TM 11-5805-356-34-1

TECHNICAL MANUAL

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE
MANUAL INCLUDING REPAIR PARTS AND SPECIAL
TOOLS LISTS

TERMINAL, TELEGRAPH TH-22/TG AND FILTER ASSEMBLY, ELECTRICAL F-316/U

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

HEADQUARTERS, DEPARTMENT OF THE ARMY

13 OCTOBER 1972

WARNING

HIGH VOLTAGE

is used in the operation of this equipment

DEATH ON CONTACT

may result if personnel fail to observe safety precautions.
Learn the areas containing high voltage in each piece of equipment.
Be careful not to contact high voltage connections when installing or operating this equipment.

Before working inside the equipment, turn power off and ground points of high potential before touching them.

CHANGE No.1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 23 *September 1983*

Direct Support and General Support Maintenance Manual

TERMINAL, TELEGRAPH TH-22/TG (NSN 5805-00-907-8300), TH-22B/TG (NSN 5805-00-907-8300), AND FILTER ASSEMBLY, ELECTRICAL F-316/U (NSN 5915-00-941-9779)

TM 11-5805-356-34-1, 13 October 1972, is changed as follows:

1. Title of the manual is changed as shown above.
2. New or revised material is indicated by a vertical bar in the margin. Where an entire chapter, section, or illustration is added or revised, the vertical bar is placed opposite the identification number and title.
3. Remove old pages and insert new pages as follows:

Remove pages	*Insert pages*
None	A and B
i and ii	i and ii
1-1	1-1/(1-2 blank)
3-3 through 3-8	3-3 through 3-8
3-19	3-19/(3-20 blank)
4-1 through 4-6	4-1 through 4-6
A-1	A-1
B-1 through B-36	None
Figure FO-3	Figure FO-3

4. File this change sheet in front of the publication.

By Order of the Secretary of the Army:

JOHN A. WICKMAN JR.
General, United States Army
Chief of Staff

Official:
ROBERT M. JOYCE
Major General, United States Army
The Adjutant General

5 SAFETY STEPS TO FOLLOW IF SOMEONE IS THE VICTIM OF ELECTRICAL SHOCK

1 DO NOT TRY TO PULL OR GRAB THE INDIVIDUAL

2 IF POSSIBLE, TURN OFF THE ELECTRICAL POWER

3 IF YOU CANNOT TURN OFF THE ELECTRICAL POWER, PULL, PUSH, OR LIFT THE PERSON TO SAFETY USING A WOODEN POLE OR A ROPE OR SOME OTHER INSULATING MATERIAL

4 SEND FOR HELP AS SOON AS POSSIBLE

5 AFTER THE INJURED PERSON IS FREE OF CONTACT WITH THE SOURCE OF ELECTRICAL SHOCK, MOVE THE PERSON A SHORT DISTANCE AWAY AND IMMEDIATELY START ARTIFICIAL RESUSCITATION

WARNING

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TECHNICAL MANUAL
No.11-5805-356-34-1

HEADQUARTERS
DEPARTMENTOF THE ARMY
WASHINGTON, DC, 13 *October* 1972

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

TERMINALS, TELEGRAPH TH-22/TG

(NSN 5805-00-907-8300).

TH-22B/TG (NSN 5805-00-907-8300),

AND

FILTER ASSEMBLY, ELECTRICAL F-316/U

(NSN 5915-00-941-9779)

			Paragraph	Page
CHAPTER	1.	INTRODUCTION		
SECTION	I.	General		
		Scope	1-1	1-1
		Maintenance Forms and Records	1-2	1-1
		Calibration	1-3	1-1
		Reporting of Error	1-4	1-1
	II.	Description and Data		
		Description	1-5	1-1
		Tabulated Data	1-6	1-1
CHAPTER	2.	FUNCTIONING OF TH-22/TG and F-316/U EQUIPMENT		
SECTION	I.	Block Diagram Analysis		
		General	2-1	2-1
		Simplified Block Diagram Analysis, TH-22/TG	2-2	2-1
		Simplified Block Diagram Analysis, F-316/U	2-3	2-2
		Detailed Block Diagram Analysis, TH-22/TG.	2-4	2-2
	II.	Schematic Diagram, TH-22/TG		
		Send Circuit	2-5	2-7
		Receive Circuit	2-6	2-8
		Break-In Circuit (Detect).	2-7	2-10
		Carrier-Suppreseion Circuit	2-8	2-11
		Threshold Circuit.	2-9	2-12
		Alarm Circuit	2-10	2-13
		Power Supply Circuit.	2-11	2-13
CHAPTER	3.	DIRECT SUPPORT MAINTENANCE INSTRUCTION		
SECTION	I.	General		
		Scope of Direct Support Maintenance	3-1	3-1
		Voltage and Resistance Mesurements	3-2	3-1
		Continuity Tests.	3-3	3-3
		Bench Testing	3-4	3-3
	II.	Tools and Equipment	....	3-6
	III.	Troubleshooting		
		Introduction	3-5	3-6
		Operational Tests.	3-6	3-6
		Localizing Trouble.	3-7	3-8

***This manual, together with TM 11-5805-356-34-2, 13 October 1972, supersedes TM 11-5805 -356-35,9 December 1966, including all changes.**

			Paragraph	Page
SECTION	IV.	Maintenance of TH-22/TG		
		Send Circuit Bias Adjustment	3-8	3-18
		Receive Circuit Bias Adjustment	3-9	3-19
		Receive Circuit Loop Current Adjustment	3-10	3-19
CHAPTER	4.	GENERAL SUPPORT MAINTENANCE INSTRUCTIONS		
SECTION	I.	General Maintenance Information		
		Scope of General Support Maintenance	4-1	4-1
		Fabrication of Test Cables	4-2	4-1
	II.	Tools and Test Equipment		
		Test Equipment and Tools, General Support Maintenance	4-3	4-1
		Materials, General Maintenance Procedures	4-4	4-2
	III.	Troubleshooting		
		General	4-5	4-2
		Signal Substitution Charts	4-6	4-2
	IV.	Maintenance of TH-22/TG		
		Repair Procedures	4-7	4-3
		Send Oscillator Frequency Adjustment	4-8	4-4
	V.	General Support Testing Procedures		
		Physical Test and Inspection	4-9	4-5
		TH-22/TG 2-Wire Operational Test	4-10	4-5
		TH-22/TG 4-Wire Operational Test	4-11	4-7
		F-316/U Operational Test	4-12	4-8
APPENDIX	A.	REFERENCES		A-1
	B.	Deleted by Change 1.		

