DEPARTMENT OF THE ARMY TECHNICAL MANUAL

FIELD AND DEPOT MAINTENANCE

FREQUENCY SHIFT

CONVERTER CV-278/GR

This copy is a reprint which includes current pages from Change 1.

HEADQUARTERS, DEPARTMENT OF THE ARMY
AUGUST 1959

TECHNICAL MANUAL

Field and Depot Maintenance

FREQUENCY SHIFT CONVERTER CV-278/GR

TM 11-5805-210-35
CHANGES No. 1

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *21 February 1963*

TM 11-5805-210-35, 27 August 1959, is changed as follows:

Page 2, paragraph 1*b*. Add the following to the list of technical manuals.

TM 11-5815-266-20P
TM 11-5815-266-35P

Page 3, paragraph *1d.* Delete subparagraph *d* and substitute:

d. Forward comments on this publication direct to: Commanding Officer, U.S. Army Electronics Materiel Support Agency, ATTN: SELMS-MP, Fort Monmouth, N.J. (DA Form 1598 (Record of Comments on Publications), (DD Form 2496 (Disposition Form), or letter may be used.)

Add subparagraph *e* after subparagraph *d*.

e. Refer to the latest issue of DA PAM 310-4 to determine whether there are new editions, changes or additional publications pertaining to your equipment. Department of the Army Pamphlet. No. 310-4 is a current index of technical manuals, technical bulletins, supply bulletins, lubrication orders, and modification work orders that are available through publications supply channels.

The index lists the individual parts (-10, -20, -35P, etc.) and the latest changes and revision of each equipment publication.

Page 17, paragraph 23, chart. Make the following changes:

Item 2. Change "TM 11-2661" to: TM 11-6625-316-12.

Item 3. Change "TM 11-5083" to: TM 11-6625-274-12.

Item 7. Change "Multimeter ME-77/U" to "Multimeter AN/URM-105" and (change "See note" to: TM 11-6625-203-12.

Item 10. Change "See note" to: TM 11-6625-262-15.

Last item. Change "See note" to: TM 11-6625-320-12.

Page 30, paragraph 42. Add the following note below the paragraph heading:

Note. **Use the following procedures to check and adjust the alignment of transformer T101 and impedance network Z101. These circuits are adjusted at the factory to accept an if. of 455 kc from the associated receiver.**

Page 31. Add chapter 3.1 after chapter 3.

CHAPTER 3.1
FOURTH ECHELON TESTING PROCEDURES

43.1. General

a. Testing procedures are prepared for use by Signal Field Maintenance Shops and Signal Service Organizations responsible for fourth echelon maintenance of signal equipment to determine the acceptability of repaired signal equipment. These procedures set forth specific requirements that repaired signal equipment must meet before it is returned to the using organization. The testing procedures may also be used as a guide to test equipment repaired at third echelon if the proper tools and test equipment are available. Summary charts of the tests and performance standards are given in paragraph 43.9.

b. Comply with the instructions preceding the body of each chart before starting the procedures given in the chart. Follow in sequence the step-by-step instructions for each test procedure; *do not vary the sequence.* For each step, perform all the actions required in the *Test equipment control settings* and *Equipment under test controls settings* columns; then perform each of the actions given in the *Test procedures* column and verify the result obtained; use the data given in the *Performance standards* column as a standard. Record the test results obtained for the standard in the *Test indication* column of the test and performance standards chart (par. 43.9).

43.2. Test Equipment and Material Required

All test equipment and material required to perform the testing procedures in this chapter are listed in *a* and *b* below and are authorized under TA 11-17 (Signal Field Maintenance Shops) and TA 11-100 (Allowances for Signal Corps Expendable Supplies for Signal Field Maintenance Shop, Continental United States), or TOE 158D (Signal Depot Company) and TA 11-101 (11-158D) (Allowance of Signal Corps Expendable Supplies for Signal Depot Company); or are repair parts items authorized for stockage at fourth echelon level. Specific types of test equipment were used to perform these fourth echelon testing procedures. If these testing procedures are performed with other models or types of test equipment, make allowances for test connections and switch and control settings that may differ from those specified in the testing procedures.

a. Test Equipment.

Item	Federal stock No.	Publication
RF Signal Generator AN/URM-25F.	6625-243-0562	TM 11-5551E
Frequency Meter AN/TSM-16.	6625-542-1666	TM 11-6625-218-12-
Electronic Multimeter TS-505(*)/U[a].	6625-243-0562	TM 11-6625-239-12, 11-5511
Multimeter TS-352(*)/U[b]-	6625-242-5023	TM 11-5527
Power Supply PP-1097A/G.	6130-669-6640	TM 11-5111
Line Unit BE-77-(*)[c] - -	5805-162-6302	TM 11-359

[a] Electronic Multimeter T505(*)/U indicates Electronic Multimeters TS-505A/U and TS-505B/U, and Multimeters TS-505C/U, TS-505D/U. and TS505E/U.
[b] Multimeter TS-352(*)/U indicates Multimeters TS-352/U, TS-352A/B, and TS-352B/U.
[c] Line unit BE-77-(*) indicates Line Units BE-77-A, BE-77-B, and UE-77-C.

b. Material.

Item	Federal stock No.	Publication
Telephone Carrier System Test Facilities Kit MK-155/TCC; the junction panel 600-volt test cable assembly is required.	6625-603-9523	TB SIG 328
Cable Assembly, Special Purpose, Electrical CX-4547/U (5 ft 6 in.) (par. 43.3)[a].	5995-617-1876	TM 11-5815-204-10-
Hookup wire, approx 4 ft; any hookup wire, #16 or #18 AWG may be used.		

[a] Part of Radio Teletypewriter Sets AN/GRC-46, AN/GRC-46B, and AN/VRC-29.

43.3. Fabrication of Test Cable

To connect test equipment to the PRINTER receptacle circuits of the CV-278/GR (figs. 21.2 and 21.3), construct a test cable as follows:

a. Obtain Cable Assembly, Special Purpose, Electrical CX-4547/U (5 ft. 6 in.) (part of Radio Teletypewriter Sets AN/GRC-46, AN/GRC-46A, AN/GRC-46B, and AN/VRC-29) (par. 43,2b).

b. Cut the CX-4547/U at the 9-pin connector end; leave the 4-pin connector intact on the cable.

c. Remove approximately 18 inches of the outer jacket from the cut end and M inch from each conductor.

d. Tin the tips of each conductor.

e. Check to make sure that the wires connected to the 4-pin connector are as follows:

(1) White wire to pin A.
(2) Green wire to pin B.
(3) Red wire to pin C.
(4) Black wire to pin D.

43.4. Modification Work Orders

No modification work orders (MWO's) were published for this equipment as of the date of this change. If the equipment is subsequently modified, any changes in the test results will be published as a concurrent Changes. A listing-of the current MWO's and Changes is contained in DA Pamphlet 310-4.

43.5. Physical Tests and Inspections

a. Equipment Required. None.

b. Conditions. Remove the equipment from its transit case.

c. *Procedure.*

Equipment under test control settings	Test and inspection procedures	Performance standards
Controls may be in any position.	*a*. Inspect front panel for damaged, loose, or missing screws, knobs or other parts.	*a*. No evidence of damaged, loose, or missing screws, knobs, or parts is found.
	b. Inspect front panel and chassis (top and bottom) for dirt, signs of excessive wear or damage, loose or missing components and hardware.	*b*. Front panel and chassis are clean. No evidence of excessive wear, damage, or loose or missing components or hardware is found.
	c. Inspect condition of finish for rust, corrosion, and spots where bare metal is exposed.	*c*. Painted surfaces do not show bare metal spots and no evidence of rust or corrosion is seen. *Note.* Touchup painting is recommended whenever practicable. Do not polish with abrasives, or paint screwheads, binding posts, and plated fasteners (TM 9-213, Painting Instructions for Field Use).
	d...Operate front panel switches	*d.* Switches operate smoothly with positive action to indicated position.
	e. Inspect condition of cable receptacles for broken, bent, or missing receptacle pins.	*e.* No evidence of broken, bent, or missing receptacle pins.
	f. Inspect chassis; be sure tubes, tube shields, and tube clamps are in proper places.	*f.* Tubes, tube shields and tube clamps are in proper places.
	g. Check equipment for applicable MWO (par. 43.4).	*g.* Equipment marked to indicate MWO, if applicable.

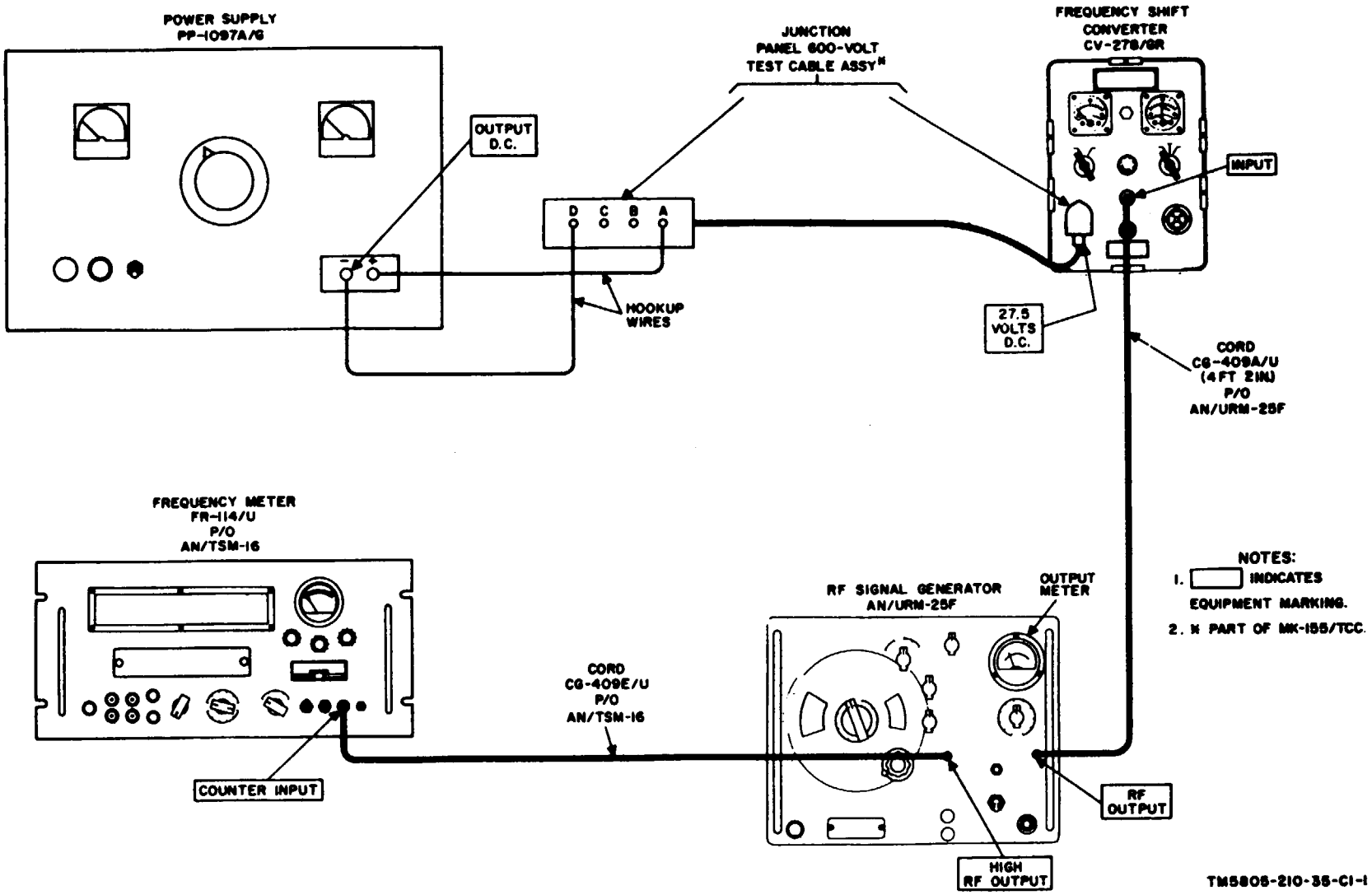

Figure 21.1. Test setup for current drain and meter tests.

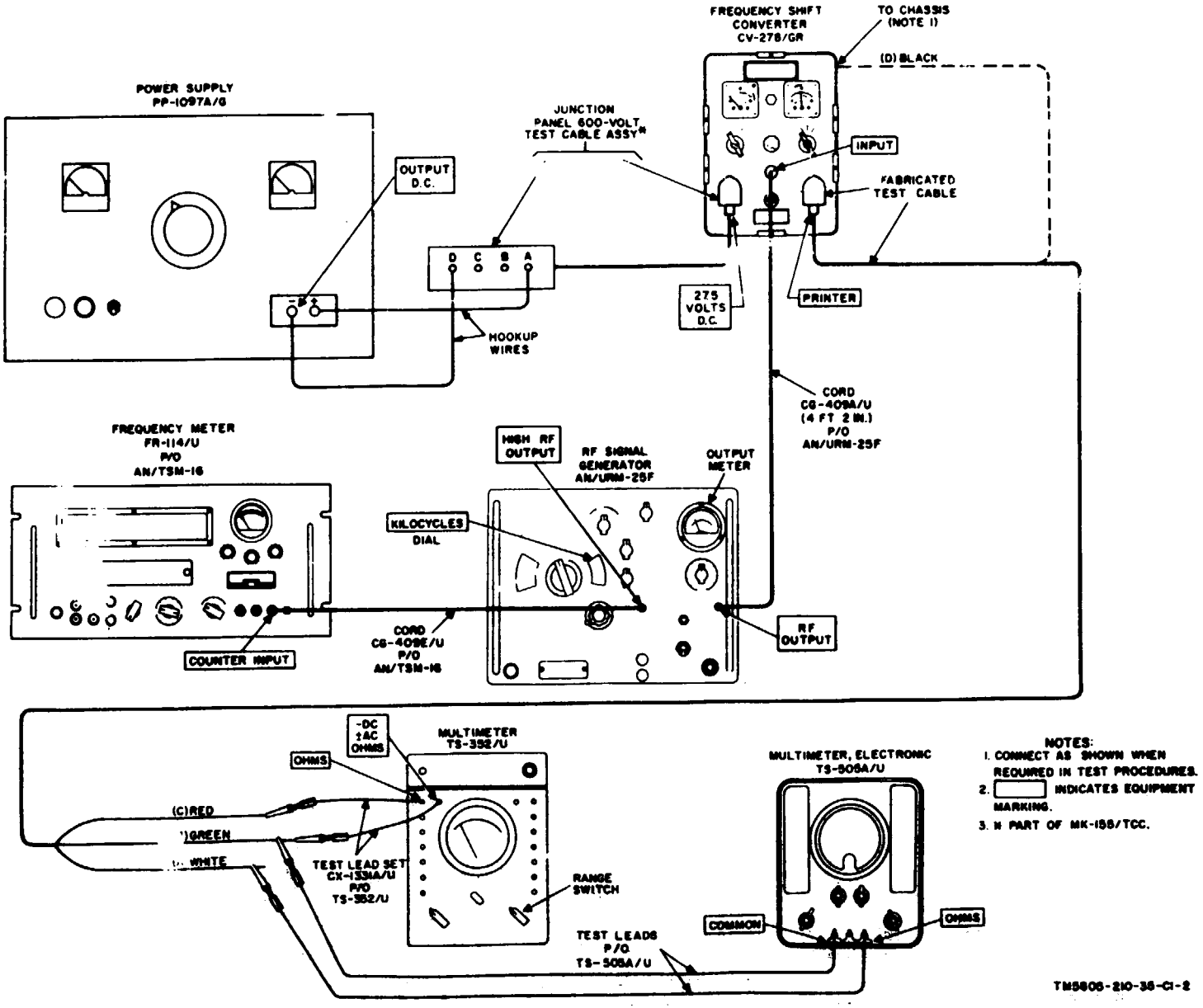

Figure 21.2. Test setup for mark-hold, frequency-shift sensitivity, and neutral output tests.

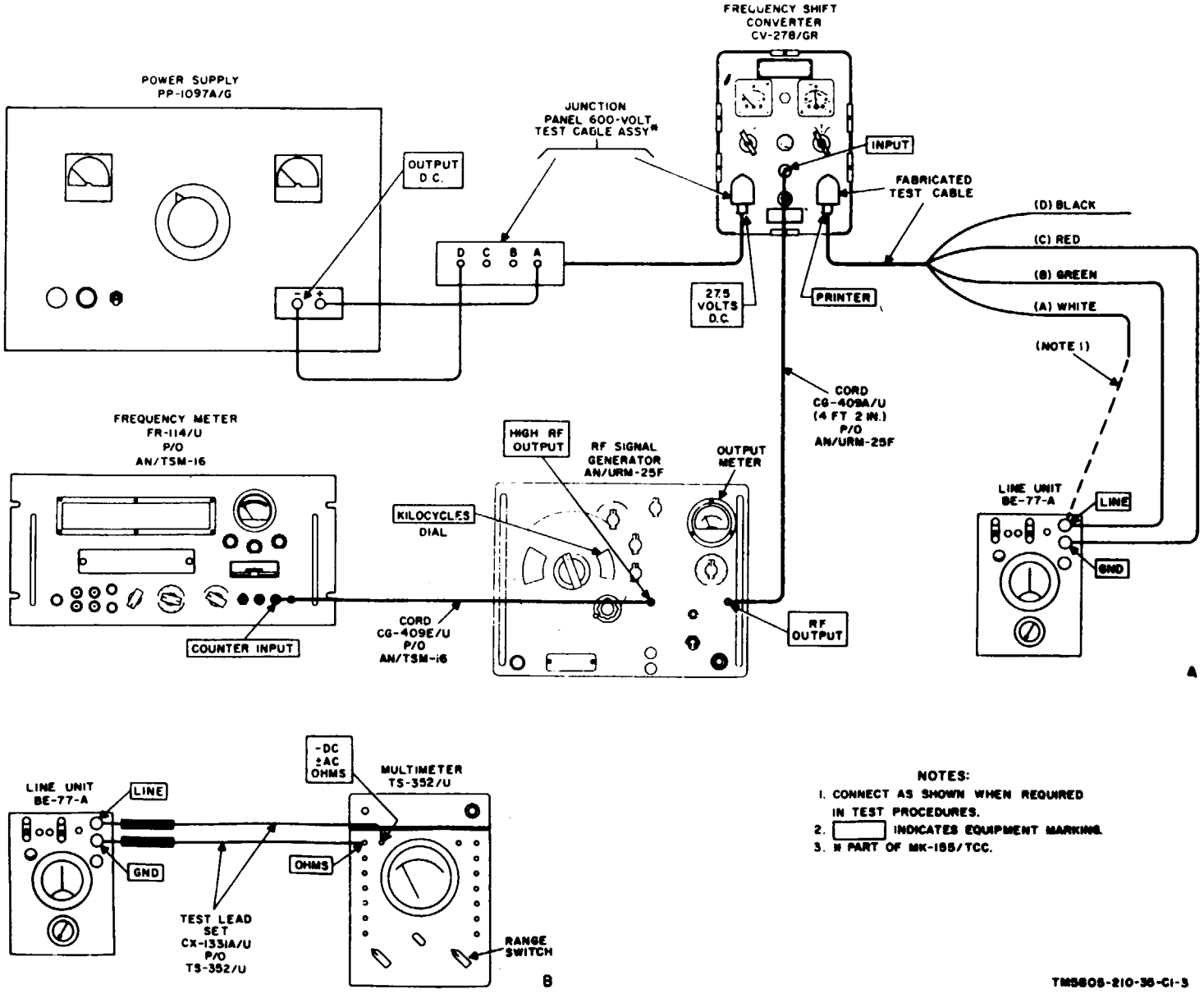

Figure 21.3. Test setups for polal output tests

43.8. Polal Output Tests

(fig. 21.3)

Perform the test procedures given in paragraphs 43.6 and 43.7 before proceeding.

a. Test Equipment and Material. The test equipment and material listed in paragraph 43.7*a* are required, except substitute Line Unit BE-77-A for the TS-505A/U.

b. Test Connections and Conditions.

(1) Remove the chassis of the CV-278/GR from its case. Remove the clamps that hold relay K101 and dummy plug P101 in place. Remove relay K101 from its receptacle and insert dummy plug P101 in its place.

(2) Adjust the TS-352/U as follows:

(a) Operate FUNCTION switch to OHMS and the range switch to RX1.

(b) Connect test leads of TS-352/U to pin jacks of TS-352/U as shown in B, figure 21.3 and touch the tips of the test leads together.

(c) Adjust the OHMS ZERO ADJ. Control until the ohmmeter indicates 0 ohm.

(3) Connect the TS-352/U as shown in A, figure 21.3. Adjust the LINE RHEOSTAT control of the BE-77-A until the ohmmeter of the TS-352/U indicates 120 ohms.

(4) Disconnect the test leads of the TS-352/U from the BE-77-A and reconnect the BE-77 as shown in A, figure 21.3. The other connections shown in A, figure 21.3 are unchanged from those shown in figure 21.1.

c. Procedure.

Note. A summary chart of the tests and performance standards is given in paragraph 43.9*e.*

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	Performance standard
			Mark Signal Circuit	
1	Controls and switches of PP-1097A/G, AN/URM-25F, and FR-114/U unchanged from settings last used in paragraph 43.7*c*, except: *PP-1097A/G* POWER: ON *AN/URM-25F* TUNING: adjust until FR-114/U indicates 455,425 cps.	*CV-278/GR* SERVICE: NOR	*a.* Allow equipment a 15-minute warmup period ..... *b.* Note BE-77-A meter indication ..... *c.* Operate SERVICE switch of CV-278/GR to REV and note BE-77-A meter indication. *d.* Operate SERVICE switch of CV-278/GR to NOR ..... *e.* Adjust TUNING dial of AN/URM-25F until FR-114/U indicates 454,575 cps. *f.* Note BE-77-A meter indication ..... *g.* Operate CV-278/GR SERVICE switch to REV and note BE-77-A meter indication.	*a.* None. *b.* 20 ma or more to the right of 0. *c.* 0 ma. *d.* None. *e.* None. *f.* 0 ma. *g.* Same indication as obtained in *b* above.
			Space Signal Circuit	
2	Unchanged, except: *PP-1097A/G* POWER: OFF	Unchanged, except SERVICE: NOR	*a.* Disconnect green (B) wire from GND terminal of BE-77-A and connect white (A) wire to line terminal of BE-77-A (A, fig. 21.3). *b.* Operate POWER switch of PP-1097A/G to ON and allow equipment a 5-minute warmup period. *c.* Note BE-77-A meter indication ..... *d.* Operate SERVICE switch of CV-278/GR to REV and note BE-77-A meter indication. *e.* Turn off power and disconnect all test equipment *f.* On CV-278/GR, remove dummy plug P101 from relay K101 receptacle and reinsert relay K101 in its receptacle. Reinsert dummy plug P101 in its receptacle. Replace clamps on relay K101 and dummy plug P101.	*a.* None *b.* None *c.* Same indication as obtained in step *b* No. 1*b*. *d.* 0 ma. *e.* None *f.* None

43.9. Summary Charts of Tests and Performance Standards

Typical summary charts that can be prepared to record the test indications covered in paragraphs 43.6 through 43.8 are given in *a, b*, and *c* below.

a. Current Drain and Meter Tests.

