier assembly. This is particularly important for those persons not familiar with transistorized equipment.

APPLICATION

The type TCU control unit is used in conjunction with the type TC transistorized carrier set for SKB or HKB phase-comparison carrier relaying. The control unit, which is also completely transistorized, serves to control carrier transmission, compare local and remote quantities during a fault, and initiate tripping for an internal fault.

CONSTRUCTION

The type TCU control unit consists of a standard 19-inch wide panel approximately 5-¼ inches (3 rack units) high. The panel is notched for mounting on a standard relay rack.All small components associated with the static circuitry are mounted on two printed circuit boards on the rear of the panel. Three adjustable controls and several larger components are mounted on a separate subassembly as shown on outline drawing Fig. 1 and component location drawing Fig. 2.

OPERATION

General

In phase-comparison relaying, the relative phase positions of the fault currents at the two ends of a line section are compared over a carrier channel to determine whether the fault is within or outside the protected line section. To make the comparison over a single carrier channel, the single-phase output voltage of the SKB or HKB relay sequence network energizes the type TCU control unit which performs the following functions:

1. Controls the transmission of carrier in half-cycle pulses at the line frequency (usually 60 Hz).
2. Compares the phase position of the pulses received from the remote terminal with similar local pulses developed directly from the sequence network output.
3. Initiates tripping if the comparison indicates an internal fault.

In addition, the control unit has two secondary functions:

1. Transient blocking and unblocking. If tripping is not set up within 25 – 32 milliseconds after FD2 operates, the flip-flop circuit is desensitized so that discharge of stored energy (in reactive circuit elements) at the clearing of an external fault will not cause incorrect tripping. However, if an internal fault develops before the external fault is cleared, the change in phase position of the local and remote carrier pulses will cancel the transient blocking after about two cycles to allow a slightly delayed tripping.

2. Carrier squelch. When tripping takes place for an internal fault, the operation of either the ICS unit in the HKB relay or the AR relay unit in the SKB relay energizes a circuit which stops transmission of carrier. This is to prevent undesirable carrier blocking of another terminal which might require sequential tripping because of a lower value of fault current at that terminal. No matter what causes carrier transmission at such a time (carrier test, for example), the carrier squelch will hold carrier off for a reasonable time to allow tripping at other terminals of the faulted line section.

Explanation of Logic Diagram and Basic Comparison Circuit

A logic diagram of one terminal of the complete system is shown in Fig. 3. The blocks in this illustration include complete units such as the carrier transmitter and receiver, and the relay

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enough to allow triggering of the flip-flop for any internal fault.

4. Transient unblocking – Approximately 25 ms. to unblock the flip-flop. This circuit requires more than a single operating pulse, but not more than two operating pulses (during an internal fault) to release the flip-flop. Thus it will not operate on a single transient pulse.

5. Phase delay – Adjustable up to 6 ms. to balance the delay in the blocking channel equipment. For type TC carrier, the channel delay is 2 ms.

INSTALLATION

The type TCU control unit is generally supplied in a cabinet or on a relay rack as part of a complete carrier assembly. The location must be free from dust, excessive humidity, vibration, corrosive fumes, or heat. The maximum ambient temperature around the chassis must not exceed 55°C. (Minimum temp. is –20°C).

SETTINGS

There are three adjustable controls (R_{101}, 102 and 103) on the rear of the unit. The settings of R_{101} and R_{102} are described in the assembly instructions. The setting of R_{103} is a factory adjustment. A procedure for checking the R_{103} setting is described in the following section under Calibration.

MAINTENANCE

Routine Maintenance

Periodic checks of the relaying system as described in the assembly instructions are desirable to indicate impending failure so that the equipment can be taken out of service for correction. At regular maintenance intervals, any accumulated dust should be removed.

Voltage values should be recorded after adjustment in order to establish reference values which will be useful when checking the apparatus. The readings will remain fairly constant over an indefinite period unless a failure occurs.

Typical voltage values are given in the following table. Readings may vary somewhat, depending on the actual zener breakdown voltage and variations between transistors.

TABLE I

Test Point DC Voltages

NOTE: All voltages are positive with respect to battery negative (TP1 or TP54). The actual values will depend somewhat on the regulated 22 volts which has a ±4% tolerance.

TEST POINT	STANDBY	SIMULATED FAULT*
1 (neg.)	–	–
2 (pos.)	22	22
3	22	11 (square wave pulse)
4	20.3	20.0
5	0	12 (square wave pulse)
6	0.5	9.8 (square wave pulse)
51	21.5	21.0
52	20	8.5
53	22	21
54 (neg.)	–	–

*Test current applied to one relay terminal only, and high enough to pick up FD1 and FD2.

Overall System Check

The overall performance of the TCU control unit in conjunction with the protective relay and carrier equipment can best be made by following the procedures described in the system instructions which accompany each equipment assembly. Test switches are provided to simulate internal or external faults, and a trip-circuit indicating light together with a receiver output milliammeter serve to indicate proper operation of the installation.

Calibration

As stated under SETTINGS, the adjustment of phase delay control R_{101} and the 4-ms. delay control R_{102} are covered in the system instructions for the complete TC-TCU carrier (or equivalent) assembly. In the following paragraphs, procedures are given for checking the transient blocking and unblocking times and the carrier squelch time.

A. Transient Blocking Time

1. Connect a s.p.s.t. toggle switch between terminal 4 of the TCU right-hand printed circuit board and terminal 17 of the left hand board. Also connect the START terminal of an electronic timer or the EXT. TRIGGER terminal of an oscilloscope with a calibrated horizontal sweep and provision for a single sweep to the above terminal 17 as shown in Fig. 8A.
2. Connect the timer STOP circuit of scope vertical input to TP53 (probe lead) and TP54 (shield lead) on the left-hand (rear view) printed circuit board of the TCU Control Unit. TP54 is negative dc and provides the return circuit for both START and STOP inputs. Set timer for positive START voltage and negative STOP voltage.
3. Connect a jumper between TP2 and TP3 on the right hand (rear view) printed circuit board. (This disables the output of the local squaring amplifier which might otherwise interfere with this test).
4. Carrier assembly energized and in standby conditions (normal) but out of service.
5. Close switch to initiate transient blocking. The voltage at TP53 to TP54 will drop from approximately 20 volts to less than one volt dc after 18 to 32 ms. This time is determined by the value of R65 in the type TCU Control Unit, and is not adjustable.
6. At the completion of testing, be sure to remove the jumper from TP2 and TP3.

B. Transient Unblocking Time

1. Connect a s.p.s.t. toggle switch between terminals 4 (pos. 45 V DC) and 7 (receiver output) of the TCU right-hand (rear view) printed circuit board, as shown in Fig. 8B.
2. Connect the timer stop circuit or scope vertical input to TP53 and TP54 as described in Part A.
3. Initially close the toggle switch. This applies positive 45 volts dc to the remote squaring amplifier input and represents a received signal. Reset the scope "single sweep" control if necessary.
4. Apply sufficient 60-Hz current through SKB relay terminals 4 and 5 (phase A to neutral) to operate both FD1 and FD2 fault detectors. A current of two amperes will be sufficient in most cases.
5. Open the toggle switch to start timing. This operation removes the simulated received carrier and starts "timing out" the transient unblocking function. The voltage at TP43-54 will rise from less than one volt to approximately 20 volts after a delay of 15 to 35 milliseconds. This delay will vary from one reading to the next because of the variation in the point on the ac wave at which the toggle switch is opened. The delay can be varied by readjustment of R103 on the rear of the TCU Control Unit.
6. To repeat the transient-unblocking timing check, close the toggle switch, then momentarily interrupt the ac to the relay. This will reset FD2 which allows the flip-flop in the TCU to reset.

C. Carrier Squelch Time

This timing check is best made using a scope with a calibrated sweep since carrier builds up relatively gradually after the "squelch" interval.

1. Connect a s.p.s.t. toggle switch from positive of the dc supply to the squelch input terminal of the carrier assembly.

   (Refer to the system dc schematic for the proper terminals. If the TC carrier set and TCU Control Unit are mounted in a cabinet, the squelch input terminal on the assembly terminal blocks (Z terminals) is the one that connects to TCU terminal 2 of J101. For the SKB relay, this squelch circuit is initiated by (1) closing of an auxiliary ICS contact or (2) closing of a contact on the AR tripping relay unit. For the HKB relay, squelch is initiated by an auxiliary ICS contact. When the protective relay and carrier are both mounted in the same cubicle, it is generally more convenient to make connections directly to the relay case terminals).

2. The toggle switch must also apply the positive dc supply voltage to the EXT. TRIGGER terminal of a scope as shown in Fig. 8C. Be sure that the dc supply

voltage is not in excess of the safe maximum value for this scope input circuit.

3. Connect the scope vertical input to TCU right-hand circuit board terminals 1 (probe) and 15 (shield). Terminal 15 is negative dc which provides the return for the scope trigger input also.

4. Set the scope vertical input for dc and an amplitude of 20 volts, and set the EXT. TRIGGER for a negative dc input. (Actually, the input will drop from battery positive to zero when the toggle switch is opened).

5. Transmit carrier by turning on the Carrier Test switch on the panel of the type TC carrier set.

6. Close the test toggle switch, then reset the scope if necessary. Closing this switch will stop transmission of carrier. Do not leave it closed longer than necessary to make the test.

7. Now open the toggle switch. Capacitor C6 in the squelch circuit will start to discharge. After an interval of 120 to 180 milliseconds, transistor Q11 will stop conducting and the voltage to the scope vertical input will rise to 20 volts, indicating carrier transmission again.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, replacement parts can be furnished, in most cases, to customers who are equipped for doing repair work. When ordering parts, always give part designation, rating, and complete equipment nameplate data.

ELECTRICAL PARTS LIST

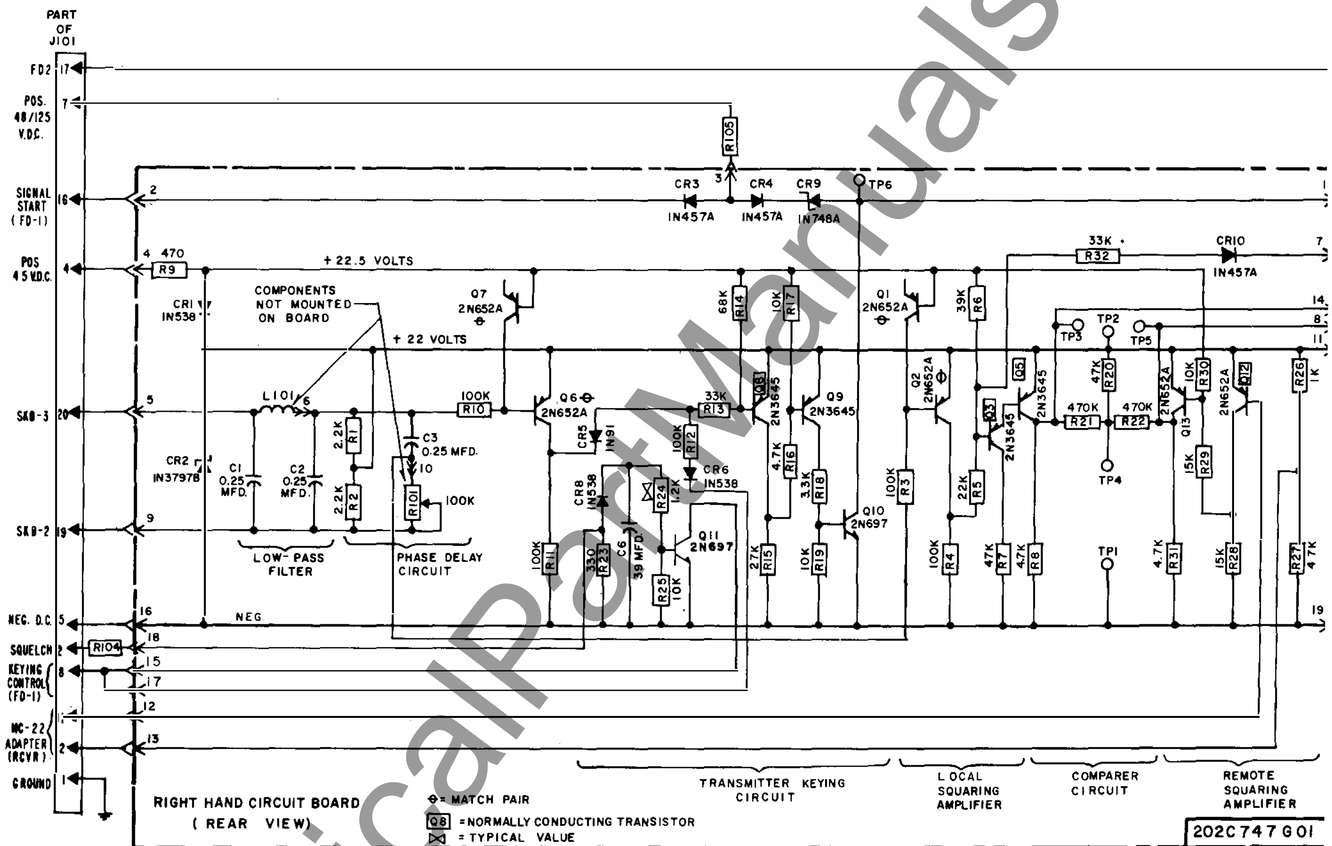
CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
RIGHT HAND BOARD (REAR VIEW) 408C338G03 TO G08		
CAPACITOR		
C1 to C5	0.25 MFD 200VDC	187A624H02
C6	39 MFD 35 VDC	187A508H04
DIODES		
CR1-CR6-CR7-CR8	1N4818 Δ	188A342H01
CR2	1N3797B-22V	185A089H09
CR3-CR4-CR10	1N457A	184A855H07
CR5	1N91	182A881H04
CR9	1N748A-3.9V	186A797H13
Δ Maybe IN538 Diodes on some boards		
RESISTORS		
R1-R2	2.2K, ½W ±10%	187A641H35
R3-R10-R12-R27	100K, ½W ±10%	187A641H75
R4-R11	100K, ½W ±5%	184A763H75
R5	22K, ½W ±10%	187A641H59
R6	39K, ½W ±5%	184A763H65
R7-R20	47K, ½W ±10%	187A641H67
R8-R16-R31	4.7K, ½W ±10%	187A641H43
R9	470 Ohm, 3W ±5%	184A636H20
R13	33K, ½W ±10%	187A641H63
R14	68K, ½W ±10%	187A641H71
R15	27K, ½W ±10%	187A641H61
R17-R19-R30	10K, ½W ±10%	187A641H51
R18	3.3K, ½W ±5%	184A763H39
R21-R22	470K, ½W ±10%	187A641H91
R23	330 Ω, 2W ±5%	185A207H15
R24	1.2K, ½W ±5%	184A763H29
R25	5.6K, ½W ±10%	187A641H45
R26	39K, ½W ±10%	187A641H65
R28-R29	15K, ½W ±10%	187A641H55
R32	33K, ½W ±5%	184A763H63
TRANSISTORS		
(Q1-Q2) - (Q6-Q7)	2N652A Matched Pair	671B632G01
Q3-Q5-Q8-Q9	2N3645	849A441H01
Q10-Q11	2N699	184A633H19
Q12-Q13	2N652A	184A638H16

ELECTRIC PARTS LIST

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
LEFT HAND CIRCUIT BOARD (REAR VIEW) STYLE 408C377G03 TO 408C337G07		
CAPACITORS		
C51	0.25MFD, 200VDC	187A624H02
C52-C55	1.0MFD 200VDC	187A624H04
C53-C54	500 MMF, 200VDC Δ	187A697H03
C56	3.0MFD 200VDC	188A293H06
Δ Maybe .05 MFD on some boards		
DIODES		
CR51-CR57-CR61	1N957B-6.8V	186A797H06
CR52-CR60	1N91	182A881H04
CR53-CR54-CR55-CR56-CR58-CR63-CR64-CR65	1N538	407C703H03
CR59	1N960B-9.1V	186A797H10
CR62	1N1789-56V	584C434H08
CR66	1N965B-15V	186A797H08
RESISTORS		
R51	40 Ohm, ½W ±10%	187A640H17
R52-R53-R55-R49-R64-R66-R85	10K, ½W ±10%	187A641H51
R54	120K, ½W ±10%	187A641H77
R56	22K, ½W ±5%	184A763H59
R57,R69-R80	4.7K, ½W ±10%	187A641H43
R58-R70-R74	22K, ½W ±10%	187A641H59
R60-R79	4.7K, ½W ±5%	184A763H43
R61-R71-R77	5.6K, ½W ±5%	184A763H45
R62	1.5K, ½W ±10%	187A641H31
R63-R82	2.2K, ½W ±10%	187A641H35
R65-R83	6.8K, ½W ±10%	187A641H47
R67 (G03-G04)	470 Ohm, 3W ±5%	184A636H20
R67 (G05-G06-G07)	750 Ohm, 3W ±5%	185A209H19
R68	47K, ½W ±10%	187A641H67
R72	15K, ½W ±10%	187A641H55
R73	Thermistor 1D101	185A211H04
R75-R84	470 Ohm, ½W ±10%	187A641H19
R76	100K, ½W ±10%	187A641H75
R78	6.8K, ½W ±5%	184A763H47
R81	8.2K, ½W ±10%	187A641H49
R86	470K, ½W ±10%	187A641H01
TRANSISTORS		
Q51-Q52-Q53-Q54	2N652A	184A638H16
Q55	2N699	184A638H19
Q56-Q57-Q58	2N697	184A638H18

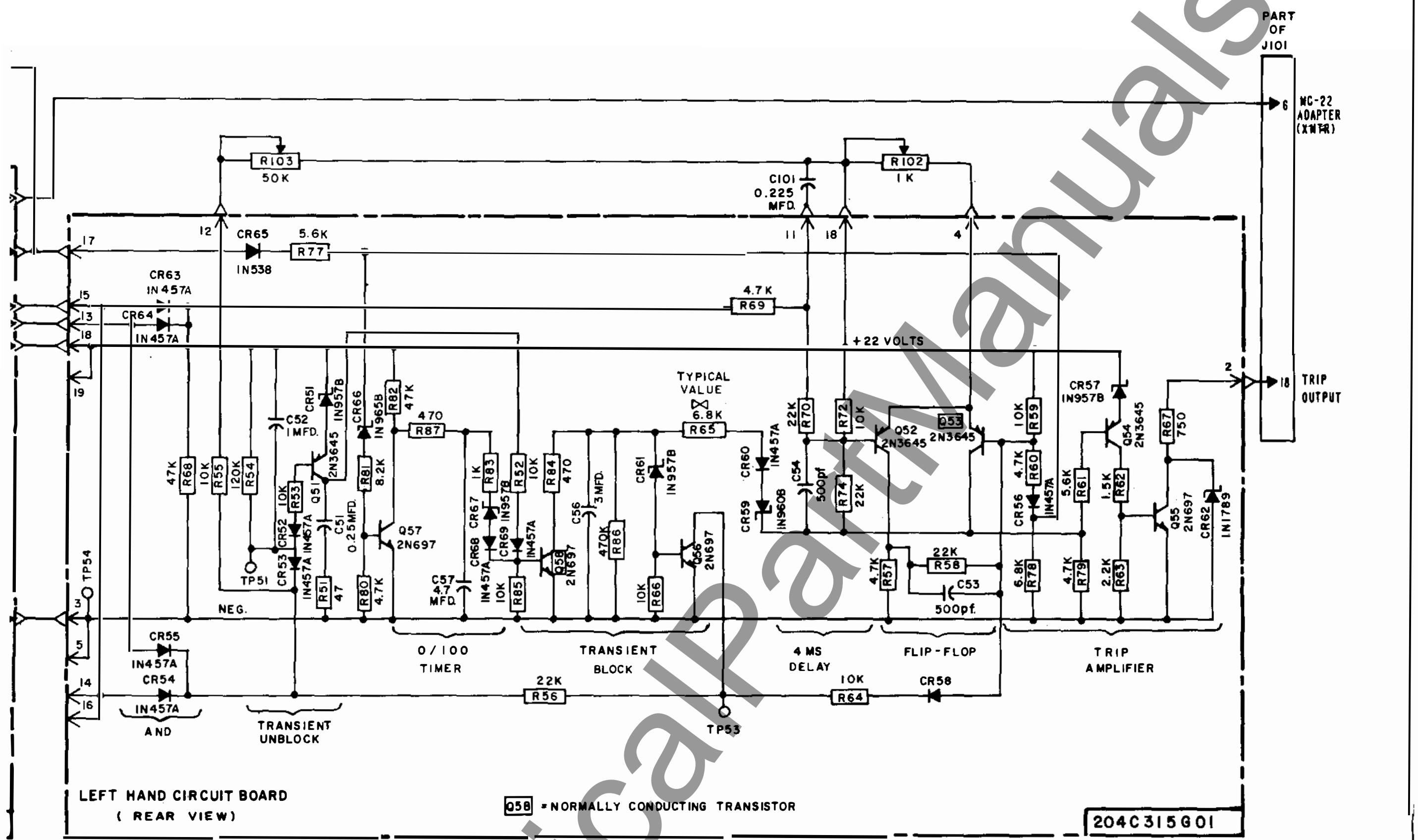
ELECTRICAL PARTS LIST

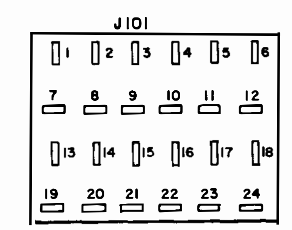
CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
LEFT HAND CIRCUIT BOARD (REAR VIEW) 204C315G01		
CAPACITOR		
C51	22MFD 50V	762A703H01
C52	1.0 MFD 35V	837A241H15
C53-C54	500MMF 500V	187A694H03
C56-C57	4.7 MFD 35V	184A661H02
DIODES		
CR51-CR57-CR61-CR67-CR52-CR53-CR54-CR55	1N957B – 6.8V	186A797H06
CR56-CR58-CR60-CR63-CR64-CR65-CR68-CR69	1N457A	184A855H07
CR59	1N960B-9.1V	186A797H10
CR62	1N1789-56V	584C434H08
CR66	1N965B-15V	186A797H08
RESISTORS		
R51	47 Ohm, ½W ±10%	187A640H17
R52-R53-R55-R59-R64-R66-R72-R85	10K, ½W ±5%	184A763H51
R54	120K, ½W ±5%	184A763H77
R56-R58-R70-R74	22K, ½W ±5%	184A763H59
R57-R60-R69-R79-R80	4.7K, ½W ±5%	184A763H43
R61-R77	5.6K, ½W ±5%	184A763H45
R62	1.5K, ½W ±5%	184A763H31
R63	2.2K, ½W ±5%	184A763H35
R65-R78	6.8K, ½W ±5%	184A763H47
R67	750 Ohm, 3W ±5%	185A209H19
R68-R82	47K, ½W ±5%	184A763H67
R81	8.2K, ½W ±5%	184A763H49
R83	1K ½W ±5%	184A763H27
R84-R87	470 Ohm, ½W ±5%	184A763H19
R86	470 K, ½W ±5%	184A763H91
TRANSISTORS		
Q51-Q52-Q53-Q54	2N3645	849A441H01
Q55	2N699	184A638H19
Q56-Q57-Q58	2N697	184A638H18
PARTS NOT ON BOARDS		
CAPACITOR		
C101	0.225 MFD 339VAC	1723409
CHOKE		
L101	8.5 Henry, 400 Ohms	188A460H01
RESISTORS		
R101	100K Pot. 2W	185A067H10
R102	1K Pot. 2W	185A067H09
R103	50K Pot. 2W	185A067H11
R104, 48VDC	300 Ohm 25W	1202847
R104, 125VDC	1250 Ohm 25W	1202589
R105, 48VDC	1000 Ohm 25W	1202588
R105, 125VDC	3750 Ohm 25W	1202955



DC VOLTAGE	R104	R105
48	300 Ω	1K
125	1.25K	3.75K
250	5K	—

Fig. 6. Internal Schematic, Ty

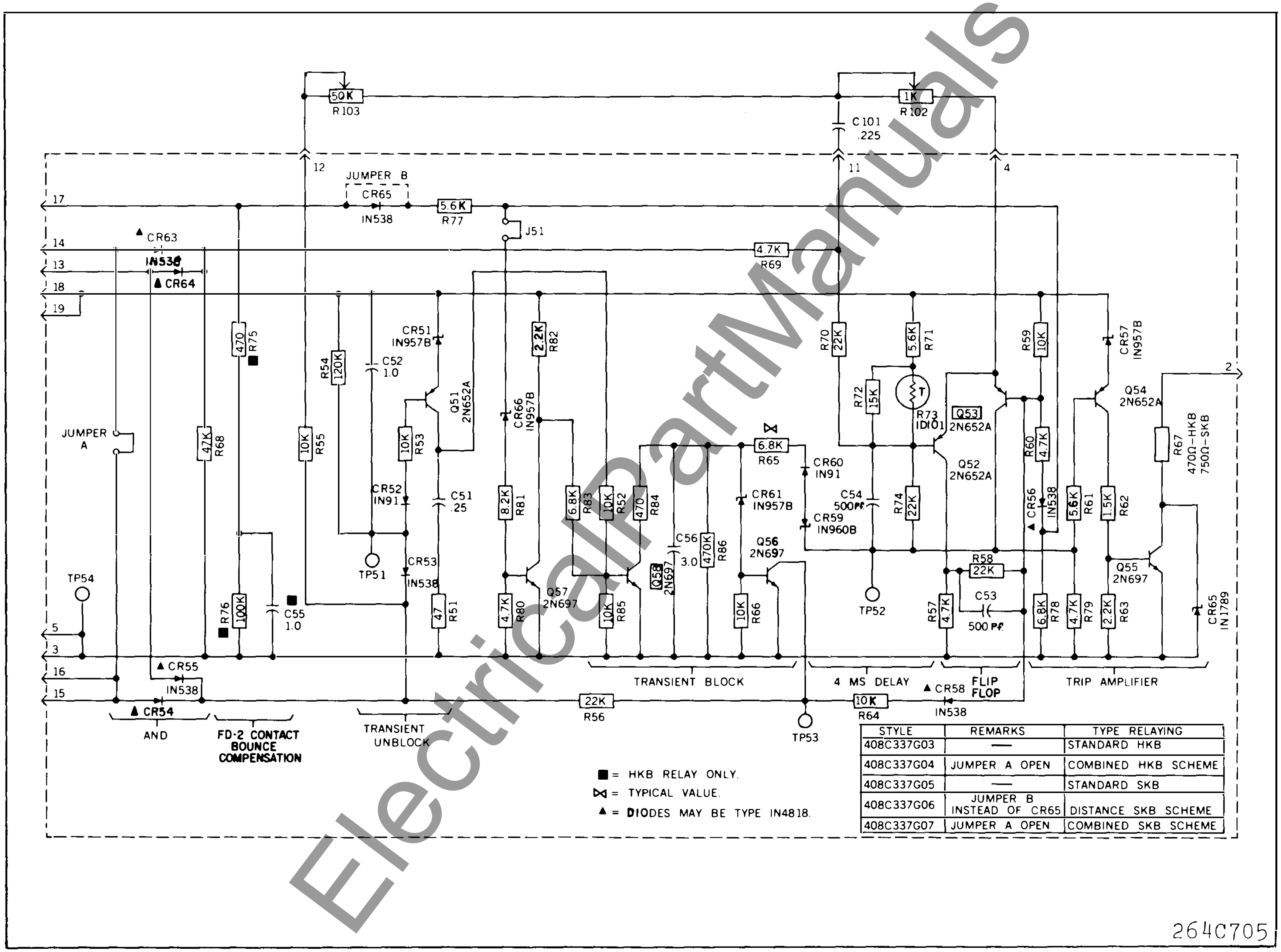




SCHEMATIC SUPERSEDES SCHEMATIC DWG. 4827D80
BOARD 204C315G01 SUPERSEDES BOARD 408C337G05
408C337G05 DOES NOT HAVE 0/100 TIMER

6296D82

...e TCU Control Unit for SKB MC-22 Relaying.



STYLE	REMARKS	TYPE RELAYING
408C337G03	—	STANDARD HKB
408C337G04	JUMPER A OPEN	COMBINED HKB SCHEME
408C337G05	—	STANDARD SKB
408C337G06	JUMPER B INSTEAD OF CR65	DISTANCE SKB SCHEME
408C337G07	JUMPER A OPEN	COMBINED SKB SCHEME

Fig. 7. Internal Schematic of Left Hand Board (rear view).

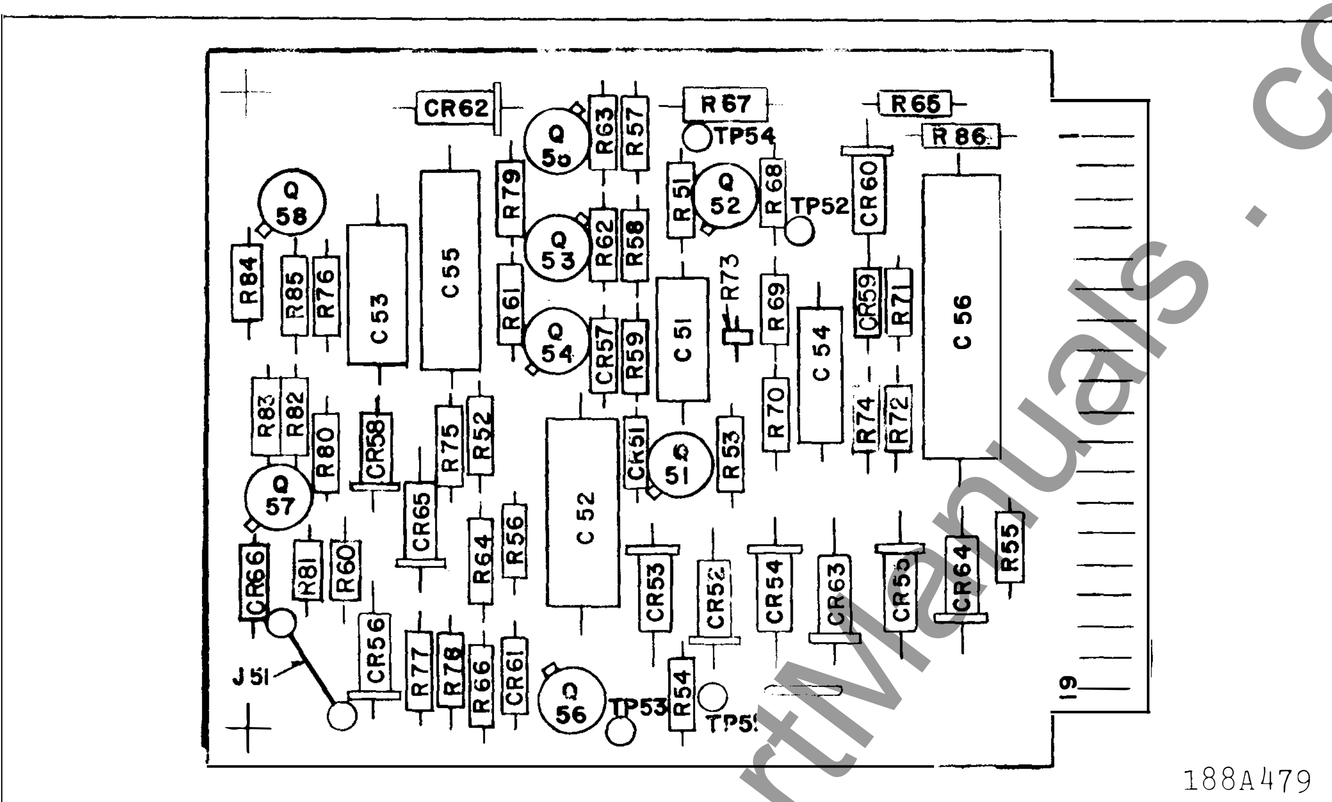


Fig. 8. Component Location on Left-Hand (rear view) Printed Circuit Board in Type TCU Control Unit.

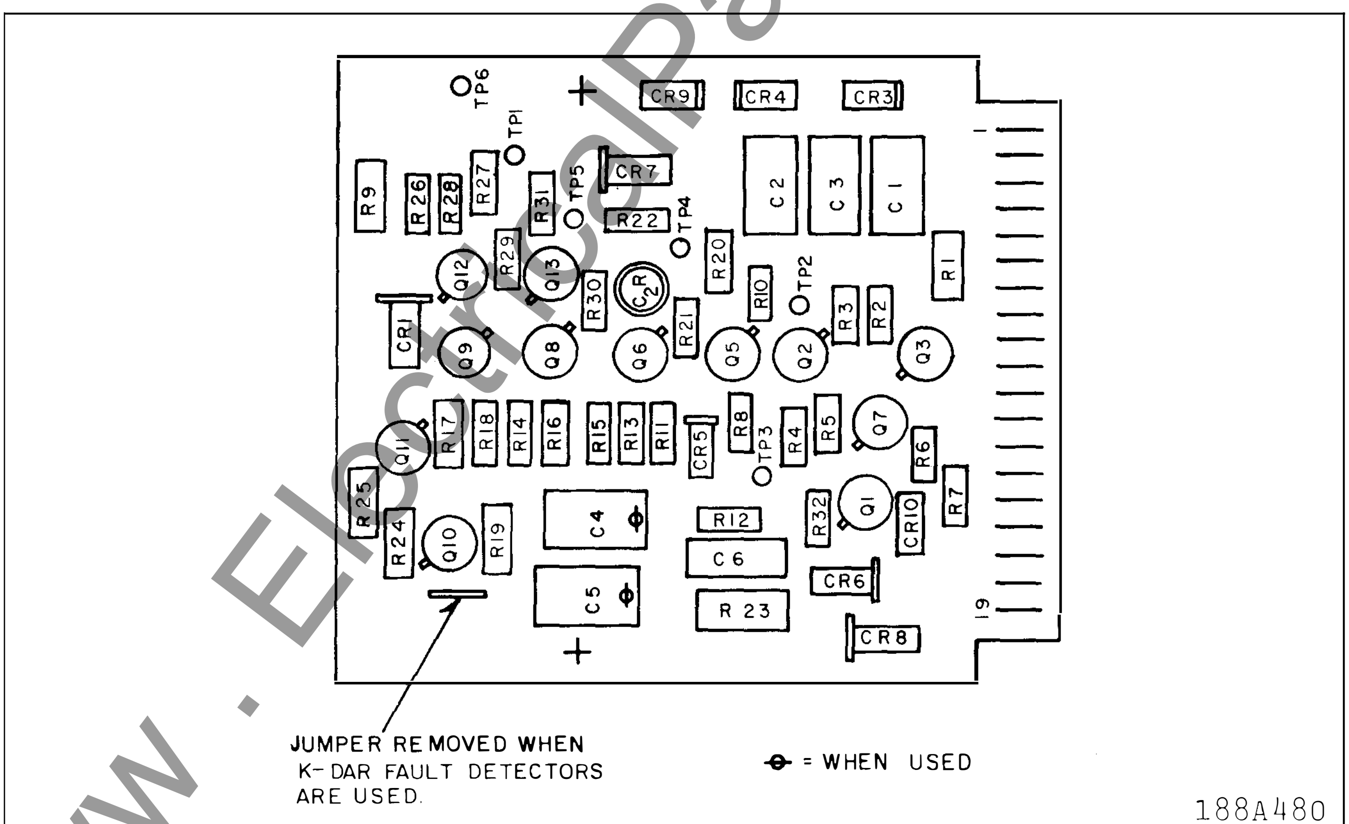
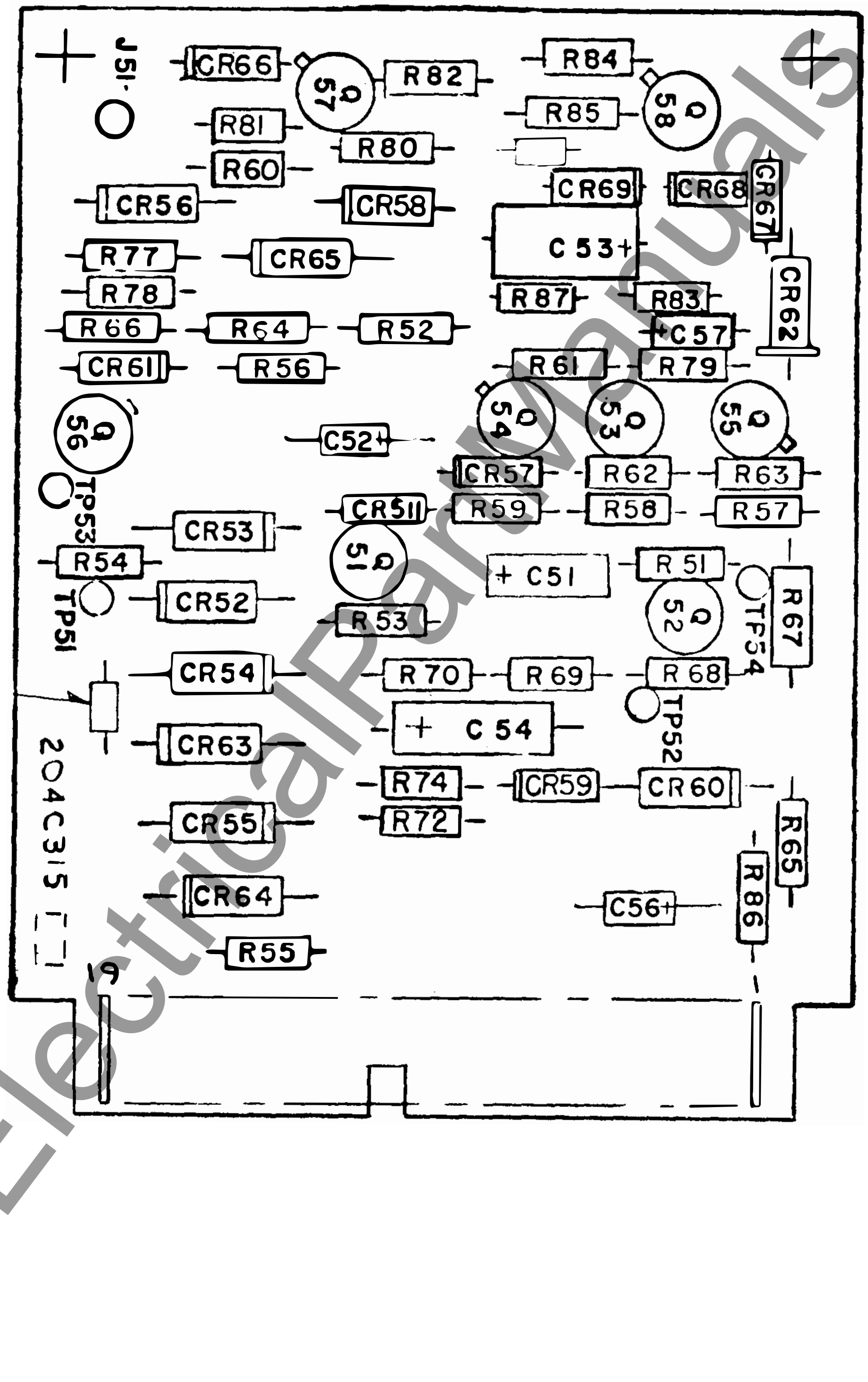


Fig. 9. Component Location on Right-Hand (rear view) Printed Circuit Board in type TCU Control Unit.



204C315

Fig. 10. Component Location on Style 204C315G01 Left Hand Board.

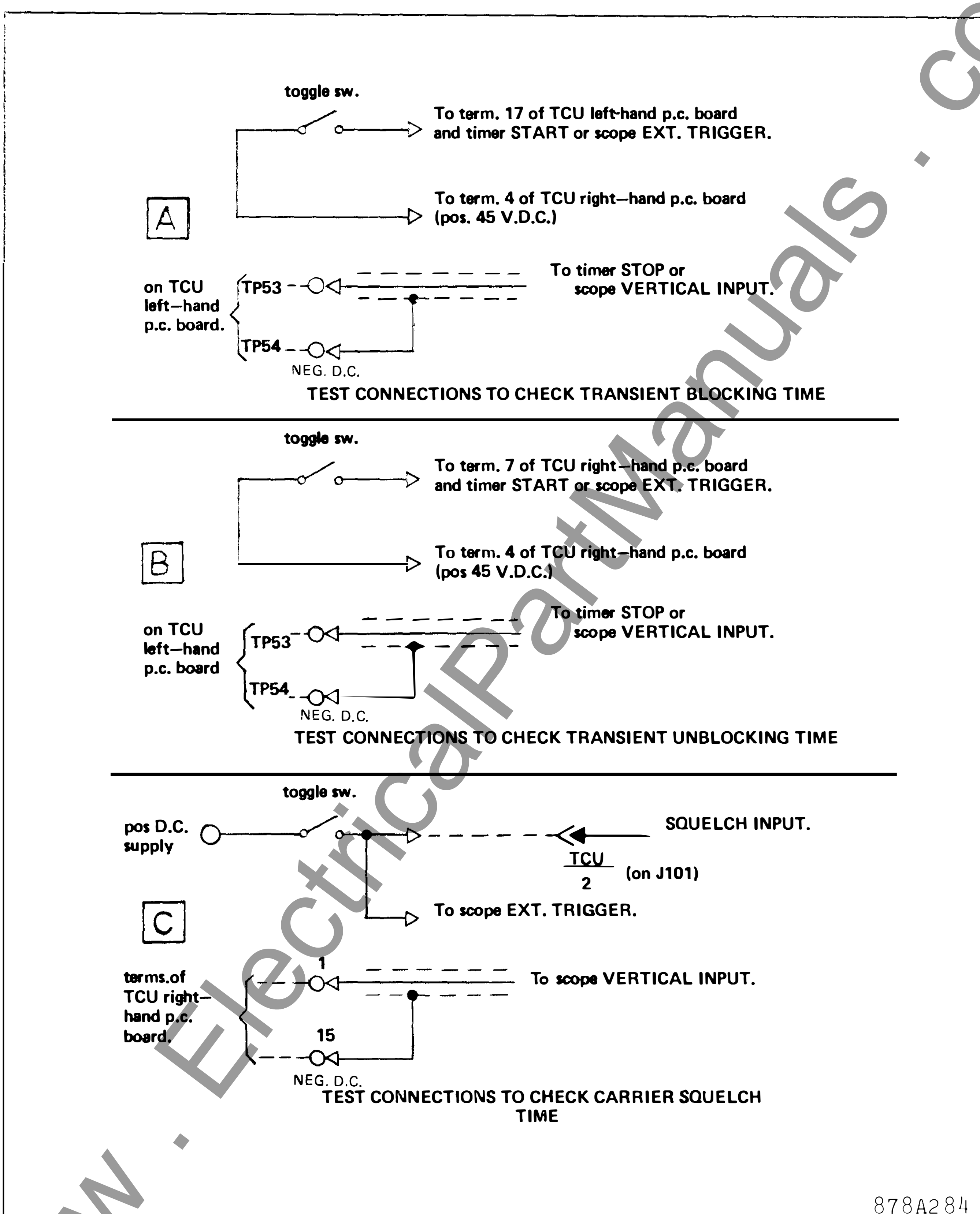


FIG. 11 TEST CONNECTIONS FOR CHECKING TRANSIENT BLOCKING AND UNBLOCKING TIMES AND CARRIER SQUELCH TIME.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TC-10 POWER LINE CARRIER TRANSMITTER-RECEIVER (WIDE BAND) 30 to 300 kHz 10 WATTS – 48, 125, 250 Vdc WITH OPTIONAL VOICE

CAUTION: It is recommended that the user of this equipment become thoroughly acquainted with the information in this instruction leaflet before energizing the carrier assembly. Failure to observe this precaution may result in damage to the equipment.

If the carrier set is mounted in a cabinet, it must be bolted down to the floor or otherwise secured before swinging out the equipment rack to prevent its tipping over.

✪ APPLICATION

The type TC-10 carrier equipment is designed for blocking type pilot relay systems. The first of these is the directional-comparison schemes using the KA-4 relay, or other electromechanical carrier relay. The TC-10 is also applied to solid-state directional-comparison systems such as the SKAU-3 or Uniflex blocking systems. The second type of system which uses the TC-10 is the phase-comparison blocking systems which use the SKB-TCU or SKBU-1 carrier relays.

The type TC-10 carrier can also be used for functions other than relaying. These include a "push-to-talk" maintenance telephone channel, data acquisition, or supervisory control.

The control of the transmitter can be handled in many different configurations. The elementary diagrams for keying the transmitter are shown in Figures 42 thru 48.

CONSTRUCTION

The transmitter-receiver unit consists of a standard 19-inch wide chassis 5¼ inches (3 rack units) high. The chassis is notched for mounting on a standard relay rack. Metering jacks, fuses, power and test switches, pilot light, and the receiver gain control are accessible from the front ✪ of the chassis, See Fig. 3. The circuitry is divided ✪ into 8 plug-in modules as shown in Fig. 3. The components mounted on each printed circuit board or other sub-assembly are shown enclosed by dotted lines on the internal schematic, Fig. 18. The locations of components on the eight printed circuit boards are shown on separate illustrations, Figures 4 through 17.

External connections to the assembly are made through a 36-circuit receptacle J3. The r-f output connection to the assembly is made through a coaxial cable jack J2. When voice communication ✪ is used, the handset plugs into a jack on the front panel of the voice adapter module.

The input attenuator control R5 is accessible from the front of the receiver input module panel. In addition, two current jacks are provided on the detector module for measuring the following quantities:

– Receiver 20-mA. output current.
– Receiver 200-mA. output current.

✪ A standard set of harnesses are available for use with the TC-10. These are shown in Figure 49 and are styles 1335D24G01 through G20. Note the inclusion of resistors on the Z block for

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

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✪ DENOTES CHANGED SINCE PREVIOUS ISSUE.
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duplicating the KA-4 function with other electromechanical relaying systems when desired.

OPERATION

TRANSMITTER

The transmitter is made up of four main stages and a filter. The stages include two crystal oscillators operating at frequencies that differ by the desired channel center frequency, a mixer and buffer amplifier, a driver stage and a power amplifier. The output filter removes harmonics that may be generated by distortion in the power amplifier.

A single crystal designated for oscillation in the 30 kHz to 300 kHz range cannot be forced to oscillate away from its natural frequency by as much as $\pm$ 150 hz. In order to obtain this desired frequency shift, it is necessary to use two crystals in the 2 MHz range. The crystals are Y1 and Y2 of Fig. 19. The frequency of Y2 is 2.00 MHz when operated with a specified amount of series capacity and the frequency of Y1 is 2.00 MHz plus the channel center frequency, or 2.03 MHz for 30 kHz center frequency. Capacitor C55 and crystal Y2 in series are connected between the positive side of the supply voltage and the base of transistor Q51, which operates in the emitter follower mode. The emitter is coupled to the base through C57. With Y2 removed, the base of Q51 would be held at approximately the midpoint of the supply voltage by R51 and R52. The crystal serves as a series resonant circuit with very high inductance and low capacitance. The circuit can be made to oscillate at other than the natural frequency of the crystal by varying the series capacitor, C55. Increasing C55 will lower the frequency of oscillations and reducing C55 will raise the frequency. This oscillator can be made to oscillate in the range of $\pm$100 Hz from its marked frequency.

Crystal Y1 is connected in a circuit that is similar except for the addition of C53 and diodes D51 and D52. By adjustment of C52 this circuit can be made to oscillate at $\pm$100 Hz from its marked frequency. The crystals taken individually have a greater variation of frequency with temperature than would be acceptable. However, by proper matching of the two crystals, the variation in their difference frequency can be kept within limits that permit holding the frequency stability of the overall transmitter to $\pm$10Hz over a temperature range of -20 to +55°C.

The frequencies produced by the two oscillators are coupled to the base of mixer transistor Q53 through C62 and C63. The sum of the two frequencies is so high that a negligible amount appears on the secondary of transformer T51, but the difference frequency is accepted and amplified by Q53 and Q54.

When the keying control is closed, it increases the output power to 10 watts. This is effected by reducing the emitter resistance of buffer-amplifier transistor Q54. When the keying control is open, transistor Q55 receives no base current and is nonconducting. Emitter resistor R70 Therefore is effectively open-circuited. The level of output power is adjusted to 1 watt by means of R64. When Q55 is made conductive by closing the keying control circuit, R70 is placed in parallel with R68 and the amount of emitter resistance unbypassed by C66 can be adjusted as required to obtain a 10-watt output level.

As shown on the Internal Schematic, Fig. 18, the voltage for the keying circuit is obtained from the 45-volt regulator supply in the Keying Module.

The driver stage consists of transistors Q56 and Q57 connected in a conventional push-pull circuit with input supplied from the collector of Q54 through transformer T52.

The power amplifier (Fig. 20) uses two series-connected power transistors, Q2 and Q4, operating as a class B push-pull amplifier with single-ended output. Diodes D2 and D4 provide protection for the base-emitter junctions of the power transistors. Zener diodes Z2 and Z4 protect the collector-emitter junctions from surges that might come in from the power line through the coaxial cable.

Terminals #17 and 18 on J3 (Fig. 18) are connected across a 2-ohm resistor R6, located on the power-amp module. When the transmitter is operating (carrier-on), approximately .5 amperes (dc) of current flows through R6 developing approximately 1 volt (dc) for 48V units and 0.25 amps (dc) of current developing 0.5V dc for 125V and 250V units. This voltage (or current) can be used to drive an indicating device such as an oscillograph or indicating relay for carrier-on indication. The value of input impedance of the device connected to these terminals will have no effect on the transmitter operation, provided that R6 remains as a shunt resistor. R6 should not be removed or value increased, in an effort to provide a higher current level for driving the indicating device, as this could jeopardize carrier-start operation.

The output transformer T3 (Fig. 21) couples the power transistors to the output filter FL102. The output filter includes two trap circuits (L102, C1, C2, L103, C3 and C4) which are factory tuned to the second and third harmonics of the transmitter frequency. Capacitors C5, C6 approximately cancel the inductive reactance of the two trap circuits at the operating frequency. Protective gap G1 is a small lightning arrester to limit the magnitude of switching surges or other line disturbances reaching the carrier set through the line tuner and coaxial cable. Auto-transformer T4 matches the filter impedance to coaxial cable of 50, 60 or 70 ohms.

The series resonant circuit composed of L105 and C7 is tuned to the transmitter frequency, and aids in providing resistive termination for the output stage. Jack J102 is mounted on the panel of FL102 and is used for measuring the r.f. output current of the transmitter into the coaxial cable. It should be noted that the filter contains no shunt reactive elements, thus providing a reverse impedance that is free of possible "across-the-line" resonances.

When keyed for voice by the voice adapter, transistor Q55 (Fig. 19) is keyed into class-A operation so that its conduction can be modulated by the voice input from the voice adapter. Potentiometer R82 in the transmitter module and R41 in the voice-adapter module are adjusted so that the nominal output of carrier is 3.25 watts (14 volts across 60 ohms). The voice input modulates the carrier through this transistor by varying the amount of conduction of Q55 so that the output power of carrier varies with the voice amplitude following the voice frequency components. Since with Q55 completely nonconducting, R64 has been set to produce a 1-watt output, maximum modulation on the side to shut off Q55 will not result in an output level of less than 1 watt carrier at any time. Also since the output level has been set at 10 watts with Q55 completely conducting by the adjusting of R70, the maximum modulation on the side of "turn-on" of Q55 will not result in a carrier output level of greater than 10 watts at any time.

The biffer keying board in addition to providing proper buffering also contains logic for the proper keying of output level in regard to protective relaying operation and voice adapter operation.

RECEIVER

The receiver is a superheterodyne type to facilitate obtaining constant bandwidth regardless of the channel frequency. The major stages include an input filter, attenuator (gain control), crystal oscillator, mixer, I.F. filters and I.F. amplifiers, diode detector, dc amplifier, and dc power output stage. See Figures 23, 24 and 25.

The fixed input filter rejects undesired signals while accepting a wide enough band of frequencies to assure fast operation. The receiver sensitivity is adjusted by means of the continuously variable input attenuator control R5. The receiver oscillator is basically the same type as the transmitter but uses an operational amplifier. The oscillator frequency is 20 kHz above the incoming signal frequency. The receiver channel frequency is determined by the input filter and the oscillator crystal.

Mixing is accomplished by feeding the incoming signal to the emitter, and the receiver oscillator signal to the base of the mixer Q211. Injection into two separate elements, base and emitter, provides a circuit capable of handling greater signal level variations than one in which injection is made into only a single element such as the base. This receiver uses an intermediate frequency of 20 kHz. Typical characteristics of both filters and the complete receiver are shown on curves, Fig. 29 and 30.

The 20 kHz I.F. signal is rectified by diodes D2 and D3. The resulting dc output is amplified by transistors Q2 and Q3, giving a receiver output current of nominally 200 mA. for a 30-ohm external relay coil circuit. Where a second output current of 20 mA. is desired, an external 2000-ohm relay circuit can be connected to the receiver output as shown in Fig. 31. If only a 20-mA output is desired, a 33-ohm resistor and diode must still be connected into the circuit as shown.

Voice Adapter Module

Voice Receiver Circuit – The voice adapter receiver (Fig. 26) consists of three r-f amplifier stages Q1, Q2, and Q3, a diode detector, and an audio amplifier Q5. The receiver features automatic volume control whereby, if the received r-f input level varies, due to line switching or weather conditions, there will be a minimal effect on listening volume and the volume control need not be readjusted. This is accomplished using a field effect transistor Q10 connected in series with C4 across the emitter resistor R8 of the second r-f amplifier stage Q2. The drain-to-source resistance of Q10 varies directly with the dc voltage applied between its gate and source (TP-A to TP-B). Therefore, controlling the dc voltage between TP-A and TP-B will affect the drain-source resistance, thereby controlling the effective emitter bypass impedance and the gain of Q2. The dc voltage applied to TP-A is maintained proportional to the signal level at the output of the detector stage. Q4 serves as a dc amplifier for feedback to the F.E.T. Fig. 41 illustrates the A.V.C. response of the receiver circuitry. Plotted simultaneously is the feedback dc voltage (TP-A to TP-B).

The demodulated audio signal is present across volume control R14. It is then fed through C11 to the audio amplifier stage Q5. The collector load of Q5 is one half of the primary winding of T2 which is used to match the impedance of the handset receiver.

Speech-Amplifier Circuit

The speech amplifier circuit is a three-stage audio amplifier using transistor Q6, Q8 and Q9. The circuit features automatic level control whereby the output, applied to modulate the TC-10 Transmitter, is held at a constant level while the microphone input level can vary up to 25dB in amplitude. This is accomplished by controlling the gain of the first amplifier stage Q6, by placing a field effect transistor Q11 in series with C18 across the Q6 emitter resistor R24. The effective drain-to-source resistance of Q11 varies in proportion to the dc voltage applied to its gate (TP-8). Therefore, controlling this dc voltage will affect the drain source resistance, thereby controlling the effective emitter bypass impedance, and the gain of Q6. The dc voltage at TP8 is maintained proportional to the audio signal level at the collector of the second amplifier stage Q8. This signal is applied to the base of Q7 which when turned on by the negative going peaks will cause current to flow through D3 and charge C19 applying a dc voltage to the gate of the F.E.T. (Q11) in proportion to the signal level. The audio signal is applied through C21 to the third amplifier Q9. The final output level can be adjusted using R37.

POWER SUPPLY

The power supply (in Fig. 18) is a series-type transistorized dc voltage regulator which has a very low stand-by current drain when there is no output current demand. The zener diode Z1 holds a constant base-to-negative voltage on the series-connected power darlington transistor Q1. Depending on the load current, the dc voltage drop through transistor Q1 and resistor R2 (in Fig. 18B) varies to maintain a constant nominal 100-volt output. The Zener diode Z2 is used in a second series regulator to supply a nominal to 45V for use with the keying circuit, receiver, and the voice adapter. It is placed in a series regulator circuit (Q2 & R1) so that it does not draw current unless called upon by the receiver and voice adapter. Capacitor C1 provides a low carrier-frequency impedance across the dc output voltage. Capacitors C2 and C3 by pass r.f. or transient voltages to ground, thus preventing damage to the transistor circuit.

For a 250-volt dc supply, the circuit of Fig. 35 is used. This consists of an external voltage-dropping resistor assembly in conjunction with a 125V TC-10 set chassis connected in series. The resistor assembly (see Fig. 34) must be mounted at the top of a cabinet or an open rack. Because of the heat dissipated, no transistorized equipment should be mounted above the resistor panel. The 250 volt TC-10 set has a constant current drain of 0.9 amperes dc, and uses 1½ amp fuses in the resistor panel.

When the TC-10 set is used with solid-state protective relays (such as the SKBU-11), power switch S2, and fuses F1 and F2 are omitted from the assembly. See Figures 22C & 22D. Instead, the dc power for the complete relaying assembly is controlled from a single switch and set of fuses. This is done to prevent an incorrect tripping or blocking output which might result from interruption of one or both sides of the dc supply to the carrier set or protective relays. For solid-state relaying applications, there are no connections to J3 terminals 7 or 6 (normally fused positive and fused negative). See Fig. 18.

RELAYING CONTROL CIRCUITS

The carrier control circuit for KDar relaying is shown in elementary form in Fig. 28. The "Transmitter Control" circuit is normally held at fused negative potential through the normally-closed carrier test pushbutton and the phase and ground carrier-start relay contacts. Opening of any of these contacts allows current to flow from fused positive through resistor R_C and the Diode D_1 to the transmitter control terminal TC 10/9 thus starting carrier transmission at full output. The reception of carrier from either the local or remote transmitter normally causes a saturated current 200 mA. to flow in the alarm and holding coils (AL and RRH) in the type KA-4 (or equivalent) receiver auxiliary relay.

If the protective relays call for stopping the transmission of carrier, closing of CSP or CSG contact connects the transmitter control circuit back to fused negative, thus stopping any carrier transmission regardless of how it was started.

If a relaying carrier channel is also used for an auxiliary function such as telemetering or supervisory control, the keying contact for this function is connected into the carrier-start circuit in series with the carrier test pushbutton. Such a contact must be normally closed (in the non-operating condition). An auxiliary relay in the receiver output, usually in place of the alarm relay, energizes the telemetering or supervisory control equipment through contacts on the auxiliary relay.

Note also that the KA-4 function for normally closed carrier-start relays and normally open carrier-stop relays is provided by using the resistor supplied as part of standard harness and connecting as shown in Figure 44.

Other types of connections are shown in Figures 44 through 49.

CARRIER CONTROL FOR OTHER FUNCTIONS

If a type TC-10 set is keyed on-off for telemetering or supervisory control only (no protective relaying), one of the circuits shown in Fig. 42 can be used. Arrangements are shown for either a normally-closed or normally-open carrier-start contact. In the former case, a diode is required to allow using the Voice Adapter for push-to-talk voice communication between stations. Note that continuous telemetering must be interrupted when it is desired to use the carrier channel for voice communication.

The receiver output can be connected for either 200 mA, or 20 mA operation as shown in Fig. 31. The 200-mA output is preferable (if a choice is available) because of a slightly better time constant in the 200-mA receiver output circuit. In some cases, both the 200-mA and the 20-mA outputs may be used together. For example, the 200-mA output can be used with a standard carrier auxiliary relay (for directional-comparison relaying), while the 20-mA output feeds a 2000-ohm receiver relay used with supervisory control equipment. The connections shown in Fig. 31 would be used for this case, with the receiver relay holding coil (RRH) in place of the RRH and AL coils shown. The alarm function would be provided by the supervisory control equipment.

CHARACTERISTICS

Frequency Range	30-300 kHz (50-300 kHz for phase comparison relaying.)
Transmitter Output	10 watts into 50 to 70 ohm resistive load
Harmonics	55 dB below 10 watts

✪ Receiver Sensitivity	125 mV input for the 180 mA minimum output current
Receiver Selectivity	1500 Hz bandwidth (3dB down); 80 dB at ±3kHz.
Transmitter-Receiver ✪ Channel Rating	40dB
Input Voltage	48, 125, or 250V dc
Supply Voltage Variation	42-56V, 105-140V, 210-280V
Battery Drain: 48V dc	0.5 amp standby, 1.35 amp transmitting
125V dc	0.25 amp standby, 0.6 amp transmitting
250V dc	0.9 amp standby or transmitting (with external resistor Panel)
Temperature Range	-20 to +55°C around chassis

FREQUENCY SPACING

The minimum recommended frequency spacing between two type TC-10 carrier sets operated in parallel without hybrid units is shown on the curve of Fig. 32. For example, at 100 kHz, the minimum spacing is 8 kHz. Closer spacing would result in the generation of inter-modulation products caused by the non-linear load presented by each transmitter to the other one.

The minimum frequency spacing between a TC-10 carrier channel and an adjacent transmitter signal keyed on-off at a rate of 60 pulses per second can be determined from the nomograph of Fig. 33. Using the example shown by the dashed line, consider a type TC-10 set used on a channel with a normal attenuation of 15 decibels. The TC-10 receiver would be set to give a margin of 15dB below the normal received signal, or for a sensitivity of -30dB (relative to a 24.5 volt, 10-watt signal). The interfering signal is assumed to be a 10-watt transmitter at the same location. To determine the minimum frequency spacing of the TC-10 receiver from this interfering signal, lay a straight edge between the -30 dB point on the receiver sensitivity scale and the zero dB point on the interfering transmitter scale. The resulting line crosses the channel spacing scale between 3 and 4 kHz. For this example, a channel spacing of at least 4kHz should be used. (In order not to conflict with the limits of Fig. 32, an r-f hybrid may be needed between the TC-10 set and the other transmitter, depending on the actual application.)

For protective relaying applications to 3-terminal lines, the transmitter frequencies are offset 100 hertz to prevent a slow beat or cancellation of the received signal when two transmitters send blocking signals to the third terminal. The three transmitters operate at fc, fc + 100 Hz. and fc - 100 Hz. All receivers operate at the channel center frequency (fc).

INSTALLATION

The type TC-10 transmitter-receiver is generally supplied in a cabinet or on a relay rack as part of a complete carrier assembly. The location must be free from dust, excessive humidity, vibration, corrosive fumes, or heat. The maximum ambient temperature around the chassis must not exceed 55°C.

ADJUSTMENTS

TRANSMITTER

The TC-10 transmitter is shipped with the power output controls R64, R82, R41 and R70, set for outputs of 1 watt, 3.2 watts and 10 watts into a 60-ohm load. If it is desired to check the adjustments or if repairs have made readjustment necessary, the coaxial cable should be disconnected from the assembly terminals and replaced with a 50 to 70 ohm non-inductive resistor of at least a 10-watt rating. Use the value of the expected input impedance of the coaxial cable and line turner. If this is not known, assume 60 ohms. Connect the T4 output lead to the corresponding tap. Connect an ac vacuum-tube voltmeter (VTVM) across the load resistor. Turn power output control R64 to minimum (full counter-clockwise). Key for reserve signal detector by jumpering terminals 21 & 11 on keying module. Turn on the power switch on the panel and note the dc voltage across terminals 3 & 35 on keying module. If this is in the range of 40 to 46 volts, rotate R64 clockwise to obtain 4 or 5 volts across the load resistor used. At this point check the adjustment of the series output tuning coil L105 by loosening the knurled shaft-locking nut and moving the adjustable core in and out a small amount from its initial position. Leave it at the point of maximum voltage across the load resistor used. Then rotate R64 farther clockwise to obtain the correct voltage for 1 watt in the load resistor, as shown in the following table.

Then change to relaying output by connecting together terminals 5 to 3 on keying module, and rotate R70 until the voltage across the load resistor is as shown in the following table for a 10 watt output. Recheck the adjustment of L105 for maximum output voltage and readjust R70 for a 10-watt output if necessary. Tighten the locking nut on L105. Open the power switch and remove the jumper used to key the transmitter to the 10 watt level. Key for voice by connecting terminal 1 to 31 on voice adapter module. Turn the power back on. Adjust "C"(R41) on the voice adapter module and/or R82 on transmitter module for a 3.2 watt output across the load resistor (14V across 60 ohms). Open the power switch, remove connections to terminals of J3, remove the load resistor, and reconnect the coaxial cable circuit to the transmitter. Note on frequencies above 200 kHz, L105 adjustment is a screw-driver adjustment. There is no knurled shaft-locking nut.

VOLTAGE (RMS)

T4 TAP	RESERVE SIGNAL 1 WATT OUTPUT	VOICE 3.2 WATTS OUTPUT	RELAYING OUTPUT 10 WATTS OUTPUT
50	7.1	12.7	22.4
60	7.8	14	24.5
70	8.4	15	26.5

Follow the procedure outlined in the line tuner instructions for its adjustment.

Normally the output filter FL102 (L105 & C7) will require no readjustment except as noted above. It is factory tuned for maximum second and third harmonic rejection, and for series resonance (maximum output at the fundamental frequency) with a 60-ohm load. A small amount of reactance in the transmitter output load circuit may be tuned out by readjustment of the movable core of L105. This may be necessary with some types of line coupling equipment. The adjustable cores of L102 and L103 have been set for maximum harmonic rejection and no change should be made in these settings unless suitable instruments are available for measuring the second and third harmonic present in the transmitter output.

The operating frequencies of crystals Y1 and Y2 have been carefully adjusted at the factory and good stability can be expected. If it is desired to check the frequencies of the individual crystals, this can be done by inserting a crystal in its proper socket with the other crystal unconnected. A sensitive frequency counter with a range of at least 2.3 MHz can be connected from TP51 to TP54. (Connection to TP54 rather than to TP53 provides a better signal to the counter and avoid some error from the effect of the counter input capacitance on the oscillator circuit.) While measurement of the oscillator crystals individually is necessary for the initial adjustment of the oscillators, generally any subsequent checks may be made with a lower range counter connected at the transmitter output. If any minor adjustment of the frequencies should be needed, the adjustment should be made with capacitor C52.

RECEIVER

The receiver has two controls: one is I.F. input control R_2 which is factory set for 180 mA DC output at J_2 (200 mA) on detector board with an input of 125mV, at rated frequency, into J1 (Receiver Input) with R_5 (Input Attenuator) on input board set for minimum attenuation. The input attenuator R_5 is the other receiver control and is front-panel mounted on the input-module. It is recommended that the receiver normally be set for a 15-db operating margin to allow for reasonable variations in receiver input signal level without affecting the output blocking current. This adjustment can be made in two ways, as follows:

1. First, measure the normal received signal from the remote terminal (after the line tuners have been adjusted) by starting the remote transmitter and measuring the voltage across the coaxial cable at the receiving terminal. This signal should preferably be measured with a tuned voltmeter such as the Sierra carrier-frequency voltmeter. If a simple VTVM reading is used, have the remote transmitter turned on and off several times to be sure the VTVM reading is actually the remote signal. Note the reading. Now disconnect the coaxial cable, and feed a signal into the carrier assembly at the coaxial terminals from a separate signal generator. Set the signal generator to the received frequency at a level 15dB below the previous measured incoming signal. With a 0-250 mA. (mimimum) dc milliammeter plugged into the 200 mA output jack on the detector module, adjust the input attenuator R5 until an output current of about 100 mA is obtained. As this point is on the steep portion of the receiver output-input curve, it may be difficult to set R5 for exactly 100 mA. This is not necessary, however, as the signal is not normally at this value. This is the operating setting of the input attenuator. Return the coaxial cable connections to normal. **NOTE:** Do not energize the local transmitter when making the foregoing adjustment as the signal generator may be damaged.

2. As an alternate procedure if no signal generator is available, the local transmitter itself may be used as the signal generator. First detemine the normal received signal from the remote terminal as explained previously under (1). Then turn off the remote transmitter. Now turn on the load transmitter and reduce its output to a value 15 dB below the normal received signal level. Then adjust the receiver gain control to gain 100 mA. output as before. When this adjustment has been made, reset the local transmitter to its normal 10-watt output level.

In applications where the line attenuation is low and a strong signal is received, the adjustment of the input attenuator becomes critical. For such applications, the setting of i-f gain control R2 may be reduced to lower the overall receiver gain. The front-panel control R5 will then have a smoother and more gradual control as the knob is rotated, making it easier to obtain the 15dB margin setting. For such a strong-signal condition, it is recommended that with R5 at maximum, the i-f gain control R2 be adjusted to give 100 mA receiver output current from an input r-f voltage 25 dB below the normal received signal level. Then the front panel input attenuator R5 is set for the normal 15-dB margin as previously described.

✪ Carrier Level Indicator Adjustment

Self-Contained Instruments

Connect a signal generator to TJ2 and TJ1 on receiver input module and adjust for rated channel frequency and the voltages listed with the procedure below. Adjust the detector module as follows:

a) Adjust the signal generator input to the receiver to 700 mv. Adjust R27 CLI level for 100 mv. at TP9 to TP11 on the detector module. (This is the 0 dB point on the CLI meter).

b) Adjust the signal generator input to the receiver to 2.2 volts. Adjust R36 span adjust for 3.0 volts at TP9 to TP11. (This is the +10dB point on the CLI meter).

c) Adjust the signal generator input to the receiver to 70 mv. Adjust R47 full scale adjust for −20dB on the internal instrument.

✪ External Instrument

a) Same as step (a) above for self-contained instrument

b) Same as step (b) above for self-contained instrument

c) Adjust the signal generator input to the receiver to 70 mv. Adjust R50 full scale adjust for −20dB on the external instrument.

VOICE ADAPTER MODULE

NOTE: Before attempting to make any settings on the voice adapter module, the associated TC-10 transmitter and receiver must be set properly as follows:

1. Using the adjustment procedures outlined previously, the output power levels under reserve signal detector, relaying, and voice conditions must be set accurately to obtain proper voice modulation.

Voice Receiver Sensitivity

The voice receiver sensitivity must be set using the sensitivity control (R1) labeled "Sens." located on the front of the module.

1. Set the remote TC-10 Transmitter for a power output level of 10-watts.
2. Connect a DC voltmeter (0-10 volts **min. sensitivity of 15,000 ohms per volt**) between TP-A and TP-B on the front of the voice adapter module.
3. Starting with "Sens." (R1) Voice adapter module at max. counterclockwise slowly turn R1 clockwise, while observing the voltmeter, to a point (Fig. 41, point A) where the voltage begins to increase rapidly. This is the proper setting of the receiver sensitivity. When the TC-10 transmitter operates at the voice power level of 3.25 watts, the voice receiver sensitivity will be set at point B, Fig. 41.

Speech Amplifier Output

The speech-amp output level is adjusted using modulating adjustment labeled "Mod." (R37) mounted on the front of the circuit board. The procedure is as follows:

1. Connect an oscilloscope and an ac VTVM across the TC-10 Transmitter output terminals.
2. Plug in the telephone handset. The voltmeter should indicate a transmitter output level of 3.25 watts (14 volts across 60 ohms).
3. Connect an audio signal generator set at 1000 Hz. at a level of 1 volt (rms) between TP5 and circuit board terminal 17 (D.C. neg.) of the speech-amp module.
4. Adjust "Mod." (R37) on the speech-amp board. Starting from max. CCW., increase the level slowly while observing the modulation pattern on the scope until a point of maximum undistorted modulation is reached. This is the proper setting.

Receiver Volume Control

The "Receiver Level" volume control R14 is located on the front of the voice adapter module. It has a knob on it and is adjusted for a comfortable listening level. This naturally differs according to each person's preference or needs.

ACCESSORIES

1) Telephone Handset
   a) Westinghouse style - 204C892H01 - noise canceling microphone.
   b) Westinghouse style - 204C892G01 - non-/noise canceling microphone.
2) Remote Hookswitch - Handset Assembly (for surface mounting)
   a) Westinghouse style - 205C246G01 - with noise canceling handset.
   b) Westinghouse style - 205C246G02 - with non/noise canceling handset.
3) Remote Hookswitch - Handset Assembly (for panel mounting)
   a) Westinghouse style - 205C266G01 - with noise canceling handset.
   b) Westinghouse style - 204C266G02 - with non/noise canceling handset.

For mounting and wiring details of the above accessories see Figs. 36 thru 39.

4) Module Extender and Test Board - 1447C86G01.
5) Exterior Carrier Level Indicator Instrument - 606B592A26.

MAINTENANCE

Periodic checks of the received carrier signal will indicate impending failure so that the equipment can be taken out of service for correction. At regular maintenance intervals, any accumulated dust should be removed, particularly from the heat sinks. It is also desirable to check the transmitter power output and receiver sensitivity at such times, making any necessary readjustments to return the equipment to its initial settings.

Voltage values should be recorded after readjustment in order to establish reference values which will be useful when checking the apparatus. The readings will remain fairly constant over an indefinite period unless a failure occurs. However, if transistors are changed, there may be considerable difference in these readings without the overall performance being affected.

Typical voltage and current values are given in Tables I through VI. Voltages should be measured with a VTVM. Readings may vary as much as ± 20%.

REPLACEMENT OF Q2 and Q4

The two transistors Q2 and Q4 in the transmitter power-amplifier stage are a matched pair with the gain of the two units matched within 5%. If one of the transistors fails, both should be replaced with a new matched pair. This is necessary to keep the second harmonic of the transmitter output at an acceptably low value. The pair of transistors should be ordered as 1 of S#3508A21H04 matched pair transistors.

CHANGE OF OPERATING FREQUENCY

The parts required for changing the operating frequency of a type TC-10 carrier set are as follows:

TRANSMITTER

1. Oscillator Crystals (Y1 & Y2), specify frequency
2. Capacitors C1, C2, C3 and C4 (on Output Filter board)
3. For ease of replacement, this is a complete plug-in module. However, the unit can be changed as noted below.

Inductors L102 and L103 in these filters are adjustable over a limited range, but forty-two combinations of capacitors and inductors are required to cover the frequency range of 30 kHz. to 300 kHz. The widths of the frequency groups vary from 1.5 kHz. at the low end of the channel frequency range to 13 kHz at the upper end. A particular assembly can be adjusted over a somewhat wider range than the width of its assigned group since some overlap is necessary to allow for component tolerances. The nominal adjustment ranges of the groups are:

30.0-31.5	61.0-64.0	113.0-119.5	207.1-214.0
32.0-33.5	64.5-68.0	120.0-127.0	214.1-222.0
34.0-36.0	68.5-72.0	127.5-135.0	222.1-230.0
36.5-38.5	72.5-76.0	135.5-143.5	230.1-240.0
39.0-41.0	76.5-80.0	145.5-151.0	240.1-250.0
41.5-44.0	80.5-84.5	151.5-159.5	250.1-262.0
44.5-47.0	85.0-89.0	160.0-169.5	262.1-274.0
47.5-50.0	89.5-94.5	170.0-180.0	274.1-287.0
50.5-53.5	95.0-100.0	180.5-191.5	287.1-300.0
54.0-57.0	100.5-106.0	192.0-200.0	
57.5-60.5	106.5-112.5	200.1-207.0	

If the new frequency lies within the same frequency group as the original frequency, the filters can be readjusted. If the frequencies are in different groups, it is possible that changes only in the fixed capacitors may be required. In general, however, it is desirable to order complete filter assemblies adjusted at the factory for the specified frequency.

The procedure for readjustment of the 2nd and 3rd harmonic traps of filter FL102 (L105 & C7) is as follows. A signal generator and a counter should be connected to terminals 4 and 5 of transformer T3 and a 500-ohm resistor and a VTVM to the terminals of protective gap G1. The ground or shield lead of all instruments should be connected to the grounded terminal of the transformer. Set the signal generator at exactly twice the channel center frequency and at 5 to 10 volts output. Turn the core screw of the large inductor, L102, to the position that gives a definite minimum reading on the VTVM. Similarly, with the signal generator set at exactly three times the channel center frequency and 5 to 10 volts output, set the core screw of the small inductor, L103, to the position that gives a definite minimum reading on the VTVM. Then remove the instruments and the 500-ohm resistor.

If the change in frequency is enough to require a different filter, it will come factory adjusted as described in the foregoing paragraph. Since it is a plug-in module, it is a simple matter to remove the old one and replace it with the new one.

After all the tabulated changes have been made for the new frequency, the transmitter can be operated with a 50 to 70-ohm load (depending on which tap of T4 is used) connected to its output, and inductor L105 can be readjusted for maximum output at the change channel frequency by the procedure described in the ADJUSTMENT section.

If the frequency-sensitive voltmeter is available the second and third harmonic traps may be adjusted (or checked) without using an oscillator as a source of double and triple the channel frequency. Connect the frequency-sensitive voltmeter from TP109 to ground and adjust the transmitter for rated output into the selected load resistor. Set the voltmeter at twice the channel frequency and, using its tuning dial and db range switch, obtain a maximum on-scale reading of the second harmonic. Then vary the core position of L102 until a minimum voltmeter reading is obtained. Similarly, tune the voltmeter to the third harmonic and adjust L103 for minimum voltmeter reading. It should be noted that this procedure may not give the true magnitude of the harmonics because of the large value of fundamental frequency voltage present at the tuned voltmeter input terminals. This condition will overload the input circuit of some commercial instruments. However, the procedure is satisfactory for adjusting the traps for maximum harmonic rejection.

If accurate measurement of the harmonic levels is desired, the frequency-selective voltmeter is connected, through a rejection filter, to the terminals of the 60-ohm load resistor. The filter must provide high rejection of the fundamental. A twin-T filter is suitable for this purpose. The insertion losses of this filter at the second and third harmonics must be measured and taken into account.

RECEIVER

1. Receiver Oscillator Crystal (Y11), specify frequency.
2. Receiver input filter (FL201), specify frequency. Order complete input module for ease of replacement.
3. If the operating frequency is reduced, the receiver gain will probably be higher. In this case, a reduction in the setting of the i-f input control R2 will give the 125-mV sensitivity. If the new operating frequency is higher, the receiver gain may be lower. If more than 125-mV is required to obtain 180 mA output, the gain can be increased by reducing the value of one or both of the resistors R29 and R36 on OSC & mixer BD. In most cases, these resistors shall fall in the range of 68 to 47 ohms.