LIST OF ILLUSTRATIONS

Figure No.	Title	Page No.
2-1	Terminal, Telegraph TH-22/TG, simplified block diagram	2-3
2-2	Filter Assembly F-316/U, simplified block diagram	2-4
2-3	Send telegraph signal time delay waveforms	2-5
3-1	TH-2/TG chassis voltage and resistance diagram	3-4
3-2	TH-22/TG chassis terminal board 1TB1 voltage and resistance diagram	3-5
3-3	TH-22/TG chassis, top view	3-12
3-4	TH-22/TG chassis withpc boards removed, top view	3-13
3-5	TH-22/TG chassis with pc boards in test position, rear view	3-14
3-6	TH-22/TG chassis, bottom view	3-15
3-7	Send card 1A1, component layout and wiring diagram	3-16
3-8	Break-in detector 1A2, component layout and wiring diagram	3-17
3-9	Receive card 1A3, component layout and wiring diagram	3-18
4-1	Operational test setup	4-10
FO-1	MIL-STD color code marking for resistors and capacitors and inductors	Back of Manual
FO-2	Terminal, Telegraph TH-22/TG, detailed block diagram	Back of Manual
FO-3	Terminal, Telegraph TH-22/TG, schematic diagram	Back of Manual
FO-4(1)	Terminal, Telegraph TH-22/TG, wiring diagram (sheet 1 of 2)	Back of Manual
FO-4(2)	Terminal, Telegraph TH-22/TG, wiring diagram (sheet 2 of 2)	Back of Manual

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual covers direct support and general support maintenance for Terminal, Telegraph TH-22/TG and Filter Assembly, Electrical F-316/U. This section outlines pertinent administrative information. Section II describes purpose, use and mechanical configuration of the equipment, and lists of electrical specifications. Chapter 2 provides detailed circuit analysis. Chapters 3 and 4 contain information appropriate to direct support maintenance and general support maintenance respectively.

1-1.1 Consolidated Index of Army Publications and Blank Forms

Refer to the latest issue of DA Pam 310-1 to determine whether there are new editions, changes or additional publications pertaining to the equipment.

1-2. Maintenance Forms, Records, and Reports

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by TM 38-750, The Army Maintenance Management System (TAMMS).

1-3. Calibration

Pertinent publications on calibration of this equipment shall be referenced as required.

1-4. Reporting of Errors and Recommending Improvements

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: DRSEL-ME-MP, Fort Monmouth, New Jersey 07703. In either case, a reply will be furnished direct to you.

1-4.1. Reporting Equipment Improvement Recommendations (EIR)

If your Telegraph, Terminal TH-22/TG or Electrical Filter Assembly F-316/U needs improvement, let us know. Send us an E IR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: DRSEL-ME-MP, Fort Monmouth, New Jersey 07703. We'll send you a reply.

Section II. DESCRIPTION AND DATA

1-5. Description

Refer to TM 11-5805-356-12 for purpose, use, and photographs of the equipment.

1-6. Tabulated Data

Refer to TM 11-5805-356-12 for lists of technical characteristics of the equipment.

CHAPTER 2

FUNCTIONING OF TH-22/TG AND f-316/U EQUIPMENT

Section I. BLOCK DIAGRAM ANALYSIS

2-1. General

a. The TH-22/TG is a full duplex telegraph signal converter. Two TH–22/TG units provide the electronics required to establish telegraph communications via a telephone channel. The F-316/U interfaces both a local telephone circuit and a TH-22/TG to the same telephone channel to facilitate simultaneous voice and telegraph communications.

b. The simplified block diagram analysis (para 2-2) describes. the major functions performed by the TH-22/TG. Paragraph 2-3 describes the function of the F-316/U. The detailed block diagram analysis (para 2-4) describes how each major function is accomplished by the TH-22/TG. Section II describes specific stages of the TH-22/TG on a schermatic diagram basis.

2-2. Simplified Mock Diagram Analysis, TH-22/TG
(fig. 2-1)

a. Send and Receive Circuits. The send circuit converts dc telegraph signals to voice frequency (vf) frequency-shift telegraph signals (1917.5 Hz mark, 1222.5 Hz space) suitable for transmission via a telephone channel. The receive circuit converts incoming vf telegraph signals to dc telegraph signals. At the vf end the send and receive circuits connect through a (vf interface) network that interfaces them with either a 2-wire or a 4-wire telephone channel. At the dc end of the send circuit, internal loop battery is provided. At the dc end of the receive circuit either internal or external loop battery may be utilized.

b. 4-Wire Full Duplex. With the network configured to interface with a 4-wire telephone channel, signals may be sent and received simultaneously (full duplex). In this case the receiving device is not available to print out home copy. If home copy is required, provisions are available to connect another receiving device in series with the send loop.

c. 4-Wire Half Duplex. If the network is configured to interface with a 4-wire telephone channel that is to be operated half duplex (radiotelephone channel for example) the normal traffic receiving device will be available to print out home copy. This function is accomplished by enabling a home copy circuit that connects the vf ends of the send and receive circuits together. Also a remote control closure (CONT) is provided to enable the radio transmitter during send operation.

d. 2-Wire Half Duplex. With the network configured to interface with a 2-wire telephone channel, only half duplex operation is possible. It is therefore necessary to remove the send vf carrier from the telephone channel while receiving. This is accomplished by the carrier suppression circuit. When the sending device ceases to transmit it goes to mark hold. The mark hold is detected by the carrier suppression. circuit which responds by inhibiting the vf output of the send circuit. Home copy is automatically provided on the normal traffic receiving device since the line side of the output and input transformers are connected in parallel, via the interface network, when it is configured for a 2-wire channel. Since the 4WS-TEL vf termination is not used with 2-wire telephone channels, it is available to connect to a local telephone circuit. At will, the operator can configure the vf interface network to connect the local telephone to the 2-wire channel terminated at 2W-4WR.

e. Break-In Circuit. If during 2-wire operaation, the distant station is transmitting and the local station has a higher priority message it is possible to break-in. The local operator activates the local break-in circuit (initiate) which locks the local send circuit in the 1180-Hz hold condition. The 1180-Hz break-in signal is able to transverse the channel in spite of the incoming vf telegraph signal (because the two signals are situated at different points on the vf spectrum)

The 1180-Hz signal enters the distant vf interface network and couples through the distant output transformer to the input of the distant break-in circuit. (detect). The distant break-in circuit (detect) responds by locking the distant send circuit in the space hold condition. The space hold couples through both the distance and local receive circuits to the input of the distant and local alarm circuits. The alarm circuits respond by producing an audible tone at their associated loudspeakers. The distant operator responds by ceasing to transmit and resetting the distant break-in circuit (detect). With the distant sending device idle (in mark hold condition) and the distant space hold released, the distant vf output is inhibited. When the distant space hold is released, the local alarm ceases to sound informing the local operator that the channel is clear to carry the higher priority message.