Note. The test procedures are covered in paragraph 43.6*c.*

Item No.	Test	Performance standard	Test indication
1	CURRENT DRAIN.....	Approximately 2.25 amperes.	
2	DISCRIMINATOR METER		
	a. At input of 455,000 cps:	*a.* Indications are	
	(1) Meter sensitivity	(1) To right and left of 0 and adjustable to 0.	
	(2) At NOR and REV positions.....	(2) Not more than one scale division to left or right of 0.	
	b. At input of 455,525 cps:	*b.* Indications are	
	(1) NOR position.....	(1) Between 3 and 5 meter scale divisions to right of 0	
	(2) Rev position	(2) Between 3 and 5 meter scale divisions to left of 0.	
	c. At input of 454,575 cps:	*c.* Indications are	
	(1) NOR position.....	(1) Between 3 and 5 meter scale divisions to left of 0.	
	(2) REV position	(2) Between 3 and 5 meter scale divisions to right of 0.	
3	SIGNAL INPUT METER:		
	a. At 20 uv input.....	*a.* Between 0 and first meter scale division.	
	b. Up to 100 uv input.....	*b.* Increase progressively past center scale.	

b. Mark-Hold, Frequency-Shift Sensitivity, and Neutral Output Tests.

Note. The test procedures are covered in paragraph 43.7*c.*

Item No.	Test	Performance standard	Test indication
1	MARK-HOLD CIRCUIT		
	a. Initial indication at 455,425 cps input.	*a.* TS-352/U indicates between 4 and 10 ohms and TS-505A/U indicates 0 ohm.	
	b. At 454,575 cps input	*b.* Same as *a* above.	
	c. With ATTENUATOR switch of AN/URM-25 at 0.3.	*c.* Same as *a* above	
	d. With black wire of fabricated test cable connected to chassis.	*d.* Same as *a* above.	
	e. With NOR and REV switch positions	*e.* Same as *a* above.	
	f. With ATTENUATOR switch of AN/URM-25F at 300.	*f.* Same as *a* above.	
2	FREQUENCY-SHIFT SENSITIVITY AND NEUTRAL OUTPUT		
	a. At 455,150 cps input	*a.* Indications are	
	(1) Switch in NOR position	(1) TS-352/U indicates 4 to 10 ohms; TS-505A/U indicates 0 ohm.	
	(2) Switch in REV position.....	(2) TS-352/U indicates 0 ohm; TS-505A/U indicates 4 to 10 ohms.	
	b. At 454,850 cps input	*b.* Indications are	
	(1) Switch in REV position.....	(1) Same as *a*(2) above.	
	(2) Switch in NOR position	(2) Same as *a*(1) above.	
	c. At 454,500 cps input	*c.* Same as *a*(2) above	
	d. At 455,500 cps input	*d.* Same as *a*(1) above	

c. Polal Output Tests.

Note. The test procedures are covered in paragraph 43.8*c.*

Item No.	Test	Performance standard	Test indication
1	MARK SIGNAL CIRCUIT		
	a. At 455,425 cps input	*a.* Indications are	
	(1) With switch at NOR	(1) 20 ma or more to right o 0.	
	(2) With switch at REV	(2) 0 ma.	
	b. At 454,575 cps input:	*b.* Indications are	
	(1) With switch at NOR	(1) 0 ma.	
	(2) With switch at REV	(2) Same indication as obtained in *a*(1) above	
2	SPACE SIGNAL CIRCUIT		
	a. With switch at NOR	*a.* Same indication as obtained in item No. 1*a*(1)	
	b. With switch at REV	*b.* 0 ma.	

Page 32, paragraph 45, chart, "Technical manual" column. Change "TM 11-858" to: TM 11-5820-334-10.

Page 35. Add paragraph 56 after paragraph 55.

56. Polal Output Test

To check the polal output of the converter follow the procedures in paragraph 43.8.

Figure 25 (foldout facing page 38). Make the following changes:

Delete the line between terminals 5 and 6 of T103 and draw a line between terminal 5 of T103 and the junction of R124, R122, and C113B.

Add the following to "Y101 484.3-KC:" (note 8).

Add the following to the notes.

8. THE 484.3-KC CRYSTAL IS USED WHEN AN IF OF 455 KC IS APPLIED TO INPUT RECEPTACLE J101. WHEN ANOTHER IF IS USED, THE CRYSTAL MUST BE CHANGED.

Page 39, appendix. Make the following changes.

Delete "TM 11-858" and substitute the following:

TM 11-5820-334-10 Operator's Manual, Radio Receiver R-392/URR.
TM 11-5820-334-20 Organizational Maintenance Manual, Radio Receiver R-392/URR.
TM 11-5820-334-35 Field and Depot Maintenance Manual, Radio Receiver R-392/URR.

Add the following

DA PAM 310-4 Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TM 11-359 Line Units BE-77, BE-77-A, BE-77-B, and BE-77-C.
TM 11-1214 Instruction Book for Oscilloscope OS-8A/U.
TM 11-2217 Distortion Test Sets TS-383/GG, TS-383A/GG, and TS-383B/GG.
TM 11-5057 Frequency Meter AN/USM-26.
TM 11-5094 Frequency Meters AN/URM-79 and AN/URM-82.
TM 11-5111 Power Supplies PP-1097A/G and PP-1097B/G.
TM 11-5511 Electronic Multimeter TS-505/U.
TM 11-5527 Multimeters TS-352/U, TS-352A/U, and TS-352B/U.
TM 11-5551E RF Signal Generator AN/URM-25F.
TM 11-5815-266-20P Organizational Maintenance Repair Parts and Special Tools List, Converter, Frequency Shift CV-278/GR.
TM 11-5815-266-35P Field and Depot Maintenance Repair Parts and Special Tools List, Converter, Frequency Shift CV-278/GR.
TM 11-6625-203-12 Operation and Organizational Maintenance, Multimeter AN/URM-105, Including Multimeter ME-77/U.

TM 11-6625-218-12	Operation and Organizational Maintenance, Frequency Meter AN/TSM-16.
TM 11-6625-274-12	Operator's and Organizational Maintenance Manual, Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U.
TM 11-6625-316-12	Operator and Organizational Maintenance Manual, Test Sets, Electron Tube TV-2/U, TV-2A/U, TV-2B/U, and TV-2C/U.
TM 11-6625-320-12	Operator's and Organizational Maintenance Manual, Voltmeter, Meter ME-30A/U and Voltmeters, Electronic ME-30B/U and ME-30C/U

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Br Svc Sch (2)	Def Elct Sup Cen (1)	11-592 (2)
GENDEP (OS) (2)	Def Tfc Mgt Svc (1)	11-597 (2)
Sig Sec, GENDEP (OS) (5)	USAECOM (5)	29-56 (2)

NG: State AG (3); units - same as active Army except allowance is one copy to each unit.
USAR: None.
For explanation of abbreviations used see AR 320-50.

TECHNICAL MANUAL

No. 11-5805-210-35

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *27 August 1959*

FREQUENCY SHIFT CONVERTER CV-278/GR

CHAPTER 1
THEORY

Section I. GENERAL

1. Scope

a. This manual covers field and depot maintenance for Frequency Shift Converter CV-278/GR. It includes instructions appropriate to third, fourth, and fifth echelons for troubleshooting, testing, alining, and repairing the equipment, replacing maintenance parts, and repairing specified maintenance parts. It also lists tools, materials, and test equipment for third, fourth, and fifth echelon maintenance. Detailed functions of the equipment are covered in paragraphs 4 through 20.

b. The complete technical manual for this equipment includes -

TM 11-5805-210-10
TM 11-5805-210-20
TM 11-5805-210-20P
TM 11-5805-210-35P

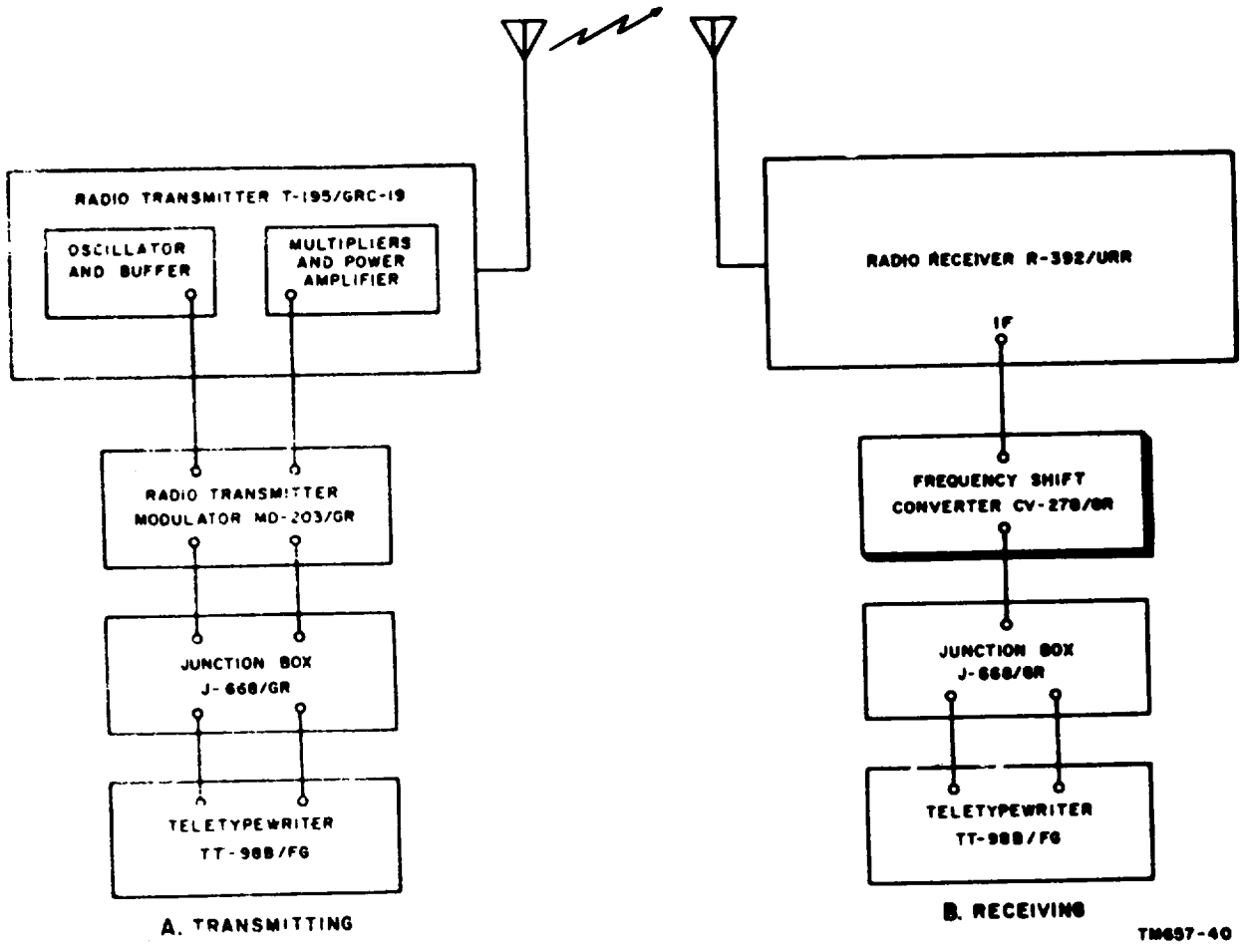


Figure 1. Radio teletypewriter communications system, simplified diagram.

c. For information on the operation of Frequency Shift Converter CV-278-GR as part of a complete system, refer to TM 11-5815-204-35.

d. Forward comments concerning this manual to the Commanding Officer, United States Army Signal Publications Agency, Fort Monmouth, N.J.

2. Forms and Records

For applicable forms and records, see paragraph 2, TM 11-5805-210-10.

3. System Application

Frequency Shift Converter CV-278/GR is a link in a complete radio teletypewriter communications system.

a. The teletypewriter signals developed in Teletypewriter TT-98B/FG (fig. 1) are supplied through Junction Box J-668/G8 to Radio Transmitter Modulator MD-203/GR. The modulator is connected directly into the exciter section of Radio Transmitter T-195/GRC-19 to produce shifts in the continuous-wave (cw) signal. The frequency shifts correspond to teletypewriter impulses. The teletypewriter signals are radiated by the transmitter antenna in the form of frequency-shift keyed (fsk) radio signals. The total frequency shift at the output of the transmitter is 850 cycles per second (cps) on any transmitter frequency. The frequency shifts 850 cps higher for a teletypewriter mark signal and back to the original frequency for a teletypewriter space signal. With no characters being transmitted, the radio frequency output rests at the higher (mark signal) of the two frequencies.

b. The frequency-shifted radio signals are intercepted by the receiver antenna and applied to Radio Receiver R-392/URR. The 455-kilocycle (kc) output receptacle of the receiver is connected directly to Frequency Shift Converter CV-278/GR. Frequency Shift Converter CV-278./GR converts the 455-kc receiver output to direct-current (dc) pulses suitable for operating the teletypewriter and reperforator printers. The dc pulses are supplied to the teletypewriters through Junction Box J-668/GR to Teletypewriter TT-98B-/FG.

Section II. THEORY OF FREQUENCY SHIFT CONVERTER CV-278/GR

4. General

Frequency Shift Converter CV-278/GR is designed to receive an intermediate-frequency (IF) signal of 450 to 500 kilocycles. The converter is intended for use with Radio Receiver R-392/URR but may be used with any other receiver having an IF output within the frequency range of 450 to .500 kc. The converter input circuits are adjusted at the factory to accept an IF of 455 kc. It will be necessary to readjust the input circuits of the converter if it is desired to operate the converter with an associated receiver having an IF other than 455 kc.

a. Radio Receiver R-392/URR receives the radio-teletypewriter signals with the 850-cps frequency shift. The intermediate-frequency output of the radio receiver contains the 850-cps shift. The two intermediate frequencies representing the high and the low frequencies are applied to the input of tile frequency-shift converted and are amplified in the RF amplifier stage (par. 6).

b. Radio receivers may have the direction of the frequency shift reversed in the IF output, with respect to the direction of the frequency shift in the radio signal received (which is a polarity or sense reversal of the received signal). Radio Receiver R-392/URR does riot have a polarity reversal of the IF output on any band. If the radio-frequency signal is being shifted from 3,000850 cps (mark) to 3,000,000 cps (space), the IF output of Radio Receiver R-392/URR is being shifted from 455,850 cps (mark) to 455,000 cps (space). These two resting frequencies are so close together that they pass through the mixer and subsequent stages of the fre-quency-shift converter with equal amplitudes, and present equal amplitudes to discriminator transformer T103 (par. 13).

c. Assume that a net is being set up. The control station transmits a teletype signal to which the remote receivers must be tuned. The transmitted signal will vary about an imaginary mid-frequency. Assume that the master oscillator in the transmitter is tuned to 3,000.000 cps. The output signal (after frequency shift keying) at the transmitter antenna will he 3,000,850 cps for mark condition, and, 3,000,000 for space condition. In order for the converter : function properly the receiver must be tuned to the midpoint of the 850 cps swing, 3,000,425 cps.

5. Block Diagram

The signal path is shown in the block diagram (fig. 2) and is discussed in *a* through *g* below. For complete circuit details, refer to the overall schematic diagram (fig. 25).

a. The IF signal from the receiver is applied to the IF input receptacle of the converter. The signal is then coupled through a tuned circuit to RF amplifier V101 for amplification prior to being applied to mixer V103. At the mixer stage, the signal heterodynes with the output of crystal oscillator V102, to produce an intermediate frequency of 29.3-kc. The 29.3-kc output signal of the mixer is developed across band-pass filter FL101. The filter functions to reject unwanted frequencies generated in the mixer.

b. First IF amplifier V105 amplifies the signal for application to stage output transformer T102. This transformer has a center-tapped secondary winding to provide two 29.3-kc signals with a phase difference of 180°.

c. The output of the band pass filter FL101 is also applied to the signal input amplifier V104. The output of V104 is rectified by CR101 and CR102 an dis then applied to signal input meter M101.

d. Second IF amplifiers V106 and V107 are used as separate amplifiers in each channel, and are coupled to discriminator drive stage V108. The drive stage ahs a dual tube and is used to increase the signal strength of the signals in both IF channels for application to discriminator stage V109.

e. Discriminator transformer T103 has dual channel inputs and outputs for use with dual discriminator rectifier V109. Rectifier unit V109 consists of four matched germanium diodes in a common envelope. Two of these diodes are connected to each of the two outputs of the discriminator transformer to comprise a separate discriminator circuit for each channel. The discriminator circuits are connected to give outputs of equal amplitude and opposite polarity for a given frequency change. Discriminator meter M102 is switched to the load resistors of either discriminator network by sections of the SERVICE switch. The meter indicates the polarity and the relative amount of frequency shift in the radioteletype signal.

f. Simultaneous positive and negative signal pulses are coupled to separate dc amplifier stages V110 and V111 through low-pass filters L103 and L104. The outputs of V110 and V111 are directly coupled to dual inputs of dc amplifier V112.

g. The dual outputs of V112 are connected through a section of the SERVICE switch. The dual outputs energize the keying relay when it is plugged into the octal socket or other equipment in the external circuit when the dummy plug is plugged into the socket. When the SERVICE switch is in NOR position and a mark signal is received, one output channel of V112 energizes the keying relay mark coil more than the other output channel. When in the REV position, the SERVICE switch reverses the connections of the plates of V112 to the mark and the space coils of keying relay K101 (or the coils of an external relay). The SERVICE switch reverses the mark and the space output by reversing the direction in which the relay operates. NOR position of the SERVICE switch provides a mark output for a received mark radio signal (frequency increase). REV position of the SERVICE switch provides a space output for the same mark radio signal.

6. RF Amplifier V101

(fig. 3)

The RF amplifier utilizes a type 26A6 pentode tube to amplify the input signal from receptacle J101 prior to being applied to mixer V103.

a. The input signal is applied to the low impedance (50 ohms) tap on autotransformer T101. Transformer T101 serves two purposes: to provide a low impedance input for the stage and to increase the amplitude of the signal by means of transformer action. The impedance between the tap and ground is matched when the interconnecting cable joins this circuit to the IF OUT receptacle of Radio Receiver R-392/URR. The fixed capacitor and the movable iron core inside the coil (in T101 assembly) serve to tune the input circuit of V101 over the 450- to 500-kc range.

b. Capacitor C101 couples the signal to the control grid (pin 1) of V101. The RF signal voltage is developed across control grid return resistor R101. Resistor R142 decreases the selectivity of the tuned circuit (T101) to insure sufficient bandwidth. Self-bias is developed by the tube current through cathode resistor R102. The suppressor grid (pin 2) is tied to the cathode (pin 7). The plate (pin 5) load for V101 is the tuned circuit of Z101. The tank of Z101 is tuned over the frequency range by the movable iron core. The screen grid of V101 is connected directly to the 27.5-volt supply

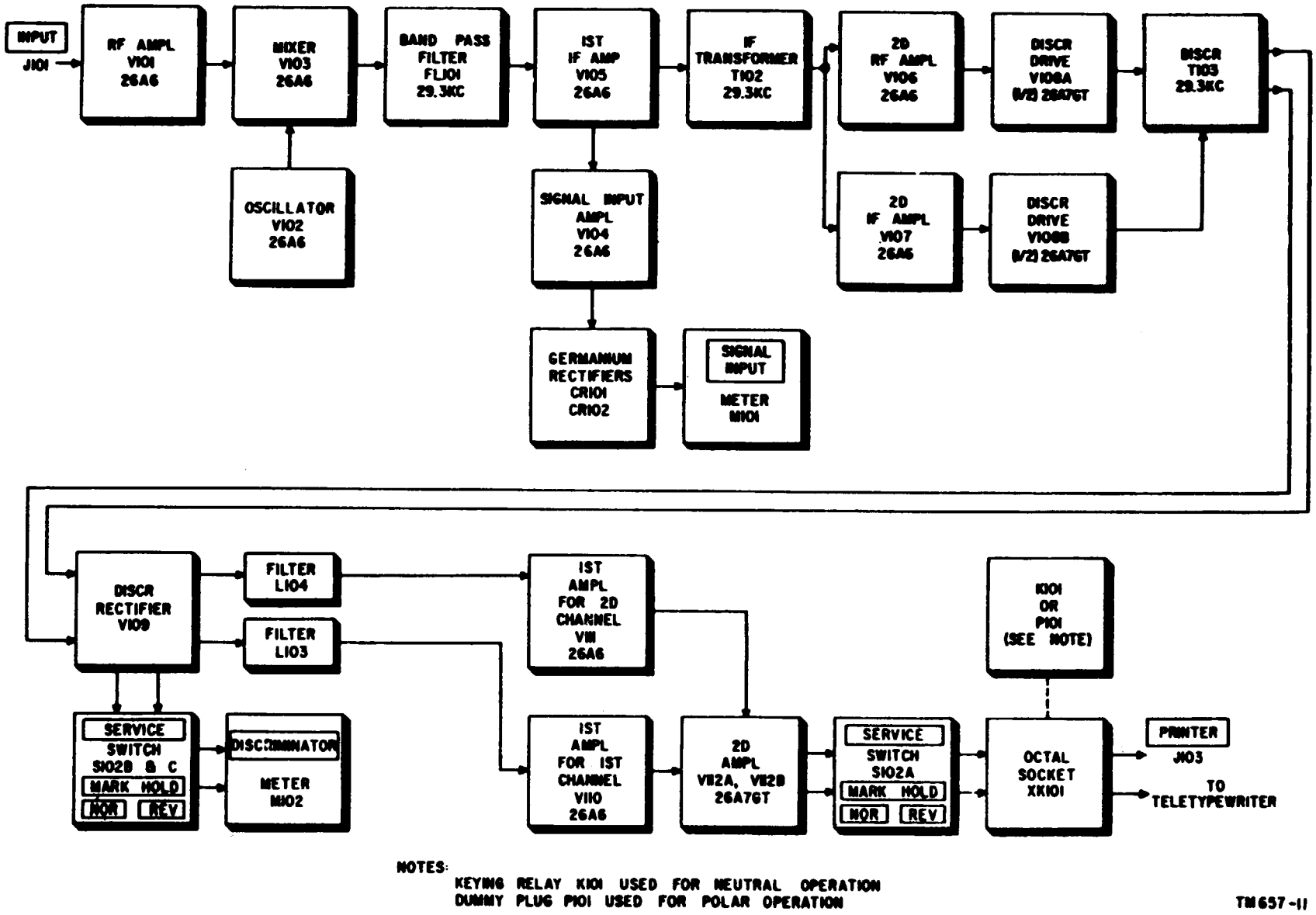


Figure 2. Frequency Shift Converter CV-278/GR, block diagram

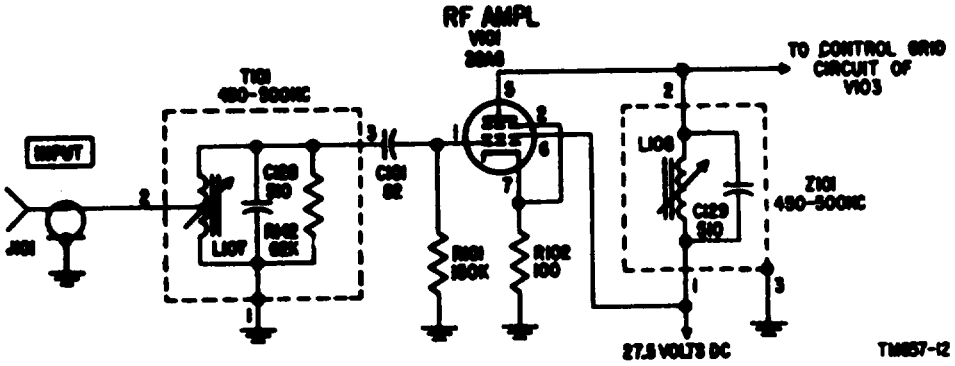


Figure 3. RF amplifier V101, schematic diagram.

line. The plate receives voltage through the tank of Z101 from the same point.

c. The tuning combination, L107, C128, L108, and C129 has a frequency range of 450 to 500 kc. When the converter is used with a receiver having an IF of 455 kc, these two tuned circuits would be peaked for that frequency. For this condition, a space signal will produce a signal of 455 kc at J101; a mark signal will produce a signal of 455.850 kc at J101. During radio-teletypewriter operation, the signal input to the converter will be deviating above (455.850) and below (455 kc) the imaginary mid-frequency of 455.425 kc. The total frequency shift is 850 cps.