✪ TABLE I

RECEIVER DC MEASUREMENTS

TEST POINT	STANDBY (NO SIGNAL)	WITH INPUT SIGNAL (MIN. OF 125mV)	REFERENCE TEST POINT
Osc. Mixer Module			
TP211	18V	18V	TP215 Ref.
TP212	0	0	TP215 Ref.
TP213	15.5V	15.5V	TP215 Ref.
TP214	6.5	6.5	TP215 Ref.
TP216	6.0	6.0	TP215 Ref.
TP217	6.2	6.2	TP215 Ref.
TP14	1.5	1.3	TP215 Ref.
TP15	1.6	1.4	TP215 Ref.
TP16	16	16	TP215 Ref.
Detector Module			
TP2	17	17	TP1 Ref.
TP5	10.3	10.3	TP1 Ref.
TP6	20.2	20.2	TP1 Ref.
TP7	10.4	10.7	TP1 Ref.
TP8	16.5	16.5	TP1 Ref.
TP9	10.5	14.0	TP1 Ref.
TP10	10.5	10.3	TP1 Ref.
TERM 11	10.4	10.4	TP1 Ref.
TERM 1	41.5	40.6	TP1 Ref.
TERM 3	10.4	10.4	TP1 Ref.
TERM 5	0	6.7	TP1 Ref.
TERM 7	0	6.7	TP1 Ref.
TERM 23	0	39.5	TP1 Ref.
TERM 33	20	20	TP1 Ref.

✪ TABLE II

RECEIVER AC MEASUREMENTS

TEST POINT	STANDBY (NO SIGNAL)	WITH INPUT SIGNAL (125mV SIGNAL)	REFERENCE TEST POINT
Osc. - Mixer Module			
TP211	.35	.35	TP215 Ref.
TP212	.35	.35	TP215 Ref.
TP213	0	0	TP215 Ref.
TP214	0	0	TP215 Ref.
TP216	0	0	TP215 Ref.
TP217	.36	.36	TP215 Ref.
TP14	.054	7.2	TP215 Ref.
TP15	.031	12.2	TP215 Ref.
TP16	.012	.170	TP215 Ref.
Term. 25	.006	2.0	Term. 27 Ref.
Term. 5	.011	.170	Term. 7 Ref.
Detector Module			
Term. 25	.0055	2.0	Term. 27 Ref.
TP 2	0	.435	TP6
TP 5	0	.300	TP11

✪ TABLE III

TRANSMITTER DC MEASUREMENTS

TEST POINT	CARRIER OFF	CARRIER ON NORMAL	CARRIER ON VOICE ON	REFERENCE TEST POINT
Transmitter Module				
TP52	19	19	19	TP51
TP53	5.5	5.5	5.5	TP51
TP54	0	3.5	3.3	TP51
TP55	0	2.0	19	TP51
TP56	0	19.5	18.5	TP51
TP57	0.5	0.5	0.5	TP51
TP58	98 (For 125V Units)	97.5	97.5	TP51
	44V (For 48V	43.8	43.8	TP51
Term. 1	0	98;44	98;44	TP51
Term. 3	98 (for 125), 44 (for 48)	97;43	97;43	TP51
Term. 9	97 (for 125), 43 (for 48)	97;43	97;43	TP51
Term. 11	97 (for 125,) 43 (for 48)	97;43	97;43	TP51
Term. 27	97 (for 125), 43 (for 48)	97;43	97;43	TP51
Term. 33	0	0	0	TP51
Term. 35	0	5	16.5	TP51
TP59	0.5	0.5	.05	TP51
Power Amp Module				
Term 1	100V;45	99;44	99;45	Term 25
Term 21	47	42	45	Term 25
Term 23	0.5	0	0	Term 25
Term 17	46	43.5	43.5	Term 25
Term 29	0	0	0	Term 25
Term 33	46	43.5	43.5	Term 25
L101	99;44	98;44	98;44	Term 25

✪ TABLE IV

TRANSMITTER AC MEASUREMENTS

TEST POINT	CARRIER OFF 125V UNITS	125V UNITS	CARRIER ON NORMAL 125V	NORMAL 48V	VOICE ON 125V	VOICE ON 48V	REFERENCE TEST POINT
Transmitter Module							
TP53	1.12		1.12		1.12		TP51
TP54	.13		.128		.128		TP51
TP55	.009		.680		.580		TP51
TP57	.01		.560		.460		TP51
TP59	.01		.560		.460		TP51
Term 11	.01		3.2		2.0		TP51
Term 27	.01		3.2		2.0		TP51
Power Amp Module							
TERM 13	0		1.02		0.98		TERM 23
TERM 19	0		1.03		0.98		TERM 21
TERM 17	0		44		33		TERM 33
Output Filter							
Input	0		45		33		Ground
TP109	0		32		30		Ground
Output	0		25		15		Ground

✪ TABLE V

Typical DC Voltage Measurements of Voice Adapter Module

All Voltages taken with respect to Neg. TPB

TEST POINT	VOLTAGE Receiving	VOLTAGE Transmitting
TP1	6.5	6.5
TP2	0	0
TP3	19.2	19.2
TP4	8.3	8.3
TP5	0	0
TP6	17	17
TP7	0	0
TP8	0	0
TERM 1	42	40.5
TERM 3	0	40.5
TERM 5	0	17
TERM 13	42	40.5
TERM 19	0	0
TERM 21	0	0
TERM 23	43	40.5
TERM 29	0	0
TERM 31	0	34.5
TERM 33	20.5	24.5
TERM 35	0	0

✪ TABLE VI

Typical AC Voltage Measurements of Voice Adapter Module

TEST POINT (TP-B return)	VOLTAGE Receiving (2)	Transmitter (1)
TP1	.220V	
TP2	.225V	
Q2-C	6.1mv	
Q3-C	.670V	
Q4-B	33mv	
TP6		6mv
TP7		21mv
TP8		2.7V (DC)
TP3		0.820V
TP4		8.6V
TERM 27		1.16V

1) Transmitting AC Voltages are with respect to neg. (TP-B) A-1kHz signal at 1 volt (RMS) is applied between TP5 and TP-B on the Voice Adapter Module. The telephone handset is inserted into the jack. R27 is set at max. CW

2) Receiving AC voltages are with respect to negative. An rf input signal at the channel frequency is applied to the receiver at a level of 25mv modulated 50% at 1KHz. Input sensitivity control R1 is set at max sensitivity (Max CW). R14 in the receiver section is set at max. CW. The telephone handset is inserted into the Voice Adapter Jack.

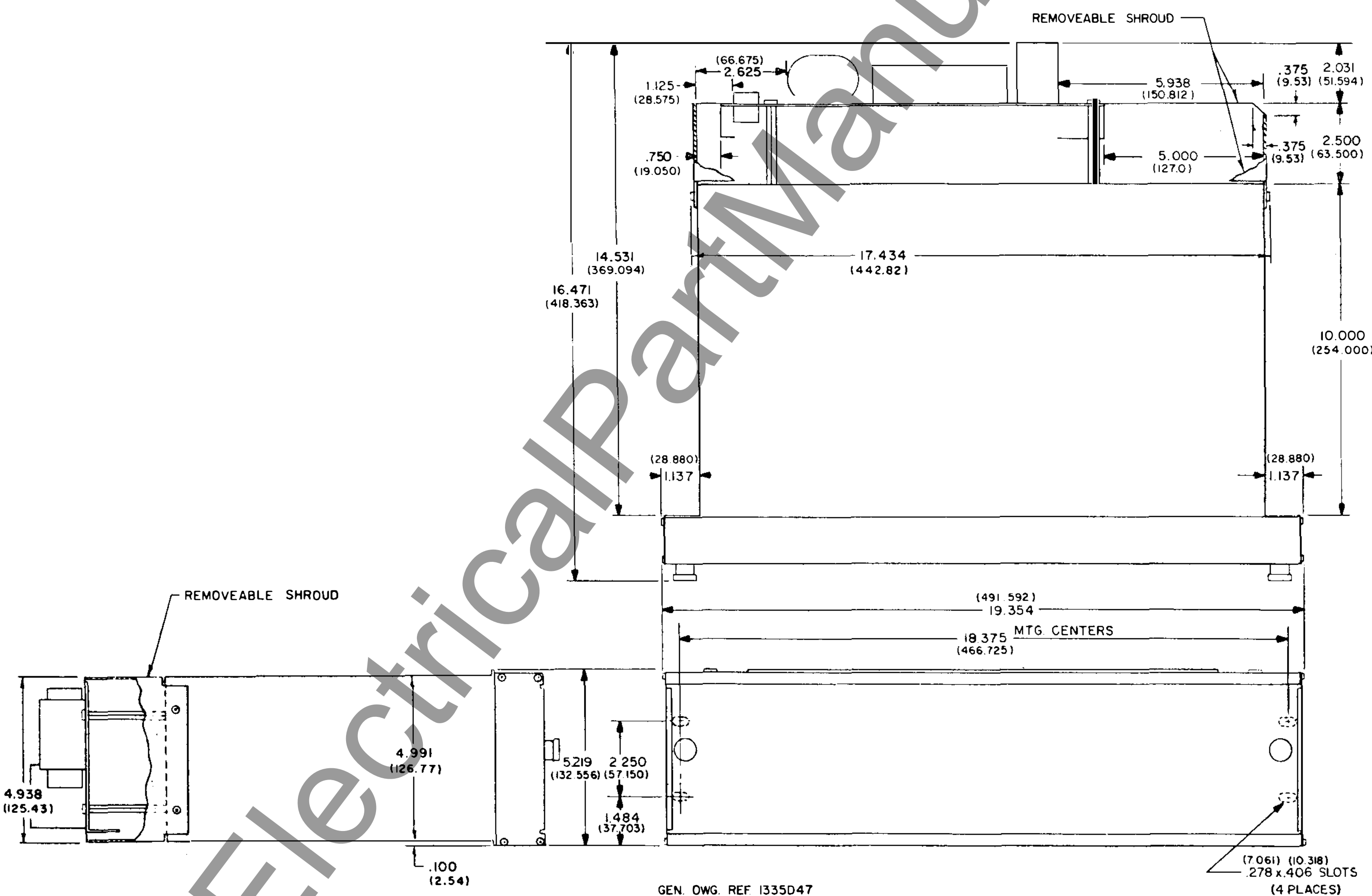
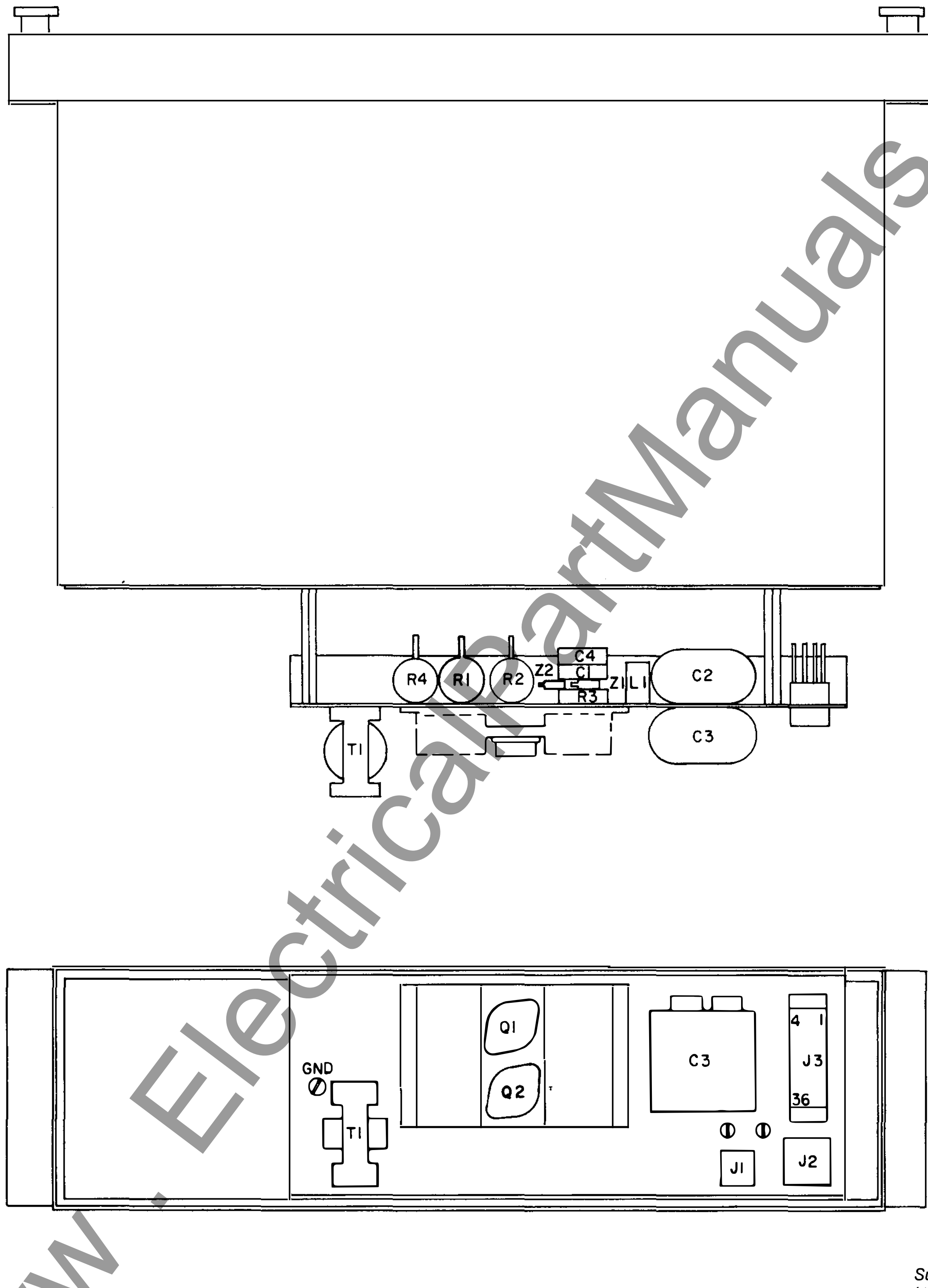


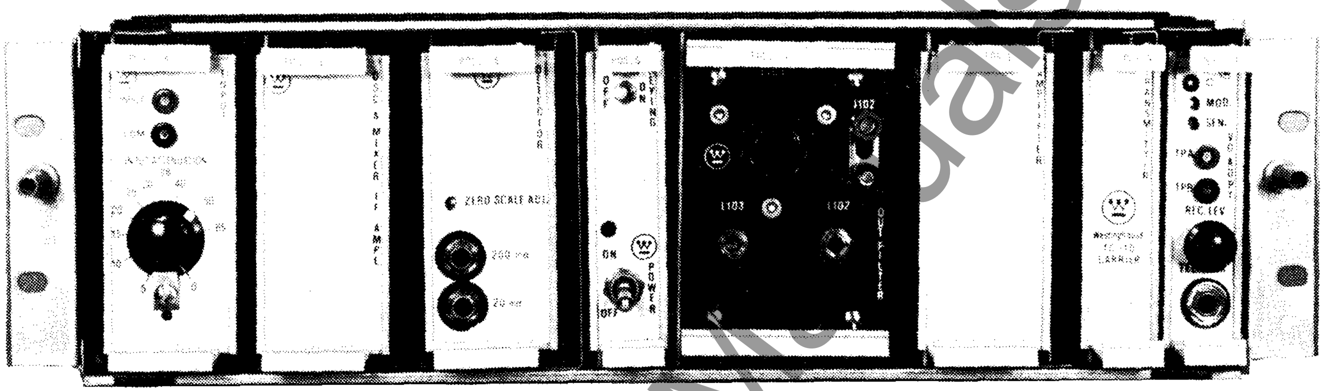
Fig. 1. Type TC-10 Carrier Assembly Outline.

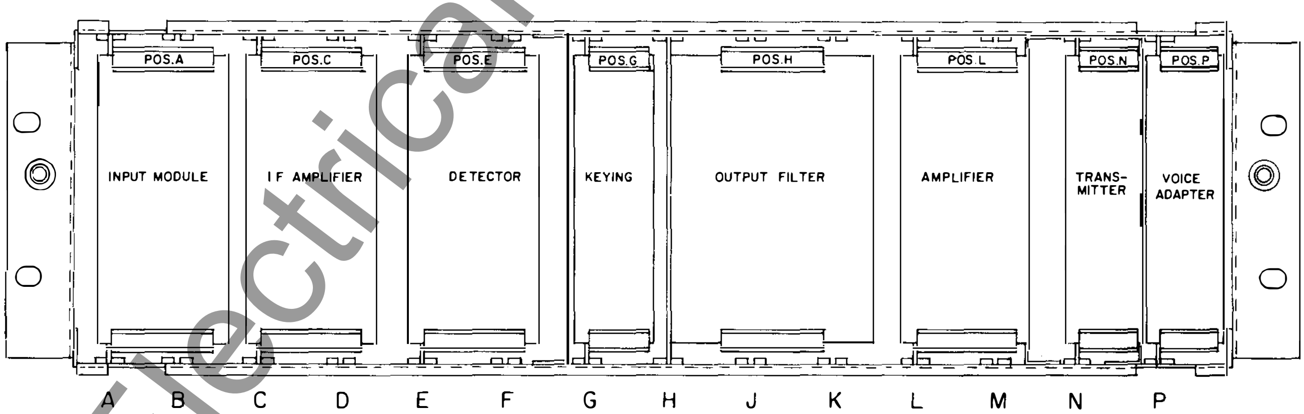
Sub. 1
(1464C70)



Sub. 4
(1464C52)

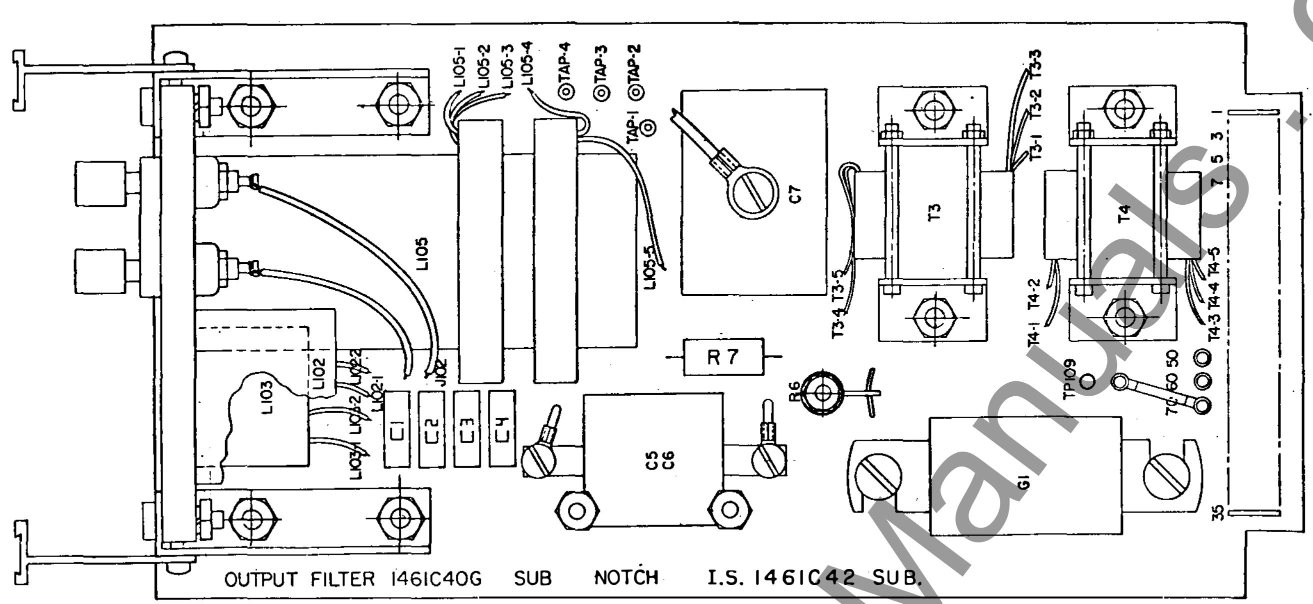
Fig. 2. Rear Chassis Parts Location.





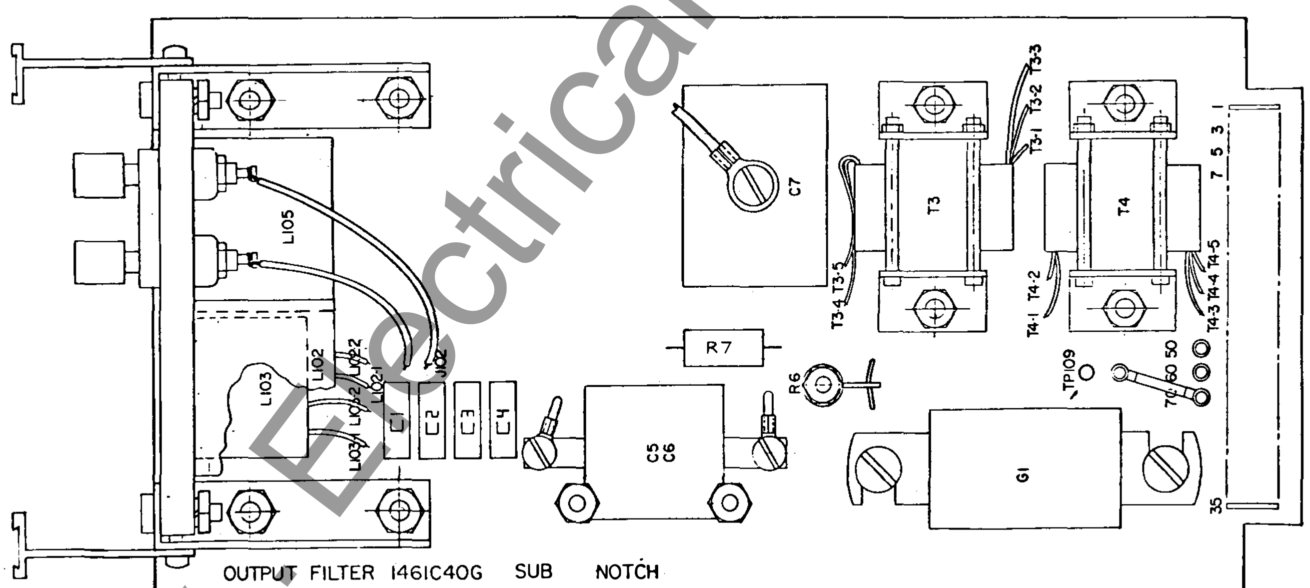
Sub. 3
(1464C69)

Fig. 3. Module Location.



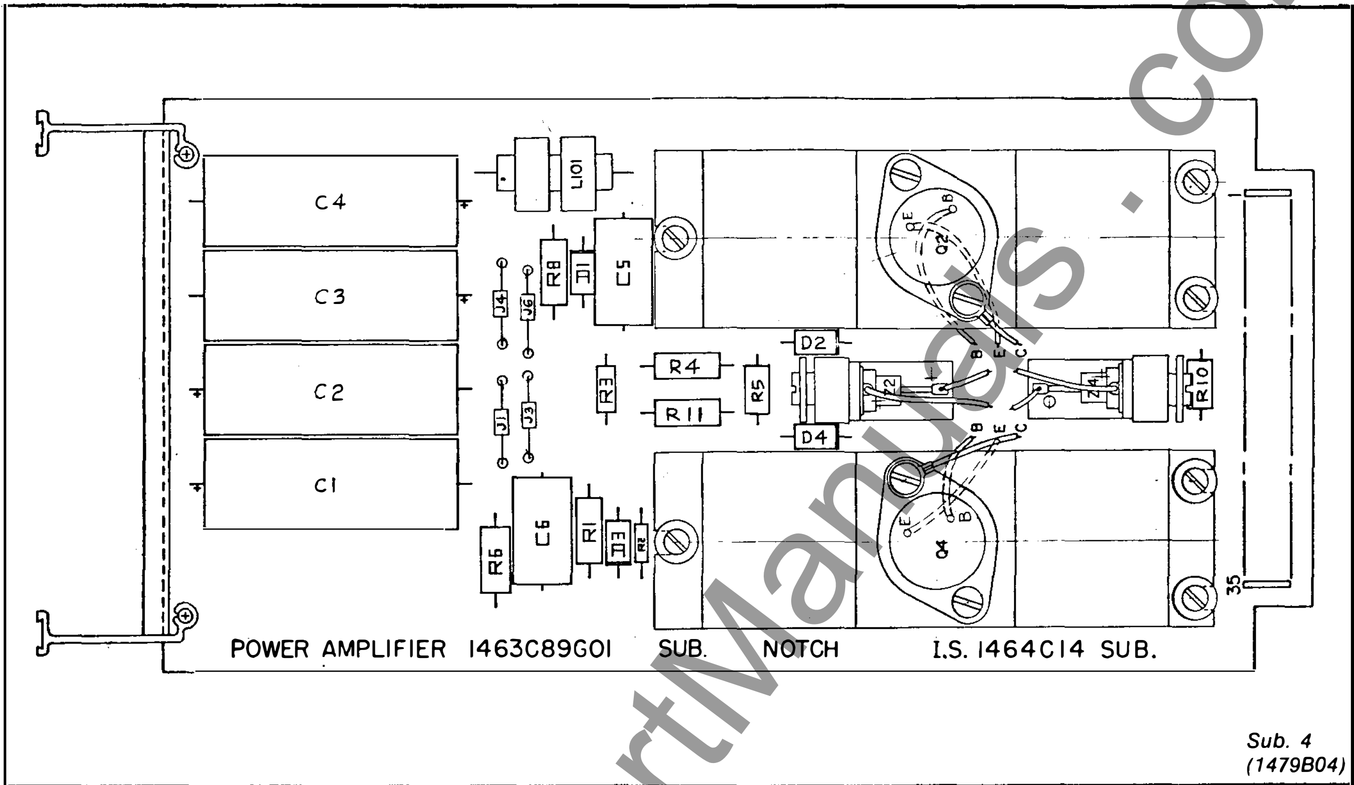
Sub. 2
(1479B33)

Fig. 4. Component Location - Transmitter Output Filter Below 200kHz.



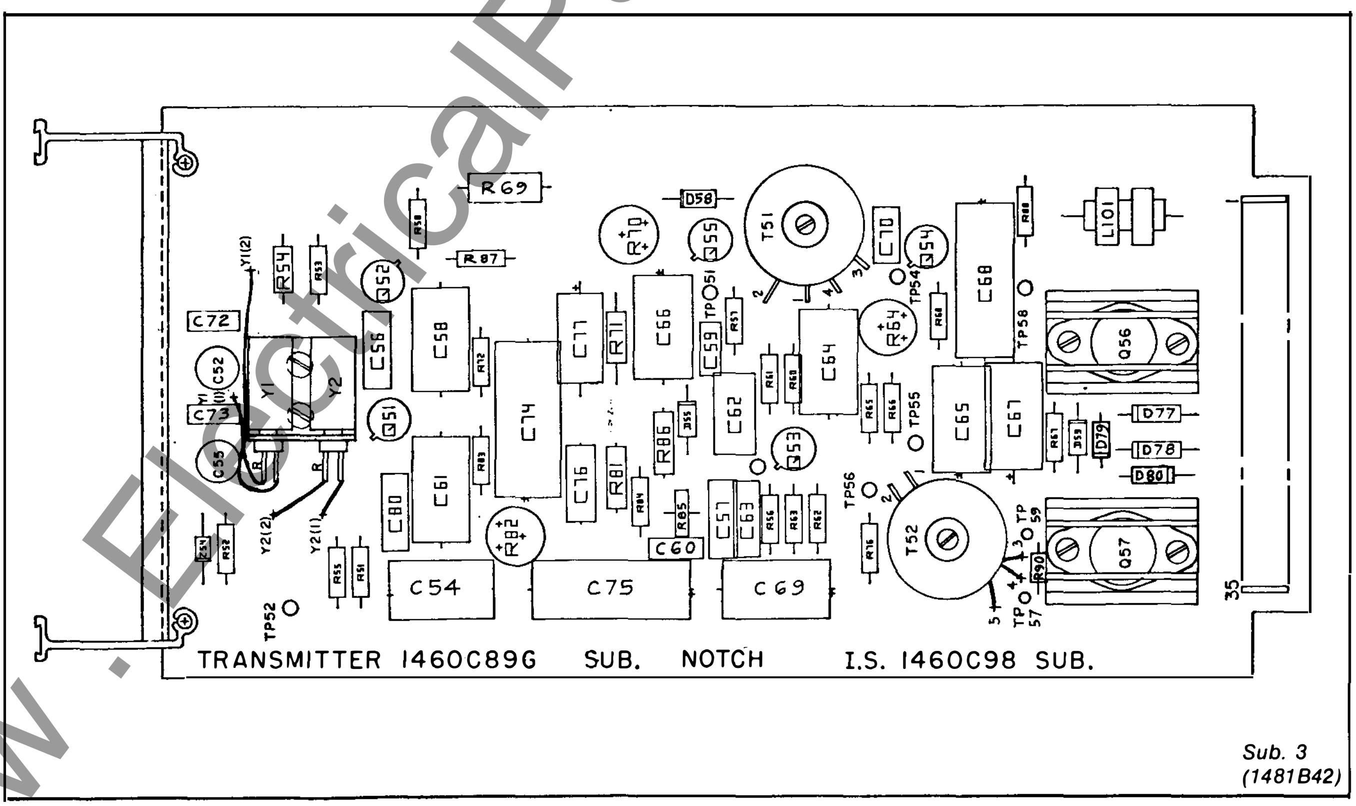
Sub. 1
(1479B48)

Fig. 5. Component Location - Transmitter Output Filter Above 200kHz.



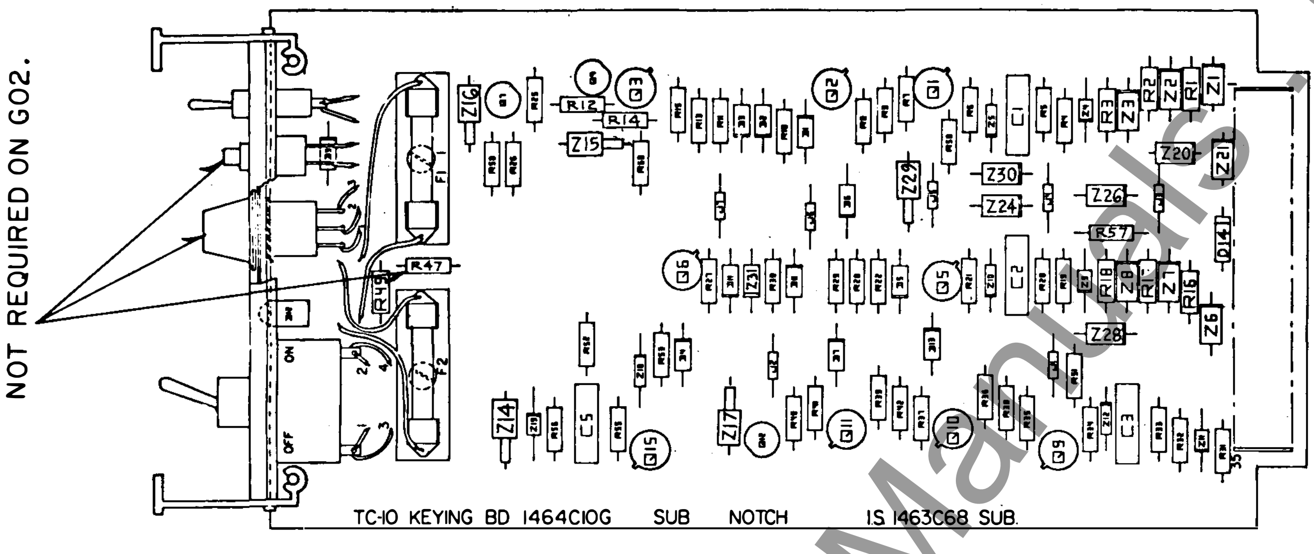
Sub. 4
(1479B04)

Fig. 6. Component Location - Transmitter Power Amplifier Module.



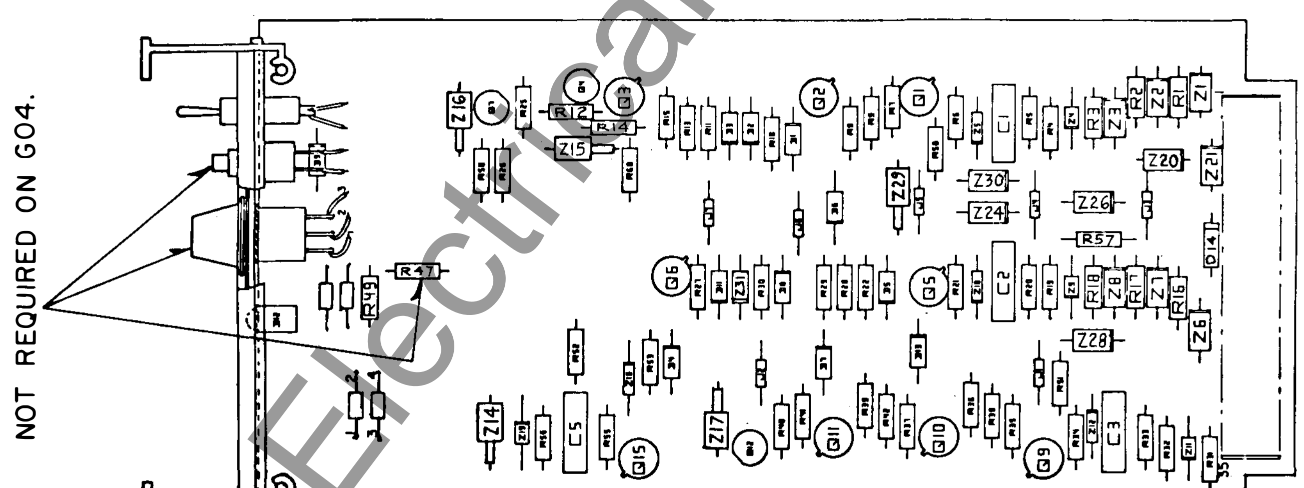
Sub. 3
(1481B42)

Fig. 7. Component Location - Transmitter Module.



Sub. 5
(1479B14)

Fig. 8. Component Location - Keying Module with Sw. & Fuses.



Sub. 5
(1479B42)

Fig. 9. Component Location - Keying Module without Sw. & Fuses.

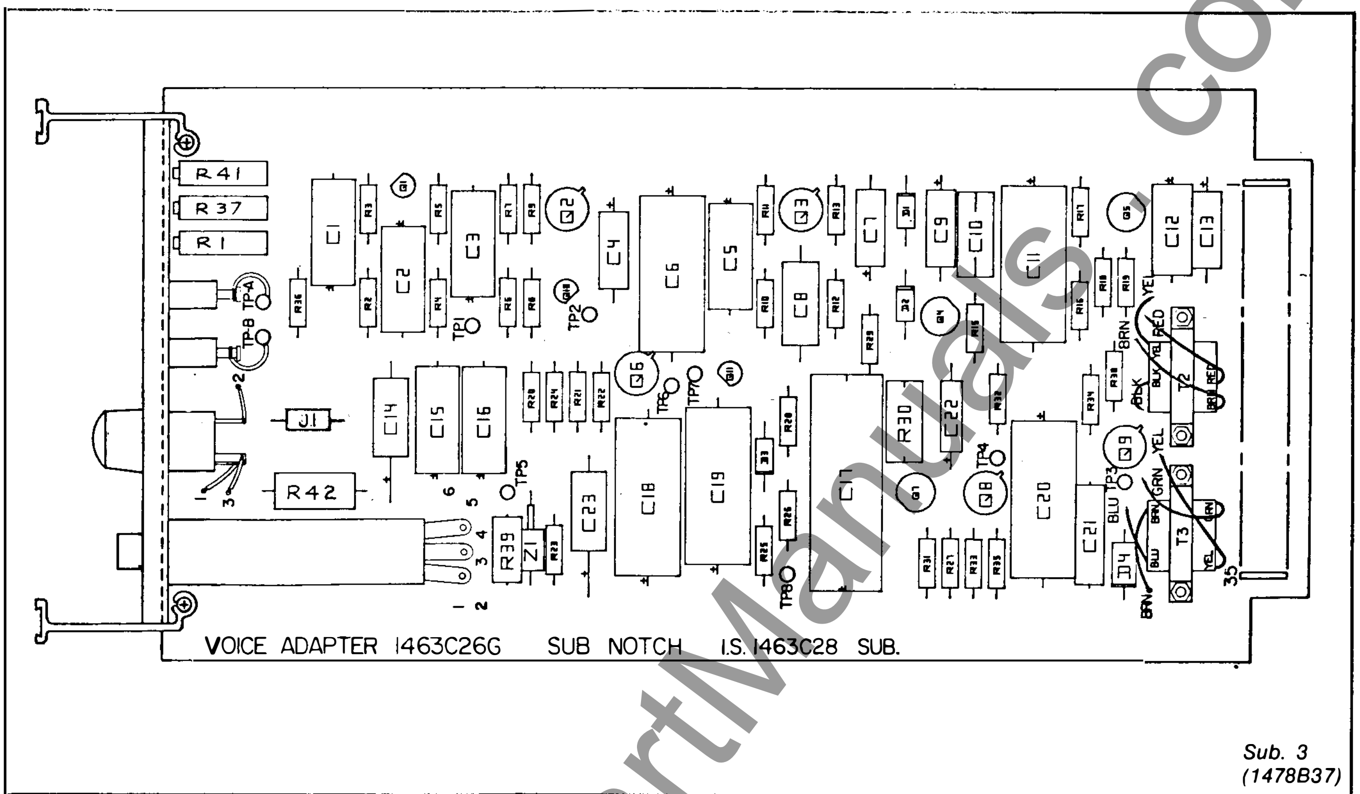


Fig. 10. Component Location - Voice Adapter Module.

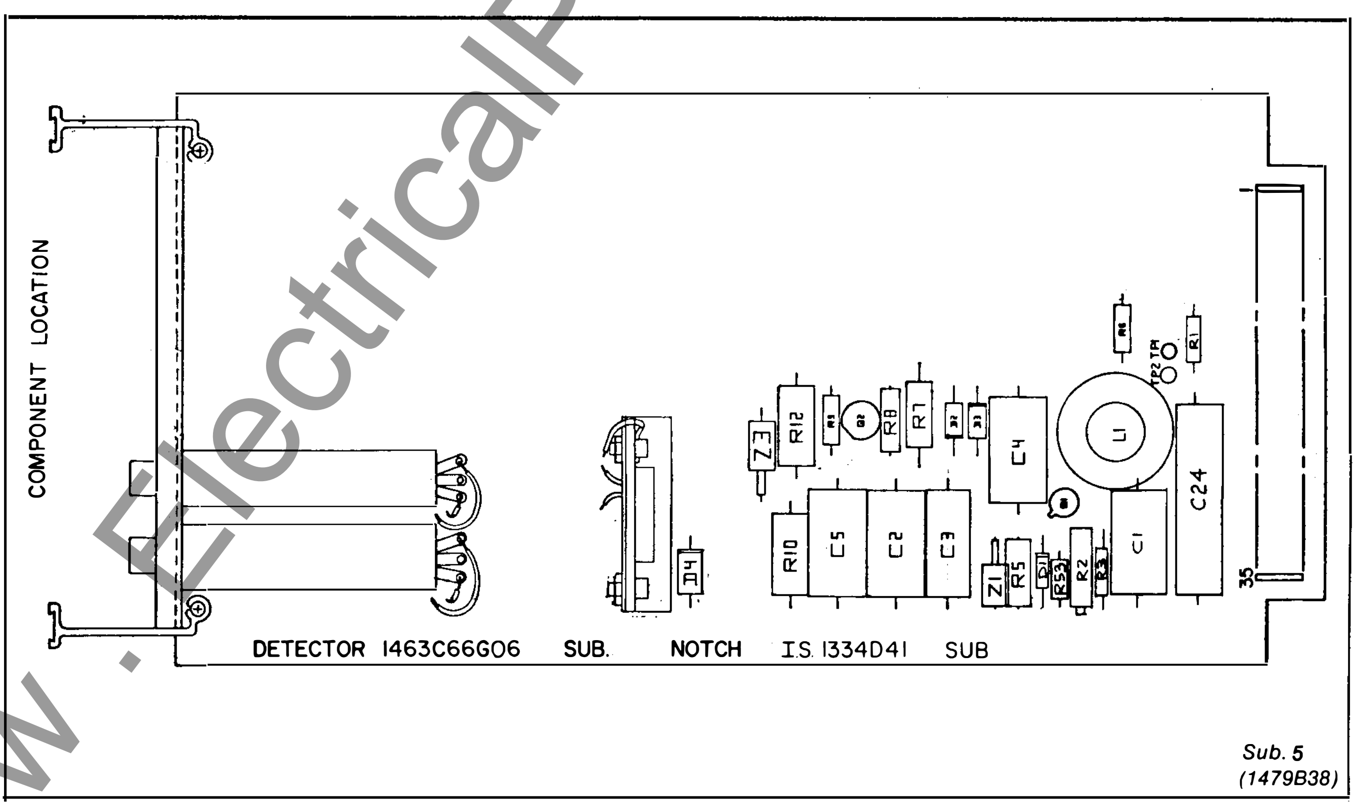


Fig. 11. Component Location - Detector Module with 200/20 mA output.

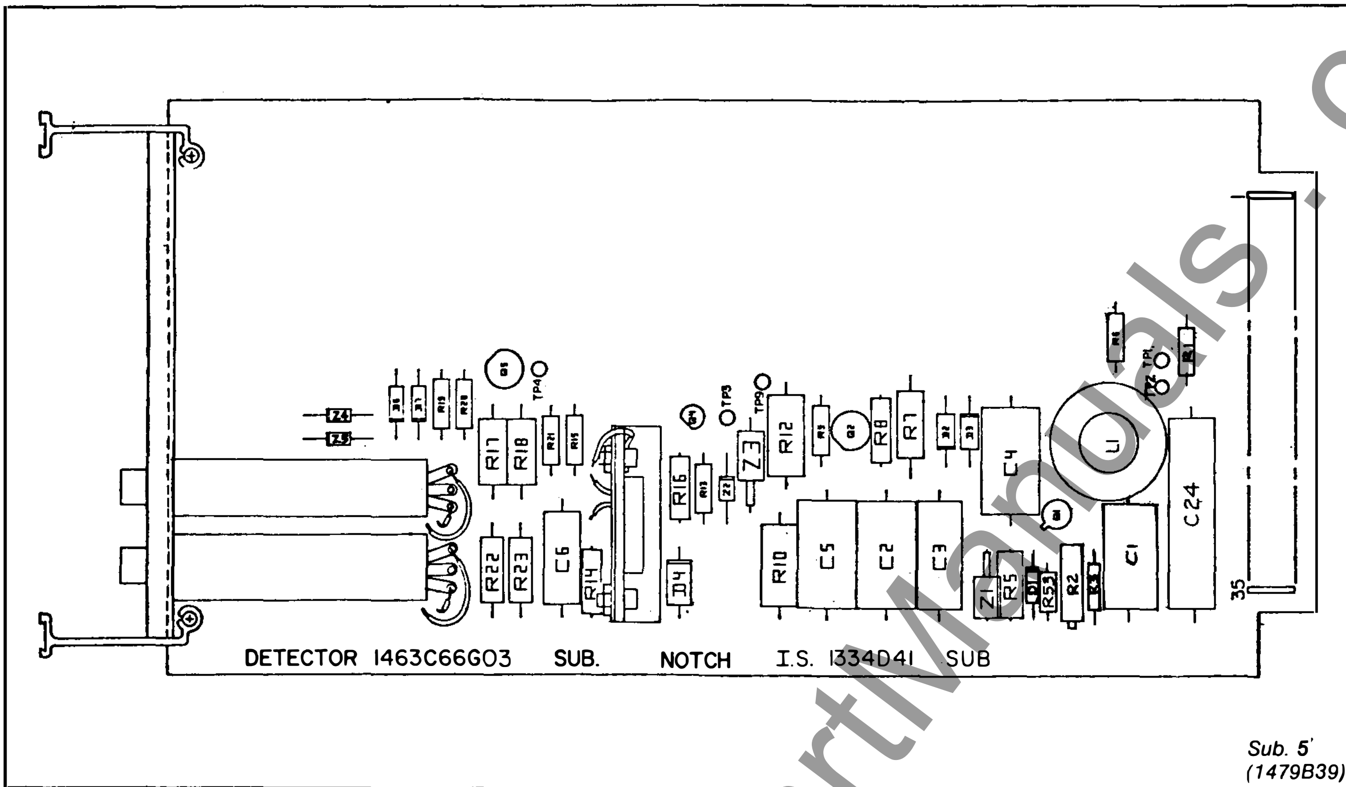


Fig. 12. Component Location - Detector Module with 200/20 mA output and two voltage outputs.

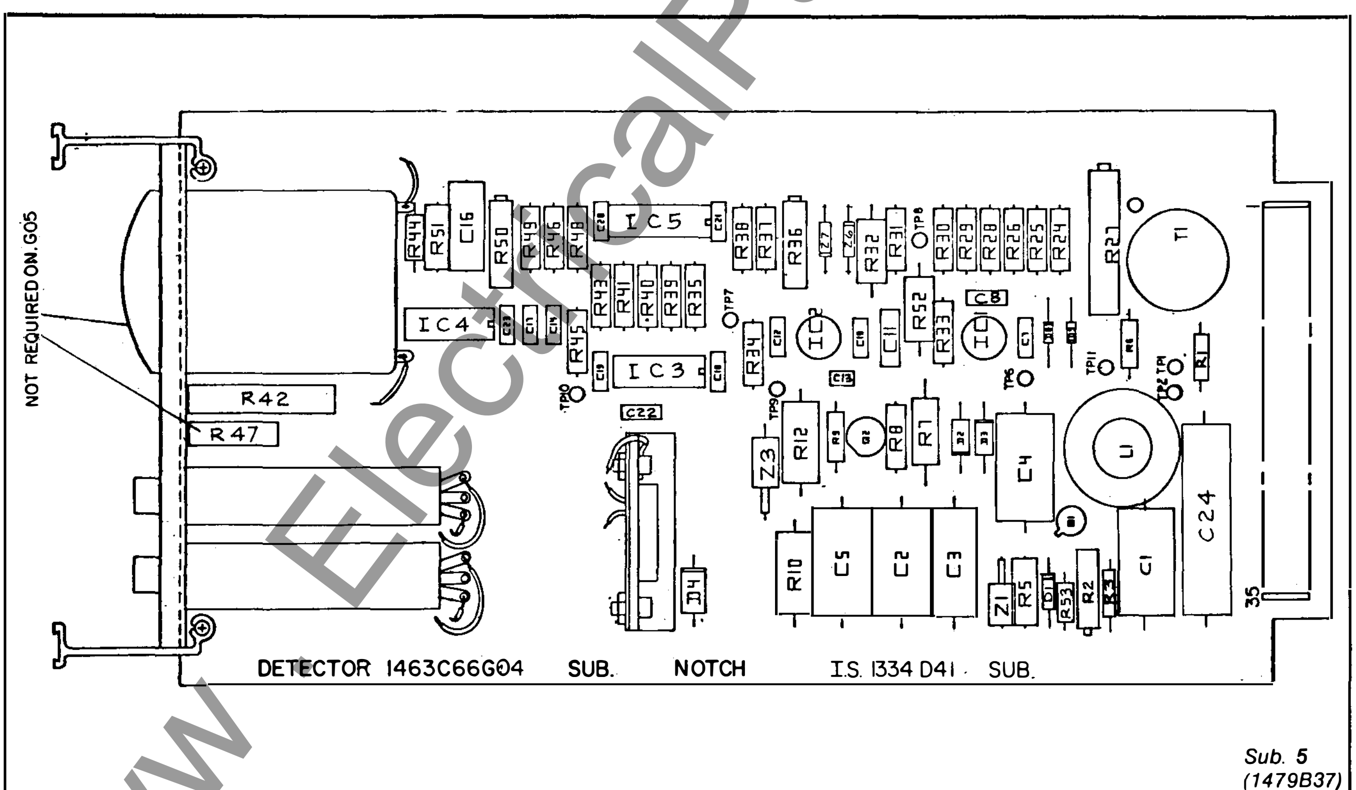
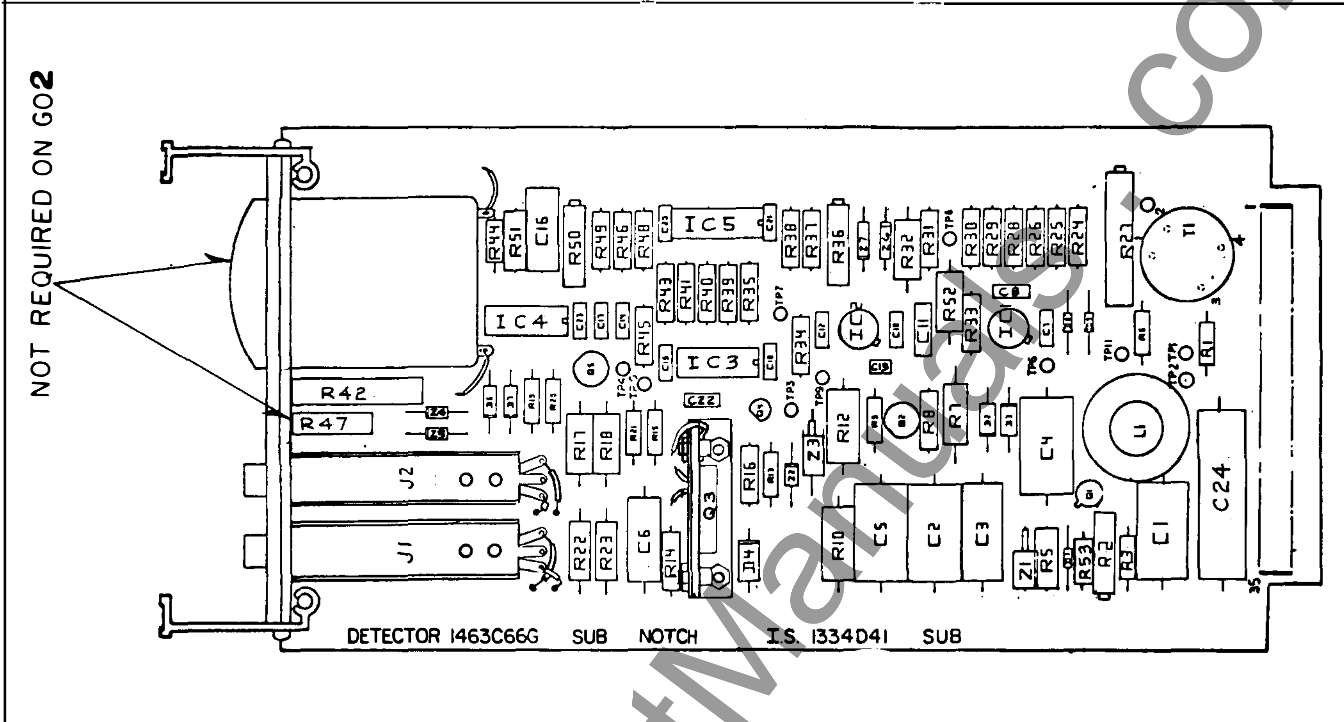
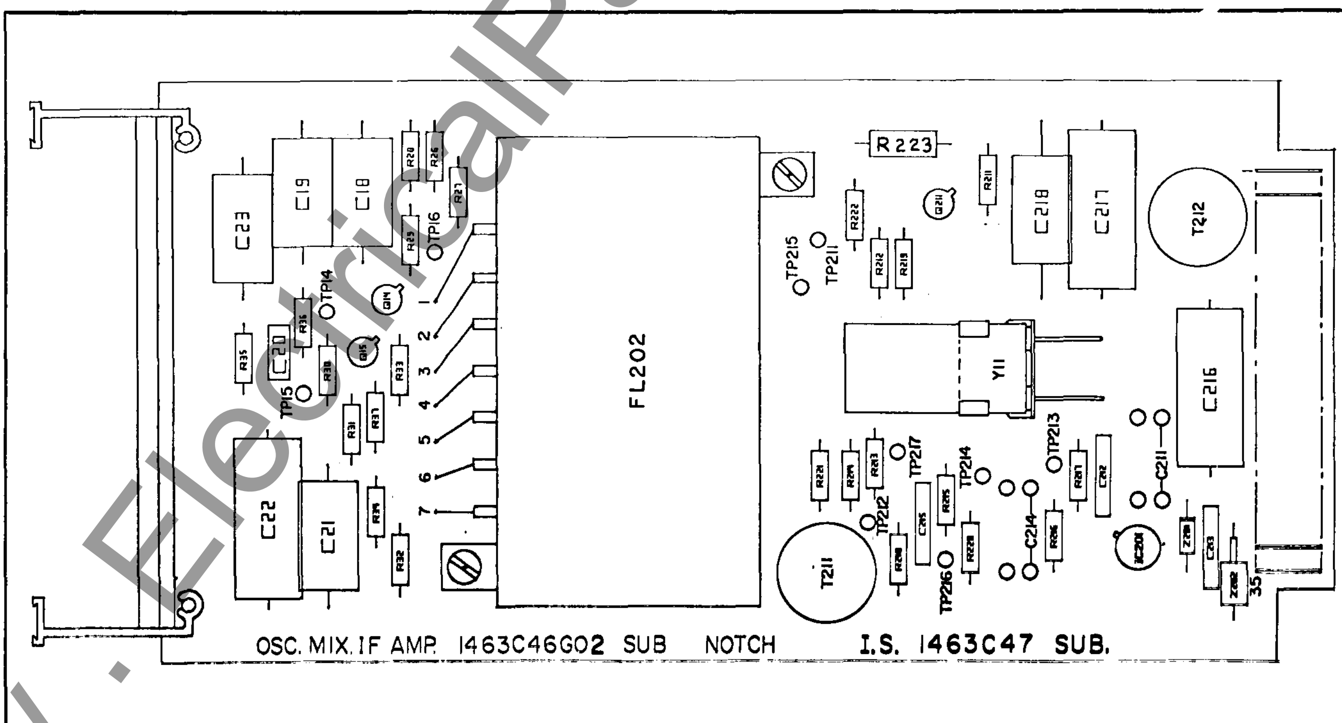


Fig. 13. Component Location - Detector Module with CLI and 200/20 mA. output.



Sub. 5
(1478B56)

Fig. 14. Component Location - Detector Module with CLI, 200/20 mA output, and two voltage outputs.



Sub. 1
(1478B82)

Fig. 15. Component Location - I.F. Amplifier - Oscillator.

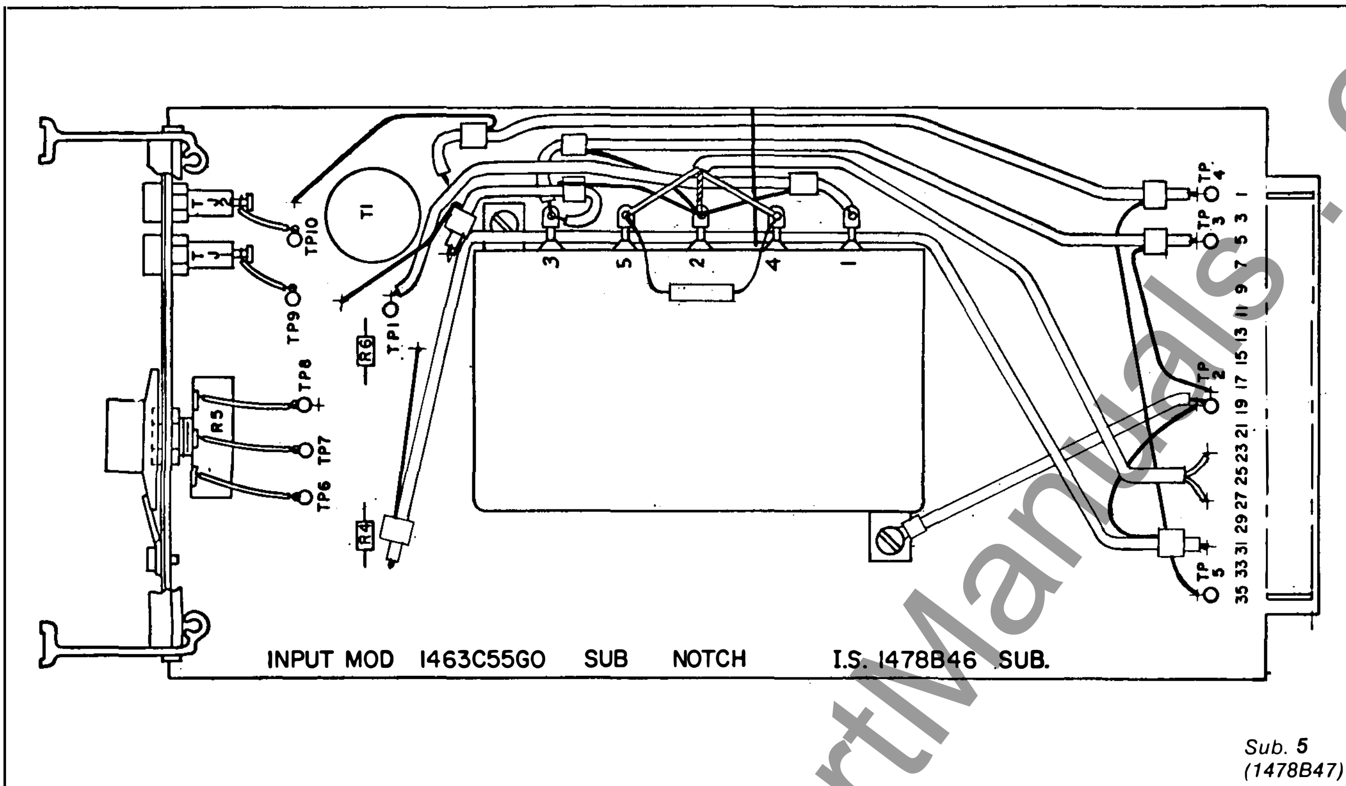


Fig. 16. Component Location - Receiver Input Module - 30 – 200kHz.

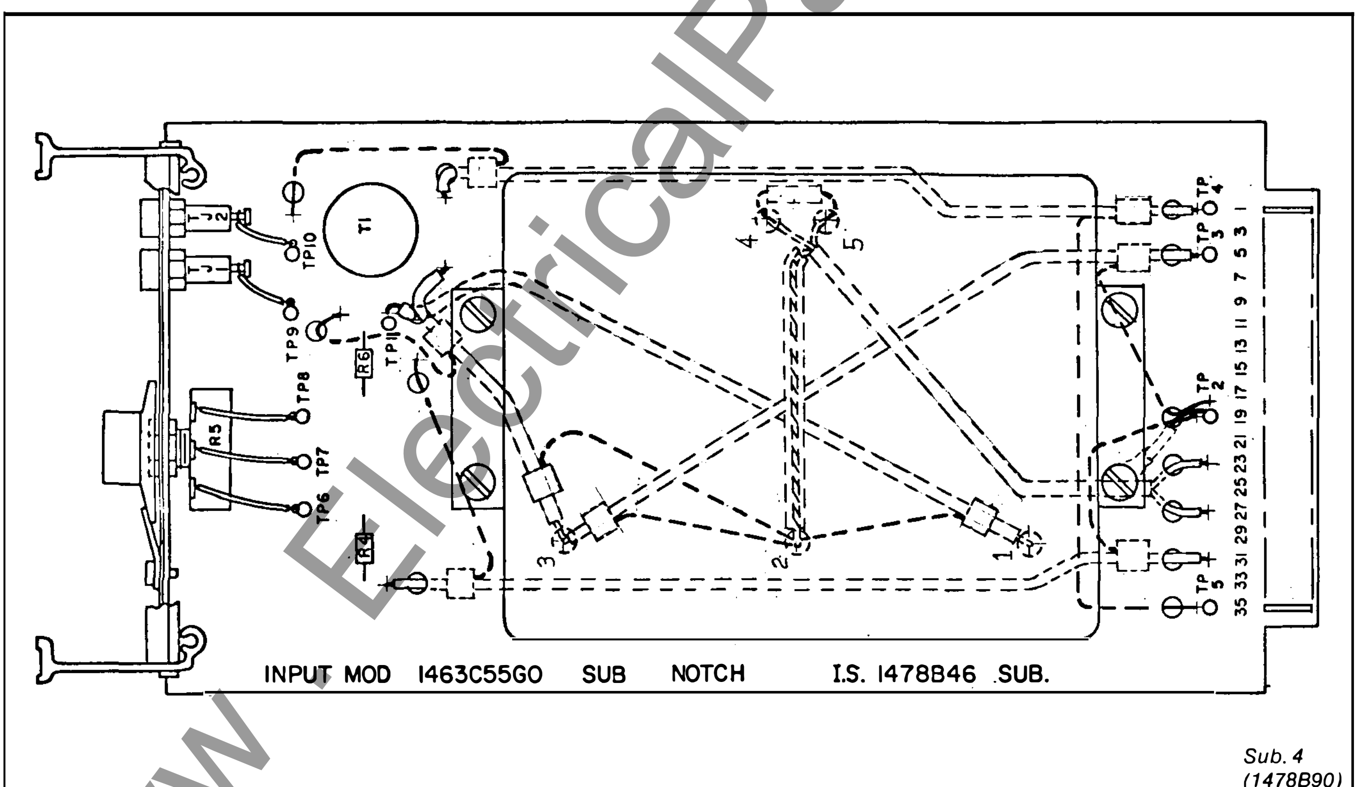


Fig. 17. Component Location - Receiver Input Module 200.1 - 300 kHz.

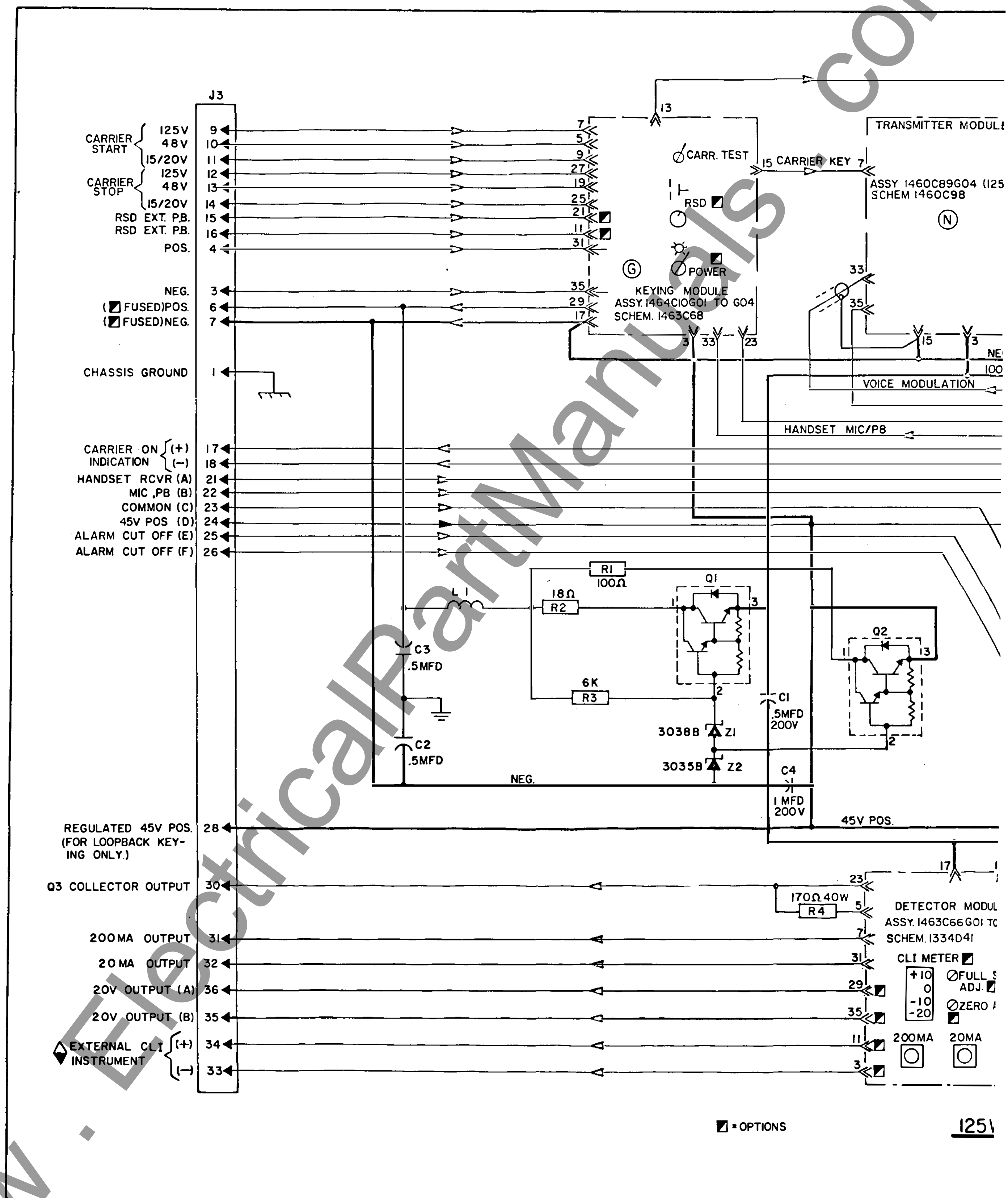
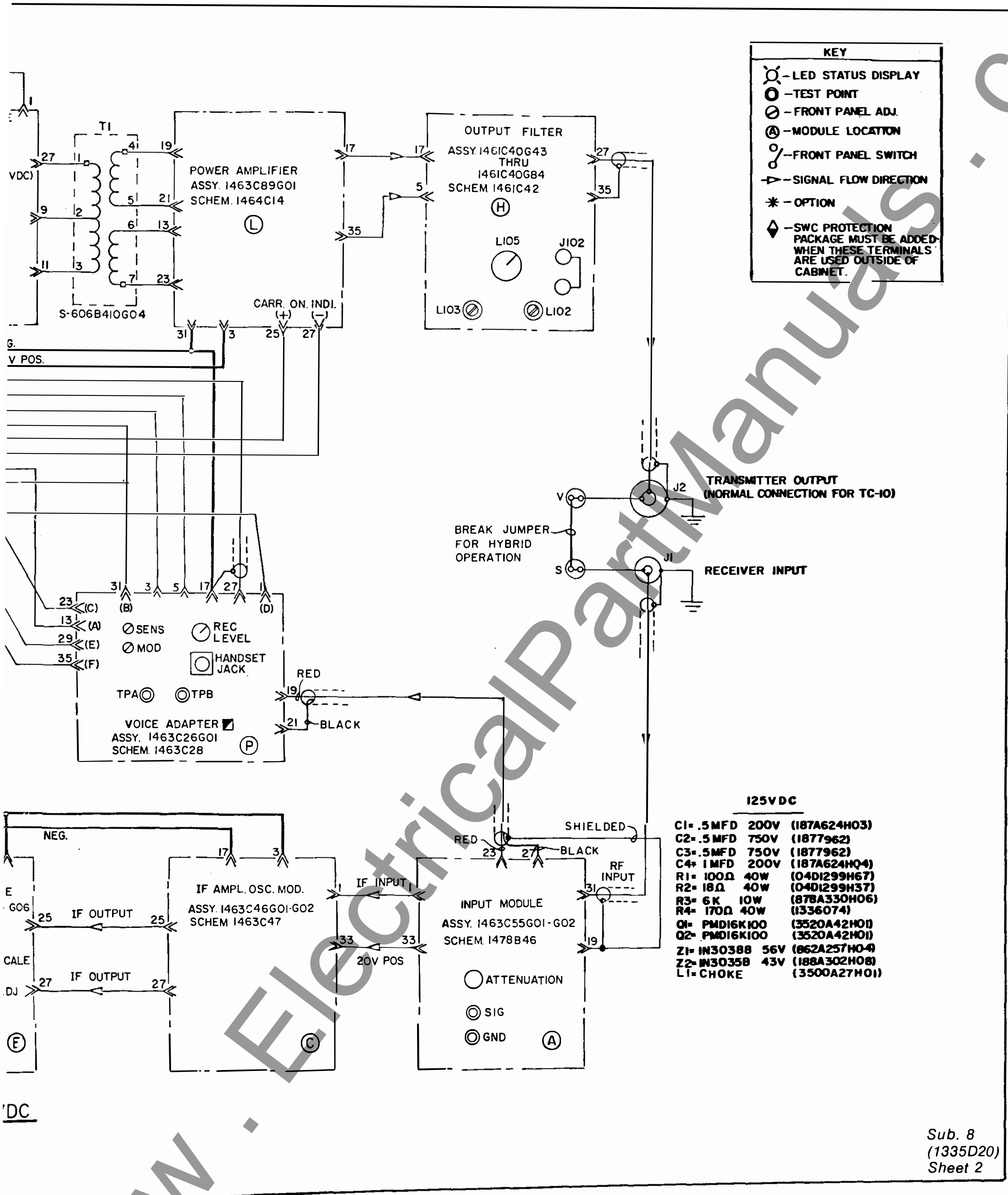
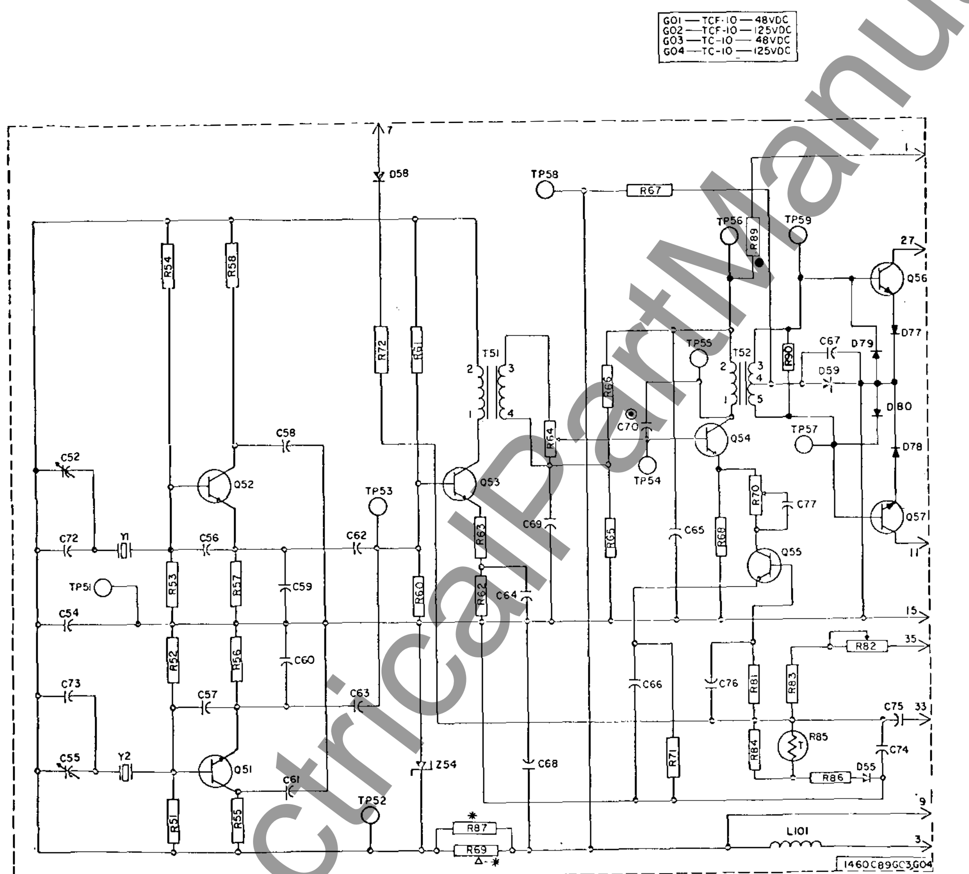


Fig. 18B. Type TC-10 Overall B



...ock Schematic for 125 VDC (1335D20 - sheet 2)



●-FOR GROUPS 3&4 (ON-OFF MODE)

✱-FOR G04 (125 V.D.C.)
△-FOR G03 (48 V.D.C.)

⊙-OMIT FOR VOICE ABOVE 60KHZ

COMPONENT		DESCRIPTION	STYLE NO.
C54	CAPACITOR	.100UF 200V	187A624H01
C56	CAPACITOR	2000.000PF 500V	187A584H01
C57	CAPACITOR	2000.000PF 500V	187A584H01
C58	CAPACITOR	.250UF 200V	187A624H02
C59	CAPACITOR	100.000PF 500V	762A757H01
C60	CAPACITOR	100.000PF 500V	762A757H01
C61	CAPACITOR	.250UF 200V	187A624H02
C62	CAPACITOR	4700.000PF 500V	762A757H04
C63	CAPACITOR	1000.000PF 500V	762A757H02
C64	CAPACITOR	.250UF 200V	187A624H02
C65	CAPACITOR	.250UF 200V	187A624H02
C66	CAPACITOR	.250UF 200V	187A624H02
C67	CAPACITOR	.250UF 200V	187A624H02
C68	CAPACITOR	.500UF 200V	187A624H11
C69	CAPACITOR	.250UF 200V	187A624H02
C70	CAPACITOR	300.000PF 500V	187A584H09
C72	CAPACITOR	3.000PF 500V	861A346H03
C73	CAPACITOR	3.000PF 500V	861A346H03
C74	CAPACITOR	1.000UF 200V	187A624H04
C75	CAPACITOR	.500UF 200V	187A624H11
C76	CAPACITOR	.010UF 600V	764A278H10
C77	CAPACITOR	.470UF 200V	186A667H01
C52	TRIMMER	5.5-18 PF	879A834H01
C55	TRIMMER	5.5-18 PF	879A834H01
D79	DIODE	1N4822	184A342H11
D80	DIODE	1N4822	184A342H11
D55	DIODE	1N457A	184A855H07
D58	DIODE	1N628	184A855H12
D59	DIODE	1N4822	188A342H11
Y1	CRYSTAL	MATCHED PAIR	(D-SPEC)
Y2	CRYSTAL	MATCHED PAIR	(D-SPEC)
D77	DIODE	1N4822	188A342H11
D78	DIODE	1N4822	188A342H11
L101	CHOKE	90.7 5%	3500A27H01
●-R89	RESISTOR	2000.0 50W 5%	184A763H34
R64	POT	1.0K .12W	629A430H02
R70	POT	1.0K .12W	629A430H02
R82	POT	25.0K	629A430H09
✱ R69	RES	7 K 3W 1%	763A126H95
✱ R87	RES	7 K 3W 1%	763A126H95
R51	RESISTOR	10.0K .50W 5%	184A763H51
R52	RESISTOR	10.0K .50W 5%	184A763H51
R53	RESISTOR	10.0K .50W 5%	184A763H51
R54	RESISTOR	10.0K .50W 5%	184A763H51
R55	RESISTOR	100.0 .50W 5%	184A763H03
R56	RESISTOR	3600.0 .50W 5%	184A763H40
R57	RESISTOR	3600.0 .50W 5%	184A763H40
R58	RESISTOR	100.0 .50W 5%	184A763H03
R60	RESISTOR	5600.0 .50W 5%	184A763H45
R61	RESISTOR	15.0K .50W 5%	184A763H55
R62	RESISTOR	10.0K .50W 5%	184A763H51
R63	SENSISTOR	1.2K .12W 10%	187A685H03
R65	RESISTOR	1.8K .50W 5%	184A763H33
R66	RESISTOR	8.2K .50W 5%	184A763H49
R67	RESISTOR	200K 50W 2%	629A531H87
R68	RESISTOR	330.0 .50W 5%	184A763H15
△-R69	RESISTOR	800.0 3.00W 5%	184A357H36
R71	RESISTOR	6.5K .50W 1%	849A320H27
R72	RESISTOR	5600.0 .50W 5%	184A763H45
R76	RESISTOR	2000.0 .50W 5%	184A763H34
R90	RESISTOR	1200.0 50W 5%	184A763H29
R81	RESISTOR	1000.0 .50W 1%	843A419H48
R83	RESISTOR	5K .50W 1%	843A420H17
R84	RESISTOR	27.0 .50W 5%	187A290H11
R85	RESISTOR	10.0 .03W 10%	185A211H03
R86	RESISTOR	750.0 .50W 1%	843A819H36
T51	TRANSFORMER		606B537G01
T52	TRANSFORMER		606B537G03
Q51	TRANSISTOR	2N697	184A638H18
Q52	TRANSISTOR	2N697	184A638H18
Q53	TRANSISTOR	2N697	184A638H18
Q54	TRANSISTOR	2N699	184A638H19
Q55	TRANSISTOR	2N697	184A638H18
Q56	TRANSISTOR	2N3583	849A516H05
Q57	TRANSISTOR	2N3583	849A516H05
Z54	ZENER	1N3686B 20.0V	185A212H06
● T51	TRANSFORMER		606B537G04
● T52	TRANSFORMER		606B537G05

Sub. **11**
(1460C98)
Sheet 2

✪ *Fig. 19. Internal Schematic - Transmitter Module.*

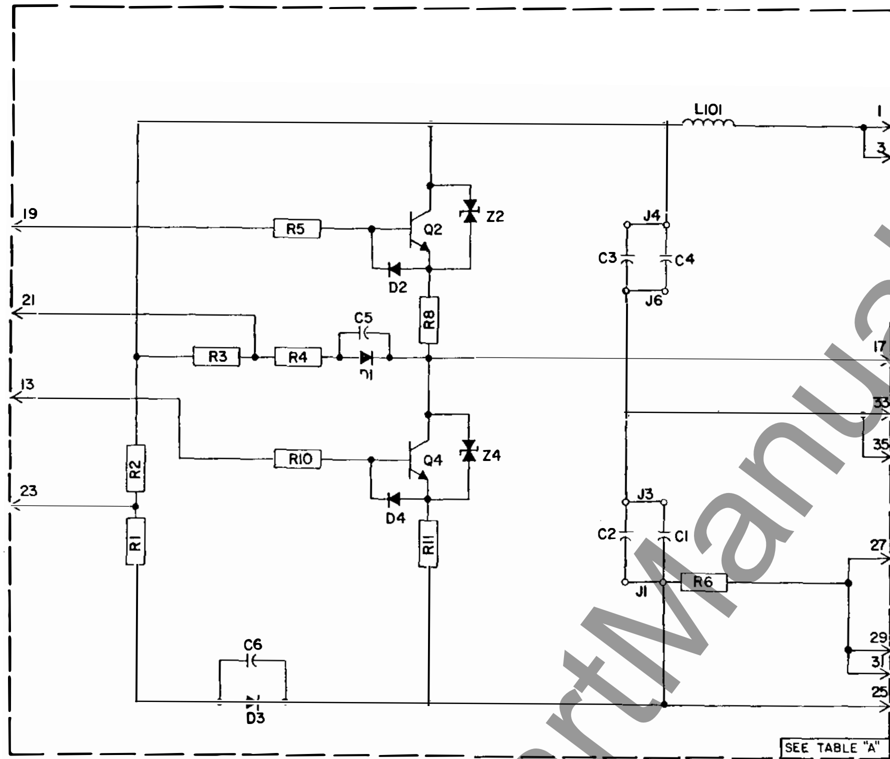


TABLE A

1463C89G01	1463C89G02	1463C89G03	COMPONENT		DESCRIPTION	STYLE NO.
1	1	–	C1	CAPACITOR	.470UF 400V	188A293H01
1	–	–	C2	CAPACITOR	.470UF 400V	188A293H01
1	1	–	C3	CAPACITOR	.470UF 400V	188A293H01
1	–	–	C4	CAPACITOR	.470UF 400V	188A293H01
1	1	1	C5	CAPACITOR	.250UF 200V	187A624H02
1	1	1	C6	CAPACITOR	.250UF 200V	187A624H02
–	–	1	C1	CAPACITOR	.220UF 400V	188A293H02
–	–	1	C3	CAPACITOR	.220UF 400V	188A293H02
1	1	1	D1	DIODE	1N4822	188A342H11
1	1	1	D2	DIODE	1N4822	188A342H11
1	1	1	D3	DIODE	1N4822	188A342H11
1	1	1	D4	DIODE	1N4822	188A342H11
1	1	1	R1	RESISTOR	2.7 1.00W 0%	629A371H24
1	1	1	R2	RESISTOR	90.9K .25W 1%	863A175H93
1	1	1	R3	RESISTOR	49.9 K .50W 1%	848A821H13
1	1	1	R4	RESISTOR	2.7 1.00W 0%	629A371H24
1	1	1	R5	RESISTOR	10.0 1.00W 5%	629A371H01
1	1	1	R6	RESISTOR	2.0 3.00W 5%	762A679H13
1	1	1	R8	RESISTOR	.3 1.00W10%	184A636H18
1	1	1	R10	RESISTOR	10.0 1.00W 5%	629A371H01
1	1	1	R11	RESISTOR	.3 1.00W10%	184A636H18
1	1	1	Q2	TRANSISTOR	2N6341	3508A21H04
1	1	1	Q4	TRANSISTOR	2N6341	3508A21H04
1	1	1	Z2	ZENER	1N2999B	629A798H04
1	1	1	Z4	ZENER	1N2999B	629A798H04
1	1	1	L101	CHOKE		3500A27H01

ENG. REF.