f. Signaling Circuit. When 2-wire or 4-wire metallic telephone channels (landlines) are used a 20-Hz ringing signal may be utilized. When the operator activates the signaling circuit, a 20-Hz signal is injected into the telephone channel via the vf interface network. The signal will activate any 20-Hz ringing device connected to the channel. It will also be detected by the distant alarm circuit and produce an audible tone at the associated loud speaker. The 20-Hz signal will not transverse radio telephone or other carrier channels. For this situation the signaling circuit is conditioned to lock the send circuits in space hold when the signaling circuit is activated. The space hold signal is able to transverse any telephone channel and activate the distant alarm circuit.

g. Threshold Circuit. The threshold circuit locks the output of the receive circuit in, mark hold whenever the vf input signal amplitude drops below a predetermined level. This function prevents noise in an idle telephone channel from keying the receiving device.

h. Power Supply Circuit. The TH-22/TG contains an internal power supply. Input power may be either 230 vac, 115 vac or 26 vdc. In any case two output voltages result: +18 volts (±1.8v) to operate active circuitry and +108 volts (±5v) to provide internal loop battery.

2-3. Simplified Block Diagram Analysis, F-316/U
(fig. 2-2)

Since the vf telegraph signal occupies only a small portion (1317 :5-1232.5 Hz) of the telephone channel band (300-3000 Hz) the channel is still usable for telephone communications even while data is being transmitted. To prevent the voice signal and data signal from interfering with each other, Electrical Filter Assembly F-316/U may be employed. As shown in figure 2-2, the F-316/U stops all voice signal frequencies in the vf telegraph band from entering the telephone channel and stops all vf telegraph frequencies from entering the local telephone circuit.

2-4. Detailed Block Diagram Analysis, TH-22/TG
(fig. FO-2)

a. Send Circuit. A sending device connected to SEND jack J1 keys the send loop. The resultant voltage signal developed across R19 couples through delay amplifiers A1Q1 and A1Q2, and emitter follower A1Q3 to modulator A1CR1-CR2. The modulator shifts the frequency of oscillator A1Q4 in accordance with the dc telegraph signal (fig. 2-3). Oscillator frequency goes to 1317.5-Hz for a mark and to 1232.5-Hz for a space. The resultant frequency-shift vf telegraph signal couples through emitter follower A1Q5, gated amplifier A1Q6, amplifier A1-Q7, an attenuator, BOOST switch S6, output transformer T3 and the vf interface network (e below) to the telephone channel terminated at binding posts E3–E4 or E5-E6. The vf output bypasses the attenuator when BOOST switch S6 is operated.

b. Carrier Suppression Circuit. Delay amplifier A2Q14 monitors the send loop via S3-1-2. Should transmission cease and the loop remain at mark hold for 2 seconds or more A2Q14 produces an output level that couples through AND gate A2Q12-Q13 to inhibit the vf output of the send circuit. The gate is enabled by the output of quiescent multivibrator A2Q8-Q9 via S5A-7-5 (set to 2W). Note that if S5 is set to other than 2W the carrier suppression circuit is thus disabled. When the first space element occurs each time transmission is initiated, A2Q14 releases the inhibit. The first space element is not distorted during transmission because A1Q1 and A1Q2 store it long enough for the carrier suppression circuit to release the inhibit. MODE ONE-MODE TWO switch S10 selects two different delay times for A1Q1 and A1Q2 to accommodate different transmission rates.

c. *Receive Circuit. The* incoming vf telegraph signal couples from the telephone channel, terminated at binding posts E5-E6, through the vf interface network (e below), input transformer