7. Mixer V103

(fig. 4)

The mixer stage uses a type 26A6 pentode tube to convert the input signal frequency to a frequency of 29.3 kc.

a. The input signal from the plate circuit of V101 is coupled to the control grid of the mixer tube through capacitor C107. Coupling capacitor C107 isolates the plate voltage of V101 from the control grid (pin 1) of V103. The signal voltage is developed across grid return resistor R105. Resistor R106 provides the self-bias (cathode resistor bias) for the tube. The suppressor grid (pin 2) is tied to the cathode. The plate load for V103 is provided by band-pass filter FL101. Voltage from the 27.5-volt dc supply line is applied through choke coil L1 to the plate (pin 5) of V103.

b. The screen grid (pin 6) of the mixer is used for the injection of the output signal from crystal oscillator V102. The signal voltage from the oscillator mixes with, or heterodynes, the input signal. The two frequencies are mixed in the tube and appear in the plate circuit as the sum and difference frequencies of the two signals. The tuned plate circuit of V103 selects the 29.3-kc signal. The band-pass filter in the plate circuit is designed to pass this difference frequency and attenuate the sum frequency and other unwanted frequencies outside its pass band.

c. Filter FL101 (fig. 25) is made up of parallel-tuned circuit C1 and L1, coupling capacitor C6, parallel-tuned circuit C2 and L2, coupling capacitor C7, parallel-tuned circuit C3 and L3, coupling capacitor C8, parallel-tuned circuit C4 and L4 coupling capacitor C9, and parallel-tuned circuit C5 and L5.

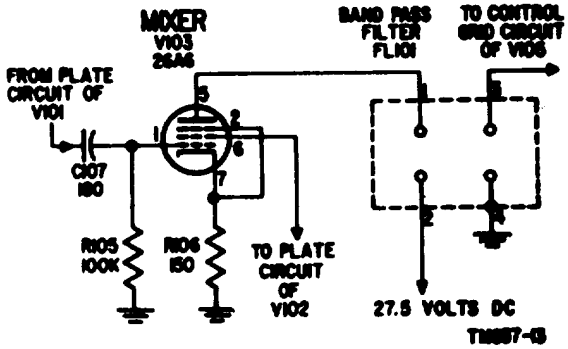


Figure 4. Mixer V103, schematic diagram.

8. Crystal Oscillator V102

(fig. 5)

The crystal oscillator uses a type 26A6 tube connected as a Pierce type oscillator to provide the heterodyne injection signal for the mixer stage.

a. The crystal (Y101) is connected between the control grid (pin 1) and the plate (pin 5) of V102. The suppressor grid (pin 2) and the cathode (pin 7) are tied

together, and are connected to ground through resistor R103. Cathode resistor bias is developed by tube current through resistor R103. Capacitor C106 is the cathode bypass capacitor. Grid return resistor R104 provides a high control grid-to-ground impedance. The oscillations of quartz crystal Y101 generate the signal voltage that is developed in the stage.

b. Plate voltage for V102 is applied through RF choke coil L102 which, with capacitor C105, forms a tuned circuit resonant to a slightly lower frequency than the natural frequency of the crystal. This is necessary to provide a capacitive plate load for the circuit to sustain oscillations. The signal voltage is taken from the plate of V102 and is connected directly to the screen grid of the

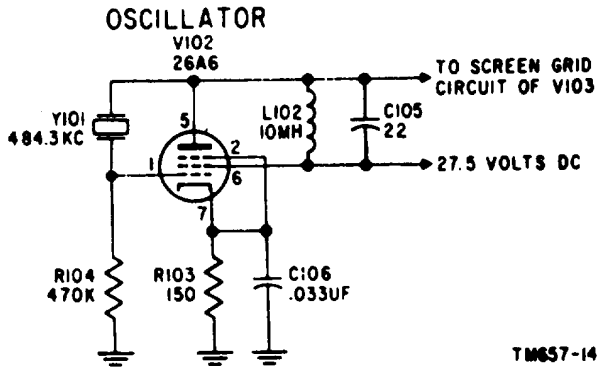


Figure 5. Crystal oscillator V102, schematic diagram.

mixer. This arrangement provides the dc potential for the screen grid of the mixer as well as for injecting the heterodyne signal.

9. First IF Amplifier V105
(Fig. 6)

First IF amplifier V105 uses a type 26A6 pentode tube to amplify the low-level 29.3-kc signal from band-pass filter FL101. The 29.3-kc signal frequency present in the plate circuit of the mixer is coupled by FL101 to the control grid of the first IF amplifier. Capacitor C108 couples a small amount of the signal voltage to the grid circuit of signal input meter amplifier V104 for operation of SIGNAL INPUT meter M101. The signal is amplified by first IF amplifier V105 for application to stage output transformer T102.

a. The suppressor grid (pin 2) of V105 is tied to the cathode (pin 7). Bias for the stage is developed by current flow through cathode resistor R110. The screen grid voltage is taken directly from the 27.5-volt dc supply line. The plate (pin 5) connects to the supply voltage through the primary winding of transformer T102, which functions as the plate load for the tube.

b. The output circuit of band-pass filter FL101 provides the dc return path for the control grid (pin 1) circuit of V105.

10. Signal Input Amplifier Stage V104
(fig. 7)

The signal input amplifier stage uses a type 26A6 pentode tube as a signal input meter amplifier at the intermediate frequency. It receives its signal from band-pass filter FL101 and transfers it to the meter rectifier circuit.

a. Bias for th stage is developed by the grid current flowing through grid resistor R109. The control

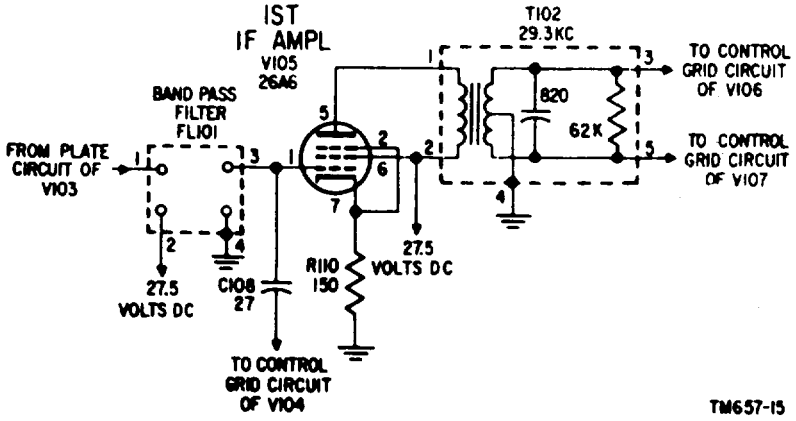


Figure 6. First IF amplifier V105, schematic diagram.

grid (pin 1) receives tile signal through capacitor C108. Coupling capacitor C108 is connected to the output of FL101. The capacitor presents a high impedance and prevents loading of the control grid circuit of V105.

b. The amplified output signal at the plate (pin 5) is connected to the rectifier circuit through capacitor C109 and resistor R108. Capacitor C109 isolates the dc plate voltage from the rectifier circuit. Resistor R108 protects the meter circuit from overloads. The rectifier circuit consists of two germanium diode rectifiers, CR101 and CR102, used as half-wave rectifiers. Diode CR101 provides the positive direct-current flow through meter M101, and diode CR102 provides the negative direct-current flew which bypasses the meter. Capacitor C110 functions as a filter capacitor for the meter. The signal input meter circuit is designed to give an on-scale indication, even though the power supply voltage is high (30 volts) and input signal voltage from the receiver IF is 1 volt.

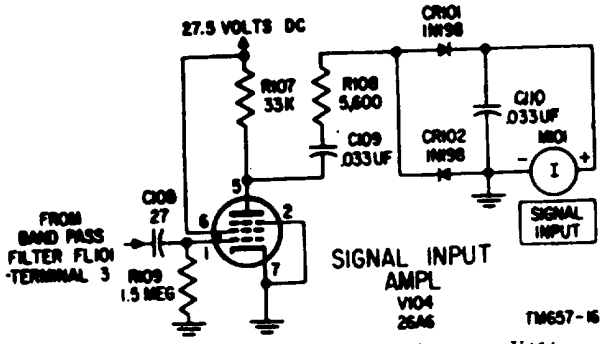


Figure 7. Signal input meter amplifier stage V104, schematic diagram.

11. Second IF Amplifier Stage V106 and V107
(fig. 8)

The second IF amplifier stage uses two type 26A6 tubes to amplify the dual channel output of transformer T102 and to transfer the two 29.3-kc signals (which are 180° out of phase) to the dual grids of tube V108.

a. The output winding of transformer T102 is center-tapped to provide the 180° phase shift to the grids of the tubes. The suppressor grids and the cathodes of both tubes are tied together, and the bias for both tubes is developed by the current flow through common cathode resistor R111. The center tap provides the grid return for both control grids. The screen voltages for both tubes are taken directly from the 27.5-volt supply lines. The plate voltages are taken from the same point through plate load resistors R112 and R113.

b. Transformer T102 is tuned to the 29.3-kc intermediate frequency by a fixed capacitor within the transformer assembly. A resistor shunts the coil within the assembly to broaden the frequency response curve of the transformer.

12. Discriminator Drive Stage V108
(fig. 9)

The discriminator drive stage uses a type 26A7GT dual pentode to provide amplification for the two signals, and to transfer them to the multiple primaries of discriminator transformer T103.

a. The control grids (pins 1 and 3) of V108 are

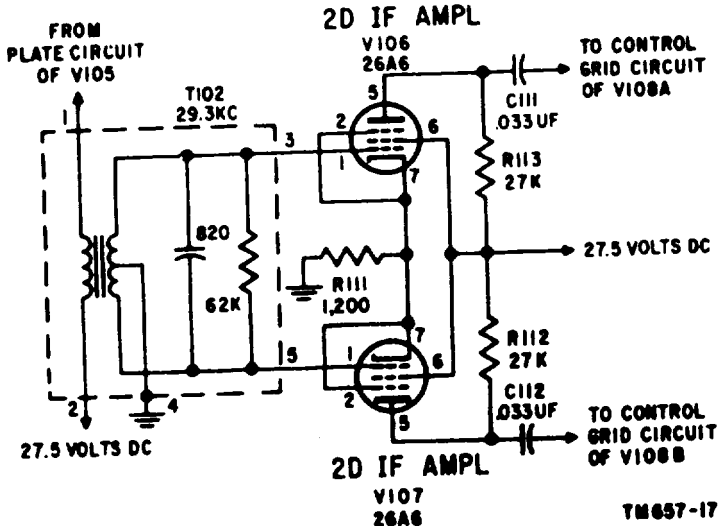


Figure 8. Second IF amplifier stage V106 and V107, schematic diagram.

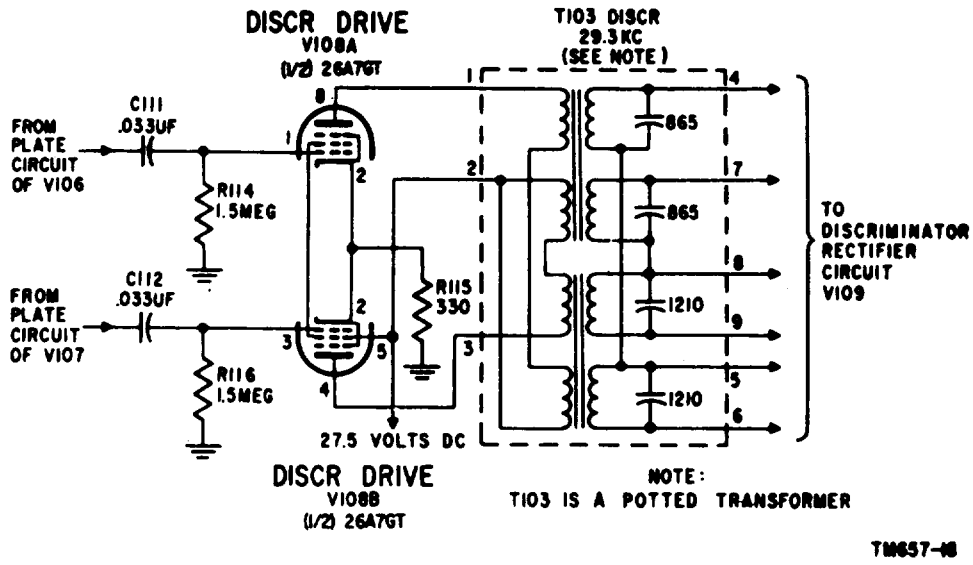


Figure 9. Discriminator drive stage V108, schematic diagram.

coupled from the plates of V106 and V107 by coupling capacitors C111 and C112. The coupling capacitors block the dc plate voltage from the grids. The signal voltages are developed across grid resistors R114 and R116. The suppressor grids are tied to the cathodes, and the cathodes are connected to ground through common cathode resistor R115. Grid bias is developed by the cathode current from both tube sections flowing through R115. Screen grid voltages for both sections are taken directly from the 27.5-volt supply line. The discriminator transformer multiple primaries provide the plate loads for the two sections of the tube. Each plate receives voltage from the 27.5-volt supply. line through two primaries (connected in series) of the discriminator transformer.

b. The limiting action of the preceding stages maintains a signal input within 2 decibels (db) to the grids of V108 even though the amplitude of the signal at INPUT receptacle J101 may vary from 200 to 250,000 microvolts. Because of this limiting action, the output signals from V108 are relatively free from amplitude modulation.

13. Dual Discriminator Channels

(fig. 10)

The dual discriminator channels consist of transformer T103 and rectifier V109. Transformer T103 couples the two 29.3-kc signals from the discriminator driver to two separate discriminator circuits. Rectifiers (V109 assembly) and associated circuit components convert the IF signal changes into dc pulses. The dc pulses are increased in amplitude (by subsequent de amplifier stages) and are used to operate associated printer equipment.

a. Discriminator transformer T103 consists of two loosely coupled toroidal coils in one assembly. The two coils contain four primaries and four secondaries. Two secondaries are connected in series to supply one channel. They are tuned to slightly different frequencies; one slightly above, and the other equally below the mid-frequency (29.3 kc). The associated primaries are wound on the cores near their secondaries. Fixed capacitors in the transformer assembly provide a large part of the capacitance required to tune each of the four secondaries. The remainder of the tuning capacitance required is provided by trimmer capacitors C113 and C114. The capacitors tune their own secondary and, because of the interaction between the primaries and secondaries, the other secondary circuits. This permits alignment of the discriminator by varying either C113 or C114. The trimmer capacitors are used to tune the two discriminator transformer outputs for crossover.

b. Discriminator rectifier unit V109 contains four type 1N63. diodes in a single tube envelope connected in two separate rectifier circuits. The two circuits operate basically as double-tuned discriminators. The individual diodes rectify the IF currents in their respective secondaries and develop a dc output. The matched pairs of diodes in V109 provide equal detection of the fsk signals in the two channels. The two channels are designated the first and the second signal channels for

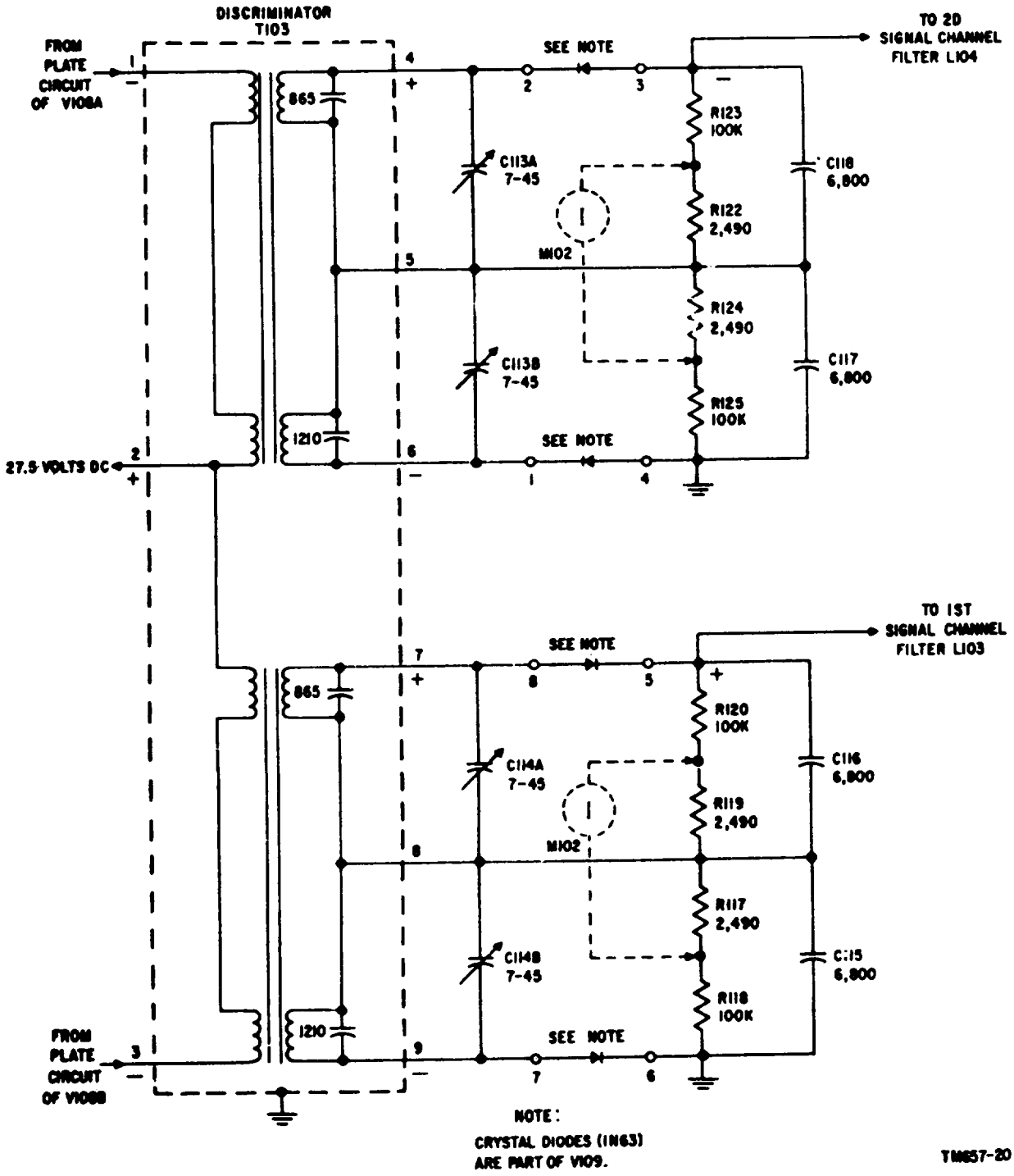


Figure 10. Dual discriminator channels, functional schematic diagram.