REARRANGE JUMPERS J1 TO J6 FOR FREQ OF OPERATION

G01	30-70KHZ	J1, J3, J4, J6
G02	70-150KHZ	J1, J3, J4, J6
G03	150-300KHZ	J1, J3, J4, J6

Sub. 5
(1464C14)

✪ *Fig. 20. Internal Schematic - Power Amplifier Module.*

1461C40G01,G43 (30-31.5KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	2500 MMF 500V	861A846H20
C2 CAPACITOR	2700 MMF 500V	861A846H21
C3 CAPACITOR	1500 MMF 500V	762A757H03
C4 CAPACITOR	3300 MMF 500V	187A584H26
C5 CAPACITOR	4000 MMF 1200V	187A705H15
C6 CAPACITOR	4000 MMF 1200V	187A705H15
C7 CAPACITOR	7000 PF 3000V	203C872H29
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G02,G44 (32-33.5KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	2500 MMF 500V	861A846H20
C2 CAPACITOR	2000 MMF 500V	187A584H01
C3 CAPACITOR	1000 MMF 500V	762A757H02
C4 CAPACITOR	3300 MMF 500V	187A584H26
C5 CAPACITOR	2500 MMF 1200V	187A705H13
C6 CAPACITOR	5000 MMF 1200V	187A705H16
C7 CAPACITOR	6000 PF 3000V	203C872H28
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G03,G45 (34-36 KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	2000 MMF 500V	187A584H01
C2 CAPACITOR	2000 MMF 500V	187A584H01
C3 CAPACITOR	390 MMF 500V	762A757H15
C4 CAPACITOR	3300 MMF 500V	187A584H26
C5 CAPACITOR	2500 MMF 1200V	187A705H13
C6 CAPACITOR	4000 MMF 1200V	187A705H15
C7 CAPACITOR	5500 PF 3000V	203C872H27
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G04,G46 (36.5-38.5KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	1500 MMF 500V	762A757H03
C2 CAPACITOR	2000 MMF 500V	187A584H01
C4 CAPACITOR	3300 MMF 500V	187A584H26
C5 CAPACITOR	3000 MMF 1200V	187A705H14
C6 CAPACITOR	2500 MMF 1200V	187A705H13
C7 CAPACITOR	5000 PF 3000V	203C872H26
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

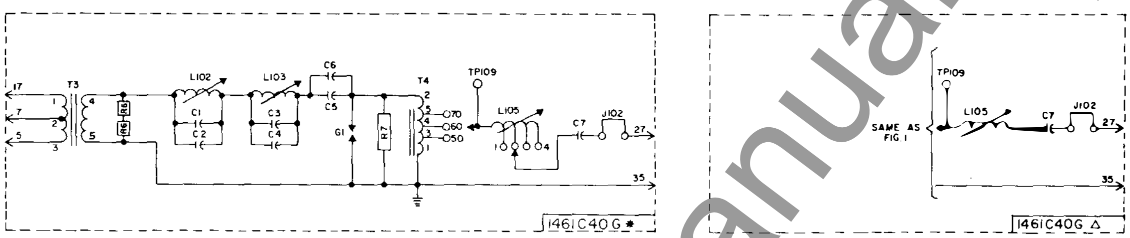


FIG 1
30 TO 200 KC

* - G01 THRU G32
G43 THRU G74

Δ - G33 THRU G42
G75 THRU G84

FIG 2 (OTHERWISE SAME AS FIG. 1)
2001 TO 300 KC

ASSEMBLY - 1461C40
COMP LOC - 1477B28
P.C. B. - 1461C41

Sub. 7
(1461C42)

Fig. 21. Internal Schematic - Transmitter Output Filter Module.

PARTS LIST 1461C42, SHEETS 1 THRU 5

1461C40G05,G47 (39-41KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	3000 MMF 500V	187A584H06
C3 CAPACITOR	820 MMF 500V	762A757H22
C4 CAPACITOR	2000 MMF 500V	187A584H01
C5 CAPACITOR	2500 MMF 1200V	187A705H13
C6 CAPACITOR	2500 MMF 1200V	187A705H13
C7 CAPACITOR	4200 PF 3000V	203C872H25
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G06,G48 (41.5-44KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	2500 MMF 500V	861A846H20
C2 CAPACITOR	150 MMF 500V	861A846H25
C3 CAPACITOR	150 MMF 500V	861A846H25
C5 CAPACITOR	200 MMF 1200V	187A705H04
C6 CAPACITOR	4000 MMF 1200V	187A705H15
C7 CAPACITOR	3500 PF 3000V	203C872H23
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G07,G49 (44.5-47KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	300 MMF 500V	187A584H09
C2 CAPACITOR	2000 MMF 500V	187A584H01
C3 CAPACITOR	180 MMF 500V	762A757H10
C4 CAPACITOR	2000 MMF 500V	187A584H01
C5 CAPACITOR	1500 MMF 1200V	187A705H11
C6 CAPACITOR	2000 MMF 1200V	187A705H12
C7 CAPACITOR	3200 PF 3000V	203C872H22
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G08,G50 (47.5-50KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	30 MMF 500V	763A209H12
C2 CAPACITOR	2000 MMF 500V	187A584H01
C3 CAPACITOR	390 MMF 500V	762A757H15
C4 CAPACITOR	1500 MMF 500V	762A757H03
C5 CAPACITOR	3000 MMF 1200V	187A705H14
C6 CAPACITOR	200 MMF 1200V	187A705H04
C7 CAPACITOR	2800 PF 3000V	203C872H20
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G09,G51 (50.5-53.5KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	300 MMF 500V	187A584H09
C2 CAPACITOR	1500 MMF 500V	762A757H03
C3 CAPACITOR	180 MMF 500V	762A757H10
C4 CAPACITOR	1500 MMF 500V	762A757H03
C5 CAPACITOR	2000 MMF 1200V	187A705H15
C7 CAPACITOR	2200 PF 3000V	203C872H17
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G10,G52 (54-57KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	82 MMF 500V	763A209H23
C2 CAPACITOR	1500 MMF 500V	762A757H03
C4 CAPACITOR	1500 MMF 500V	762A757H03
C5 CAPACITOR	3000 MMF 1200V	187A705H14
C6 CAPACITOR	500 MMF 1200V	187A705H09
C7 CAPACITOR	3500 PF 3000V	203C872H23
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G11,G53 (57.5-60.5KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	1000 MMF 500V	762A757H02
C2 CAPACITOR	390 MMF 500V	762A757H15
C3 CAPACITOR	1000 MMF 500V	762A757H02
C4 CAPACITOR	300 MMF 500V	187A584H09
C5 CAPACITOR	3000 MMF 1200V	187A705H14
C7 CAPACITOR	3100 PF 3000V	203C872H21
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G12,G54 (61-64KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	1000 MMF 500V	762A757H02
C2 CAPACITOR	250 MMF 500V	861A846H11
C3 CAPACITOR	1000 MMF 500V	762A757H02
C4 CAPACITOR	180 MMF 500V	187A584H11
C5 CAPACITOR	300 MMF 1200V	187A705H06
C6 CAPACITOR	2500 MMF 1200V	187A705H13
C7 CAPACITOR	2800 PF 3000V	203C872H20
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G13,G55 (64.5-68KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	1000 MMF 500V	762A757H02
C2 CAPACITOR	100 MMF 500V	762A757H01
C3 CAPACITOR	1000 MMF 500V	762A757H02
C4 CAPACITOR	36 MMF 500V	763A209H14
C5 CAPACITOR	2500 MMF 1200V	187A705H13
C7 CAPACITOR	2500 PF 3000V	203C872H19
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G14,G56 (68.5-72KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	360 MMF 500V	762A757H14
C2 CAPACITOR	620 MMF 500V	187A584H11
C3 CAPACITOR	820 MMF 500V	762A757H22
C4 CAPACITOR	100 MMF 500V	762A757H01
C5 CAPACITOR	200 MMF 1200V	187A705H04
C6 CAPACITOR	2000 MMF 200V	187A705H12
C7 CAPACITOR	2200 PF 3000V	203C872H17
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G15,G57 (72.5-76KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	250 MMF 500V	861A846H11
C2 CAPACITOR	620 MMF 500V	187A584H11
C3 CAPACITOR	820 MMF 500V	762A757H22
C5 CAPACITOR	1500 MMF 1200V	187A705H11
C7 CAPACITOR	2000 PF 3000V	203C872H15
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G16,G58 (76.5-80KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	180 MMF 500V	762A757H10
C2 CAPACITOR	620 MMF 500V	187A584H11
C3 CAPACITOR	130 MMF 500V	762A757H07
C4 CAPACITOR	620 MMF 500V	187A584H11
C5 CAPACITOR	300 MMF 1200V	187A705H06
C6 CAPACITOR	1500 MMF 1200V	187A705H11
C7 CAPACITOR	1800 PF 3000V	203C872H13
L102 POT CORE		6708133G04
L103 POT CORE		6708133G06
L105 COIL		292B086G01
T3 TRANSFORMER		2928526G04
T4 TRANSFORMER		2928526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G17, G59 (80.5-84.5KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	1500 MMF 500V	762A757H03
C3 CAPACITOR	270 MMF 500 V	762A757H12
C4 CAPACITOR	1500 MMF 500 V	762A757H03
C5 CAPACITOR	4000 MMF 1200 V	187A705H15
C7 CAPACITOR	2400 PF 3000V	2C3C872H18
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G18, G60 (85-89KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	1000 MMF 500 V	762A757H02
C2 CAPACITOR	360 MMF 500 V	762A757H14
C3 CAPACITOR	82 MMF 500 V	763A209H23
C4 CAPACITOR	1500 MMF 500 V	762A757H03
C5 CAPACITOR	4000 MMF 1200 V	187A705H15
C7 CAPACITOR	2100 PF 3000V	2C3C872H16
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	167A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G19, G61 (89.5-94.5KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	1000 MMF 500V	762A757H02
C2 CAPACITOR	200 MMF 500 V	762A757H11
C3 CAPACITOR	1000 MMF 500 V	762A757H02
C4 CAPACITOR	390 MMF 500 V	762A757H15
C5 CAPACITOR	3000 MMF 1200 V	187A705H14
C6 CAPACITOR	500 MMF1200V	187A705H09
C7 CAPACITOR	1900 PF 3000V	203C872H14
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G20, G62 (95-100KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	1000 MMF 500V	762A757H02
C2 CAPACITOR	82 MMF 500 V	763A209H23
C3 CAPACITOR	1000 MMF 500 V	762A757H02
C4 CAPACITOR	250 MMF 500V	861A846H11
C5 CAPACITOR	3000 MMF 1200 V	187A705H14
C7 CAPACITOR	1700 PF 3000V	2C3C872H12
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	167A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G21, G63 (100.5-106KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	360 MMF 500V	762A757H14
C2 CAPACITOR	620 MMF 500 V	187A584H11
C3 CAPACITOR	1000 MMF 500 V	762A757H02
C4 CAPACITOR	130 MMF 500 V	762A757H07
C5 CAPACITOR	2500 MMF 1200 V	187A705H13
C7 CAPACITOR	1500 PF 3000V	203C872H11
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G22, G64 (106.5-112.5KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	250 MMF 500V	861A846H11
C2 CAPACITOR	620 MMF 500 V	187A584H11
C3 CAPACITOR	1000 MMF 500 V	762A757H02
C5 CAPACITOR	2500 MMF 1200 V	187A705H13
C7 CAPACITOR	1300 PF 3000V	2C3C872H10
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G23, G65 (113-119.5KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	150 MMF 500V	861A846H25
C2 CAPACITOR	620 MMF 500V	187A584H11
C3 CAPACITOR	62 MMF 500 V	763A209H20
C4 CAPACITOR	820 MMF 500V	762A757H22
C5 CAPACITOR	200 MMF1200 V	187A705H04
C6 CAPACITOR	2000 MMF 1200 V	187A705H12
C7 CAPACITOR	1100 PF 3000V	203C872H08
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G24, G66 (120-127KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	56 MMF 500V	763A209H19
C2 CAPACITOR	620 MMF 500V	187A584H11
C3 CAPACITOR	390 MMF 500 V	762A757H15
C4 CAPACITOR	390 MMF 500 V	762A757H15
C6 CAPACITOR	2000 MMF 1200 V	187A705H12
C7 CAPACITOR	1000 PF 3000V	203C872H07
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	167A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G25, G67 (127.5-135KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	300 MMF 500V	187A584H09
C2 CAPACITOR	300 MMF 500V	187A584H09
C3 CAPACITOR	82 MMF 500V	763A209H23
C4 CAPACITOR	620 MMF 500 V	187A584H11
C5 CAPACITOR	200 MMF 1200 V	187A705H04
C6 CAPACITOR	1500 MMF 1200 V	187A705H11
C7 CAPACITOR	900 PF 3000V	2C3C872H06
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	168A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G26, G68 (135.5-143KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	270 MMF 500 V	762A757H12
C2 CAPACITOR	270 MMF 500V	762A757H12
C4 CAPACITOR	620 MMF 500 V	187A584H11
C5 CAPACITOR	1500 MMF 1200 V	187A705H11
C7 CAPACITOR	800 PF 3000V	2C3C872H05
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G27, G69 (143.5-151KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	300 MMF 500V	187A584H09
C2 CAPACITOR	180 MMF 500V	762A757H10
C3 CAPACITOR	300 MMF 500 V	187A584H09
C4 CAPACITOR	250 MMF 500V	861A846H11
C5 CAPACITOR	400 MMF 1200 V	187A705H08
C6 CAPACITOR	1500 MMF 1200 V	187A705H11
C7 CAPACITOR	1100 PF 3000V	203C872H08
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G28, G70 (151.5-159.5KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	180 MMF 500V	762A757H10
C2 CAPACITOR	250 MMF 500V	861A846H11
C3 CAPACITOR	250 MMF 500 V	861A846H11
C4 CAPACITOR	250 MMF500V	861A846H11
C5 CAPACITOR	200 MMF 1200 V	187A705H04
C6 CAPACITOR	1500 MMF 1200 V	187A705H11
C7 CAPACITOR	1000 PF 3000V	203C872H07
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G29,G71 (160-169.5KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	180 MMF 500V	762A757H10
C2 CAPACITOR	200 MMF 500V	762A757H11
C3 CAPACITOR	200 MMF 500V	762A757H11
C4 CAPACITOR	250 MMF 500V	861A846H11
C5 CAPACITOR	1500 MMF 1200 V	187A705H11
C7 CAPACITOR	900 PF 3000V	203C872H06
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	186A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G30,G72 (170-180KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	82 MMF 500V	763A209H23
C2 CAPACITOR	250 MMF 500V	861A846H11
C3 CAPACITOR	390 MMF 500V	762A757H15
C5 CAPACITOR	400 MMF 1200 V	187A705H08
C6 CAPACITOR	1000 MMF 1200 V	187A705H10
C7 CAPACITOR	750 PF 3000V	203C872H04
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G31,G73 (180.5-191.5KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	300 MMF 500V	187A584H09
C3 CAPACITOR	150 MMF 500 V	861A846H25
C4 CAPACITOR	200 MMF 500 V	762A757H11
C5 CAPACITOR	200 MMF 1200 V	187A705H04
C6 CAPACITOR	1000 MMF 1200 V	187A705H10
C7 CAPACITOR	650 PF 3000V	203C872H02
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	186A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G32,G74 (192-200KC)

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	20 MMF 500V	763A209H07
C2 CAPACITOR	250 MMF 500V	861A846H11
C3 CAPACITOR	130 MMF 500 V	762A757H07
C4 CAPACITOR	180 MMF 500V	762A757H10
C6 CAPACITOR	1000 MMF 1200 V	187A705H10
C7 CAPACITOR	600 PF 3000V	203C872H02
L102 POT CORE		670B133G05
L103 POT CORE		670B133G07
L105 COIL		292B086G01
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G33,G75 (200.1-207 KC) *

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	56 MMF 500V	763A209H19
C2 CAPACITOR	270 MMF 500V	762A757H12
C3 CAPACITOR	200 MMF 500 V	762A757H11
C4 CAPACITOR	30 MMF 500V	763A209H12
C5 CAPACITOR	200 MMF 1200 V	187A705H04
C6 CAPACITOR	500 MMF 1200 V	187A705H09
C7 CAPACITOR	1200 PF 3000V	203C872H09
L102 POT CORE		670B133G09
L103 POT CORE		670B133G08
L105 POT CORE		670B133G09
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A115H01

1461C40G34,G76 (207.1-214 KC) *

COMPONENT	DESCRIPTION	STYLE
C2 CAPACITOR	300 MMF 500V	187A584H09
C3 CAPACITOR	200 MMF 500 V	762A757H11
C4 CAPACITOR	20 MMF 500V	763A209H07
C5 CAPACITOR	200 MMF 1200 V	187A705H04
C6 CAPACITOR	500 MMF 1200 V	187A705H09
C7 CAPACITOR	1200 PF 3000V	203C872H09
L102 POT CORE		670B133G09
L103 POT CORE		670B133G08
L105 POT CORE		670B133G09
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A115H01

1461C40G35,G77 (214.1-222 KC) *

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	130 MMF 500V	861A846H25
C2 CAPACITOR	150 MMF 500V	861A846H25
C3 CAPACITOR	150 MMF 500V	861A846H25
C4 CAPACITOR	56 MMF 500V	763A209H19
C5 CAPACITOR	400 MMF 1200 V	187A705H08
C6 CAPACITOR	200 MMF 1200 V	187A705H04
C7 CAPACITOR	1100 PF 3000V	203C872H08
L102 POT CORE		670B133G09
L103 POT CORE		670B133G08
L105 POT CORE		670B133G09
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G36,G78 (222.1-230KC) *

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	62 MMF 500V	763A209H20
C2 CAPACITOR	200 MMF 500V	762A757H11
C3 CAPACITOR	62 MMF 500V	763A209H20
C4 CAPACITOR	130 MMF 500V	762A757H07
C5 CAPACITOR	400 MMF 1200V	187A705H08
C6 CAPACITOR	200 MMF 1200 V	187A705H04
C7 CAPACITOR	1100 PF 3000V	203C872H08
L102 POT CORE		670B133G09
L103 POT CORE		670B133G08
L105 POT CORE		670B133G09
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G37,G79 (230.1-240KC) *

COMPONENT	DESCRIPTION	STYLE
C2 CAPACITOR	250 MMF 500V	861A846H11
C3 CAPACITOR	150 MMF 500V	861A846H25
C4 CAPACITOR	20 MMF 500V	763A209H07
C6 CAPACITOR	500 MMF 1200 V	187A705H09
C7 CAPACITOR	1000 PF 3000V	203C872H07
L102 POT CORE		670B133G09
L103 POT CORE		670B133G08
L105 POT CORE		670B133G09
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G38,G80 (240.1-250KC) *

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	30 MMF 500V	763A209H12
C2 CAPACITOR	200 MMF 500V	762A757H11
C3 CAPACITOR	130 MMF 500V	762A757H07
C4 CAPACITOR	30 MMF 500V	763A209H12
C6 CAPACITOR	500 MMF 1200 V	187A705H09
C7 CAPACITOR	900 PF 3000V	203C872H06
L102 POT CORE		670B133G09
L103 POT CORE		670B133G08
L105 POT CORE		670B133G09
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G39,G81 (250.1-262KC) *

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	56 MMF 500V	763A209H19
C2 CAPACITOR	150 MMF 500V	861A846H25
C3 CAPACITOR	62 MMF 500V	763A209H20
C4 CAPACITOR	82 MMF 500V	763A209H23
C5 CAPACITOR	400 MMF 1200V	187A705H08
C7 CAPACITOR	800 PF 3000V	203C872H05
L102 POT CORE		670B133G09
L103 POT CORE		670B133G08
L105 POT CORE		670B133G09
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G40,G82 (262.1-274KC) *

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	36 MMF 500V	763A209H14
C2 CAPACITOR	150 MMF 500V	861A846H25
C3 CAPACITOR	100 MMF 500 V	762A757H01
C4 CAPACITOR	30 MMF 500V	763A209H12
C5 CAPACITOR	400 MMF 1200V	187A705H08
C7 CAPACITOR	700 PF 3000V	203C872H03
L102 POT CORE		670B133G09
L103 POT CORE		670B133G08
L105 POT CORE		670B133G09
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G41,G83 (274.1-287KC) *

COMPONENT	DESCRIPTION	STYLE
C1 CAPACITOR	20 MMF 500V	763A209H07
C2 CAPACITOR	150 MMF 500V	861A846H25
C3 CAPACITOR	100 MMF 500 V	762A757H01
C4 CAPACITOR	20 MMF 500V	763A209H07
C5 CAPACITOR	400 MMF 1200 V	187A705H08
C7 CAPACITOR	650 PF 3000V	203C872H02
L102 POT CORE		670B133G09
L103 POT CORE		670B133G08
L105 POT CORE		670B133G09
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

1461C40G42,G84 (287.1-300KC) *

COMPONENT	DESCRIPTION	STYLE
C2 CAPACITOR	150 MMF 500V	861A846H25
C3 CAPACITOR	82 MMF 500V	763A209H23
C4 CAPACITOR	30 MMF 500V	763A209H12
C5 CAPACITOR	400 MMF 1200 V	187A705H08
C7 CAPACITOR	600 PF 3000V	203C872H01
L102 POT CORE		670B133G09
L103 POT CORE		670B133G08
L105 POT CORE		670B133G09
T3 TRANSFORMER		292B526G04
T4 TRANSFORMER		292B526G03
R6 RESISTOR	3K ± 5% 8W (2 REQ)	188A317H01
R7 RESISTOR	15K 10% 2W	187A642H55
G1 LIGHTNING ARRESTER		877A116H01

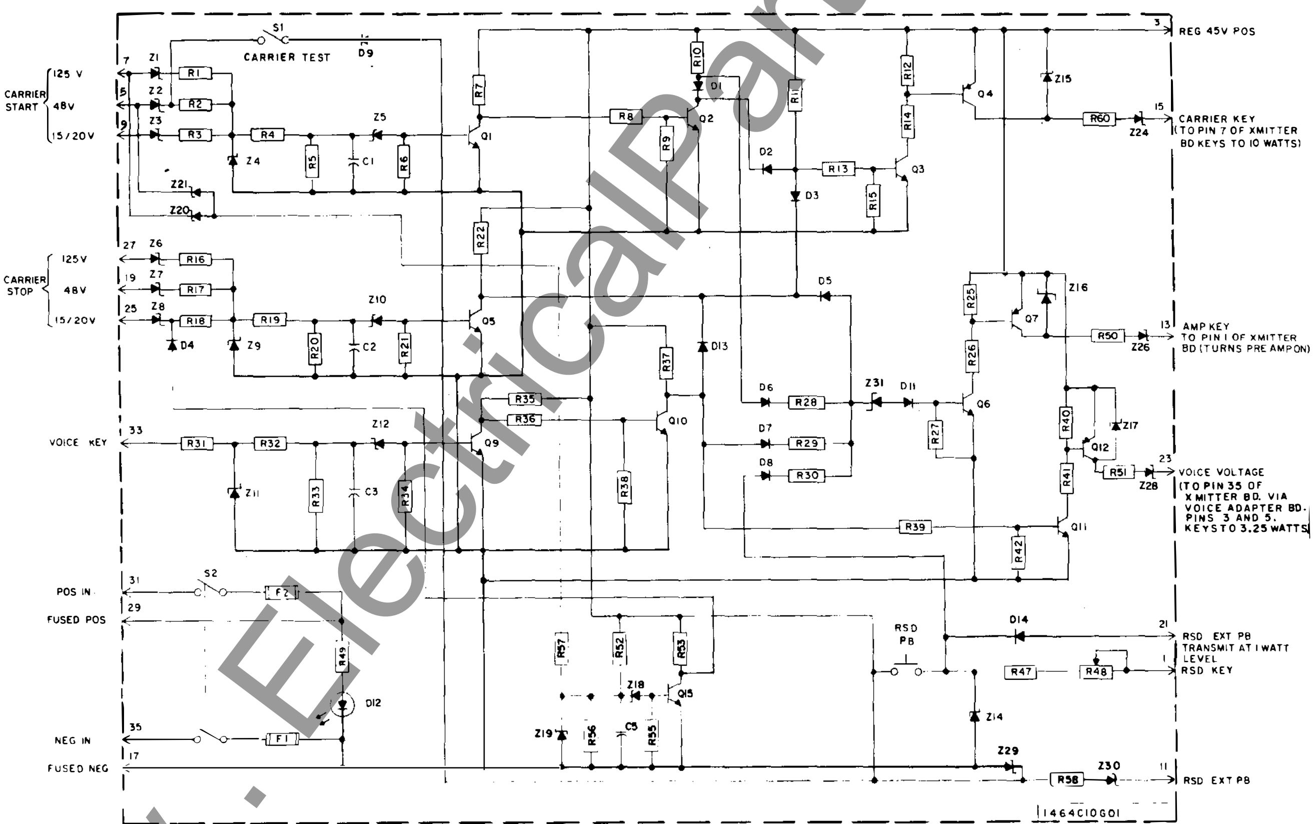
1464C10G01

COMPONENT		DESCRIPTION	STYLE NO.
C1	CAPACITOR	.047UF 200V	849A437H04
C2	CAPACITOR	.047UF 200V	849A437H04
C3	CAPACITOR	.047UF 200V	849A437H04
~~C4~~	~~CAPACITOR~~	~~1.000UF 200V~~	~~187A624H04~~
C5	CAPACITOR	.047UF 200V	849A437H04
D1	DIODE	1N457A	184A855H07
D2	DIODE	1N457A	184A855H07
D3	DIODE	1N457A	184A855H07
D4	DIODE	1N457A	184A855H07
D5	DIODE	1N457A	184A855H07
D6	DIODE	1N457A	184A855H07
D7	DIODE	1N457A	184A855H07
D8	DIODE	1N457A	184A855H07
D9	DIODE	1N457A	184A855H07
~~D10~~	~~DIODE~~	~~1N457A~~	~~184A855H07~~
D11	DIODE	1N457A	184A855H07
D12	DIODE	LED	3508A22H01
D13	DIODE	1N457A	184A855H07
D14	DIODE	1N457A	184A855H07
J1	JUMPER	0 OHM RESISTOR	862A478H01
J2	JUMPER	0 OHM RESISTOR	862A478H01
J3	JUMPER	0 OHM RESISTOR	862A478H01
J4	JUMPER	0 OHM RESISTOR	862A478H01
J5	JUMPER	0 OHM RESISTOR	862A478H01
J6	JUMPER	0 OHM RESISTOR	862A478H01
J7	JUMPER	0 OHM RESISTOR	862A478H01
R1	RESISTOR	33.0K .50W 2%	629A531H68
R2	RESISTOR	13.0K .50W 2%	629A531H59
R3	RESISTOR	820.0 .50W 2%	629A531H30
R4	RESISTOR	1500.0 .50W 5%	184A763H31
R5	RESISTOR	6200.0 .50W 5%	184A763H46
R6	RESISTOR	10.0K .50W 5%	184A763H51
R7	RESISTOR	12.0K .50W 5%	184A763H53
R8	RESISTOR	27.0K .50W 5%	184A763H61
R9	RESISTOR	10.0K .50W 5%	184A763H51
R10	RESISTOR	12.0K .50W 5%	184A763H53
R11	RESISTOR	12.0K .50W 5%	184A763H53
R12	RESISTOR	4700.0 .50W 5%	184A763H43
R13	RESISTOR	27.0K .50W 5%	184A763H61
R14	RESISTOR	12.0K .50W 5%	184A763H53
R15	RESISTOR	10.0K .50W 5%	184A763H51
R16	RESISTOR	33.0K .50W 2%	629A531H68
R17	RESISTOR	13.0K .50W 2%	629A531H59
R18	RESISTOR	820.0 .50W 2%	629A531H30
R19	RESISTOR	1500.0 .50W 5%	184A763H31
R20	RESISTOR	6200.0 .50W 5%	184A763H46
R21	RESISTOR	10.0K .50W 5%	184A763H51
R22	RESISTOR	12.0K .50W 5%	184A763H53
R25	RESISTOR	4700.0 .50W 5%	184A763H43
R26	RESISTOR	12.0K .50W 5%	184A763H53
R27	RESISTOR	10.0K .50W 5%	184A763H51
R28	RESISTOR	27.0K .50W 5%	184A763H61
R29	RESISTOR	27.0K .50W 5%	184A763H61

COMPONENT		DESCRIPTION	STYLE NO.
R30	RESISTOR	27.0K .50W 5%	184A763H61
R31	RESISTOR	1800.0 .50W 5%	184A763H33
R32	RESISTOR	1500.0 .50W 5%	184A763H31
R33	RESISTOR	6200.0 .50W 5%	184A763H46
R34	RESISTOR	10.0K .50W 5%	184A763H51
R35	RESISTOR	12.0K .50W 5%	184A763H53
R36	RESISTOR	27.0K .50W 5%	184A763H61
R37	RESISTOR	12.0K .50W 5%	184A763H53
R38	RESISTOR	10.0K .50W 5%	184A763H51
R39	RESISTOR	27.0K .50W 5%	184A763H61
R40	RESISTOR	4700.0 .50W 5%	184A763H43
R41	RESISTOR	12.0K .50W 5%	184A763H53
R42	RESISTOR	10.0K .50W 5%	184A763H51
R47	RESISTOR	8200.0 .50W 5%	184A763H49
R49	RESISTOR	18.0K .50W 2%	629A531H62
R50	RESISTOR	300.0 .50W 5%	184A763H14
R51	RESISTOR	300.0 .50W 5%	184A763H14
R52	RESISTOR	12.0K .50W 5%	184A763H53
R53	RESISTOR	10.0K .50W 5%	184A763H51
~~R54~~	~~RESISTOR~~	~~10.0K .50W 5%~~	~~184A763H51~~
R55	RESISTOR	10.0K .50W 5%	184A763H51
R56	RESISTOR	6200.0 .50W 5%	184A763H46
R57	RESISTOR	1.0K .50W 5%	184A763H27
R58	RESISTOR	300.0 .50W 5%	184A763H14
~~R59~~	~~RESISTOR~~	~~300.0 .50W 5%~~	~~184A763H14~~
R60	RESISTOR	300.0 .50W 5%	184A763H14
R48	POT	250K .50W 10%	880A687H06
Q1	TRANSISTOR	2N699	184A638H19
Q2	TRANSISTOR	2N699	184A638H19
Q3	TRANSISTOR	2N699	184A638H19
Q4	TRANSISTOR	2N3645	849A441H01
Q5	TRANSISTOR	2N699	184A638H19
Q6	TRANSISTOR	2N699	184A638H19
Q7	TRANSISTOR	2N3645	849A441H01
Q9	TRANSISTOR	2N699	184A638H19
Q10	TRANSISTOR	2N699	184A638H19
Q11	TRANSISTOR	2N699	184A638H19
Q12	TRANSISTOR	2N3645	849A441H01
Q15	TRANSISTOR	2N699	184A638H19
Z1	ZENER	1R200 200.0V	629A369H01
Z2	ZENER	1R200 200.0V	629A369H01
Z3	ZENER	1R200 200.0V	629A369H01
Z4	ZENER	1N3686B 20.0V	185A212H06
Z5	ZENER	1N957B 6.8V	186A797H06
Z6	ZENER	1R200 200.0V	629A369H01
Z7	ZENER	1R200 200.0V	629A369H01
Z8	ZENER	1R200 200.0V	629A369H01
Z9	ZENER	1N3686B 20.0V	185A212H06
Z10	ZENER	1N957B 6.8V	186A797H06
Z11	ZENER	1N3686B 20.0V	185A212H06
Z12	ZENER	1N957B 6.8V	186A797H06
Z14	ZENER	1N3038B 56.0V	862A257H04
Z15	ZENER	1N3038B 56.0V	862A257H04
Z16	ZENER	1N3038B 56.0V	862A257H04
Z17	ZENER	1N3038B 56.0V	862A257H04

COMPONENT		DESCRIPTION	STYLE NO.
Z18	ZENER	1N957B 6.8V	186A797H06
Z19	ZENER	1N3686B 20.0V	185A212H06
Z20	ZENER	1SKE200 200.0V	878A619H01
Z21	ZENER	1SKE200 200.0V	878A619H01
~~Z22~~	~~ZENER~~	~~1SKE200 200.0V~~	~~[illegible]~~
~~Z23~~	~~ZENER~~	~~1N3038B 56.0V~~	~~[illegible]~~
Z24	ZENER	1SKE200 200.0V	878A619H01
~~Z25~~	~~ZENER~~	~~1N3038B 56.0V~~	~~[illegible]~~
Z26	ZENER	1SKE200 200.0V	878A619H01
~~Z27~~	~~ZENER~~	~~1N3038B 56.0V~~	~~[illegible]~~
Z28	ZENER	1SKE200 200.0V	878A619H01
Z29	ZENER	1N3038B 56.0V	862A257H04
Z30	ZENER	1SKE200 200.0V	878A619H01
Z31	ZENER	1N957B 6.8V	186A797H06

COMPONENT		STYLE NO
S1	SWITCH	849A299H03
S2	POWER SW	880A357H01
RSD	SWITCH	3510A06H01
F1	FUSE	183A981H23
F2	FUSE	183A981H23



Sub. 8
(1463C68)
Sheets 1 & 2

Fig. 22A. Internal Schematic - Keying Module - with DC Power Switch and Fuses - With Reserve Signal Detector Pushbutton and Control.

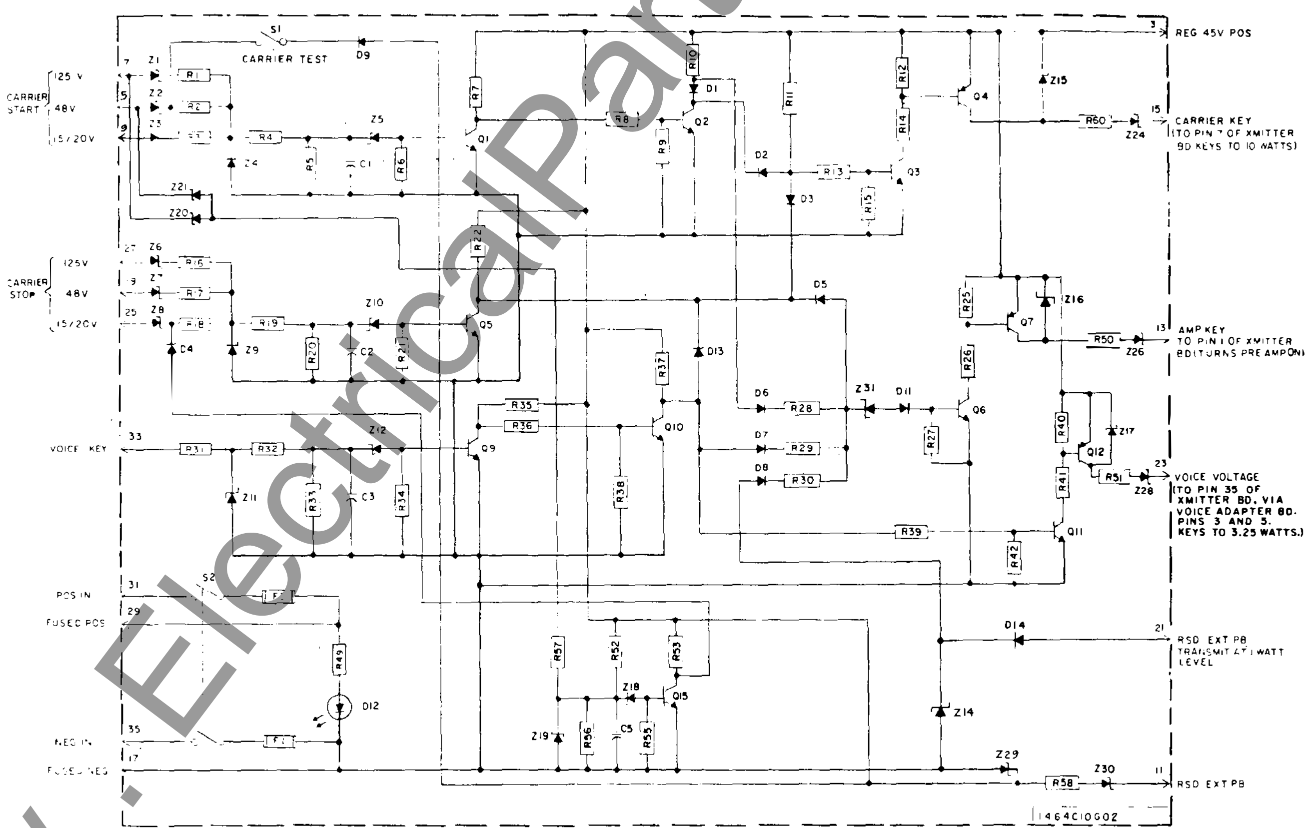
1464C10G02

COMPONENT		DESCRIPTION	STYLE NO.
C1	CAPACITOR	.047UF 200V	849A437H04
C2	CAPACITOR	.047UF 200V	849A437H04
C3	CAPACITOR	.047UF 200V	849A437H04
~~C4~~	~~CAPACITOR~~	~~[illegible]~~	~~187A624H04~~
C5	CAPACITOR	.047UF 200V	849A437H04
D1	DIODE	1N457A	184A855H07
D2	DIODE	1N457A	184A855H07
D3	DIODE	1N457A	184A855H07
D4	DIODE	1N457A	184A855H07
D5	DIODE	1N457A	184A855H07
D6	DIODE	1N457A	184A855H07
D7	DIODE	1N457A	184A855H07
D8	DIODE	1N457A	184A855H07
D9	DIODE	1N457A	184A855H07
~~D10~~	~~DIODE~~	~~1N457A~~	~~184A855H07~~
D11	DIODE	1N457A	184A855H07
D12	DIODE	LED	3508A22H01
D13	DIODE	1N457A	184A855H07
D14	DIODE	1N457A	184A855H07
J1	JUMPER	0 OHM RESISTOR	862A478H01
J2	JUMPER	0 OHM RESISTOR	862A478H01
J3	JUMPER	0 OHM RESISTOR	862A478H01
J4	JUMPER	0 OHM RESISTOR	862A478H01
J5	JUMPER	0 OHM RESISTOR	862A478H01
J6	JUMPER	0 OHM RESISTOR	862A478H01
J7	JUMPER	0 OHM RESISTOR	862A478H01
R1	RESISTOR	33.0K .50W 2%	629A531H68
R2	RESISTOR	13.0K .50W 2%	629A531H59
R3	RESISTOR	820.0 .50W 2%	629A531H30
R4	RESISTOR	1500.0 .50W 5%	184A763H31
R5	RESISTOR	6200.0 .50W 5%	184A763H46
R6	RESISTOR	10.0K .50W 5%	184A763H51
R7	RESISTOR	12.0K .50W 5%	184A763H53
R8	RESISTOR	27.0K .50W 5%	184A763H61
R9	RESISTOR	10.0K .50W 5%	184A763H51
R10	RESISTOR	12.0K .50W 5%	184A763H53
R11	RESISTOR	12.0K .50W 5%	184A763H53
R12	RESISTOR	4700.0 .50W 5%	184A763H43
R13	RESISTOR	27.0K .50W 5%	184A763H61
R14	RESISTOR	12.0K .50W 5%	184A763H53
R15	RESISTOR	10.0K .50W 5%	184A763H51
R16	RESISTOR	33.0K .50W 2%	629A531H68
R17	RESISTOR	13.0K .50W 2%	629A531H59
R18	RESISTOR	820.0 .50W 2%	629A531H30
R19	RESISTOR	1500.0 .50W 5%	184A763H31
R20	RESISTOR	6200.0 .50W 5%	184A763H46
R21	RESISTOR	10.0K .50W 5%	184A763H51
R22	RESISTOR	12.0K .50W 5%	184A763H53
R25	RESISTOR	4700.0 .50W 5%	184A763H43
R26	RESISTOR	12.0K .50W 5%	184A763H53
R27	RESISTOR	10.0K .50W 5%	184A763H51
R28	RESISTOR	27.0K .50W 5%	184A763H61
R29	RESISTOR	27.0K .50W 5%	184A763H61

COMPONENT		DESCRIPTION	STYLE NO.
R30	RESISTOR	27.0K .50W 5%	184A763H61
R31	RESISTOR	1300.0 .50W 5%	184A763H33
R32	RESISTOR	1500.0 .50W 5%	184A763H31
R33	RESISTOR	6200.0 .50W 5%	184A763H46
R34	RESISTOR	10.0K .50W 5%	184A763H51
R35	RESISTOR	12.0K .50W 5%	184A763H53
R36	RESISTOR	27.0K .50W 5%	184A763H61
R37	RESISTOR	12.0K .50W 5%	184A763H53
R38	RESISTOR	10.0K .50W 5%	184A763H51
R39	RESISTOR	27.0K .50W 5%	184A763H61
R40	RESISTOR	4700.0 .50W 5%	184A763H43
R41	RESISTOR	12.0K .50W 5%	184A763H53
R42	RESISTOR	10.0K .50W 5%	184A763H51
R49	RESISTOR	18.0K .50W 2%	629A531H62
R50	RESISTOR	300.0 .50W 5%	184A763H14
R51	RESISTOR	300.0 .50W 5%	184A763H14
R52	RESISTOR	12.0K .50W 5%	184A763H53
R53	RESISTOR	10.0K .50W 5%	184A763H51
~~R54~~	~~RESISTOR~~	~~10.0K .50W 5%~~	~~184A763H51~~
R55	RESISTOR	10.0K .50W 5%	184A763H51
R56	RESISTOR	6200.0 .50W 5%	184A763H46
R57	RESISTOR	1.0K .50W 5%	184A763H27
R58	RESISTOR	300.0 .50W 5%	184A763H14
~~R59~~	~~RESISTOR~~	~~300.0 .50W 5%~~	~~184A763H14~~
R60	RESISTOR	300.0 .50W 5%	184A763H14
Q1	TRANSISTOR	2N699	184A638H19
Q2	TRANSISTOR	2N699	184A638H19
Q3	TRANSISTOR	2N699	184A638H19
Q4	TRANSISTOR	2N3645	849A441H01
Q5	TRANSISTOR	2N699	184A638H19
Q6	TRANSISTOR	2N699	184A638H19
Q7	TRANSISTOR	2N3645	849A441H01
Q9	TRANSISTOR	2N699	184A638H19
Q10	TRANSISTOR	2N699	184A638H19
Q11	TRANSISTOR	2N699	184A638H19
Q12	TRANSISTOR	2N3645	849A441H01
Q15	TRANSISTOR	2N699	184A638H19
Z1	ZENER	1R200 200.0V	629A369H01
Z2	ZENER	1R200 200.0V	629A369H01
Z3	ZENER	1R200 200.0V	629A369H01
Z4	ZENER	1N3686B 20.0V	185A212H06
Z5	ZENER	1N957B 6.8V	186A797H06
Z6	ZENER	1R200 200.0V	629A369H01
Z7	ZENER	1R200 200.0V	629A369H01
Z8	ZENER	1R200 200.0V	629A369H01
Z9	ZENER	1N3686B 20.0V	185A212H06
Z10	ZENER	1N957B 6.8V	186A797H06
Z11	ZENER	1N3686B 20.0V	185A212H06
Z12	ZENER	1N957B 6.8V	186A797H06
Z14	ZENER	1N3038B 56.0V	862A257H04
Z15	ZENER	1N3038B 56.0V	862A257H04
Z16	ZENER	1N3038B 56.0V	862A257H04
Z17	ZENER	1N3038B 56.0V	862A257H04

COMPONENT		DESCRIPTION	STYLE NO.
Z18	ZENER	1N957B 6.8V	186A797H06
Z19	ZENER	1N3686B 20.0V	185A212H06
Z20	ZENER	15KE200 200.0V	878A619H01
Z21	ZENER	15KE200 200.0V	878A619H01
~~Z22~~	~~ZENER~~	~~15KE200 200.0V~~	~~878A619H01~~
~~Z23~~	~~ZENER~~	~~1N3038B 56.0V~~	~~862A257H04~~
Z24	ZENER	15KE200 200.0V	878A619H01
~~Z25~~	~~ZENER~~	~~1N3038B 56.0V~~	~~862A257H04~~
Z26	ZENER	15KE200 200.0V	878A619H01
~~Z27~~	~~ZENER~~	~~1N3038B 56.0V~~	~~862A257H04~~
Z28	ZENER	15KE200 200.0V	878A619H01
Z29	ZENER	1N3038B 56.0V	862A257H04
Z30	ZENER	15KE200 200.0V	878A619H01
Z31	ZENER	1N957B 6.8V	186A797H06

COMPONENT		STYLE NO.
S1	SWITCH	849A299H03
S2	POWER SW	880A357H01
F1	FUSE	183A981H23
F2	FUSE	183A981H23



Sub. 8
(1463C68)
Sheets 3 & 4

✪ *Fig. 22B. Internal Schematic - Keying Module - with DC Power Switch and Fuses - without Reserve Signal Detector Components.*

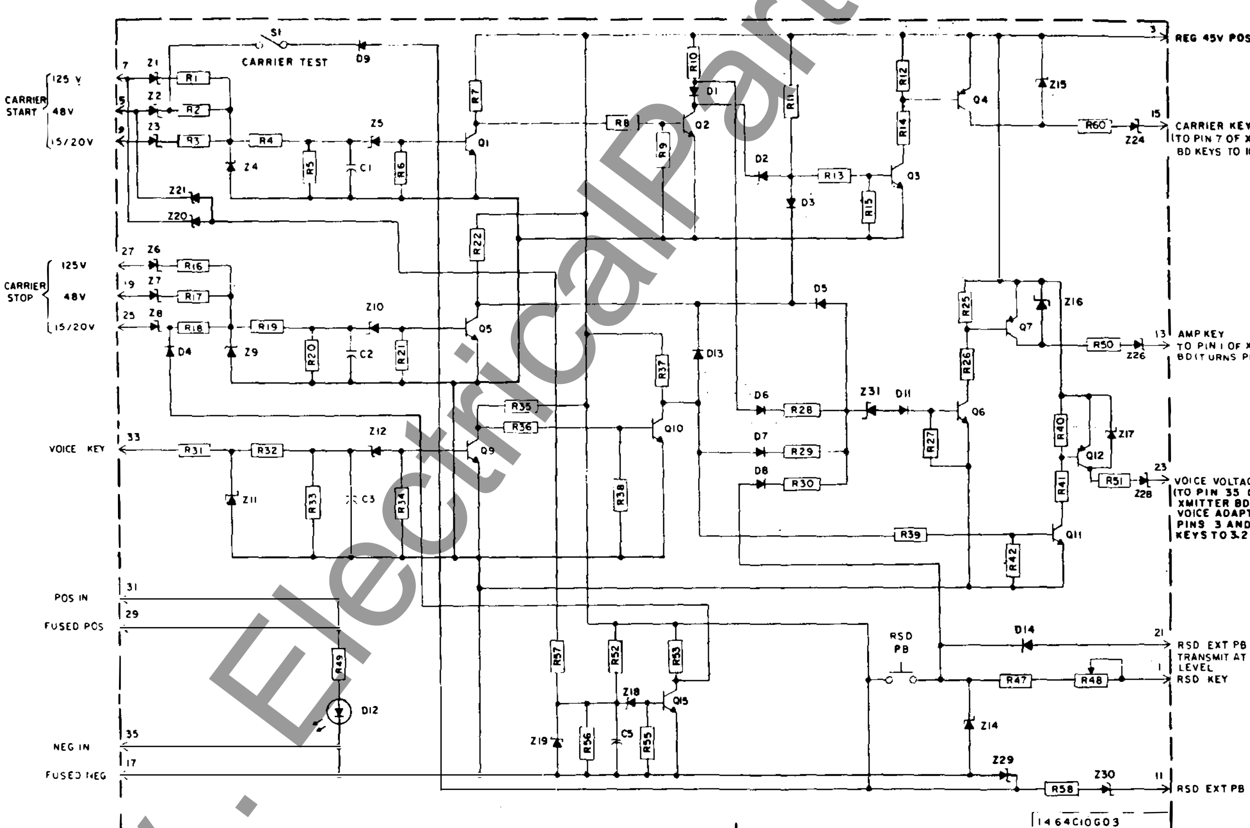
1464C10G03

COMPONENT		DESCRIPTION	STYLE NO.
C1	CAPACITOR	.047UF 200V	849A437H04
C2	CAPACITOR	.047UF 200V	849A437H04
C3	CAPACITOR	.047UF 200V	849A437H04
~~C4~~	~~CAPACITOR~~	~~1.000UF 200V~~	~~187A624H04~~
C5	CAPACITOR	.047UF 200V	849A437H04
D1	DIODE	1N457A	184A855H07
D2	DIODE	1N457A	184A855H07
D3	DIODE	1N457A	184A855H07
D4	DIODE	1N457A	184A855H07
D5	DIODE	1N457A	184A855H07
D6	DIODE	1N457A	184A855H07
D7	DIODE	1N457A	184A855H07
D8	DIODE	1N457A	184A855H07
D9	DIODE	1N457A	184A855H07
~~D10~~	~~DIODE~~	~~1N457A~~	~~184A855H07~~
D11	DIODE	1N457A	184A855H07
D12	DIODE	LED	3508A22H01
D13	DIODE	1N457A	184A855H07
D14	DIODE	1N457A	184A855H07
J1	JUMPER	0 OHM RESISTOR	862A478H01
J2	JUMPER	0 OHM RESISTOR	862A478H01
J3	JUMPER	0 OHM RESISTOR	862A478H01
J4	JUMPER	0 OHM RESISTOR	862A478H01
J5	JUMPER	0 OHM RESISTOR	862A478H01
J6	JUMPER	0 OHM RESISTOR	862A478H01
J7	JUMPER	0 OHM RESISTOR	862A478H01
R1	RESISTOR	33.0K .50W 2%	629A531H66
R2	RESISTOR	13.0K .50W 2%	629A531H57
R3	RESISTOR	820.0 .50W 2%	629A531H30
R4	RESISTOR	1500.0 .50W 5%	184A763H31
R5	RESISTOR	6200.0 .50W 5%	184A763H46
R6	RESISTOR	10.0K .50W 5%	184A763H51
R7	RESISTOR	12.0K .50W 5%	184A763H53
R8	RESISTOR	27.0K .50W 5%	184A763H61
R9	RESISTOR	10.0K .50W 5%	184A763H51
R10	RESISTOR	12.0K .50W 5%	184A763H53
R11	RESISTOR	12.0K .50W 5%	184A763H53
R12	RESISTOR	4700.0 .50W 5%	184A763H43
R13	RESISTOR	27.0K .50W 5%	184A763H61
R14	RESISTOR	12.0K .50W 5%	184A763H53
R15	RESISTOR	10.0K .50W 5%	184A763H51
R16	RESISTOR	33.0K .50W 2%	629A531H66
R17	RESISTOR	13.0K .50W 2%	629A531H57
R18	RESISTOR	820.0 .50W 2%	629A531H30
R19	RESISTOR	1500.0 .50W 5%	184A763H31
R20	RESISTOR	6200.0 .50W 5%	184A763H46
R21	RESISTOR	10.0K .50W 5%	184A763H51
R22	RESISTOR	12.0K .50W 5%	184A763H53
R25	RESISTOR	4700.0 .50W 5%	184A763H43
R26	RESISTOR	12.0K .50W 5%	184A763H53
R27	RESISTOR	10.0K .50W 5%	184A763H51
R28	RESISTOR	27.0K .50W 5%	184A763H61
R29	RESISTOR	27.0K .50W 5%	184A763H61

COMPONENT		DESCRIPTION	STYLE NO.
R30	RESISTOR	27.0K .50W 5%	184A763H61
R31	RESISTOR	1800.0 .50W 5%	184A763H33
R32	RESISTOR	1500.0 .50W 5%	184A763H31
R33	RESISTOR	6200.0 .50W 5%	184A763H46
R34	RESISTOR	10.0K .50W 5%	184A763H51
R35	RESISTOR	12.0K .50W 5%	184A763H53
R36	RESISTOR	27.0K .50W 5%	184A763H61
R37	RESISTOR	12.0K .50W 5%	184A763H53
R38	RESISTOR	10.0K .50W 5%	184A763H51
R39	RESISTOR	27.0K .50W 5%	184A763H61
R40	RESISTOR	4700.0 .50W 5%	184A763H43
R41	RESISTOR	12.0K .50W 5%	184A763H53
R42	RESISTOR	10.0K .50W 5%	184A763H51
R47	RESISTOR	8200.0 .50W 5%	184A763H49
R49	RESISTOR	18.0K .50W 2%	629A531H62
R50	RESISTOR	300.0 .50W 5%	184A763H14
R51	RESISTOR	300.0 .50W 5%	184A763H14
R52	RESISTOR	12.0K .50W 5%	184A763H53
R53	RESISTOR	10.0K .50W 5%	184A763H51
~~R54~~	~~RESISTOR~~	~~10.0K .50W 5%~~	~~184A763H51~~
R55	RESISTOR	10.0K .50W 5%	184A763H51
R56	RESISTOR	6200.0 .50W 5%	184A763H46
R57	RESISTOR	1.0K .50W 5%	184A763H27
R58	RESISTOR	300.0 .50W 5%	184A763H14
~~R59~~	~~RESISTOR~~	~~300.0 .50W 5%~~	~~184A763H14~~
R60	RESISTOR	300.0 .50W 5%	184A763H14
R48	POT	25.0K .50 W 10%	880A687H06
Q1	TRANSISTOR	2N699	184A638H19
Q2	TRANSISTOR	2N699	184A638H19
Q3	TRANSISTOR	2N699	184A638H19
Q4	TRANSISTOR	2N3645	849A441H01
Q5	TRANSISTOR	2N699	184A638H19
Q6	TRANSISTOR	2N699	184A638H19
Q7	TRANSISTOR	2N3645	849A441H01
Q9	TRANSISTOR	2N699	184A638H19
Q10	TRANSISTOR	2N699	184A638H19
Q11	TRANSISTOR	2N699	184A638H19
Q12	TRANSISTOR	2N3645	849A441H01
Q15	TRANSISTOR	2N699	184A638H19
Z1	ZENER	1R200 200.0V	629A369H01
Z2	ZENER	1R200 200.0V	629A369H01
Z3	ZENER	1R200 200.0V	629A369H01
Z4	ZENER	1N3686B 20.0V	185A212H06
Z5	ZENER	1N957B 6.8V	186A797H06
Z6	ZENER	1R200 200.0V	629A369H01
Z7	ZENER	1R200 200.0V	629A369H01
Z8	ZENER	1R200 200.0V	629A369H01
Z9	ZENER	1N3686B 20.0V	185A212H06
Z10	ZENER	1N957B 6.8V	186A797H06
Z11	ZENER	1N3686B 20.0V	185A212H06
Z12	ZENER	1N957B 6.8V	186A797H06
Z14	ZENER	1N3038B 56.0V	862A257H04
Z15	ZENER	1N3038B 56.0V	862A257H04
Z16	ZENER	1N3038B 56.0V	862A257H04
Z17	ZENER	1N3038B 56.0V	862A257H04

COMPONENT		DESCRIPTION	STYLE NO.
Z18	ZENER	1N957B 6.8V	[illegible]
Z19	ZENER	[illegible] 20.0V	[illegible]
Z20	ZENER	1.5KE200 200.0V	[illegible]
Z21	ZENER	1.5KE200 200.0V	[illegible]
~~Z22~~	~~ZENER~~	~~[illegible] 200.0V~~	~~[illegible]~~
~~Z23~~	~~ZENER~~	~~[illegible] 56.0V~~	~~[illegible]~~
Z24	ZENER	[illegible]	[illegible]
~~[illegible]~~	~~ZENER~~	~~[illegible]~~	~~[illegible]~~
Z26	[illegible]	[illegible]	[illegible]
~~Z27~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~
Z28	[illegible]	[illegible]	[illegible]
Z29	[illegible]	[illegible]	[illegible]
Z30	[illegible]	[illegible]	[illegible]
Z31	ZENER	1N957B 6.8V	186A797H06

COMPONENT		DESCRIPTION	STYLE NO.
S1	SWITCH		849A299H03
RSD	SWITCH		3510A06H01
JUMPER		0 OHM RES	862A478H01
JUMPER		0 OHM RES	862A478H01
JUMPER		0 OHM RES	862A478H01
JUMPER		0 OHM RES	862A478H01



Sub. 8
(1463C68)
Sheets 5 & 6

Fig. 22C. Internal Schematic - Keying Module - without DC Power switch or Fuses - with Reserve Signal Detector Pushbutton and Control.

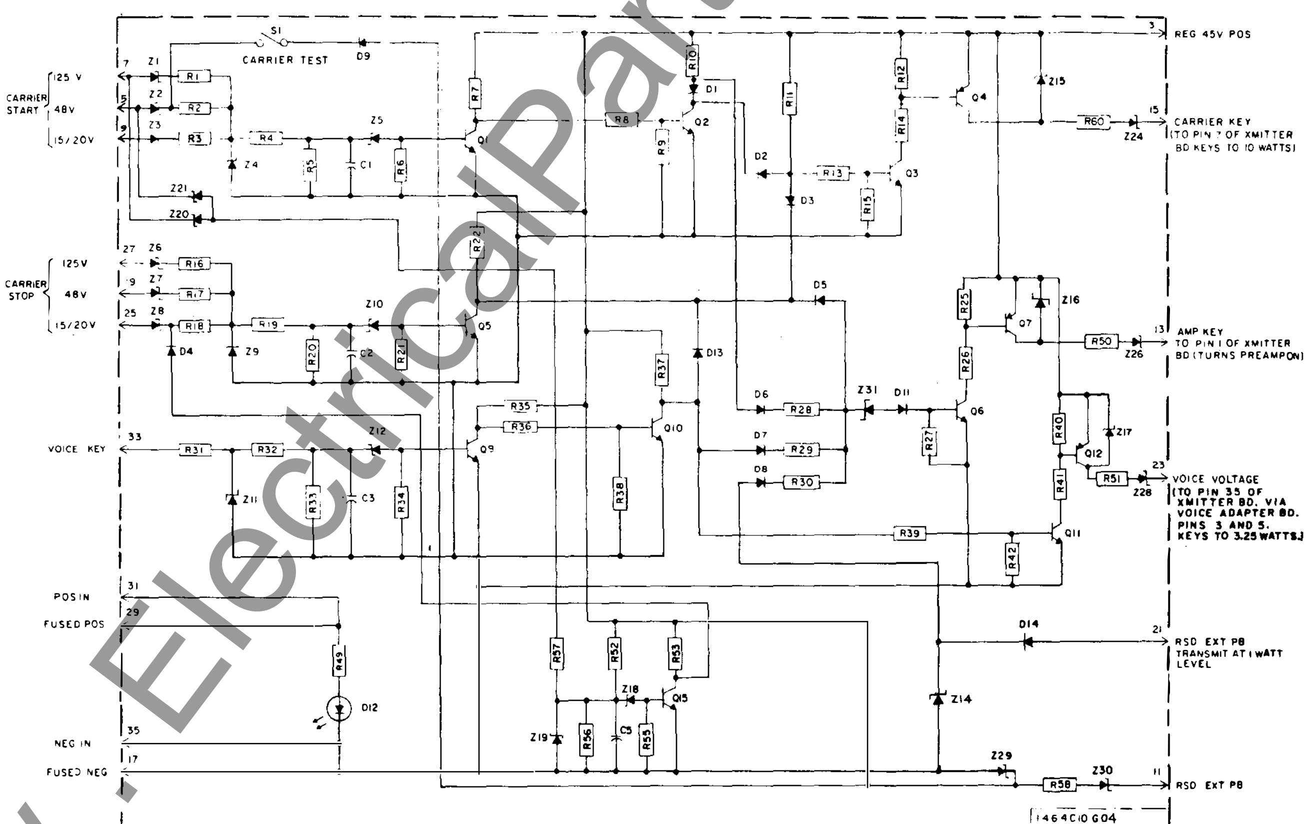
1464C10G04

COMPONENT		DESCRIPTION	STYLE NO.
C1	CAPACITOR	.047UF 200V	849A437H04
C2	CAPACITOR	.047UF 200V	849A437H04
C3	CAPACITOR	.047UF 200V	849A437H04
~~C4~~	~~CAPACITOR~~	~~1.000UF 200V~~	
C5	CAPACITOR	.047UF 200V	849A437H04
D1	DIODE	1N457A	184A855H07
D2	DIODE	1N457A	184A855H07
D3	DIODE	1N457A	184A855H07
D4	DIODE	1N457A	184A855H07
D5	DIODE	1N457A	184A855H07
D6	DIODE	1N457A	184A855H07
D7	DIODE	1N457A	184A855H07
D8	DIODE	1N457A	184A855H07
D9	DIODE	1N457A	184A855H07
~~D10~~	~~DIODE~~	~~1N457A~~	~~184A855H07~~
D11	DIODE	1N457A	184A855H07
D12	DIODE	LED	3508A22H01
D13	DIODE	1N457A	184A855H07
D14	DIODE	1N457A	184A855H07
J1	JUMPER	0 OHM RESISTOR	862A478H01
J2	JUMPER	0 OHM RESISTOR	862A478H01
J3	JUMPER	0 OHM RESISTOR	862A478H01
J4	JUMPER	0 OHM RESISTOR	862A478H01
J5	JUMPER	0 OHM RESISTOR	862A478H01
J6	JUMPER	0 OHM RESISTOR	862A478H01
J7	JUMPER	0 OHM RESISTOR	862A478H01
R1	RESISTOR	33.0K .50W 2%	629A531H68
R2	RESISTOR	13.0K .50W 2%	629A531H59
R3	RESISTOR	820.0 .50W 2%	629A531H30
R4	RESISTOR	1500.0 .50W 5%	184A763H31
R5	RESISTOR	6200.0 .50W 5%	184A763H46
R6	RESISTOR	10.0K .50W 5%	184A763H51
R7	RESISTOR	12.0K .50W 5%	184A763H53
R8	RESISTOR	27.0K .50W 5%	184A763H61
R9	RESISTOR	10.0K .50W 5%	184A763H51
R10	RESISTOR	12.0K .50W 5%	184A763H53
R11	RESISTOR	12.0K .50W 5%	184A763H53
R12	RESISTOR	4700.0 .50W 5%	184A763H43
R13	RESISTOR	27.0K .50W 5%	184A763H61
R14	RESISTOR	12.0K .50W 5%	184A763H53
R15	RESISTOR	10.0K .50W 5%	184A763H51
R16	RESISTOR	33.0K .50W 2%	629A531H68
R17	RESISTOR	13.0K .50W 2%	629A531H59
R18	RESISTOR	820.0 .50W 2%	629A531H30
R19	RESISTOR	1500.0 .50W 5%	184A763H31
R20	RESISTOR	6200.0 .50W 5%	184A763H46
R21	RESISTOR	10.0K .50W 5%	184A763H51
R22	RESISTOR	12.0K .50W 5%	184A763H53
R25	RESISTOR	4700.0 .50W 5%	184A763H43
R26	RESISTOR	12.0K .50W 5%	184A763H53
R27	RESISTOR	10.0K .50W 5%	184A763H51
R28	RESISTOR	27.0K .50W 5%	184A763H61
R29	RESISTOR	27.0K .50W 5%	184A763H61

COMPONENT		DESCRIPTION	STYLE NO.
R30	RESISTOR	27.0K .50W 5%	184A763H61
R31	RESISTOR	1800.0 .50W 5%	184A763H33
R32	RESISTOR	1500.0 .50W 5%	184A763H31
R33	RESISTOR	6200.0 .50W 5%	184A763H46
R34	RESISTOR	10.0K .50W 5%	184A763H51
R35	RESISTOR	12.0K .50W 5%	184A763H53
R36	RESISTOR	27.0K .50W 5%	184A763H61
R37	RESISTOR	12.0K .50W 5%	184A763H53
R38	RESISTOR	10.0K .50W 5%	184A763H51
R39	RESISTOR	27.0K .50W 5%	184A763H61
R40	RESISTOR	4700.0 .50W 5%	184A763H43
R41	RESISTOR	12.0K .50W 5%	184A763H53
R42	RESISTOR	10.0K .50W 5%	184A763H51
R49	RESISTOR	18.0K .50W 2%	629A531H62
R50	RESISTOR	300.0 .50W 5%	184A763H14
R51	RESISTOR	300.0 .50W 5%	184A763H14
R52	RESISTOR	12.0K .50W 5%	184A763H53
R53	RESISTOR	10.0K .50W 5%	184A763H51
~~R54~~	~~RESISTOR~~	~~10.0K .50W 5%~~	~~184A763H51~~
R55	RESISTOR	10.0K .50W 5%	184A763H51
R56	RESISTOR	6200.0 .50W 5%	184A763H46
R57	RESISTOR	1.0K .50W 5%	184A763H27
R58	RESISTOR	300.0 .50W 5%	184A763H14
~~R59~~	~~RESISTOR~~	~~300.0 .50W 5%~~	~~184A763H14~~
R60	RESISTOR	300.0 .50W 5%	184A763H14
Q1	TRANSISTOR	2N699	184A638H19
Q2	TRANSISTOR	2N699	184A638H19
Q3	TRANSISTOR	2N699	184A638H19
Q4	TRANSISTOR	2N3645	849A441H01
Q5	TRANSISTOR	2N699	184A638H19
Q6	TRANSISTOR	2N699	184A638H19
Q7	TRANSISTOR	2N3645	849A441H01
Q9	TRANSISTOR	2N699	184A638H19
Q10	TRANSISTOR	2N699	184A638H19
Q11	TRANSISTOR	2N699	184A638H19
Q12	TRANSISTOR	2N3645	849A441H01
Q15	TRANSISTOR	2N699	184A638H19
Z1	ZENER	1R200 200.0V	629A369H01
Z2	ZENER	1R200 200.0V	629A369H01
Z3	ZENER	1R200 200.0V	629A369H01
Z4	ZENER	1N3686B 20.0V	185A212H06
Z5	ZENER	1N957B 6.8V	186A797H06
Z6	ZENER	1R200 200.0V	629A369H01
Z7	ZENER	1R200 200.0V	629A369H01
Z8	ZENER	1R200 200.0V	629A369H01
Z9	ZENER	1N3686B 20.0V	185A212H06
Z10	ZENER	1N957B 6.8V	186A797H06
Z11	ZENER	1N3686B 20.0V	185A212H06
Z12	ZENER	1N957B 6.8V	186A797H06
Z14	ZENER	1N3038B 56.0V	862A257H04
Z15	ZENER	1N3038B 56.0V	862A257H04
Z16	ZENER	1N3038B 56.0V	862A257H04
Z17	ZENER	1N3038B 56.0V	862A257H04
Z18	ZENER	1N957B 6.8V	186A797H06

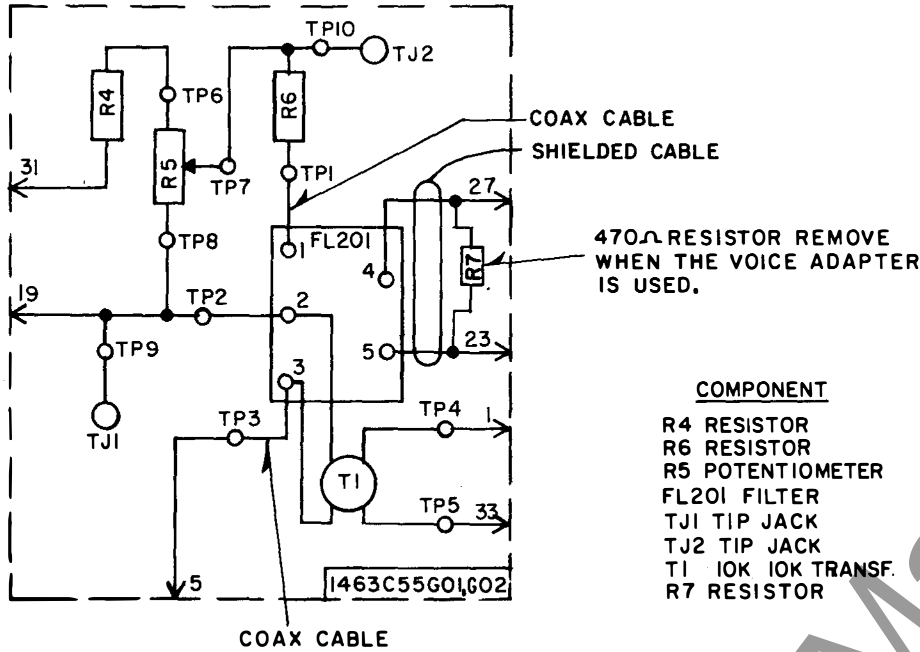
COMPONENT		DESCRIPTION	STYLE NO.
Z19	ZENER	1N3686B 20.0V	185A212H06
Z20	ZENER	15KE200 200.0V	878A619H01
Z21	ZENER	15KE200 200.0V	878A619H01
~~Z22~~	~~ZENER~~	~~15KE200 200.0V~~	~~878A619H01~~
~~Z23~~	~~ZENER~~	~~1N3038B 56.0V~~	~~862A257H04~~
Z24	ZENER	15KE200 200.0V	878A619H01
~~Z25~~	~~ZENER~~	~~1N3038B 56.0V~~	~~862A257H04~~
Z26	ZENER	15KE200 200.0V	878A619H01
~~Z27~~	~~ZENER~~	~~1N3038B 56.0V~~	~~862A257H04~~
Z28	ZENER	15KE200 200.0V	878A619H01
Z29	ZENER	1N3038B 56.0V	862A257H04
Z30	ZENER	15KE200 200.0V	878A619H01
Z31	ZENER	1N957B 6.8V	186A797H06

COMPONENT	DESCRIPTION	STYLE NO.
S1 SWITCH		849A299H03
JUMPER	0 OHM RES.	862A478H01
JUMPER	0 OHM RES	862A478H01
JUMPER	0 OHM RES	862A478H01
JUMPER	0 OHM RES	862A478H01



Sub. 8
(1463C68)
Sheets 7 & 8

✪ *Fig. 22D. Internal Schematic - Keying Module - without DC Power Switch or Fuses - without Reserve Signal Detector Components.*



COMPONENT	DESCRIPTION	STYLE NO.
R4 RESISTOR	10 K .50W 5%	184A763H51
R6 RESISTOR	10 K .50W 5%	184A763H51
R5 POTENTIOMETER	10 K 2 W	185A086H10
FL201 FILTER		□
TJ1 TIP JACK	BLACK	187A332H02
TJ2 TIP JACK	RED	187A332H01
T1 10K 10K TRANSF.		714B677G01
R7 RESISTOR	470Ω .50W 5%	184A763H19

□ = ORDER BY FREQUENCY.