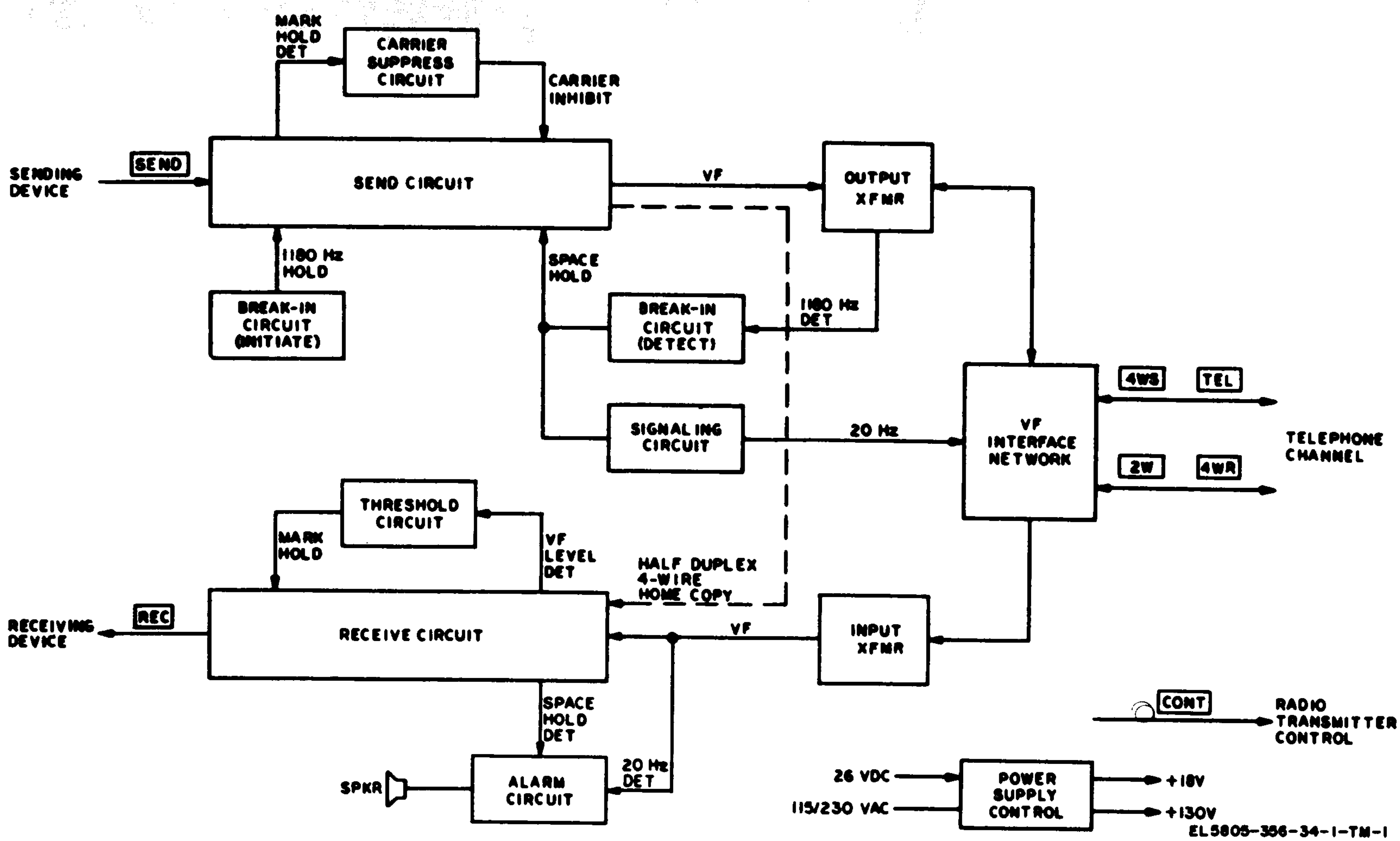


Figure 2-1. Terminal, Telegraph TH-22/TG, simplified block diagram.

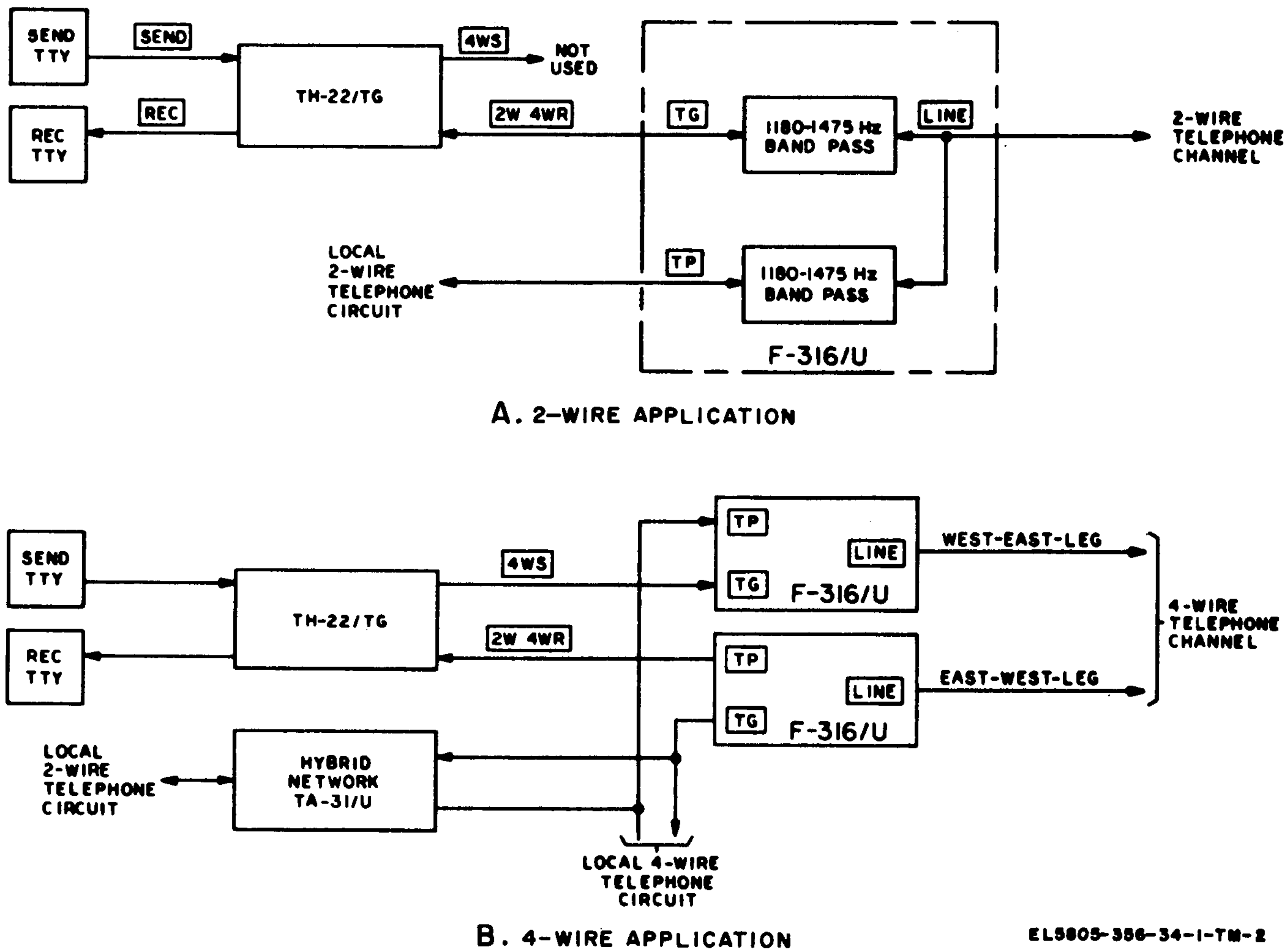


Figure 2-2. Filter Assembly F-316U, simplified block diagram.

T2, and emitter follower A3Q1 to limiter amplifier A3Q2-Q3. The limited vf signal couples through emitter follower A3Q4 and discriminator driver A3Q5 to discriminator network Z2, CR7-CR10. The discriminator converts the vf telegraph frequency-shift signal to a dc telegraph voltage signal. It converts a 1317.5-Hz tone to a mark and a 1232.5-Hz tone to a space, The mark-space voltage signal couples through emitter follower A3Q6-Q7 and differential amplifier A3Q8-Q10 to operate electronic switch A3Q11. The electronic switch keys the receive loop. A receiving device connected to REC jack J3 prints out the received message. Where external battery is to be used the battery is connected to EXT BAT jack J4. Internal battery loop current may be adjusted at R12.

d. *Threshold Circuit.* Signal detector A3CR6-CR7 develops a dc level output in proportion to input vf signal level. When the vf level drops below a predetermined value, the dc level couples through differential amplifier A3Q13-Q14 to turn on electronic switch A3Q12. The switch lights THRESHOLD lamp DS2 and couples a ground through emitter follower A3Q9 to lock the receive loop in mark hold. When the vf level exceeds the predetermined value, the mark hold is released. Either of two predetermined values (-25 dbm, -45 dbm) are strap selected at limiter amplifier A3Q2-Q3.

e. *Vf Interface Network. The* network has three major configurations, selected by 4W-2W-TEL switch S5.

(1) *4-wire telephone channel interface.* With S5 set to 4W. input transformer T2 connects to binding posts E5-E6. The signal path is from E5 through S5C-1-2 to T2. The return is from T2 through C13, S5B-2-1 to E6. Output transformer T3 connects to E3-E4. The signal path is from T3 through C15 and S5C-5-6 to E3. The return is from E4 through S5B-6-5 and S4A-8-7 to T3.