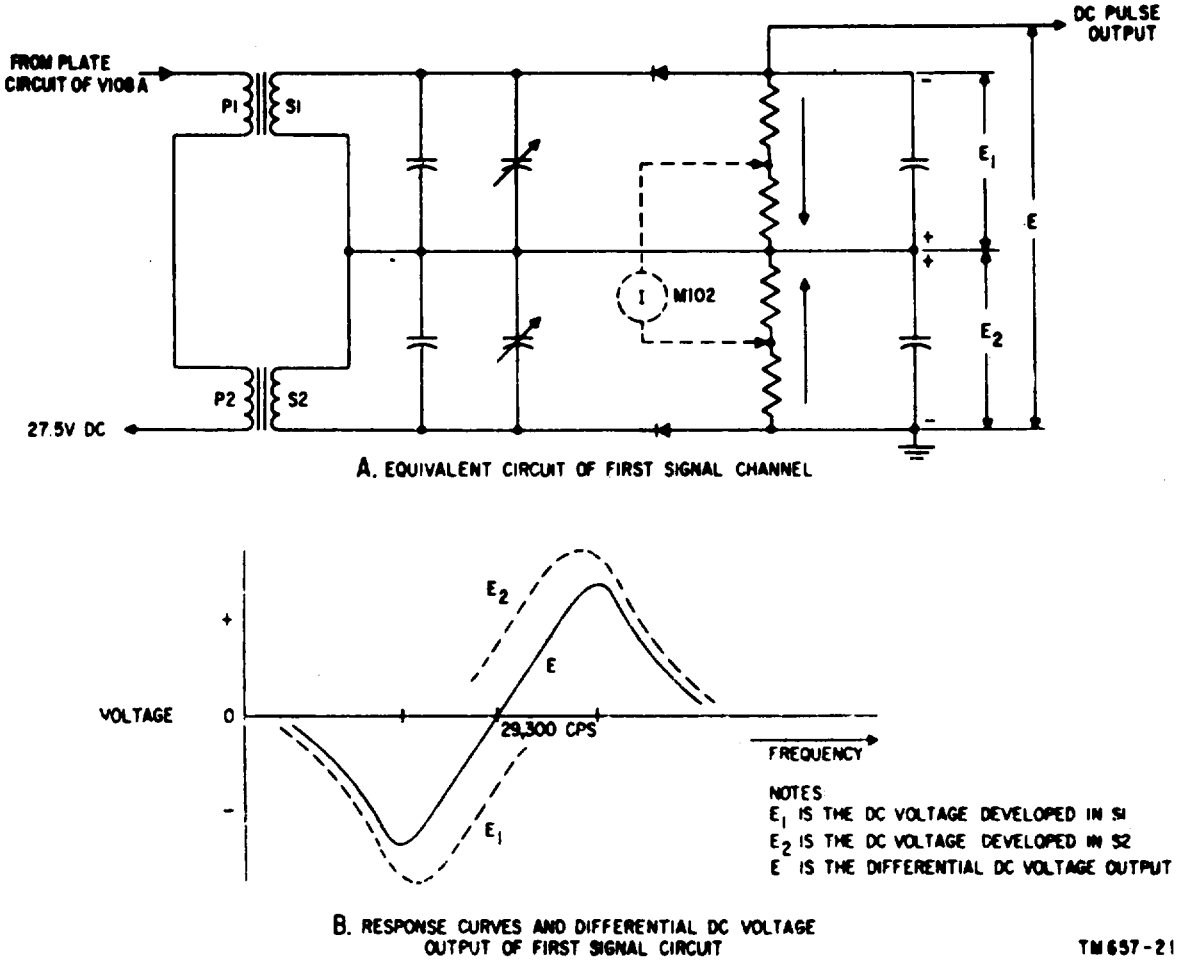


Figure 11. Equivalent circuit and response curves of first signal channel.

convenience in explaining tile circuit functions. The resonant frequencies of the secondary windings are tuned so that whenever the frequency shifts, it will cause a positive or negative pulse to be developed. The polarity is determined by the type of signal being received. For example, a mark signal from the receiver gives a negative impulse output. When the input is 29.3 kc or at the mid-frequency (midway between the resonant frequencies of the two secondaries), the voltages developed across each load are equal in amplitude and opposite in polarity. The voltages effectively cancel each other to give a zero voltage output from the channel.

c. The instantaneous voltages appearing across the tuned secondaries of the first channel (as the frequency is changed) are indicated by the dotted lines of the graph (fig. 11). The differential dc voltage output of the channel is indicated by the solid curved line, and is the algebraic sum of the two voltages appearing across the secondary loads. As the intermediate frequency applied to the channel varies between the resonant frequencies of the two tuned circuits, the differential dc voltage output varies between positive and negative values. When the input is near the resonant frequency of one of the secondaries, the opposite dc voltage developed across the load of the other secondary is at a minimum value. When the input IF changes to near the resonant frequency of the other secondary, the conditions are reversed. At the mid-frequency (29.3 kc), the output voltages of both discriminator channels are zero. The second channel in the discriminator is an exact duplicate of the first signal channel except for the polarity of the differential dc voltage output. This is reversed with respect to that obtained from the first signal channel, giving a positive dc pulse output for the same mark signal.

d. The dc pulse outputs of the two discriminator channels are transferred to low-pass filter networks L103

and L104 (fig. 12). The low-pass filter networks effectively reduce high noise frequencies to prevent them from being coupled to the following first dc amplifiers. The time constants of the low-pass filters are designed to permit operation at printer speeds up to 100 words per minute (wpm).

14. DISCRIMINATOR Meter M102

(fig. 10)

The DISCRIMINATOR meter indicates the average value of a normal frequency-shifted radioteletypewriter signal as is used with the AN/GRC-46 and AN/VRC-29. With the SERVICE switch in the NOR position, the indication is to the right for a steady mark signal and to the left for a steady space signal. It reads zero for a steady 455-kc radio signal. The scale divisions indicate the approximate amount of the frequency shift (approximately 100 cycles for each major division).

a. DISCRIMINATOR meter M102 is switched by S102 to either one or the other of the resistive loads of the discriminator output channels. The meter is a zero center microammeter, and is connected at points between the two load resistors in the circuit of each secondary for a differential reading. The meter readings are proportional to the differential dc voltages developed at these points. The direction in which the meter pointer deflects depends on the polarity of the differential voltage. The meter is switched across equal values of resistance in both channels for the purpose of obtaining uniformity.

b. The electrical values of all components in the discriminator meter circuit have been chosen so that the divisions of the meter scale represent approximately 100 cycles of frequency shift when the input dc supply voltage is 30 volts and the input signal from the receiver is 10,000 microvolts.

15. First Dc Amplifier Stages V110 and V111

(fig. 12)

The first dc amplifiers are type 26A6 pentode tubes. They provide amplification for the positive and negative dc signal pulses received from the discriminator through low-pass filters L103 and

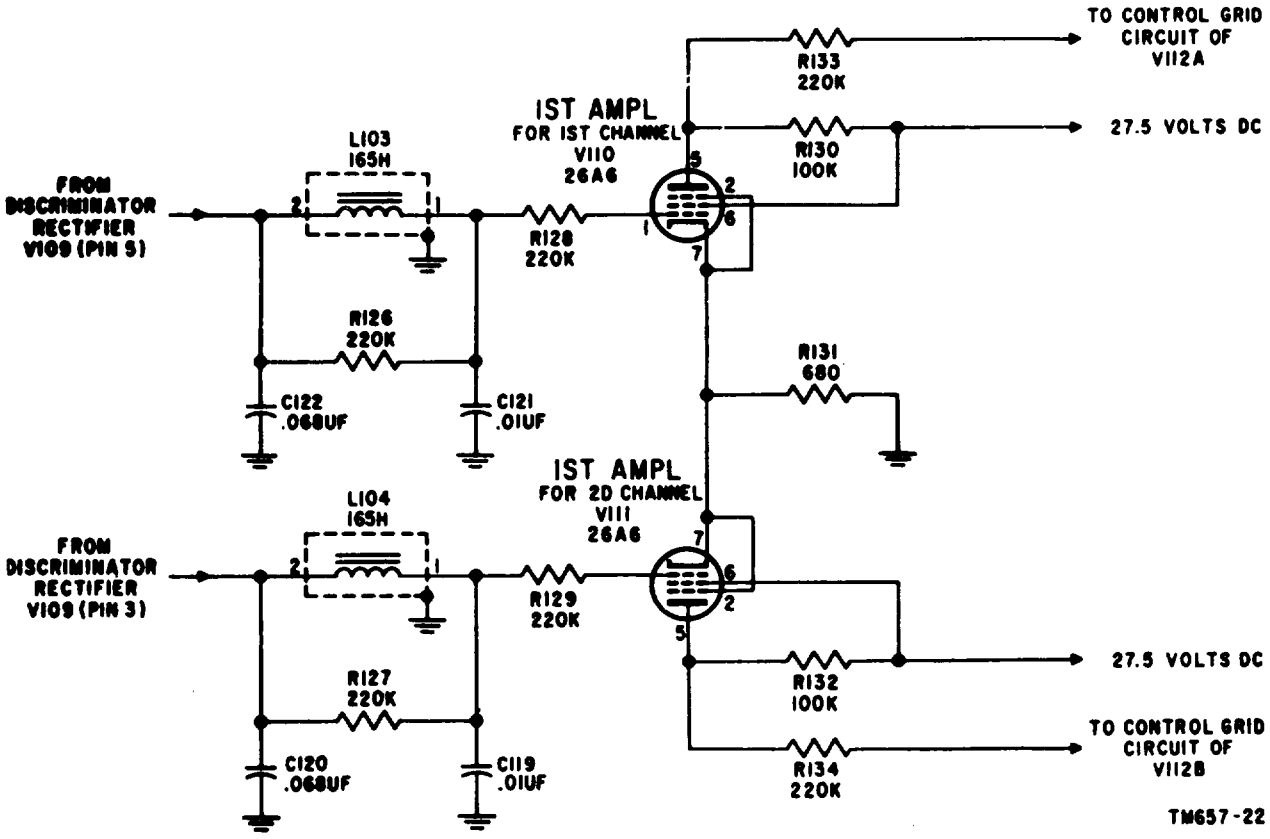


Figure 12. First dc amplifier stages V110 and V111, schematic diagram

43.6. Current Drain and Meter Tests

a. Test Equipment and Material.
(1) Power Supply PP-1097A/G.
(2) RF Signal Generator AN/URM-25F.
(3) Frequency Meter AN/TSM-16 (includes Frequency Meter FR-114/U).
(4) Telephone Carrier System Test Facilities Kit MK-155/TCC; the junction panel 600-volt test cable assembly in the MK-155/TCC is required.
(5) Hookup wires.

b. Test Connections and Conditions.
(1) Connect the equipment as shown in figure 21.1.
(2) Connect the power cords of the test equipment to the ac power source.

c. Procedure.

Note. A summary chart of the tests and performance standards is given in paragraph 43.9*a*.

Step No.	Test equipment control settings	Equipment under test Control settings	Test procedures	Performance standard
1	*PP-1097A/G* OUTPUT VOLTAGE ADJUST: fully counter-clockwise. POWER: ON AN/UMM-25F POWER: ON *FR 14/4U* POWER-STANDBY-OFF: POWER	*CV-278/GR* POWER: ON	*Current Drain* *a.* Rotate PP-1097A/G OUTPUT VOLTAGE ADJUST control clockwise until DC VOLTS meter indicates 30 volts dc. *b.* Note indication of PP-1097A/G DC AMPERES meter *c.* Allow equipment a 15-minute warmup period and repeat procedure given in a above.	*a*. None. *b*. Approximately 2.25 ampere. *c.* None.
2	Unchanged, except *AN/URM-25F* BAND SWITCH: 220-60KILOCYCLES TUNING: 455 on KILOCYCLES dial TUNING: 455 on KILOCYCLES dial ATTENUATOR: 10K FUNCTION SWITCH: 0W SET RF OUTPUT: fully counterclockwise % MOD AUDIO OUTPUT LEVEL: fully counterclockwise MICROVOLTS: fully clockwise *PR-1I4/U* FUNCTION: TEST MULTIPLY FREQUENCY BY: 1 AUTO-MANUAL: AUTO DISPLAY TIME: midposition TRIGGER VOLTAGE: fully counterclockwise SENSITIVITY: fully counterclockwise INT.-EXT. (rear panel of chassis): INT. 115V-230V (rear panel of chassis: 115V	Unchanged, except SERVICE: NOR	*DISCRIMINATOR Meter* *a.* Adjust SET RF OUTPUT control of AN/URM-25F to obtain 10 on upper MICROVOLTS scale. *b.* Adjust OUTPUT VOLTAGE ADJUST control of PP-1097A/G to obtain 27.5 indication on DC VOLTS meter. *c.* Adjust FR-114/U as follows: (1) Rotate TRIGGER VOLTAGE clockwise until numerical indicators begin to count. Note position of control. (2) Continue to rotate TRIGGER VOLTAGE control clockwise until numerical indicators atop counting. (3) Set TRIGGER VOLTAGE control midway between the two positions noted in (1) and (2) above. (4) Numerical indicators should indicate 100000 or 099999 cps. (5) Operate FUNCTION switch to FREQ. COUNT. (6) Rotate SENSITIVITY control clockwise until INPUT LEVEL meter indicates in left portion of green area. (7) Repeat procedures in (1), (2), and (3) above. (8) Rotate SENSITIVITY control clockwise until INPUT LEVEL meter indicates midway in green area. *d.* Rotate TUNING dial of AN/URM-25F until DISCRIMINATOR meter of CV-278/GR indicates to right and left of 0 (center scale), then, adjust to obtain 0 indication. *e.* Note frequency count of FR-114/U numerical counters *f.* Rotate SERVICE switch of CV-278/GR to REV and NOR several times and note DISCRIMINATOR meter indication at each switch position. *g.* Rotate TUNING dial of AN/URM-25F until FR-114/U indicate 445, 425 cps. *h.* Operate SERVICE switch of CV-278/GR to NOR and observe DISCRIMINATOR meter indication. *i.* Operate SERVICE switch of CV-278/GR to REV and observe DISCRIMINATOR meter indication. *j.* Operate SERVICE switch of CV-278/GR to NOR *k.* Rotate TUNING dial of AN/URM-25F until FR-114/U indicates 454, 575 cps. *l.* Observe DISCRIMINATOR meter indication of CV-278/GR. *m*. Operate SERVICE switch of CV-278/GR to REV and observe DISCRIMINATOR meter indication.	*a*. None. *b*. None. *c.* None. *d*. DISCRIMINATOR indicates to right and left of 0 and is adjustable to 0. *e*. 455,000 cps ± 15. *f.* DISCRIMINATOR meter should not indicate not indicate more division to left or right of 0. *g*. None. *g*. DISCRIMINATOR meter indicates between 3 and 5 meter scale divisions to right of 0. *i.* DISCRIMINATOR meter indicates between 3 and 5 meter scale divisions to left of 0. *j.* None. *k.* None. *l.* DISCRIMINATOR meter Indicates between 3 and 5 meter scale divisions to left of 0. *m*. DISCRIMINATOR meter indicates between 3 and 5 meter ale divisions to right of 0.
3	Unchanged, except *AN/URM-UP* ATTENUATOR: 1K	Unchanged	*SIGNAL INPUT Meter* *a.* Adjust OUTPUT VOLTAGE ADJUST control of PP-1097A/C until DC VOLTS meter indicates 30 volts dc. *b.* Adjust SET RF OUTPUT control of AN/URM-25F until output meter indicates 2 on upper MICROVOLTS scale. Observe indication of SIGNAL INPUT meter of CV-278/GR. *c.* Rotate ATTENUATOR switch of AN/URM-25F through each of its positions to 100K and observe indication of SIGNAL INPUT meter of CV-278/GR at each position. *d*. Proceed to test procedures given in paragraph 43.7	*a*. None. *b*. SIGNAL INPUT meter should be between 0 and first meter scale division. *c.* SIGNAL INPUT meter indication should progressively increase past center center scale. d. None.

43.7. Mark-Hold, Frequency-Shaft Sensitivity, and Neutral Output Tests

(fig. 21.2)

Perform the procedures given in paragraph 43.0 before proceeding.

a. Test Equipment and Material. The test equipment and material listed in paragraph 43.6*a* are required. Also, the following items are required:

(1) Multimeter TS-352/U.
(2) Multimeter, Electronic TS-505A/U.
(3) Test cable, fabricated according to instructions in paragraph 43.3.

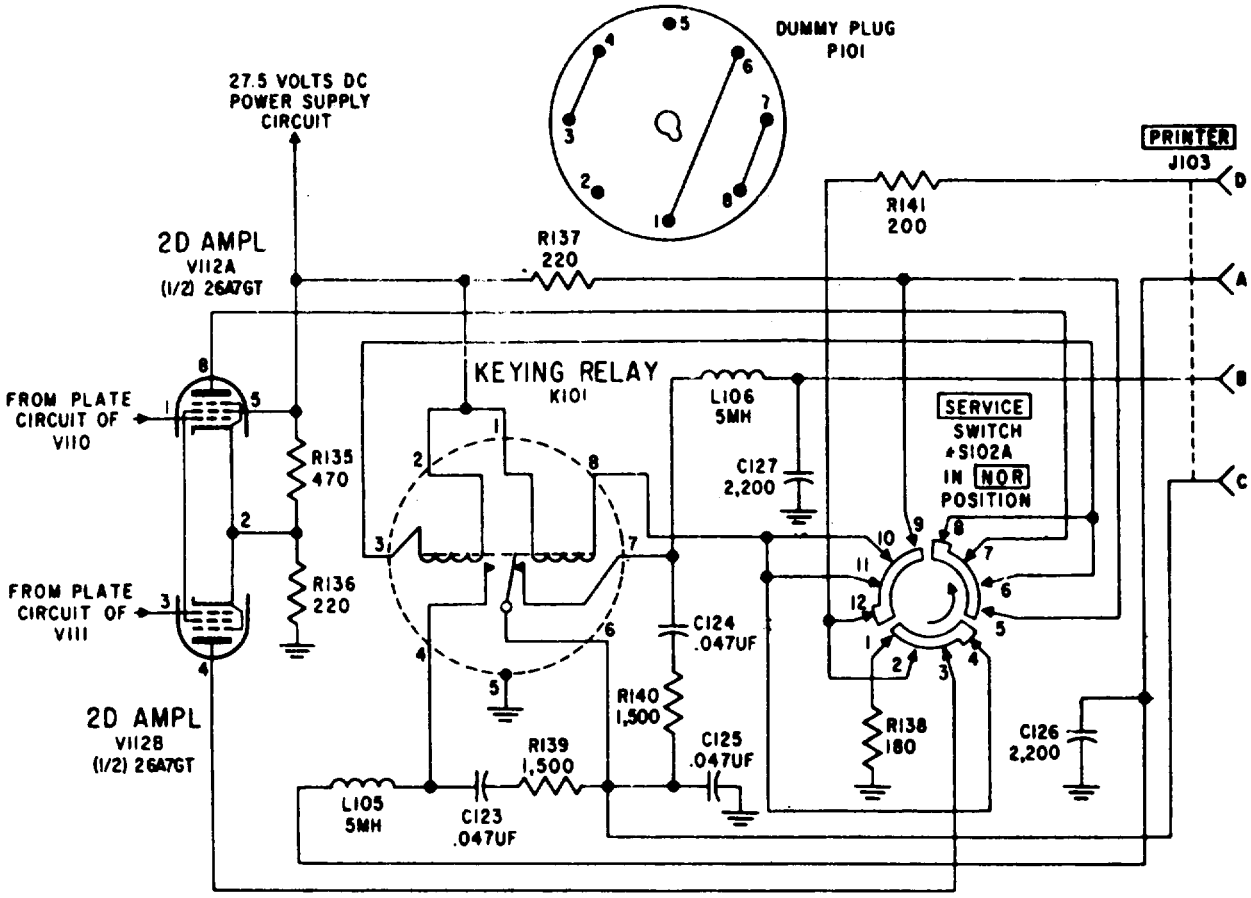
b. Test Connections and Conditions. The connections given in figure 21.1 are unchanged.

(1) Operate the POWER switch on the PP-1097A/G to OFF.
(2) Connect the power cord of the TS-505A/U to the ac power source and set controls as given in step No. 1 (c below) Test equipment control settings column. Touch COMMON and OHMS test lead probes together (fig. 21.2), and adjust OHMS ADJ. control until the ohmeter indicates 0 ohm.
(3.) Set the controls of the TS-352(*)/U as given in step No. 1 (c below) Test equipment control settings column and connect test leads to the pin jacks of the TS-352//U as shown in figure 21.2. Touch the probes of the test leads together, and adjust OHMS ZERO ADJ. control until the ohmmeter indicates 0 ohm.
(4) Connect the equipment as shown in figure 21.2.

c. Procedure.

Note. A summary chart of the tests and performance standards is given in paragraph 43.9*b*.