Sub. 3
(1478B46)

✪ *Fig. 23. Internal Schematic - Receiver Input Module.*

COMPONENT		DESCRIPTION	STYLE NO.
C18	CAPACITOR	.250UF 200V	187A624H02
C19	CAPACITOR	.250UF 200V	187A624H02
C20	CAPACITOR	100.000PF 500V	762A757H01
C21	CAPACITOR	.250UF 200V	187A624H02
C22	CAPACITOR	1.000UF 200V	187A624H04
C23	CAPACITOR	.250UF 200V	187A624H02
▲ C211	CAPACITOR	SEE NOTE ▲	
C213	CAPACITOR	.100UF 50V	184A663H04
C215	CAPACITOR	.100UF 50V	184A663H04
C216	CAPACITOR	1.000UF 200V	187A624H04
C217	CAPACITOR	1.000UF 200V	187A624H04
C218	CAPACITOR	.250UF 200V	187A624H02
O C214	CAPACITOR	SEE NOTE O	
IC201	INT CKT	MA710	201C826H03
J1	JUMPER	0 OHM RESISTOR	862A478H01
R26	RESISTOR	3300.0 .50W 5%	184A763H39
R27	RESISTOR	22.0K .50W 5%	184A763H59
R28	RESISTOR	680.0 .50W 5%	184A763H23
R29	RESISTOR	68.0 .50W 5%	187A290H21
R30	RESISTOR	10.0K .50W 5%	184A763H51
R31	RESISTOR	330.0 .50W 5%	184A763H15
R32	RESISTOR	3300.0 .50W 5%	184A763H39
* R33	RESISTOR	1000.0 .50W 5%	184A763H27
R34	RESISTOR	22.0K .50W 5%	184A763H59
R35	RESISTOR	680.0 .50W 5%	184A763H23
R36	RESISTOR	68.0 .50W 5%	187A290H21
R37	RESISTOR	10.0K .50W 5%	184A763H51
R211	RESISTOR	10.0K .50W 5%	184A763H51
R212	RESISTOR	1000.0 .50W 5%	184A763H27
R213	RESISTOR	10.0K .50W 5%	184A763H51
R214	RESISTOR	2700.0 .50W 5%	184A763H37
R215	RESISTOR	10.0K .50W 5%	184A763H51
R216	RESISTOR	8200.0 .50W 5%	184A763H49
R217	RESISTOR	2000.0 .50W 5%	184A763H34
R218	RESISTOR	150.0 .50W 5%	184A763H07
R219	RESISTOR	330.0 .50W 5%	184A763H15
R220	RESISTOR	47.0K .50W 5%	184A763H67
R221	RESISTOR	220.0K .50W 5%	184A763H83
R222	RESISTOR	1800.0 .50W 5%	184A763H33
R223	RESISTOR	1000.0 1W 5%	184A643H27
● R33	RESISTOR	300.0 .50W 5%	184A763H14
Q14	TRANSISTOR	2N4249	849A441H03
Q15	TRANSISTOR	2N4249	849A441H03
Q211	TRANSISTOR	2N4249	849A441H03
* FL2	FILTER		762A613G01
● FL202	FILTER		187A590G03
Z201	ZENER	1N753A 6.2V	862A606H01
Z202	ZENER	1N3027B 20.0V	188A302H07
Y11	CRYSTAL	SEE NOTE □	
T211	TRANSF.		714B677G01
T212	TRANSF.		205C043G03

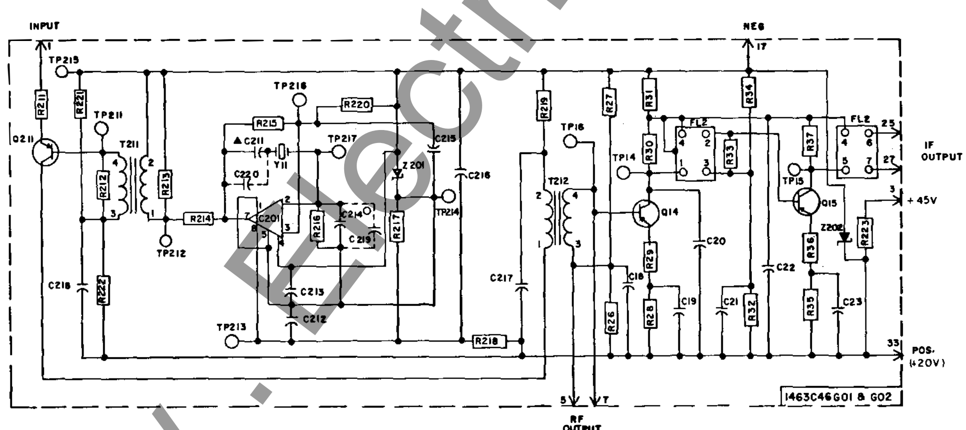
▲ C211 RANGES FROM 100PF TO 1000PF

O C214 MAY VARY UP TO 100PF 187A695H01 THROUGH H23

□ Y11 FREQ. EQUALS RCVR (CHANNEL) FREQUENCY PLUS 20KHZ

* FOR G01 FOR NARROW BAND TC-10

● FOR G02 FOR WIDE BAND TC-10



Sub. 4
(1463C47)

✪ *Fig. 24. Internal Schematic - I.F. Amplifier Oscillator Module.*

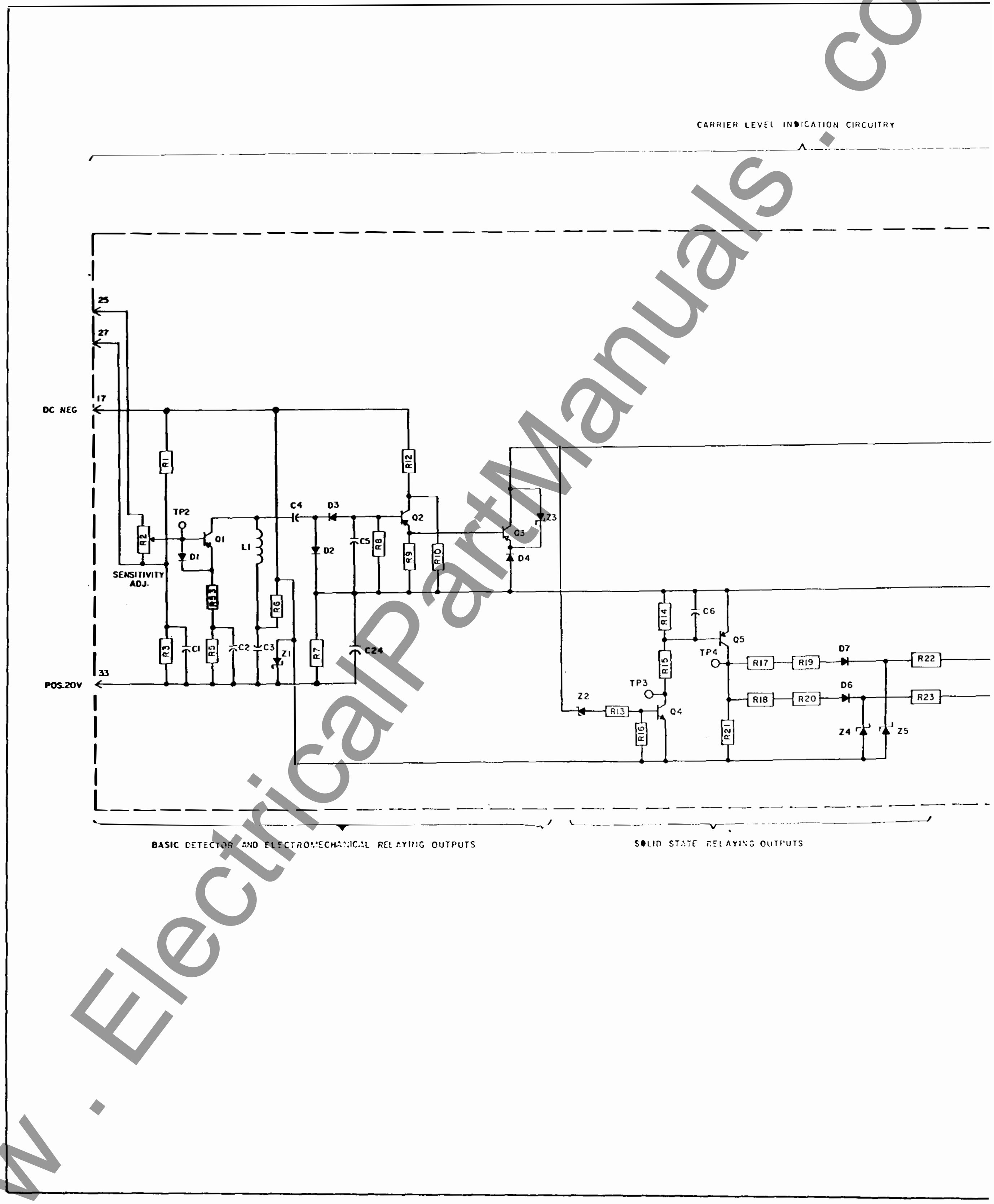
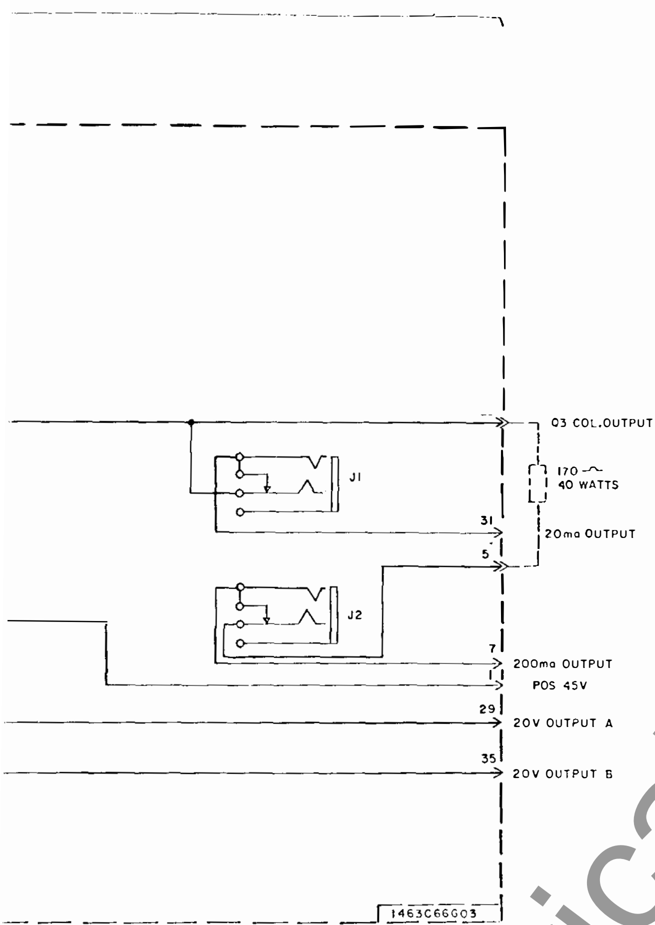


Fig. 25B. Internal Schematic - Detector Mo
20 Volt Outputs.



COMPONENT		DESCRIPTION	STYLE NO.
C1	CAPACITOR	.250UF 200V	187A624H02
C2	CAPACITOR	.250UF 200V	187A624H02
C3	CAPACITOR	.100UF 200V	187A624H01
C4	CAPACITOR	.250UF 200V	187A624H02
C5	CAPACITOR	.250UF 200V	187A624H02
C6	CAPACITOR	.270UF 200V	188A669H05
C7	CAPACITOR	.010UF 50V	184A663H01
C24	**CAPACITOR**	**2.000UF 200V**	**187A624H08**

D1	DIODE	1N4148	836A928H06
D2	DIODE	1N457A	184A855H07
D3	DIODE	1N457A	184A855H07
D4	DIODE	1N4218	188A342H06
D6	DIODE	1N645A	837A692H03
D7	DIODE	1N645A	837A692H03

R1	RESISTOR	27.0K .50W 5%	184A763H61
R3	RESISTOR	4700.0 .50W 2%	629A531H48
R5	RESISTOR	470.0 1.00W 5%	187A643H19
R6	RESISTOR	2000.0 .50W 5%	184A763H34
R7	RESISTOR	560.0 1.00W 5%	187A643H21
R8	RESISTOR	10.0K .50W 1%	848A820H45
R9	RESISTOR	1500.0 .50W 5%	184A763H31

COMP LOC. 1479B39

COMPONENT		DESCRIPTION	STYLE NO.
R10	RESISTOR	4.7K2.00W10%	187A642H43
R53	**RESISTOR**	**[illegible] .50W 5%**	**187A[illegible]**
R12	RESISTOR	4.7K2.00W10%	187A642H43
R13	RESISTOR	27.0K .50W 5%	184A763H61
R14	RESISTOR	10.0K .50W 1%	848A820H45
R15	RESISTOR	6800.0 .50W 5%	184A763H47
R16	RESISTOR	10.0K .50W 1%	848A820H45
R17	RESISTOR	700.0 3.00W 5%	763A127H28
R18	RESISTOR	700.0 3.00W 5%	763A127H28
R19	RESISTOR	120.0 .50W 5%	184A763H05
R20	RESISTOR	120.0 .50W 5%	184A763H05
R21	RESISTOR	82.0K .50W 5%	184A763H73
R22	RESISTOR	150.0 3.00W 5%	762A679H01
R23	RESISTOR	150.0 3.00W 5%	762A679H01

Q1	TRANSISTOR	2N4249		849A441H03
Q2	TRANSISTOR	2N3645		849A441H01
Q4	TRANSISTOR	2N3417		848A851H02
Q5	TRANSISTOR	2N4356		849A441H02
Q3	**TRANSISTOR**	**2N4903**		**187A673H13**
Z1	ZENER	1N3027B	20.0V	182A302H07
Z2	ZENER	1N3686B	20.0V	185A212H06
Z3	ZENER	1N3038B	56.0V	862A257H04
Z4	ZENER	1N4747A	20.0V	849A487H01
Z5	ZENER	1N4747A	20.0V	849A487H01
Z6	ZENER	1N4460	6.2V	837A693H08
Z7	ZENER	1N4460	6.2V	837A693H08

L1	CHOKE	187A598H01

Sub. 10
(1334D41)
Sheet 2

dule - with 200mA and 20mA outputs, and Two

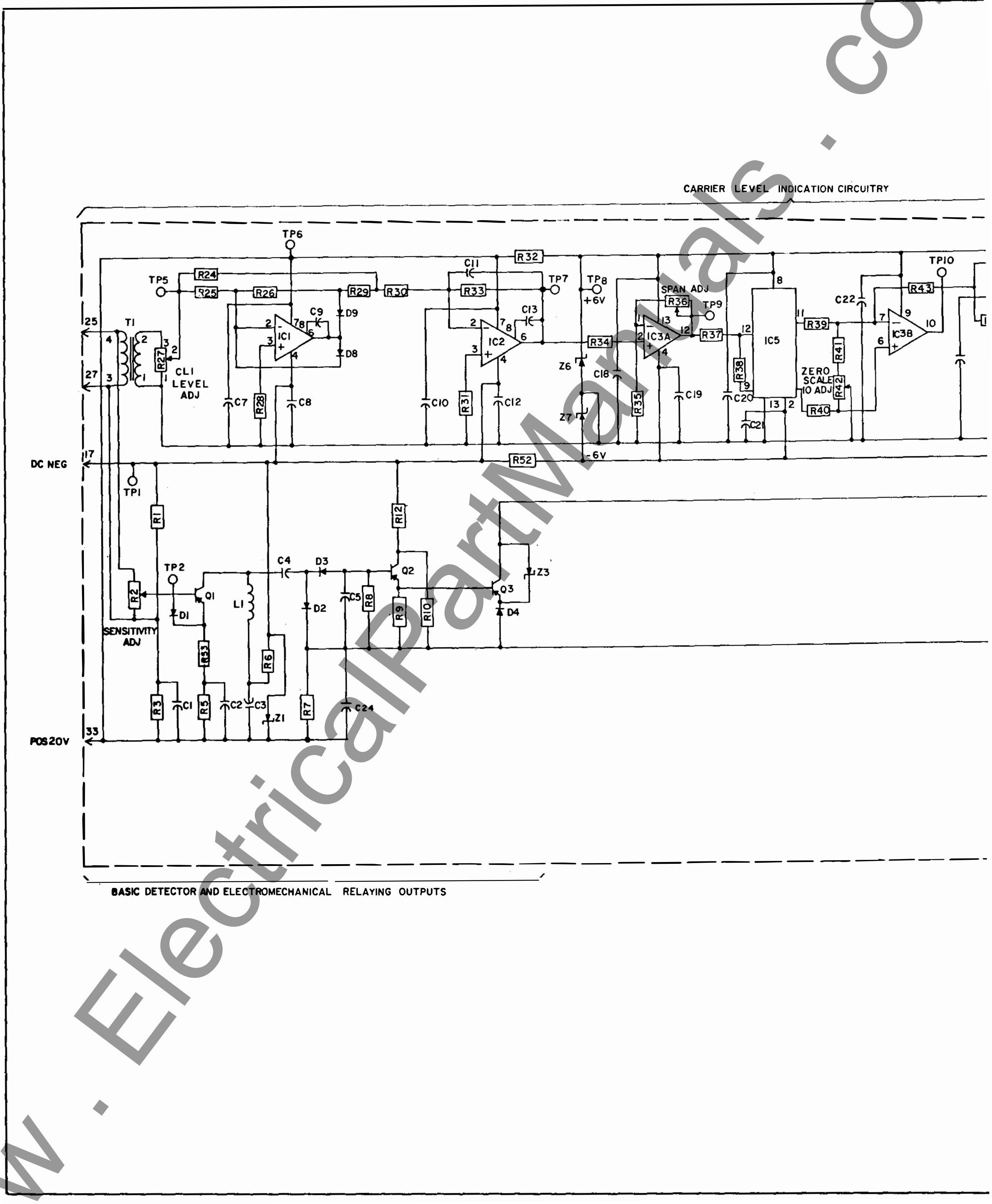
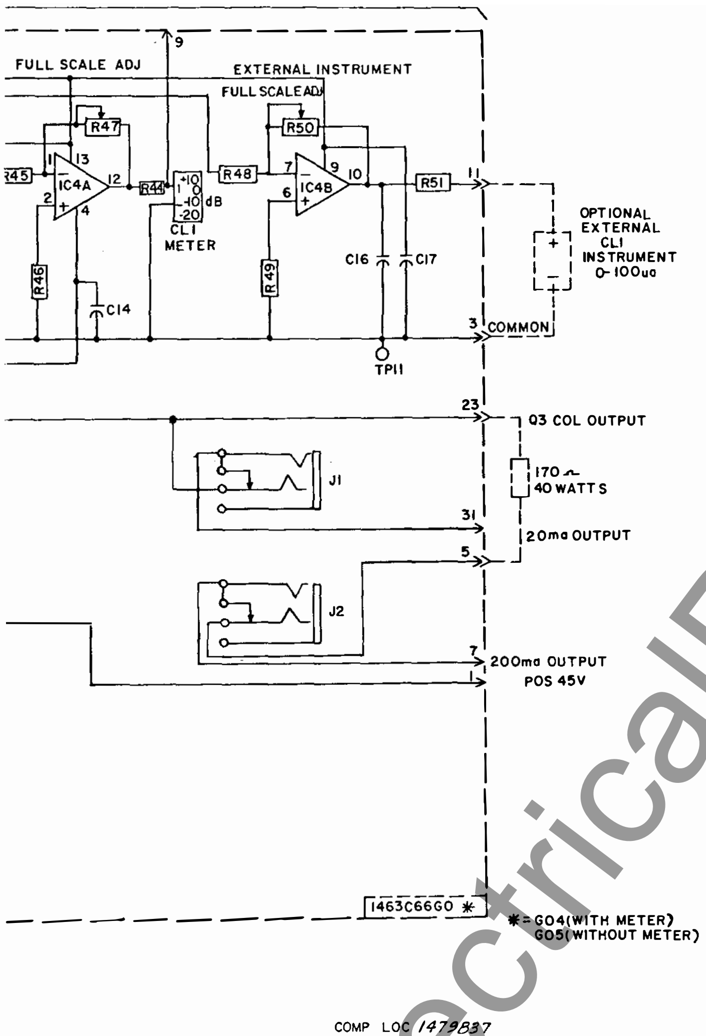


Fig. 25D. Internal Schematic - Detector Mod



COMPONENT		DESCRIPTION	STYLE NO.
C1	CAPACITOR	.250UF 200V	187A624H02
C2	CAPACITOR	.250UF 200V	187A624H02
C3	CAPACITOR	.100UF 200V	187A624H01
C4	CAPACITOR	.250UF 200V	187A624H02
C5	CAPACITOR	.250UF 200V	187A624H02
C7	CAPACITOR	.010UF 50V	184A663H01
C8	CAPACITOR	.010UF 50V	184A663H01
C9	CAPACITOR	33.000PF 200V	879A989H07
C10	CAPACITOR	.010UF 50V	184A663H01
C11	CAPACITOR	.470UF 50V	762A680H04
C12	CAPACITOR	.010UF 50V	184A663H01
C13	CAPACITOR	33.000PF 200V	879A989H07
C14	CAPACITOR	.010UF 50V	184A663H01
C16	CAPACITOR	.270UF 200V	188A669H05
C17	CAPACITOR	.010UF 50V	184A663H01
C18	CAPACITOR	.010UF 50V	184A663H01
C19	CAPACITOR	.010UF 50V	184A663H01
C20	CAPACITOR	.010UF 50V	184A663H01
C21	CAPACITOR	.010UF 50V	184A663H01
C22	CAPACITOR	.010UF 50V	184A663H01
C23	CAPACITOR	.010UF 50V	184A663H01
C24	CAPACITOR	2.000 UF 200V	187A624H05
D1	DIODE	1N4148	836A928H06
D2	DIODE	1N457A	184A855H07
D3	DIODE	1N457A	184A855H07
D4	DIODE	1N4818	188A342H06
D8	DIODE	1N4148	836A928H06
D9	DIODE	1N4148	836A928H06
IC1	INT CKT	SE531T	3512A10H01
IC2	INT CKT	SE531T	3512A10H01
IC3	INT CKT	747DM	1443C52H01
IC4	INT CKT	747DM	1443C52H01
IC5	INT CKT	SN56502	3512A09H01
R2	POT	10.0K .75W	880A826H05
R27	POT	50.0K .50W	629A645H06
R36	POT	250.0K .75W	880A826H10
R42	POT	2.5K .25W	629A645H07
* R47	POT	5.0K .75W	880A826H09
R50	POT	5.0K .75W	880A826H09
R1	RESISTOR	27.0K .50W 5%	184A763H61
R3	RESISTOR	4700.0 .50W 2%	629A531H48
R5	RESISTOR	470.0 1.00W 5%	187A643H19
R6	RESISTOR	2000.0 .50W 5%	184A763H34
R7	RESISTOR	300.0 5W 5%	783A129H26
R8	RESISTOR	10.0K .50W 1%	848A820H45
R9	RESISTOR	1500.0 .50W 5%	184A763H31
R10	RESISTOR	4.7K 2.00W 10%	187A642H43
R53	RESISTOR	68Ω .50W 5%	187A290H21
R12	RESISTOR	4.7K 2.00W 10%	187A642H43
R24	RESISTOR	4750.0 .50W 1%	848A820H14
R25	RESISTOR	4750.0 .50W 1%	848A820H14
R26	RESISTOR	15.0K .50W 1%	848A820H62
R28	RESISTOR	4990.0 .50W 1%	848A820H16
R29	RESISTOR	4990.0 .50W 1%	848A820H16
R30	RESISTOR	4990.0 .50W 1%	848A820H16
R31	RESISTOR	4990.0 .50W 1%	848A820H16
R32	RESISTOR	100.0 3.00W 5%	763A127H20
R33	RESISTOR	10.0K .50W 1%	848A820H45
R34	RESISTOR	2.0K .50W 1%	848A819H77
R35	RESISTOR	4990.0 .50W 1%	848A820H16
R37	RESISTOR	1000.0 .50W 1%	848A819H48
R38	RESISTOR	15.0K .50W 1%	848A820H62
R39	RESISTOR	2.0K .50W 1%	848A819H77
R40	RESISTOR	2.0K .50W 1%	848A819H77
R41	RESISTOR	17.8K .50W 1%	848A820H69
R43	RESISTOR	1000.0 .50W 1%	848A819H48
R44	RESISTOR	100.0 .50W 2%	629A531H08
R45	RESISTOR	560.0 .50W 2%	629A531H26
R46	RESISTOR	1000.0 .50W 1%	848A819H48
R48	RESISTOR	560.0 .50W 2%	629A531H26
R49	RESISTOR	1000.0 .50W 1%	848A819H48
R51	RESISTOR	100.0 1.00W 5%	187A643H03
R52	RESISTOR	100.0 3.00W 5%	763A127H20
L1	CHOKE		187A599H01
	* METER		3508A77H02
T1	TRANSFORMER	10K/10K	714B677G01
Q1	TRANSISTOR	2N4249	849A441H03
Q2	TRANSISTOR	2N3645	849A441H01
Q3	TRANSISTOR	2N4903	187A673H13
Z1	ZENER	1N3027B 20.0V	188A302H07
Z3	ZENER	1N3038B 56.0V	862A257H04
Z6	ZENER	1N4460 6.2V	837A693H08
Z7	ZENER	1N4460 6.2V	837A693H08

Sub. 10
(1334D41)
Sheet 4

ule - with CLI - with 200mA and 20mA outputs.

DWG. NO. 1335D47		DWG SUB. Y3/8678		PART NAME GEN ASSY		APPAR. TYPE CARRIER				FIN. CODE					
BILL OF MATERIAL		PART DESCRIPTION TC-10 CARRIER		SCALE		DIMENSIONS IN INCHES				RTRV. CODE					
										NOTE CODE	F	F			
										FIG. NO.	125 V	48 V			
										CLASS A	01	02	03	04	05
CLASS	ITEM	PART NAME	DEF.	MATERIAL SIZE / DESCRIPTION	MAT'L CODE / STYLE DWG	SIZE CODE / ITEM GR.	RTRV. CODE	NOTE CODE	FINISH	ENG. REF.	REQ.				
	1	CHASSIS			1335D41	G01				3RU 125V	1	–			
	2	CHASSIS			1335D41	G02				3RU 48V	–	1			
	3	MODULE		OUTPUT FILTER	1461C40					Loc. H	D' SPEC				
	4	MODULE		AMPLIFIER	1463C89					Loc. L					
	5	MODULE		TRANSMITTER	1460C89					Loc. N					
	6	MODULE		KEYING	1464C10					Loc. G					
	7	MODULE		VOICE ADAPTER	1463C26					Loc. P					
	8	MODULE		DETECTOR	1463C66					Loc. E					
	9	MODULE		I.F. AMPLIFIER	1463C46					Loc. C					
	10	MODULE		INPUT	1463C55					Loc. A					
	11	FILTER		INPUT				A							
	12	CRYSTAL		TRANSMIT				B							
	13	CRYSTAL		RECEIVE				C							
	14	NAMEPLATE	MFR		236P261	H01		D		NARROW BAND					
	~~15~~	~~SCREW~~		~~#4X.188 RD HD TF~~	~~877A535~~	~~H01~~					2	2			
	16	PANEL		250 V POWER	1456C69	G01									
	17	HARNESS		STANDARD	1335D24	G13		E		48, 125 V	D' SPEC				
	18	HARNESS		STANDARD	1336D31	G13		E		250 V					
	19	NAMEPLATE	MFR		236P258	H01		D		WIDE BAND					
	20	TAPE	LGH	3.300 (.004X.500)	44788AX	17M					2	2			
	21	SCREW		190-32X.375 Fil. Hd. Str.	877A510	H04			46A003		1	1			
	22	WASHER		.190 Wide Str.	877A649	H05			46A003		1	1			
	23	NUT		.190-32 Hex Str.	877A230	H23			46A003		1	1			

NOTES :

A= DWG'S 1478B95 & 1478B96 (REF INPUT FILTER) BELOW 200 KHZ
DWG. 1465C35 FOR OVER 200 KHZ

B= TRANSMIT CRYSTAL PER DWG. 408C743

C= RECEIVE CRYSTAL PER DWG. 762A800 (CRYSTAL FREQ. EQUALS RECEIVER (CHANNEL) FREQ. PLUS 20KC

D= STENCIL CAT. NO. FREQ. & VOLTAGE PER STOCK ORDER & FIG. 1 THIS DWG.
(SEE D-SPEC FOR DECODING OF CAT. NO.)

E= PER STOCK ORDER STANDARD 6 FT. BOTTOM ENTRANCE
WITH COAXIAL & KNIFE SWITCH.

F= AFTER ASSY. TEST PER M-10690

G= PROVISON FOR EXTERNAL C.L.I INCLUDED

H= PROVISON FOR EXTERNAL RSD ALWAYS INCLUDED

OUTLINE ———— 1464C70
COMP. LOCATION (CKT. BD) ———— 1464C69
I.L. 41-944.35 (WIDE BAND)
SCHEMATIC ———— 1335D20
TEST SPEC ———— 855186
I.L. 41-944.36 (NARROW BAND)

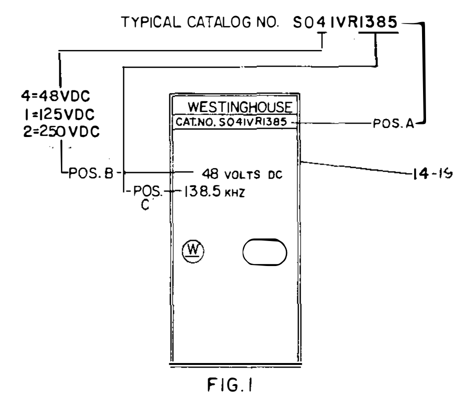


FIG. 1

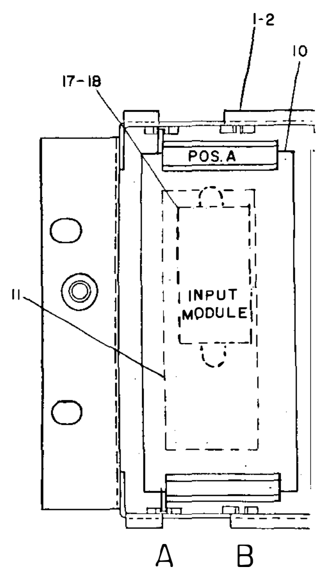


Fig. 27. Type TC-10 Carrier General

TC-10 CODING SHEET

CATALOG NUMBER

TC10-S041VR1385-STD
E113NF (KDAR)6 B/T
Z22 L C A N

- Standard 6' Universal Harness bottom entrance with coax and knife switch
- B Bottom entrance
- T Top entrance
- Length of harness IN FEET
- Application for Special Harness
- Delineator Separating Catalog of TC-10 from Harness

Frequency
Four digit number giving frequency in 0.5 KHZ steps from 30 KHZ to 300 KHZ

Receiver Monitoring Options (NOTE "H")
R Reserve signal detector only
F RSD, carrier level indication, instrument, analog output (NOTE "G")
L RSD, CLI, analog output (EXTERNAL CLI) NO INSTRUMENT ON MODULE
C CLI, analog output, INSTRUMENT ON MODULE (NOTE "G")
A CLI, analog output (EXTERNAL CLI) NO INSTRUMENT ON MODULE
N None of the above

Voice Adapter Option
V With adapter
N Without adapter

Filter Range
1 Wide Band (1500 Hz) I.L.41-944.35 (IT. 19 THIS DWG)
3 Narrow Band (500 Hz) I.L.41-944.36 (IT. 14 THIS DWG)

Battery Voltage
4 48 volts
1 125 volts
2 250 volts (includes external converter panel, 6 racks units high)

Power Level
0 1 Watt Output
1 10 Watt Output
2 100 Watt output (includes external amplifier, 6 rack units high)

E-Electromechanical Relay Outputs
200 MA and 20 MA
180 MA into 30 OHM Coil (S) (Relaying)
20 MA into 2000 OHM Coil (S) (Supervisory)

S-Solid State
200 MA output
20 MA output
2-20 Volt Output
1-45 volt Output
Z-SPECIAL APPLICATION
Style #Delineator

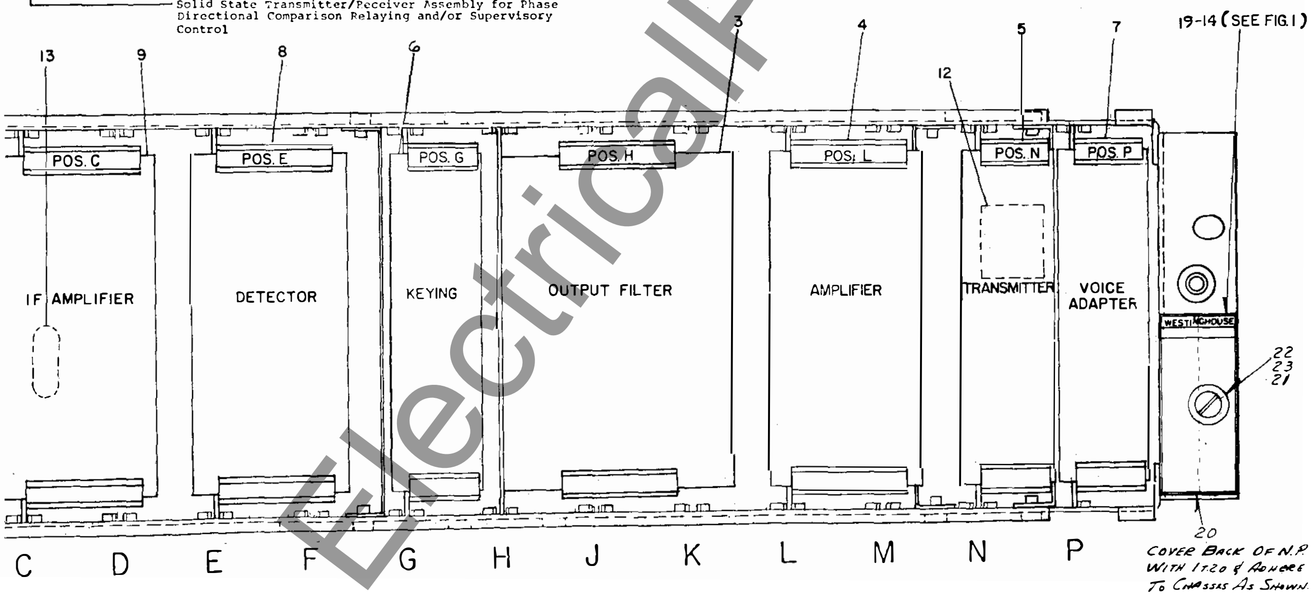
Solid State Transmitter/Receiver Assembly for Phase Directional Comparison Relaying and/or Supervisory Control

TC-10 DECODING SHEET

(Figure 3)

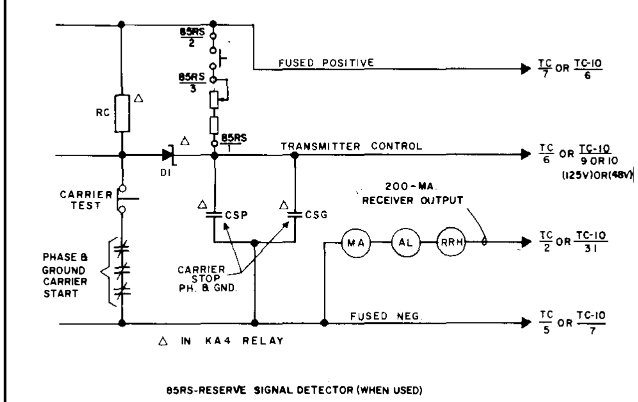
			CODE
Chassis 1335D41G01	125VDC		1
G02	48VDC		4
G01	250VDC	Plus Converter Panel*	2
Input Module 1463C55G01			≤ 200 KHZ
G02			≥ 200.5 KHZ
If Amp Osc Module 1463C46G01	Narrow Band		3
GC2	Wide Band		1
Detector 1463C66G01	Solid State, CLI Circuit, Instrument		S, C OR F
G02	Solid State, CLI Circuit		S, A OR L
G03	Solid State		S, R OR N
G04	Electro Mech., CLI Circuit, Instrument		E, C OR F
G05	Electro Mech., CLI Circuit		E, A OR L
G06	Electro Mech.,		E, R OR N
Voice Adapter 1463C26G01			V
	No Voice Modulation		N
Output Filter 1461C40G43 thru G84	Determined by frequency		----
PWR AMP 1463C89G01	30-70 KHZ		
1463C89G02	70-150 KHZ		
1463C89G03	150-300 KHZ		
Transmitter 1460C89G03	48V		
1460C89G04	125V		
Keying Module (NOTE "H") 1464C10G01	W/Switch, Fuses, RSD		E, R OR F OR L
G02	W/Switch, Fuses		E, C OR A OR N
G03	W/RSD		S, R OR F OR L
G04	NONE OF ABOVE		S, C OR A OR N
Transmit Crystal	From 408C743 (878A717-722) per frequency		----
Receive Crystal	From 762A800 (878A710-715) per freq. + 20KHZ		----
Nameplate	Per catalog/Style No.		
Input Filter	Per 1465C31 (30-50 KHZ)	PER FREQ.	----
	1465C32 (50.5-80 KHZ)		
	1465C33 (80.5-100 KHZ)		
	1336D55 (100.5-149.5 KHZ)		----
	1336D56 (150-199 KHZ)		
	1465C34 (199.5-200 KHZ)		
	1336D57 (201-250 KHZ)		
	1336D58 (251-300 KHZ)		

*- CONVERTER PANEL 250 VDC TO 125 VDC Ⓦ S# 1456C69A01



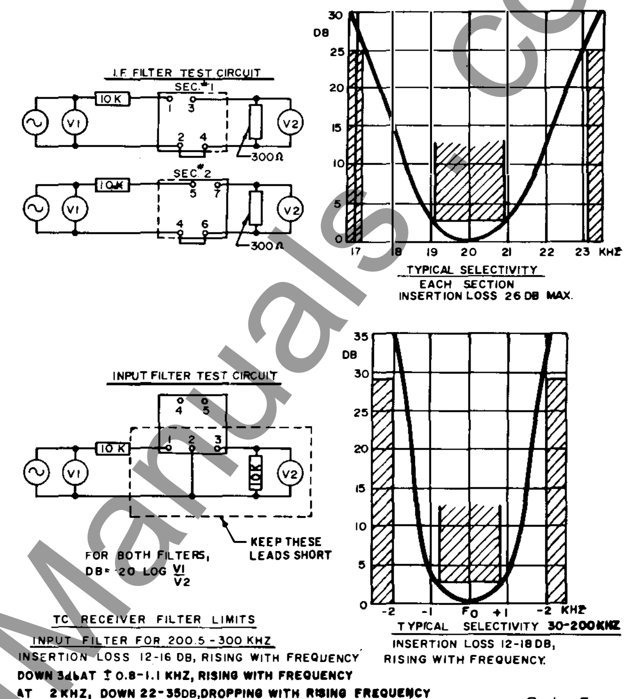
Sub 9
(1335D47)

Assembly in Terms of Catalog Number.



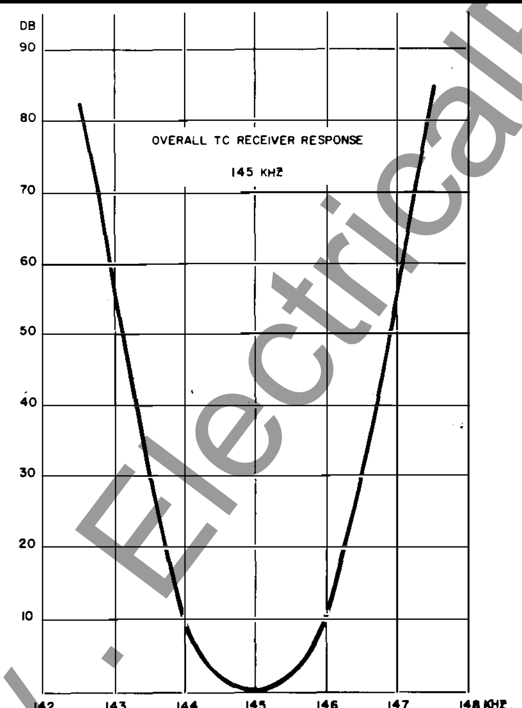
Sub. 3
(862A837)

Fig. 28. Elementary K-Dar Carrier Control Circuits.



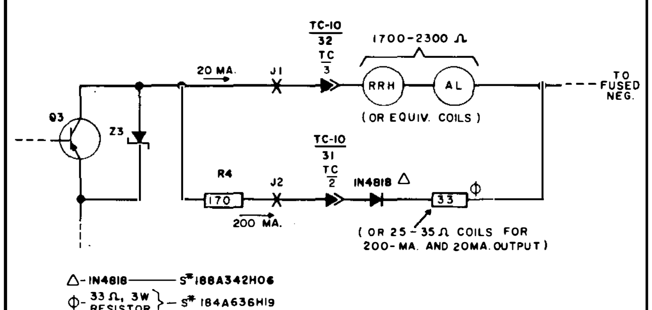
Sub. 5
(629A425)

Fig. 29. Type TC-10 Receiver Filter Characteristics.



Sub. 2
(Curve 538014)

Fig. 30. Type TC-10 Overall Selectivity Curve.



Sub. 5
(862A934)

Fig. 31. Type TC-10 Receiver Output For 20 ma Operation.

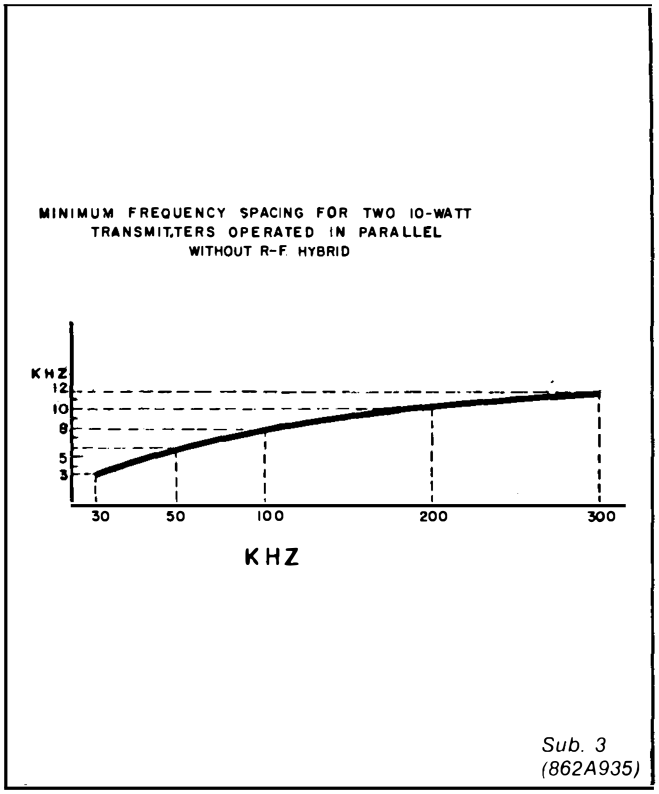


Fig. 32. Minimum Frequency Spacing for Two 10 watt Transmitters Operated in Parallel.

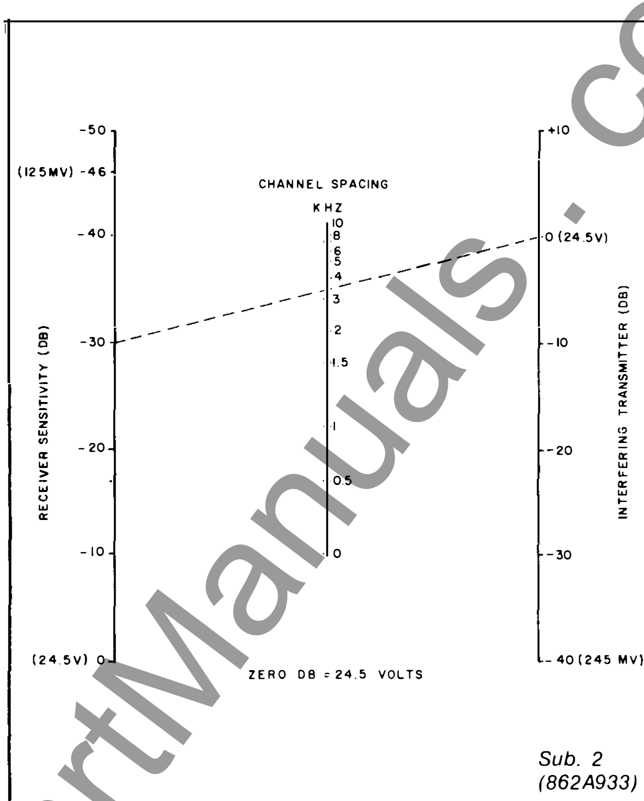


Fig. 33. Minimum Channel Spacing for Keyed Carrier 60 pps.

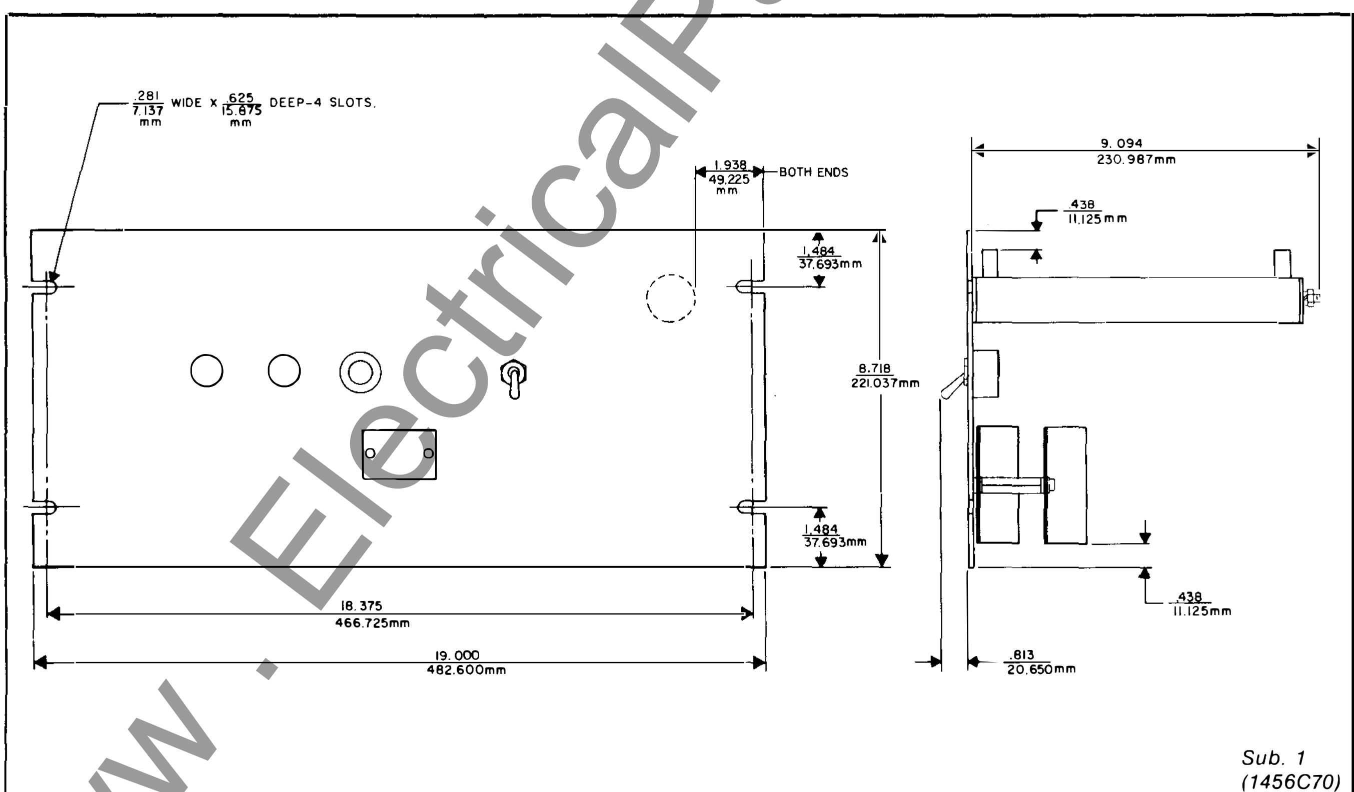
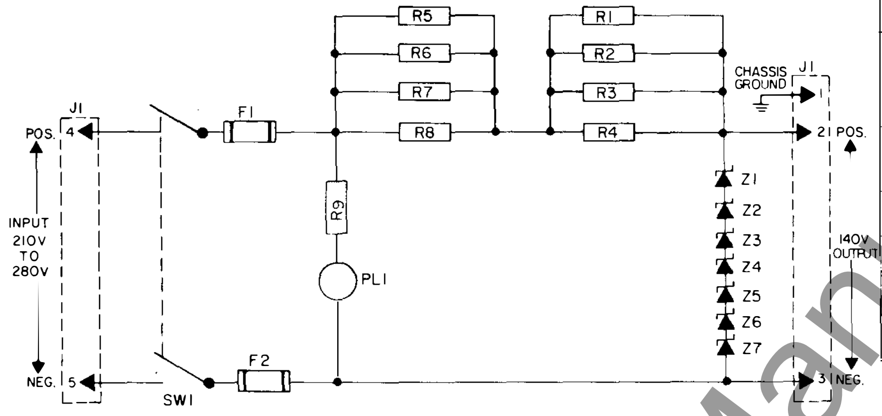


Fig. 34. Outline of External Resistor Unit for 250 Volt Operation.

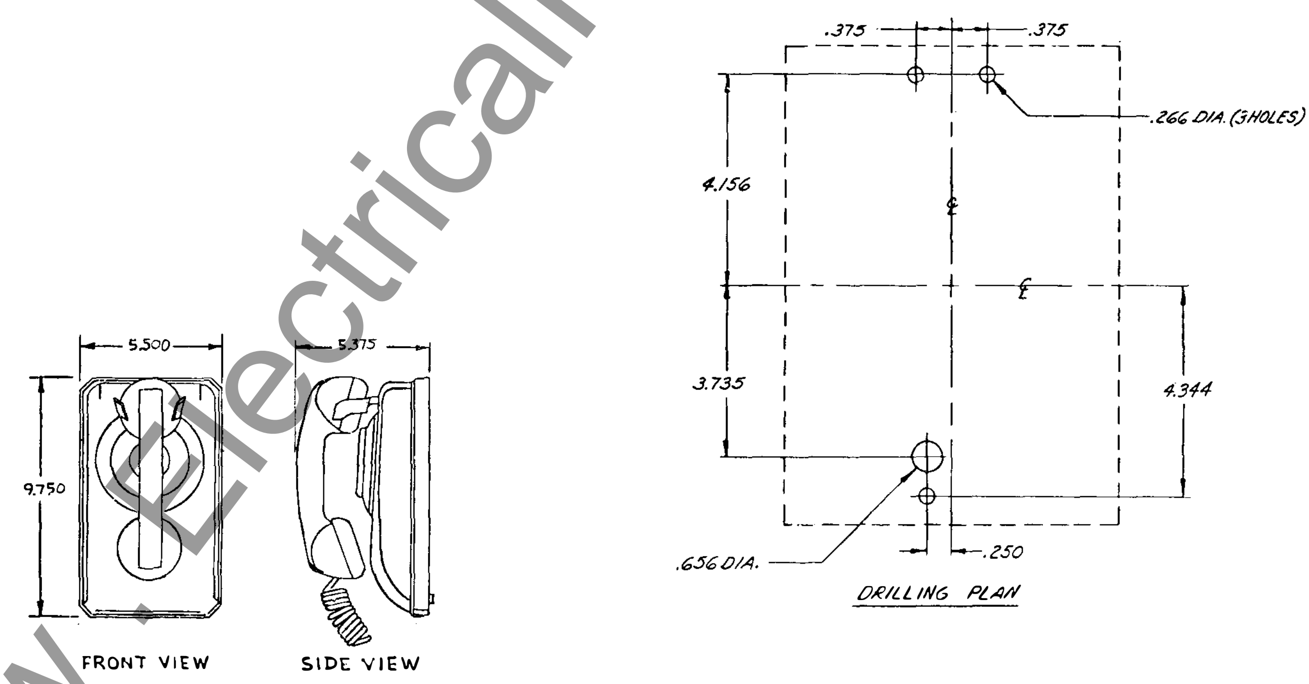


COMPONENT	DESCRIPTION	STYLE NO
RESISTOR R1,R2,R3,R4 R5,R6,R7,R8	250 Ω 160 W 5%	1337180
R9	100 K 1W 5%	187A643H75
ZENER DIODE Z1,Z2,Z3,Z4,Z5 Z6,Z7	20V, 50W IN2818B	184A854H19
PANEL LIGHT PL1	261308-1197	183A825G11
FUSE F1-F2	1 1/2 AMP	11D9195H26
SWITCH SW1	ST 22K (DPST)	880A357H01
TERMINAL BLK J1	5 TERM	837A253H04

WIRING DWG REF 1456C68

Sub. 1
(775B835)

Fig. 35. Schematic of External Resistor Unit for 250 VDC Operation.



Sub. 3
(718B444)

Fig. 36. Remote Hookswitch Assembly for Surface Mounting.

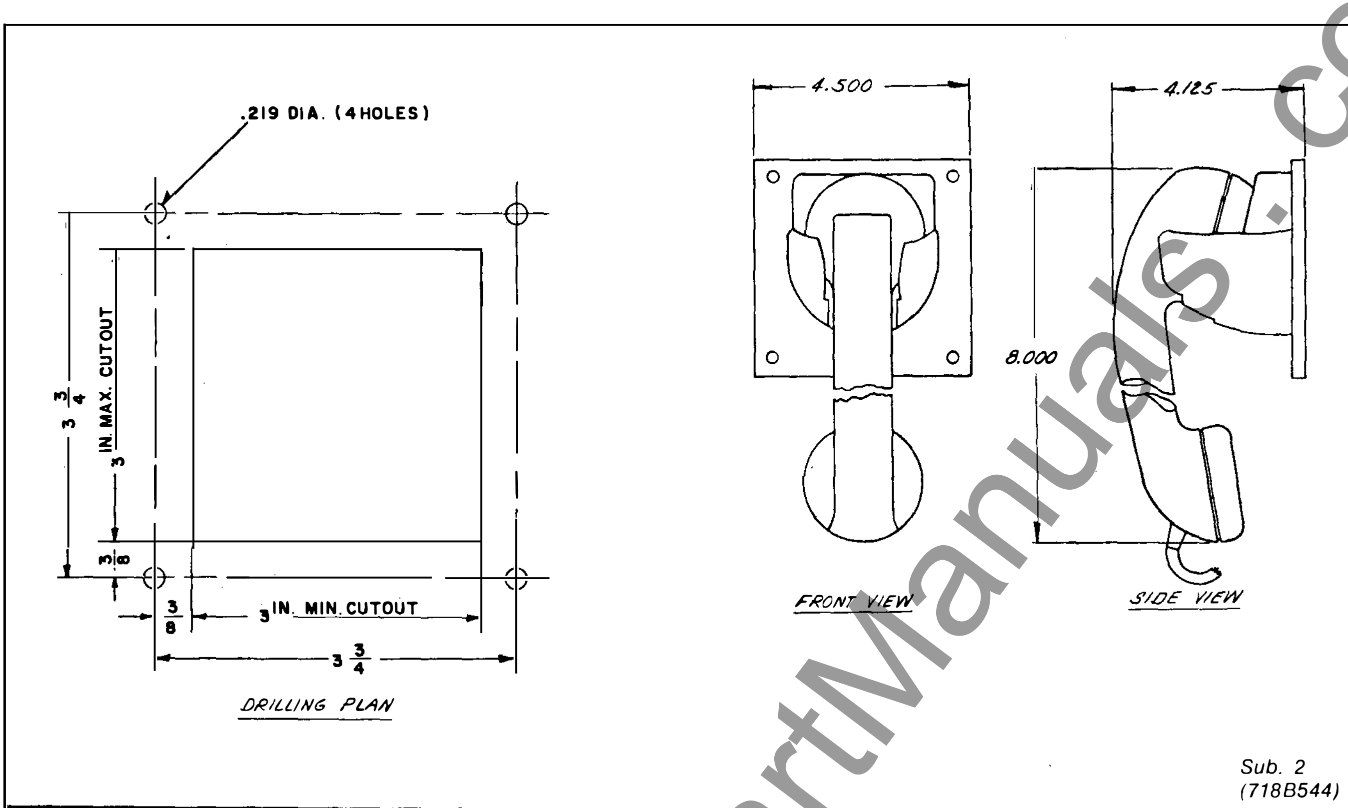


Fig. 37. Remote Hookswitch Assembly for Panel Mounting.

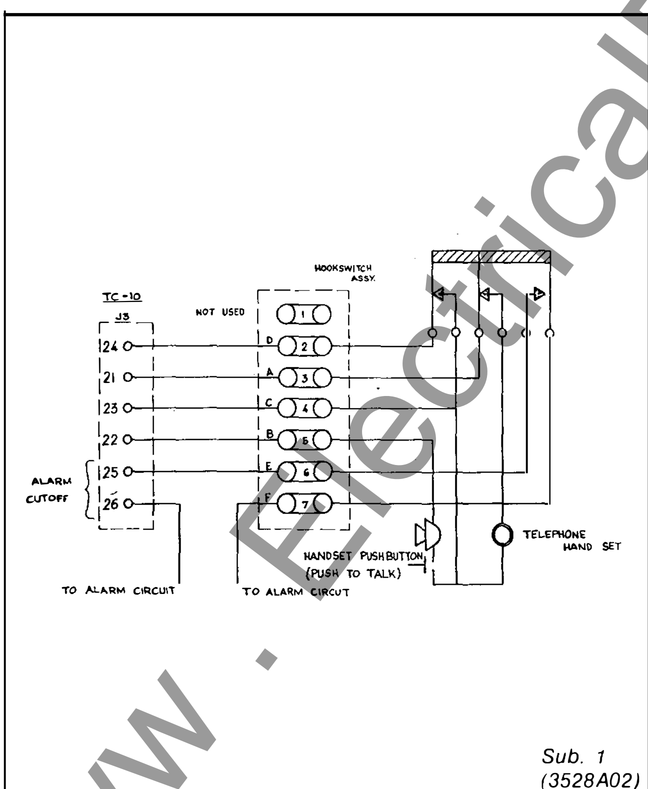


Fig. 38. Remote Hookswitch Assembly Internal Schematic and Interconnection Diagram.

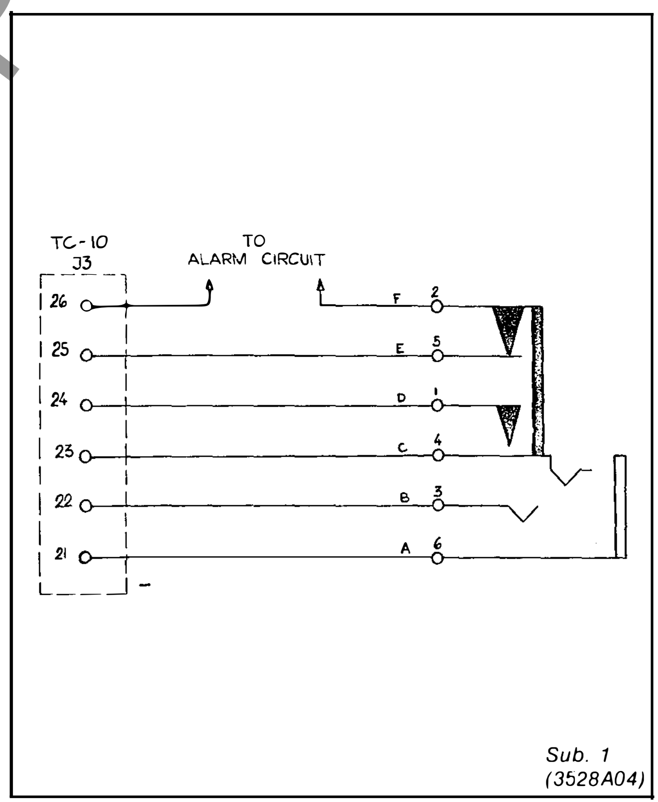


Fig. 39. Remote Telephone Jack Assembly and Interconnection Diagram.

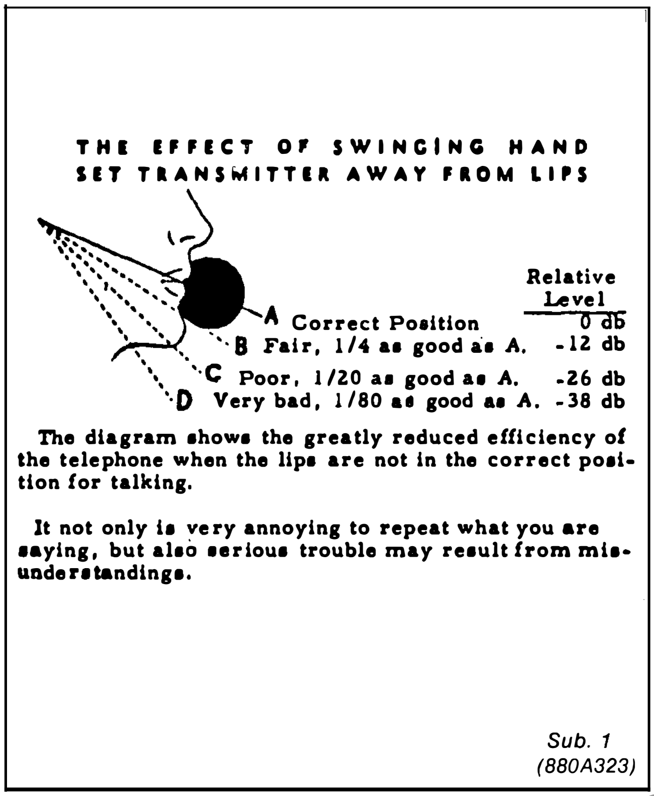


Fig. 40. Proper Usage of the Noise Cancelling Handset.

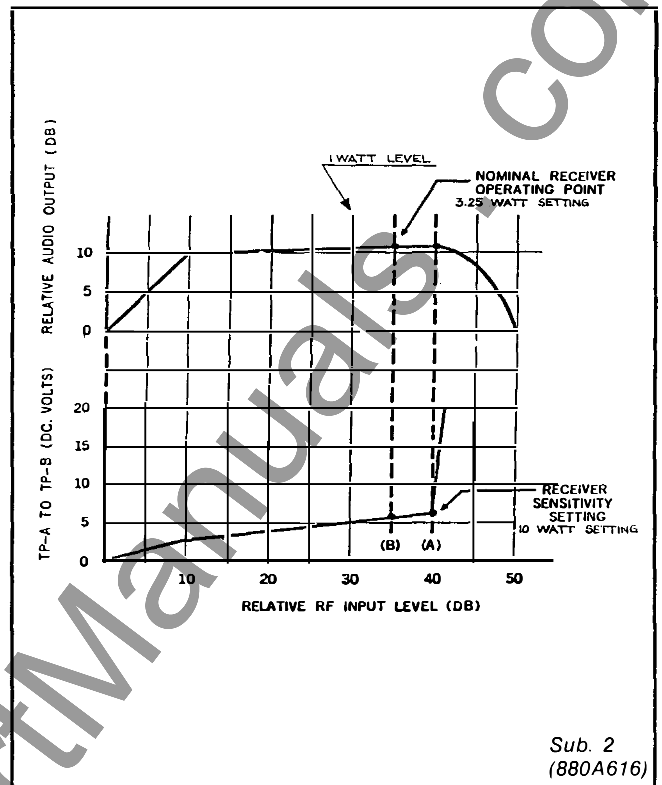


Fig. 41. Voice Receiver Automatic Volume Control Response.

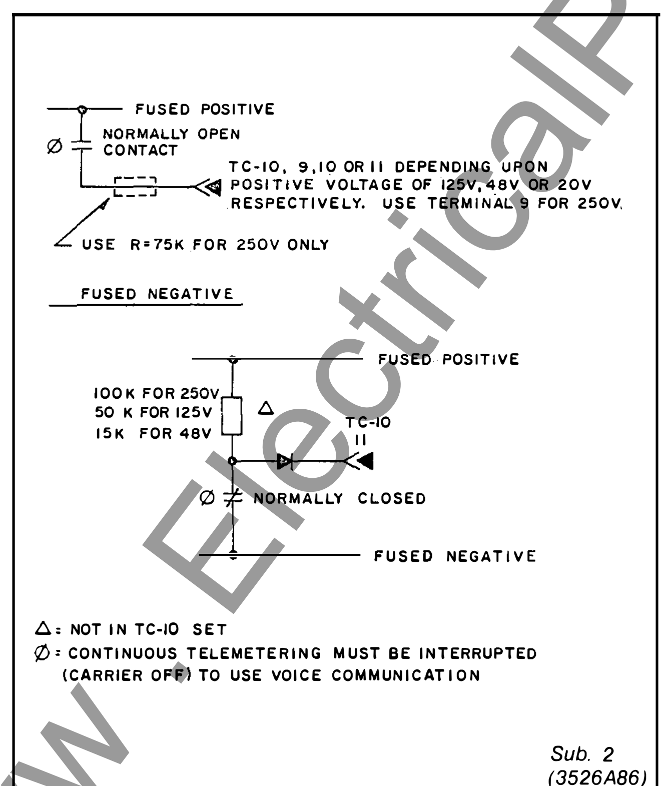


Fig. 42. ***External Circuitry for On-Off Keying of Type TC-10 Transmitter for Telemetering or Supervisory Control (Without Protective Relaying) from either Normally Closed or Normally-Open Contact).***

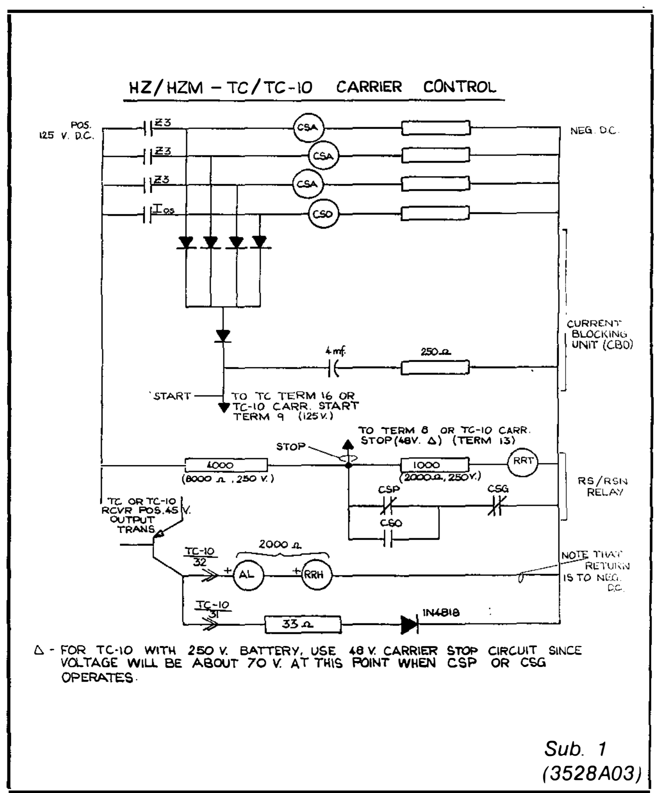


Fig. 43. Interconnection Diagram for HZ/HZM and TC-10.

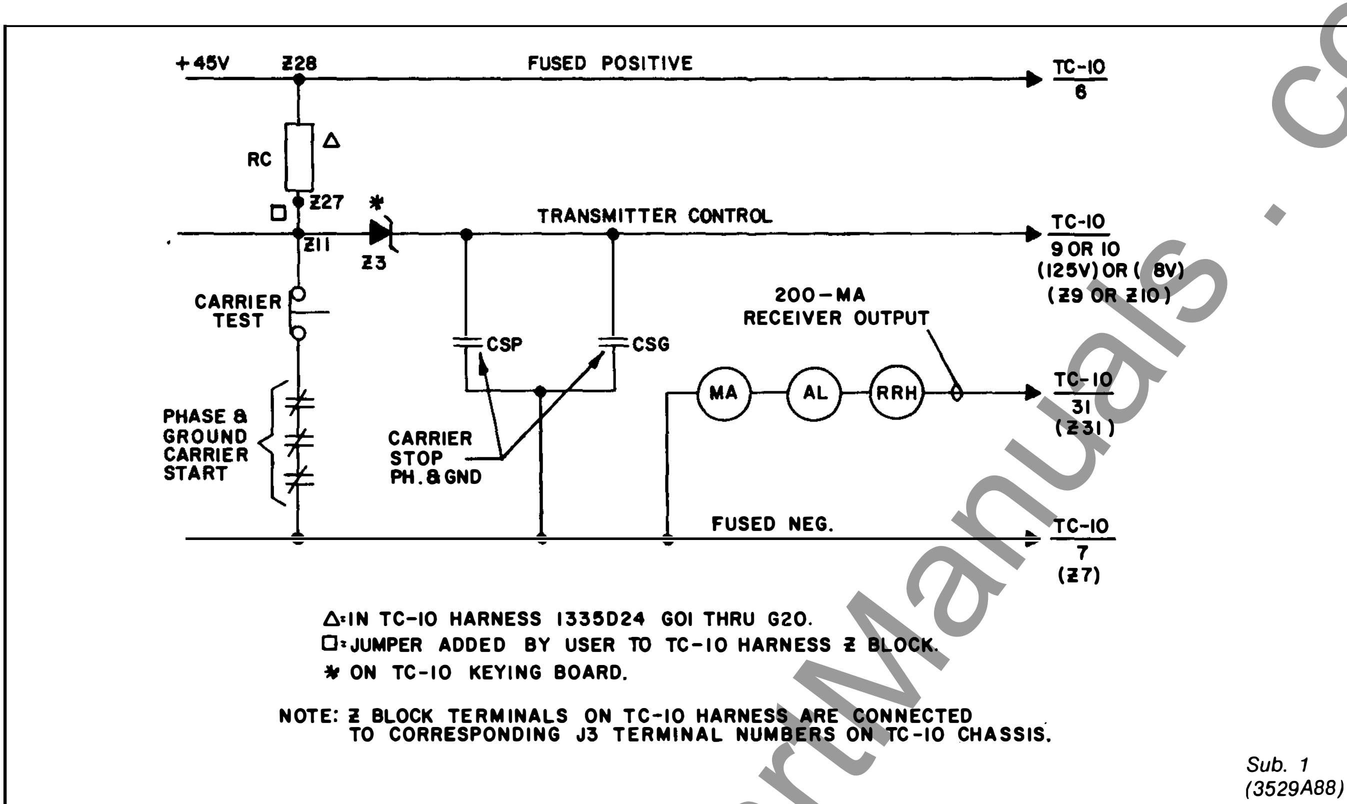


Fig. 44. Elementary Carrier Control Circuit using Normally Closed Carrier Start Contacts and Normally Open Carrier Stop Contacts.

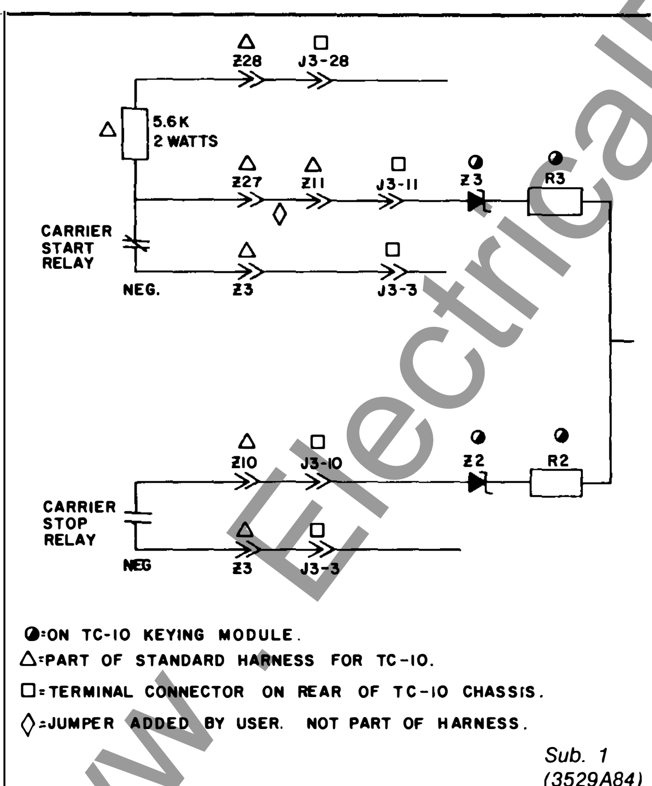


Fig. 45. Connections using Normally Closed Contacts for Carrier Start and Normally Open Contacts for Carrier Stop.

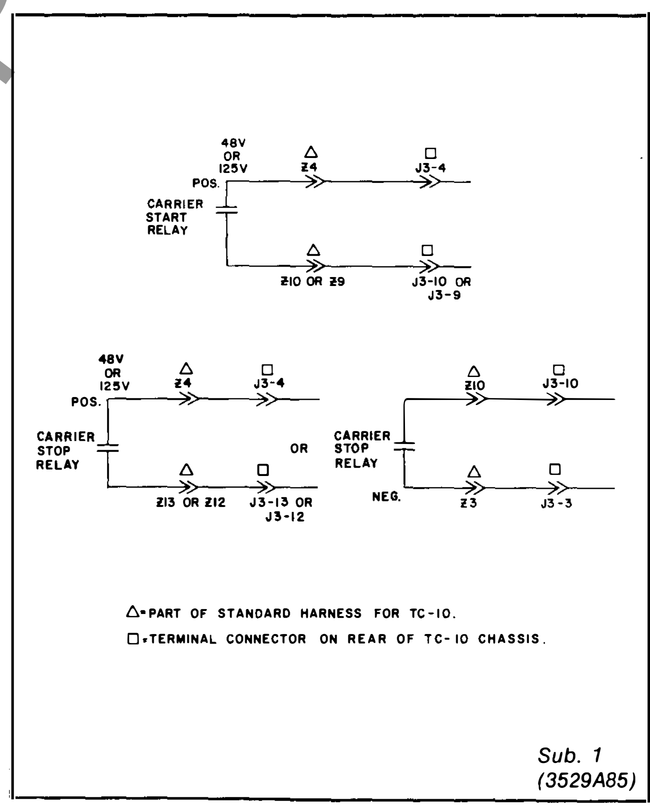


Fig. 46. Connections using Normally Open Contacts for Both Carrier Start and Carrier Stop.

DWG. NO.	DWG. SUB	PART NAME	APPAR TYPE
1335D24	1284	HARNESS	TC-10

BILL OF MATERIAL — PART DESCRIPTION: — SCALE: — DIMENSIONS IN INCHES

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
FIN. CODE																							
RTRV. CODE																							
NOTE CODE	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B			
FIG. NO	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2			

CLASS	ITEM	PART NAME	DEF.	MATERIAL SIZE / DESCRIPTION	MATL CODE / STYLE DWG	SIZE CODE / ITEM GR	RTRV CODE	NOTE CODE	FIN SH	ENG. REF	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	01	KNIFE SW.	—		185A365	H01					1		1		1		1		1		1		1		1		1		1				
	02	TERM. BLK	—		805432					25B6965	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3			
	03	MKR. STR	—	1 TO 12	292B483	H01					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
	04	↓	—	13 TO 24	↓	H02					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
	05	↓	—	25 TO 36	↓	H03					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
	06	SCREW	—	.190-32x.25 FIL HD	877A510	H02				STL. 46AQ03	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6			
	07	SCREW	—	.190-32x.25 BIND HD	877A280	H02				BRS. M.	30	29	30	29	30	29	30	29	30	29	30	29	30	29	30	29	30	29	30	29			
	08	WASH-LOCK	—	.190 STL	183A917	H05					6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6			
	09	TERM-HDW.	—		541D196	G01					3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3			
	10	TERMINAL	—		184A151	H03					31	29	31	29	31	29	31	29	31	29	31	29	31	29	31	29	31	29	31	29			
	11	↓	—		↓	H10					5	1	5	1	5	1	5	1	5	1	5	1	5	1	5	1	5	1	5	1			
	12	↓	—		↓	H17					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
	13	CONN. ASSY	—	36 PIN	3516A81	G01					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
	14	CONNECTOR	—	24-20 GA.	3508A33	H03					29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29			
	15	UNIRING	—		187A775	H02					1		1		1		1		1		1		1		1		1		1				
	16	PLUG	—	UHF	187A688	H01		Ø			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
M	17	CABLE	LGH	2088 (*20)	62111FC	30X		*			1	1	1	1	1	1	1	1	1	1	1	1											
	18	↓	↓	2784 (*20)	62111FC	30X		↓															1	1	1	1	1	1	1	1			
	19	↓	↓	96 (*14)	62111LA	35F		↓			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
	20	↓	↓	108 (COAX)	62522AB	30A		↓			1		1		1		1		1		1												
	21	↓	↓	120	↓	↓		↓															1		1								
	22	↓	↓	144	↓	↓		↓																			1		1				
	23	PLUG	—	BNC	584C292	H06		Ø				1		1		1		1		1		1		1		1		1		1			
	24	RESISTOR	BOS	5.6K 2WATTS	187A642	H45					2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			

/ 3FT / 4FT / 5FT / 6FT / 8FT /

A-TC-10 X/R WITH COAX CABLE & KNIFE SW.

B-TC-10 X/R WITHOUT COAX CABLE & KNIFE SW.

*-CUT TO SUIT AT ASSY.

Δ-RUBBER STAMP S* ON TERM BLOCK WITH SILVER INK S* 35106AB004 PER DWG 541D196 FIG. 14 (S* PER SO)

Ø-SECURE TO HARNESS FOR SHIPMENT WHEN COAX. IS NOT USED.

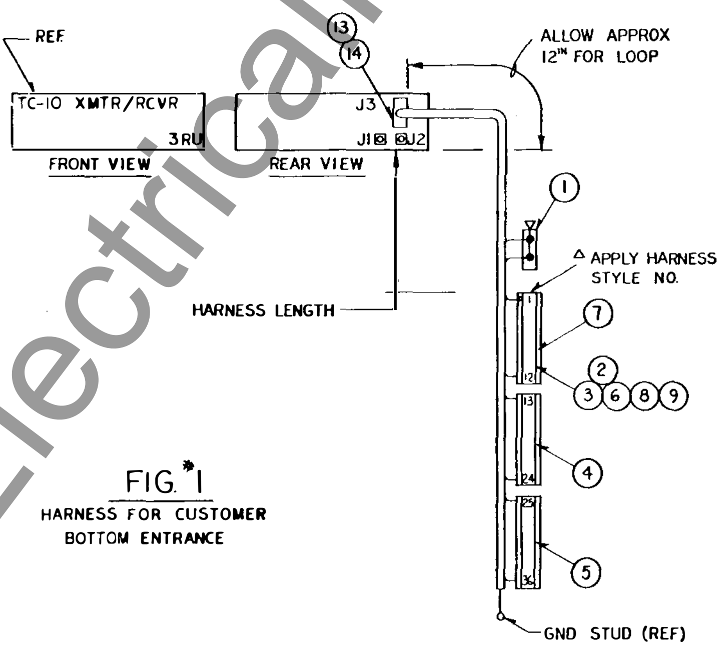


FIG. *1
HARNESS FOR CUSTOMER BOTTOM ENTRANCE

TC-10 XMTR/RCVR.

TC-10 XMTR/RCVR PLUG P3 (TERM AS VIEWED WITH PLUG INSERTED INTO J3 RECEPTACLE.)

REA

WIRE LEGEND

SYM	DESCRIPTION
NONE	CABLE - 62111FC30X
[AA]	- 62111LA35F
-⊏⊐	- 62522AB30

INTL. SCHEMA

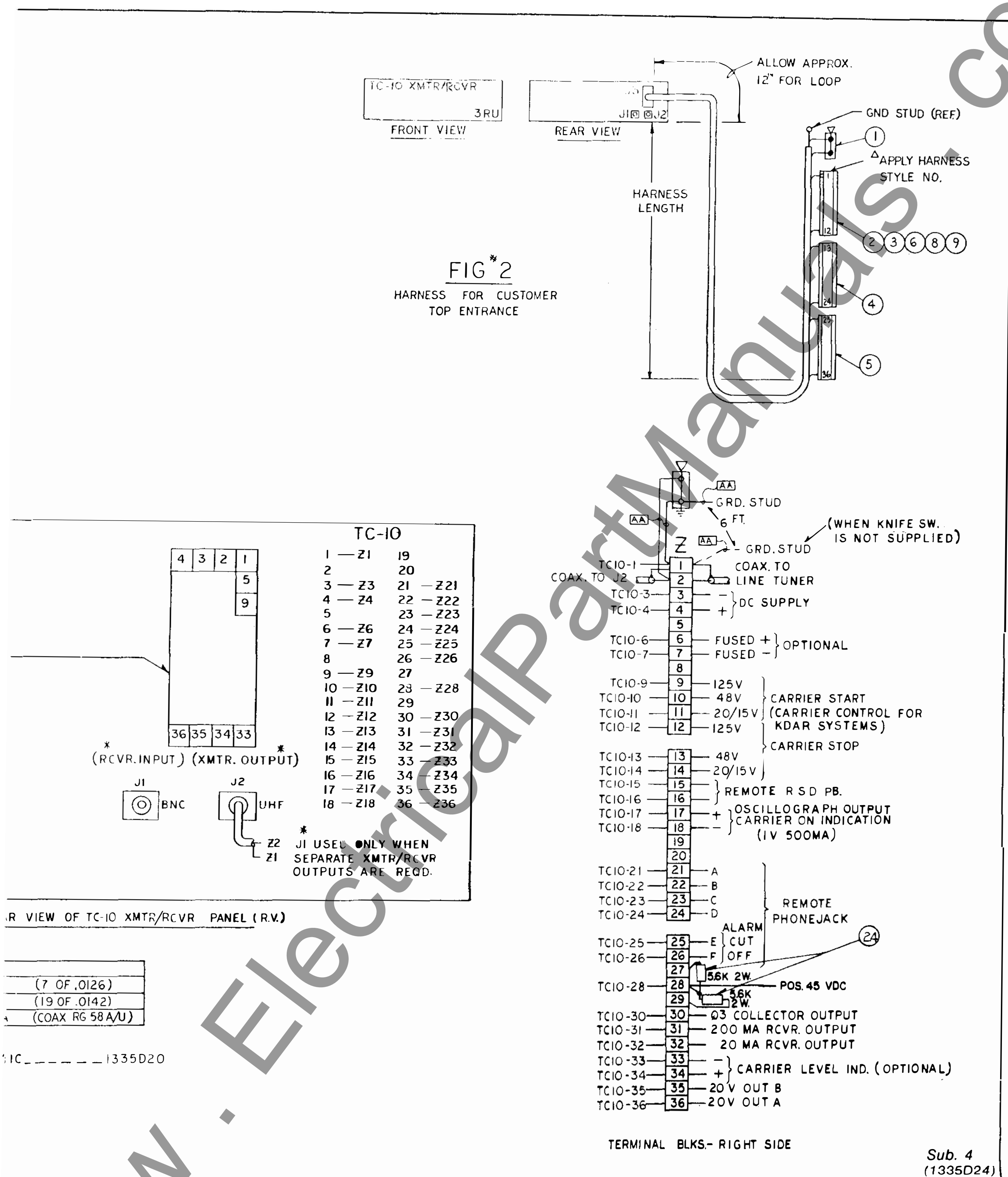


Fig. 49. Standard Harness for TC-10.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TC POWER LINE CARRIER TRANSMITTER – NARROW BAND RECEIVER 30 to 300 kHz – 10 Watts – for 48, 125, 250 V.D.C. with Optional Voice Communication

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES 41-944.34A, dated July 1975
✪ Denotes change from previous issue.