(2) *2-wire telephone channel interface.* With S5 set to 2W both transformers connect in

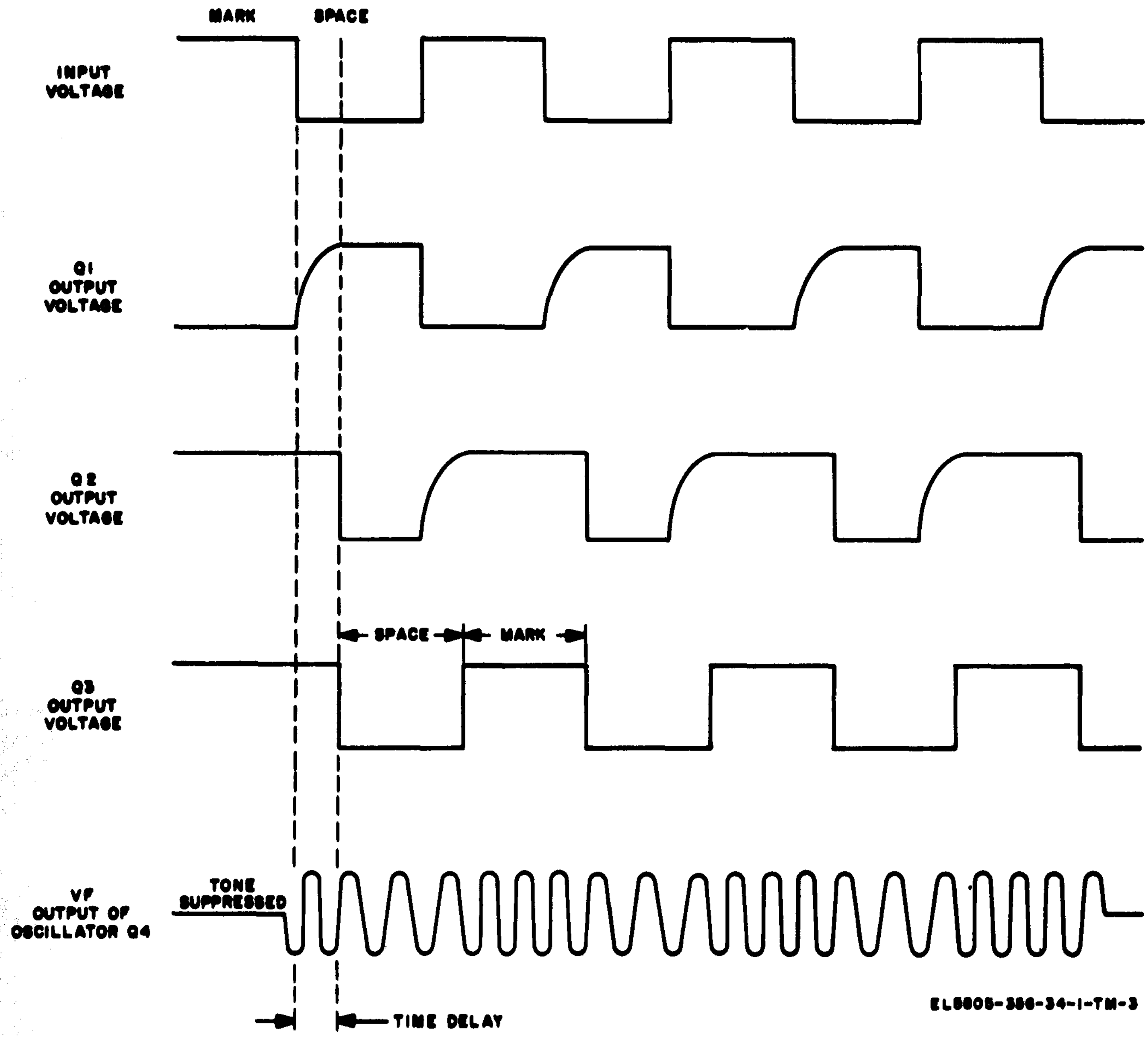


Figure 2-3. Send telegraph signal time delay waveforms.

parallel to binding posts E5-E6. The output signal path is from T8 through C15, S5C-5-7 and S5C-8-1 to E5. The return is E6 through S5B-1-3, S5B-7-5, and S4A-8-7 to T8. The input signal path is from E5 through S5C-1-3 to T2. The return is from T2 through C18, SIA-2-1 and S5B-3-1 to E6.

(3) *Local telephone.* With S5 set to TEL, E5 connects to E3 through S5C-1-4 and E6 connects to E4 through S5B-1-4.

f. Break-In Circuit (Initiate). When BREAK-IN switch S2 is depressed, contacts S2A-10-12 make to lock oscillator A1Q4 in the 1180-Hz hold condition. The 1180-Hz hold signal couples through the telephone channel to the distant TH-22/TG. Note that while S2 is depressed, contacts S2-7-8 open the send loop, contacts S2-1-3 close to lock the receive loop in mark hold, and contacts S2-4-6 close to reset multivibrator A2Q8-Q9 via emitter follower A2Q6.

g. *Break-In Circuit (Detect).* An incoming 1180-Hz break-in signal couples through the vf interface network from binding post E5 through S5C-1-3, S5C-7-5, and C15 to T3. The return is from T3 through S4A-7-8, S5B-5-7 and S5B-3-1 to E6. The 1180-Hz signal developed at the send circuit side of T3 couples through 1180-Hz (pass) filter Z1, emitter follower A2Q1, dc amplifier A2Q2-Q3, and emitter follower A2Q4 to rectifier A2CR1. The 1180-Hz signal produces a dc level at the output of A2CR1. The level couples through dc amplifier A2Q5 to delay integrator A2CR2. The resultant transition at the output of A2CR2 couples through emitter follower A2Q6 to reset multivibrator A2Q8-Q9. The new output of A2Q8-Q9 couples through S5A-7-5 to release the inhibit from the send circuit. The new output of A2Q8-Q9 also couples through buffer amplifier A2Q7 and S5A-3-1 to lock the send circuit in the space hold condition. The break-in (detect) function can be disabled by strapping terminals 1-2 at the input to A2Q7.

h. Signaling Circuit (20∿). With VF-20∿ switch S4 set to 20∿ and RING switch S1 depressed, the 20 cycle ringer is activated by +18 v applied to it via S4-3-1 and S1B-6-4. The 20-Hz ringing signal couples through the vf interface network to either binding posts E4-E3 or E5-E6 depending on the setting of S5. With S5 set to 4W the signal path is from the 20 cycle ringer through lamp DS3, S1A-6-4 and S5C-5-6 to E3. The return is from E4 through S5B-6-5 and S1A-7-9 to the 20 cycle ringer. With S5 set to 2W the 20-Hz signal path is from the 20 cycle ringer through lamp DS3, S1A-6-4, S5C-5-7, and S5C-3-1 to E5. The return is from E6 through S5B-1-3, S5B-7-5 and S1A-7-9 to the 20 cycle ringer.