Step No.	Test equipment control settings	Equipment under test Control settings	Test procedures	Performance standard
			Mark-Hold Circuit	
1	Controls and switches of PP-1097A/G, AN/URM-25F, and FR-114/U unchanged from settings last used in paragraph 43.6c, except: *AN/URM-25F* MICROVOLTS: fully clockwise SET RF OUTPUT: fully clockwise ATTENUATOR: 300 obtained *TS-352/U* FUNCTION: OHMS Range switch: RX1 *TS-505A/U* FUNCTION: OHMS RANGE: RX1 obtained	*CV-278/GR* SERVICE: MARK HOLD	*a*. Adjust OUTPUT VOLTAGE ADJUST control of PP-1097A/G until DC VOLTS meter indicates 22 volts. *b*. Adjust MICROVOLTS control of AN/URM-25F until output meter indicates 2 on lower scale of MICRO-VOLTS meter scale *c*. Carefully rotate TUNING dial of AN/URM-25F until numerical indicators of FR-114/U count 455, 425 cps. Note TS-352/U and TS-505A/U ohmmeter indications. *d*. Carefully rotate TUNING dial of AN/URM-25F until numerical indicators of FR-114/U count 454, 575 cps. Note TS-352/U and TS-505A/U ohmmeter indications. *e*. Rotate ATTENUATOR switch of AN /URM-25F clockwise to 0.3 position and note TS-352/U and TS-505A/U ohmmeter indications. *f*. Connect black wire (D) of fabricated test cable to chassis of CV-278/GR, and note TS-352/U and TS-505A/U ohmmeter indications. *g*. Operate SERVICE switch of CV-278/GR to NOR and REV and note TS-352/U and TS-505A/U ohmmeter indications at each switch position. *h*. Operate SERVICE switch of CV-278/GR to REV. Operate ATTENUATOR switch of AN/URM-25F to 300. *i*. Note TS-352/U and TS-505A/U ohmmeter indications *j*. Disconnect black wire of fabricated test cable from chassis of CV-278/GR (*f* above).	*a*. None. *b*. None. *c*. TS-352/U (in mark circuit) ohmmeter indicates between 4 and 10 ohms; TS-505A/U (in space circuit) ohmmeter indicates 0 ohm. *d*. Same indication as obtained in *c* above. *e*. Same as obtained in *c* above. *f*. Same indication as obtained in *c* above. *g*. Same indication as obtained in *c* above. *h*. None. *i*. Same indication as obtained in *c* above. *j*. None.
			Frequency-Shift Sensitivity and Neutral Output	
2	Unchanged, except *AN/URM-25F* ATTENUATOR: 1K	Unchanged, except SERVICE: NOR	*a*. Adjust SET RF OUTPUT control of AN/URM-25F until output meter indicates 3 on upper MICRO-VOLTS scale. *b*. Slowly rotate TUNING dial of AN/URM-25F clockwise until FR-114/U indicates 455, 150 cps. *c*. Note TS-352/U and TS-505A/U ohmmeter indications *d*. Operate SERVICE switch of CV-278/GR to REV *e*. Note TS-352/U and TS-505A/U ohmmeter indications. *f*. Slowly rotate TUNING dial of AN/URM-25F counter-clockwise until F-114/U indicates 454, 850 cps. *g*. Note TS-352/U and TS-505A/U ohmmeter indications *h*. Operate SERVICE switch of CV-278/GR to NOR *i*. Note TS-352/U and TS-505A/U ohmmeter indications *j*. Adjust SET RF OUTPUT control of AN/URM-25F until output meter indicates 10 on upper MICRO-VOLTS scale; slowly rotate TUNING dial counter-clockwise until FR-114/U indicates 454, 500 cps. *k*. Note TS-352/U and TS-505A/U ohmmeter indications *l*. Slowly rotate TUNING dial of AN/URM-25F clockwise until FR-114/U indicates 455, 500 cps. *m*. Note TS-352/U and TS--505A/U ohmmeter indications *n*. Proceed to the lest procedures given in paragraph 43.8	*a*. None. *b*. None. *c*. TS-352/U indicates 4 to 10 ohms and TS-505A/U indicates 0 ohm. *d*. None. *e*. TS-352/U indicates 0 ohm and TS-505A/U: indicates 4 to 10 ohms. *f*. None. *g*. Same indications as obtained in *e* above. *h*. None. *i*. Same indications as obtained in *c* above. *j*. None. *k*. Same indications as obtained in e above. *l*. None. *m*. Same as obtained in *c* above. *n*. None.



NOTE
*** ALL WAFER SWITCHES ARE DRAWN AS VIEWED FROM BACK. SECTION 'A' IS NEAREST CONTROL KNOB.**

TM657 -23

Figure 13. Second dc amplifier stage V112, schematic diagram.

L104. The output of these stages drives the control grids of second dc amplifier V112.

a. The positive and negative signal pulses for the control grids of V110 and V111 are taken from the low-pass filters through coupling resistors R128 and R129. The bias for the two tubes is developed by the current flow through common cathode resistor R131. The suppressor grids are tied to the cathodes. The screen grid voltages for both tubes are taken directly from the 27.5-volt supply line. The plate voltages for both tubes are supplied from the 27.5-volt supply line through plate load resistors R130 and R132.

b. The outputs from the two stages are taken directly from the plates. Amplifier V111 is cut off when a mark radio signal is received by the converter because of the negative voltage supplied to the control grid by the second signal channel. Amplifier V110 is conducting because of a positive voltage supplied to the control grid by the first signal channel, which overrides the negative grid bias.

16. Second Dc Amplifier Stage V112
(fig. 13)

The second dc amplifier stage employs a type 26A7 dual pentode tube to amplify the dc signals in both channels. The signals are applied to one of two outputs: keying relay K101 for neutral output, or directly to PRINTER receptacle J103 for polar output.

a. The dc signal pulses are applied to the control grids of V112. Because of the high cutoff bias on V112, the signal voltages to the control grids must be high to drive the tube sections into conduction. The bias is derived from the total current flowing through resistor R136.

b. The voltages for the plates of V112 are taken from the 27.5-volt supply line through the keying relay coils when the keying relay is in socket XK101. When plug P101 is substituted for relay K601, 27.5 volts from the converter is supplied to the plates of V112 through circuits in the printer (par. 17).

17. Keying Relay K101

a. With the SERVICE switch (S102) in the NOR position, the plates (pins 4 and 8) of V112 fig. 13) connect to the keying relay coils at terminals 8 and 3 on socket XK101. The relay coils are tied together by the jumper between terminals 1 and 2 on socket XK101, and this point is connected to the 27.5-volt supply line. The keying relay has a movable contact arm (pin 6) that is moved to relay contact 4 or 7 by the stronger magnetic field. The field is produced by one of the relay coils, depending on which plate of V112 is conducting. The contact arm (pin 6) is connected to pin C of J103, and the contacts (4 and 7) are connected to pins A and B of J103 through coils L105 and L106. The keying relay contacts provide for closing and opening the external printer circuit, or loop. An external loop voltage must be available for operating the printer.

b. Capacitors C123, C124, and C125 and series resistors R139 and R140 shunt both relay contact points to minimize sparking at the relay contacts. Capacitors C126 and C127 and inductors L105 and L106 are inserted in the circuits between the relay contacts and receptacle J103 for filtering unwanted pulses from the external circuits.

c. With the SERVICE switch (S102) in the MARK HOLD position, both plates of V112 are tied together and connected to the 27.5-volt line through resistor R137. Terminal 8 of K101 is also connected to ground through resistor R138. The current flowing through this path energizes the mark coil of the keying relay and causes a steady mark output.

18. Signal Polarity

When an RF signal corresponding to a mark frequency is received (425 cycles above the imaginary mid frequency for 850-cycle shift signals) and S102 is in the NOR position, the relay armature makes contact with the relay contact connected to terminal B of receptacle J103 (fig. 13). When an RF signal corresponding to a space frequency is received (425 cycles below the imaginary mid frequency), with S102 in the same position, the relay causes its armature to make contact with the relay contact connected to terminal A of receptacle J103. When S102 is in the REV position, the output function of the relay is reversed; that is, a mark signal causes a space output, and a space signal causes a mark output.

19. External Mark-Hold Circuit

The purpose of the external mark-hold circuit is to permit the printer to be placed in a constant mark condition in the event of no received signal or a malfunction of the associated equipment. The mark-hold circuit is activated by placing a ground on the wire connected to pin D of the printer cable plug. In the AN/GRC-46 and AN/VRC-29, the external mark-hold circuit is operated by the SEND-REC-MARK-HOLD switch. The grounding of pin D of J103 completes a circuit through

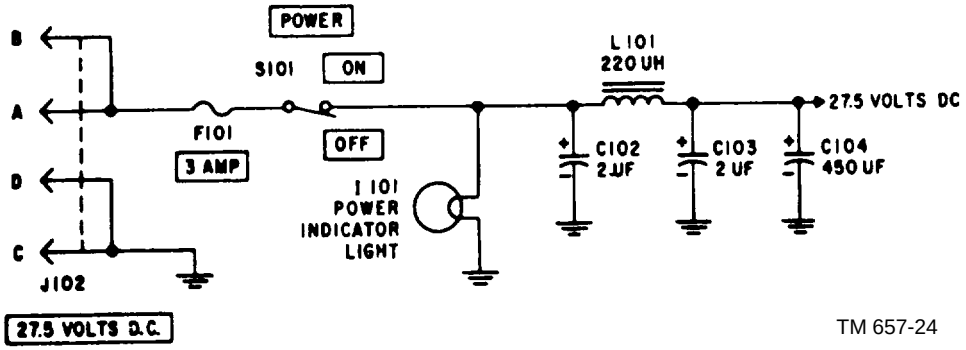


Figure 14. Power supply circuit, schematic diagram.

resistor R141, section A of S102, and the mark coil of K101 to the 27.5-volt supply line. The continuous current that flows through this circuit energizes the mark coil when the SERVICE switch is in the NOR or the REV position.

20. Power Supply Circuit
(fig. 14)

The primary power supply voltage for Frequency Shift Converter CV-278/GR is 27.5 volts dc. This low voltage supplies the tube heaters and the screen grid and plate circuits; no high voltage power supply is needed.

a. The positive dc power line is connected to the converter through pins A and B of 27.5 VOLTS D.C. receptacle J102; the negative line is connected through pins C and D, where it is grounded to the chassis. The converter is protected by the 3-ampere fuse (F101). The power is applied through the POWER switch (S101) to the line filter, which consists of inductor L101 and capacitors C102, C103, and C104.

b. The pi-type line filter C102, L101, and C103 suppresses noise and other transient disturbances and any RF that may be in the power line. Capacitor C104 bypasses the 27.5-volt de supply line to ground, thereby preventing random noise pulses from going into the converter. Power indicator I 101 indicates application of primary power.

CHAPTER 2

TROUBLESHOOTING

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

21. General Instructions

The field and depot maintenance procedures in this manual *supplement* the procedures described in the organizational maintenance manual. The systematic troubleshooting procedure, which begins with the operational and sectionalization checks that can be performed at an organizational level, is carried to a higher level in this manual. Sectionalizing, localizing, and isolating techniques used in the troubleshooting procedures are more advanced. Field maintenance localizing and isolating procedures are described in paragraphs 24 through 33.

22. Organization of Troubleshooting Procedures

a. General. The first step in servicing a defective converter is to sectionalize the fault. Sectionalization means tracing the fault to a major component, or a section of the converter such as the RF, IF, discriminator, and dc amplifier sections. The second step is to localize the fault. Localization means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burnt-out resistors, arcing, and shorted transformers can often be located by sight, smell, and hearing. The majority of faults, however, must be isolated by checking voltages and resistances.

b. Sectionalization. Listed below is a group of tests arranged to reduce unnecessary work and to aid in tracing trouble in a defective converter. Sectionalize the trouble to a part of the circuitry of the converter (liars. 26-28), by the following methods:

(1) Visual inspection. The purpose of visual inspection is to locate faults without testing or measuring circuits. All meter readings, scope patterns, or other visual signs should be observed and an attempt made to sectionalize the fault to a particular unit.

(2) Operational tests. Operational tests frequently indicate the general location of trouble. In many instances, the tests will help in determining the exact nature of the fault. When trouble is shown by a wrong meter reading, the wrong indication will help in determining the probable location of the trouble. The equipment performance check list (TM 11-5805-2120) will indicate the general location of the trouble. The troubleshooting chart (par. 26) will indicate the general location of the trouble when the converter is tested alone and a signal generator supplies the signal to the INPUT receptacle.

c. Localization. The tests listed below will aid in isolating the trouble. First, localize the trouble to a single stage or circuit; then isolate the trouble within that circuit by voltage, resistance, and continuity measurements. Use the following methods of trouble localization:

(1) Voltage and resistance measurements. These measurements will show abnormal voltage and resistance readings and help locate the individual component part at fault. Use resistor capacitor color codes (figs. 23 and 24) to find the value of the components. Use voltage and resistance diagrams (fig. 18) to find normal readings, with no signal, and compare them with the readings taken. If a measured value varies more than 10 percent from the given value, closer examination of the involved circuits is necessary. The resistances of the windings of the transformers and coils are given in paragraph 30. Before making resistance checks, be sure that the power source has been turned off.

(2) Troubleshooting chart. The trouble symptoms listed in the troubleshooting chart

{par. 26) will aid in localizing the trouble to a section of the converter.

(3) Stage gain chart. The stage gain charts (par. 28) will help to locate hard-to-find troubles in an individual stage or circuit.

(4) Intermittent troubles. In all these tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble can often be made to appear by tapping or jarring the converter. Check the wiring and connections to the converter.

(5) Signal substitution. Signal substitution procedure (par. 27) enable the repairman to localize a trouble quickly to a stage. A signal generator, audio oscillator, and oscilloscope are units of test equipment that may be used in signal substitution procedures.

23. Test Equipment Required

The following chart lists the test equipment required for troubleshooting Frequency Shift Converter CV-278/GR. Also listed are the associated technical manuals and the assigned common names.

Test equipment	Technical manual	Common name
Distortion Test Set TS383/GR.	TM 11-2217 set.	Distortion test
Electron Tube Test Set TV-2/U.	TM 11-2661	Tube tester
Electron Tube Test Set TV-7/U.	TM 11-5083	Tube fester
Electronic Multimeter TS-505/U.	TM 11-5511	Vtvm
Frequency Meter AN/URM-79.	TM 11-5094 meter	Frequency
Frequency Meter AN/USM-26.	TM 11-5057 meter.	Frequency
Multimeter ME-77/U	See note	Multimeter
Oscilloscope OS-8A/U	TM 11-1214	Oscilloscope
Signal Generator AN/URM-25.	TM 11-5551	Signal generator
Instrument Multirange Shunt MX-1471/U.	See note instrument	Shunt
Teletypewriter Test Set TS-917/GM.	See note test set	Teletypewriter
Voltmeter, Meter ME30A/U.	See note	Voltmeter

Note. Refer to the instructions packed with the equipment

Section II. TROUBLESHOOTING FREQUENCY SHIFT CONVERTER CV-278/GR

Caution: Do not attempt removal or replacement of parts before reading the instructions in paragraph 36 through 39.

24. Checking Filament and B+ Circuits for Shorts

a. When To Check. when any of the following conditions apply, check for short circuits and clear the trouble before applying power.

(1) When the converter is being serviced apart from the other units of Radio Teletypewriter set AN/GRC-46 or AN/VRC-29 and the nature of its abnormal symptoms is not known.

(2) When abnormal symptoms reported from operational tests indicate possible shorts.

b. Conditions for Tests. To prepare for the short-circuit tests, perform the following steps:

(1) Remove the converter from the mounting (TM 11-5805-210-20).

(2) Remove the case from the converter (par. 36).

(3) Remove all the tubes and the indicator lamp.

(4) Turn the POWER switch to ON.

(5) Place the SERVICE .switch on NOR.

c. Measurements. Make the resistance measurements indicated in the following chart. If abnormal results are obtained. Make the additional isolating checks outlined. When the faulty part is found, repair the trouble before applying power to the unit. Measurements are made between the check point and ground unless otherwise stated.

Point of measurement	Isolating procedure	Normal indication
Between terminals A or B and C or D of J102 (fig. 25).	Turn POWER switch to OFF. A low resistance reading indicates a short in J102, the fuse holder or S101. Remove F101 to isolate the short to either J102 or S101.	Infinity

Point of measurement	Isolating procedure	Normal indication
Between terminals A or B, and C or D of J102.	Replace fuse F101. Remove all the tubes, the pilot lamp, and keying relay K101. Turn POWER switch to ON. If incorrect reading is obtained, check dropping resistor R135 and R136, the capacitors, and other electrical items connected to the 27-volt dc supply circuit t some key point to localize the short.	690 ohms

25. Test Setup
(fig. 15)

Bench tests of the converter require connection to a power source and, to various test equipments. The power source must be connected to the converter for all dynamic-servicing procedures. The test equipment connections vary from test to test. Remove the converter chassis from the case (par. 36), and make a test setup as outlined below.

a. Power Supply Connections. Use a power source capable of supplying 27.5 volts at 2.0 amperes dc to the unit. Connect the power source positive wire to pins A and B of the connector plug, and the negative wire to pins C and D of the connector plug.

b. Test Equipment. Connect the test equipment as specified for the particular test that follow. The general setup is shown in figure 15.

26. Localizing Troubles

a. General. Procedures are outlined in d below for localizing troubles in the converter by signal substitution and circuit measurements. Parts location is indicated in figures 16 and 17. The nature of the operational symptoms will determine which of the localizing procedures will be necessary. When use of the procedures results in localization of trouble to a particular stage, use the techniques

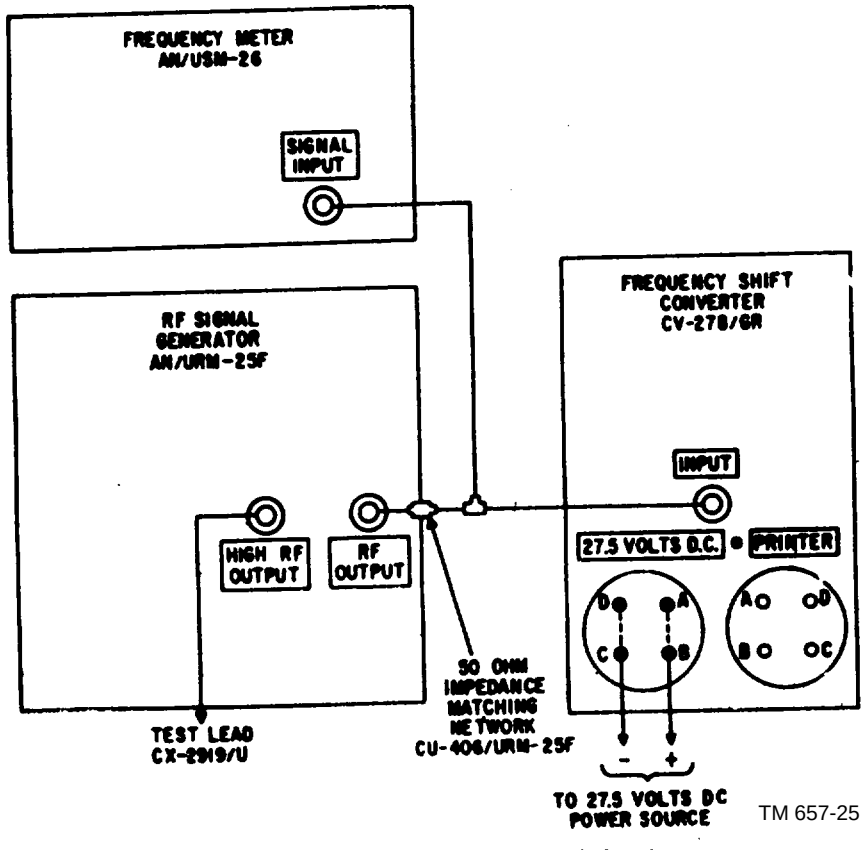


Figure 15. Test connections for troubleshooting.

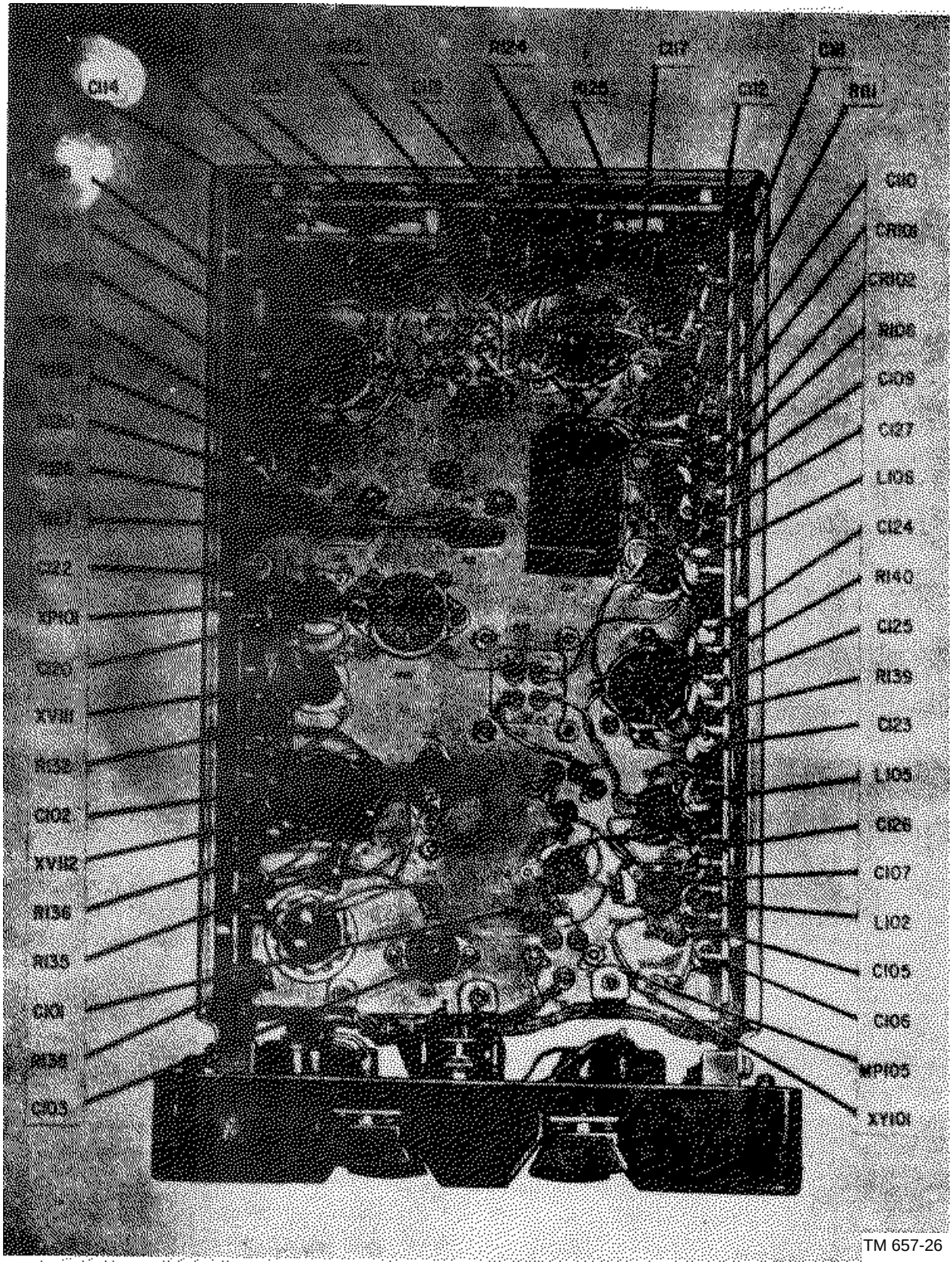


Figure 16. Frequency Shift Converter CV-278/GR, bottom view.