EFFECTIVE APRIL 1978

Relaying Control Circuits

The carrier control circuit for KDar relaying is shown in elementary form in Figure 6. The "Transmitter Control" circuit is normally held at fused negative potential through the normally-closed carrier test pushbutton and the phase and ground carrier-start relay contacts. Opening of any of these contacts allows current to flow from fused positive through resistor R_C and the diode D_1 to the transmitter control terminal TC/6, thus starting carrier transmission at full output. The potential of terminal TC/6 rises to plus 20 volts, limited by a Zener diode in the transmitter proper. The reception of carrier from either the local or remote transmitter normally causes a saturated current of about 200 ma. to flow in the alarm and holding coils (AL and RRH) in the type KA-4 (or equivalent) receiver auxiliary relay.

If the protective relays call for stopping the transmission of carrier, closing of CSP or CSG contact connects the transmitter control circuit back to fused negative, thus stopping any carrier transmission regardless of how it was started.

If a relaying carrier channel is also used for an auxiliary function such as telemetering or supervisory control, the keying contact for this function is connected into the carrier-start circuit in series with the carrier test pushbutton. Such a contact must be normally closed (in the non-operating condition). An auxiliary relay in the receiver output, usually in place of the alarm relay, energizes the telemetering or supervisory control equipment through contacts on the auxiliary relay.

Carrier Control For Other Functions

If a type TC set is keyed on-off for telemetering or supervisory control only (no protective relaying.) one of the circuits show in Figure 16 can be used. Arrangements are shown for either a normally-closed or normally-open carrier-start contact. In the former case, a diode is required to allow using the Voice adapter for push-to-talk voice communication between stations. Note that continuous telemetering must be interrupted when it is desired to use the carrier channel for voice communication.

The receiver output can be connected for either 200 ma. or 20 ma. operation as shown in Figure 11. The 200-ma. output is preferable (if a choice is available) because of a slightly better time constant in the 200 ma. receiver output circuit. In some cases, both the 200-ma. and 20-ma. outputs may be used together. For example, the 200-ma. output can be used with a standard carrier auxiliary relay (for directional-comparison relaying), while the 20-ma. output feeds a 2000-ohm receiver relay used with supervisory control equipment. The connections shown in Fig. 11 would be used for this case, with the receiver relay holding coil (RRH) in place of the 33-ohm resistor and the 2000-ohm supervisory relay in the 20-ma. output in place of the RRH and AL coils shown. The alarm function would be provided by the supervisory control equipment.

CHARACTERISTICS

Frequency range	30-300 kHz (50-300 kHz for phase comparison relaying)
Transmitter output	10 watts into 50 to 70 ohm resistive load
Harmonics	55 db below 10 watts
Receiver sensitivity	40 mv. input for 180 ma. minimum output current
Receiver selectivity	500 Hz bandwidth (3 db down); 3kHz wide at 65 db down
Transmitter-receiver Channel rating	50 db
Input Voltage	48, 125, or 250 V. d-c
Supply voltage variation	42-56V, 105-140V, 210-280V
Battery Drain:	
48 V.D.C.	0.5 amp standby, 1.35 amp transmitting
125 V.D.C.	0.25 amp standby, 1.1 amp transmitting
250 V.D.C.	1.5 amp standby or transmitting
Temperature range	–20 to +60°C around chassis

Frequency Spacing

The minimum recommended frequency spacing between two Type TC carrier sets operated in parallel without hybird units is shown on the curve of Fig. 12. For example, at 100 kHz, the minimum spacing is 8 kHz. Closer spacing would result in the generation of intermodulation products caused by the non-linear load presented by each transmitter to the other one.

The minimum frequency spacing between a TC carrier channel and an adjacent transmitter signal keyed on-off at a rate of 60 pulses per second can be determined from the nomograph of Fig. 13. Using the example shown by the dashed line, consider a type TC set used on a channel with a normal attenuation of 15 decibels. The TC receiver would be set to give a margin of 15 db below the normal received signal, or for a sensitivity of –30 db (relative to a 24.5 volt, 10-watt signal). The interfering signal is assumed to be a 10-watt transmitter at the same location. To determine the minimum frequency spacing of the TC receiver from this interfering signal, lay a straight edge between the –30 db point on the receiver sensitivity scale and the zero-dc point on the interfering transmitter scale. The resulting line crosses the channel spacing scale at 2 kHz. For this example, a channel spacing of at least 2 kHz should be used. (In order not to conflict with the limits of Fig. 12, an r-f hybrid may be needed between the TC set and the other transmitter, depending on the actual application.)

For protective relaying applications to 3-terminal lines, the transmitter frequencies are offset 100 hertz to prevent a slow beat or cancellation of the received signal when two transmitters send blocking signals to the third terminal. The three transmitters operate at fc, fc + 100 Hz, and fc –100 Hz. All receivers operate at the channel center frequency (fc).

INSTALLATION

The type TC transmitter-receiver is generally supplied in a cabinet or on a relay rack as part of a complete carrier assembly. The location must be free from dust, excessive humidity, vibration, corrosive fumes, or heat. The maximum ambient temperature around the chassic must not exceed 60°C.

ADJUSTMENTS

Transmitter

There are two adjustable controls on the transmitter printed-circuit board: (1) the power output control R112, and (2) base bias control R142 for transistors Q104 and Q105. The control R142 is factory adjusted for a quiescent (no-signal) current of 0.2 ± 0.05 ma. d.c. at terminal 2 of transformer T103. This applies a small amount of forward base bias to transistors Q104 and Q105 to minimize cross-over distortion. A thermistor (R141) is included for temperature compensation. This control (R142) need not be changed except as described in the MAINTENANCE section.

The other adjustment on the transmitter is the power output control R112 on the transmitter printed circuit board. Disconnect the coaxial cable from the assembly terminals and replace with a 50 to 70 ohm noninductive resistor of at least a 10-watt rating. Use the value of the expected input impedance of the coaxial cable and line tuner. If this is not known, assume 60 ohms. Connect the T106 output lead to the corresponding tap. Connect an a-c vacuum tube voltmeter (VTVM) across the load resistor. Turn the transmitter power output control R112 to minimum (full counterclockwise).

Now turn on the power switch on the panel and note the d-c voltage across the two pin jacks TP1 and TP2. If this is in the range of approximately 42 to 46 volts, throw the carrier-test switch SW101 on the panel to the ON position. Slowly advance the output control R112 on the transmitter printed circuit board until about 10 volts is obtained across the output load resistor. At this point, check the adjustment of the series output tuning coil L105 by loosening the knurled shaft-locking nut and moving the adjustable core in and out a small amount from its initial position. Leave it at the point of maximum voltage across the load resistor.

Now continue to advance the output control R112 until the output voltage tabulated in the following table is obtained across the load resistor. Recheck the setting of L105 to be sure it is at its maximum point for 10 watts output. Tighten the locking nut.

Note: For 200-300kHz sets, inductor L105 is a pot core and the foregoing adjustment check is generally unnecessary since there is little chance of its setting being disturbed. However, if desired, the pot core setting can be checked using a screwdriver to vary the setting of the adjustable core. There is no locking device as the adjustable core is held in place by friction.

Turn off the carrier test switch SW101, remove the load resistor, and reconnect the coaxial cable circuit to the transmitter.

T106	Voltage for 10 Watts Output
50	22.4
60	24.5
70	27.0

Transmitter Filter

Normally, the output filter (FL102) will require no readjustment except as noted under Adjustments-Transmitter, as it is factory tuned for maximum second and third harmonic rejection, and for series resonance (maximum output at the fundamental frequency) with a 60-ohm load. A small amount of reactance in the transmitter output load circuit may be tuned out by readjustment of the movable core of L105. This may be necessary with some types of line coupling equipment. The adjustable cores of L102 and L103 have been set for maximum harmonic rejection at the factory, and no change should be made in these settings unless suitable instruments are available for measuring the second and third harmonic present in the transmitter output.

Follow the procedure outlined in the line tuner instructions for its adjustment.

Receiver

The receiver board has two controls; the i.f. input control R239 which is factory-set to give a sensitivity of 40 mv. for 180 ma. output, and the local oscillator output control R212. The oscillator output is preset at the factory of 0.5 volt. This setting can be checked by connecting an a-c VTVM between receiver test points TP202 and TP206 (shield lead of VTVM). The voltmeter reading with the equipment energized, but not transmitting, should be 0.5 volt rms. Note Fig. 5 for location of components on the receiver printed board.

The other adjustment on the receiver is the gain control R207 which is front-panel mounted. It is recommended that the receiver gain normally be set for a 15-db operating margin to allow for reasonable variations in receiver input signal level without affecting the output blocking current. This adjustment can be made in two ways, as follows:

1. First, measure the normal received signal from the remote terminal (after the line tuners have been adjusted) by starting the remote transmitter and measuring the voltage across the coaxial cable at the receiving terminal. This signal should preferably be measured with a tuned voltmeter such as the Sierra carrier-frequency voltmeter. If a simple VTVM is used, have the remote transmitter tuned on and off several times to be sure the VTVM reading is actually the remote signal. Note the reading. Now disconnect the coaxial cable, and feed a signal into the carrier assembly at the coaxial terminals from a separate signal generator. Set the signal generator to the received frequency at a level 15 db below the previously measured incoming signal. With a 0-250 ma. (minimum) d-c milliammeter plugged into J203, adjust the receiver gain control unit an output current of about 100 ma, is obtained. As this point is on the steep portion of the receiver output-input curve, it may be difficult to set the gain control for exactly 100 ma. This is not necessary, however, as the signal is not normally at this value. This is the operating setting of the receiver gain control. Return the coaxial cable connections to normal.

   NOTE: Do not energize the local transmitter when making the foregoing adjustment as the signal generator may be damaged.

2. As an alternate procedure if no signal generator is available, the local transmitter itself may be used as the signal generator. First determine the normal received signal from the remote terminal as explained previously under (1). Then turn off the remote transmitter.

   Now turn on the local transmitter and reduce its output to a value 15 db below the normal received signal level. Then adjust the receiver gain control to give 100 ma. output as before. When this adjustment has been made, reset the local transmitter to its normal 10-watt output level.

In applications where the line attenuation is low and a strong signal is received, the adjustment of the receiver gain control R207 becomes critical. For such applications, the setting of i-f gain control R239 may be reduced to lower the overall receiver gain. The front-panel control R207 will then have a smoother and more gradual control as the knob is rotated, making it easier to obtain the 15-db margin setting. For such a strong-signal condition, it is recommended that with R207 at maximum, the i-f gain control R239 be adjusted to give 100 ma. receiver output current for an input r-f voltage 25 db below the normal received signal level. Then the front panel control R207 is set for the normal 15-db margin as previously described.

MAINTENANCE

Periodic checks of the received carrier signal will indicate impending failure so that the equipment can be taken out of service for correction. At regular maintenance intervals, any accumulated dust should be removed, particularly from the heat sinks. It is also desirable to check the transmitter power output and receiver sensitivity at such times, making any necessary readjustments to return the equipment to its initial settings.

Voltage values should be recorded after adjustment in order to establish reference values which will be useful when checking the apparatus. The readings will remain fairly constant over an indefinite period unless a failure occurs. However, if transistors are changed, there may be considerable difference in these readings without the overall performance being affected.

Typical voltage and current values are given in Table I through IV. Voltages should be measured with a VTVM. Readings may vary as much as ± 20%.

Adjustment of R142 on Transmitter Board

The small adjustable resistor (pot.) R142 sets the forward base bias on transmitter transistors Q104 and Q105 to the proper point for class-B operation. This is a factory adjustment and need not be changed unless transistors Q104 or Q105 (or both) are replaced. However, if these transistors are changed, or if the R142 setting is disturbed in error, the following adjustment procedure should be followed to reset R142:

First remove d-c power from the TC carrier set assembly. Unsolder the lead from terminal 2 of transformer. T103 (just above FL101) and temporarily connect a low-range d-c milliammeter (0-1.0 or so) between the removed lead (+) and T103 terminal 2 (–). Turn the slotted control on the small pot (R142) to full counterclockwise. Now, apply power to the TC carrier set, but do not transmit carrier. Advance the pot until the d-c milliammeter reads 0.2 mA d.c. ± 0.05 mA. Turn off the power, remove the milliammeter, and solder the lead back on terminal 2 of T103. Again apply d-c power and proceed with the transmitter adjustment as described in the ADJUSTMENTS section.

Replacement of Q107-Q108

The two transistors Q107 and Q108 in the transmitter power-amplifier stage are a matched pair with the gain of the two units matched within 5%. If one of the transistors fails, both should be replaced with a new matched pair. This is necessary to keep the second harmonic of the transmitter output at an acceptably low value. The pair of transistors should be ordered as "2 of style 187A673H16 transistors."

✪ Note: Only Power Amplifier module styles 774B881G01 thru G05 and 774B541G01 thru G05 use type 2N3792 transistors. When ordering replacement transistors, be sure to check module style. Other style power amplifier modules can be modified by changing diodes D104 thru D106 to type 1N4818 Diodes. Order these as four of style 188A342H06.

CHANGE OF OPERATING FREQUENCY

The parts required for changing the operating frequency of a type TC carrier set are as follows:

Transmitter

1. Oscillator Crystal (Y101), specify frequency

   NOTE: Modify A-B-C jumpers on transmitter board if required for new frequency. See table marked "‡" under internal schematic (Fig. 7).

2. R136 Jumper

   For operation in 30-50kHz range, clip off R136 as indicated in Fig. 3.

3. Capacitors C111 & C113 (on Power Amp. board)

   a. 39-50 kHz – 0.47 mfd. – S#188A293H01
   b. 50.5-75 kHz – 0.22 mfd. – S#188A293H02
   c. 75.5-100 kHz – 0.15 mfd. – S#188A293H03
   d. 100.5-150 kHz – 0.10 mfd. – S#188A293H04
   e. 150.5-300 kHz – 0.047 mfd. – S#188A293H05

4. Transmitter Module Mounting Plate

   When changing from a frequency of 200kHz or below to a frequency above 200kHz, the following is also necessary:

   Transmitter module mounting plate S#691B610H01 and associated hardware.

   This is necessary to raise the transmitter printed circuit board (module) away from the main panel as the 200.5-300kHz receiver input filter FL201 mounts underneath it. See Fig. 2.

5. Zener Diode Z104

   For the 200.5-300kHz range, a type 1N2999B zener diode Z104 is mounted on the Q108 heat sink adjacent to the protective diode Z103. Remove the lead from the Q108 heat sink (see Fig. 2 for location) and connect it to the insulated terminal of zener diode Z104.

6. FL101 and FL102

Filter FL101 is a small series-resonant tuned circuit between the driver and power amplifier stages of the transmitter. It has just two terminals. Filter FL102 is a larger assembly, described under OPERATION. It has three external connections: input, output, and ground. This filter is mounted by four corner posts. To replace, unsolder the three leads, remove the nuts from the mounting posts, and lift the filter assembly from the posts. The new filter can now be installed.

Inductors L101, L102, and L103 in these filters are adjustable over a limited range, but forty-two combinations of capacitors and inductors are required to cover the frequency range of 30 kHz to 300 kHz. The widths of the frequency groups vary from 1.5 kHz at the low end of the channel frequency range to 13 kHz at the upper end. A particular assembly can be adjusted over a somewhat wider range than the width of its assigned group since some overlap is necessary to allow for component tolerances. The nominal kHz adjustment ranges of the groups are:

30.0–31.5	72.5– 76.0	160.0–169.5
32.0–33.5	76.5– 80.0	170.0–180.0
34.0–36.0	80.5– 84.5	180.5–191.5
36.5–38.5	85.0– 89.0	192.0–200.0
39.0–41.0	89.5– 94.5	200.1–207.0
41.5–44.0	95.0–100.0	207.1–214.0
44.5–47.0	100.5–106.0	214.1–222.0
47.5–50.0	106.5–112.5	222.1–230.0
50.5–53.5	113.0–119.5	230.1–240.0
54.0–57.0	120.0–127.0	240.1–250.0
57.5–60.5	127.5–135.0	250.1–262.0
61.0–64.0	135.5–143.0	262.1–274.0
64.5–68.0	145.5–151.0	274.1–287.0
68.5–72.0	151.5–159.5	287.1–300.0

If the new frequency lies within the same frequency group as the original frequency, the filters can be readjusted. If the frequencies are in different groups, it is possible that changes only in the fixed capacitors may be required. In general, however, it is desirable to order complete filter assemblies adjusted at the factory for the specified frequency.

A signal generator, a frequency counter, and a vacuum-tube voltmeter are required for readjustment of FL101. The signal generator and the counter should be connected across terminals 4 and 5 of transformer T103 and the voltmeter across terminals 1 and 2 of transformer T104. The signal generator should be set at the channel center frequency and at 2 at 3 volts output. The core screw of the small inductor should be tuned to the position that gives a true maximum reading on the VTVM. Turning the screw to either side of this position should definitely reduce the reading. The change in inductance with core position is less at either end of the travel than when near the center and consequently the effect of core screw rotation on the VTVM reading will be less when the resonant inductance occurs near the end of core travel.

The procedure for readjustment of the 2nd and 3rd harmonic traps of filter FL102 is somewhat similar. A signal generator and a counter should be connected to terminals 3 and 4 of transformer T105 and a 500-ohm resistor and a VTVM to the terminals of protective gap G101. The ground or shield lead of all instruments should be connected to the grounded terminal of the transformer. Set the signal generator at exactly twice the channel center frequency and at 5 to 10 volts output. Turn the core screw of the large inductor, L102, to the position that gives a definite minimum reading on the VTVM. Similarly, with the signal generator set at exactly three times the channel center frequency and 5 to 10 volts output, set the core screw of the small inductor, L103, to the position that gives a definite minimum reading on the VTVM. Then remove the instruments andthe 500-ohm resistor.

If the change in frequency is enough to require a different filter, it will come factory adjusted as described in the foregoing paragraph.

After all the tabulated changes have been made for the new frequency, the transmitter can be operated with a 50 to 70-ohm load (depending on which tap of T106 is used) connected to its output, and inductor L105 can be readjusted for maximum output at the changed channel frequency by the procedure described in the ADJUSTMENT section.

If a frequency-sensitive voltmeter is available, the second and third harmonic traps may be adjusted (or checked) without using an oscillator as a source of double and triple the channel frequency. Connect the frequency-sensitive voltmeter from TP109 to ground and adjust the transmitter for rated output into the selected load resistor. Set the voltmeter at twice the channel frequency and, using its tuning dial and db range switch, obtain a maximum on-scale reading of the second harmonic. Then vary the core position of L102 until a minimum voltmeter reading is obtained. Similarly, tune the voltmeter to the third harmonic and adjust L103 for minimum voltmeter reading. It should be noted that this procedure may not give the true magnitude of the harmonics because of the large value of fundamental frequency voltage present at the tuned voltmeter input terminals. This condition will overload the input circuit of some commercial instruments. However, the procedure is satisfactory for adjusting the traps for maximum harmonic rejection.

If accurate measurement of the harmonic levels is desired, the frequency-selective voltmeter is connected, through a rejection filter, to the terminals of the 60-ohm load resistor. The filter must provide high rejection of the fundamental. A twin-T filter is suitable for this purpose. The insertion losses of this filter at the second and third harmonics must be measured and taken into account.

TABLE I
Receiver D.C. Measurements

Note: All voltages are <u>negative</u> with respect to Pos. 45V. (TP206).

TEST POINT	STANDBY (No Signal)			WITH 40 M.V. INPUT		
TP201	35-38			35-38		
TP202	0			0		
TP203	11-12			11-12		
TP204	< 0.5			2- 3		
TP205	18-22			18-22		
TRANSISTOR	**E***	**B***	**C***	**E***	**B***	**C***
Q201	36.5	37	42.0	36.5	36	42.0
Q202	36.5	37.5	43.0	36.0	35.5	43.0
Q203	<0.5	0	18.0	<0.5	0	18.0
Q204	2.1	2.75	18.0	2.7	2.9	18.0
Q205	2.2	2.8	18.0	2.5	2.7	18.0
Q206	2.2	2.8	11.0	2.6	2.8	11.5
Q207	<0.5	<0.5	22.0	2.0	2.2	5.0
Q208	<0.5	<0.5	44.0	11.7	2.0	2.0

*E – Emitter, B – Base, C – Collector
All voltages read with d-c vacuum-tube voltmeter.
<0.5 means "less than 0.5V."

TABLE II
Receiver RF Measurements

Note: Taken with 100kHz receiver filter, 0.040 volt input signal, and gain control R207 at maximum. Depending on receiver frequency and transistor characteristics, the following values will vary appreciably.

TEST POINT	TYPICAL A-C VOLTAGE
FL201-IN to Gnd.	0.020
FL201-OUT to Gnd.	0.027
Q203 - E to TP206	0.047
Q203- C to TP206	1.650
Q204 - B to TP206	0.012
Q204 - C to TP206	0.200
Q205 - B to TP206	0.007
Q205 - C to TP206	0.380
Q206 - B to TP206	0.110
Q206 - C to TP206	2.350
TP202 to TP206	0.500

All voltages read with a-c vacuum-tube voltmeter.

TABLE III

Transmitter D-C Measurements

Note: All voltages are positive with respect to Neg. DC.(TP104). All voltages read with d-c VTVM.

TEST POINT	CARRIER OFF	CARRIER ON
TP101	8.5 volts d.c	8.5 volts d.c.
TP102	<0.5	20
TP103	<0.5	19.5
TP105	<0.5	9
TP106	44	24
TP107	44	24
TP108	45	44
TP110	0.6 ✪	0.75 ✪
TP111	0.6 ✪	0.75 ✪
TP112	0	<0.5
TP113	45	44
J101 (Front Panel)	5 ma. max.	0.6 amp.

TRAN-SISTOR	E	B	C	E	B	C
Q101	7.8	7.9	2.0	7.8	7.8	1.8
Q102	8.1	8.7	1.0	8.1	8.7	1.0
Q103	< 0.5	< 0.5	< 0.5	20.0	20.0	9.0
✪ Q104	< 0.1	0.6	45	< 0.5	0.75	44
✪ Q105	< 0.1	0.6	45	< 0.5	0.75	44
Q106	0	< 0.5	44.5	0	0.8	1.2
Q107	44.3	44.2	0	24	24	0
Q108	45.0	44.7	44.5	44.2	44.0	24.2

Receiver

1. Receiver Oscillator Crystal (Y201), specify frequency, and modify A-B-C jumpers as required.
2. Receiver input filter (FL201), specify frequency.
3. Resistors R211-R238 Combination
   See values in Fig. 7 below internal schematic.
4. If the operating frequency is reduced, the receiver gain will probably be higher. In this case, a reduction in the setting of the i-f input control R239 will give the 40-mv. sensitivity. If the new operating frequency is higher, the receiver gain may be lower.

TABLE IV

Transmitter RF Measurements

Note: "Carrier-on" voltages taken with transmitter set to 10 watts output (24.5 volts across 60 ohms). These voltages subject to variation, depending on frequency and transistor characteristics.

TEST POINT	A-C VOLTAGE
T101-3 to TP104	1.5 volts, rms.
TP103 to TP102	0.2
Q103-C to TP104	1.1 ϕ
TP110 to T102-4	0.2
TP111 to T102-4	0.2
Q104-C to TP104	3.3
Q105-C to TP104	3.3
T103-4 to Gnd.	1.1
T104-1 to Gnd.	1.4
Q107-B to TP107	0.5 volts, rms.
Q108-B to TP113	0.5
Q107-C to TP107	14-16
Q108-C to TP113	14-16
T105-4 to Gnd.	105
T106-2 to Gnd.	100-160 *
TP109 to Gnd.	30-50 *
J102 to Gnd.	24.5

Note: T101-3 = tap 3 of Transformer T101
Q104-C = Collector of Transistor Q104
TP105 = Test point 105
All voltages read with a-c VTVM
* These values may vary considerably with frequency.
ϕ High impedance circuit. VTVM causes significant loading.

Recommended Test Equipment

I. Minimum Test Equipment for Installation

a. Milliammeter 0-250 ma. DC
b. 60-ohm 10-watt non-inductive resistor.
c. A-C Vacuum Tube Voltmeter (VTVM) or equivalent. Voltage range 0.01 to 30 volts, frequency range 60 Hz ro 330 kHz input impedance — one megohm, minimum.

d. D-C Vacuum Tube Voltmeter (VTVM) or equivalent.

Voltage Range:	0.1 to 300 volts
Input Impedance:	1.0 megohm, min.

II. Desirable Test Equipment for Apparatus Maintenance.

a. All items listed in I.

b. Signal Generator

Output Voltage:	up to 10 volts r.m.s.
Frequency Range:	20 to 330 kHz

c. Oscilloscope

d. Ohmmeter

e. Capacitor checker

f. Frequency counter

g. Frequency-selective voltmeter

Renewal Parts

Repair work can be done most satisfactorily at the factory. However, replacement parts can be furnished, in most cases, to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ELECTRICAL PARTS LIST

Transmitter Section

SYMBOL	RATING	STYLE NUMBER
C101	0.1 mfd, 200 V. DC	187A624H01
C102	.005 mfd, 300 V. DC	187A694H29
C103	180 pf. 500 V. DC	187A695H29
C104	0.25 mfd, 200 V. DC	187A624H02
C105	0.25 mfd, 200 V. DC	187A624H02
C106	0.25 mfd, 200 V. DC	187A624H02
C107	0.25 mfd, 200 V. DC	187A624H02
C108	0.50 mfd, 200 V. DC	187A624H03
C109	0.25 mfd, 200 V. DC	187A624H02
C110	0.25 mfd, 200 V. DC	187A624H02
† C111	(See Table Below)	–
C112	39 pfd, 500 V. DC	187A695H12
† C113	(See Table Below)	–
C114	100 pf. 500 V. DC	187A695H23
C115	100 pf. 500 V. DC	187A695H23
C116	0.001 mfd, 500 V. DC	187A694H11
CA	Part of FL101	Vary with Frequency
CB, CC, CD, CE	Part of FL102	Vary with Frequency
† FREQ.	C111, C113	Style Number
30 - 50 **kHz**	0.47 mfd, 400 V. DC	188A293H01
50.5- 75 **kHz**	0.22 mfd, 400 V. DC	188A293H02
75.5-100 **kHz**	0.15 mfd, 400 V. DC	188A293H03
100.5-100 **kHz**	0.1 mfd, 400 V. DC	188A293H04
150.5-300 **kHz**	0.047 mfd, 400 V. DC	188A293H05
D101	1N457A	184A855H07
D103	1N4818	188A342H06
D104	1N91	182A881H04
D005	1N4818	188A342H06
D106	1N91	182A881H04
G101	Type RVS Arrester	632A026A01
J101	Closed Circuit Jack	187A606H01
J102	Banana Plug Jack	2 of 185A431H01
J103	Coaxial Cable Jack	187A633H01
J104	24-Term Receptacle	187A699H01
J105	12-Term Receptacle	629A205H02

ELECTRICAL PARTS LIST

Transmitter Section (Cont.)

SYMBOL	RATING	STYLE NUMBER
L101	Part of FL101	
L102	FL102 Trap Coil (2nd Harmonic)	Vary with Frequency
L103	FL102 Trap Coil (3rd Harmonic)	
L104	400 mh.	292B096G01
L105	FL102 Coil (part of series-resonant circuit tuned to fundamental freq.)	Vary with Frequency
L106	2MH	3500A27H01
Q101	2N2905A	762A672H10
Q102	2N2905A	762A672H10
Q103	2N525	184A638H13
Q104	2N3712	762A672H07
Q105	2N3712	762A672H07
Q106	TI-481	184A638H11
Q107	2N3792 Matched Pair	187A673H16
Q108	2N3792	187A673H16

SYMBOL	OHMS	± TOL %	WATTS	STYLE NUMBER
R101	5,600	5	1	187A643H45
R102	2,200	10	0.5	187A641H35
R103	10,000	10	0.5	187A641H51
R104	100,000	5	0.5	184A763H75
R105	390	5	0.5	184A763H17
R106	1,200	5	0.5	184A763H29
R107	10,000	10	0.5	187A641H51
R108	100,000	5	0.5	184A763H75
R109	390	5	0.5	184A763H17
R111	1,200	5	0.5	187A763H29
R112	1 K Pot	20	0.25	629A430H02
R113	4,700	5	0.5	184A763H43
R114	10,000	10	0.5	187A641H51
R115	150	5	0.5	184A763H07
R116	100	5	0.5	184A763H03
R117	1,000 48 V dc	5	25	1202588
	3,750 125 V dc	5	25	1202955
	8,500 250 V dc	5	25	1267310

ELECTRICAL PARTS LIST

Transmitter Section (Cont.)

SYMBOL	OHMS	± TOL %	WATTS	STYLE NUMBER
R118	10,000	2	0.5	629A531H56
R119	62	22	0.5	629A531H03
R120	10,000	5	2	185A207H51
R121	10	5	2	187A683H01
R122	10	5	0.5	187A290H01
R123	10	10	0.5	187A290H01
R124	100	10	1	187A644H03
R125	1,000	10	0.5	187A641H27
R126	4,700	10	1	187A644H43
R127	10	10	0.5	187A640H01
R128	2,200	5	1	187A644H35
R129	2.7	10	0.5	184A636H14
R130	10	10	0.5	187A640H01
R131	4,700	5	1	187A644H43
R132	2.7	10	0.5	184A636H14
R133	0.27	10	1	184A636H18
R134	0.27	10	1	184A636H18
R135	3,000	10	5	188A317H01
R136	12,000	10	0.5	184A763H53
R137	15,000	10	2	187A642H55
R138	1,000	10	0.5	187A641H27
R139	1,000	10	0.5	187A641H27
R140	68	2	0.5	629A531H04
R141	30	Type 3D202 Thermistor		185A211H06
✪ R142	25K Pot	20	1/8	629A430H15
R143	20K	2	0.5	629A531H63
✪ R144	2.0	10	3.0	762A679H03

SYMBOL	RATING	STYLE NUMBER
T101	10,000/400 ohms	205C043G01
T102	10,000/400 c.t.	714B666G01
T103	1930/60 ohms L633000	1962694
T104	Turns ratio, 1/0.5, Pri-/each sec.	292B526G01
T105	10/500 ohms	292B526G02
✪ T106	500/50 - 60 - 70 ohms	292B526G03
Y101	30-300 kHz crystal per 328C083	Specify Frequency
Z101	Zener Diode 1N5357B (20V. ±5%)	862A288H03
Z102	Zener Diode 1N2999B (56V. ±5%)	629A798H04
Z103	Zener Diode 1N2999B (56V. ±5%)	629A798H04
Z104	Zener Diode 1N2999B (56V. ±5%)	629A798H04

ELECTRICAL PARTS LIST

Receiver Section

SYMBOL	RATING	STYLE NUMBER
C201	0.1 mfd., 200 V. DC	187A624H01
C202	300 pf. 500 V. DC	187A695H35
C203	180 pf. 500 V. DC	187A695H29
C204	0.25 mfd., 200 V. DC	187A624H02
C205	0.25 mfd., 200 V. DC	187A624H02
C206	0.25 mfd., 200 V. DC	187A624H02
C207	0.25 mfd., 200 V. DC	187A624H02
C208	0.25 mfd., 200 V. DC	187A624H02
C209	0.25 mfd., 200 V. DC	187A624H02
C210	0.25 mfd., 200 V. DC	187A624H02
C211	0.1 mfd., 200 V. DC	187A624H01
C212	0.25 mfd., 200 V. DC	187A624H02
C213	2.0 mfd., 200 V. DC	187A624H05
C214	0.25 mfd., 200 V. DC	187A624H02
C215	39 pfd., 500 V. DC	187A695H12
C216	200 pfd. 500 V. DC	762A757H11
D201	1N457A	184A855H07
D202	1N457A	184A855H07
D203	1N4818	188A342H06
D204	1N4818	188A342H06
FL201	Receiver Input Filter 30-300 kHz	Specify Frequency
FL202	Receiver i.f. Filter - 20kHz (2 sections) (FL-2) ✪	762A613G01
J201	Receiver Coax. Input Jack	187A638H01
J202	Closed Circuit Jack (20MA)	187A606H01
J203	Closed Circuit Jack (200MA)	187A606H01
L201	33 mh.	187A599H02
Q201	2N2905A	762A672H10
Q202	2N2905A	762A672H10
Q203	2N2905A	762A672H10
Q204	2N2905A	762A672H10
Q205	2N2905A	762A672H10
Q206	2N2905A	762A672H10
Q207	2N3645	849A441H01
Q208	2N4903	187A673H13

ELECTRICAL PARTS LIST

Receiver Section (Cont.)

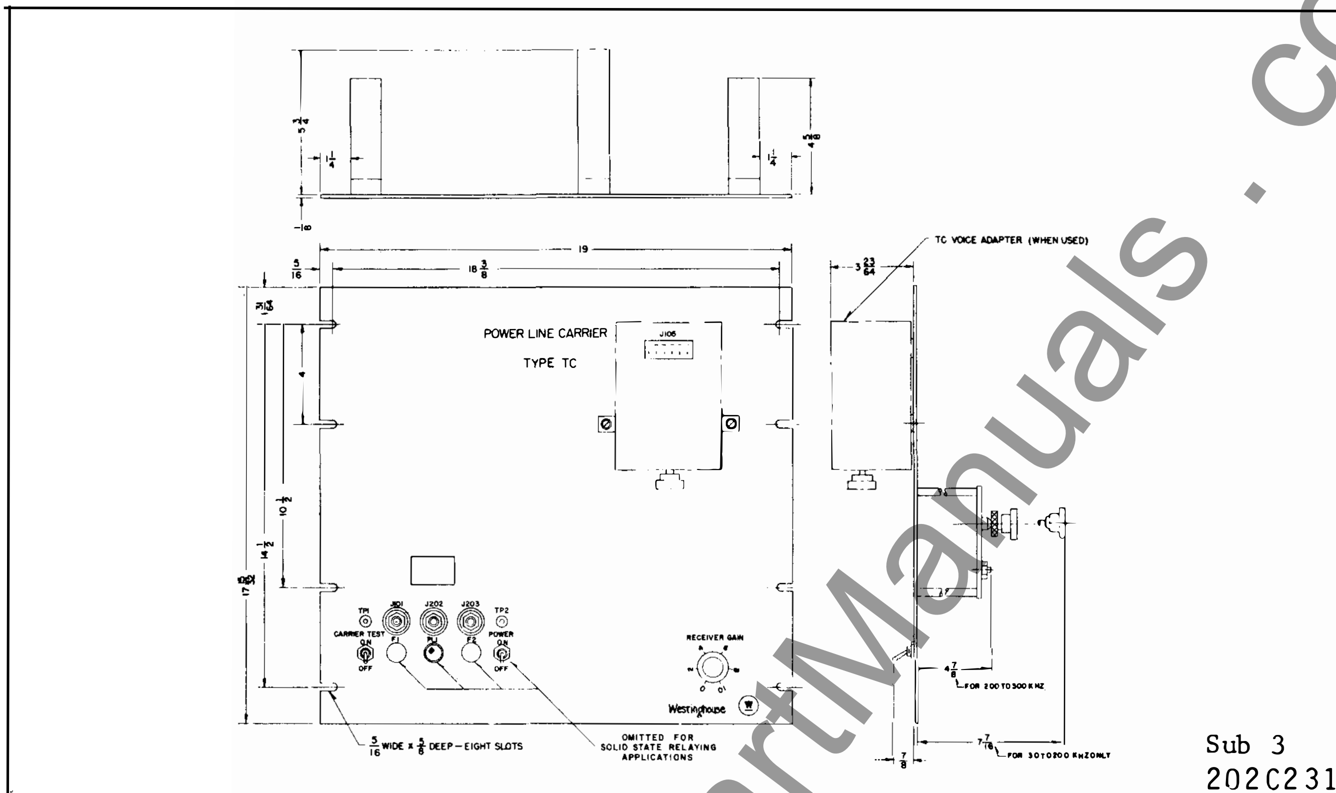
SYMBOL RESISTORS	RATING			STYLE NUMBER
	OHMS	±TOL.%	WATTS	
R201	10,000	10	0.5	187A641H51
R202	2,200	10	0.5	187A641H35
R203	10,000	10	0.5	187A641H51
R204	100,000	5	0.5	184A763H75
R205	390	5	0.5	185A763H17
R206	1,200	5	0.5	184A763H29
R207	25 K Pot.	10	2	185A086H07
R208	10,000	10	0.5	187A641H51
R209	100,000	5	0.5	184A763H75
R210	390	5	0.5	184A763H17
R211	51	5	0.5	187A290H18
R212	1 K Pot.	20	0.25	629A430H02
R213	1,200	5	0.5	184A763H29
R214	5,600	5	1	187A643H45
R215	20,000	5	0.5	184A763H58
R216	3,600	5	0.5	184A763H40
R217	620	5	0.5	184A763H22
R218	33	5	0.5	187A290H13
R219	10,000	10	0.5	187A641H51
R220	20,000	5	0.5	184A763H58
R221	1K	5	0.5	184A763H27
R222	3,600	5	0.5	184A763H40
R223	620	5	0.5	184A763H22
R224	33	5	0.5	187A290H13
R225	10,000	10	0.5	187A641H51
R226	20,000	5	0.5	184A763H58
R227	1K	5	0.5	184A763H27
R228	3,600	5	0.5	184A763H40
R229	620	5	0.5	184A763H22
R230	10	5	0.5	187A290H01
R231	2,000	5	0.5	184A763H34
R232	1,200	5	2	185A207H29
R233	4,700	10	2	187A642H43
R234	5,100	5	0.5	184A763H44
✪ R235	1.5K	5	0.5	184A763H21
R236	4,700	10	1	187A644H43

ELECTRICAL PARTS LIST

SYMBOL	OHMS	RATING ±TOL. %	RATING WATTS	STYLE NUMBER
R237	170	5	40	1336074
R239	1 K Pot	20	0.25	629A430H02
R240	50	Sensistor	0.25	187A685H08
✪ R280	56	5	5	187A290H19
T201	10,000/100 Ohms			714B666G01
T202	10,000/400 Ohms			205C043G01
T203	25K/300 Ohms			205C043G03
Y201	50-320kHz Crystal per 328C083			Specify Frequency
Z201	1N3027B (20V ±5%)			184A449H07
Z202	1N1789 (56V ±10%)			584C434H08

Power Supply Section

SYMBOL	FUNCTION	DESCRIPTION OR RATING	STYLE NUMBER
C1	(+) to (–) bypass	0.45 mfd. 330 VAC	1723408
C2	A-C grounding	0.5 mfd. 1500 VDC	1877962
C3	A-C grounding	0.5 mfd. 1500 VDC	1887962
F1, F2	Overload Protection	1.5a, 48/125 VDC	11D9195H26
F1, F2	Overload Protection	2.0a, 250 VDC	478067
PL1	Neon Pilot Light 125/250 Volts	120 Volts	183A955H01
PL1	Filament-type for 48 Volts	55 Volts	187A133H02
Q1	Series Regulator	Type 2N6259 ✪ Silicon Transistor	3503A41H01
R1	125V: Series dropping	26.5 ohms, 3½"	04D1299H44
R2	125V: Series dropping	Same as R1	04D1299H44
R3	125V: Current limiting	500 ohms, 3½"	1268047
	48V: For 48 VDC, R1 = R2 = 0	–	–
	48V: R3 = 26.5 ohms	3½"	04D1299H44
R4	Current limiting	100K, 0.5 watt	184A763H75
SW1	Power Switch	3a, 250V. AC-DC 6a, 125V. AC-DC	880A357H01
SW101	Carrier Test	Same as SW1	880A357H01
TP1	Test Point (+)	Pin Jack – red	187A332H01
TP2	Test Point (–)	Pin Jack – black	187A332H02
Z1	Voltage Regulator	1N2828B (45V.)	184A854H06
Z2	Surge Protection	1N3009A (130V.) Zener Diodes	184A617H12
Z3	Voltage Reg. for 250V.	1N2813B (15V.)	184A854H11



✪ *Fig. 1 Type TC Carrier Assembly – Outline*

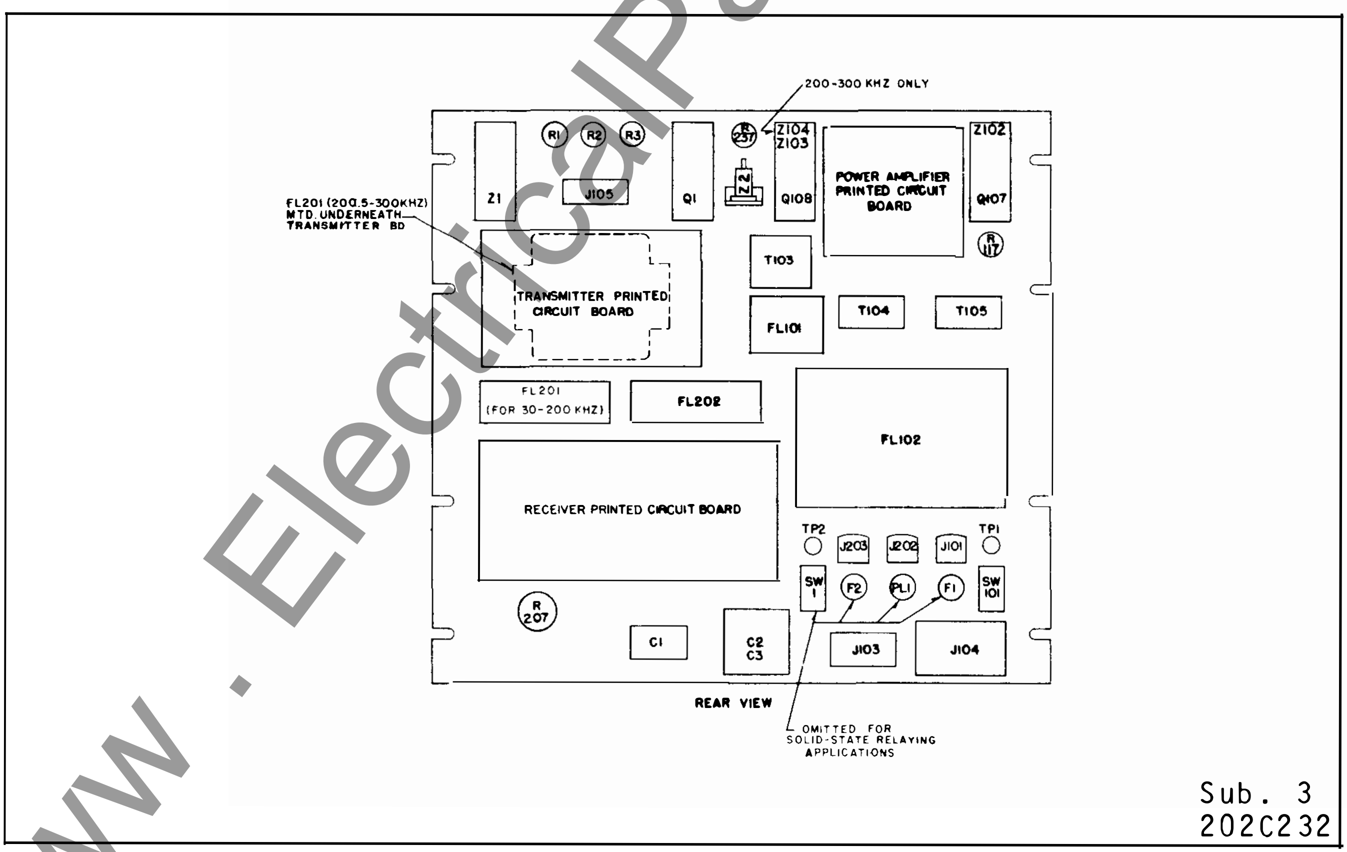


Fig. 2 Type TC Carrier Assembly – Parts Location

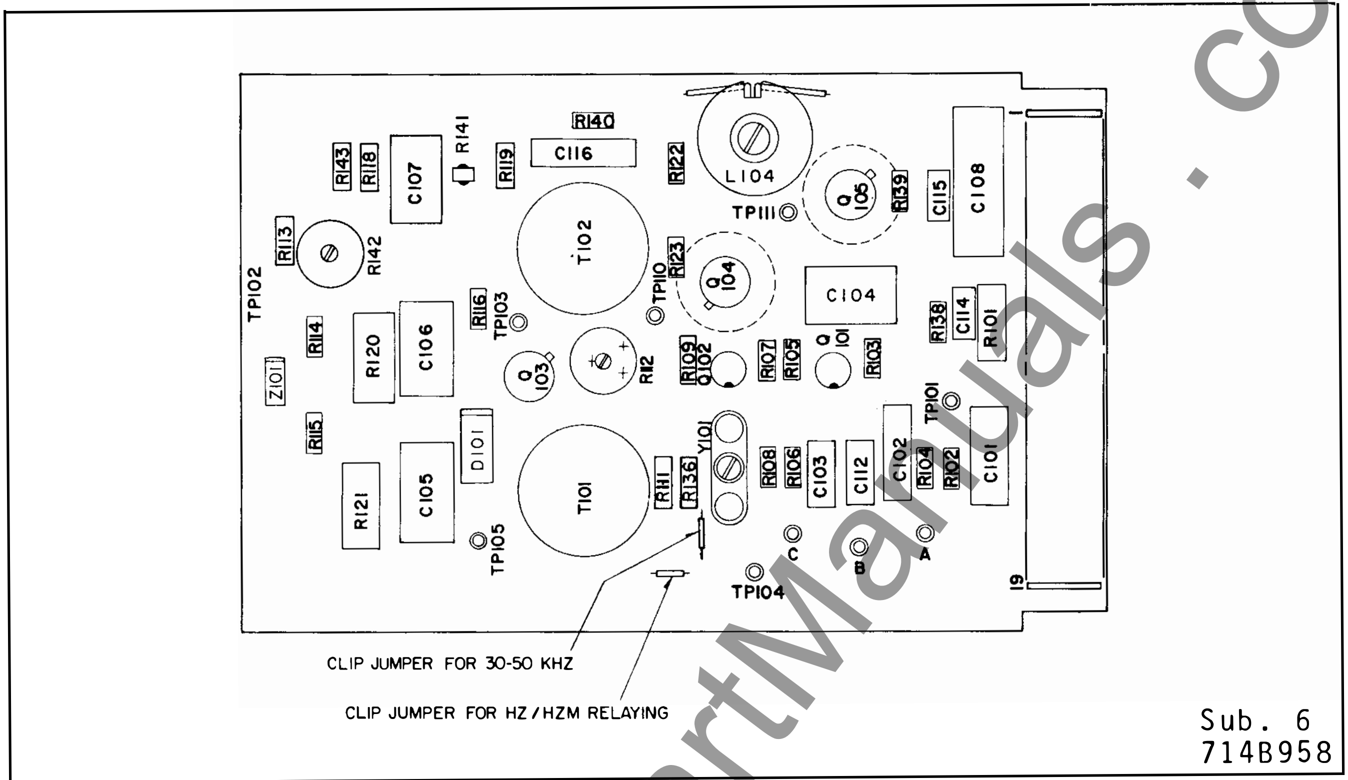
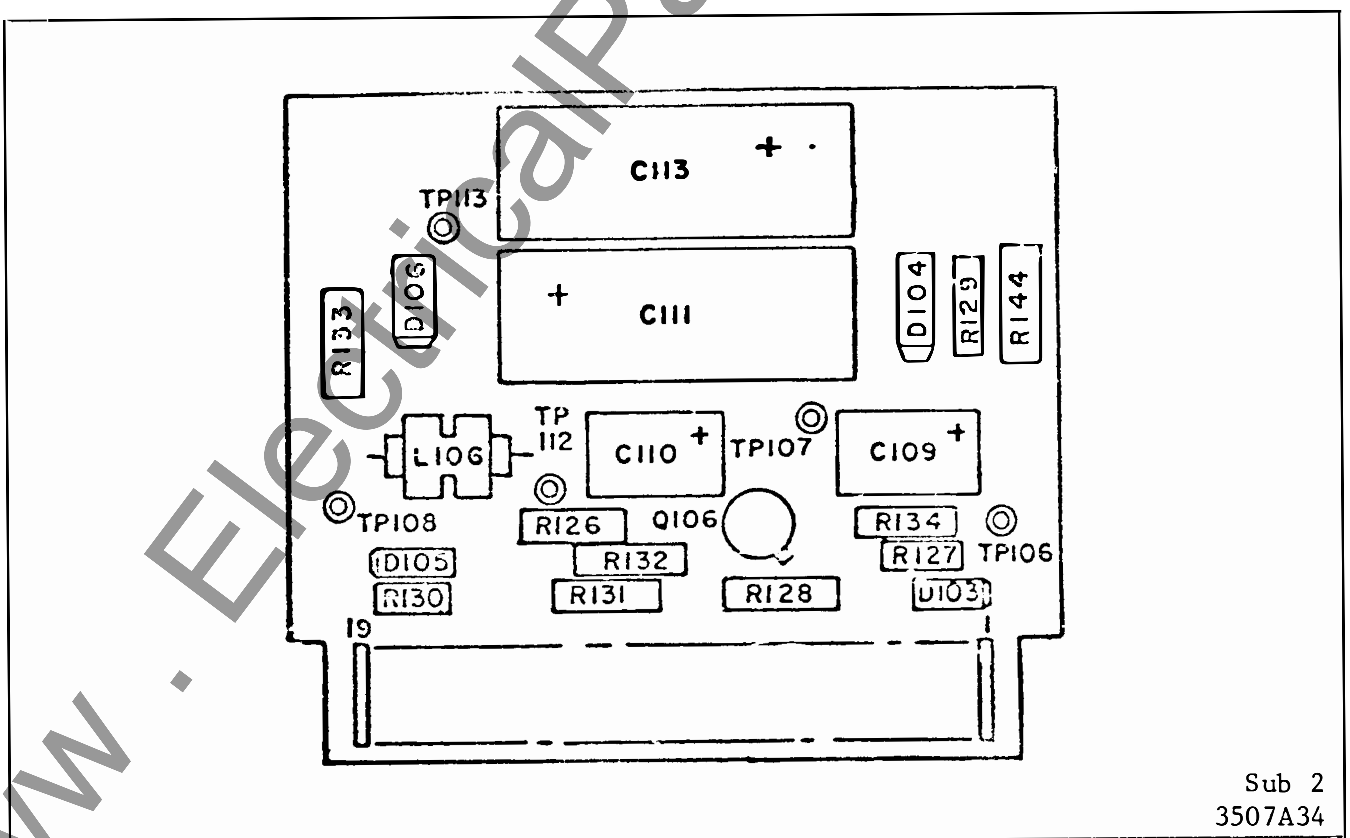


Fig. 3 Transmitter Printed Circuit – Parts Location



✪ *Fig. 4 Power Amplifier Printed Circuit – Parts Location*

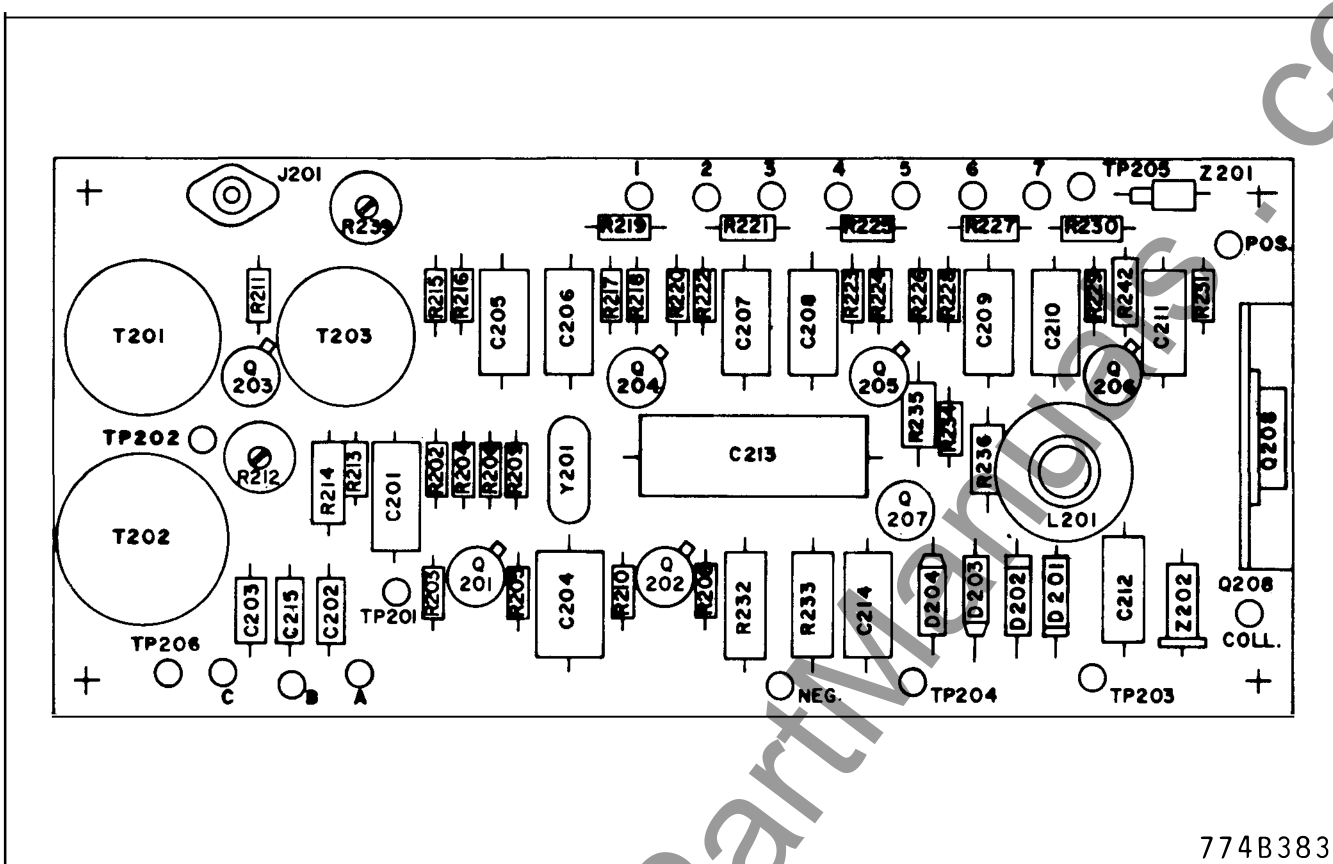
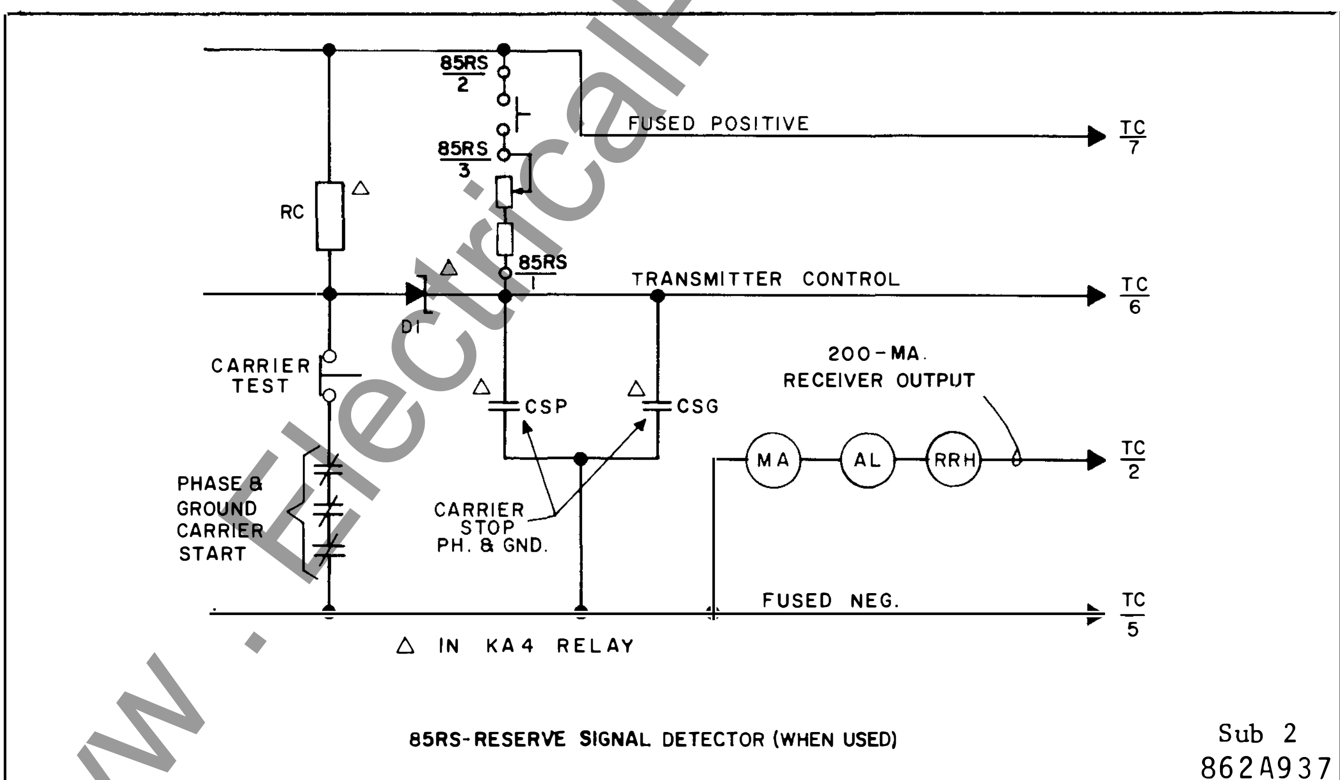


Fig. 5 Receiver Printed Circuit – Parts Location



✪ *Fig. 6 Elementary K-Dar Carrier Control Circuits*

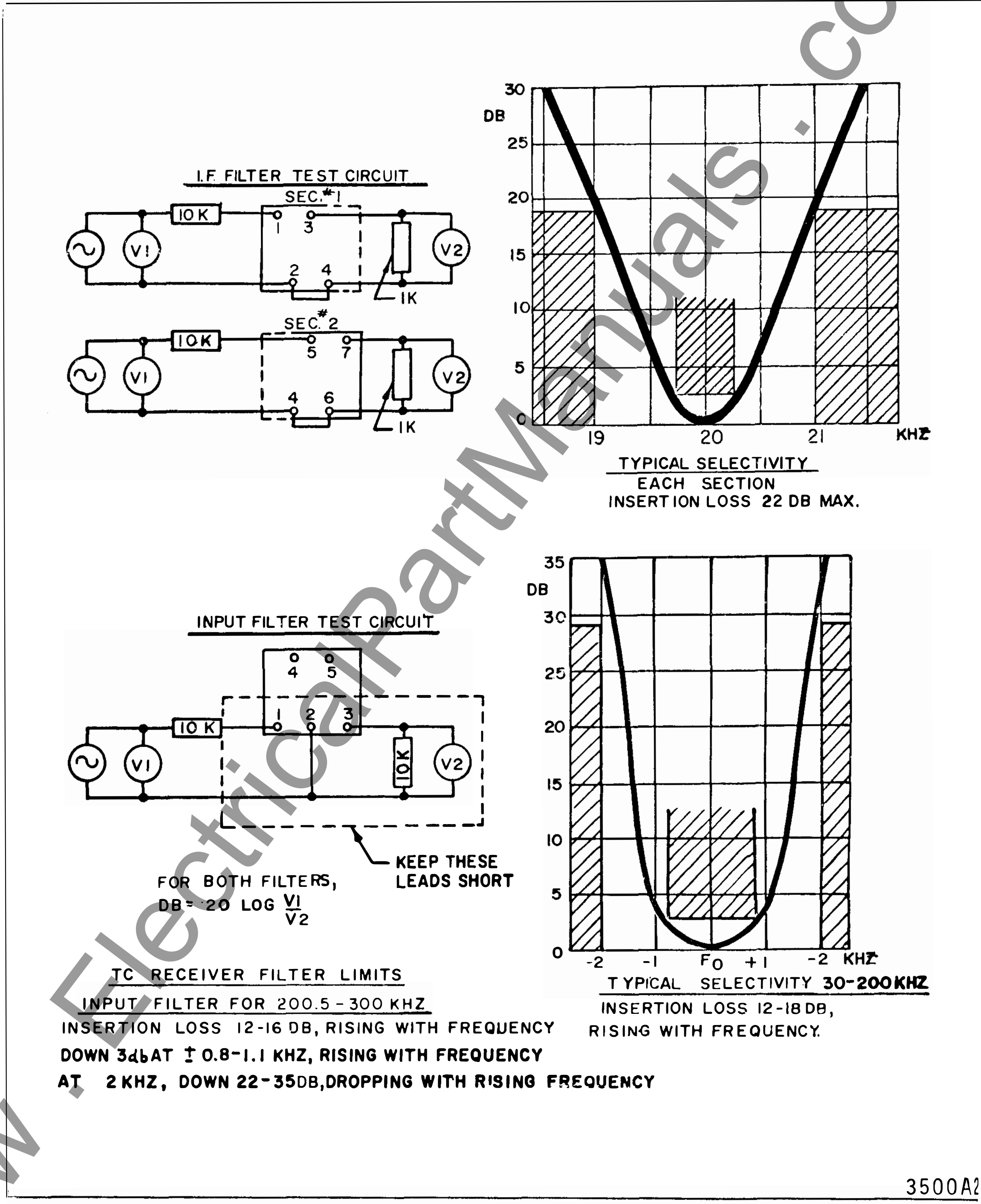


Fig. 8 Receiver Filter Characteristics

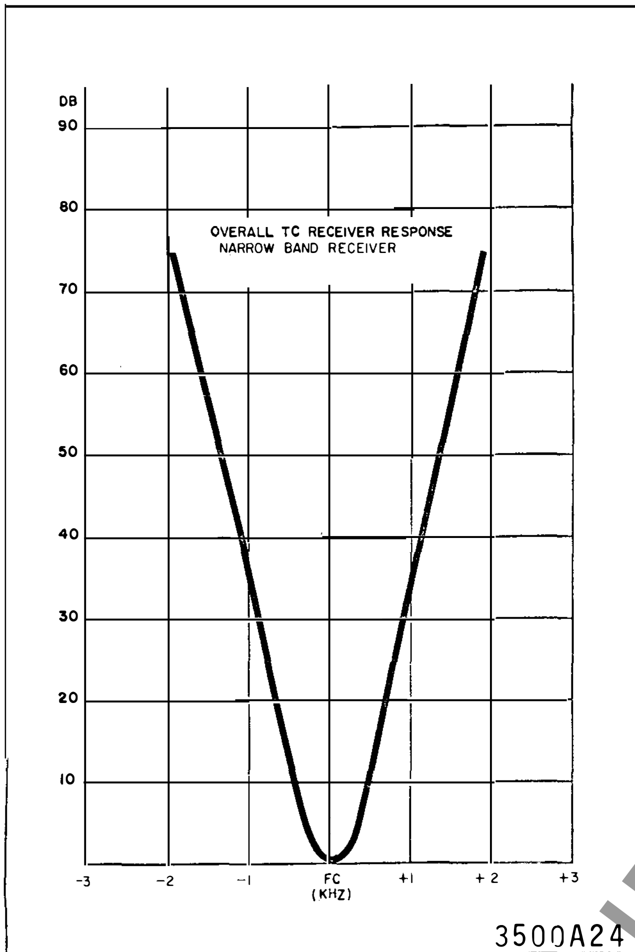


Fig. 9 Overall Selectivity Curve 3500A24

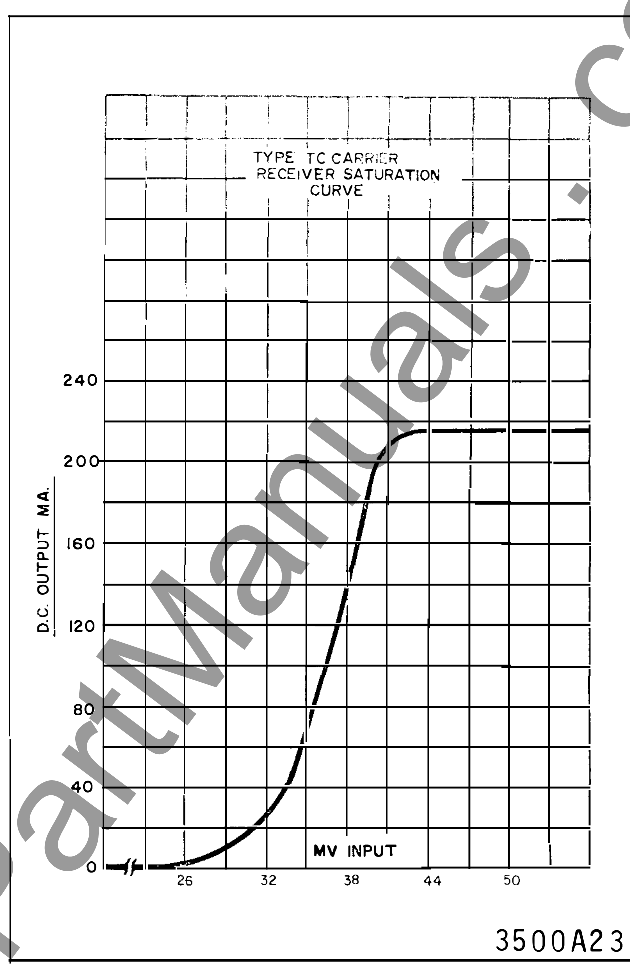


Fig. 10 Receiver – 200 ma. Output Characteristic.

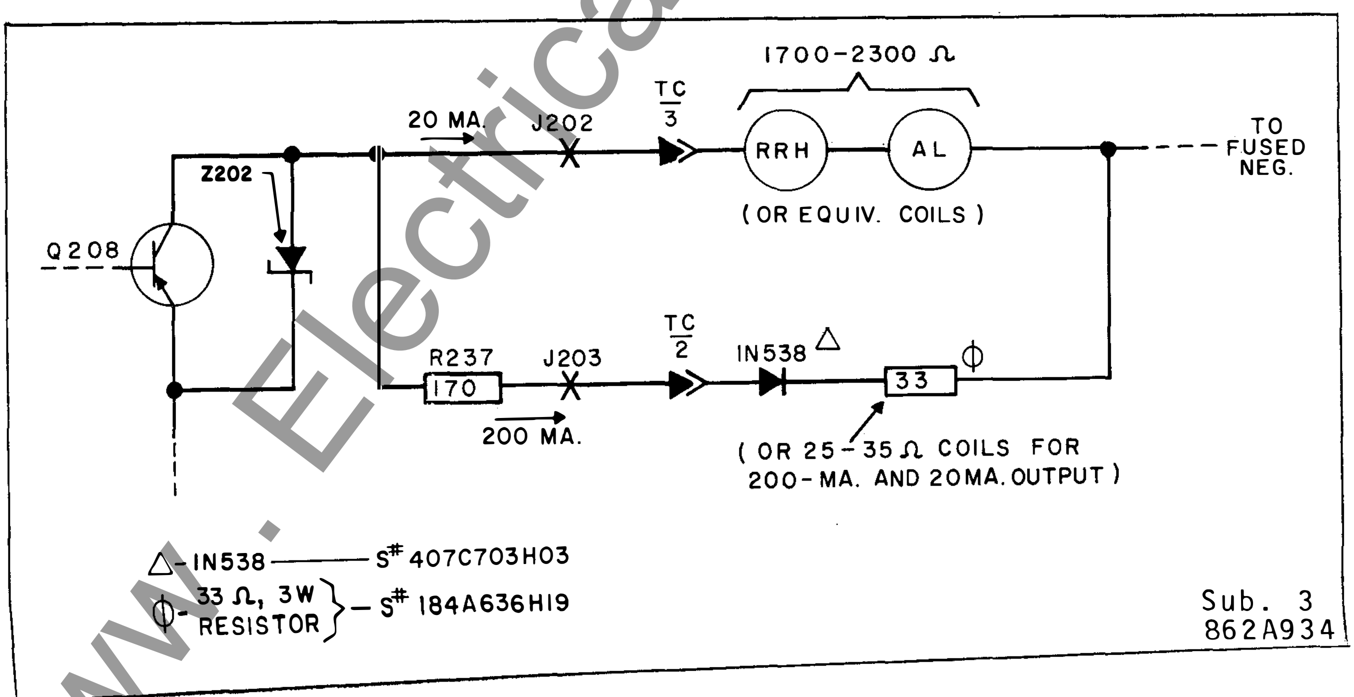


Fig. 11 TC Receiver Output for 20-ma. Operation

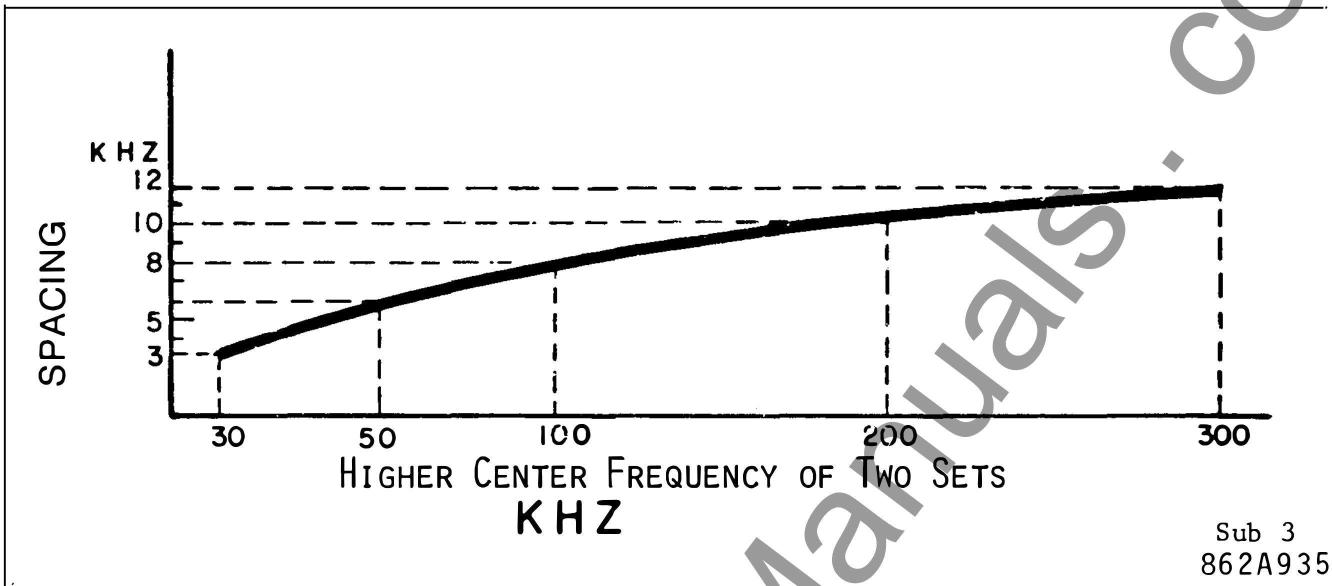


Fig. 12 Minimum Frequency Spacing for Two 10-Watt Transmitters Operated in Parallel.

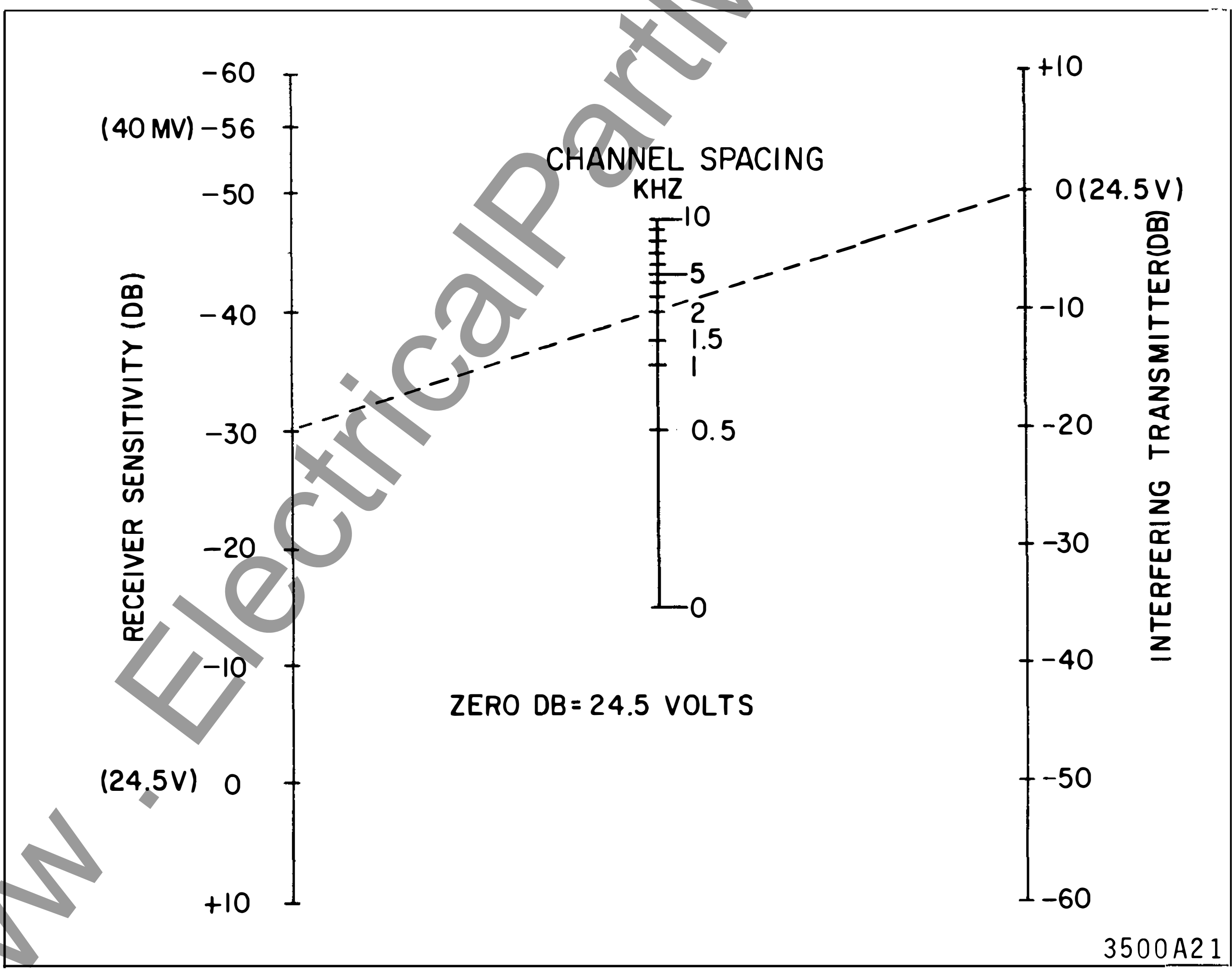


Fig. 13. Minimum Channel Spacing for Keyed Carrier 60 p.p.s.