NOTE

If S4 is left in the 20∿ position output transformer T3 is disconnected from telephone channel at contacts S4-7-8.

i. Signaling Circuit (Vf). With VF-20 switch S4 set to VF, contacts S4-1-3 are open to disable the 20 cycle ringer. When RING switch S1 is depressed, contacts S1B-7-8 open the send loop, thus locking the send circuit in the space hold condition. The space hold signal is transmitted through the vf network into the telephone channel in the same manner as any send vf signal.

j. Alarm Circuit (20∿). When a 20-Hz signal is received via the telephone channel, it couples through the vf interface network as would any receive vf signal. At the output of input trans. former T2, however, it couples to ring detector A2CR1, the resultant dc level at the output of A2CR1 couples through differential amplifier A2-Q16-Q17 to enable freerun multivibrator A2Q-18-Q19. The audio rate output of A2Q18-Q19 couples through af amplifier A2Q20 to produce an audible tone at speaker LS1

k. Alarm Circuit (Vf). When a space hold signal is received via the telephone channel it couples through a vf interface network into the receive circuit as would any receive vf signal. If the space hold persists for 2 seconds or more delay amplifier A2Q15 produces a dc level output that activates the alarm circuit as described in *j* above.

l. NORM-REC-SEND Switch S3. For half duplex operation on a 2-wire telephone channel or for full duplex operation on a 4-wire telephone channel, S3 is left in its NORM position. For half duplex operation on a 4-wire telephone channel such as a radio-telephone channel, S3 is set to SEND for transmission and to REC for reception. When set to SEND, contacts S3-9-12 provide a closure at CONT binding posts E1-E2 to operate the remote radio transmitter if required. Also contacts S3-1-4 make to enable the send vf output by disabling AND gate A2Q12-Q13. Contacts S3-5-8 make to bypass capacitor C13 in the vf interface network thus providing a dc path for the external circuit common battery holding function if required (C13 is also bypassed with S3 in NORM position when COMBAT terminals 5-6 are strapped). When S3 is set to REC, contacts S3-1-3 make to inhibit the send Vf output.

m. 4-Wire Half Duplex Home Copy Circuit. When S5 is set to either 4W or TEL the output of the send circuit, at amplifier A1Q7, connects through S5A-12-9 or S5A-10-9 and 4W HC strap terminals to the input of the receive circuit, at emitter follower A3Q1.

n. Power Supply Circuit. The power supply furnishes all required operating voltages for the TH-22/TG from any of three primary power sources: 230 volts ac, 115 volts ac, or 26 volts dc. A switch adapts the power supply circuit to operate with any of these input voltages. When operating from an ac power source, the source voltage is applied direct to the input of power transformer T1. Transformer T1 produces both high and low ac voltage outputs from the input, The high voltage output of T1 is rectified and filtered by high voltage rectifier CR5-CR4 and is applied to the +108-volt bus; the low voltage output is applied to low voltage rectifier CR2-CR3, where the ac voltage is rectified and filtered. The filtered output is applied to the input of low voltage regulator Q4-CR6, which maintains the output voltage at +18 volts on the +18-volt bus. When operating from a 26-volt dc power source, input power is applied through a separate connector to overvoltage protector Q1-CR1, which prevents damage due to transients. Output of the overvoltage protector is applied to inverter Q2-Q3. The inverter develop an ac voltage across the primary of transformer T1. From this point on, operation of the transformer and the high and low voltage sections is identical with that described for an ac power source.

Section II. SCHEMATIC DIAGRAM, TH-22/TG

2-5. Send Circuit
(fig. FO-3)

a. Delay Amplifier A1Q1.

(1) Telegraph signals are applied through current-limiting resistor A1R2 to the base of transistor A1Q1. When a space signal (open, no voltage) is applied to the SEND jack (J1 or J2), 0 volt on the base of transistor A1Q1 cuts A1Q1 off; the +1.8 volts on its collector is applied to the input of the following stage (A1Q2). When a mark (closed circuit) is applied to the SEND jack, transistor A1Q1 is turned on. This places the base of transistor A1Q2 at a very low voltage. Resistors A1R1 and A1R3 provide base and emitter bias, respectively. Resistor A1R4 is the collector load resistor. Capacitors A1C1 and A1-C2 provide a time-delay (fig. 2-3) for the incoming signals. When the TH-22/TG is operated in MODE TWO, capacitor A2C2 is removed from the circuit, reducing the time-delay for the faster transmitting speed.

(2) At the beginning of a space signal, transistor A1Q1 is turned off, and the collector voltage rises to +18 volts. Capacitors A1C1 and A1C2 charge through collector load resistor A1-R4 of transistor A1Q1. The slow voltage rise across capacitors A1C1 and A1C2 delays the leading edge of the space pulse applied to the base of transistor A1Q2. When space-to-mark transition occurs, transistor A1Q1 is turned on, the collector voltage drops and capacitor A1C1 rapidly discharges through conducting transistor A1-Q1.

b. Delay Amplifier A1Q2.

(1) Input to amplifier A1Q2 is developed across capacitors A1C1 and A1C2. The positive voltage at the base required to turn transistor A1Q2 on is applied *through* base bias resistor A1R5. The pulses that appear at the base of transistor A1Q2 are amplified and developed across load resistor A1R7 and capacitor A1C8. Voltage divider A1R8, A1R9, and A1R10 supplies emitter bias for transistor A1Q2; variable resistor A1R9 allows this bias voltage to be adjusted to the proper operating level. Capacitors A1C8 and A1C4 help provide the time-delay for the input telegraph signal. Capacitor A1C4 is removed from the circuit when the TH-22/TG is operated in mode two, providing a shorter time-delay for the faster telegraph signal speed.

(2) At the beginning of a mark signal, transistor A1Q2 is turned off, and its collector voltage rises to +18 volts. Capacitors A1C3 and A1C4 charge through collector load resistor A1-R7 of transistor A1Q2. The voltage rise across capacitors A1C3 and A1C4 delays the leading edge of the mark pulse applied to the base of transistor A1Q3. When a mark-to-space transition occurs, transistor A1Q2 is turned on and the collector voltage drops; capacitors A1C3 and A1C4 discharge rapidly through conducting transistor A1Q2.