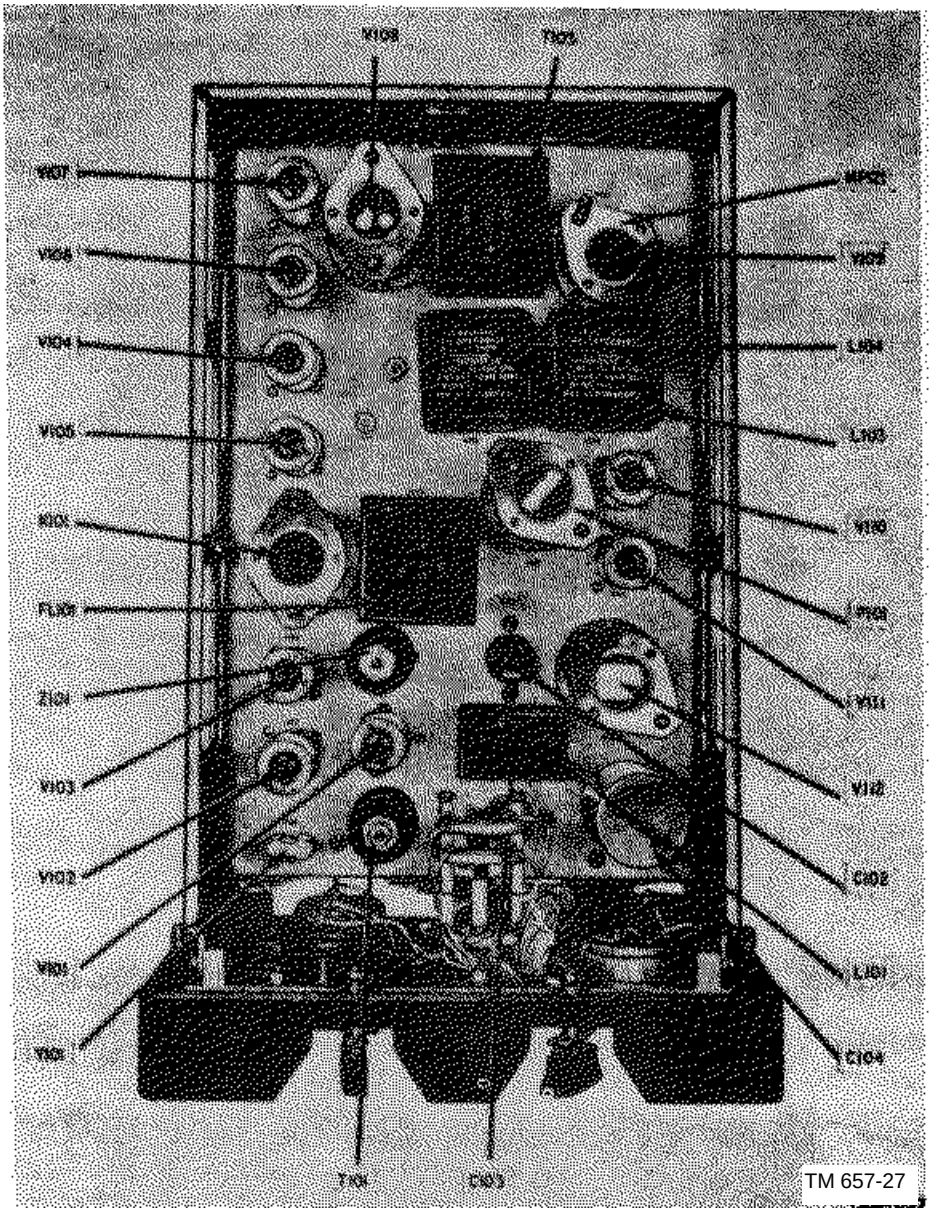


Figure 17. Frequency Shift Converter SV-278/GR, top view

outlined in paragraph 29 to locate the trouble to a particular part in the stage or circuit.

b. Use of Chart. The troubleshooting chart is designed to supplement the operational checks detailed in the equipment performance check list and the tube testing techniques (TM 11-5805-210-20). If previous operational checks have resulted in reference to a particular item of this chart, go directly to the referenced item. If no operational symptoms are known, begin with item 1 of the equipment performance check and proceed until the trouble is located.

Caution: **If operational symptoms are not known, or they indicate the possibility of short circuits within the converter, make the short circuit checks described in paragraph 24 before applying power to the unit.**

c. Conditions for Tests. All the dynamic checks in the chart are to be conducted with the converter connected to a power source as described in paragraph 25. The signal generator, vtvm, frequency

meter, and other test equipment are to be connected to various points in the circuits, as directed throughout the chart.

***Caution*: Do not attempt to remove or replace parts before reading the instructions in paragraph 36 through 39.**

d. Troubleshooting Chart.

Note. Perform the operations given in the equipment performance check list (TM 11-5805-210-20) before using this chart, unless the trouble has already been sectionalized.

Item	Indication	Probable trouble	Procedure
1	Indicator lamp does not light with converter ON.	Lamp burned out	Replace blown fuse F101
		Battery cable defective	Check indicator lamp
		Blown fuse F101	Check battery cables
			Check battery voltage
			Check- continuity of switch S101 and voltage supply wires.
2	SIGNAL INPUT meter does not indicate but DISCRIMINATOR meter gives normal indications when a 455-kc (approx.) signal (par. 42d) of 1,000 microvolts is applied to the INPUT receptacle of the converter.	Defective meter M101	Check V104 by substitution.
		Defective CR101 or CR102	Check CR101 and CR102 (par. 32)
		Defective signal input amplifier stage.	Check meter M101 by substitution
			Check signal input amplifier circuit by signal substitution (par. 27).
			Make voltage and resistance measurements on signal input amplifier stage (fig. 18).
			Check gain in signal input amplifier stage (par. 28).
3	The SIGNAL INPUT and DISCRIMINATOR meters do riot indicate.	Defective mixer, or IF amplifier stage.	Check V103 and V105 by substitution
			Check mixer and IF amplifier circuits by signal substitution (par. 27).
			Make voltage and resistance on mixer and IF amplifier stages (fig. 18).
			Check gain of mixer and IF amplifier stage (par. 28b).
		Defective crystal Y101	Check Y101 by substitution
		Defective oscillator stage	Check V102 by substitution.
			Make voltage and resistance measurements on oscillator stage (fig. 18).
		Defective RF amplifier stage	Check V101 by substitution.
			Check RF amplifier by signal substitution (par. 27).
			Make voltage and resistance measurements on RF amplifier stage (fig. 18).
			Check gain of RF amplifier stage (par. 28b)
		T101 or Z101 misalined	Aline T101 and Z101 (par. 42)
	SIGNAL INPUT meter is normal but DISCRIMINATOR meter shows no signs of indicating with the same signal applied as in item 2.	Defective meter M102	Check meter M102 by substitution
		Defective switch S102 (secs B and C).	Check switch S102 wiring
		Defective discriminator drive stage.	Check V108 by substitution
			Check discriminator drive stage by signal substitution (par. 27).
			Make voltage and resistance measurements on discriminator drive stage (fig. 18).
			Check gain of discriminator drive stage (par. 28b(5)).
		Defective second IF amplifier stage.	Check V106 and V107 by substitution
			Check second IF amplifier stage by signal substitution (par. 27).
			Make voltage and resistance measurements on second IF amplifier stage (fig. 18).
			Check gain of second IF amplifier stages (par. 28b(4)).

Item	Indication	Probable trouble	Procedure
4 (Cont.)		Defective first IF amplifier stages.	Check V105 and V106 by substitution Check first IF amplifier stages by signal substitution (par. 27). Make voltage and resistance measurements on first IF amplifier stages (fig. 18). Check gain of first IF amplifier stage (par. 28b(3)).
5	DISCRIMINATOR meter does not read zero with the same signal applied as in items 2 and 4.	If the DISCRIMINATOR pointer is far off zero, check for defective V109. Defective discriminator rectifier	Check discriminator rectifier circuits (first and second channels) by voltage and resistance measurements (par. 30, fig. 18). ***Caution*: Remove one wire from the meter (M102) terminals to prevent damaging the meter.** Check discriminator circuits by signal substitution (par. 27).
		If the DISCRIMINATOR pointer is not far off zero, the discriminator is probably misalined.	Aline discriminator (par. 43)
6	SIGNAL INPUT and DISCRIMINATOR meters read normally with mark and space signal applied (par. 28*c*), but relay K101 does not operate.	Defective switch S102A or wiring.	Check switch and output circuits of V112 by continuity measurements. See paragraph 31 for output circuit checks.
		Defective relay K101	Check relay K101 by substitution
		Defective second dc amplifier stage.	Check V112 by substitution Check the mark and space signal dc voltage in both channels of the second dc amplifier. Refer to signal substitution (par. 27) and stage gain measurements (par. 28). Make voltage and resistance measurements on second dc amplifier stage (fig. 18).
		Defective first dc amplifier stages.	Check V110 and VI11 by substitution Check the mark and space signal dc voltages in both channels of the first dc amplifier stage. Refer to signal substitution (par. 27) and stage gain measurements (par. 28). Make voltage and resistance measurements on first dc amplifier stages (fig. 18).
		Defective L103 and L104 filter circuits.	Make voltage and resistance measurements on L103 and L104 filter circuits (par. 30). Check filter circuits by signal substitution (par. 27).
7	Output from converter erratic.	Defective stage or circuit causing distortion or intermittent operation.	Sectionalize the trouble by substituting a 455-kc signal at the INPUT receptacle and by substituting a 29.3-kc signal at the grid of V105 (par. 27). Make voltage measurements (fig. 18) Where a signal voltage is low for no apparent reason, check stage gain (par. 28).

27. Signal Substitution

a. General. Signal substitution procedures help to localize a trouble to a stage of the converter. An externally generated signal is substituted for the signal normally present in each stage. The test equipment required for the signal substitution tests are a signal generator and a vtvm. In the tests, ground one side of the signal generator to the converter chassis, and connect the output to the test point. The substituted signal may be injected at the plate or grid circuits of a stage through an isolating capacitor. The capacitor is used to prevent damage to the signal generator from dc voltages.

The amount of signal voltage injected should not be

greater than the maximum voltage present at that point during normal operation. See stage gain reading in paragraph 28.

b. Dc Amplifier Tests. Start these tests at the output of the last stage of each channel and work back toward the first stage.

(1) Set the signal generator to produce an unmodulated output signal of 29,300 cycles at .7 volt.
(2) Connect the vtvm to measure the alternating-current (ac) voltage between the plate (pin 8) and ground of the first channel output amplifier (V112A).
(3) Apply the signal to pin 1 (grid) of V112A. Watch for an indication on the vtvm. If no indication, check tube V112 and associated circuit components.
(4) Apply the signal to pin 1 (grid) of V110. Watch for an indication on the vtvm. If no indication, check tube V110 and associated circuit components, (5) Connect the vtvm to measure the ac voltage between the plate (pin 4) and ground of the second channel output de amplifier (V112B).
(6) Apply the signal to pin 3 (grid) of V112B. Watch for an indication on the vtvm. If no indication, check tube V112 and associated circuit components.
(7) Apply the signal to pin 1 (grid) of V111. Watch for an indication on the vtvm. If no indication, check tube V111 and associated circuit components.

c. Discriminator and IF Amplifier Stage Tests.
When performing these tests, follow the procedures outlined below:

(1) Set the signal generator to produce an unmodulated output signal of 29,300 cycles at .7 volt.
(2) Place the SERVICE switch in the NOR position.
(3) Apply the signal to pin 1 (grid) of V105. The discriminator meter should read zero.
(4) Vary the signal generator above 29,300 cycles. The mark frequency is 29,725 cps and the space frequency is 28,875 cps. If the meter reads for only one of these frequencies, check the associated channel tubes and circuit components.

d. RF Tests. Set up the signal to produce an unmodulated output of 455 kc (or the associated receiver IF) at 1,000 microvolts (uv).

(1) Apply the signal to INPUT receptacle J101. A reading should be obtained on SIGNAL INPUT meter M101.
(2) If there is no indication on M101, check V101, V102, V103, V104, and associated circuit components.

28. Stage Gain Measurements

Use the techniques outlined in a through f below when the output of a stage of the converter is abnormally low-or distorted and the voltage ad resistance measurements appear to be normal. These tests are referenced in the troubleshooting chart (par. 26*d*).

a. General Instructions. A signal generator, a frequency meter, an electronic multimeter, and an oscilloscope are units of test equipment that are used in stage gain measurements. Connect the test equipment to the converter as described in paragraphs 25 and 27. Record the input and the output levels of the signal for the stage. Determine whether the signal level is normal at the test point indicated. Signal level readings are given in b through f below.

b. RF and IF Stage Gains. Apply an unmodulated signal to the INPUT receptacle. Set the gain generator for a 1,000-uv output at 455 kc (par. 42*d*). The ac voltages (signal levels) at the points indicated, when divided by the .001-volt input signal level, give the gains between those points in the circuits and the INPUT receptacle.

(1) *RF amplifier stage.*

Test connection	Ac voltage	Gain
Pin 1 of V101	.0058	5.8
Pin 5 of V101	.19	190

(2) Mixer stage.

Test connection	Ac voltage	Gain
Pin 1 of V103	.22	220
Pin 1 of V103	2.3	2,300

(3) *First IF amplifier stage.*

Test connection	Ac voltage	Gain
Pin 1 of C105	.62	620
Pin 5 of V105	2.35	2,350

(4) Second IF amplifier stage.

Test connection	Ac voltage	Gain
Pin 1 of V106	4	4,000
Pin 1 of V107	4	4,000
Pin 5 of V106	7.6	7,600
Pin 5 of V107	7.6	7,600

(5) *Discriminator drive stage.*

Test connection	Ac voltage	Gain
Pin 1 of V108	7.6	7,600
Pin 3 of V108	7.6	7,600
Pin 8 of V108	5.7	5,700
Pin 4 of V108	5.7	5,700

c. Discriminator Circuit Tests. Check the discriminator circuits by substituting mark, space, and center input signals at the control grid of V105 and measuring the voltages in the first and second signal channels.

(1) Set the signal generator for an unmodulated signal output of .7 volt at the center frequency of 29,300 cps. Adjust the signal generator voltage with the vtvm.

(2) Measure the ac signal voltages in the first and second signal channels (between pins 1 and 2, and between pins 7 and 8) supplying the rectifier V109. These voltages may vary ± 10 percent.

Test connection	Ac voltage	Gain
Pin 1 of V109	44	44,000
Pin 2 of V109	33	33,000
Pin 7 of V109	44	44,000
Pin 8 of V109	33	33,000

(3) Measure the dc signal voltages at the first and second signal channels (pins 3 and 5 of V109) with mark, space, and center input signal. The mark frequency is 29,725 cps and the space frequency is 28,875 cps. The reading should be 0 ± 1 volt at these points at 29,300 cps. The readings were taken with a 20,000 ohms-per-volt voltmeter.

Test connection	Dc voltage (volts)
Pin 3 of V109	-13 (mark) ± .45 (center) +12 (pace)
Pin 5 of V109	-12 (mark) ± .15 (center) +13 (space)

d. First Dc Amplifier Stages and Filters. Check the first dc amplifier stage with the same signals applied as in c above and measure the dc voltage in both channels. These voltages may vary considerably depending upon the adjustment of the circuit.

Test connection	Dc voltage (volts)
Pin 1 of V110	15 (mark) -5.2 (space)
Pin 5 of V110	2.5 (mark) 21 (space)
Pin 1 of V111	-5.5 (mark) 13 (space)
Pin 5 of V111	21 (mark) 2.3 (space)

e. Second Dc Amplifier Stage Test. Check the second dc amplifier stage with the same signals applied as in c above, and measure the dc voltages in both signal channels.

Test connection	Dc voltage (volts)
Pin 1 of V112	.5 (mark) 12 (pace)
Pin 8 of V112	27.1 (mark) 23.5 (space)
Pin 3 of V112	12 (mark) .5 (space)
Pin 4 of V112	23.5 (mark) 27.1 (space)

f. Signal Input Amplifier Test. Check the signal input amplifier stage by substituting a signal at the control grid of V105 and noting the reading of SIGNAL INPUT meter M101.

(1) Set the signal generator for a 29,300-cps unmodulated output signal at 1-volt level.

(2) If M101 does not read, trace the signal from pin 1 of V105 to the meter.
(3) Meter M101 should read full-scale.

Test connection	Dc voltage (volts)
Pin 1 of V104	2
Pin 5 of V104	1
Junction of CRIO1 and CR102	1

29. Isolating Trouble Within Stage

When trouble has been localized to a stage, either through operational checks (TM 11-5805-210-20) or by signal substitution (par. 27), use the following techniques to isolate the defective part:

a. Test the tube involved, either in the tube tester or by substituting a similar type tube which is known to be operating normally.

b. Take voltage measurements at the tube sockets (fig. 18), and other points related to the stage in question (fig. 25).

c. If voltage readings are abnormal, take resistance readings (fig. 18) to isolate open and short circuits. Refer also to the de resistance of transformers and coils (par. 30).

d. If signals are weak, and all checks fail to indicate a defective part, check the alignment of the stages (para. 42 and 43).

e. If the signals are weak after alinement and the usual checks fail to locate a defective part, check the stage gain (par. 28).

30. Dc Resistance of Transformers and Coils

The dc resistances of transformer windings and coils (windings alone) in the converter are listed below:

Transformer or coil	Terminals	Ohms (± 10%)
T101	1-3	4
	1-2	Less than 1
Z101	1-2	3J
FL101	1-2	8
	3-4	8
T102	1-2	4.5
	3-4	16
	4-5	16
T103	1-3	4
	1-2	2
	2-3	2
	4-5	8
	5-6	8
T103 (Cont.)	7-8	8
	8-9	8
L103	1-2	5,500
L104	1-2	5,600
L105	Across coil	5.5
L106	Across coil	5.5
L101	Across coil	.2
L102	Across coil	36
K101	Across winding	160

31. Making Continuity Measurements on Output Circuit (Neutral Output)

Apply mark and space radio signals to the converter (455-kc signal of 1,000 microvolts). Check the operation of keying relay KI01 and the output circuits.

a. With a mark signal input and the SERVICE switch at NOR, there should be a short circuit between pins B and C of J103 and an open circuit between pins A and C of J103. Grounding pin D should make no change.

b. With a space signal input and S102 at NOR, there should be a short circuit between pins A and C of J103. There should be an open circuit between pins B and C of J103. Grounding pin D should cause an open circuit between pins B and C.

c. With a mark signal input and S102 at MARK HOLD, pins B and C should show a short circuit, and pins A and C an open circuit.

d. With a space signal input and S102 at MARK HOLD, pins B and C should show a short circuit, and pins A and C an open circuit.

32. Testing Crystal Diodes

After every 250 hours of operation, test the crystal diodes in the converter. Follow the procedure outlined below to test the crystal diode.

a. V109 Assembly. Test the four crystal diodes in the V109 assembly with an electronic ohmmeter. See figure 19 for base connections. The condition of each pair of' the crystal diodes is satisfactory when the forward resistance is leas than 200 ohms, and the backward resistance is greater than 20,000 ohms. The forward resistance of each crystal in a balanced pair (pins 1-4 and 2-3, or pins 6-7 and 5-8) should be within 10 percent of each other.

b. M101 Rectifiers. The crystal diode rectifiers, CRIOI1 and CR102, are not matched. The forward

and backward resistance values need only be in the ratio of 100 to 1.

33. Checking Voltages at Tubes

To avoid the necessity of removing a resistor board or other part when voltages are to measures at a tube socket, remove the tube, insert a short length of thin insulates wire (both ends bares) into the desired socket contact, and replace the tube. Make the connection to the exposed end of the wire..

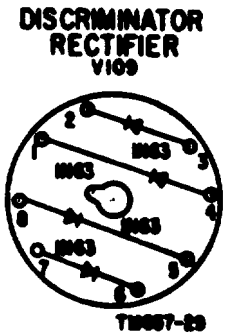


Figure 19. V109 base connections.

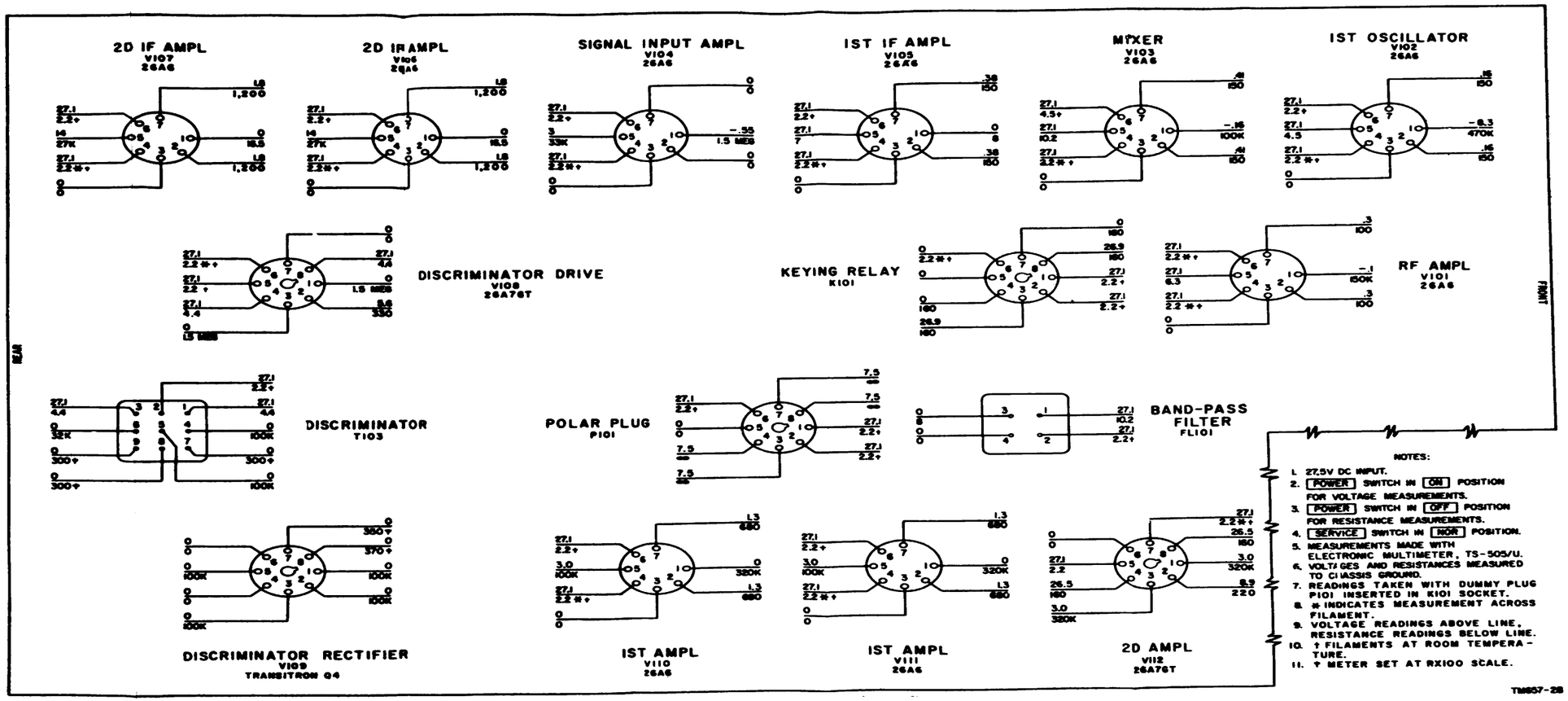


Figure 18. Tube socket voltage and resistance diagrams.