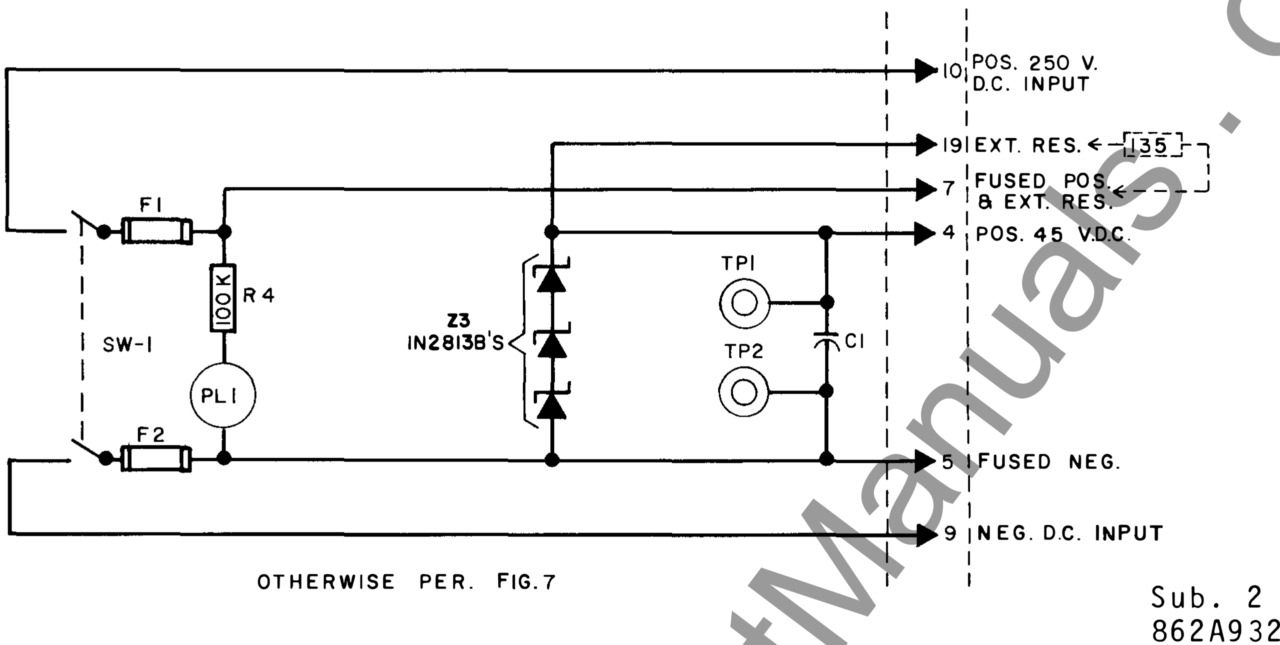


Fig. 14 Detail of Power Supply Section for 250-volt Supply

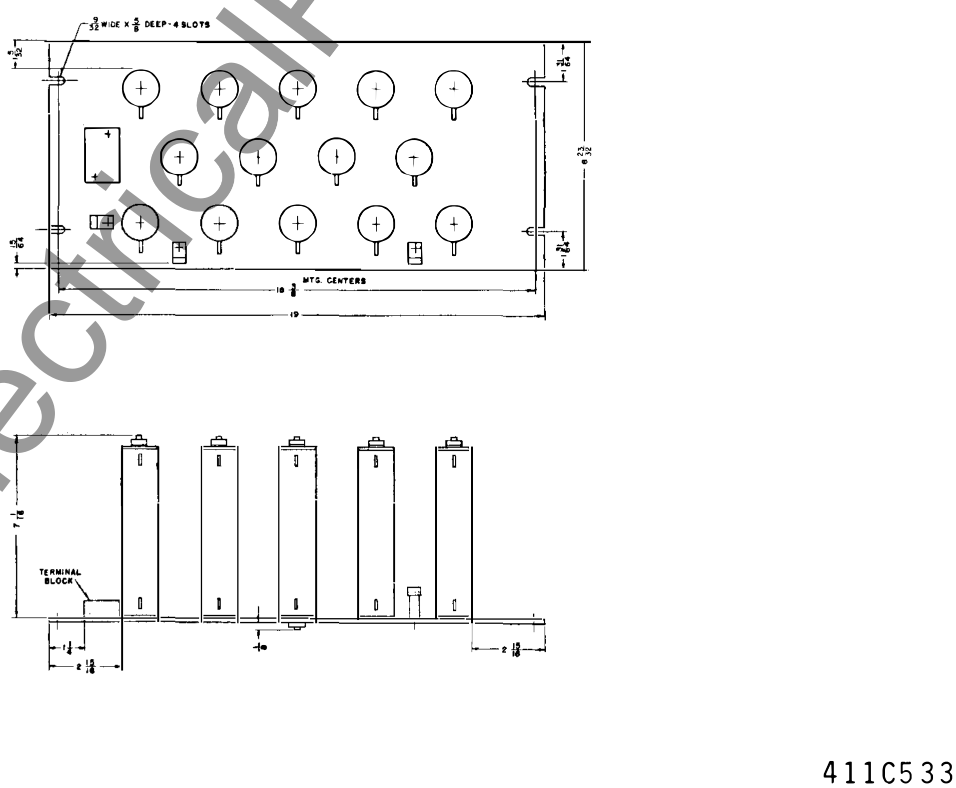


Fig. 15 Outline of External Resistor Unit for 250-Volt Operation.

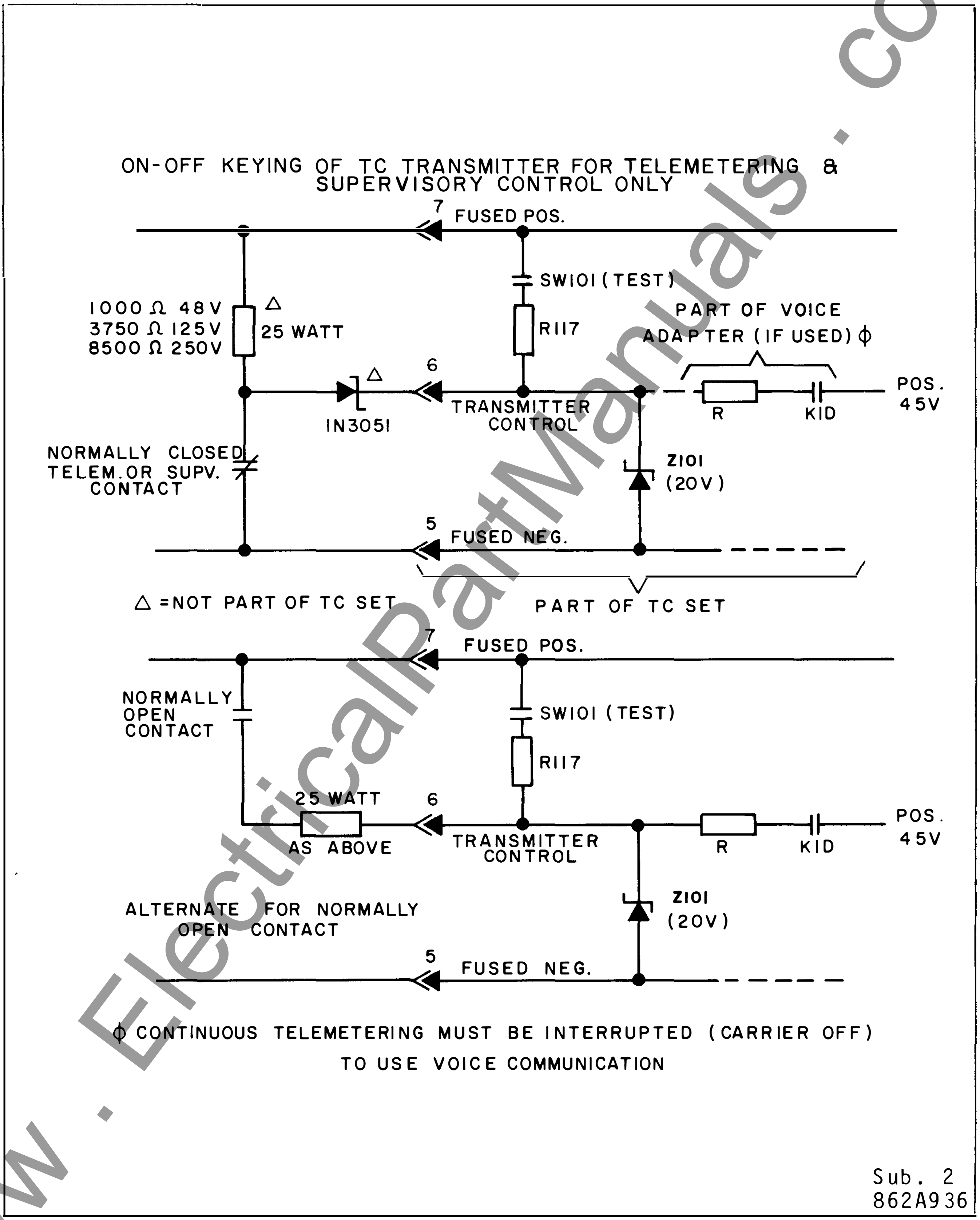


Fig. 16 External Circuitry For On-Off Keying of Type TC Transmitter For Telemetering or Supervisory Control (Without Protective Relaying) From Either Normally-Closed or Normally-Open Contact.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TC POWER LINE CARRIER TRANSMITTER-RECEIVER ASSEMBLY – 30 to 300 kHz For Directional and Phase Comparison Relaying 10 Watts – 48, 125, 250 V.D.C. with Optional Voice

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LIST OF ILLUSTRATIONS

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-944.33B, DATED MARCH 1977 AND ADDENDUM DATED JUNE 1977

EFFECTIVE FEBRUARY 1978

✪ Denotes change from superseded issue.

CAUTION It is recommended that the user of this equipment become thoroughly acquainted with the information in this instruction leaflet before energizing the carrier assembly. Failure to observe this precaution may result in damage to the equipment.

If the carrier set is mounted in a cabinet, it must be bolted down to the floor or otherwise secured before swinging out the equipment rack to prevent its tipping over.

APPLICATION

The type TC carrier equipment is designed for protective relaying of power transmission lines employing either of two types of blocking relaying systems: (1) directional comparison relaying, using the type KA-4 or equivalent carrier relay, or (2) phase-comparison relaying, using type SKB-TCU, SKBU-1, or type SKBU-11 relay equipment.

The type TC set can also be used for other functions including "push-to-talk" maintenance telephone communication, keyed carrier telemetering, and supervisory control.

CONSTRUCTION

The transmitter-receiver unit consists of a standard 19-inch wide panel 17½ inches (10 rack units) high. The panel is notched for mounting on a standard relay rack. All components are mounted on the rear of the panel. Metering jacks, fuses, power and test switches, pilot light, and the receiver gain control are accessible from the front of the panel. See Fig. 1. The circuitry is divided into several sub-assemblies as shown in Fig. 2. The components mounted on each printed circuit board or other sub-assembly are shown enclosed by dotted lines on the internal schematic, Fig. 7. The location of components on the three printed circuit boards are shown on separate illustrations, Figures 3, 4, and 5.

External connections to the assembly are made through a 24-circuit receptacle J104. The r-f output connection to the assembly is made through a coaxial cable jack J103. When voice communication is used, the voice adapter plugs into receptacle J105 on the front panel.

The receiver gain control R207 is accessible from the front of the panel. In addition, three current jacks are provided for measuring the following quantities.

J101 – Transmitter power-amplifier collector current.

J202 – Receiver 20-ma. output current.

J203 – Receiver 200-ma. output current.

The receiver filter input resistor R201 is connected directly to term. #1 of FL201 and is covered with insulating sleeving.

OPERATION

TRANSMITTER

The transmitter is made up of four main stages and two filters. The stages include a crystal oscillator, buffer-amplifier, driver, and power amplifier. With reference to internal schematic, Fig. 7, the oscillator crystal serves as a series-resonant circuit between the collector of Q101, and the base of Q102. The output of Q102 is fed back through capacitors C102, C103, and C112 to the base input of Q101, thus providing oscillation at the crystal frequency. The frequency is essentially independent of voltage or temperature changes of the transistors. Thus the frequency stability is that of the crystal itself.

The oscillator output energizes the buffer-amplifier transistor Q103 through the potentiometer R112 which controls the transmitter power output. Keying of the transmitter output is controlled in the buffer-amplifier stage by changing the dc potential supplied to Q103 emitter circuit.

The buffer output energizes the driver stage which operates class B. When voice modulation is used, the transmitter modulating voltage is applied to the base-emitter circuit of transistors Q104 and Q105.

The output of the driver stage passes through filter FL101, then to the input transformer T104 of the power amplifier stage. Filter FL101 improves the waveform of the signal applied to the power amplifier. This stage used two series-connected type 2N3792 power transistors, Q107 and Q108 operating as a class B push-pull amplifier with single-ended output. Transistor Q106 applies forward base bias to Q107 and Q108 when the carrier-start circuit is energized. Diodes D103 and D105 provide protection for the base-emitter junction of the power transistors. Zener diodes Z102 and Z103 protect the collector-emitter junctions from surges which may come in from the power line through the coaxial cable.

Terminals #19 and #20 on J104 are connected across a 2 ohm resistor R144, located on the power-amp module. When the transmitter is operating (carrier-on), approximately .5 amperes (dc) of current flows through R144 developing approximately 1 volt (dc). This voltage (or current) can be used to drive an indicating device such as an oscillograph or indicating relay for carrier-on indication. The value of input impedance of the device connected to these terminals will have no effect on the transmitter operation, provided that R144 remains as a shunt resistor. **R144 should not be removed** or value increased, in an effort to provide a higher current level for driving the indicating device, as this could jeopardize carrier-start operation.

The output transformer T105 couples the power transistors to the transmitter output filter FL102. The output filter includes two trap circuits (L102, C_B, and L103, C_C) which are factory tuned to the second and third harmonics of the transmitter frequency. Capacitor C_D approximately cancels the inductive reactance of the two trap circuits at the operating frequency. Protective gap G101 is a small lightning arrester to limit the magnitude of switching surges or other line disturbances reaching the carrier set through the line tuner and coaxial cable. Auto-transformer T106 matches the filter impedance to coaxial cables of 50, 60, or 70 ohms characteristic impedance.

The series-resonant circuit composed of L105 and C_E is tuned to the transmitter frequency, and aids in providing resistive termination for the output stage. Jack J102 is mounted on the rear panel of FL102 and is used for measuring the r.f. output current of the transmitter into the coaxial cable. It should be noted that the filter contains no shunt reactive elements, resulting in a reverse impedance free of possible "across-the-line" resonances.

RECEIVER

The receiver is a superheterodyne type to facilitate obtaining constant bandwidth regardless of the channel frequency. The major stages include an input filter, attenuator (gain control), crystal oscillator, mixer, i.f. filters and i.f. amplifiers, diode detector, dc amplifier, and dc power output stage.

The fixed input filter rejects undesired signals while accepting a wide enough band of frequencies to assure fast operation. The receiver sensitivity is adjusted by means of the continuously variable input control R207. The receiver oscillator (Q201 and Q202) is basically the same as the transmitter oscillator. The oscillator frequency is 20 kHz above the incoming signal frequency. The receiver channel frequency is determined by the input filter and the oscillator crystal.

Mixing is accomplished by feeding the incoming signal to the emitter, and the receiver oscillator signal to the base of the mixer Q203. Mixer oscillator requirements are met through adjustment of potentiometer R212. Injection into two separate elements, base and emitter, provides a circuit capable of handling greater signal level variations than one in which injection is made into only a single element such as the base. This receiver uses an intermediate frequency of 20 kHz. Typical characteristics of both filters and the complete receiver are shown on curves, Fig. 8 and 9.

The 20 kHz i.f. signal is rectified by diodes D201 and D202. The resulting dc output is amplified by transistors Q207 and Q208, giving a receiver output current of nominally 200 ma. for a 30-ohm external relay coil circuit. Where a second output current of 20 ma. is desired, an external 2000-ohm relay circuit can be connected to the receiver output as shown in Fig. 11. If only a 20-ma output is deisred, a 33-ohm resistor and diode must still be connected into the circuit as shown. Fig. 10 shows the receiver 200-ma. output characteristic.

POWER SUPPLY

The power supply circuit for 48 or 125-v. dc supply uses a series-type transistorized dc voltage regulator which has a very low standby current drain when there is not output current demand. The zener diode Z1 holds a constant base-to-negative voltage on the series-connected power transistor Q1. Depending on the load current, the dc voltage drop through the transistor Q1 and resistors R1 and R2 varies to maintain a constant output voltage of approximately 45-v. dc. The zener diode Z2 serves to protect the collector-base junction of Q1 from surge voltages. Capacitor C1 provides a low carrier-frequency impedance across the dc output voltage. Capacitors C2 and C3 bypass r.f. or transient voltages to ground, thus preventing damage to the transistor circuit.

For a 250-volt dc supply, the circuit of Fig. 14 is used. This consists of an external voltage-dropping resistor assembly (135 ohms total) in conjunction with three 15-volt Zener diodes on the TC set chassis connected in series. The resistor assembly (see Fig. 15) must be mounted at the top of a cabinet or an open rack. Bacause of the heat dissipated, no tansistorized equipment should be mounted above the resistor panel. The 250-volt TC set has a constant current drain of 1.5 amperes dc, and uses 2-amp. fuses.

When the TC set is used with solid-state protective relays (such as the SKBU-11), the pilot light PL1, power switch SW-1, and fuses F1 and F2 are omitted from the assembly. See Figures 1 and 2. Instead, the dc power to the complete relaying assembly is controlled from a single switch and set of fuses. This is done to prevent an incorrect tripping or blocking output which might result from interruption of one or both sides of the dc supply to the carrier set or protective relays. For solid-state relaying aplications, there are no connections to J104 terminals 7 or 5 (normally fused positive and fused negative). See Fig. 7.

RELAYING CONTROL CIRCUITS

The carrier control circuit for KDar relaying is shown in elementary form in Fig. 6. The "Transmitter Control" circuit is normally held at fused negative potential through the normally-closed carrier test pushbutton and the phase and ground carrier-start relay contacts. Opening of any of these contacts allows current to flow from fused positive through resistor R_C and the Diode D_1 to the transmitter control terminal TC/6, thus starting carrier transmission at full output. The potential of terminal TC/6 rises to plus 20 volts, limited by a Zener diode in the transmitter proper. The reception of carrier from either the local or remote transmitter normally causes a saturated current of about 200 ma. to flow in the alarm and holding coils (AL and RRH) in the type KA-4 (or equivalent) receiver auxiliary relay.

If the protective relays call for stopping the transmission of carrier, closing of CSP or CSG contact connects the transmitter control circuit back to fused negative, thus stopping any carrier transmission regardless of how it was started.

If a relaying carrier channel is also used for an auxiliary function such as telemetering or supervisory control, the keying contact for this function is connected into the carrier-start circuit in series with the carrier test pushbutton. Such a contact must be normally closed (in the non-operating condition). An auxiliary relay in the receiver output, usually in place of the alarm relay, energizes the telemetering or supervisory control equipment through contacts on the auxiliary relay.

CARRIER CONTROL FOR OTHER FUNCTIONS

If a type TC set is keyed on-off for telemetering or supervisory control only (no protective relaying), one of the circuits shown in Fig. 16 can be used. Arrangements are shown for either a normally-closed or normally-open carrier-start contact. In the former case, a diode is required to allow using the Voice Adapter for push-to-talk voice communication between stations. Note that continuous telemetering must be interrupted when it is desired to use the carrier channel for voice communication.

The receiver output can be connected for either 200-ma. or 20-ma. operation as shown in Fig. 11. The 200-ma. output is preferable (if a choice is available) because of a slightly better time constant in the 200-ma. receiver output circuit. In some cases, both the 200-ma. and the 20-ma. outputs may be used together. For example, the 200-ma. output can be used with a standard carrier auxiliary relay (for directional-comparison relaying), while the 20-ma. output feeds a 2000-ohm receiver relay used with supervisory control equipment. The connections shown in Fig. 11 would be used for this case, with the receiver relay holding coil (RRH) in place of the 33-ohm resistor and the 2000-ohm supervisory relay in the 20-ma. output in place of the RRH and AL coils shown. The alarm function would be provided by the supervisory control equipment.

CHARACTERISTICS

Frequency range	30-300 kHz (50-300 kHz for phase comparison relaying)
Transmitter output	10 watts into 50 to 70-ohm resistive load
Harmonics	55 db below 10 watts
Receiver sensitivity	125 mv. input for 180 ma. minimum output current
Receiver selectivity	1500 Hz bandwidth (3 db down); 80 db at ± 3 kHz.
Transmitter-receiver Channel rating	40 db
Input Voltage	48, 125, or 250V dc
Supply voltage variation	42-56V, 105-140V, 210-280V
Battery Drain:	
48V dc	0.5 amp standby, 1.35 amp transmitting
125V dc	0.25 amp standby, 1.1 amp transmitting
250V dc	1.5 amp standby or transmitting
Temperature range	−20 to +60°C around chassis

FREQUENCY SPACING

The minimum recommended frequency spacing between two Type TC carrier sets operated in parallel without hybrid units is shown on the curve of Fig. 12. For example, at 100 kHz, the minimum spacing is 8 kHz. Closer spacing would result in the generation of intermodulation products caused by the non-linear load presented by each transmitter to the other one.

The minimum frequency spacing between a TC carrier channel and an adjacent transmitter signal keyed on-off at a rate of 60 pulses per second can be determined from the nomograph of Fig. 13. Using the example shown by the dashed line, consider a type TC set used on a channel with a normal attenuation of 15 decibels. The TC receiver would be set to give a margin of 15 db below the normal received signal, or for a sensitivity of −30 db (relative to a 24.5 volt, 10-watt signal). The interfering signal is assumed to be a 10-watt transmitter at the same location. To determine the minimum frequencys spacing of the TC receiver from this interfering signal, lay a straight edge between the −30 db point on the receiver sensitivity scale and the zero dc point on the interfering transmitter scale. The resulting line crosses the channel spacing scale between 3 and 4 kHz. For this example, a channel spacing of at least 4 kHz should be used. (In order not to conflict with the limits of Fig. 12, an r-f hybrid may be needed between the TC set and the other transmitter, depending on the actual application.)

For protective relaying applications to 3-terminal lines, the transmitter frequencies are offset 100 hertz to prevent a slow beat or cancellation of the received signal when two transmitters send blocking signals to the third terminal. The three transmitters operate at fc, fc + 100 Hz, and fc − 100 Hz. All receivers operate at the channel center frequency (fc).

INSTALLATION

The type TC transmitter-receiver is generally supplied in a cabinet or on a relay rack as part of a complete carrier assembly. The location must be free from dust, excessive humidity, vibration, corrosive fumes, or heat. The maximum ambient temperture around the chassis must not exceed 60°C.

ADJUSTMENTS

TRANSMITTER

There are two adjustable controls on the transmitter printed-circuit board: (1) the power output control R112, and (2) base bias control R142 for transistors Q104 and Q105. The control R142 is factory adjusted for a quiescent (no-signal) current of 0.2 ± 0.05 ma. dc at terminal 2 of transformer T103. This applies a small amount of forward base bias to transistors Q104 and Q105 to minimize cross-over distortion. A thermistor (R141) is included for temperature compensation. This control (R142) need not be changed except as described in the MAINTENANCE section.

The other adjustment on the transmitter is the power output control R112 on the transmitter printed circuit board. Disconnect the coaxial cable from the assembly terminals and replace with a 50 to 70 ohm noninductive resistor of at least a 10-watt rating. Use the value of the expected input impedance of the coaxial cable and line tuner. If this is not known, assume 60 ohms. Connect the T106 output lead to the corresponding tap. Connect an ac vacuum tube voltmeter (VTVM) across the load resistor. Turn the transmitter power output control R112 to minimum (full counterclockwise).

Now turn on the power switch on the panel and note the dc voltage across the two pin jacks TP1 and TP2. If this is in the range of approximately 42 to 46 volts, throw the carrier-test switch SW101 on the panel to the ON position. Slowly advance the output control R112 on the transmitter printed-circuit board until about 10 volts is obtained across the output load resistor. At this point, check the adjustment of the series output tuning coil L105 by loosening the knurled shaft-locking nut and moving the adjustable core in and out a small amount from its initial position. Leave it at the point of maximum voltage across the load resistor.

Now continue to advance the output control R112 until the output voltage tabulated in the following table is obtained across the load resistor. Recheck the setting of L105 to be sure it is at its maximum point for 10 watts output. Tighten the locking nut.

Note: For 200-300 kHz sets, inductor L105 is a pot core and the foregoing adjustment check is generally unnecessary since there is little chance of its setting being disturbed. However, if desired, the pot core setting can be checked using a screwdriver to vary the setting of the adjustable core. There is no locking device as the adjustable core is held in place by friction.

Turn off the carrier test switch SW101, remove the load resistor, and reconnect the coaxial cable circuit to the transmitter.

T106 Tap	Voltage for 10 Watts Output
50	22.4
60	24.5
70	27.0

TRANSMITTER FILTER

Normally, the output filter (FL102) will require no readjustment except as noted under Adjustments-Transmitter, as it is factory tuned for maximum second and third harmonic rejection, and for series resonance (maximum output at the fundamental frequency) with a 60-ohm load. A small amount of reactance in the transmitter output load circuit may be tuned out by readjustment of the movable core of L105. This may be necessary with some types of line coupling equipment. The adjustable cores of L102 and L103 have been set for maximum harmonic rejection at the factory, and no change should be made in these settings unless suitable instruments are available for measuring the second and third harmonic present in the transmitter output.

Follow the procedure outlined in the line tuner instructions for its adjustment.

RECEIVER

The receiver board has two controls; the i.f. input control R239 which is factory-set to give a sensitivity of 125 mv. for 180 ma. output, and the local oscillator output control R212. the oscillator output is preset at the factory of 0.5 volt. This setting can be checked by connecting an ac VTVM between receiver test points TP202 and TP206 (shield lead of VTVM). The voltmeter reading with the equipment energized, but not transmitting, should be 0.5 volt rms. Note Fig. 5 for location of components on the receiver printed board.

The other adjustment on the receiver is the gain control R207 which is front-panel mounted, It is recommended that the receiver gain normally be set for a 15-db operating margin to allow for reasonable variations in receiver input signal level without affecting the output blocking current. This adjustment can be made in two ways, as follows:

1. First, measure the normal received signal from the remote terminal (after the line tuners have been adjusted) by starting the remote transmitter and measuring the voltage across the coaxial cable at the receiving terminal. This signal should preferably be measured with a tuned voltmeter such as the Sierra carrier-frequency voltmeter. If a simple VTVM is used, have the remote transmitter turned on and off several times to be sure the VTVM reading is actually the remote signal. Note the reading. Now disconnect the coaxial cable, and feed a signal into the carrier assembly at the coaxial terminals from a separate signal generator. Set the signal generator to the received frequency at a level 15db below the previously measured incoming signal. With a 0-250 mA. (minimum) dc milliammeter plugged into J203, adjust the receiver gain control unit until an output current of about 100 ma. is obtained. As this point is on the steep portion of the receiver output-input curve, it may be difficult to set the gain control for exactly 100 ma. This is not necessary, however, as the signal is not normally at this value. This is the operating setting of the receiver gain control. Return the coaxial cable connections to normal.

   NOTE: Do not energize the local transmitter when making the foregoing adjustment as the signal generator may be damaged.

2. As an alternate procedure if no signal generator is available, the local transmitter itself may be used as the signal generator. First determine the normal received signal from the remote terminal as explained previously under (1). Then turn off the remote transmitter.

   Now turn on the local transmitter and reduce its output to a value 15 db below the normal received signal level. Then adjust the receiver gain control to give 100 ma. output as before. When this adjustment has been made, reset the local transmitter to its normal 10-watt output level.

In applications where the line attenuation is low and a strong signal is received, the adjustment of the receiver gain control R207 becomes critical. For such applications, the setting of i-f gain control R239 may be reduced to lower the overall receiver gain. The front-panel control R207 will then have a smoother and more gradual control as the knob is rotated, making it easier to obtain the 15-db margin setting. For such a strong-signal condition, it is recommended that with R207 at maximum, the i-f gain control R239 be adjusted to give 100 ma. receiver output current for an input r-f voltage **25 db** below the normal received signal level. Then the front panel control R207 is set for the normal 15-db margin as previously described.

MAINTENANCE

Periodic checks of the received carrier signal will indicate impending failure so that the equipment can be taken out of service for correction. At regular maintenance intervals, any accumulated dust should be removed, particularly from the heat sinks. It is also desirable to check the transmitter power output and receiver sensitivity at such times, making any necessary readjustments to return the equipment to its initial settings.

Voltage values should be recorded after adjustment in order to establish reference values which will be useful when checking the apparatus. The readings will remain fairly constant over an indefinite period unless a failure occurs. However, if transistors are changed, there may be considerable difference in these readings without the overall performance being affected.

Typical voltage and current values are given in Tables I through IV. Voltages should be measured with a VTVM. Readings may vary as much as ± 20%.

ADJUSTMENT OF R142 ON TRANSMITTER BOARD

The small adjustable resistor (pot.) R142 sets the forward base bias on transmitter transistors Q104 and Q105 to the proper point for class-B operation. This is a factory adjustment and need not be changed unless transistors Q104 and Q105 (or both) are replaced. However, if these transistors are changed, or if the R142 setting is disturbed in error, the following adjustment procedure should be followed to reset R142:

First remove dc power from the TC carrier set assembly. Unsolder the lead from terminal 2 of transformer T103 (just above FL101) and temporarily connect a low-range dc milliammeter (0-1.0 or so) between the removed lead (+) and T103 terminal 2 (−). Turn the slotted control on the small pot (R142) to full counterclockwise. Now, apply power to the TC carrier set, but do **not** transmit carrier. Advance the pot until the dc milliammeter reads 0.2 mA dc ± 0.05 mA. Turn off the power, remove the milliammeter, and solder the lead back on terminal 2 of T103. Again apply dc power and proceed with the transmitter adjustment as described in the ADJUSTMENTS section.

REPLACEMENT OF Q107-Q108

The two transistors Q107 and Q108 in the transmitter power-amplifier stage are a matched pair with the gain of the two units matched within 5%. If one of the transistors fails, both should be replaced with a new matched pair. This is necessary to keep the second harmonic of the transmitter output at an acceptably low value. The pair of transistors should be ordered as "2 of style 187A673H16 transistors".

Note: Only Power Amplifier module styles 774B881G01 thru G05 and 774B541G01 thru G05 use type 2N3792 transistors. When ordering replacement transistors, be sure to check module style. Other style power amplifier modules can be modified by ✪ changing diodes D104 thru D106 to type 1N4818 Diodes. Order these as four of style 188A342H06.

CHANGE OF OPERATING FREQUENCY

The parts required for changing the operating frequency of a type TC carrier set are as follows:

TRANSMITTER

1. **Oscillator Crystal (Y101), specify frequency**

   NOTE: Modify A-B-C jumpers on transmitter board if required for new frequency. See table marked "‡" under internal schematic (Fig. 7).

2. **R136 Jumper**

   For operation in 30-50 kHz range, clip off R136 as indicated in Fig. 3.

3. **Capacitors C111 and C113 (on Power Amp. board)**

   a. 30-50kHz – 0.47 mfd. – S#188A293H01
   b. 50.5-75kHz – 0.22 mfd. – S#188A293H02
   ✪ c. 75.5-100kHz – 0.15 mfd. – S#188A293H03
   d. 100.5-150kHz – 0.10 mfd. – S#188A293H04
   ✪ e. 150.5-300kHz – 0.047 mfd. – S#188A293H05

4. **Transmitter Module Mounting Plate**

   When changing from a frequency of 200 kHz or below to a frequency above 200 kHz, the following is also necessary:

   Transmitter module mounting plate S#691B610H01 and associated hardware.

   This is necessary to raise the transmitter printed circuit board (module) away from the main panel as the 200.5-300 kHz. receiver input filter FL201 mounts underneath it. See Fig. 2.

5. **Zener Diode Z104**

   For the 200.5-300kHz. range, a type 1N2999B zener diode Z104 is mounted on the Q108 heat sink adjacent to the protective diode Z103. Remove the lead from the Q108 heat sink (see Fig. 2 for location) and connect it to the insulated terminal of zener diode Z104.

6. **FL101 and FL102**

   Filter FL101 is a small series-resonant tuned circuit between the driver and power amplifier stages of the transmitter. It has just two terminals. Filter FL102 is a larger assembly, described under OPERATION. It has three external connections: input, output, and ground. This filter is mounted by four corner posts. To replace, unsolder the three leads, remove the nuts from the mounting posts, and lift the filter assembly from the posts. The new filter can now be installed.

Inductors L101, L102, and L103 in these filters are adjustable over a limited range, but forty-two combinations of capacitors and inductors are required to cover the frequency range of 30 kHz to 300 kHz. The widths of the frequency groups vary from 1.5 kHz at the low end of the channel frequency range to 13 kHz at the upper end. A particular assembly can be adjusted over a somewhat wider range than the width of its assigned group since some overlap is necessary to allow for component tolerances. The nominal adjustment ranges of the groups are:

30.0-31.5	61.0- 64.0	113.0-119.5	207.1-214.0
32.0-33.5	64.5- 68.0	120.0-127.0	214.1-222.0
34.0-36.0	68.5- 72.0	127.5-135.0	222.1-230.0
36.5-38.5	72.5- 76.0	135.5-143.0	230.1-240.0
39.0-41.0	76.5- 80.0	145.5-151.0	240.1-250.0
41.5-44.0	80.5- 84.5	151.5-159.5	250.1-262.0
44.5-47.0	85.0- 89.0	160.0-169.5	262.1-274.0
47.5-50.0	89.5- 94.5	170.0-180.0	274.1-287.0
50.5-53.5	95.0-100.0	180.5-191.5	287.1-300.0
54.0-57.0	100.5-106.0	192.0-200.0	
57.5-60.5	106.5-112.5	200.1-207.0	

If the new frequency lies within the same frequency group as the original frequency, the filters can be readjusted. If the frequencies are in different groups, it is possible that changes only in the fixed capacitors may be required. In general, however, it is desirable to order complete filter assemblies adjusted at the factory for the specified frequency.

A signal generator, a frequency counter, and a vacuum-tube voltmeter are required for readjustment of FL101. The signal generator and the counter should be connected across terminals 4 and 5 of transformer T103 and the voltmeter across terminals 1 and 2 of transformer T104. The signal generator should be set at the channel center frequency and at 2 to 3 volts output. The core screw of the small inductor should be turned to the position that gives a true maximum reading on the VTVM. Turning the screw to either side of this position should definitely reduce the reading. The change in inductance with core position is less at either end of the travel than when near the center and consequently the effect of core screw rotation on the VTVM reading will be less when the resonant inductance occurs near the end of core travel.

The procedure for readjustment of the 2nd and 3rd harmonic traps of filter FL102 is somewhat similar. A signal generator and a counter should be connected to terminals 3 and 4 of transformer T105 and a 500-ohm resistor and a VTVM to the terminals of protective gap G101. The ground or shield lead of all instruments should be connected to the grounded terminal of the transformer. Set the signal generator at exactly twice the channel center frequency and at 5 to 10 volts output. Turn the core screw of the large inductor, L102, to the position that gives a definite minimum reading on the VTVM. Similarly, with the signal generator set at exactly three times the channel center frequency and 5 to 10 volts output, set the core screw of the small inductor, L103, to the position that gives a definite minimum reading on the VTVM. Then remove the instruments and the 500-ohm resistor.

If the change in frequency is enough to require a different filter, it will come factory adjusted as described in the foregoing paragraph.

After all the tabulated changes have been made for the new frequency, the transmitter can be operated with a 50 to 70-ohm load (depending on which tap of T106 is used) connected to its output, and inductor L105 can be readjusted for maximum output at the changed channel frequency by the procedure described in the ADJUSTMENT section.

If the frequency-sensitive voltmeter is available the second and third harmonic traps may be adjusted (or checked) without using an oscillator as a source of double and triple the channel frequency. Connect the frequency-sensitive voltmeter from TP109 to ground and adjust the transmitter for rated output into the selected load resistor. Set the voltmeter at twice the channel frequency and, using its tuning dial and db range switch, obtain a maximum on-scale reading of the second harmonic. Then vary the core position of L102 until a minimum voltmeter reading is obtained. Similarly, tune the voltmeter to the third harmonic and adjust L103 for minimum voltmeter reading. It should be noted that this procedure may not give the true magnitude of the harmonics because of the large value of fundamental frequency voltage present at the tuned voltmeter input terminals. This condition will overload the input circuit of some commercial instruments. However, the procedure is satisfactory for adjusting the traps for maximum harmonic rejection.

If accurate measurement of the harmonic levels is desired, the frequency-selective voltmeter is connected, through a rejection filter, to the terminals of the 60-ohm load resistor. The filter must provide high rejection of the fundamental. A twin-T filter is suitable for this purpose. The insertion losses of this filter at the second and third harmonics must be measured and taken into account.

TABLE I

Receiver DC Measurements

Note: All voltages are negative with respect to Pos. 45V. (TP206).

TEST POINT	STANDBY (No Signal)			WITH 125 M.V. INPUT		
TP201	35-38			35-38		
TP202	0			0		
TP203	11-12			11-12		
TP204	< 0.5			2-3		
TP205	18-22			18-22		
TRANSISTOR	**E***	**B***	**C***	**E***	**B***	**C***
Q201	36.5	37	42.0	36.5	36	42.0
Q202	36.5	37.5	43.0	36.0	35.5	43.0
Q203	<0.5	0	18.0	<0.5	0	18.0
Q204	2.1	2.75	18.0	2.7	2.9	18.0
Q205	2.2	2.8	18.0	2.5	2.7	18.0
Q206	2.2	2.8	11.0	2.6	2.8	11.5
Q207	<0.5	<0.5	22.0	2.0	2.2	5.0
Q208	<0.5	<0.5	44.0	11.7	2.0	2.0

*E – Emitter, B – Base, C – Collector
All voltages read with dc vacuum-tube voltmeter.
<0.5 means "less than 0.5V."

TABLE II

Receiver RF Measurements

Note: Taken with 100 kHz receiver filter, 0.125-volt input signal, and gain control R207 at maximum. Depending on receiver frequency and transistor characteristics, the following values will vary appreciably.

TEST POINT	TYPICAL AC VOLTAGE
FL201-IN to Gnd.	0.067
FL201-OUT to Gnd.	0.04
Q203 - E to TP206	0.097
Q203 - C to TP206	0.06
Q204 - B to TP206	0.01
Q204 - C to TP206	0.09
Q205 - B to TP206	0.013
Q205 - C to TP206	1.15
Q206 - B to TP206	0.15
Q206 - C to TP206	2.5
TP202 to TP206	0.5

All voltages read with ac vacuum-tube voltmeter.

TABLE III

Transmitter DC Measurements

Note: All voltages are positive with respect to Neg. DC. (TP104). All voltages read with dc VTVM.

TEST POINT	CARRIER OFF	CARRIER ON
TP101	8.5 volts dc	8.5 volts dc
TP102	<0.5	20
TP103	<0.5	19.5
TP105	<0.5	9
TP106	44	24
TP107	44	24
TP108	45	44
TP110	0.6	0.75
TP111	0.6	0.75
TP112	0	<0.5
TP113	45	44
J101 (Front Panel)	5 ma. max.	0.6 amp.

TRAN-SISTOR	E	B	C	E	B	C
Q101	7.8	7.9	2.0	7.8	7.8	1.8
Q102	8.1	8.7	1.0	8.1	8.7	1.0
Q103	<0.5	<0.5	<0.5	20.0	20.0	9.0
Q104	0.1	0.6	45	<0.5	0.75	44
Q105	0.1	0.6	45	<0.5	0.75	44
Q106	0	<0.5	44.5	0	0.8	1.2
Q107	44.3	44.2	0	24	24	0
Q108	45.0	44.7	44.5	44.2	44.0	24.2

RECEIVER

1. Receiver Oscillator Crystal (Y201), spceify frequency, and modify A-B-C jumpers as required.
2. Receiver input filter (FL201), specify frequency.
3. Resistors F211-R238 Combination See values in Fig. 7 below internal schematic.
4. If the operating frequency is reduced, the receiver gain will probably be higher. In this case, a reduction in the setting of the i-f input control R239 will give the 125-mv. sensitivity. If the new operating frequency is higher, the receiver gain may be lower. If more than 125-mv. is required to obtain 180 ma. output, the gain can be increased by reducing the value of one or both of the resistors R218 and R224. In most cases, these resistors should fall in the range of 22 to 33 ohms.

TABLE IV

Transmitter RF Measurements

Note: "Carrier-on" voltages taken with transmitter set to 10 watts output (24.5 volts across 60 ohms). These voltages subject to variation, depending on frequency and transistor characteristics.

TEST POINT	AC VOLTAGE
T101-3 to TP104	1.5 volts, rms.
TP103 to TP102	0.2
Q103-C to TP104	1.1 ϕ
TP110 to T102-4	0.2
TP111 to T102-4	0.2
Q104-C to TP104	3.3
Q105-C to TP104	3.3
T103-4 to Gnd.	1.1
T104-1 to Gnd.	1.4
Q107-B to TP107	0.5 volts, rms.
Q108-B to TP113	0.5
Q107-C to TP107	14-16
Q108-C to TP113	14-16
T105-4 to Gnd.	105
T106-2 to Gnd.	100-160*
TP109 to Gnd.	30-50*
J102 to Gnd.	24.5

Note: T101-3 = tap 3 of Transformer T101
Q104-C = Collector of Transistor Q104
TP105 = Test Point 105

All voltages read with ac VTVM

*These values may vary considerably with frequency.

ϕ High impedance circuit. VTVM causes significant loading.

RECOMMENDED TEST EQUIPMENT

I. **Minimum Test Equipment for Installation**

a. Milliammeter 0-250 ma DC

b. 60-ohm 10-watt non-inductive resistor.

c. AC Vacuum Tube Voltmeter (VTVM) or equivalent. Voltage range 0.01 to 30 volts, frequency range 60 Hz to 330 kHz, input impedance — one megohm, minimum.

d. DC Vacuum Tube Voltmeter (VTVM) or equivalent.

Voltage Range:	0.1 to 300 volts
Input Impedance:	1.0 megohm, min.

II. **Desirable Test Equipment for Apparatus Maintenance.**

a. All items listed in I.

b. Signal Generator

Output Voltage:	up to 10 volts r.m.s.
Frequency Range:	20 to 330 kHz

c. Oscilloscope

d. Ohmmeter

e. Capacitor checker

f. Frequency counter

g. Frequency-selective voltmeter

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, replacement parts can be furnished, in most cases, to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ELECTRICAL PARTS LIST

Transmitter Section

SYMBOL	RATING	STYLE NUMBER
C101	0.1 mfd, 200 V. DC	187A624H01
C102	.005 mfd, 300 V. DC	187A694H29
C103	180 pf. 500 V. DC	187A695H29
C104	0.25 mfd, 200 V. DC	187A624H02
C105	0.25 mfd, 200 V. DC	187A624H02
C106	0.25 mfd, 200 V. DC	187A624H02
C107	0.25 mfd, 200 V. DC	187A624H02
C108	0.50 mfd, 200 V. DC	187A624H03
C109	0.25 mfd, 200 V. DC	187A624H02
C110	0.25 mfd, 200 V. DC	187A624H02
† C111	(See Table Below)	–
C112	39 pfd, 500 V. DC	187A695H12
† C113	(See Table Below)	–
C114	100 pf. 500 V. DC	187A695H23
C115	100 pf. 500 V. DC	187A695H23
C116	0.001 mfd, 500 V. DC.	187A694H11
CA	Part of FL101	Vary with Frequency
CB, CC, CD, CE	Part of FL102	Vary with Frequency
† FREQ.	C111, C113	Style Number
30 - 50 **kHz**	0.47 mfd, 400 V. DC	188A293H01
50.5- 75 **kHz**	0.22 mfd, 400 V. DC	188A293H02
75.5-100 **kHz**	0.15 mfd, 400 V. DC	188A293H03
100.5-150 **kHz**	0.1 mfd, 400 V. DC	188A293H04
150.5-300 **kHz**	0.047 mfd, 400 V. DC	188A293H05
D101	1N457A	184A855H07
D103	1N4818	188A342H06
D104	1N4818	188A342H06
D105	1N4818	188A342H06
D106	1N4818	188A342H06
G101	Type RVS Arrester	877A124H01
J101	Closed Circuit Jack	187A606H01
J102	Banana Plug Jack	2 of 185A431H01
J103	Coaxial Cable Jack	187A633H01
J104	24-Term Receptacle	187A669H01
J105	12-Term Receptable	629A205H02

ELECTRICAL PARTS LIST

Transmitter Section (Cont.)

SYMBOL	RATING	STYLE NUMBER
L101	Part of FL101	
L102	FL102 Trap Coil (2nd Harmonic)	Vary with Frequency
L103	FL102 Trap Coil (3rd Harmonic)	Vary with Frequency
L104	400 mh.	292B096G01
L105	FL102 Coil (part of series-resonant circuit tuned to fundamental freq.)	Vary with Frequency
L106	2.0 mh.	✪ 3500A27H01
Q101	2N2905A	762A672H10
Q102	2N2905A	762A672H10
Q103	2N525	184A638H13
Q104	2N3712	762A672H07
Q105	2N3712	762A672H07
Q106	TI-481	184A638H11
Q107 Q108	2N3792 – Matched Pair	187A673H16

SYMBOL	OHMS	± TOL. %	WATTS	STYLE NUMBER
R101	5,600	5	1	187A643H45
R102	2,200	10	0.5	187A641H35
R103	10,000	10	0.5	187A641H51
R104	100,000	5	0.5	187A763H75
R105	390	5	0.5	184A763H17
R106	1,200	5	0.5	184A763H29
R107	10,000	10	0.5	187A641H51
R108	100,000	5	0.5	184A763H75
R109	390	5	0.5	184A763H17
R111	1,200	5	0.5	187A763H29
R112	1 K Pot	20	0.25	629A430H02
R113	4,700	5	0.5	184A763H43
R114	10,000	10	0.5	187A641H51
R115	150	5	0.5	184A763H07
R116	100	5	0.5	184A763H03
R117	1,000 48 V. DC	5	25	1202588
	3,750 125 V. DC	5	25	1202955
	8,500 250 V. DC	5	25	1267310

ELECTRICAL PARTS LIST

Transmitter Section (Cont.)

SYMBOL	OHMS	± TOL. %	WATTS	STYLE NUMBER
R118	10,000	2	0.5	629A531H56
R119	62	2	0.5	629A531H03
R120	10,000	5	2	185A207H51
R121	10	5	2	187A683H01
R122	10	5	0.5	187A290H01
R123	10	10	0.5	187A290H01
R124	100	10	1	187A644H03
R125	1,000	10	0.5	187A641H27
R126	4,700	10	1	187A644H43
R127	10	10	0.5	187A640H01
R128	2,200	5	1	187A644H35
R129	2.7	10	0.5	184A636H14
R130	10	10	0.5	187A640H01
R131	4,700	5	1	187A644H43
R132	2.7	10	0.5	184A636H14
R133	0.27	10	1	184A636H18
R134	0.27	10	1	184A636H18
R135	3,000	10	5	188A317H01
R136	12,000	10	0.5	184A763H53
R137	15,000	10	2	187A642H55
R138	1,000	10	0.5	187A641H27
R139	1,000	10	0.5	187A641H27
R140	68	2	0.5	629A531H04
R141	30	Type 3D202 Thermistor		185A211H06
R142	25K Pot	20	1/8	629A430H15
R143	20K	2	0.5	629A531H63
R144	2 Ω	–	3W	762A679H13

SYMBOL	RATING	STYLE NUMBER
T101	10,000/400 ohms	205C043G01
T102	10,000/400 c.t.	205C043G04
T103	1930/60 ohms Lspec 633000	1962694
T104	Turns ratio, 1/0.5, Pri-/each sec.	292B526G01
T105	10/500 ohms	292B526G02
T106	500/50 - 60 - 70 ohms	292B526G03
Y101	30-300 kHz crystal per 328C083	Specify Frequency
Z101	Zener Diode 1N5357B (20 V. ± 5%)	862A288H03
Z102	Zener Diode 1N2999B (56 V. ± 5%)	629A798H04
Z103	Zener Diode 1N2999B (56 V. ± 5%)	629A798H04
Z104	Zener Diode 1N2999B (56 V. + 5%)	629A798H04

ELECTRICAL PARTS LIST

Receiver Section

SYMBOL	RATING	STYLE NUMBER
C201	0.1 mfd., 200 V. DC	187A624H01
C202	300 pf. 500 V. DC	187A695H35
C203	180 pf. 500 V. DC	187A695H29
C204	0.25 mfd., 200 V. DC	187A624H02
C205	0.25 mfd., 200 V. DC	187A624H02
C206	0.25 mfd., 200 V. DC	187A624H02
C207	0.25 mfd., 200 V. DC	187A624H02
C208	0.25 mfd., 200 V. DC	187A624H02
C209	0.25 mfd., 200 V. DC	187A624H02
C210	0.25 mfd., 200 V. DC	187A624H02
C211	0.1 mfd., 200 V. DC	187A624H01
C212	0.25 mfd., 200 V. DC	187A624H02
C213	2.0 mfd., 200 V. DC	187A624H05
C214	0.25 mfd., 200 V. DC	187A624H02
C215	39 pfd., 500 V. DC	187A695H12
D201	1N457A	184A855H07
D202	1N457A	184A855H07
D203	1N4818 ✪	188A342H06
D204	1N4818	188A342H06
FL201	Receiver Input Filter 30-300 kHz	Specify Frequency
FL202	Receiver i.f. Filter - 20 kHz (2 sections)	187A590G02
J201	Receiver Coax. Input Jack	187A638H01
J202	Closed Circuit Jack(20 MA)	187A606H01
J203	Closed Circuit Jack (200MA)	187A606H01
L201	33 mh.	187A599H02
Q201	2N2905A	762A672H10
Q202	2N2905A	762A672H10
Q203	2N2905A	762A672H10
Q204	2N2905A	762A672H10
Q205	2N2905A	762A672H10
Q206	2N2905A	762A672H10
Q207	2N3645	849A441H01
Q208	2N4903	187A673H13

ELECTRICAL PARTS LIST

Receiver Section (Cont.)

SYMBOL RESISTORS	RATING			STYLE NUMBER
	OHMS	± TOL. %	WATTS	
R201	10,000	10	0.5	187A641H51
R202	2,200	10	0.5	187A641H35
R203	10,000	10	0.5	187A641H51
R204	100,000	5	0.5	184A763H75
R205	390	5	0.5	184A763H17
R206	1,200	5	0.5	184A763H29
R207	25 K Pot.	10	2	185A086H07
R208	10,000	10	0.5	187A641H51
R209	100,000	5	0.5	184A763H75
R210	390	5	0.5	184A763H17
† R211	–	–	–	See † Note Below
R212	1 K Pot.	20	0.25	629H430H02
R213	1,200	5	0.5	184A763H29
R214	5,600	5	1	187A643H45
R215	20,000	5	0.5	184A763H58
R216	3,600	5	0.5	184A763H40
R217	620	5	0.5	184A763H22
R218	33	5	0.5	187A290H13
R219	10,000	10	0.5	187A641H51
R220	20,000	5	0.5	184A763H58
R221	300	5	0.5	184A763H14
R222	3,600	5	0.5	184A763H40
R223	620	5	0.5	184A763H22
R224	33	5	0.5	187A290H13
R225	10,000	10	0.5	187A641H51
R226	20,000	5	0.5	184A763H58
R227	300	5	0.5	184A763H14
R228	3,600	5	0.5	184A763H40
R229	620	5	0.5	184A763H22
R230	10	5	0.5	187A290H01
R231	2,000	5	0.5	184A763H34
R232	1,200	5	2	185A207H29
R233	4,700	10	2	187A642H43

† R211 - 10K - above 50 kHz — S#187A641H51
22K - 30-50 kHz — S#187A641H59

ELECTRICAL PARTS LIST
Receiver Section (Cont.)

SYMBOL	OHMS	RATING ± TOL. %	RATING WATTS	STYLE NUMBER
R234	5,100	5	0.5	184A763H44
R235	1,500	5	0.5	184A763H21
R236	4,700	10	1	187A644H43
R237	170	5	40	1336074
† R238	–	–	–	See † Note Below
R239	1 K Pot.	20	0.25	629A430H02
R240	50	Sensistor	0.25	187A685H08
R280	56	5	0.5	187A290H19
T201	10,000/10,000 Ohms			714B677G01
T202	10,000/400 Ohms			205C043G01
T203	25,000/300 Ohms			205C043G03
Y201	50-320 kHz Crystal per 328C083			Specify Frequency
Z201	1N3027B (20 V. ± 5%)			184A449H07
Z202	1N1789 (56 V. ± 10%)			584C434H08

Power Supply Section

SYMBOL	FUNCTION	DESCRIPTION OR RATING	STYLE NUMBER
C1	(+) to (–) bypass	0.45 mfd. 330 V. AC	1723408
C2	AC grounding	0.5 mfd. 1500 V. DC	1877962
C3	AC grounding	0.5 mfd. 1500 V. DC	1877962
F1, F2	Overload Protection	1.5a, 48/125 V. DC	11D9195H26 ✪
F1, F2	Overload Protection	2.0a. 250 V. DC	478067
PL1	Neon Pilot Light 125/250 Volts	120 Volts	183A955H01
PL1	Filament-type for 48 Volts	55 Volts	187A133H02
Q1	Series Regulator	*Type 2N6259 Silicon Transistor	3503A41H01
R1	125V { Series dropping	26.5 ohms, 3½"	04D1299H44
R2	125V { Series dropping	Same as R1	04D1299H44
R3	125V { Current limiting	500 ohms,. 3½"	1268047
	48V { For 48 V. DC, R1 = R2 = 0	–	–
	48V { R3 = 26.5 ohms	3½"	04D1299H44
R4	Current Limiting	100K, 0.5 watt	184A763H75
SW1	Power Switch	3a, 250 V. AC-DC 6a, 125 V. AC-DC	880A357H01
SW101	Carrier Test	Same as SW1	880A357H01
TP1	Test Point (+)	Pin Jack – red	187A332H01
TP2	Test Point (–)	Pin Jack – black	187A332H02
Z1	Voltage Regulator	1N2828B (45 V.)	184A854H06
Z2	Surge Protection	1N3009A (130 V.) Zener Diodes	184A617H12
Z3	Voltage reg. for 250 V.	1N2813B (15 V.)	184A854H11

† R238 - omit above 50 kHz – 23K, 30-50 kHz, S#187A641H59

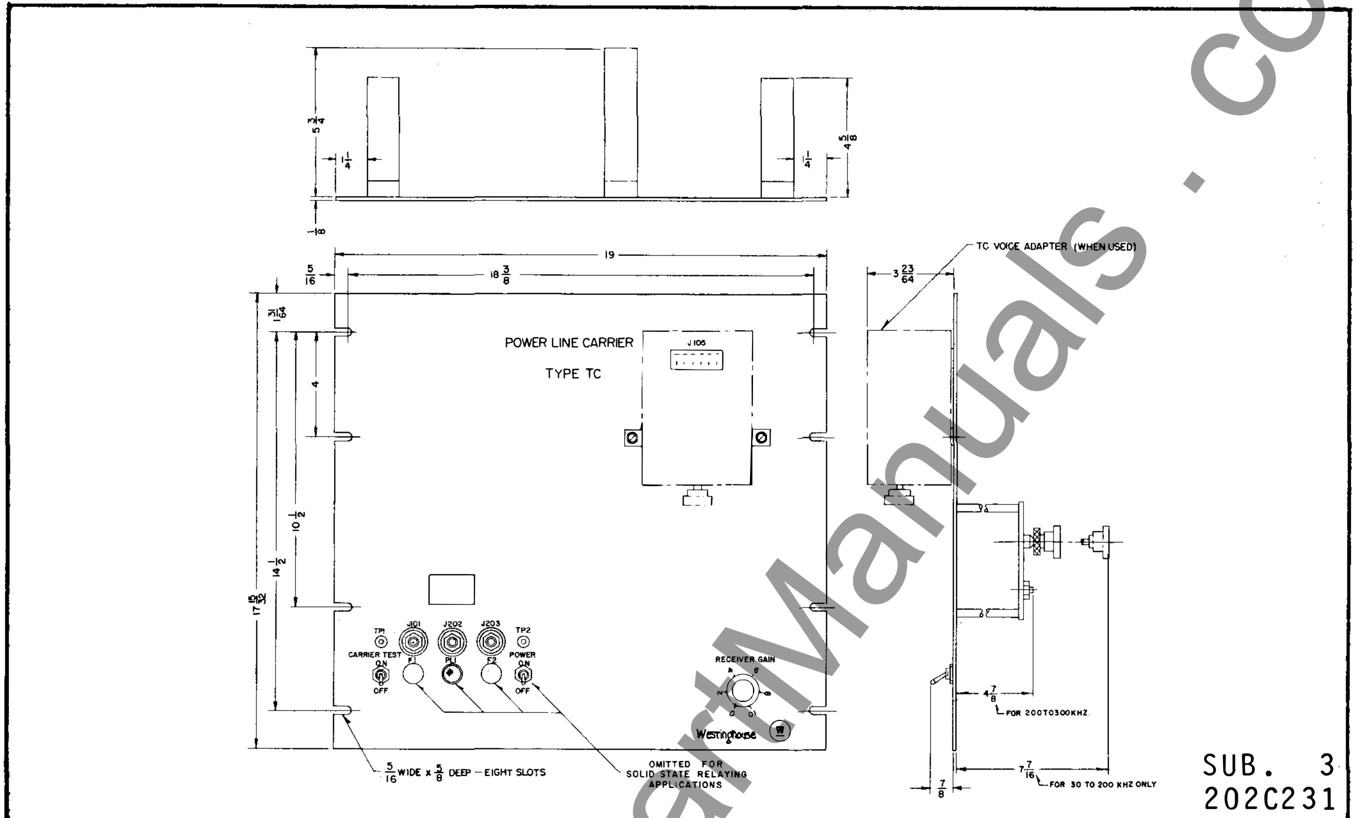


Fig. 1. Type TC Carrier Assembly – Outline

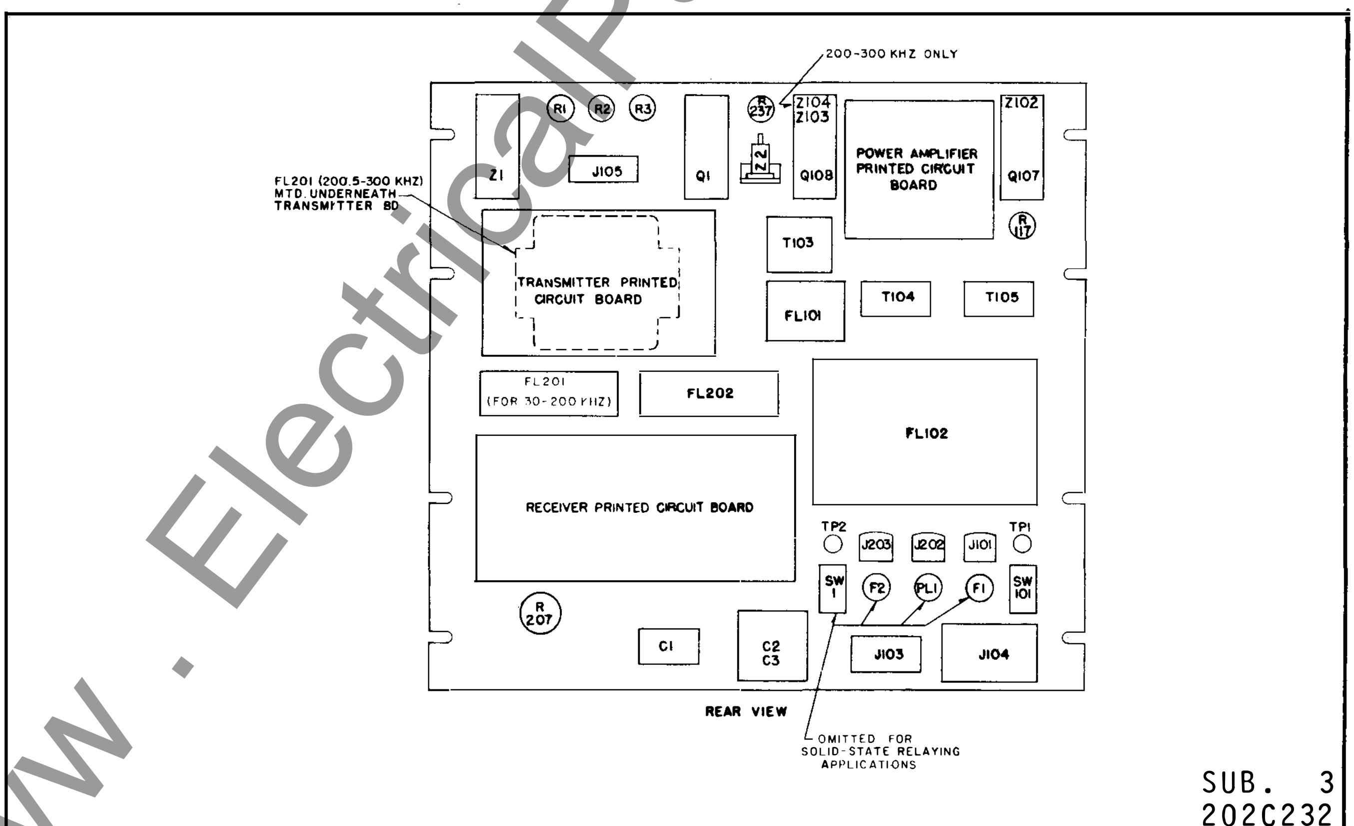


Fig. 2. Type TC Carrier Assembly – Parts Location

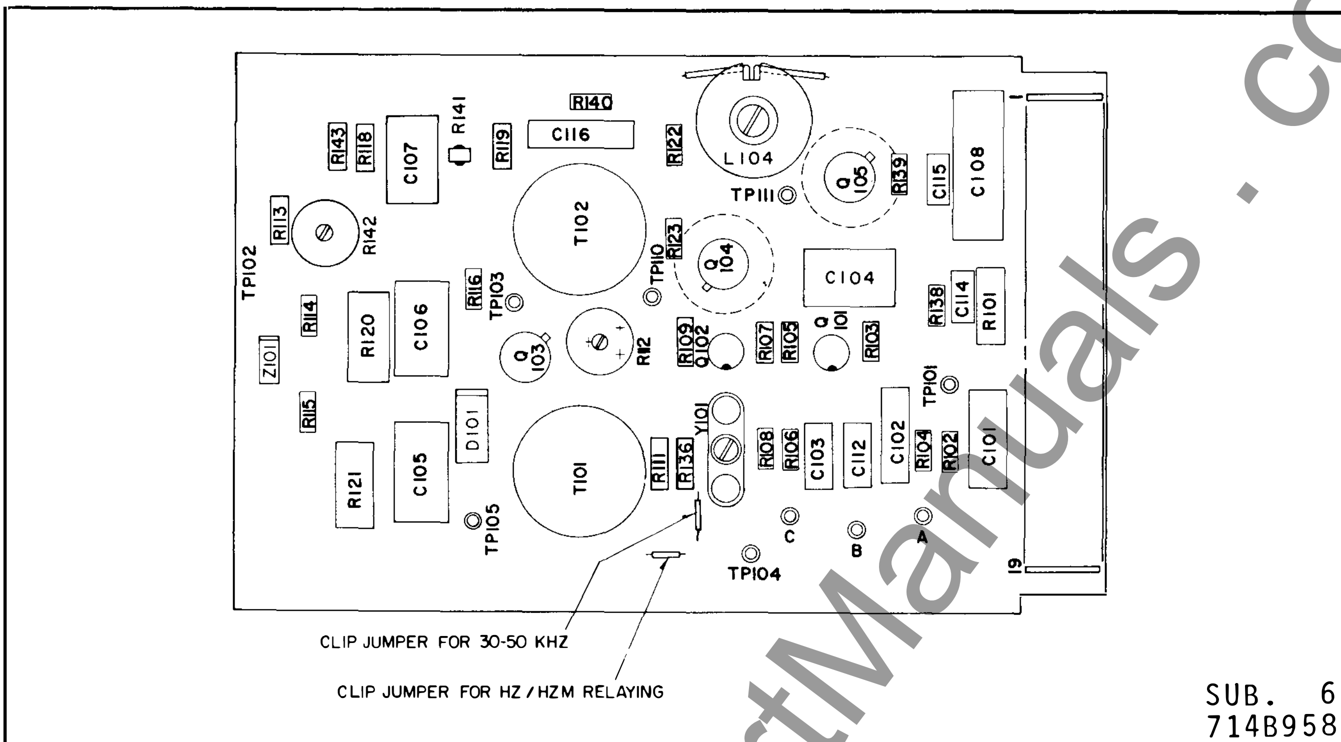


Fig. 3. Transmitter Printed Circuit – Parts Location

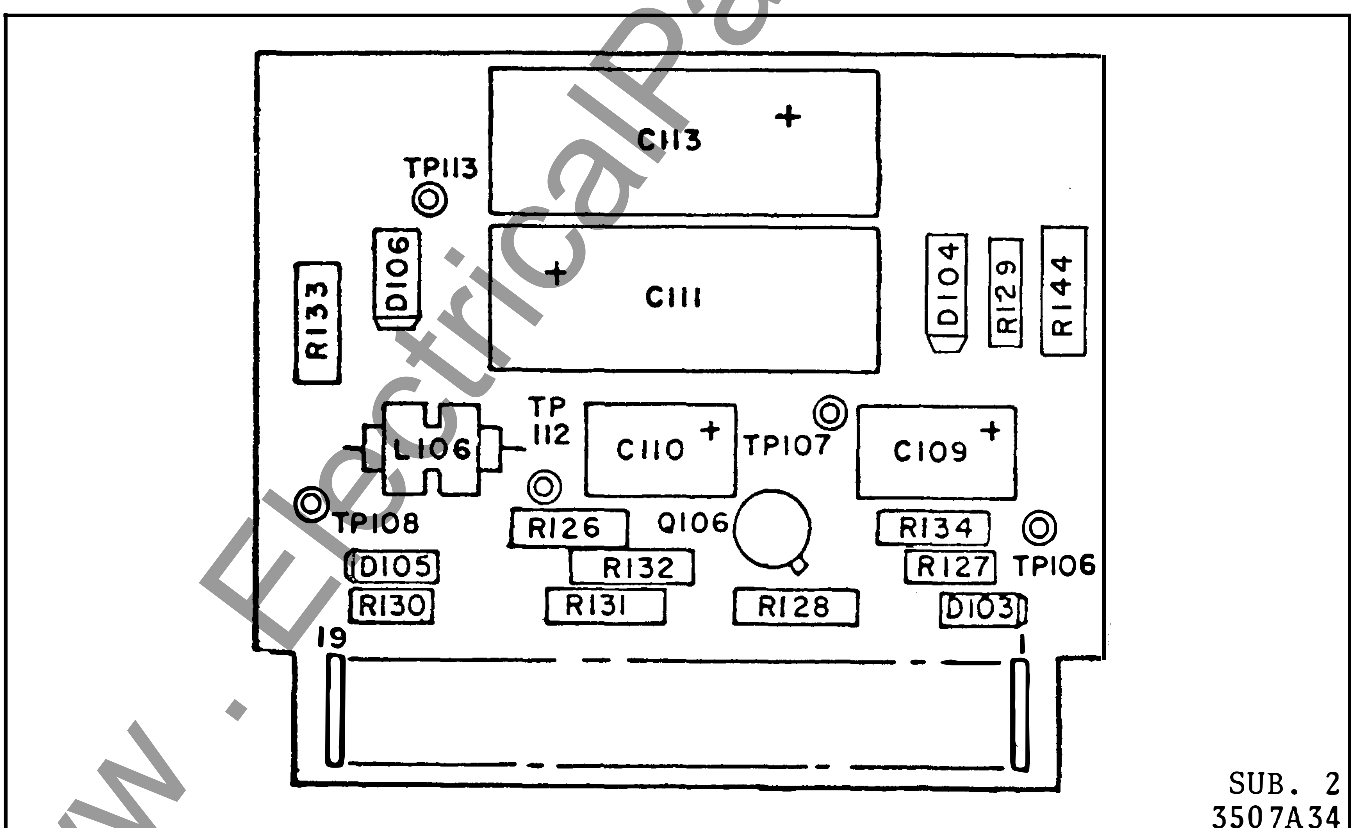


Fig. 4. Power Amplifier Printed Circuit – Parts Location

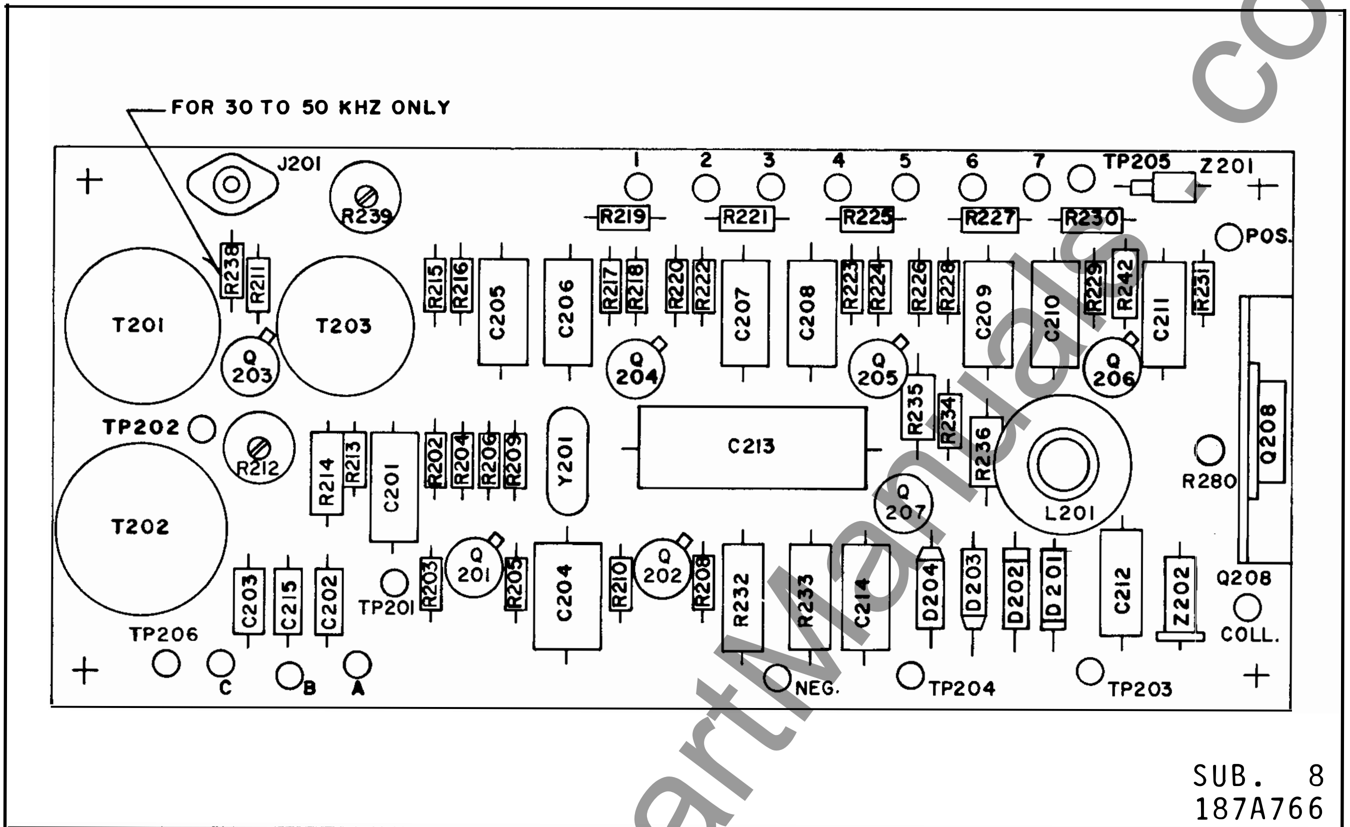


Fig. 5. Receiver Printed Circuit – Parts Location

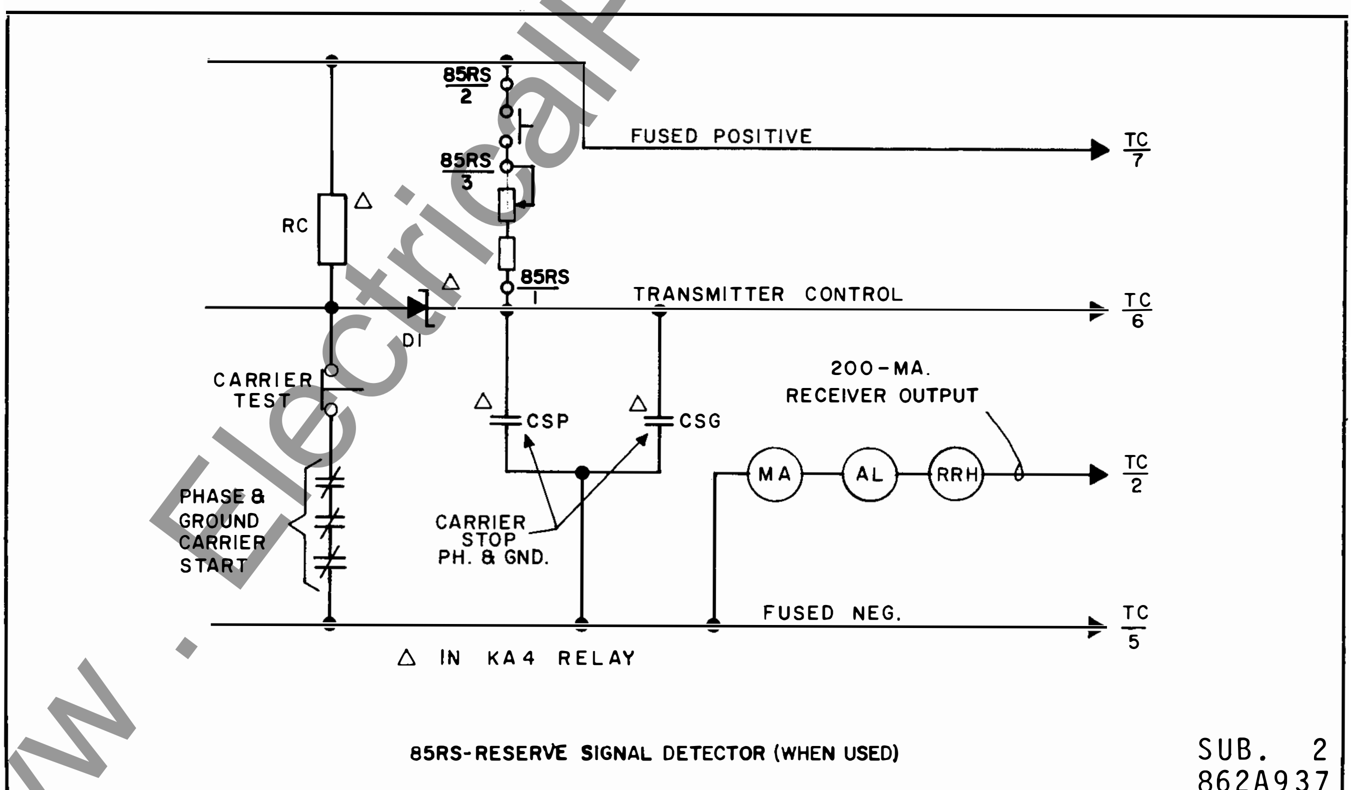


Fig. 6. Elementary K-Dar Carrier Control Circuits.

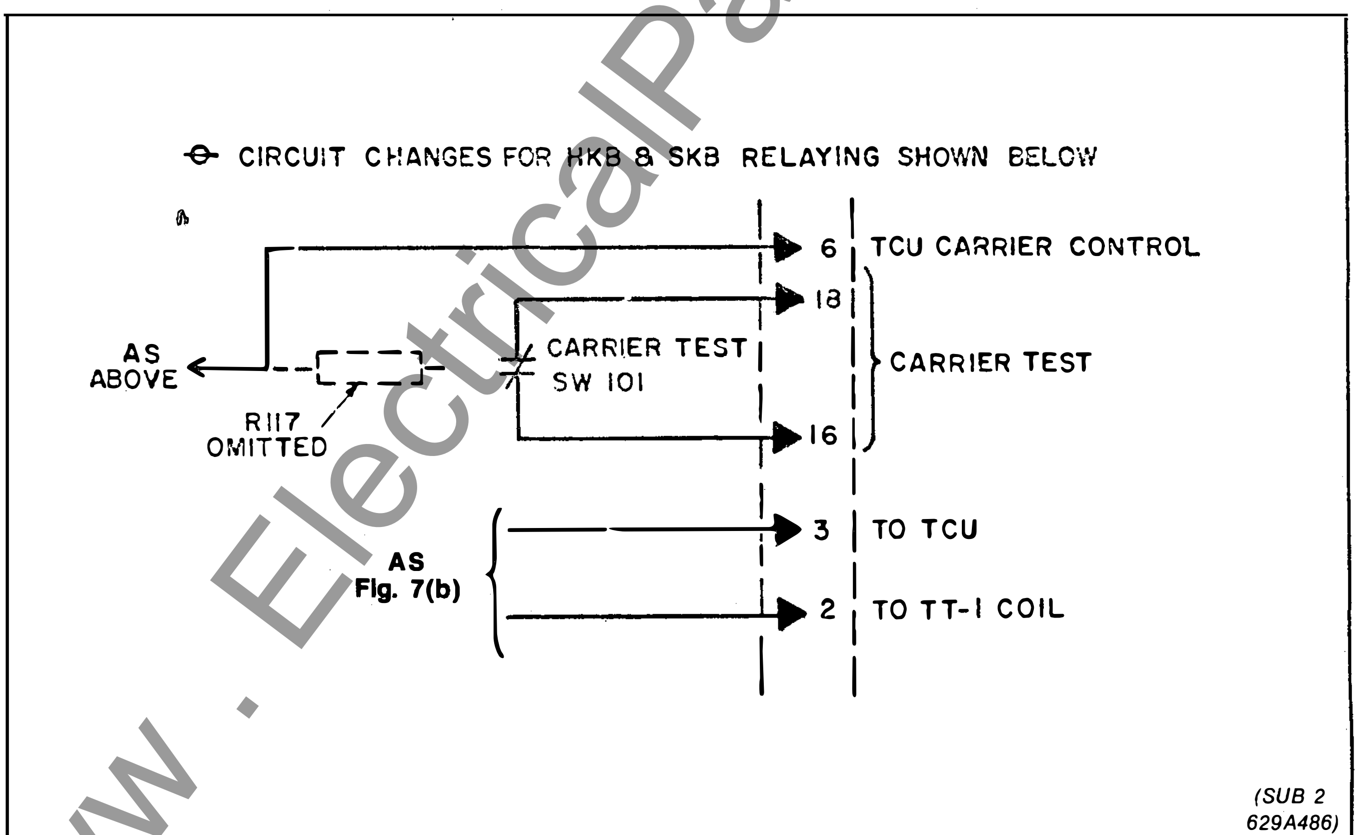


Fig. 7(a) TC Carrier Assembly for HKB & SKB Relaying – Internal Schematic. Use with Figure 7(b) Dwg. 6692D89-Sub 5.