(3) Resistor A1R6 couples the control signal generated by break-in circuit multivibrator A2Q8-A2Q9 from the output of buffer amplifier A2Q7. When the multivibrator is set, indicating that a break-in signal haa been detected, a positive voltage is applied to the base of delay amplifier A1Q2 through resistor A1R6. This voltage takes control over the transistor operation, causing the transistor to conduct continuously and forcing the transistor to remain in a state corresponding to a space input regardless of the input applied at the SEND jacks.

c. *Emitter Follower A1Q3.* Emitter follower A1Q3 isolates the modulator from the input circuits. The input signal, developed across capacitor A1C3 is fed through current-limiting resistor A1R11 to the base of transistor A1Q3. When transistor A1Q3 conducts (mark signal at the input), the emitter becomes more positive. When the incoming signal at the input is a space, transistor A1Q3 is cut off, making the emitter less positive.

d. Modulator A1CR1-A1CR2.

(1) The modulator circuit changes the operating frequency of, the oscillator in response to the incoming mark-space signals by connecting and disconnecting capacitors A105-A1C7 across the tank circuit of the oscillator. With a space input, the capacitors are connected and the opcrating frequency of the oscillator is 1282.5 Hz. With a mark input, the capacitors are disconnected and the operating frequency of the oscillator is 1817.5 Hz.

(2) The connection and disconnection of the capacitors is controlled by diodes A1CR1 and A1-CR2. When the diodes conduct, the capacitiors are connected to the circuit. When the diodes are

back-biased and non-conducting, the capacitors are isolated from the circuit. The anode of A1-CR2 is connected to a potential of approximately +9 volts developed by voltage divider A1R15 and A1R16. The cathode of A1CR1 is connected to a voltage divider made up of transistor A1Q3 and resistor A1R12. With a space input, transistor A1Q3 is biased to cutoff and the diodes are forward-biased through resistor A1R12, which is returned to 0 volt dc. With a mark input, transistor A1Q3 is forward-biased and conducts, making the cathode of diode A1CR1 approximately +18 volts and back-biasing the diodes.

(3) Capacitor A1C5, one of the capacitors added to the tank circuit to obtain the lower space frequency, is a variable capacitor to permit exact adjustment of the space frequency to 1232.5 Hz. As the resistance of back-biased diodes can vary significantly between different samples, resistors A1R13 and A1R14 are placed across the diodes to assure an approximately equal division of the back-biasing voltage.

e. Oscillator A1Q4, Emitter Follower A1Q5.

(1) The oscillator circuit uses a two-stage feedback amplified arrangement to produce three output frequencies: 1180 Hz for break-in signals, 1232.5 Hz for space signals, and 1317.5 Hz for mark signals.

(2) The signal generated in the basic tuned circuit (inductor A1L1 and capacitors A1C9, A1-C10, and A1C11) is amplified by transistor A1-Q4 and direct-coupled to transistor A1Q5. The output signal of transistor A1Q5 is developed across resistors A1R23 and A1R24. Part of this signal voltage is fed back through capacitor A1-C16 and resistor A1R22 to maintain the tuned circuit in oscillation. In addition, the voltage developed across emitter resistor A1R24 is fed back to the base of transistor A1Q4, through the parallel combination of resistor A1R17 and capacitor A1C8, for maintaining the output of transistor A1Q4 at a constant level, independent of frequency. Resistors A1R20 and A1R21 are emitter biasing resistors. Capacitor A1C15 bypasses emitter resistor A1R21, leaving emitter resistor A1R20 unbypassed to provide local feedback. Resistor A1R19 is the collector load for transistor A1Q4.

(3) The output frequency is determined by the tuned circuit with capacitors added to lower the frequency of the basic circuit. When a mark frequency is to be generated, the modulator prevents the addition of any capacitors by presenting a high impedance. When a space frequency is to be generated, the modulator, by presenting a low impedance, adds capacitors A1C5, A1C6, and A1-C7 to lower the output frequency of the tuned circuit.

(4) A break-in signal is generated by the operation of BREAK IN switch S2. Operation of the switch opens the local send teletypewriter circuit (contacts 7 and 8), equivalent to a space input, defeating the carrier-suppression circuit and causing the modulator to connect capacitors A1C5; A1C6, and A1C7 across the oscillator tank. In addition, operation of the switch connects capacitors A1C12, A1C13, and A1C14 across the tank (contacts 10 and 12), causing the break-in frequency to be generated.

f. Gated Amplifier A1Q6. The vf signals applied to this circuit are amplified or inhibited, according to the gating signal applied to the emitter of transistor A1Q6 by the carrier-suppression circuit. The input signal is developed across base resistor A1R26 and applied to transistor A1-Q6, where it is amplified and developed across collector load resistor A1R27. The output signal is direct-coupled to amplified A1Q7. Resistor A1-R28 provides emitter bias. The gating signal consists of a biasing voltage that reverse-biases the emitter-base junction of transistor A1Q6. With transistor A1Q6 cut off, the signals applied to its base are inhibited. Resistor A1R25 limits the base current of transistor A1Q6.

g. Amplifier A1Q7. This circuit amplifies the vf signals direct-coupled to the base of transistor A1Q7. The amplified output signal is developed across the primary of output transformer T3. Resistor A1R29 is a collector load resistor, and resistor A1R30 provides emitter bias. Capacitors A1C17 and A1C18, together with resistors A1R-31, A1R32, and A1R33, match the impedance of the output of transistor A1Q7 to that of the input of transformer T3, and provide a constant 600-ohm output impedance. Resistors R18, R21, and R22 form a pi-type attenuation network, which is switch out of the signal path (for increased break-in signal strength) by BOOST switch S6.

2-6. Receive Circuit

(fig. FO-3)

a. *Emitter Follower A3Q1.* Emitter follower A3Q1 matches the output impedance of transformer T2 to the input ‘impedance of limiter-amplifier A3Q2. The incoming vf signals from the transmission line are impressed across the primary of input transformer T2 and a corresponding output signal is developed across its secondary. The secondary signal is applied to the base of transistor A3Q1 through coupling capacitor A3C2. The output signal of emitter follower A3-Q1, developed across emitter resistor A3R5, is applied through coupling capacitor A3C3 to limiter-amplifier A3Q2. Resistors A3R2, A3R3, and A3R4, together with capacitor A3C1, form a biasing and decoupling network. When four-wire home copy is strapped in, the transmitted vf signal is coupled through resistor A3R1 to the receive circuit.

b. Limiter-Amplifier A3Q2-A3Q3.