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CHAPTER 3

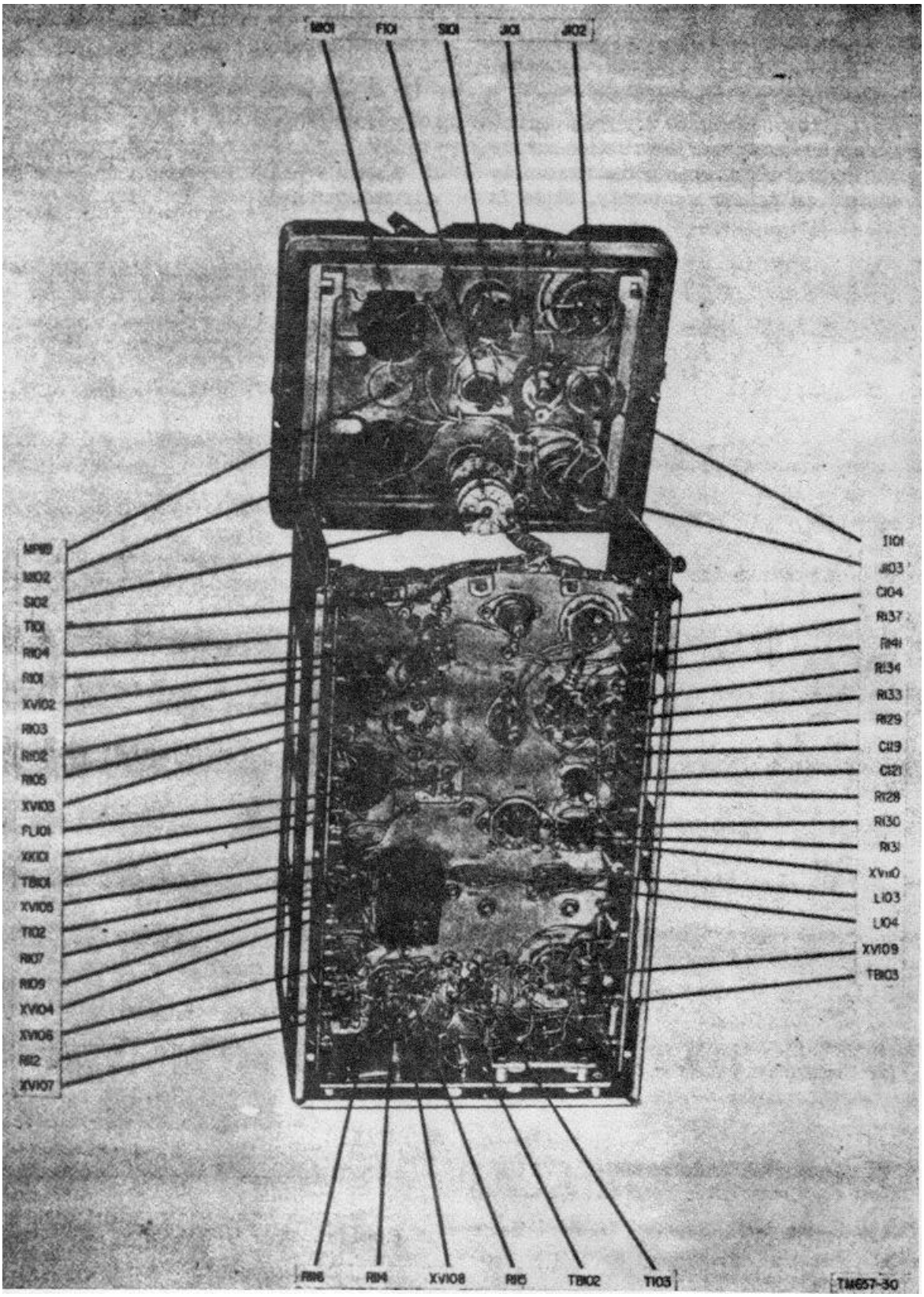


Figure 20. Front panel tilted on chassis.

(2) Loosen the two unpainted Phillips head machine screws and the lockwashers that hold the front panel to the wrap-around (at the top and bottom on the right-hand side).

(3) Loosen the two captive type, painted Phillips head machine screws at the left side of the front panel (at the top and bottom).

(4) Swing the front panel to the right.

b. Replacement.

(1) Swing the front panel to the left and tighten the two captive type, painted Phillips head machine screws at the left aide of the front panel (at the top and bottom).

(2) Tighten the two unpainted Phillips head machine screws to secure the front panel to the wrap-around (at the top and bottom on the right-hand side).

(3) Secure the converter in its case (par. 36).

38. SERVICE Switch Removal and Replacement

a. Removal.

(1) Remove the case from the chassis (par. 36).

(2) Swing the front panel from the chassis (par. 37).
(3) Unsolder all the wires that extend from the switch contact lugs, and tag the leads.
(4) Remove the Phillips head machine screw and lockwasher that hold the knob on the shaft, and remove the knob.
(5) Remove the hexagonal nut and lockwasher from the switch bushing, and remove the switch from the panel.
(6) Remove the jumper wire from the switch lugs.

b. Replacement.

(1) Connect the jumper to the switch lugs.

(2) Position the switch on the panel. See that the tab is in the hole on the panel.

(3) Replace the knob and lockwasher. Tighten the hexagonal nut to secure the knob in place.

(4) Solder the wires in place on the switch contact lugs.

39. Receptacle Removal and Replacement

a. Removal.

(1) Unsolder the wires from the PRINTER or the 27.5 VOLTS D. C. receptacle and tag the wires.

(2) Unscrew the threaded ring, using the special wrench in Tool Equipment TE-113, and remove the receptacle.

b. Replacement.

(1) Insert the receptacle. Be sure to replace the rubber gasket and index the receptacle so that the locating pin for the plug is at the top.
(2) Insert and tighten the threaded ring.
(3) Connect and solder the wires to the receptacle.

40. Rectifier Diodes CR101 and CR102

a. Removal.

(1) Remove the case from the chassis (par. 36).
(2) Unsolder and remove the defective diode from the resistor board (fig. 20 TB101).
(3) Remove excess solder and clean the lugs on the resistor board.

b. Replacement.

(1) Place the diode in the exact position formally occupied by the defective diode.
(2) Solder the diode in place. Hold the diode lead with pliers to keep the heat from flowing up the lead to the diode.

Section II. ALINEMENT

41. Test Equipment Required for Alinement

The following test equipment is required for the alinement of Frequency Shift Converter CV-278/GR.

Item	Terminal manual
RF Signal Generator AN/URM-25F	TM 11-5551E
Electronic Multimeter TS-505/U	TM 11-5511
Frequency Meter AN/USM-26	TM 11-5057

42. Alinement Procedures for T101 and Z101

The slotted screws for the alinement of the tuned circuits of T101 and Z101 are accessible on the top of the individual components (fig. 17). Connect tine equipment as shown in figure 21.

a. Turn the frequency-shift converter and the signal generator on, and allow them at least 10 minutes to warm up.

b. Connect the output of the signal generator to the INPUT receptacle (J101) of tile converter. Set the signal generator for an output signal of 455 kc (unmodulated) at 1,000 microvolts.

c. Connect the frequency meter between plate (pin 5) and ground of IF amplifier V105. Set the frequency meter controls for measuring the 29,300-cps intermediate frequency.

d. Adjust the frequency of the signal generator until the intermediate frequency is 29,300 ±5 cps.

Note the exact signal generator dial reading required for the particular crystal (Y101) in the converter, and use this dial reading (approximately 455 kc) for the alinement. This reading may also he used for other tests (pars. 27d, 28, and 29).

e. Remove oscillator tube V102 from its socket.

f. Connect Electronic Multimeter TS-505/U between the chassis and the cathode (pin 7) of the mixer (V103) for an ac measurement. Increase the signal generator output temporarily if necessary to obtain a first indication, but do not apply more than 1.0 volt.

g. Loosen the locking nuts on the adjusting screws and aline T101 and Z101 for maximum deflection on the multimeter, with a 1,000-microvolt signal applied. Tighten the locking nuts after aligning the adjusting screws.

h. Replace oscillator tube V102 in its socket. The frequency should read 29,300 cps when the tube warms up, or should not have drifted more than ±15 cps.

43. Alinement Procedure for T103

The discriminator may be alined by applying a 29,300-cps signal to the grid of V105, or by using the 455-kc (approximately) signal applied to J101 during the alignment of T101 and Z101 (par. 42). With either method, 29,300-cps IF must be checked accurately with a frequency meter. Maintain the IF as close to 29,300 cps as possible, not exceeding a deviation of ±15 cps. See that the pointer of the DISCRIMINATOR meter is at zero when the power is off. This alinement adjusts the discriminator to the circuit constants for the proper operation of the discriminator.

a. Connect the frequency meter between the plate (pin 5) of the IF amplifier (V105) and the chassis.

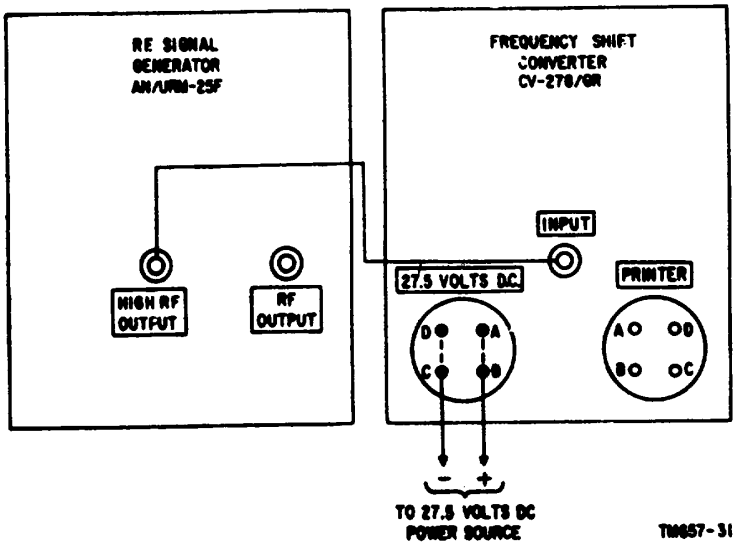


Figure 21. Test setup for alinement.

b. Turn trimmer capacitors C113 and C114 (fig. 16) until the rotors are set at approximately mid-capacity.

c. Connect the signal generator to J101 and increase the output to 1,000 microvolts. With the SERVICE switch in the NOR or MARK HOLD position, adjust either one of the trimmers to bring the pointer of the DISCRIMINATOR meter to zero.

d. Turn the SERVICE switch to REV. If the pointer of the meter should not read zero, and if it is one division to the left, adjust any trimmer until the pointer reads one-half division to the left; then turn the SERVICE switch to NOR and see whether the pointer now reads zero. If the pointer is slightly off, repeat the adjustment procedure until the pointer does read zero, or within plus or minus one-half division, with the SERVICE switch in any of its three positions. If the pointer cannot be set near or on zero, trouble is indicated in the discriminator circuit.

CHAPTER 4

FINAL TESTING

44. Purpose of Final Testing

The tests outlined in this chapter are designed to measure the performance capability of a repaired converter. Equipment that meets the minimum standards stated in the tests will furnish satisfactory operation equivalent to that of new equipment.

45. Test Equipment Required for Final Testing

In addition to the test equipment listed in paragraph 23, the following items are required for final testing:

Item	Technical manual
Radio Transmitter Modulator MD203/GR	TM 11-582-205-10
Radio Receiver R392/URR	TM 11-853
Teletypewriter Test Set TS-658/UG	See note

***Note*. Refer to literature packed with equipment.**

46. Test Connections

Some test connections for final testing are shown in the figures accompanying the test paragraphs. The general test connections are the same as for troubleshooting (fig. 15).

47. Current Drain Check

a. With the POWER switch in the OFF position, connect the dc power supply cable to the converter. Decrease the voltage and turn the converter on.

b. Increase the output voltage to 30 volts. Observe the current drawn on an ammeter. The tubes should light and the current drawn by the converter should be approximately 2.25 amperes at 30 volts.

c. If abnormal supply current or heating of parts is observed, disconnect the power to the converter and find the trouble with resistance measurements (par. 24).

48. Frequency-Shift Sensitivity Test

a. Connect the equipment as shown in figure 15.

b. Turn the POWER switch to ON and allow the equipment to warm up for 10 minutes (with normal power supply voltage of 27.5 volts applied).

c. Adjust the frequency of the signal generator to obtain 29,300 ± 5-cps IF, as indicated by the frequency meter.

d. Reduce the dc supply voltage to 22 volts for this test.

e. Adjust the signal generator output to 200 microvolts.

f. Connect an ohmmeter to terminals B and C of PRINTER receptacle J103.

g. Slowly change the frequency of the signal generator above and below the 29.3-kc midfrequency and note the ohmmeter reading. The frequency shift sensitivity is satisfactory if the relay armature makes a mark contact before the decrease from 29,300 cps exceeds 100 cps, and a space contact before the increase from 29,300 cps exceeds 100 cps.

h. Connect the ohmmeter to terminals A and C of PRINTER receptacle J103 and repeat step g above.

***Note*. With the SERVICE switch at the NOR position, a mark contact is indicated by an ohmmeter reading, of 5 to 8 ohms between terminals B and C of PRINTER receptacle J103, and an open circuit reading between terminals A and C. A space contact is indicated by an ohmmeter reading of 5 to 9 ohms between terminals A and C of J103, and an open circuit reading between terminals B and C.**

49. Gain Test

a. Connect the equipment as shown in figure 15.

b. Turn the POWER switch to ON and let the equipment warm up for 10 minutes with normal power supply voltage of 27.5 volts dc (par. 48).

c. Adjust the signal generator output to 200 microvolts.

d. Connect the ac vtvm to measure the grid voltages of discriminator drive tube V108 (pins I and 3) The voltages must be within 6 to 10 volts.

e. Connect the dc vtvm to measure the voltages between terminals 1 of L103 and L104 and ground.

f. Adjust the frequency of the signal generator to obtain a balanced condition of the discriminator (par. 43*d*).

g. The voltages at terminals 1 of L103 and L104 should be close to zero, or not more than ± 1.5 volts from zero. The IF should not be outside the range of 29,300 cps ± 80 cps.

h. Change the signal generator frequency to 500 cps higher than the frequency at balance and measure the dc voltage at terminals 1 of L103 and L104. The voltage at L103 (terminal 1) should be -10 to -18 volts dc. The voltage at L104 (terminal 1) should be +10 to -18 volts dc.

i. Change the signal generator frequency to 500 cps lower than the frequency at balance and measure the dc voltages at the same points (h above). The voltages at L103 (terminal 1) should be +10 to +18 volts dc. The voltage at L104 (terminal 1) should be -10 to -18 volts dc.

50. Signal Input Meter Test

a. Use the same procedure given in paragraph 49a and b.

b. Adjust the dc supply to 30 volts for this test.

c. Adjust the frequency of the signal generator as described in paragraph 42*d*.

d. Vary the input signal level to the converter from 200 microvolts to 1 volt. The pointer should move about 0 at 200 microvolts input and should not read off-scale as the input signal is raised to 1 volt.

51. DISCRIMINATOR Meter Test

a. Follow the same procedure given in paragraph 50*a* and *b*.

b. Adjust the signal generator to obtain an input signal of 10,000 microvolts, and maintain this signal level throughout the test.

c. Set the frequency control of the signal generator to obtain a DISCRIMINATOR meter reading of approximately plus or minus four scale divisions.

d. Adjust the dc supply voltage between 22 and 30 volts to a value which gives maximum deflection on the DISCRIMINATOR meter. Maintain this voltage during the test.

e. Adjust the signal generator frequency to obtain a balanced condition of the discriminator (par. 43d).

f. Adjust the signal generator to a frequency 425 cps below the frequency obtained in e above.

g. With the SERVICE switch in the NOR position, note the DISCRIMINATOR meter reading. The reading should be between +3 and +5 divisions.

h. Turn the SERVICE switch to the REV position. The reading should be between minus three and minus five divisions.

i. Adjust the signal generator to a frequency 425 cycles above the frequency obtained in e above.

j. With the SERVICE switch in the NOR position, the reading should be between minus three and minus five divisions.

k. With the SERVICE switch in the REV position, the reading should be between plus three and plus five divisions.

52. Neutral Output Test

a. Connect the equipment as shown in figure 21. Ground the units together.

b. Turn the equipment on, and allow 10 minutes for warmup. Adjust the dc power supply voltage to 26 volts.

c. With a signal level of 1,000 microvolts, find the frequency at balance (par. 43*d*).

d. Set the output level and frequency of the signal generator, and the SERVICE switch, u required in the test chart below. To obtain the external mark-hold function, ground pin D of PRINTER receptacle J103.

The IF (*cps*) column in the chart gives the signal generator frequency above and below the frequency described in paragraph 43*d*.

Note. **A mark output i indicated by a closed circuit between terminals B-C of J103. A space output is indicated by a closed circuit between terminals A-C of J103.**

Signal	Signal level	Frequency shift (cps)	IF (cps)	S102 position	CV-278/GR Output
Mark	1,000 uv	300	-150	NOR	Mark
Mark	1,000 uv	300	-150	REV	Space
Mark	1,000 uv	1, 000	-500	NOR	Mark
Mark	1,000 uv	1, 000	-500	REV	Space
Spa	1,000 uv	300	+150	NOR	Space
Spa	1,000 uv	300	+150	REV	Mark
Spa	1,000 uv	1, 000	+500	NOR	Space
Spa	1,000 uv	1, 000	+500	REV	Mark
Spa	1 volt	1, 000	+500	MARK HOLD	Mark
Mark	1 volt	1, 000	-500	MARK HOLD	Mark
None	None	None	None	MARK HOLD	Mark
Spa	1 volt	850	+425	NOR	Mark
Spa	1 volt	850	+425	REV	Mark'
None	None	None	None	NOR	Mark'
None	None	None	None	REV	Mark'

[1] With external mark hold.

53. Amplitude Limiting Test

a. Follow the procedure given in paragraph 49a and b.

b. Adjust the output of the signal generator for an output signal of 200 microvolts, and the supply voltage of 26 volts.

c. Observe the db readings at the control grids (pins 1 and 3) of discriminator driver V108, with the vtvm.

d. When the signal voltage is increased to 250,000 microvolts, the voltages at the control grids should vary not more than 2 db.

54. Bias Distortion Test

When a frequency-shift keyed signal generator is not available, the distortion may be measured at 850 cycles frequency shift by using a correctly alined Radio Transmitter Modulator MD-203/GR to produce the frequency-shifted signals and Radio Receiver R-392/URR to receive the fsk signals. Because of the lengthy adjustments required to change the test sets (TS-658/UG and TS-383/GR) from 60 wpm to 100 wpm or vice versa, the TS-658/UG is used at 100 wpm and the TS-383/GR is used at 60 wpm.

a. Connect the equipment as shown in the test circuit (fig. 22)

b. Turn the converter POWER switch to ON. Adjust the supply voltage to 27.5 volts dc and allow 10 minutes for the equipment to warm up. Connect a separate dc supply and a rheostat for the loop current through Teletypewriter Test Set TS-917/GM to the printer connector on the converter.

c. Adjust the oscillator tuning to any frequency within the range of the modulator (TM 11-5820-205-35). The output of the modulator has the same frequency as the input (without frequency shift). Set the signal level at 1 volt.

d. Adjust the variable resistor (rheostat) to give a loop current of 20 milliamperes.

e. Set the MCS BAND SELECTOR switch (modulator) for the signal generator frequency used (1.5 to 3 mc).

f. Set the TS-658/UG for 100 wpm, and for reversals.

g. Tune the receiver to the FSK signal from the modulator. Vary the tuning so that the SIGNAL INPUT meter on the converter reads maximum and the DISCRIMINATOR meter reads on or near zero.

h. Rotate tile SERVICE switch from NOR to REV and back to NOR. The discriminator circuit is properly balanced when the pointer of the DISCRIMINATOR meter stays on or near zero plus or minus one-half division, with the SERVICE switch in either the NOR, MARK HOLD, or REV position. Leave the switch in the NOR position.

i. Set the TS-658/UG for the character R at a speed of 100 wpm, and set the distortion at zero.

j. Adjust Teletypewriter Test Set TS-917/GM controls for the most steady scope display. Posi

tion the display and increase or decrease its length to permit reading the per cent distortion on the calibrated scale.

k. The distortion limits are 10 percent at 60 wpm and 15 percent at 100 wpm, with no noise in the signal.

l. Repeat the procedure given in i above with Distortion Test Se TS-383/GR. Set for the character Rat a speed of 60 wpm and with no distortion.

55. Changing Speed of Test Set TS-658/UG

To change the speed of Test Set TS-658/UG to 100 wpm (600 opm), install gear set No. 113855.