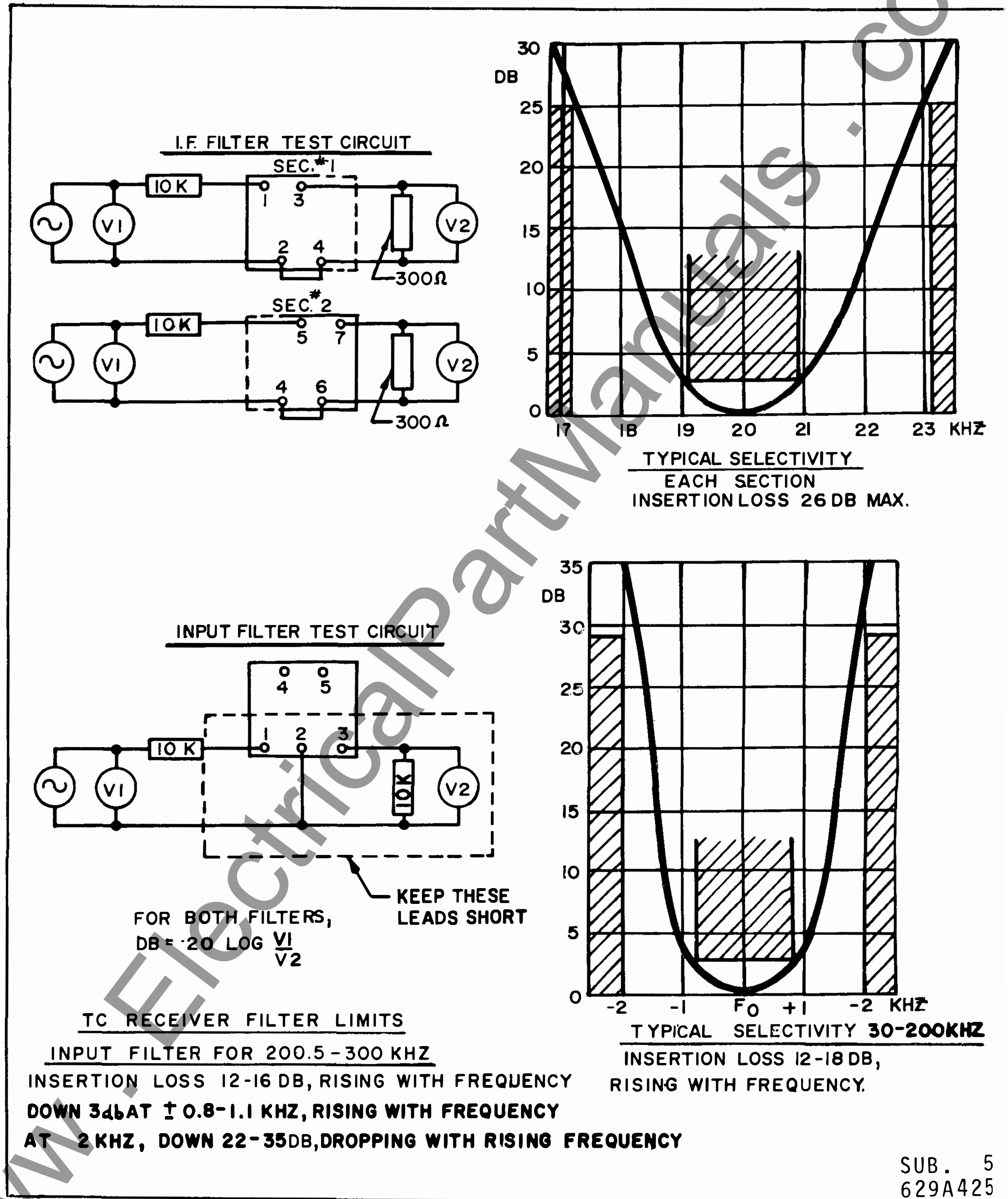


Fig. 8. Type TC Receiver Filter Characteristics

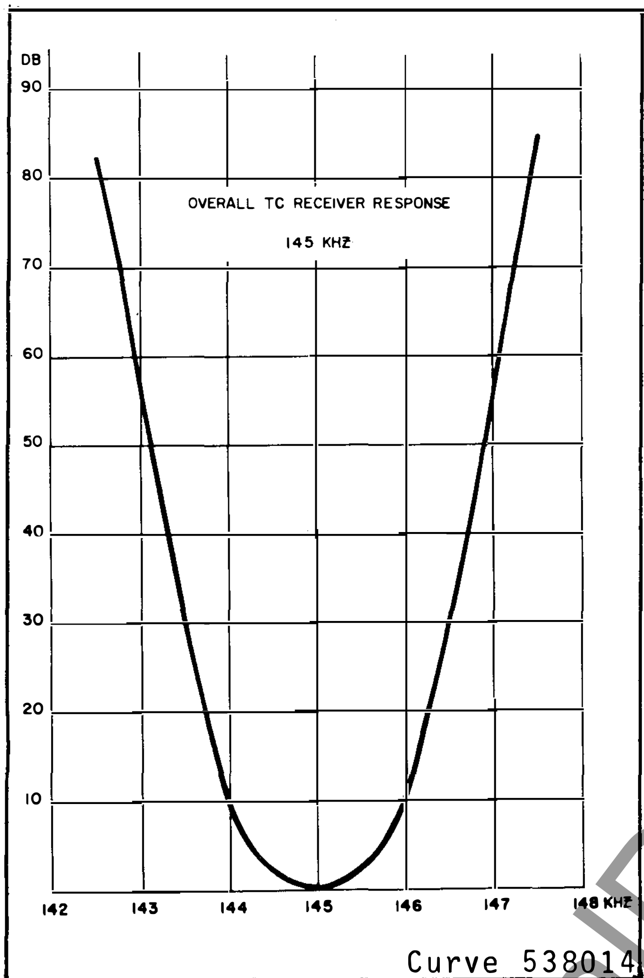


Fig. 9. Type TC Overall Selectivity Curve

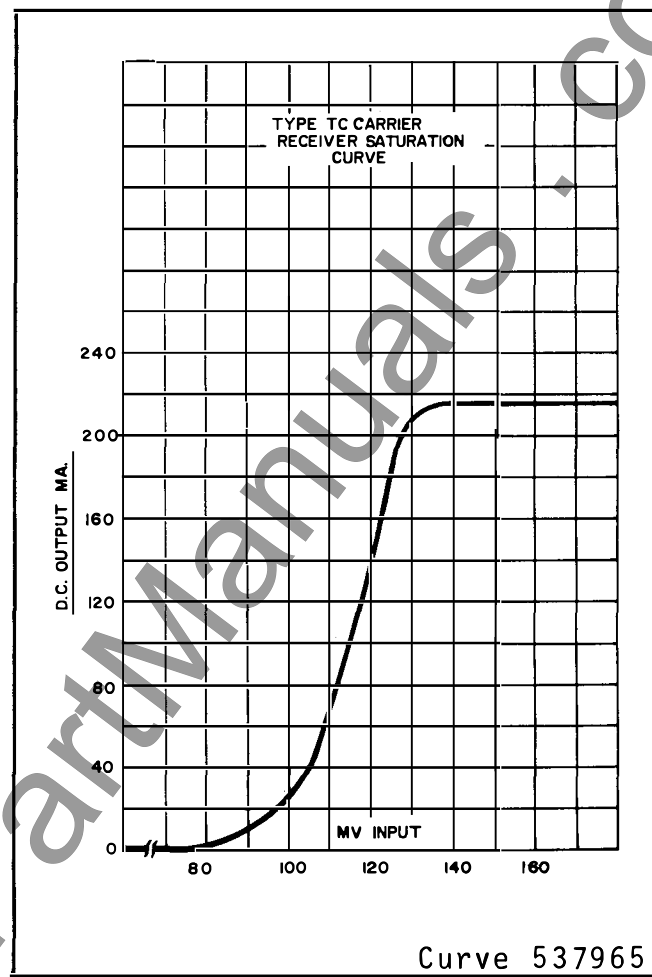


Fig. 10. Type TC Receiver - 200 ma. Output Characteristic.

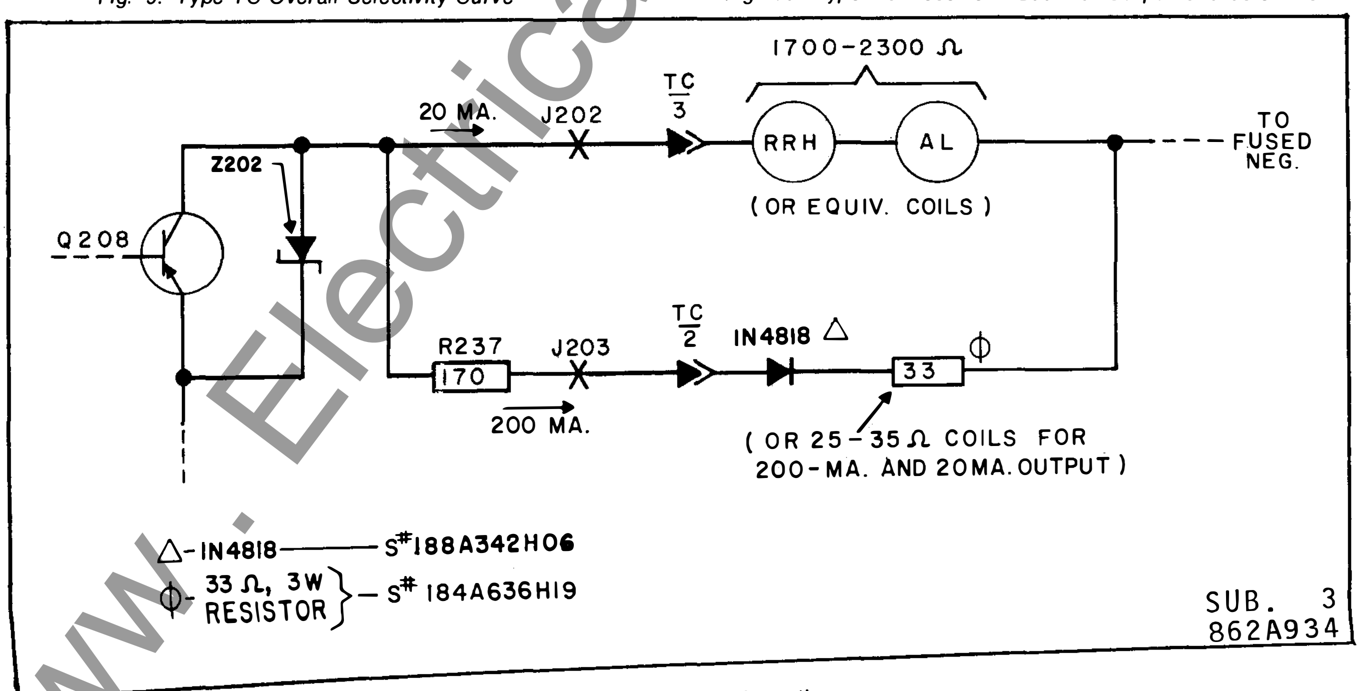


Fig. 11. TC Receiver Output For 20-ma. Operation

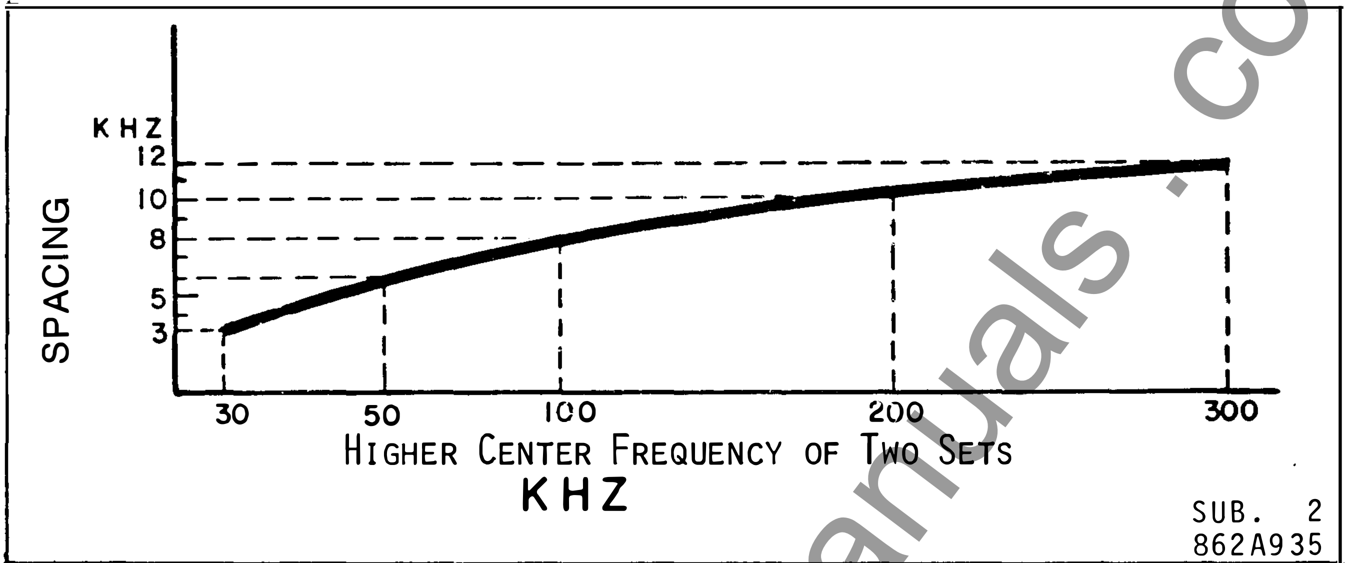


Fig. 12. Minimum Frequency Spacing for Two 10-Watt Transmitters Operated in Parallel.

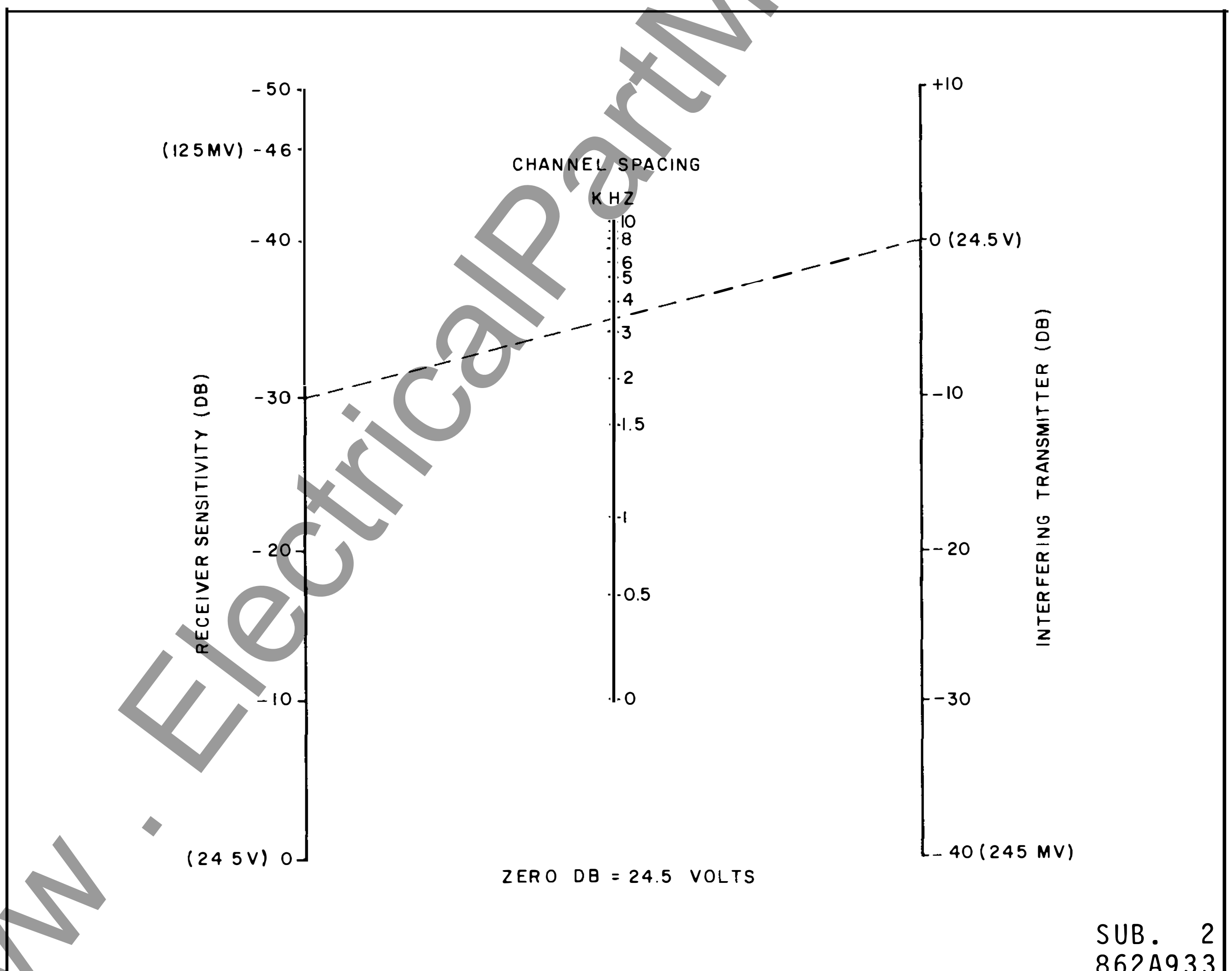


Fig. 13. Minimum Channel Spacing for Keyed Carrier 60 p.p.s.

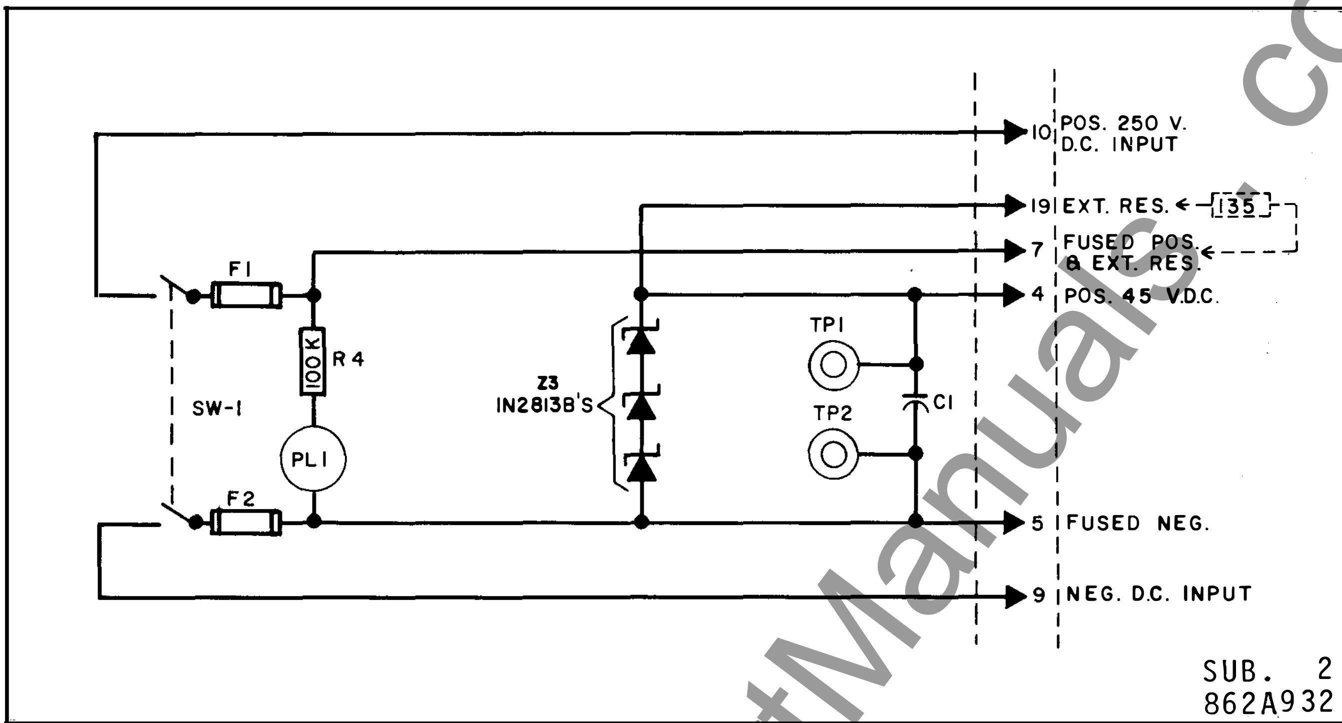


Fig. 14. Detail of Power Supply Section For 250-Volt Supply

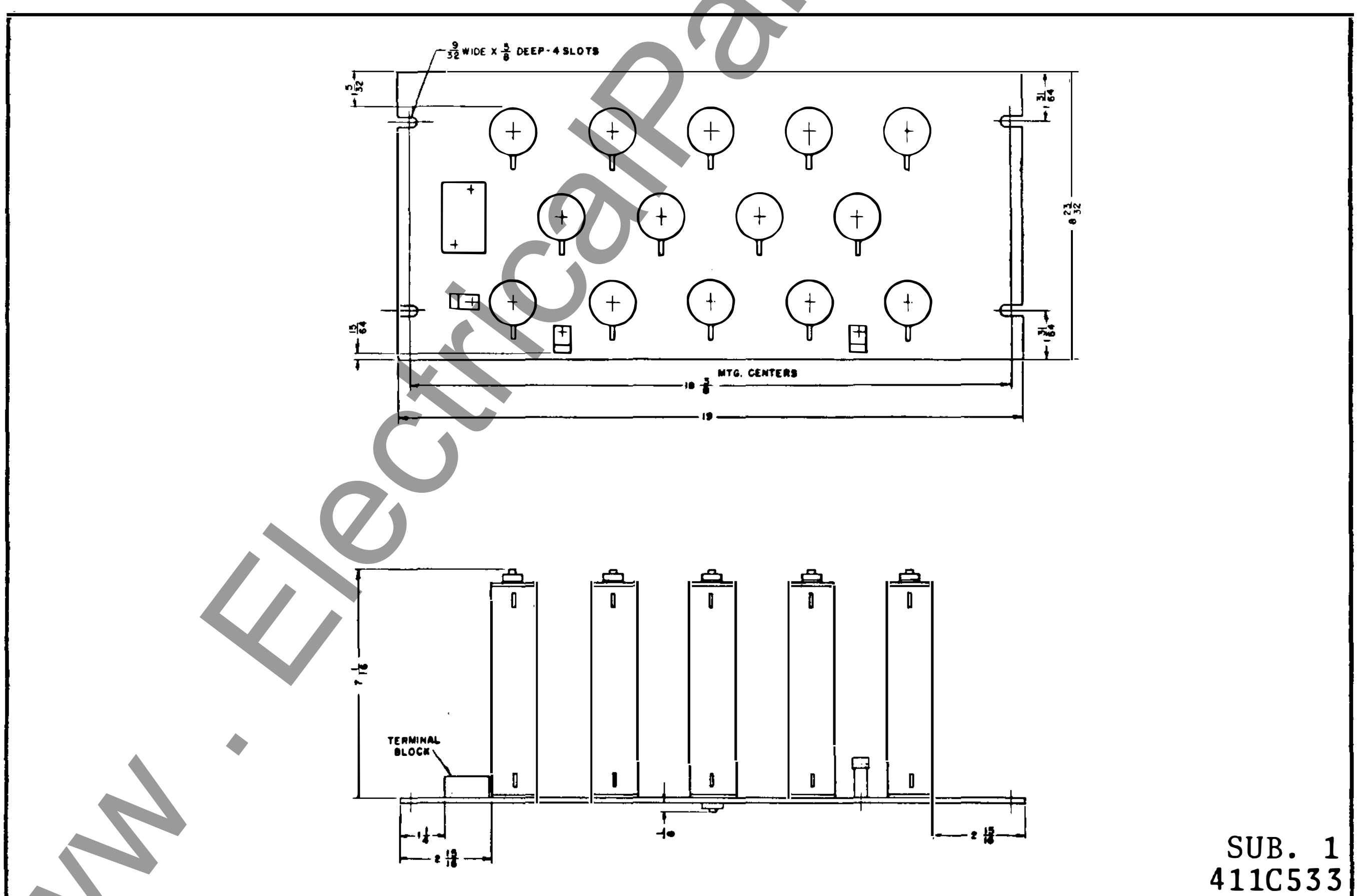


Fig. 15. Outline of External Resistor Unit for 250-volt Operation.

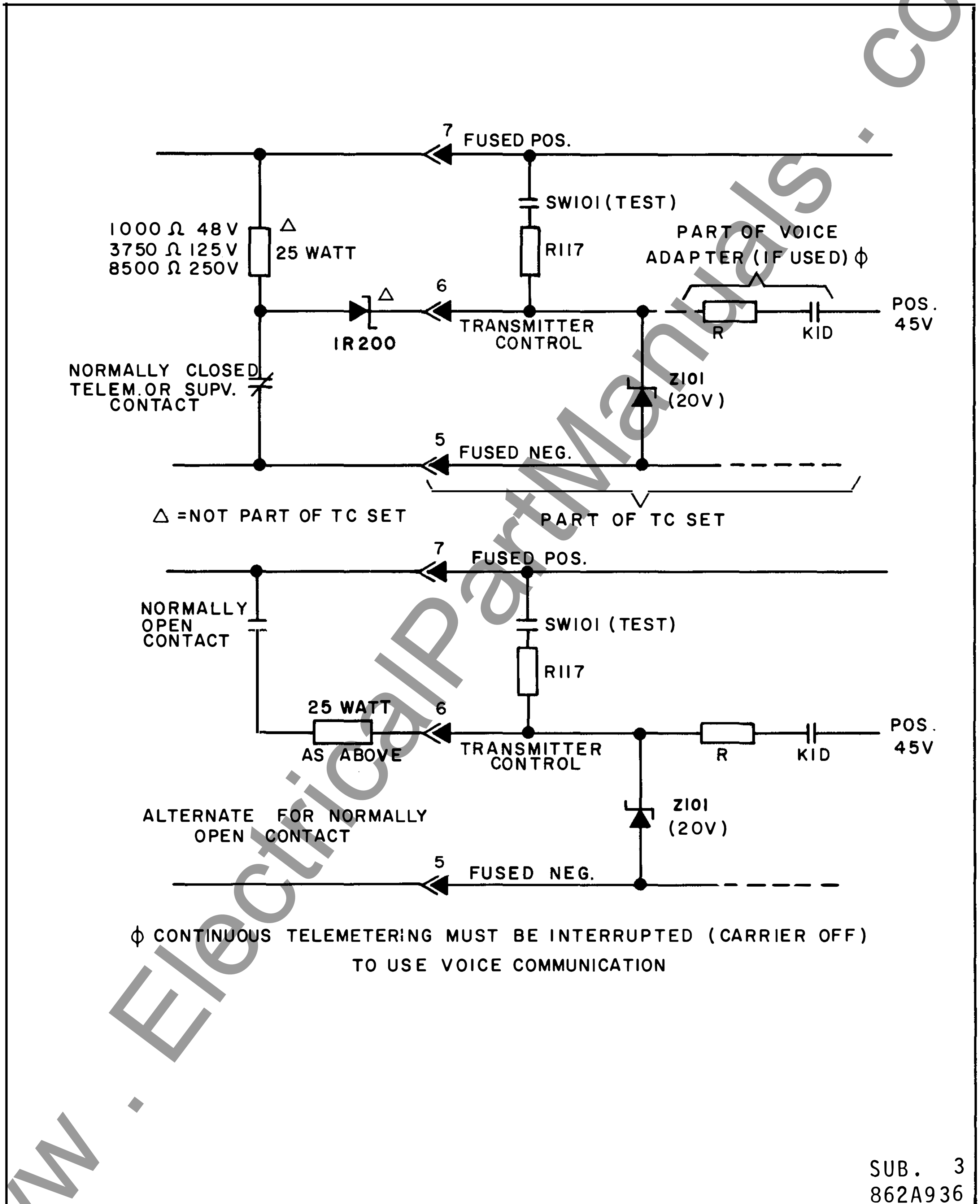


Fig. 16. External Circuitry For On-Off Keying of Type TC Transmitter For Telemetering or Supervisory Control (Without Protective Relaying) From Either Normally-Closed or Normally-Open Contact.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **CORAL SPRINGS, FL.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TC POWER LINE CARRIER TRANSMITTER-RECEIVER ASSEMBLY FOR USE WITH SOLID-STATE RELAYING SYSTEMS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-944.32A

✪ **Denotes change from superseded issue.**

EFFECTIVE JUNE 1976

CAUTION

It is recommended that the user of this equipment become thoroughly acquainted with the information in this instruction leaflet before energizing the carrier assembly. Failure to observe this precaution may result in damage to the equipment.

If the carrier set is mounted in a cabinet, it must be bolted down to the floor or otherwise secured before swinging out the equipment rack to prevent its tipping over.

APPLICATION

The type TC carrier equipment covered by these instructions is designed for use with solid-state relaying systems for transmission line protection. It can also be used for maintenance communication between terminals of a line section.

CONSTRUCTION

The transmitter-receiver unit consists of a standard 19-inch wide panel 17½ inches (10 rack units) high. The panel is notched for mounting on a standard relay rack. All components are mounted on the rear of the panel. Metering jacks, a test switch, and the receiver gain control are accessible from the front of the panel. See Fig. 1. The circuitry is divided into several sub-assemblies as shown in Figure 2. The components mounted on each printed circuit board or other sub-assembly are shown enclosed by dotted lines on the internal schematic, Fig. 8. The location of components on the five printed circuit boards are shown on separate illustrations, Figures 3 through 7.

External connections to the assembly are made through a 24-circuit receptacle J104. The r-f output connection to the assembly is made through a coaxial cable jack J103. When voice communication is used, the voice adapter plugs into receptacle J105 on the front panel.

The receiver gain control R207 is accessible from the front of the panel. In addition, three current jacks are provided for measuring the following quantities.

J101 – Transmitter power-amplifier collector current.

J202 – Receiver CLI 0-3 ma. output current.

J203 – Receiver 200-ma. output current.

The receiver filter input resistor R201 is connected directly to term. #1 of FL201 and is covered with insulating sleeving.

OPERATION

Transmitter

The transmitter is made up of four main stages and two filters. The stages include a crystal oscillator, buffer-amplifier, driver, and power amplifier. With reference to internal schematic, Fig. 8, the oscillator crystal serves as a series-resonant circuit between the collector of Q101 and the base of Q102. The output of Q102 is fed back through capacitors C102, C103, and C112 to the base input of Q101, thus providing oscillation at the crystal frequency. The frequency is essentially independent of voltage or temperature changes of the transistors. Thus the frequency stability is that of the crystal itself.

The oscillator output energizes the buffer-amplifier transistor Q103 through the potentiometer R112 which controls the transmitter power output. Keying of the transmitter output is controlled in the buffer-amplifier stage by changing the d-c potential supplied to Q103 emitter circuit. This is accomplished in the two buffered-input keying circuits (transistors Q151-152 and Q153-154-155 and associated components). Normally Q152 is conducting, causing a flow of current from positive 45 v.d.c. through R117 and transistor Q152 to negative. When a d-c voltage is applied to carrier-start terminal 6 or 7 (of J104), transistor Q151 is turned on which in turn switches transistor Q152 to a non-conducting state. Then the path from pos. 45 v.d.c. goes through R117, diodes Z159 and D151, then up to the transmitter board through Zener diode Z101 to negative. The 20-volt d-c potential across Z101 supplies voltage to transistor Q103, causing transmission of carrier. Note that operation of carrier test switch SW101 applies positive 20 v.d.c. to J104 terminal 6 circuit and similarly allows the transmission of carrier.

When carrier is being transmitted for any reason, a carrier-stop request from the protective relays takes preference over any carrier-start operation. When a d-c voltage is applied to J104 terminal 8 or 9, transistor Q154 turns on, Q155 turns off, and Q153 turns on which connects the transmitter keying circuit back to negative d.c. thus stopping carrier. If carrier is started through the Voice Adapter, the diode D151 isolates the d-c carrier-start voltage from negative (through Z159, and Q152 which is normally conducting). The zener diode Z159 prevents the small forward voltage across D151 and Q153 from causing a small amount of carrier transmission under standby conditions.

The buffer output energizes the driver stage which operates class B. When voice modulation is used, the transmitter modulating voltage is applied to the base-emitter circuit of transistors Q104 and Q105.

The output of the driver stage passes through filter FL101, then to the input transformer T104 of the power amplifier stage. Filter FL101 improves the waveform of the signal applied to the power amplifier. This stage uses two series-connected type 2N 3792 power transistors, Q107 and Q108, operating as a class-B push-pull amplifier with single-ended output. Transistor Q106 applies forward base bias to Q107 and Q108 when the carrier start circuit is energized. Diodes D103 and D105 provide protection for the base-emitter junction of the power transistors. Zener diodes Z102 and Z103 protect the collector-emitter junctions from surges which might come in from the power line through the coaxial cable.

The output transformer T105 couples the power transistors to the transmitter output filter FL102. The output filter includes two trap circuits (L102, C_B, and L103, C_C) which are factory tuned to the second and third harmonics of the transmitter frequency. Capacitor C_D approximately cancels the inductive reactance of the two trap circuits at the operating frequency. Protective gap G101 is a small lightning arrester to limit the magnitude of switching surges or other line disturbances reaching the carrier set through the line tuner and coaxial cable. Auto-transformer T106 matches the filter impedance to coaxial cables of 50, 60, or 70 ohms characteristic impedance.

The series-resonant circuit composed of L105 and C_E is tuned to the transmitter frequency, and aids in providing resistive termination for the output stage as well as attenuation for higher order harmonics. Jack J102 is mounted on the rear panel of FL102 and is used for measuring the r.f. output current of the transmitter into the coaxial cable. It should be noted that the filter contains no shunt reactive elements, resulting in a reverse impedance free of possible "across-the-line" resonances.

Receiver

The receiver is a superheterodyne type to facilitate obtaining constant bandwidth regardless of the channel frequency. The major stages include an input filter, attenuator (gain control), crystal oscillator, mixer, i.f. filters and i.f. amplifiers, diode detector, d-c amplifier, and d-c power output stage.

The fixed input filter rejects undesired signals while accepting a wide enough band of frequencies to assure fast operation. The receiver sensitivity is adjusted by means of the continuously variable input control R207. The receiver oscillator (Q201 and Q202) is basically the same as the transmitter oscillator. The oscillator frequency is 20 kHz above the incoming signal frequency. The receiver channel frequency is determined by the input filter and the oscillator crystal.

Mixing is accomplished by feeding the incoming signal to the emitter, and the receiver oscillator signal to the base of the mixer Q203. Mixer oscillator requirements are met through adjustment of potentiometer R212. Injection into two separate elements, base and emitter, provides a circuit capable of handling greater signal level variations than one in which injection is made into only a single element such as the base. This receiver uses an intermediate frequency of 20 kHz. Typical characteristics of both filters and the complete receiver are shown on curves, Fig. 9 and 10.

The 20-kHz i.f. signal is rectified by diodes D201 and D202. The resulting d-c output is amplified by transistors Q207 and Q208, giving a receiver output current of nominally 200 ma. for a 30-ohm external alarm relay coil circuit. Fig. 11 shows the receiver 200-ma. output characteristic.

NOTE: For all applications, an alarm relay or equivalant resistive load (30-35 ohms, 3 watt) must be connected to the receiver 200-ma. output circuit.

For solid-state relaying applications, the receiver also has a 20-volt d-c buffered output (transistors Q253 and Q254 on receiver CLI and output board). At an input signal level that would give about 100-ma. output current, the receiver 20-volt output will appear at J104 terminal 18.

To provide a more accurate indication of received signal level, a carrier level indicator (CLI) is provided on the receiver auxiliary circuit board. This device includes a sensitivity adjustment (R252), two amplifier stages (Q251 and Q252), and a diode detector. The filtered output of the detector is brought out through J202 to J104 terminals 16 and 17 for connection to an external 0-3 d-c milliameter. A typical CLI curve of output milliamperes vs. receiver input signal margin is shown in Fig. 12.

Power Supply

The power supply circuit for 48 or 125-v.d-c supply uses a series-type transistorized d-c voltage regulator which has a very low standby current drain when there is no output current demand. The zener diode Z1 holds a constant base-to-negative voltage on the series-connected power transistor Q1. Depending on the local current, the d-c voltage drop through the transistor Q1 and resistors R1 and R2 varies to maintain a constant output voltage of approximately 45-v. d-c. The zener diode Z2 serves to protect the collector-base junction of Q1 from surge voltages. Capacitor C1 provides a low carrier-frequency impedance across the d-c output voltage. Capacitors C2 and C3 bypass r.f. or transient voltages to ground, thus preventing damage to the transistor circuits. Inductance L1 and capacitor C4 serve as a filter to prevent any appreciable carrier-frequency energy from getting onto the external d.c. supply circuits.

For a 250-volt d-c supply, the circuit of Figure 15 is used. This consists of an external voltage-dropping resistor assembly (135 ohms total) in conjunction with three 15-volt Zener diodes on the TC set chassis connected in series. The resistor assembly (see Figure 16) must be mounted at the top of a cabinet or an open rack. Because of the heat dissipated, no transistorized equipment should be mounted above the resistor panel. The 250-volt TC set has a constant current drain of 1.5 amperes d-c.

Relaying Control Circuits

The transmitter start and stop control circuits and the receiver 20-volt output (previously described) allow this type TC set to be used with solid-state protective and auxiliary relays which also have 20-volt input and output "logic". In addition, these carrier control circuits are designed to absorb and limit externally generated surges so they will not damage the transistors or associated components.

For flexibility in application, provision is also made for keying the transmitter from either 48 or 125 volts d.c. Also, the 200-ma receiver output circuit is brought out to a J104 terminal for connection to a 30-ohm alarm relay, if desired.

CHARACTERISTICS

Frequency range	30-300 kHz (50-300 kHz for phase comparison relaying)
Transmitter output	10 watts into 50 to 70-ohm resistive load
Harmonics	55 db below 10 watts.
Receiver sensitivity	125 mv. input for 180 ma. minimum output current
Receiver selectivity	1500 Hz bandwidth (3 db down); down 80 db at ± 3kHz.
Transmitter-receiver channel rating	40 db
Input Voltage	48, 125, or 250 V. d-c
Supply voltage variation	42-56V, 105-140V, 210-280V
Battery Drain: 48 V.D.C.	0.5 amp standby, 1.35 amp transmitting
125 V.D.C.	0.25 amp standby, 1.1 amp transmitting
250 V.D.C.	1.5 amp standby or transmitting
Temperature range	−20 to +60°C. around chassis.

Frequency Spacing

The minimum recommended frequency spacing between two Type TC carrier sets operated in parallel without hybrid units is shown on the curve of Fig. 13. For example, at 100 kHz. the minimum spacing is 8 kHz. Closer spacing would result in the generation of intermodulation products caused by the non-linear load presented by each transmitter to the other one.

The minimum frequency spacing between a TC carrier channel and an adjacent transmitter signal keyed on-off at a rate of 60 pulses per second can be determined from the nomograph of Fig. 14. Using the example shown by the dashed line, consider a type TC set used on a channel with a normal attenuation of 15 decibels. The TC receiver would be set to give a margin of 15 db below the normal received signal, or for a sensitivity of −30 db (relative to a 24.5 volt, 10-watt signal). The interfering signal is assumed to be a 10-watt transmitter at the same location. To determine the minimum frequency spacing of the TC receiver from this interfering signal, lay a straight edge between the −30 db point on the receiver sensitivity scale and the zero-db point on the interfering transmitter scale. The resulting line crosses the channel spacing scale between 3 and 4 kHz. For this example, a channel spacing of at least 4 kHz should be used. (In order not to conflict with the limits of Fig. 13, an r-f hybrid may be needed between the TC set and the other transmitter, depending on the actual application.)

For protective relaying applications to 3-terminal lines, the transmitter frequencies are offset 100 hertz to prevent a slow beat or cancellation of the received signal when two transmitters send blocking signals to the third terminal. The three transmitters operate at fc, fc + 100 Hz, and fc − 100 Hz. All receivers operate at the channel center frequency (fc).

INSTALLATION

The type TC transmitter-receiver is generally supplied in a cabinet or on a relay rack as part of a complete carrier assembly. The location must be free from dust, excessive humidity, vibration, corrosive fumes, or heat. The maximum ambient temperature around the chassis should not exceed 60°C.

ADJUSTMENTS

Transmitter

The main adjustment on the transmitter is the power output control R112 on the transmitter printed circuit board. Disconnect the coaxial cable from the assembly terminals and replace with a 50 to 70 ohm noninductive resistor of at least a 10-watt rating. Use the value of the expected input impedance of the coaxial cable and line tuner. If this is not known, assume 60 ohms. Connect the T106 output lead to the corresponding tap. Connect an a-c vacuum tube voltmeter (VTVM) across the load resistor. Turn the transmitter power output control R112 to minimum (full counterclockwise).

NOTE: Do not change the adjustment of the R142 control on the printed circuit board. See Maintenance section for R142 adjustment.

Now apply d-c power and note the d-c voltage across the two pin jacks TP1 and TP2. If this is in the range of approximately 42 to 46 volts, throw the carrier-test switch SW101 on the panel to the ON position. Slowly advance the output control R112 on the transmitter printed-circuit board until about 10 volts is obtained across the output load resistor. At this point, check the adjustment of the series output tuning coil L105 by loosening the knurled shaft-locking nut and moving the adjustable core in and out a small amount from its initial position. Leave it at the point of maximum voltage across the load resistor. For 200-300 kHz operation, L105 is a "pot core" and has a adjustable core screw. Use a screw-driver in this case. No locking device is needed.

Now continue to advance the output control R112 until the output voltage tabulated in the following table is obtained across the load resistor. Recheck the setting of L105 to be sure it is at its maximum point for 10 watts output. Tighten the locking nut. Turn off the carrier test switch SW101, remove the load resistor, and reconnect the coaxial cable circuit to the transmitter.

NOTE: For 200-300kHz sets, inductor L105 is a pot core and the foregoing adjustment check is generally unnecessary since there is little chance of its setting being disturbed. However, if desired, the pot core setting can be checked using a screwdriver to vary the setting of the adjustable core. There is no locking device as the adjustable core is held in place by friction.

T106 Tap	Voltage for 10 Watts Output
50	22.4
60	24.5
70	27.0

Transmitter Filter

Normally, the output filter (FL102) will require no readjustment except as noted under Adjustments-Transmitter, as it is factory tuned for maximum second and third harmonic rejection, and for series resonance (maximum output at the fundamental frequency) with a 60-ohm load. The adjustable cores of L102 and L103 have been set for maximum harmonic rejection at the factory, and no change should be made in these settings unless suitable instruments are available for measuring the second and third harmonic present in the transmitter output.

Follow the procedure outlined in the line tuner instructions for its adjustment.

Receiver

The receiver board has two controls; the i.f. input control R239 which is factory-set to give a sensitivity of 125 mv. for 180 ma. output, and the local oscillator output control R212. The oscillator output is preset at the factory at 0.5 volt. This setting can be checked by connecting an a-c VTVM between receiver test points TP202 and TP206 (shield lead of VTVM.) The voltmeter reading with the equipment energized, but not transmitting, should be 0.5 volt rms. Note Fig. 5 for location of components on the receiver printed board.

The other adjustment on the receiver is the gain control R207 which is front-panel mounted. It is recommended that the receiver gain normally be set for a 15-db operating margin to allow for reasonable variations in receiver input signal level without affecting the output blocking current. This adjustment can be made in two ways, as follows:

1. First, measure the normal received signal from the remote terminal (after the line tuners have been adjusted) by starting the remote transmitter and measuring the voltage across the coaxial cable at the receiving terminal. This signal should preferably be measured with a tuned voltmeter such as the Sierra carrier-frequency volt-

meter. If a simple VTVM is used, have the remote transmitter turned on and off several times to be sure the VTVM reading is actually the remote signal. Note the reading. Now disconnect the coaxial cable, and feed a signal into the carrier assembly at the coaxial terminals from a separate signal generator. Set the signal generator to the received frequency at a level 15 db below the previously measured incoming signal. With a 0-250 ma. (minimum) d-c milliammeter plugged into J203, adjust the receiver gain control until an output current of about 100 ma. is obtained. As this point is on the steep portion of the receiver output-input curve, it may be difficult to set the gain control for exactly 100 ma. This is not necessary, however, as the signal is not normally at this value. This is the operating setting of the receiver gain control. Return the coaxial cable connections to normal.

NOTE: Do not energize the local transmitter when making the foregoing adjustment as the signal generator may be damaged.

2. As an alternate procedure if no signal generator is available, the local transmitter itself may be used as the signal generator. First determine the normal received signal from the remote terminal as explained previously under (1). Then turn off the remote transmitter.

   Now turn on the local transmitter and reduce its output to a value 15 db below the normal received signal level. Then adjust the receiver gain control to give 100 ma. output as before. When this adjustment has been made, reset the local transmitter to its normal 10-watt output level.

In applications where the line attenuation is low and a strong signal is received, the adjustment of the receiver gain control R207 becomes critical. For such applications, the setting of i-f gain control R239 may be reduced to lower the overall receiver gain. The front-panel control R207 will then have a smoother and more gradual control as the knob is rotated, making it easier to obtain the 15-db margin setting.

For such a strong-signal condition, it is recommended that with R239 at maximum, the i-f gain control R237 be adjusted to give 100 ma. receiver output current for an input r-f voltage 25 db below the normal received signal level. Then the front panel control R207 is set for the normal 15-db margin as previously described.

Carrier Level Indicator (CLI)

The CLI should be adjusted on a clear dry day when line conditions are considered normal. After the receiver sensitivity has been set for a 15-db margin, turn on the remote transmitter at its normal 10-watt output. With a small screw-driver, adjust the CLI input control R252 to give a reading of 2.5 ma. on the 0-3 ma. d-c milliammeter in the CLI output circuit. This current can be read at J202 on the TC set panel for convenience. If the received signal varies for any reason, the CLI output current will change accordingly, as indicated by the curve in Fig. 12.

When carrier is transmitted from the local station, the pointer of the local CLI output milliammeter will be driven off scale. This will not in any way damage the instrument as the CLI saturation current is less than 4 ma. d.c.

MAINTENANCE

Periodic checks of the received carrier signal will indicate proper operation of the equipment. At regular maintenance intervals, any accumulated dust should be removed, particularly from the heat sinks. It is also desirable to check the transmitter power output and receiver sensitivity at such times, making any necessary readjustments to return the equipment to its initial settings.

Voltage values should be recorded after adjustment in order to establish reference values which will be useful when checking the apparatus. The readings will remain fairly constant over an indefinite period unless a failure occurs. However, if transistors are changed, there may be considerable difference in these readings without the overall performance being affected.

Typical voltage and current values are given in Tables I through VI. Voltages should be measured with a VTVM. Readings may vary as much as ± 20%.

The transmitter keying board is mounted over the power amplifier board. See Fig. 2. In order to check test-point voltages on the power-amplifier board, first remove the keying circuit-board receptacle mounting screws and the two screws holding down the upper end of the board. Now carefully lift the transmitter keying board away from the power-amplifier board, pulling from the top, but do not disturb the chassis harness wiring any more than necessary. This will expose the test points on the power-amplifier board so that voltage readings can be taken.

Similarly, the receiver CLI and output board can be moved to uncover the right-hand portion of the receiver board. Remove the four mounting screws holding the receiver auxiliary board in place. Lift up this board from the left side and pull it away from the receiver board. This will expose the right half of the receiver board.

Adjustment of R142 on Transmitter Board

The small adjustable resistor (pot.) R142 sets the forward base bias on transmitter transistors Q104 and Q105 to the proper point for class-B operation. This is a factory adjustment and need not be changed unless transistors Q104 or Q105 (or both) are replaced. However, if these transsistors are changed, or if the R142 setting is disturbed in error, the following adjustment procedure should be followed to reset R142:

First remove d-c power from the TC carrier set assembly. Unsolder the lead from terminal 2 of transformer T103 (just above FL101) and temporarily connect a low-range d-c milliammeter (0-1.0 or so) between the removed lead (+) and T103 terminal 2 (–). Turn the slotted control on the small pot (R142) to full counterclockwise. Now, apply power to the TC carrier set, but do not transmit carrier. Advance the pot until the d-c milliammeter reads 0.2 mA d.c. ± .05 mA. Turn off the power, remove the milliammeter, and solder the lead back on terminal 2 of T103. Again apply d-c power and proceed with the transmitter adjustment as described in the ADJUSTMENTS section.

Replacement of Q107 - Q108

The two transistors Q107 and Q108 in the transmitter power-amplifier stage are a matched pair with the gain of the two units matched within 5%. If one of the transistors fails, both should be replaced with a new matched pair. This is necessary to keep the second harmonic of the transmitter output at an acceptably low value. The pair of transistors should be ordered as "2 of style 187A673H16 transistors Type 2N3792".

NOTE: Only power amplifier module styles 774B541G01 through G05 are used with Type 2N3792 transistors. When ordering replacement transistors, check to see that you have this style module. If not, the existing module can be modified by changing D104 and D106 to type 1N4818 Diodes. Order these diodes as "2 of style 188A342H06".

CHANGE OF OPERATING FREQUENCY

The parts required for changing the operating frequency of a type TC carrier set are as follows:

Transmitter

1. Oscillator Crystal (Y101), specify frequency.
   NOTE: Modify A-B-C jumpers on transmitter board if required for new frequency. See table marked "†" under internal schematic (Fig.8).
2. R136 Jumper
   For operation in 30-50kHz range, clip off R136 as indicated in Fig. 3.
3. Capacitors C111 and C113 (on Power Amp. board)
   a. 30-50 kHz – 0.47 mfd. – S#188A293H01
   b. 50.5-75 kHz – 0.22 mfd. – S#188A293H02
   c. 75.5-100 kHz – 0.15 mfd. – S#188A293H03
   d. 100.5-150 kHz – 0.10 mfd. – S#188A293H04
   e. 150.5-300 kHz – 0.047 mfd. – S#188A293H05
4. Transmitter Module Mounting Plate
   When changing from a frequency of 200KHz or below to a frequency above 200KHz, the following is also necessary:
   Transmitter module mounting plate S#691B610H01 and associated hardware.
   This is necessary to raise the transmitter printed circuit board (module) away from the main panel as the 200.5-300kHz. receiver input filter FL201 mounts underneath it. See Fig. 2.
5. Zener Diode Z104
   For the 200.5-300kHz. range, a type 1N2999A zener diode Z104 is mounted on the Q108 heat sink adjacent to the protective diode Z103. Remove the lead from the Q108 heat sink (see Fig. 2 for location) and connect it to the insulated terminal of zener diode Z104.
6. FL101 and FL102
   Filter FL101 is a small series-resonant tuned circuit between the driver and power amplifier stages of the transmitter. It has just two terminals. Filter FL102 is a larger assembly, described under OPERATION. It has three external connections: input, output, and ground. This filter is mounted by four corner posts. To replace, unsolder the three leads, remove the nuts from the mounting posts, and lift the filter assembly from the posts. The new filter can now be installed.

Inductors L101, L102, and L103 in these filters are adjustable over a limited range, but forty-two combinations of capacitors and inductors are required to cover the frequency range of 30 kHz to 300 kHz. The widths of the frequency groups vary from 1.5 kHz at the low end of the channel frequency range to 13 kHz at the upper end. A particular assembly can be adjusted over a somewhat wider range than the width of its assigned group since some overlap is necessary to allow for component tolerances. The nominal kHz adjustment ranges of the groups are:

30.0-31.5	61.0- 64.0	113.0-119.5	207.1-214.0
32.0-33.5	64.5- 68.0	120.0-127.0	214.1-222.0
34.0-36.0	68.5- 72.0	127.5-135.0	222.1-230.0
36.5-38.5	72.5- 76.0	135.5-143.0	230.1-240.0
39.0-41.0	76.5- 80.0	143.5-151.0	240.1-250.0
41.5-44.0	80.5- 84.5	151.5-159.5	250.1-262.0
44.5-47.0	85.0- 89.0	160.0-169.5	262.1-274.0
47.5-50.0	89.5- 94.5	170.0-180.0	274.1-287.0
50.5-53.5	95.0-100.0	180.5-191.5	287.1-300.0
54.0-57.0	100.5-106.0	192.0-200.0	
57.5-60.5	106.5-112.5	200.1-207.0	

If the new frequency lies within the same frequency group as the original frequency, the filters can be readjusted. If the frequencies are in different groups, it is possible that changes only in the fixed capacitors may be required. In general, however, it is desirable to order complete filter assemblies adjusted at the factory for the specified frequency.

A signal generator, a frequency counter, and a vacuum-tube voltmeter are required for readjustment of FL101. The signal generator and the counter should be connected across terminals 4 and 5 of transformer T103 and the voltmeter across terminals 1 and 2 of transformer T104. The signal generator should be set at the channel center frequency and at 2 at 3 volts output. The core screw of the small inductor should be turned to the position that gives a true maximum reading on the VTVM. Turning the screw to either side of this position should definitely reduce the reading. The change in inductance with core position is less at either end of the travel than when near the center and consequently the effect of core screw rotation on the VTVM reading will be less when the resonant inductance occurs near the end of core travel.

The procedure for readjustment of the 2nd and 3rd harmonic traps of filter FL102 is somewhat similar. A signal generator and a counter should be connected to terminals 3 and 4 of transformer T105 and a 500-ohm resistor and a VTVM to the terminals of protective gap G101. The ground or shield lead of all instruments should be connected to the grounded terminal of the transformer. Set the signal generator at exactly twice the channel center frequency and at 5 to 10 volts output. Turn the core screw of the large inductor, L102, to the position that gives a definite minimum reading on the VTVM. Similarly, with the signal generator set at exactly three times the channel center frequency and 5 to 10 volts output, set the core screw of the small inductor, L103, to the position that gives a definite minimum reading on the VTVM. Then remove the instruments and the 500-ohm resistor.

If the change in frequency is enough to require a different filter, it will come factory adjusted as described in the foregoing paragraph.

After all the tabulated changes have been made for the new frequency, the transmitter can be operated with a 50 to 70-ohm load (depending on which tap of T106 is used) connected to its output, and inductor L105 can be readjusted for maximum output at the changed channel frequency by the procedure described in the ADJUSTMENT section.

If a frequency-sensitive voltmeter is available, the second and third harmonic traps may be adjusted (or checked) without using an oscillator as a source of double and triple the channel frequency. Connect the frequency-sensitive voltmeter from TP109 to ground and adjust the transmitter for rated output into the selected load resistor. Set the voltmeter at twice the channel frequency and, using its tuning dial and db range switch, obtain a maximum on-scale reading of the second harmonic. Then vary the core position of L102 until a minimum voltmeter reading is obtained. Similarly, tune the voltmeter to the third harmonic and adjust L103 for minimum voltmeter reading. It should be noted that this procedure may not give the true magnitude of the harmonics because of the large value of fundamental frequency voltage present at the tuned voltmeter input terminals. This condition will overload the input circuit of some commercial instruments. However, the procedure is satisfactory for adjusting the traps for maximum harmonic rejection.

If accurate measurement of the harmonic levels is desired, the frequency-selective voltmeter is connected, through a rejection filter, to the terminals of the 60-ohm load resistor. The filter must provide high rejection of the fundamental. A twin-T filter is suitable for this purpose. The insertion losses of this filter at the second and third harmonics must be measured and taken into account.

Receiver

1. Receiver Oscillator Crystal (Y201), specify frequency, and modify A-B-C jumpers as required.
2. Receiver input filter (FL201), specify frequency.
3. Resistors R211-R238 Combination
   See values in Fig. 8 below internal schematic.
4. Resistors R218 and R224 may have to be reduced.
   See following paragraph.

The emitter resistors R218 and R224 of the i-f stages are normally 33 ohms to give the required receiver gain. If the operating frequency is reduced, the receiver gain will probably be higher. In this case, a reduction in the setting of the i-f input control R239 will give the 125-mv. sensitivity. If the new operating frequency is higher, the receiver gain will be lower. If more than 125 mv. is required to obtain 180 ma. output, the gain can be increased by reducing the value of one or both of the resistors R218 and R224. In most cases, these resistors should fall in the range of 22 to 33 ohms.

TABLE I

Receiver D.C. Measurements

Note: All voltages are negative with respect to Pos. 45 V. (TP206)

TEST POINT	STANDBY (No Signal)	WITH 125 M.V. INPUT
TP201	35-38	35-38
TP202	0	0
TP203	11-12	11-12
TP204	< 0.5	2- 3
TP205	18-22	18-22
TRANSISTOR	**V COLL.**	**V COLL.**
Q201	43	43
Q202	43.5	43.5
Q203	18.0	18.0
Q204	18.0	18.0
Q205	18.0	18.0
Q206	11.0	11.5
Q207	22.0	5.0
Q208	44.0	2.0

All voltages read with d-c vacuum-tube voltmeter.
< 0.5 – means "less than 0.5"

TABLE II

Receiver RF Measurements

Note: Taken with 100 kHz receiver filter, 0.125-volt input signal, and gain control R207 at maximum. Depending on receiver frequency and transistor characteristics, the following values will vary appreciably.

TEST POINT	TYPICAL AC VOLTAGES
FL201-IN to Gnd.	.07
FL201-OUT to Gnd.	.04
Q203 - E to TP206	.10
Q204 - C to TP206	.09
Q205 - B to TP206	.013
Q205 - C to TP206	1.2
Q206 - B to TP206	.15
Q206 - C to TP206	2.5
TP202 to TP206	0.5

All voltages read with a-c vacuum-tube voltmeter.

TABLE III

Transmitter D-C Measurements

Note: All voltages are positive with respect to Neg. D.C. (TP104). All voltages read with d.c. VTVM.

TEST POINT	CARRIER OFF	CARRIER ON
TP101	8.5 volts d.c.	8.5 volts d.c.
TP102	<0.5	20
TP103	<0.5	19.5
TP105	<0.5	9
TP106	44	24
TP107	44	24
TP108	45	44
TP110	<1.0	< 1.0
TP111	<1.0	< 1.0
TP112	0	< 0.5
TP113	45	44
J101 (Front Panel)	5 ma. max.	0.6 amp.

TRANSISTOR	V COLL.	V COLL.
Q101	2.0	1.8
Q102	1.0	1.0
Q103	< 0.5	9.0
Q104	45	44
Q105	45	44
Q106	44.5	1.2
Q107	0	0
Q108	44.5	24.2

TABLE IV
Transmitter RF Measurements

Note: "Carrier-on" voltages taken with transmitter set to 10 watts output (24.5 volts across 60 ohms). These voltages subject to variation, depending on frequency and transistor characteristics.

TEST POINT	A-C VOLTAGE
T101-3 to TP104	1.5 volts, rms.
TP103 to TP102	0.2
TP105 to TP104	1.1 ϕ
TP110 to T102-4	0.2
TP111 to T102-4	0.2
Q104-C to TP104	3.3
Q105-C to TP104	3.3
T103-4 to Gnd.	1.1
T104-1 to Gnd.	1.4
Q107-B to TP107	0.5 volts, rms.
Q108-B to TP113	0.5
Q107-C to TP107	14-16
Q108-C to TP113	14-16
T105-4 to Gnd.	105
T106-2 to Gnd.	100-160*
TP109 to Gnd.	30-50 *
J102 to Gnd.	24.5

Note: T101-3 = tap 3 of Transformer T101
Q104-C = Collector of Transistor Q104
TP105 = Test point 105
All voltages read with a-c VTVM
* These values may vary considerably with frequency.
ϕ - High-impedance circuit. VTVM causes significant loading.

TABLE V
Transmitter Keying Board
D.C Voltages

TEST POINT	NORMAL (Carrier Off)	CARRIER ON (D.C. on J104-6 or 7)	CARRIER STOP (D.C. on J104-6 or 7 and J104-8 or 9)
TP151	16 v.d.c.	<1.0 v.d.c.	<1.0 v.d.c.
Term. 17	<1.0	24.6	4.9
TP152	16	16	<1.0
TP153	<1.0	<1.0	16
Term. 1	0 *	20	<1.0

* May show <1.0 volt with VTVM

TABLE VI

Receiver CLI and Output Board
(with normal received signal)

TEST POINT	D.C VOLTAGE – TO NEG.	SIGNAL VOLTAGE (a.c.)
TP-251	4.9 v.d.c.	0.3 v. rms.
TP-252	9.8	2.9
TP-253	< 1.0	–
TP-254	19.7	–

Recommended Test Equipment

I. Minimum Test Equipment for Installation

a. Milliammeter 0-250 ma. DC

b. 60-ohm 10-watt non-inductive resistor.

c. A-C Vacuum Tube Voltmeter (VTVM). Voltage range 0.01 to 30 volts, frequency range 60 Hz to 330 kHz, input impedance—one megohm, minimum.

d. D-C Vacuum Tube Voltmeter (VTVM).

Voltage Range: 0.1 to 300 volts
Imput Impedance: 1.0 megohm, min.

II. Desirable Test Equipment for Apparatus Maintenance.

a. All items listed in I.

b. Signal Generator

Output Voltage: up to 10 volts r.m.s.
Frequency Range: 20 to 330 kHz

c. Oscilloscope

d. Ohmmeter

e. Capacitor checker

f. Frequency counter

g. Frequency-selective voltmeter

Renewal Parts

Repair work can be done most satisfactorily at the factory. However, replacement parts can be furnished, in most cases, to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ELECTRICAL PARTS LIST

Transmitter Section

SYMBOL	RATING	STYLE NUMBER
C201	0.1 mfd, 200 V.DC	187A624H01
C102	.005 mfd, 300 V.DC	187A694H29
C103	180 pf. 500 V.DC	187A695H29
C104	0.25 mfd, 200 V.DC	187A624H02
C105	0.25 mfd, 200 V.DC	187A624H02
C106	0.25 mfd, 200 V.DC	187A624H02
C107	0.25 mfd, 200 V.DC	187A624H02
C108	0.50 mfd, 200 V.DC	187A624H03
C109	0.25 mfd, 200 V.DC	187A624H02
C110	0.25 mfd, 200 V.DC	187A624H02
† C111	(See Table Below)	—
C112	39 pf. 500 V.D.C.	187A695H12
† C113	(See Table Below)	—
C114	100 pf., 500 V.DC	187A695H23
C115	100 pf., 500 V.DC	187A695H23
C116	0.001 mfd, 500 V.DC	187A694H11
CA	Part of FL101	Vary with Frequency
CB, CC, CD, CE	Part of FL102	Vary with Frequency
D101	1N457A	184A855H07
D103	1N4818	188A342H06
✪ D104	1N4818	188A342H06
D105	1N4818	188A342H06
✪ D106	1N4818	188A342H06
G101	Type RVS Arrester	637A026A01
J101	Closed Circuit Jack	187A606H01

#200.5 — 300 kHz only.

† FREQ. (C111, C113)	RATING	STYLE NUMBER
30 -50 kHz	0.47 mfd, 400 V.DC	188A293H01
50.5-75 kHz	0.22 mfd, 400 V.DC	188A293H02
75.5-100 kHz	0.15 mfd, 400 V.DC	188A293H03
100.5-150 kHz	0.1 mfd, 400 V.DC	188A293H04
150.5-300 kHz	0.047 mfd, 400 V.DC	188A293H05

ELECTRICAL PARTS LIST

Transmitter Section (Cont.)

SYMBOL	RATING		STYLE NUMBER
J102	Banana Plug Jack		2 of 185A431H01
J103	Coaxial Cable Jack		187A633H01
J104	24-Term Receptacle		187A669H01
J105	12-Term Receptacle		629A205H02
L101	Part of FL101		Vary with Frequency
L102	FL102 Trap Coil (2nd Harmonic)		Vary with Frequency
L103	FL102 Trap Coil (3rd Harmonic)		Vary with Frequency
L104	400 mh.		292B096G01
L105	FL102 Coil (part of series-resonant circuit tuned to fundamental freq.)		Vary with Frequency
✪ L106	2.0 mh.		3500A27H01
Q101	2N2905A		762A672H10
Q102	2N2905A		762A672H10
Q103	2N525		184A638H13
Q104	2N3712		762A672H07
Q105	2N3712		762A672H07
Q106	TI-481		184A638H11
✪ Q107	2N3792	Matched Pair	187A673H16
Q108	2N3792		187A673H16

SYMBOL	OHMS	± TOL. %	WATTS	STYLE NUMBER
R101	5,600	5	1	187A643H45
R102	2,200	10	0.5	187A641H35
R103	10,000	10	0.5	187A641H51
R104	100,000	5	0.5	187A763H75
R105	390	5	0.5	184A763H17
R106	1,200	5	0.5	184A763H29
R107	10,000	10	0.5	184A641H51
R108	100,000	5	0.5	184A763H75
R109	390	5	0.5	184A763H17
R111	1,200	5	0.5	187A763H29
R112	1 K Pot	20	0.25	629A430H02
R113	4,700	5	0.5	184A763H43
R114	10,000	10	0.5	187A641H51
R115	150	5	0.5	184A763H07

ELECTRICAL PARTS LIST

Transmitter Section (Cont.)

SYMBOL	OHMS	± TOL. %	WATTS	STYLE NUMBER
R116	100	5	0.5	184A763H03
R117	1,000	5	25	1202588
R118	10,000	2	0.5	629A531H56
R119	62	2	0.5	629A531H03
R120	10,000	5	2	185A207H51
R121	10	5	2	187A683H01
R122	10	5	0.5	187A290H01
R123	10	10	0.5	187A290H01
R124	100	10	1	187A644H03
R125	1,000	10	0.5	187A641H27
R126	4,700	10	1	187A644H43
R127	10	10	0.5	187A640H01
R128	2,200	5	1	187A644H35
R129	2.7	10	0.5	184A636H14
R130	10	10	0.5	187A640H01
R131	4,700	5	1	187A644H43
R132	2.7	10	0.5	184A636H14
R133	0.27	10	1	184A636H18
R134	0.27	10	1	184A636H18
R135	3,000	10	5	188A317H01
R136	12,000	2	0.5	629A531H58
R137	15,000	10	2	187A642H55
R138	1,000	10	0.5	187A641H27
R139	1,000	10	0.5	187A641H27
R140	68	2	0.5	629A531H04
R141	30	Type 3D202 Thermistor		185A211H06
R142	25K pot.	20	0.125	629A430H13
R143	20,000	2	0.5	629A531H63

SYMBOL	RATING		STYLE NUMBER
SW101	Carrier Test Switch		880A357H01
T101	10,000/400 ohms		205C043G01
T102	10,000/400 c.t.		714B666G01
T103	1930/60 ohms	L633000	1962694
T104	Turns ratio, 1/0.5	Pri./each sec.	292B526G01
T105	10/500 ohms		292B526G02
T106	500/50 - 60 - 70 ohms		292B526G03
Y101	30-300 kHz crystal per 328C083		Specify Frequency
Z101	1N5357B (20 V ±5%)		862A288H03
Z102	1N2999B (56 V ±5%)		629A798H04
Z103	1N2999B (56 V ±5%)		629A798H04

ELECTRICAL PARTS LIST
Transmitter Keying Board

SYMBOL	RATING	STYLE NUMBER
C151-C152	0.47 mfd., 200 V.	849A437H04
C154	47 mfd., 50 V.	863A530H01
D151	1N457A	184A855H07
D152	1N4818	188A342H06
Q151 to Q155	2N3417	848A851H02
R151-R159	47K, ½ W.	629A531H72
R152-R153-R160-R161	4.7K, ½ W.	629A531H48
R154-R162	82K, ½ W.	629A531H78
R155-R158-R163-R166-R169	10K, ½ W.	629A531H56
R156-R164-R167	6.8K, ½ W.	629A531H52
R157-R165-R168	27K, ½ W.	629A531H66
R170	700, 5 W.	763A129H04
Z151-Z152-Z155-Z156	1N3688A (24V)	862A288H01
✪ Z153-Z157	1N3686B (20V)	185A212H06
Z154-Z158	1N957B (6.8V)	185A797H06
Z159	1N748A (3.9V)	185A797H13
Z160	1N5357B (20V)	862A288H02
Receiver Section		
C201	0.1 mfd., 200 V. DC	187A624H01
C202	300 pf. 500 V. DC	187A695H35
C203	180 pf. 500 V. DC	187A695H29
C204	0.25 mfd. 200 V. DC	187A624H02
C205	0.25 mfd, 200 V. DC	187A624H02
C206	0.25 mfd, 200 V. DC	187A624H02
C207	0.25 mfd., 200 V. DC	187A624H02
C208	0.25 mfd., 200 V. DC	187A624H02
C209	0.25 mfd., 200 V. DC	187A624H02
C210	0.25 mfd., 200 V. DC	187A624H02
C211	0.1 mfd., 200 V. DC	187A624H01
C212	0.25 mfd., 200 V. DC	187A624H02
C213	2.0 mfd., 200 V. DC	187A624H05
C214	0.25 mfd., 200 V. DC	187A624H02
C215	39 pfd., 500 V. DC	187A695H12
D201	1N457A	184A855H07
D202	1N457A	184A855H07
D203	1N4818	188A342H06
D204	1N4818	188A342H06

ELECTRICAL PARTS LIST

Receiver Section (cont.)

SYMBOL	RATING	STYLE NUMBER
FL201	Receiver Input Filter 30-300 kHz	Specify Frequency
FL202	Receiver i.f. Filter - 20kHz (2 sections)	187A590G02
J201	Receiver Coax, Input Jack	187A638H01
J202	Closed Circuit Jack (CLI)	187A606H01
J203	Closed Circuit Jack (200MA)	187A606H01
L201	33 mh.	187A599H02
Q201	2N2905A	762A672H10
Q202	2N2905A	762A672H10
Q203	2N2905A	762A672H10
Q204	2N2905A	762A672H10
Q205	2N2905A	762A672H10
Q206	2N2905A	762A672H10
Q207	2N3645	849A441H01
Q208	2N4903	187A673H13

SYMBOL	RATING			STYLE NUMBER
	OHMS	± TOL. %	WATTS	
R201	10,000	10	0.5	187A641H51
R202	2,200	10	0.5	187A641H35
R203	10,000	10	0.5	187A641H51
R204	100,000	5	0.5	184A763H75
R205	390	5	0.5	184A763H17
R206	1,200	5	0.5	184A763H29
R207	25K Pot.	10	2	185A086H07
R208	10,000	10	0.5	187A641H51
R209	100,000	5	0.5	184A763H17
R210	390	5	0.5	184A763H17
† R211	—	—	—	See † Note Below
R212	1 K pot.	20	0.25	629A430H02
R213	1,200	5	0.5	184A763H29
R214	5,600	5	1	187A643H45
R215	20,000	5	0.5	184A763H58
R216	3,600	5	0.5	184A763H40

† R211 — 10K - above 50kHz - S#187A641H51
22K - 30-50kHz - S#187A641H59

ELECTRICAL PARTS LIST

Receiver Section (Cont.)

SYMBOL	RATING			STYLE NUMBER
	OHMS	± TOL. %	WATTS	
R217	620	5	0.5	184A763H22
R218	33	5	0.5	187A290H13
R219	10,000	10	0.5	187A641H51
R220	20,000	5	0.5	184A763H58
R221	300	5	0.5	184A763H14
R222	3,600	5	0.5	184A763H40
R223	620	5	0.5	184A763H22
R224	33	5	0.5	187A290H13
R225	10,000	10	0.5	187A641H51
R226	20,000	5	0.5	184A763H58
R227	300	5	0.5	184A763H14
R228	3,600	5	0.5	184A763H40
R229	620	5	0.5	184A763H22
R230	10	5	0.5	187A290H01
R231	2,000	5	0.5	184A763H34
R232	1,200	5	2	185A207H29
R233	4,700	10	2	187A642H43
R234	5,100	5	0.5	184A763H44
✪ R235	1.5K	5	0.5	184A763H21
R236	4,700	10	1	187A644H43
R237	170	5	40	1336074
† R238	—	—	—	See † Note Below
R239	1 K pot.	20	0.25	629A430H02
R240	50	Sensistor	0.25	187A685H08
R241	100	Type 3D102 Thermistor		185A211H12
R242	100	Type TM-¼ Sensistor		187A685H06
✪ R280	56	5	0.5	187A290H19
T201	10,000/10,000 Ohms			714B677G01
T202	10,000/400 Ohms			205C043G01
T203	25,000/300 Ohms			205C043G03
Y201	50-320kHz Crystal per 328C083			Specify Frequency
Z201	1N3027B (20V. ±5%)			184A449H07
Z202	1N1789 (56V. ±10%)			584C434H08

Receiver CLI and Output Board

SYMBOL	RATING	STYLE NUMBER
C251 to C253 C255 to C260	0.27 mfd, 200 V.d.c.	188A669H05
C254	0.82 mfd, 200 V.d.c.	188A669H15
D251-D252	1N457A	184A855H07
D253	1N645A	837A692H03
Z251	1N3686B (20V.)	185A212H06
Z252	1N3688A (24V.)	862A288H01

† R238 - omit - above 50kHz
- 22K, 30-50kHz, S#187A641H59.

ELECTRICAL PARTS LIST

Receiver CLI and Output Board (Cont.)

SYMBOL	RATING	STYLE NUMBER
R251	2.7K, TM-¼ Sensistor	187A685H05
R252	5K, ¼W. pot.	629A430H07
R253	220, ½W.	184A763H11
R254	2.2K, ½W.	184A763H35
R255-R260	15K, ½W.	184A763H55
R256	2.4K, ½W.	184A763H36
R257	330, TM-¼ Sensistor	187A685H07
R258-R259	4.7K, ½W.	184A763H43
R261	560, ½W.	184A763H21
R262-R265	1.2K, ½W.	184A763H29
R263-R264	180, ½W.	184A763H09
R266	27K, ½W.	629A531H66
R267-R269	10K, ½W.	629A531H56
R268	6.8K, ½W.	629A531H52
R270	82K, ½W.	629A531H78
R271	150, 3W.	762A679H01
Q251-Q252	2N4356	849A441H02
✪ Q253	2N3417	848A851H02
Q254	2N3645	849A441H01

Power Supply Section

SYMBOL	FUNCTION		DESCRIPTION OR RATING	STYLE NUMBER
C1	(+) to (−) bypass		0.45 mfd. 330 VAC	1723408
C2	A-C grounding		0.5 mfd, 1500 VDC	1877962
C3	A-C grounding		0.5 mfd, 1500 VDC	1877962
C4	Filter		1.8 mfd, 800 VDC	14C9400H12
L1	Filter		5.5 mh.	719B135G01
✪ Q1	Series Regulator		2N6259	3503A41H01
R1	125V	Series dropping	26.5 ohms, 40W.	04D1299H44
R2	125V	Series dropping	Same as R1	04D1299H44
R3	125V	Current limiting	500 ohms, 40W.	1268047
R1	48V	For 48 VDC, R1 = R2 0	–	–
R2	48V	For 48 VDC, R1 = R2 0	–	–
R3	48V	R3 = 26.5 ohms	40W.	04D1299H44
TP1	Test point (+)		Pin Jack -- red	187A332H01
TP2	Test point (−)		Pin Jack – black	187A332H02
Z1	Voltage Regulator		1N2828B (45V.)	184A854H06
Z2	Surge Protection		1N3009A (130V.) Zener Diodes	184A617H12
Z3	Voltage Reg. – for 250 V.D.C.		1N2813B (15V.)	184A854H11

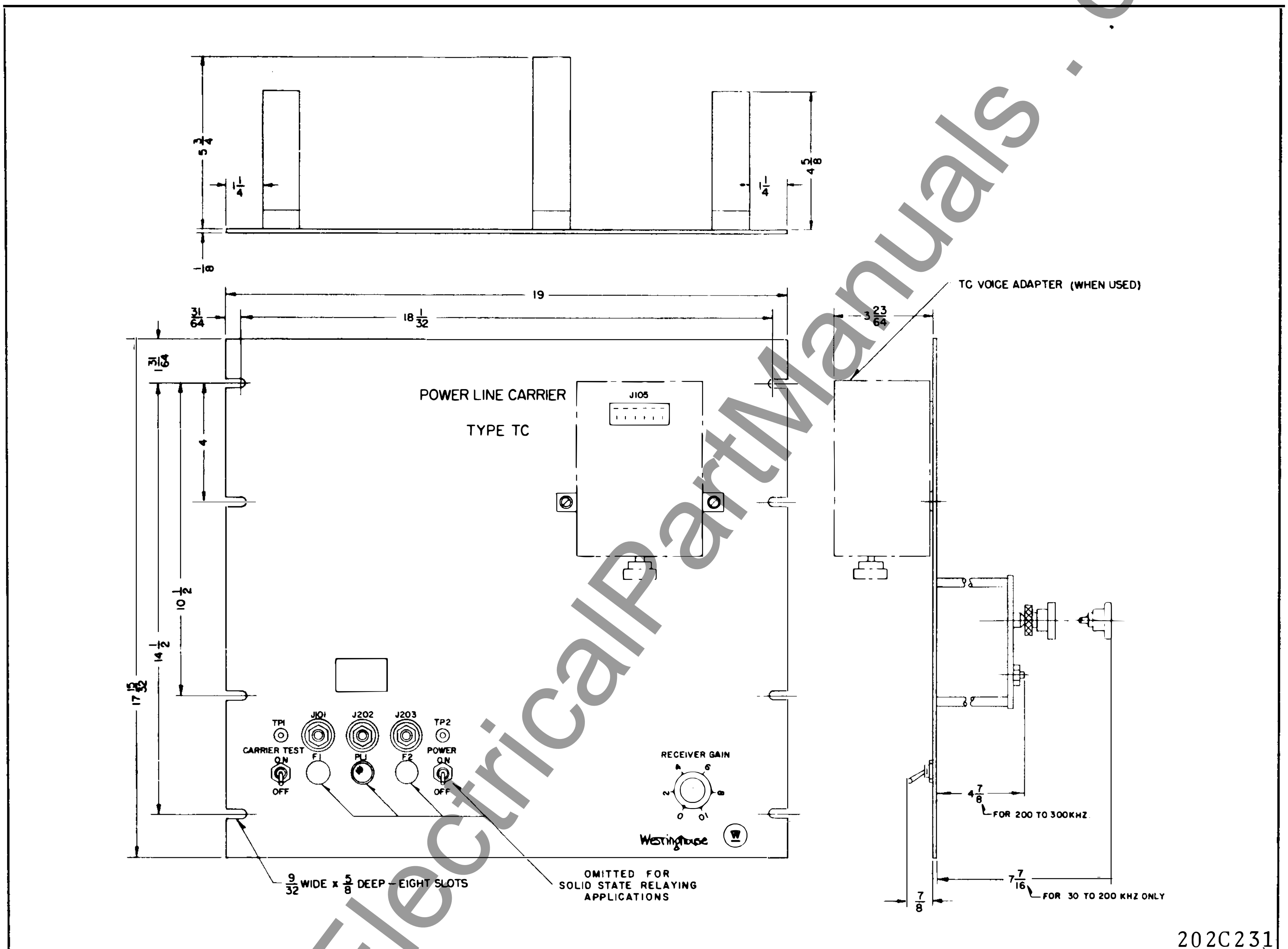


Fig. 1 Type TC Carrier Assembly — Outline

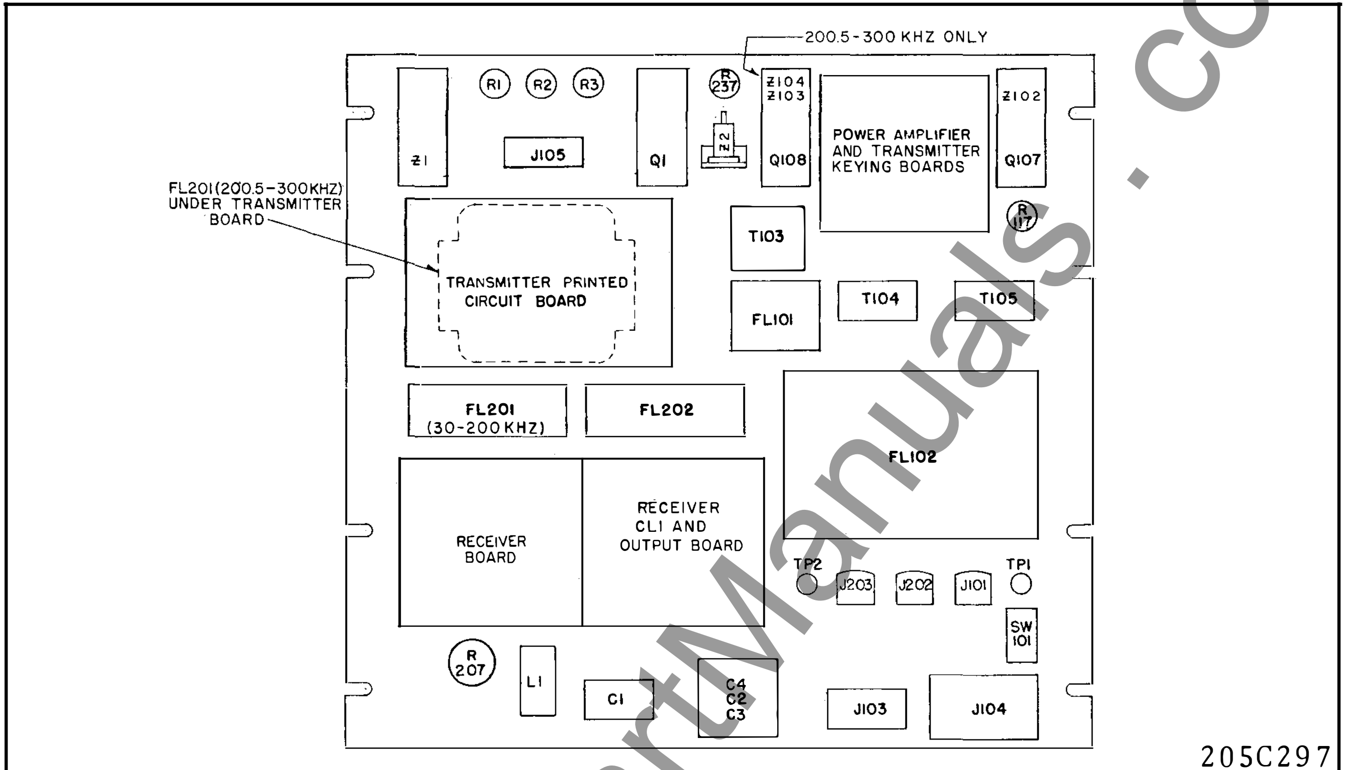


Fig. 2 Type TC Carrier Assembly — Parts Location

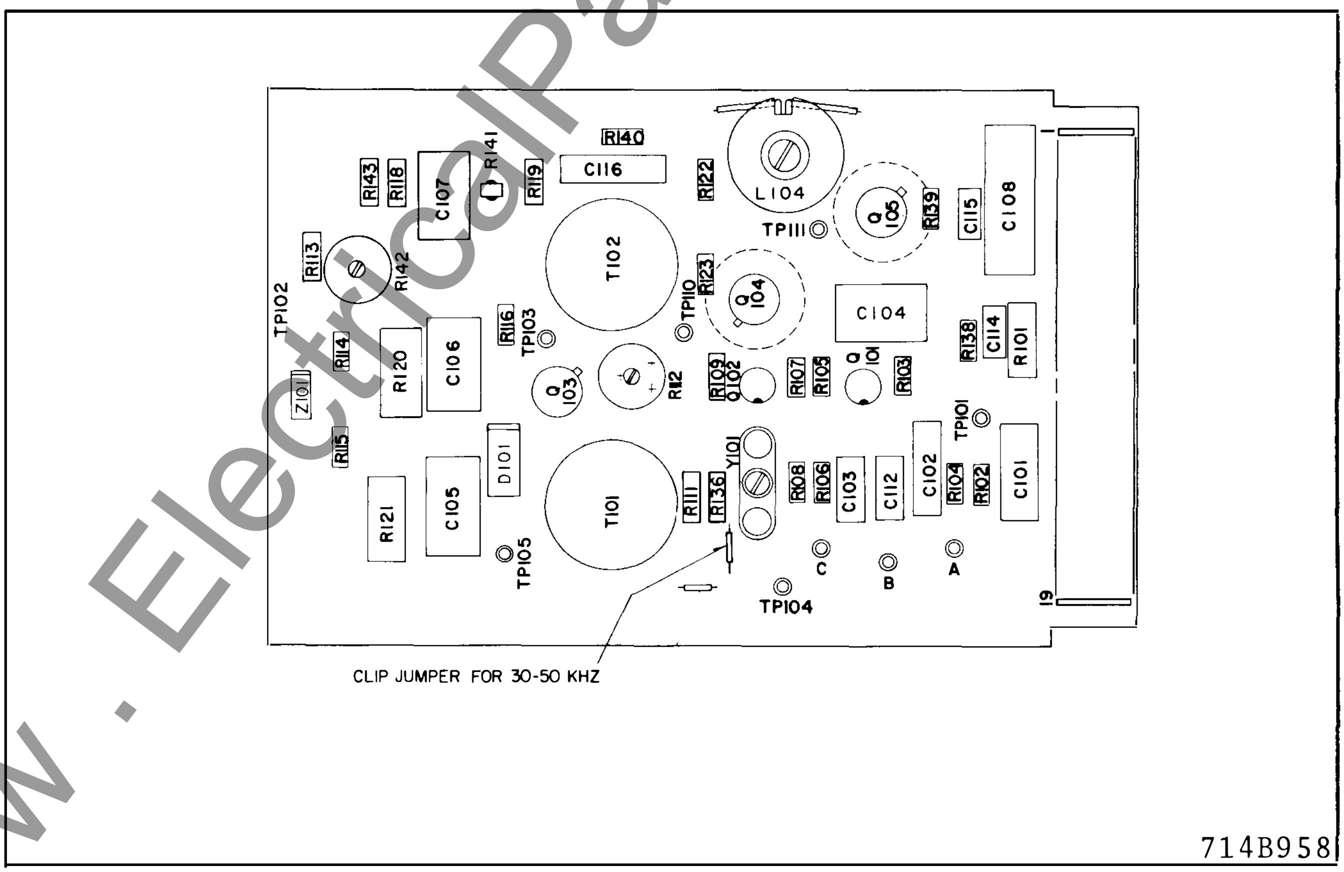


Fig. 3 Transmitter Printed Circuit — Parts Location

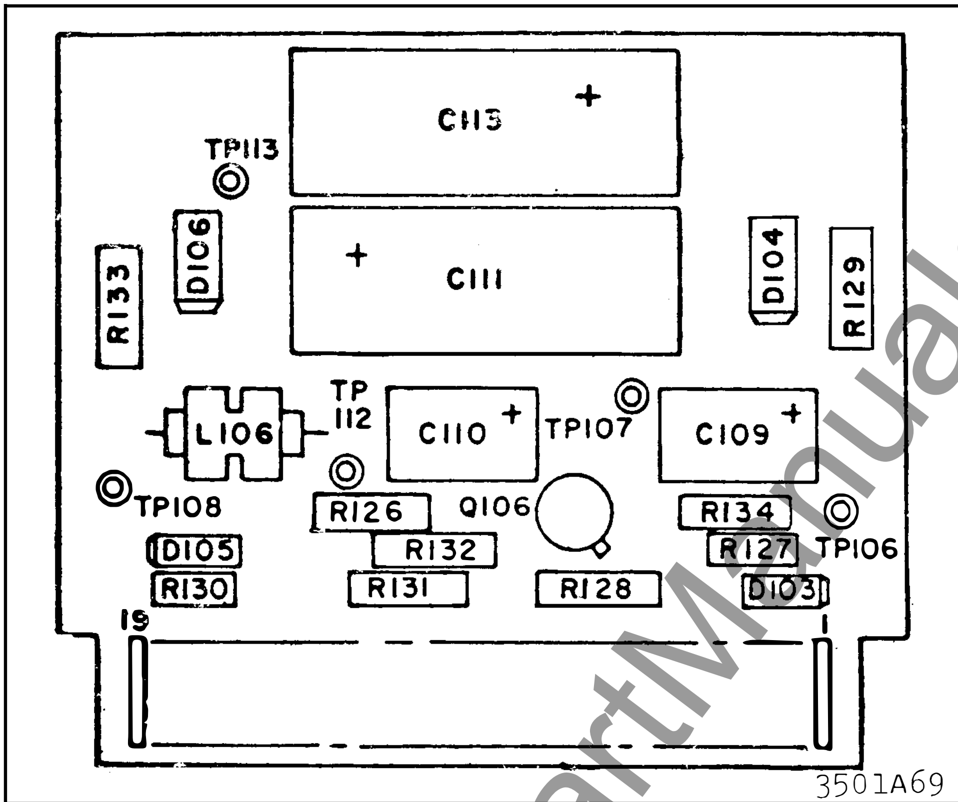


Fig. 4 Power Amplifier Printed Circuit — Parts Location

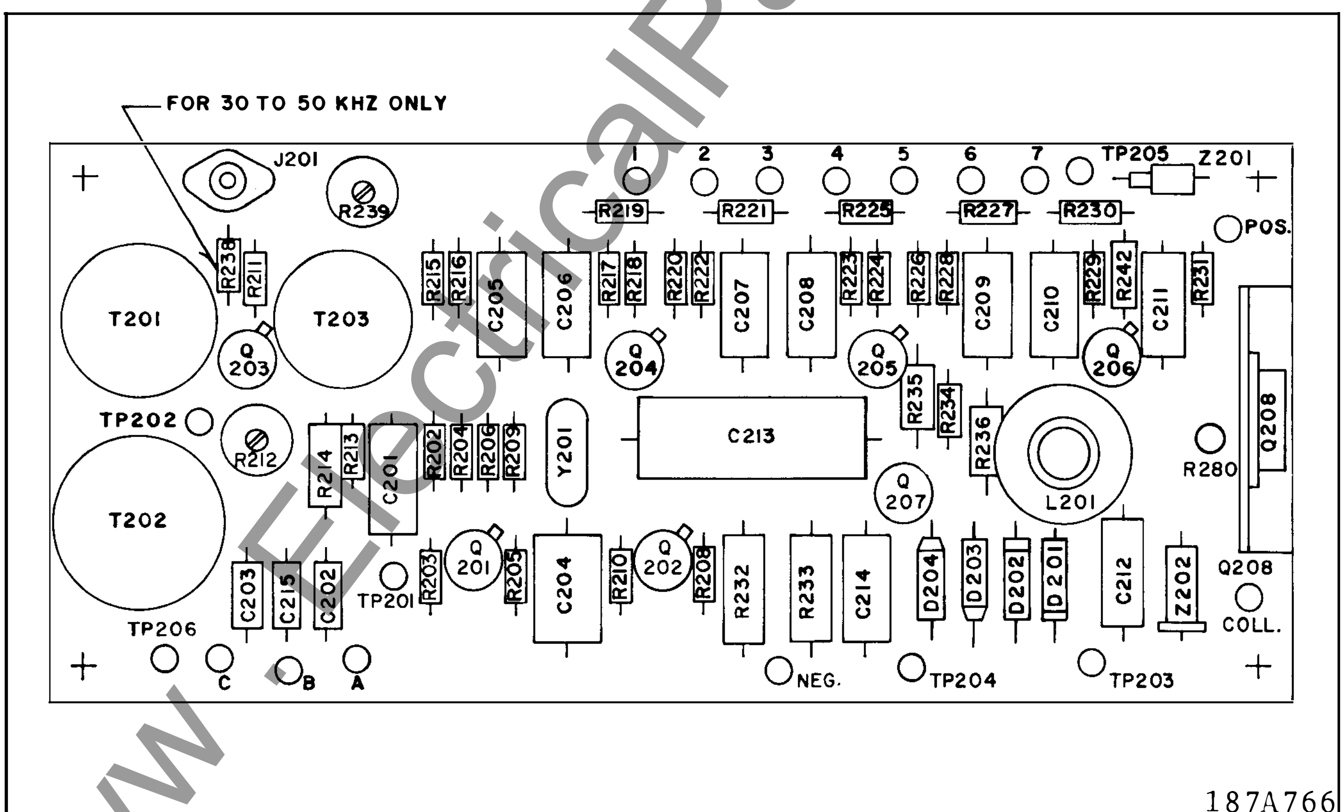
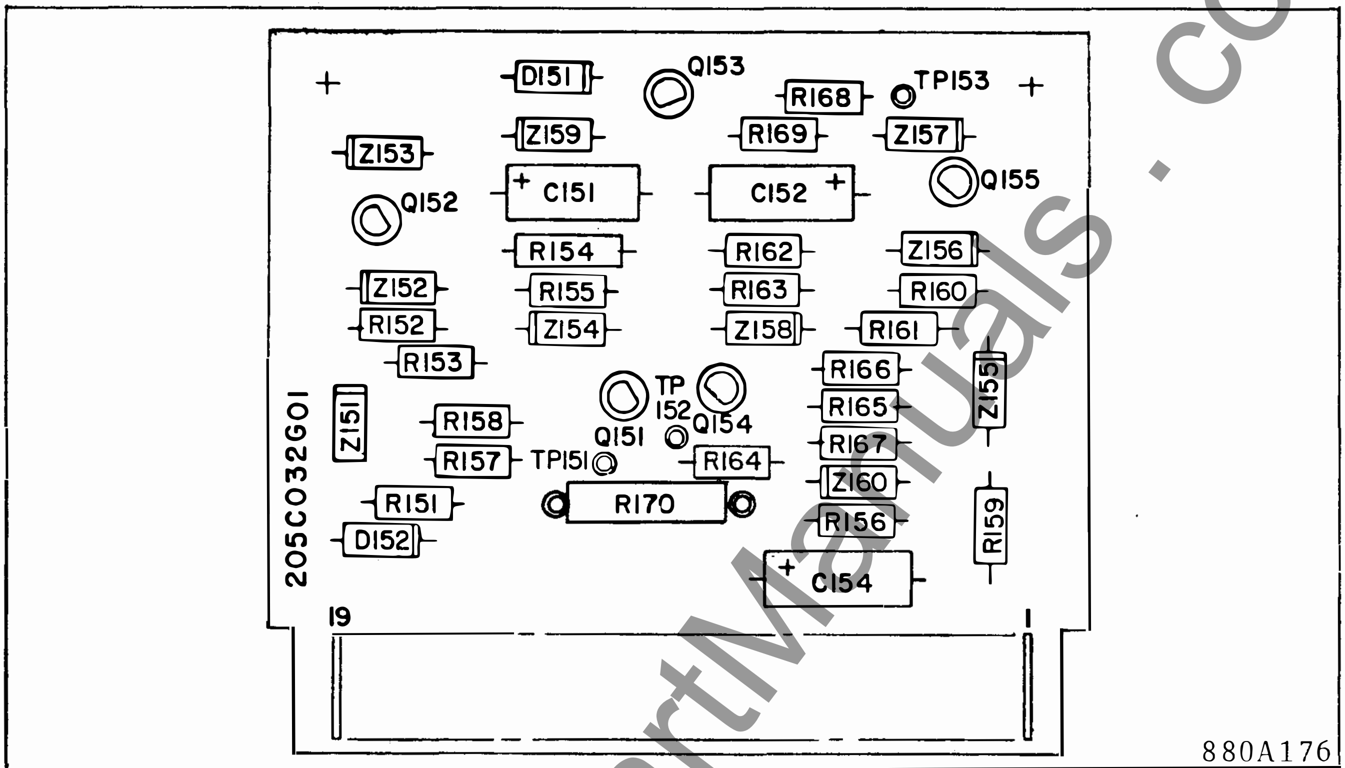


Fig. 5 Receiver Printed Circuit — Parts Location



✪ *Fig. 6. Transmitter Keying Board — Parts Location.*

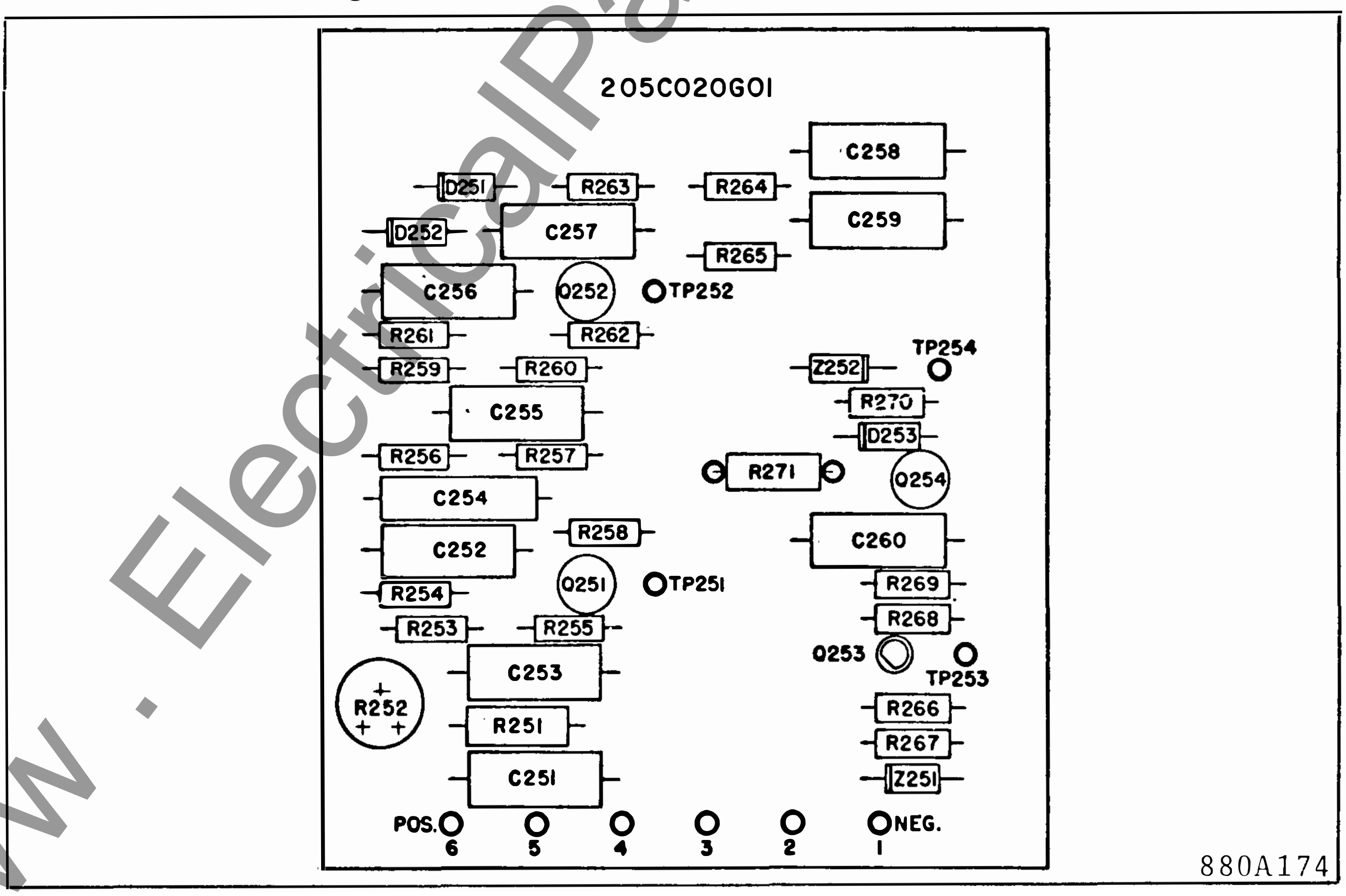


Fig. 7. Receiver CLI and Output Board — Parts Location.

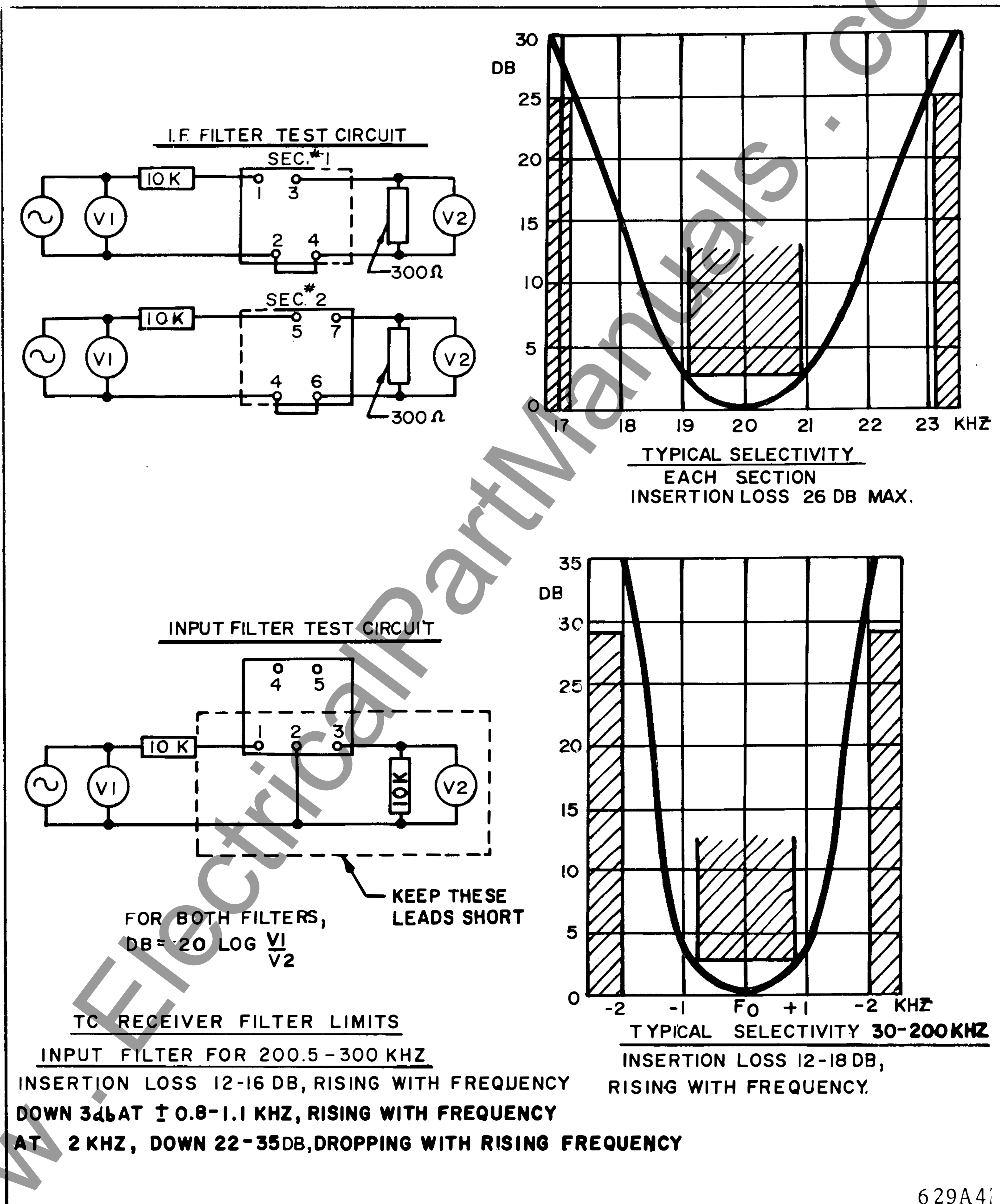


Fig. 9. Type TC Receiver Filter Characteristics

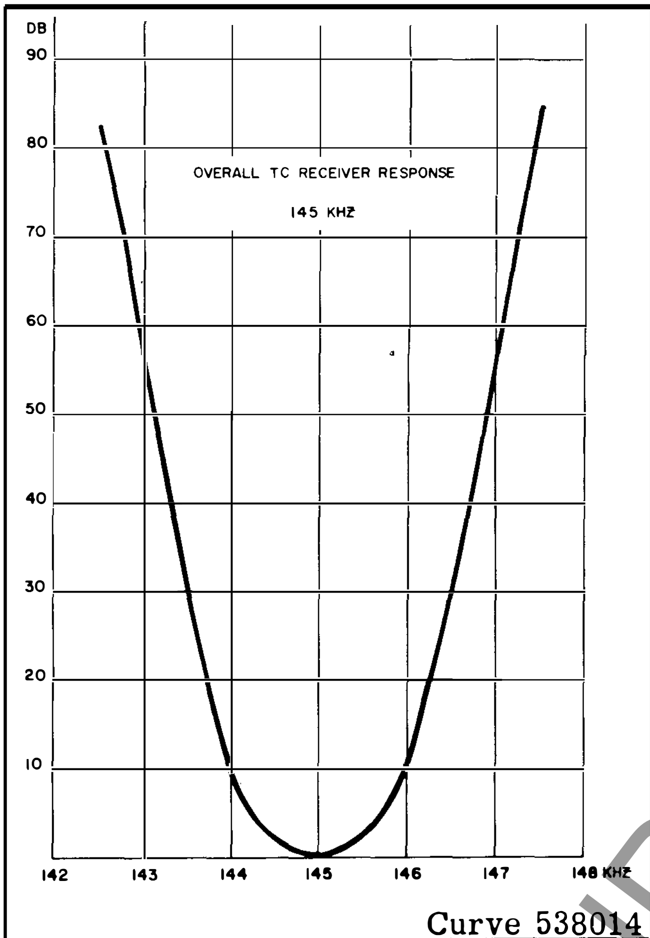


Fig. 10. Type TC Receiver Overall Selectivity Curve.

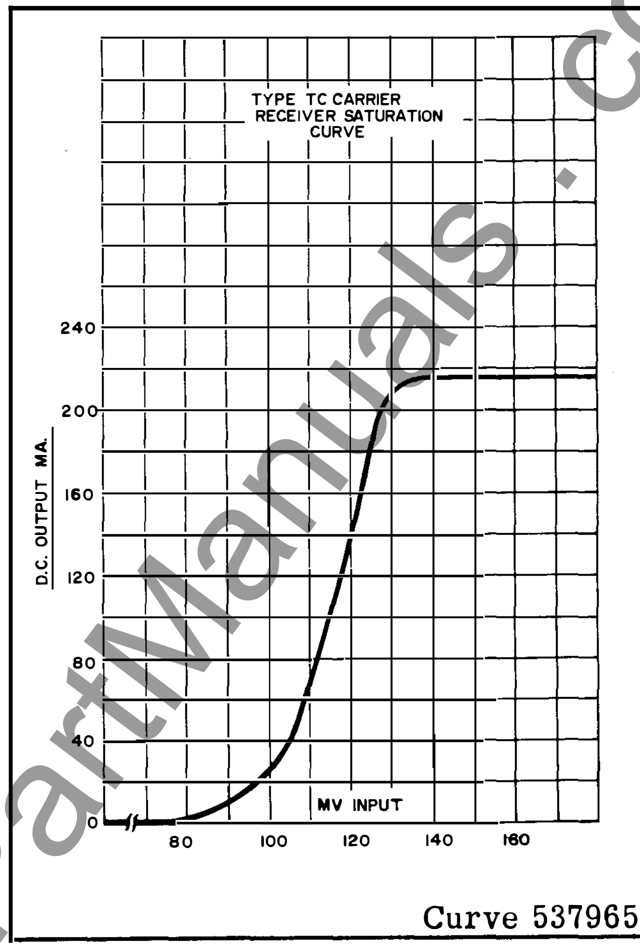


Fig. 11. Type TC Receiver – 200 ma. Output Characteristic.

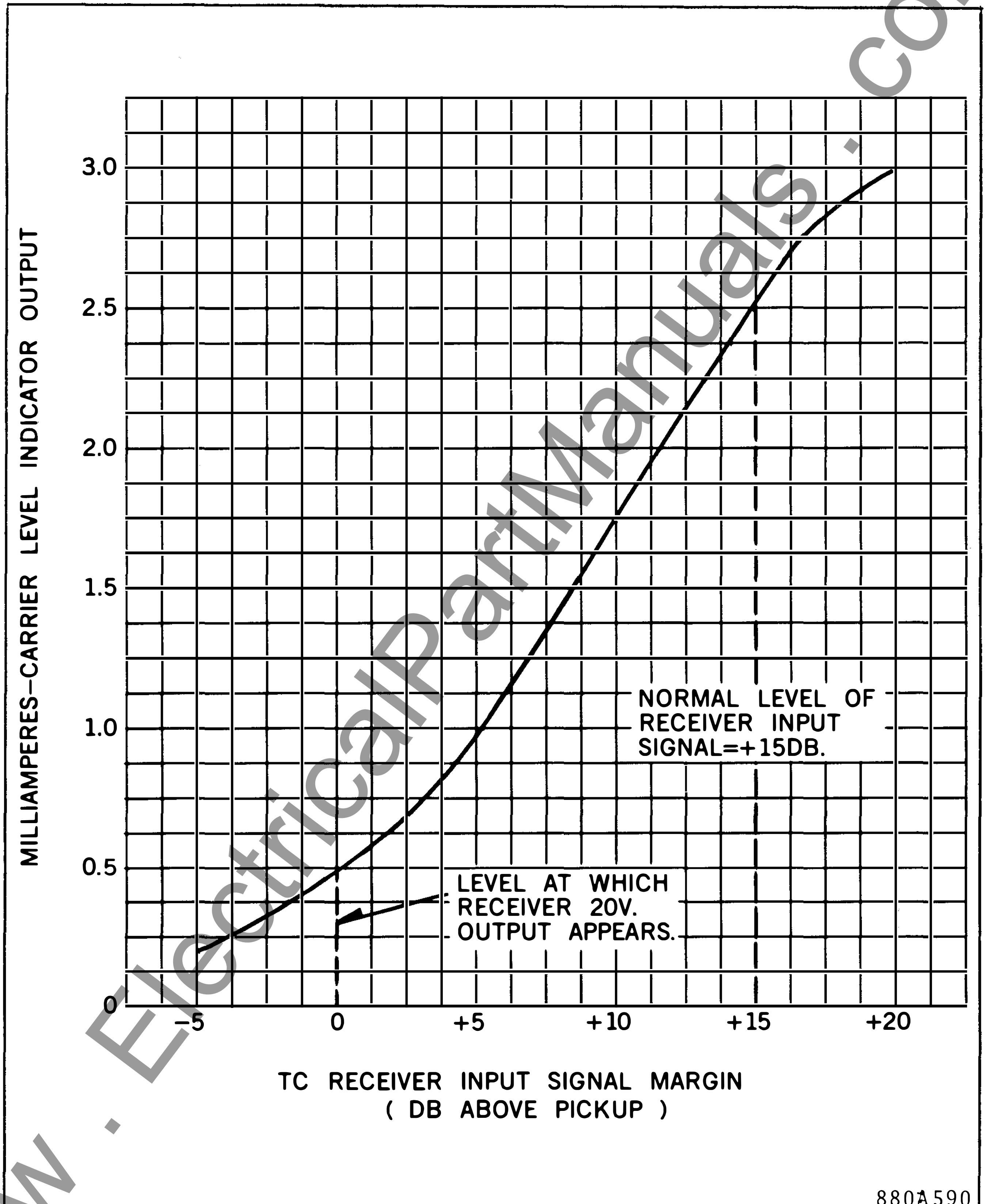


Fig. 12. Typical curve of the carrier level indicator current vs. receiver margin above minimum operating level.

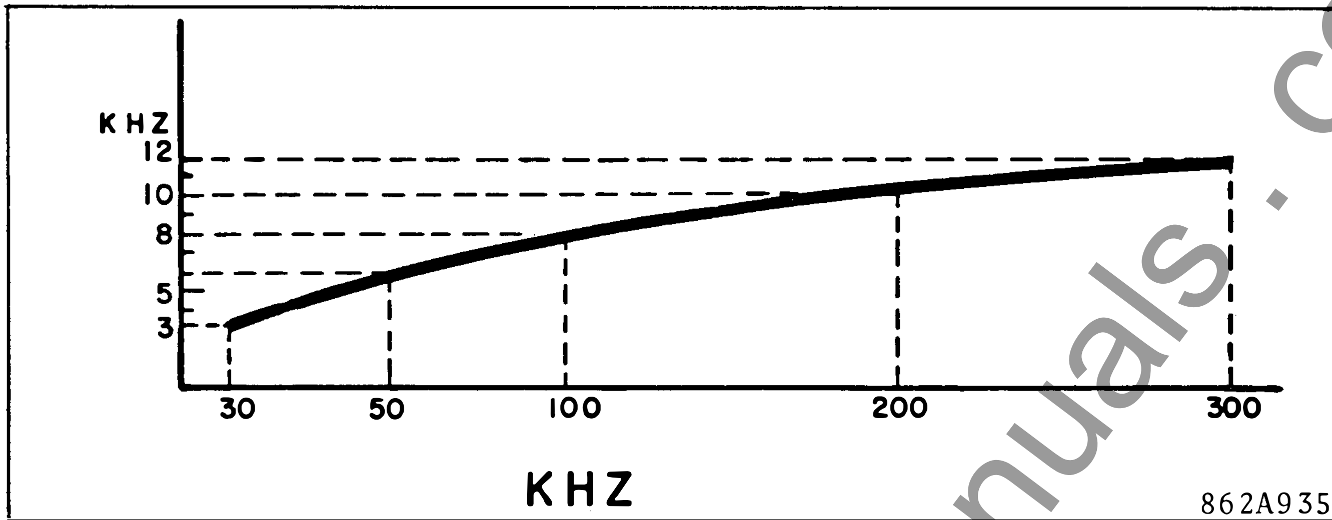


Fig. 13. Minimum Frequency Spacing for Two 10-Watt Transmitters Operated in Parallel.

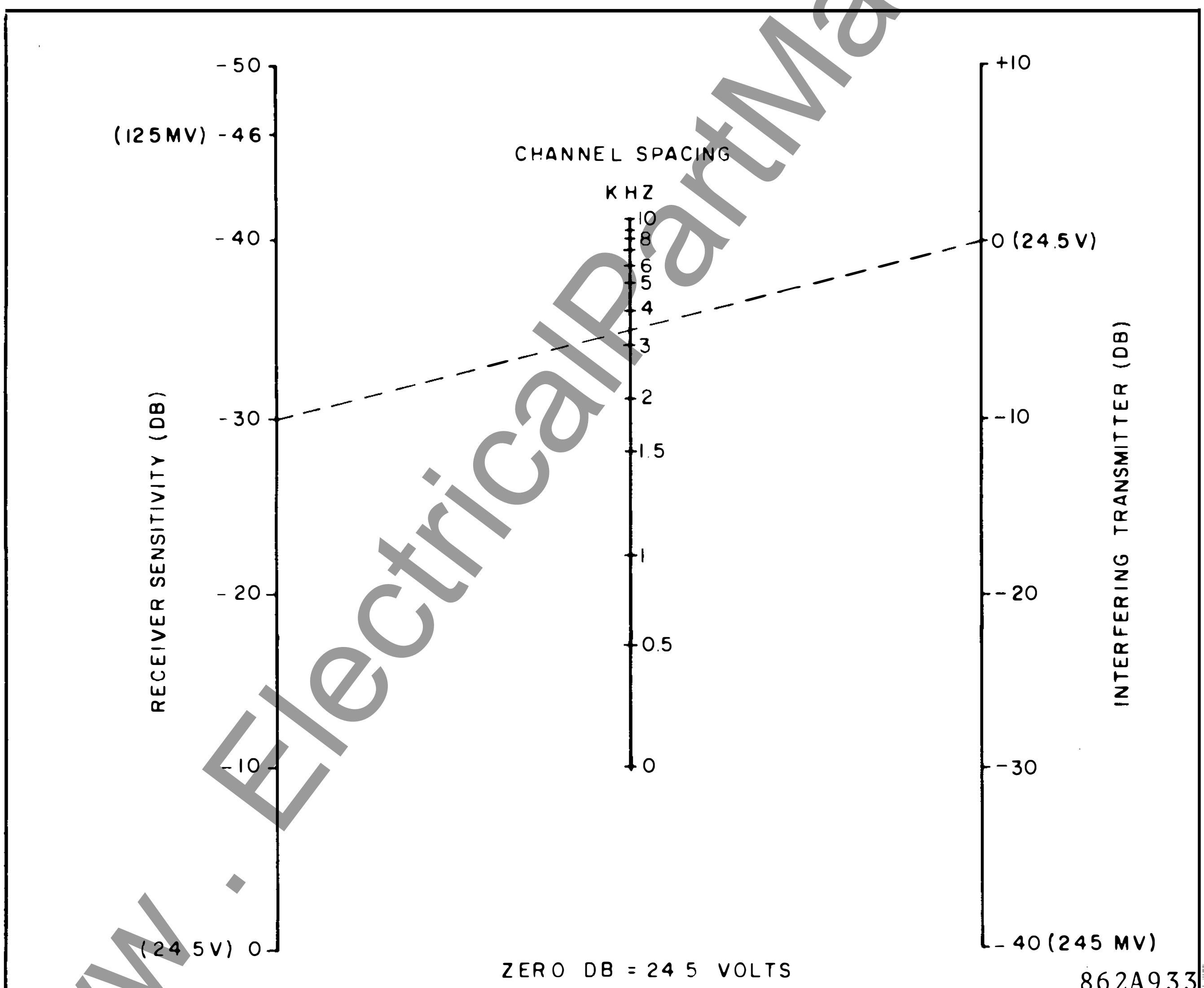


Fig. 14. Minimum Channel Spacing for Keyed Carrier 60 p.p.s.

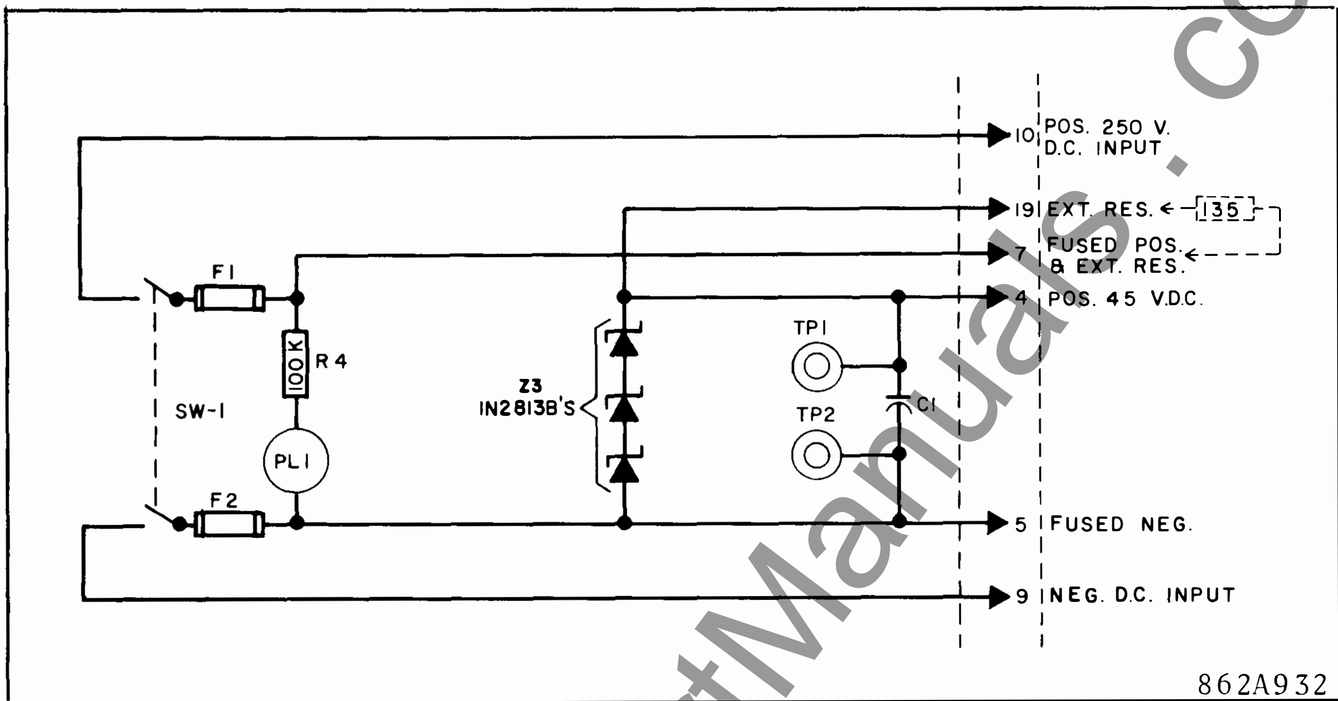


Fig. 15. Detail of Power Supply Section for 250-Volt Supply.

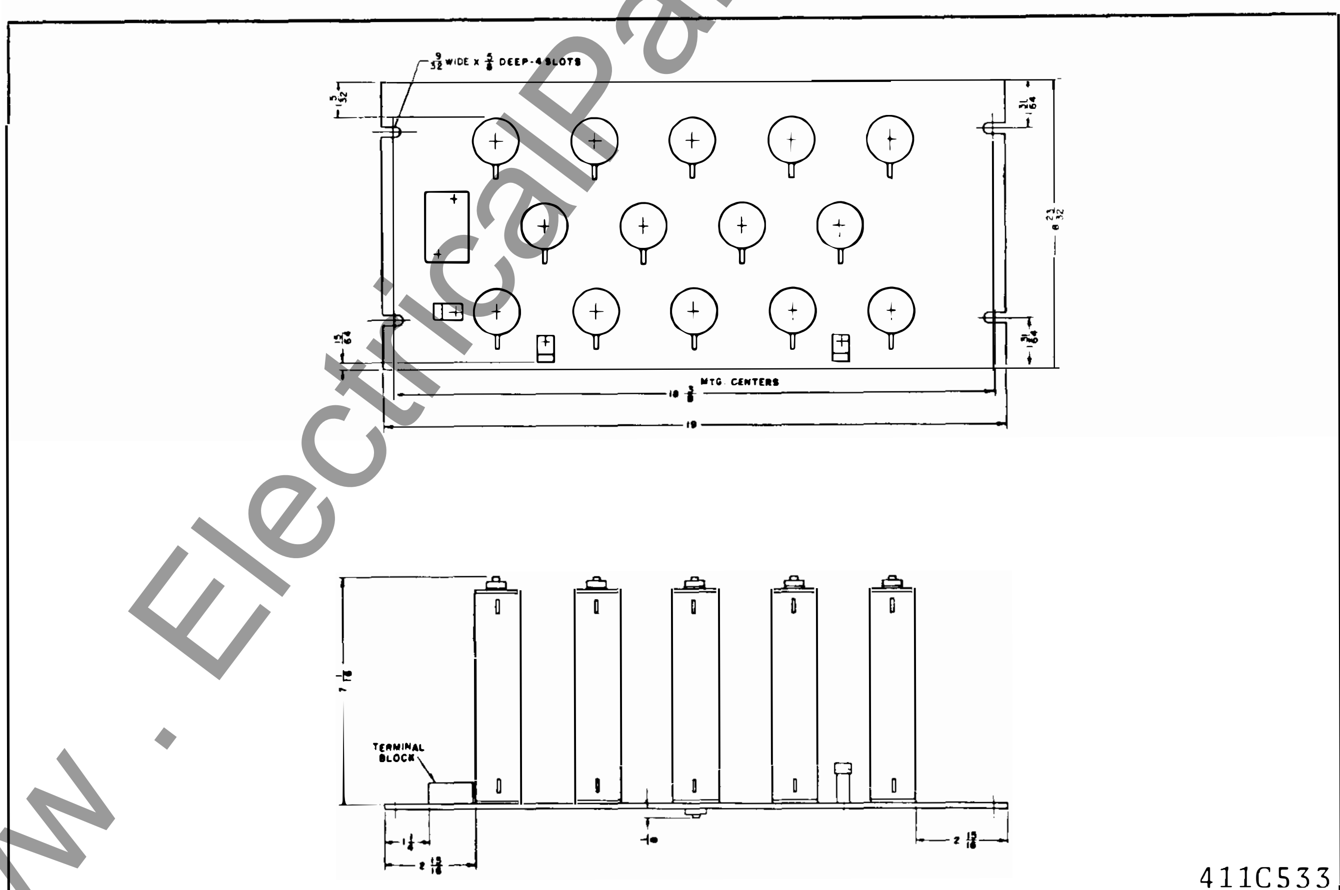


Fig. 16. Outline of External Resistor Unit for 250-Volt Operation.

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RELAY-INSTRUMENT DIVISION

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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

RESERVE SIGNAL DETECTOR FOR TC AND KR CARRIER

APPLICATION

The reserve signal detector is a device used to detect changes in received signal level on a power-line carrier channel. The relaying receiver output current is saturated at normal received signal levels. Thus, even a substantial reduction in the received signal may not give a corresponding drop in receiver output current. The reserve signal detector makes it possible to detect such changes in signal level before the signal drops to a low enough value to cause an incorrect relay operation.

CONSTRUCTION

The reserve signal detector is available in two different mechanical designs; one for switchboard mounting, and one for rack mounting (19" panel). The unit for switchboard mounting is shown in Figure 1 which includes outline dimensions and schematic wiring. Figure 2 shows the outline of the rack-mounting unit, and Figure 3 is the internal schematic for this design. Electrically both units consist of a fixed resistor, a variable resistor, and a normally open pushbutton connected in series.

OPERATION

The resistors and pushbutton of the reserve signal detector are connected into the transmitter carrier-start circuit, effectively functioning as a separate transmitter output control. This control is obtained by varying the d-c voltage to the amplifier stage following the crystal oscillator in either the KR or TC transmitter. With TC set, the output will not drop appreciably until sufficient resistance has been inserted to drop the voltage across zener diode CR101 below its 20-volt breakdown. The adjustable resistor is effective over a 40-db range of transmitter output. If a fault occurs while a reserve signal test is being made (with reduced transmitter output), operation of any carrier-start protective relay will instantly restore full output as long as required for the relaying function. The connections of the reserve signal detector into the carrier-start circuit are shown on the overall schematic which applies to a particular order.

ADJUSTMENT

Because of differences in transmitter output, supply voltage, and service conditions, it is not practical to have a calibrated dial for this unit. However, calibration may be made at installation by recording output (either db or volts) at various knob settings of R1. Then, by depressing pushbutton S1 and adjusting the R1 dial so as to obtain one-half the normal saturated receiver output current (on a clear dry day), any increase in line attenuation at a later time may be noted as the difference between the original setting, and that required to obtain the one-half maximum receiver output current at the time of checking. The normal procedure for this test is to start with the knob full counterclockwise, and rotate slowly until the remote receiver output drops to half its maximum value.

NOTE: The nominal "one-half maximum" value for the TC set is 100 ma, and for the KR set, 10 ma. Since these values are half way up a steep curve, it may be rather difficult to adjust to exactly 10 or 100 ma. If the receiver output current is within ± 20 per cent of the nominal 10 or 100 ma figure, any attenuation figures will be correct within one db.

If communication between stations on a line section makes the foregoing periodic adjustment procedure inconvenient, there is a second method of using the reserve signal detector. First, set the receiver sensitivity to the desired margin for deterioration of signal. Depending on power company standards, this will usually be somewhere between 6 and 15 db. Now on a clear dry day, close S1 and increase R1 setting until the remote receiver output current drops 20 per cent. Leave the control at this point. At another time when a reserve signal test is to be made, it is necessary only to close the S1 pushbotton and have the remote operator note the receiver output current. If it does not drop more than 20 per cent or so, the desirable receiver margin still exists. If the receiver output drops to a low value or to zero, it indicates that the original margin no longer exists. This could mean increased line loss, reduced transmitter output, reduced receiver sensitivity, or a combination of these factors.

PARTS LIST

Symbol	Description	Style
R1	100-K Pot.	1475074
R2	2000-ohm resistor	1267296
S1	Pushbutton Switch	327C854H01

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, replacement parts can be furnished, in most cases, to customers who are equiped for doing repair work. When ordering parts, always give the complete nameplate data as well as the part identification as given in the Parts List.

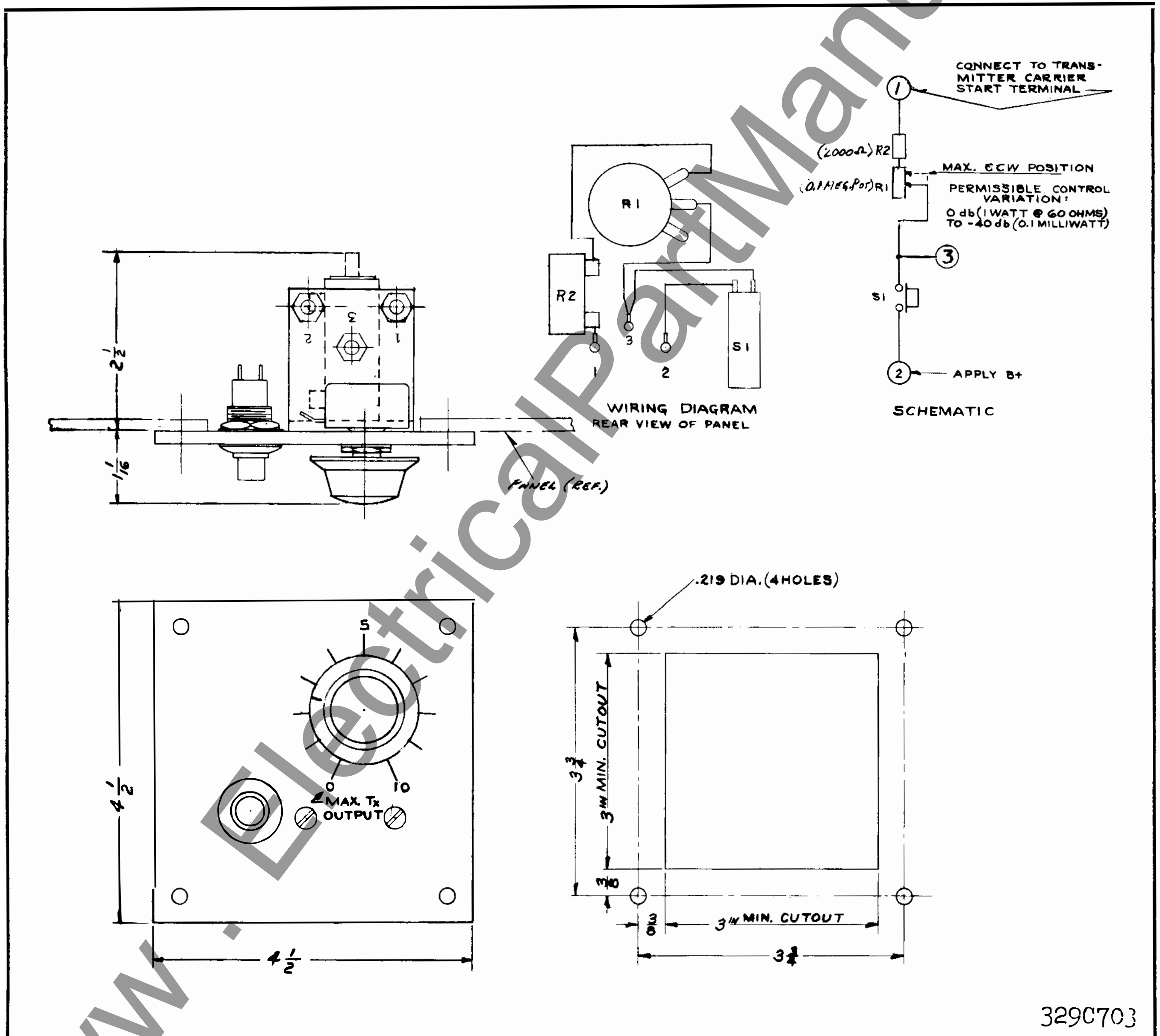

Fig. 1. Reserve Signal Detector for Panel Mounting.

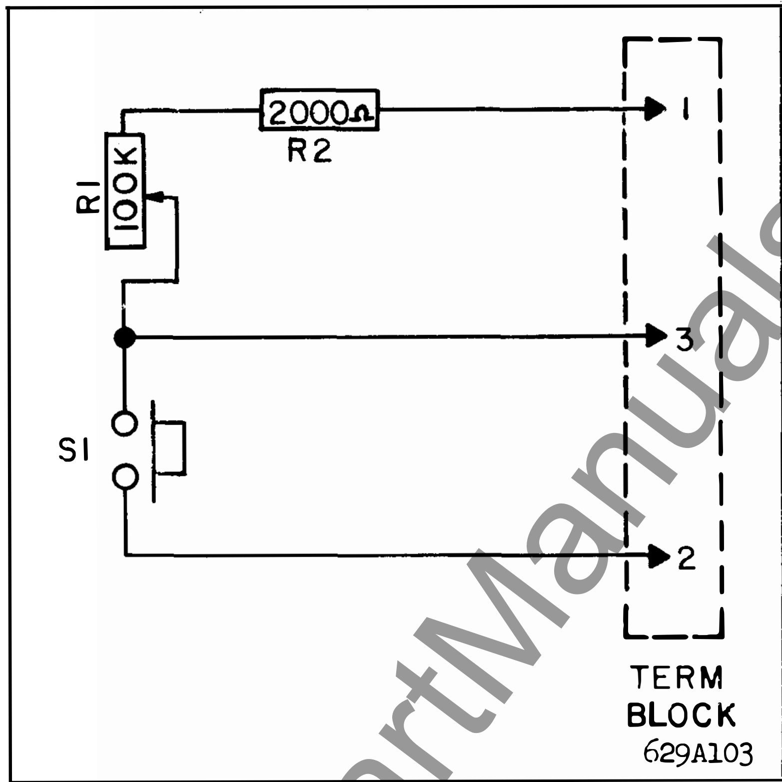

Fig. 2. Reserve Signal Detector for 19-inch Rack Mounting.

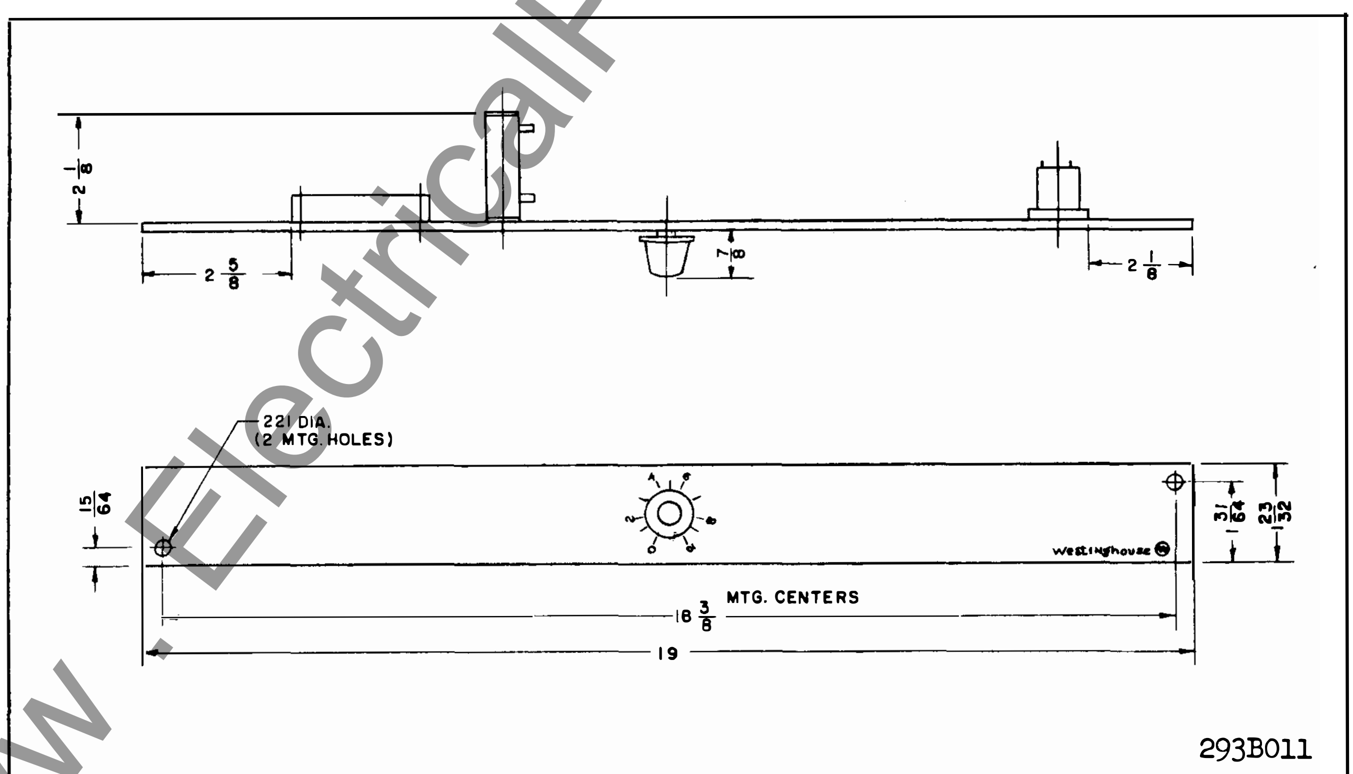

Fig. 3. Reserve Signal Detector for 19-inch Rack Mounting.

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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TC VOICE ADAPTER
Style 408C020G02
Style 408C020G01

APPLICATION

The type TC Voice Adapter is used to provide a voice channel between type TC carrier sets at different locations. Simple "push-to-talk" operation is provided using a handset which can be plugged into jacks in the Voice Adapter or mounted on an associated switchboard panel.

CHARACTERISTICS

The TC Voice Adapter has sufficient gain to provide 30 to 50 per cent modulation of the carrier transmitter, with a normal speaking voice level. The received audio signal level is adjustable, through a volume control mounted on the Voice Adapter, up to approximately zero dbm level. When transmitting, the Voice Adapter circuit energizes the transmitter to an unmodulated level of 7.5 to 14 db less than for a relaying operation to allow satisfactory modulation.

CONSTRUCTION

The unit is mounted in a metal box chassis consisting of a cover and a frame. A 12-terminal plug on the back of the unit allows it to be plugged into a TC transmitter-receiver. With the exception of the telephone jacks, all electrical components are mounted on printed circuit board. Connections between this board and the 12-terminal plug are made through flexible leads. For maintenance purposes, the printed circuit board may be unfastened and swung out away from the chassis after removing the cover of the box.

OPERATION

The circuit consists of three grounded emitter transistor stages which include an RF amplifier, a power detector and an audio amplifier (see Internal Schematic). When receiving, the RF input signal passes from the coaxial cable connection on the Transmitter-Receiver, through a portion of the input filter into the receiver section of the Voice Adapter. The signal is then fed through the level control R-1 to the RF amplifier Q-1. This stage is transformer coupled to the power detector circuit Q-2 which in turn drives the base of audio output stage Q-3. This base drive is applied through capacitor C-6 and relay contacts K-1A. The signal is amplified by transistor Q-3 and then transformer-coupled through T-2 to the telephone receiver line. This connection is made through relay contacts K-1B and K-1C. There is no AVC action in these receiver circuits, so it is necessary to adjust the input control R-1 for the best listening level.

The audio output stage Q-3 serves two functions. It is the output stage for the receiver section previously explained and it also serves as the modulator when transmitting. This is accomplished by relay K-1. Pressing the pushbutton on the test telephone energizes this relay and also closes the circuit which provides microphone current. The microphone output is applied to the base of amplifier Q-3 through capacitor C-7 and relay contacts K-1A. When relay K-1 is energized, contact K-1A is switched to select the speech input signal at capacitor C-7 and open the receiver circuits from capacitor C-6. Transistor Q-3 again serves as an amplifier and its output eventually reaches resistor R-119 and capacitor C-107 in the transmitter-receiver through relay contacts K-1B and K-1C. These same contacts disconnect the telephone receiver. Signal applied to the R-50 and C-14 combination will modulate the transmitter.

The carrier transmitter must be unblocked before it is possible to transmit the modulated carrier signal. This is accomplished by applying carrier-start voltage to the transmitter through contacts K-1D in the Voice Adapter. Energizing relay K-1 in the adapter closes contacts K-1D which supply carrier-start voltage to the transmitter-control circuit. This unblocks the emitter circuit of Q-103 in the transmitter which then permits transmission of carrier. The d-c voltage applied to this bleeder circuit by the adapter is about ½ the voltage supplied when a relaying function occurs. Therefore, the unmodulated transmitter output when unblocked by the Voice Adapter is from 7.5 db to 14 db less than the output when unblocked for a relaying operation. This differential is necessary to provide proper blocking of speech when a relaying function occurs.

As previously mentioned, voice communication is a secondary function and does not interfere with the primary function of relaying. To accomplish this, it is necessary to block the audio output stage Q-3 on the adapter whenever a relaying function occurs. The D-C voltage which unblocks the carrier transmitter is also implied to the base of transistor Q-3 through a voltage-dividing network consisting of resistors R-20 and R-11, plus the diode CR-1.

When a relaying function occurs, the voltage developed across resistor R-11 is sufficiently high to drive the base of stage Q-3 positive with respect to the emitter and therefore, blocks the circuit. This action prevents the speech modulation of the carrier signal. Effectively, a voice conversation carried on over a relaying channel will be interrupted instantly when a relaying operation occurs.

On the other hand, as previously explained, the start voltage supplied by the adapter is less than half the start voltage supplied by the transmitter-receiver when a relaying operation occurs. Because of this difference in carrier-start voltages, the Voice Adapter when modulating, does not block stage Q-3. The voltage developed across resistor R-11 is not great enough to block transistor Q-3.

Telephone Usage

Telephone jacks are provided as an integral part of the adapter to accommodate a Westinghouse S#330 C678H04 noise cancelling handset. This telephone is an auxiliary and is not an integral part of the unit. It employs a push-to-talk button which must be pushed when transmitting and released when receiving. The side of the telephone plug marked "TOP" must be inserted into the corresponding socket marked "TOP" on the chassis of the adapter. Since this telephone has a noise cancelling handset, it is necessary to speak directly into the microphone. Talking over, or under the mouthpiece will result in severe attenuation of the speech signal. Optimum results can be achieved only by speaking directly into the telephone.

Pushing the button on the telephone unblocks the local transmitter which will result in an alarm signal at the remote terminal. This alarm will continue to ring until the operator at the receiving terminal inserts his telephone or the transmitting telephone pushbutton is released. The two stations are then ready to carry on a conversation. Because of the reduced RF output of the transmitter when unblocked by the adapter, it may, in some cases be necessary to use the carrier test button for ringing.

When used with supervisory equipment audio, block is performed through a supervisory preference contact. The jumper normally connecting terminals 4 and 17 on the transmitter-receiver is omitted and in its place is connected this contact. When a supervisory function is initiated, this contact opens, removing the B+ supplied to the adapter. Voice communication is interrupted when this occurs.

Adjustments

There are no adjustments to make on this unit other than the adjustment of the input control R-1, to a comfortable listening level. No control is provided for modulation. Adjustment of the relaying transmitter-receiver is not required.

MAINTENANCE

Voltage and resistance values should be recorded in order to establish reference values which will be useful when checking the apparatus.

ELECTRICAL PARTS LIST

Circuit Symbol	Description
	CAPACITORS
C-1	0.25μf± 20%, 200VDC, Paper
C-2	0.1μf + 20%, 200VDC
C-3	Same as C-1
C-4	10 μf, −10% + 100% 50VDC
C-5	Same as C-2
C-6	Same as C-4
C-7	.01μf, ± 10% 300VDC
C-8	Same as C-4
C-9	Same as C-7
C-10	Same as C-4
C-11	100μf, −10% + 100%, 25 VDC
C- 12	50μf, −10%, + 100%, 50vdc
C-13	Same as C-4
	DIODES
CR-1	IN63
CR-2	IN63
	JACKS
J-1	Telephone Jack
J-2	Telephone Jack
	RELAY
K-1	48V, 1000-Ohm Coil, 4 Transfer contacts
	REACTOR
L-1	50-mh Shunt Reactor
	PLUG
P-105	12 Circuit Voice Adapter Plug
	TRANSISTORS
Q-1	2N274
Q-2	2N274
Q-3	2N525
	RESISTORS
R-1	2.5K, ±30%, 1/4 W, Pot.
R-2	1K, ±5%, ½ W
R-3	3.9K ±5%, ½ W
R-4	560 Ohms, ± 10%, ½ W
R-5	2.2K, ±10%, ½ W
R-6	39K, ±5%, ½ W
R-7	Same as R-2
R-8	Same as R-5
R-9	270 Ohms, ±5%, ½ W
R-10	Same as R-2
R-11	22K, ±10%, ½ W
R-12	820 Ohms, ±5%, ½ W
R-13	150 Ohms, ±10%, ½ W
R-14	220 Ohms, ±10%, ½ W
R-15	1K, ±10%, 2 W
R-16	470 Ohms, ±5%, 1W
R-17	750 Ohms, ±5%, 1W
R-18	3.9K, ±5%, 1W for style 408C020G01
R-18	12K, ±5%, 1W for style 408C020G01
R-19	470 Ohms, ±10%, ½ W
R-20	2.4K, ±5%, ½ W
	TRANSFORMERS
T-1	Impedance Ratio 25K/300 Ohms
T-2	25K/600 Ohms
	TEST POINTS
TP-1	Q3 Base
TP-2	Pos D.C. to transistors

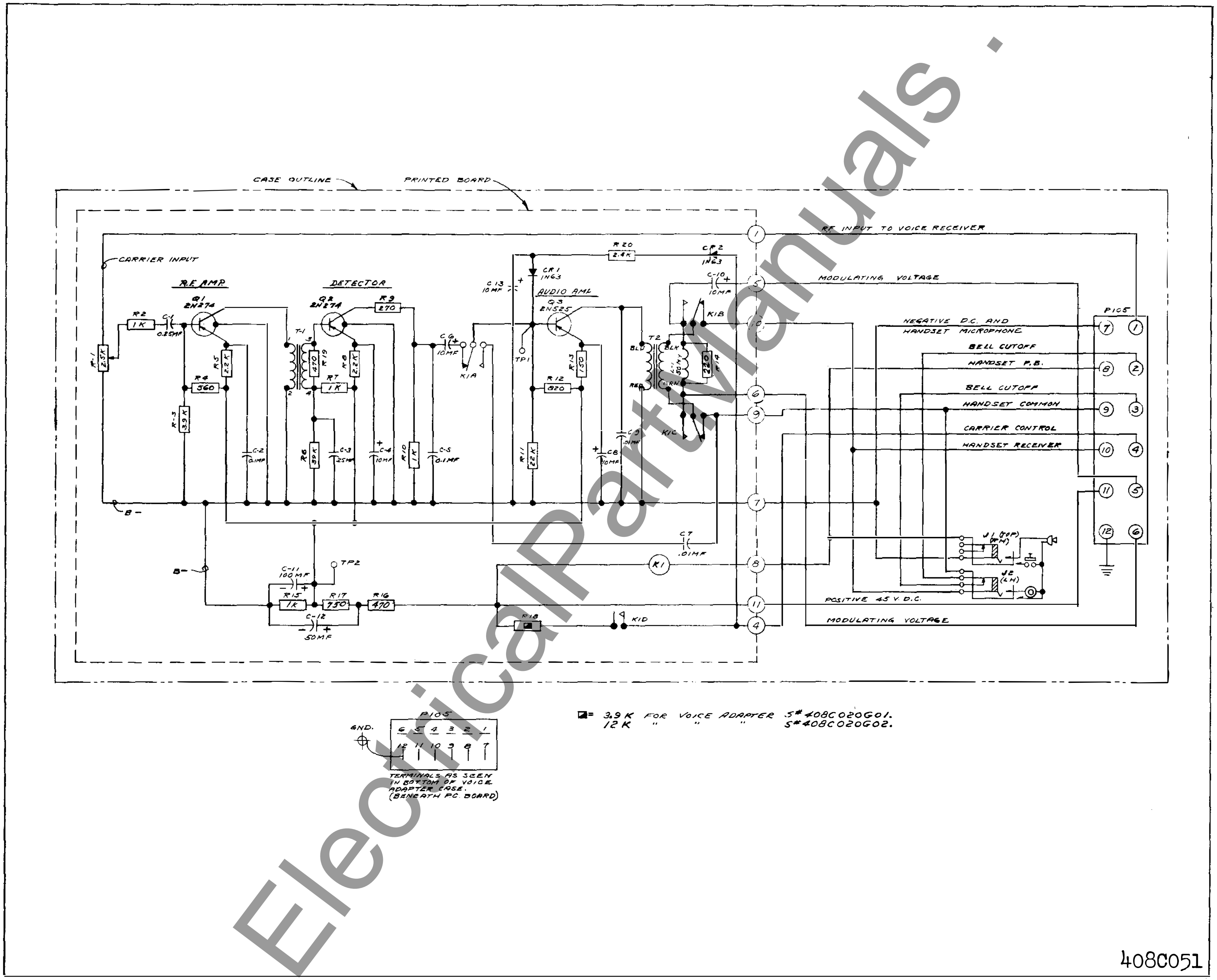

Fig. 1 Internal Schematic - Type TC Voice Adapter.

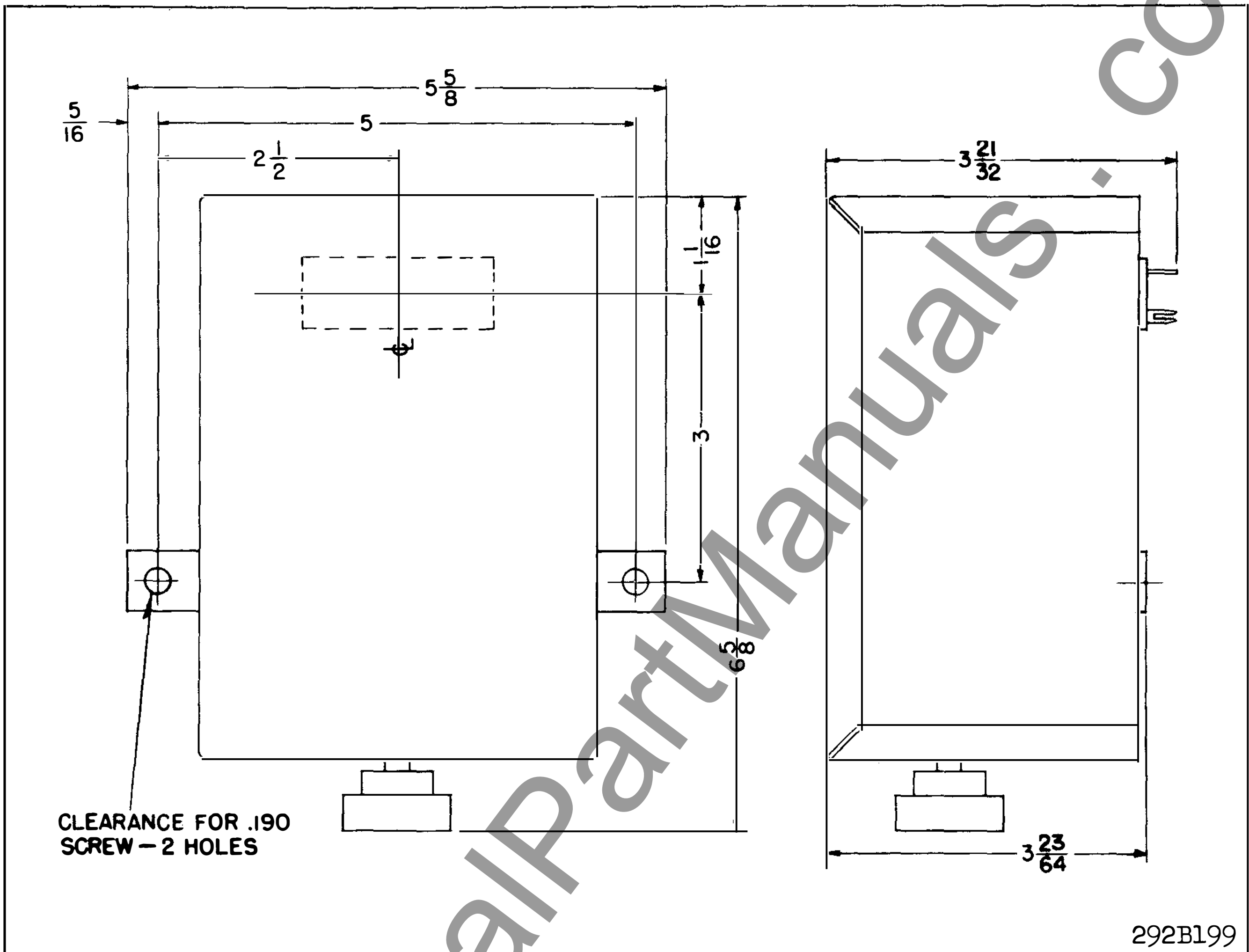

Fig. 2 Outline- Type TC Voice Adapter.

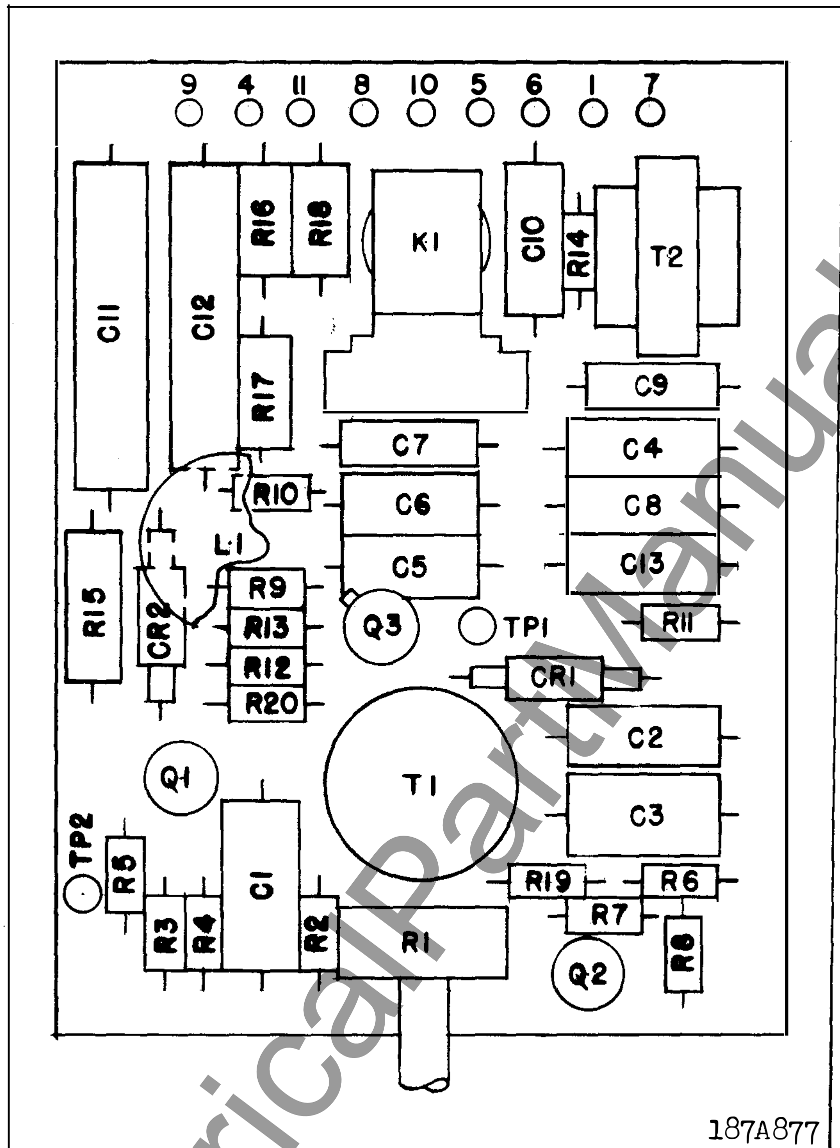

Fig. 3 Printed Circuit Board Component Location - Type TC Voice Adapter

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