***Note*. Do not turn the motor counterclockwise with the brushes down. Do not bend the brushes.**

a. Open the case and remove the case cover.

b. Open the cover above the .the commutator.

c. Loosen the hexagonal head locking screw on the brush rotor and turn the brush holder to raise the brushes to a horizontal position; tighten the locknut.

d. Remove the four machine screws from the bottom of the case; lift the chassis out of the case.

e. Remove the thumbscrew gear set holder that holds the square gear sets on the mounting post.

f. Turn the motor worm gear until the set screw, in the fiber gear on the brush rotor shaft, is facing the fuses.

g. Loosen the set screw in the fiber gear and remove the fiber gear.

h. Loosen the set screw in the motor worm gear; remove the motor worm gear.

i. Install the iron worm gear of gear set No. 113855 on the motor shaft (with hub in) and aline the center of the gear with the center of the haft of the brush rotor. Tighten the set screw.

j. Install the fiber gear (with hub out) on the brush rotor shaft. Mesh the gears carefully and tighten the set screw.

k. Plug the motor into a 110-volt 60-cycle line and check the operation while the brushes are off the segments.

l. Mount the spare gear sets on the post, with the thumbscrew holder.

m. Install the chassis in the case and secure it with the four machine screw.

n. Open the cover above the commutator, loosen the hexagonal head locking screw, and lower the brushes. Hold the pin against the fiber stop while tightening the locking screw.

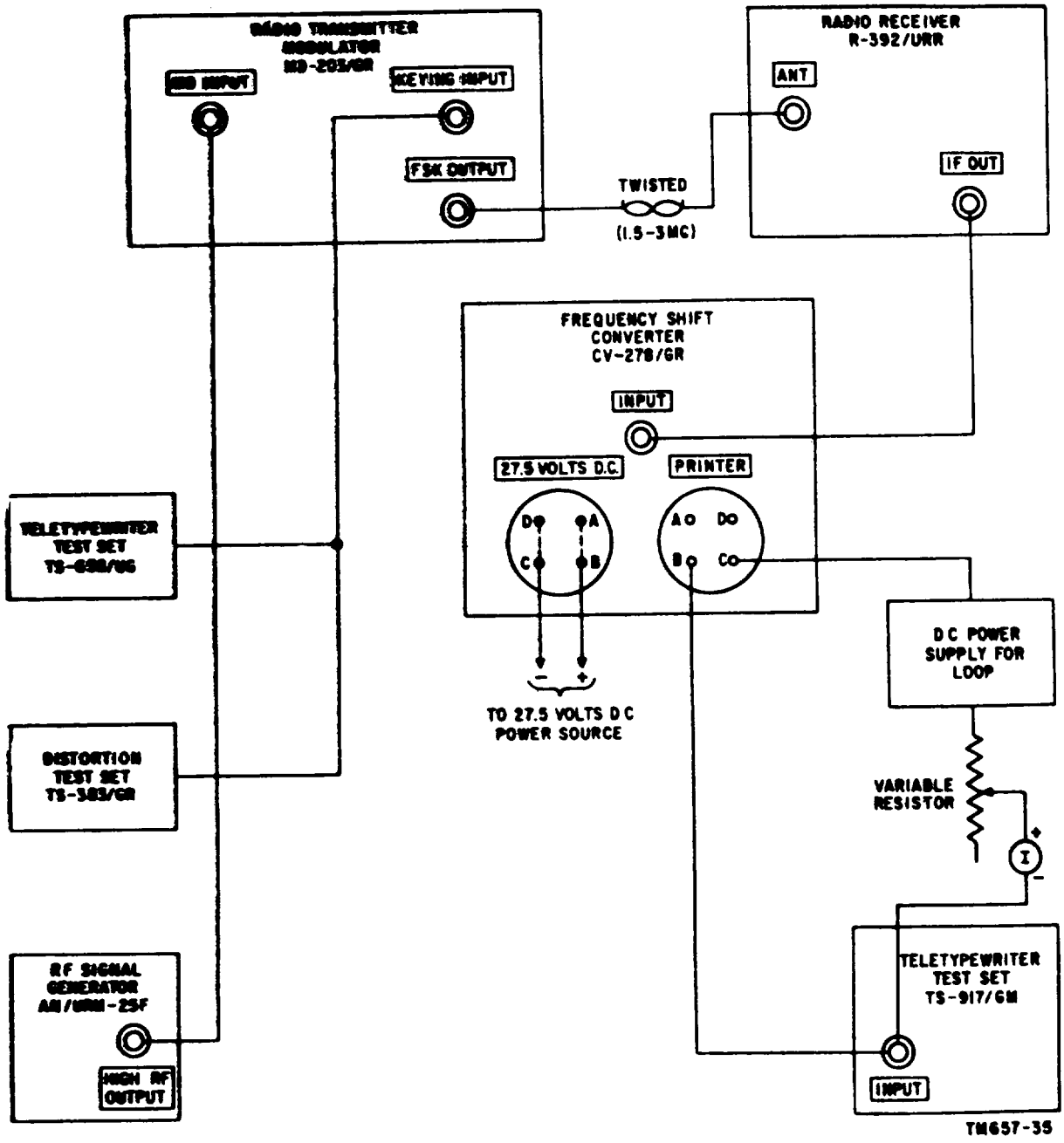
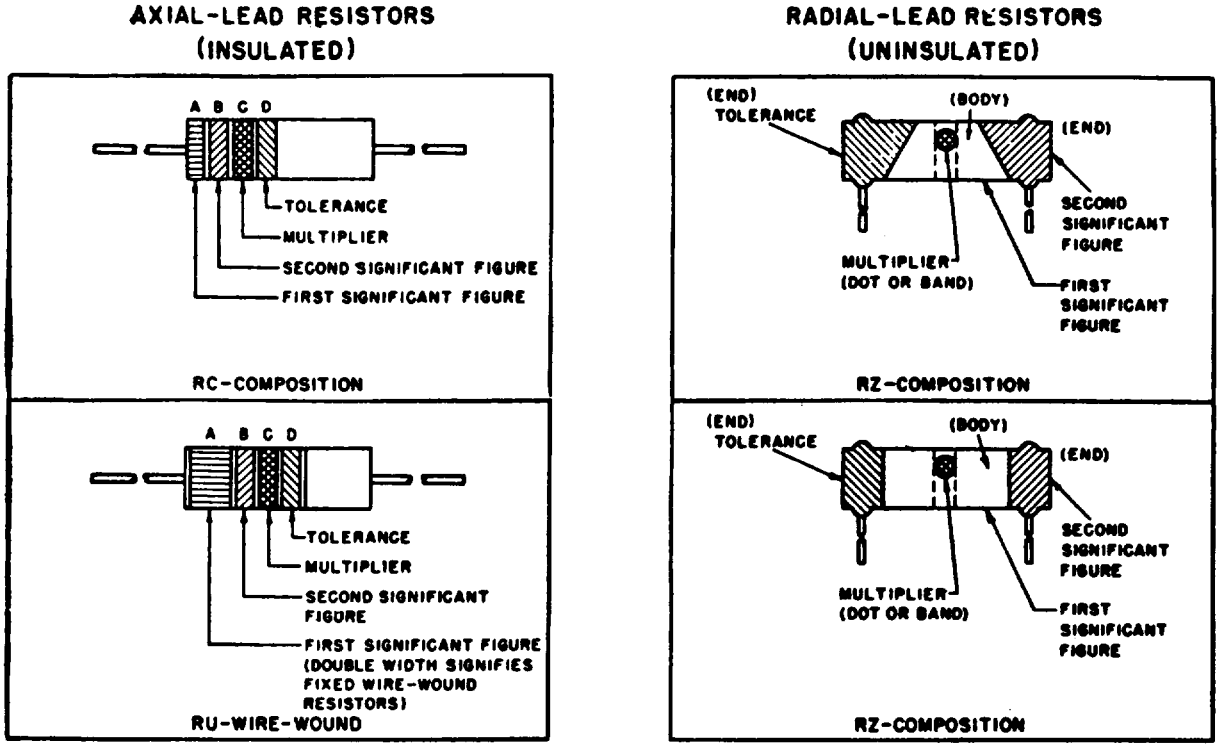


Figure 22. Bias distortion test circuit, using Radio Transmitter Modulator MD-203/GR and Radio Receiver R-392/URR.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)



RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK		BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

* FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

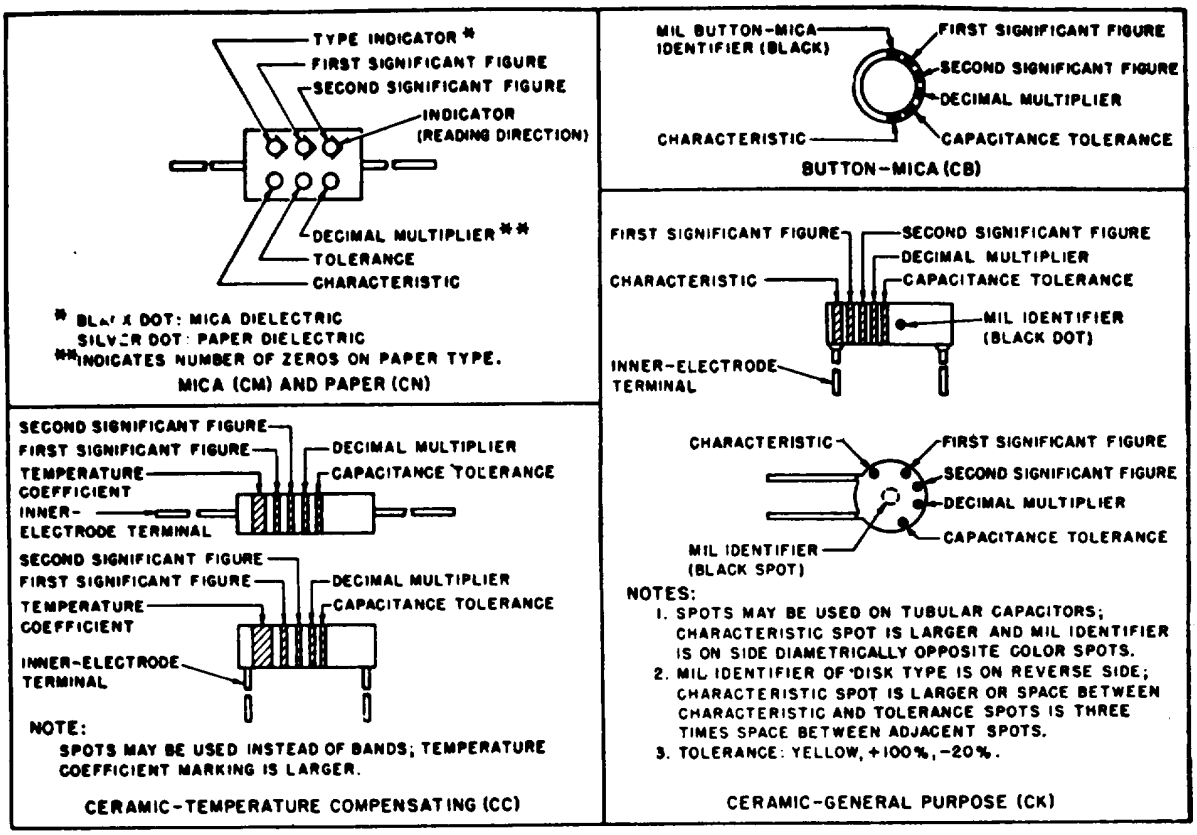
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-RI

Figure 23. MIL-STD resistor color code markings.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE [2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500) [3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-CI

Figure 24. MIL-STD capacitor color code markings.

APPENDIX

REFERENCES

Following is a list of applicable references which are available to the field and depot maintenance repairman of Frequency Shift Converter CV-78/GR:

TM 11-5815-204-10	Radio Teletypewriter Sets AN/GRC-46 and AN/ VRC-29, Operator's Manual.
TM 11-5815-204-20	Radio Teletypewriter Sets AN/GRC-46 and AN/ VRC-29, Organizational Maintenance.
TM 11-5815-204-35	Radio Teletypewriter 8i AN/GRC-46 and AN/ VRC-29, Field and Depot Maintenance.
TM 11-5820-205-10	Radio Transmitter Modulator MD-203/GR, Operator's Manual.
TM 11-5820-205-20	Radio Transmitter Modulator MD-203/GR, Organizational Maintenance.
TM 11-5820-205-35	Radio Transmitter Modulator MD-203/GR, Field and Depot Maintenance.
TM 11-5805-210-10	Frequency Shift Converter CV-278/GR, Operator's Manual.
TM 11-5805-210-20	Frequency Shift Converter CV-278/GR, Organizational Maintenance.
TM 11-806	Radio Transmitter T-195/ GRC-19.
TM 11-858	Radio Receiver R392/ URR.

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[AG 413.44 (31 Jul 59)]

By Order of Wilber M. Brucker, Secretary of the Army:

L. L. LEMNITZER,
General, United States Army,
Chief of Staff.

Official:

R. V. LEE,
Major General, United States Army,
The Adjutant General.

Distribution:
Active Army:

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Dcf Atomic Spt Agcy (5)
CNGB (1)
Tech Stf, DA (1) except
CSigO (18)
Tech Stf Bd (1)
USA Arty Bd (1)
USA Armor Bd (1)
USA Inf Bd (1)
USA AD Bd (1)
USA Abn & Elct Bd (1)
USA Avn Bd (1)
USA ATB (1)
USCONARC (5)
US ARADCOM (2)
U8 ARADCOM Rgn (2)
08 Maj Cord (5)
OS Base Comd (5)
Log Cord (5)
MDW (1)
Armies (5) except
First US Army (7)
Corps (2)
Div (2)
USATC (2)
Svc Colleges (5)
Br Svc Sch (5) except
USASC (25)
Gen Dep (2) except
Atlanta Gen Dep (none)
Sig Sec, Gen Dep (10)
Sig Dep (17)
Army Pictorial Cen (2)
Engr Maint Cen (1)
USA Ord Mid Comd (3)
USASSA (15)
USASSAMRO (1)
USA Sig Pub Agcy (8)
UBA Sig Er, Agcy (1)
USA Comm Agcy (2)
USA Sig Eqp Spt Agcy (2)
USA Sig Msl Spt Agcy (13)
WRAMC (1)
AFIP (1)
AMS (1)
Ports of Emb (08) (2)
Trans Terminal Comd (1)
Army Terminals (1)
OS Sup Agcy (1)
Yuma Test Sta (2)
USA Elct PG (1)
Sig LIb (6)
Sig Fld Maint Shops (3)
Mil Dist (1)
Mil Dist (1)
USA Corps (Res) (1)
Sector Comd, USA Corps (Res) (1)
JBUSMC (2)
Units org under fol TOE:.
11-5 (2)
11-7 (2)
11-16 (2)
11-37 (2)
11-39 (2)
11-55 (2)
11-57(2)
11-97 (2)
11-98 (2)
11-117 (2)
11-155 (2)
11-500 (AA-AE) (2)
11-555 (2)
11-557 (2)
11-587 (2)
11-592 (2)
11-597 (2)

NG: State AG (3);units-same as Active Army except allowance is one copy to each unit.
USAR: None.
For explanation of abbreviations used, see AR 320-50.

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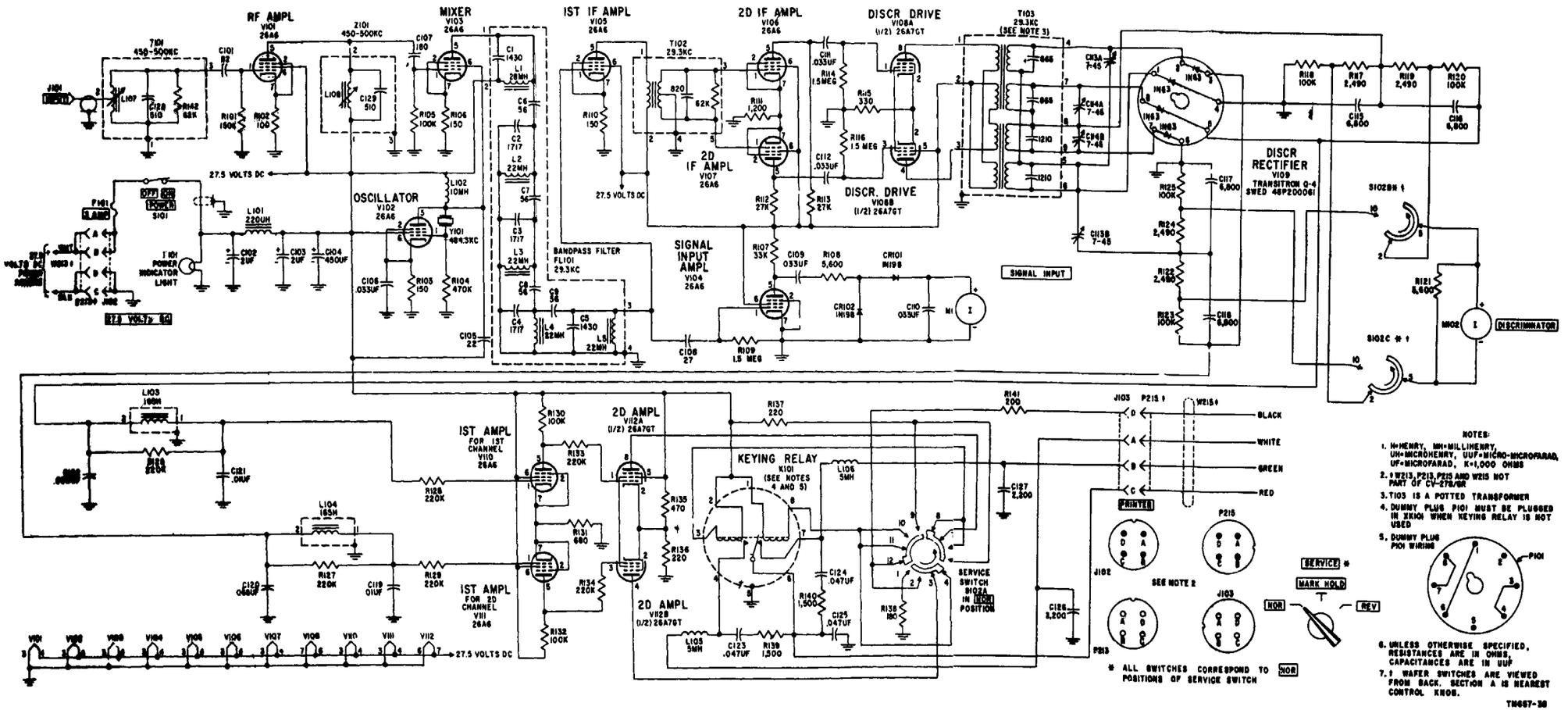

Figure 25. Frequency Shift Converter CV-278/GR, schematic diagram.

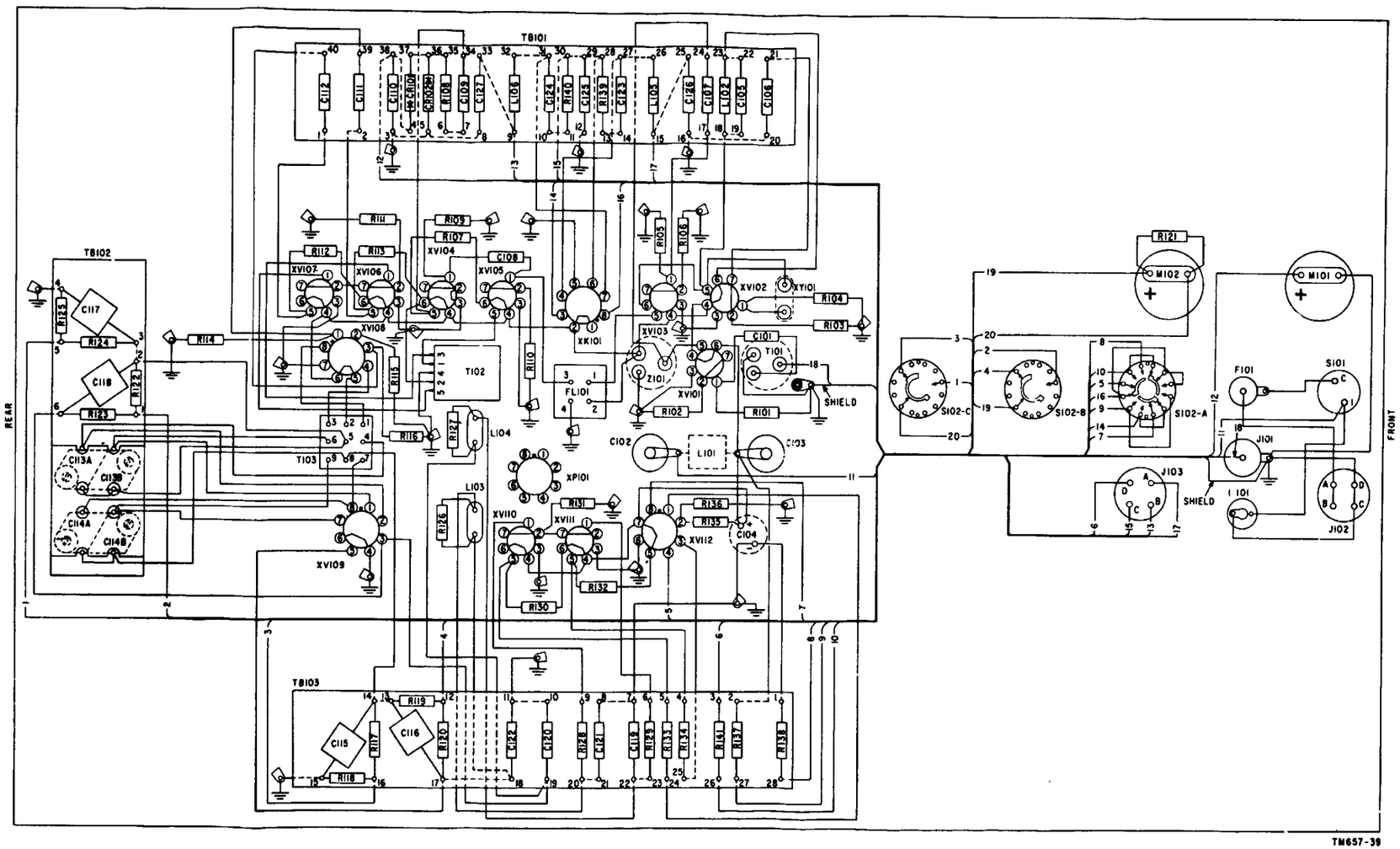

Figure 26. Frequency Shift Converter CV-278/GR, wiring diagram.

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