(1) Limiter-amplifier A3Q2-A3Q3, a two-stage limiter-amplifier, removes amplitude variations from the input signal. The input signal is coupled to transistor A3Q2 through capacitor A3C3 and resistor A3R59. Large input signals are clipped on both half-cycles by the combination of diode A3CR2 and the transistor A3Q2 base-emitter junction of transistor A3Q2. Output of transistor A3Q2, developed across collector load resistor A3R9, is direct-coupled to transistor A3Q3, where additional amplification takes place; transistor A3Q3 output is developed at the transistor collector. Stabilizing feedback voltage is developed across unbypassed emitter resistor A3R16 and coupled through resistor A3R7 to the base of transistor A3Q2. Additional feedback is developed in the emitter circuit of transistor A3-Q2 by resistors A3R10 and A3R12.

(2) The SENS strapping provides two levels of gain. For low sensitivity, the SENS strap is connected between terminals 2 and 3, so that resistor R12 is not bypassed, and produces a degenerative feedback voltage that reduces the gain of transistor A3Q2. For high sensitivity, the strap is connected between SENS terminals 1 and 2. Capacitor A3C5 bypasses mister A3R12, preventing it from producing degenerative feedback and increasing the gain of transistor A3Q2. Capacitor A3C6 provides a high frequency dropoff to prevent oscillation at high frequencies. Resistors A3R8 and A3R6, together with capacitor, A3C4, provide base biasing and decoupling. Capacitor A3C7 bypasses emitter resistor A3R15.

c. Emitter *Follower A3Q4.* This circuit matches the high output impedance of amplifier A3Q3 to the low input impedance of discriminator driver A3Q5 and the input to the threshold circuit. The input signal to the emitter follower is direct-coupled to the base of transistor A3Q4, and the output signal is developed across emitter resistor A8R17. This output signal is applied directly to the input of the threshold circuit, and through coupling capacitor A3C8 to the input of discriminator driver A3Q5.

d Discriminator Driver A3Q5. This circuit provides discriminator transformer Z2 with a constant-amplitude fsk signal. The input signal from coupling capacitor A3C8 is applied through current-limiting resistor A3R18, developed across base resistor A3R19, and fed to the base of transistor A3Q5. The output signal of transistor A3-Q5 is developed across the primary windings of discriminator transformer Z2. Resistor A3R20 provides emitter bias for transistor A8Q5.

e. *Discriminator Transformer Z2.*

(1) The two primaries of discriminator transformer Z2 are tuned by internal capacitors connected across each winding. One winding is tuned to a frequency slightly above the mark frequency, and the other is tuned to a frequency slightly below the space frequency. The two windings are series-connected in the collector circuit of the discriminator driver. Since, at resonance, voltage is at a maximum across a parallel tuned circuit, the further the input frequency is from resonance, the lower in amplitude is the voltage across the primary. While the input voltage to the transformer varies in frequency, the output voltage, due to the action of the tuned circuits, varies in amplitude.

(2) The input voltage to the transformer is applied to both primary windings. However, the mark frequency develops a greater voltage across the secondary winding at terminals 7 and 10 than at terminals 3 and 6. The space frequency develops a greater voltage across the secondary winding at terminals 3 and 6 than at terminals 9 and 10. The output voltages from both windings are applied to the discriminator.

f. Discriminator ASCR7-A3CR8, A3CR9-A3-CR10.

(1) The discriminator transformer output is applied to discriminator diodes A3CR7-A3CR8 and A9CR9-A3CR10, where the amplitude-varying signals are rectified and developed across an internal capacitor between terminals 5 and 11 of transformer Z2 for space signals or between terminals 9 and 11 for mark signals.

(2) These voltages are added together algebraically, and the sum is added to the voltage developed by voltage divider A3R21 and A3R22. The resultant voltage is applied to the base of emitter follower A3Q6. The output voltage is approximately +6 volts for space output, and approximately +18 volts for mark output,

(8) BIAS ADJ resistor R14 determines the magnitude *of the* difference between mark and space voltages, providing positive on-off operation of transistor A3Q6. The output of transistor

A3Q6 is developed across emitter load resistor A3R23.

g. *Emitter Follower A3Q6 and A3Q7.* The discriminator output is applied to emitter follower A3Q6, and the output of A3Q6 is applied to emitter follower A3Q7. This circuit filters the carrier from the demodulated discriminator output signal and applies the clean signal to dc amplifier A3Q8. Filtering is performed by resistors A3R24 and A3R25, together with capacitors A3-C10 and A8C11. The output voltage, developed across emitter resistors A3R26 and A3R27, is direct-coupled from the emitter of transistor A3-Q7 to the input of differential amplifier A3Q8 and A3Q10.

h. *Differential Amplifier A3Q8-A3Q10.*

(11) This circuit operates electronic switch A3Q11 from either of two signal inputs. The first input is the telegraph signal for operating the loop equipment. The signal is developed at the emitter of transistor A3Q7 and applied to the base of transistor A3Q8. The second signal, from the threshold circuit, locks the electronic switch in the mark condition when the threshold circuit is activated by loss of signal level; the signal from the threshold circuit is applied. to the base of transistor A8Q10 through transistor ASQ9 (para 2-8d). When both signals are applied, the threshold signal at the base of transistor A3Q10 has precedence, and the electronic switch is operated to the mark condition whenever the input signal is below the threshold level.

(2) The input signal applied to the base of transistor A3Q8 biases the transistor to the conducting (mark) or nonconducting (space) state. The on-off states of transistor A3Q8 bias transistor A3Q10 to an opposite state through common emitter resistor A3R29. When transistor A3-Q10 conducts, a portion of the positive voltage developed across collector load resistors A3R33 and A3R34 is direct-coupled to the electronic switch. An input signal applied to the base of transistor A3Q10 biases it to the conducting state, overriding the biasing voltage developed at the emitter by common emitter resistor A3R29. Resistor A3R28 is the collector load for transistor A3Q8.

i. *Electrontic Switch A3Q11.* This circuit provides the open and closed circuit connections required to operate the teletypewriter equipment. Controlling voltage for the switch is applied to the base of transistor A3Q11. This control voltage biases the transistor to conduct (mark) or not conduct (space). When conducting, the current flows from the +108-volt line through INT. BAT LOOP CUR resistor R12, EXT. BAT jack J4, REC jack J3, and telegraph receiving equipment to the collector of transistor A3Q11; it then flows through the closed electronic switch (conducting transistor A3Q11) for mark signals, completing the circuit. There is no current flow for space signals. The magnitude of the receive loop current is controlled by adjusting INT. BAT LOOP CUR resistor R12.

2–7. Break-In Circuit (Detect) (fig. FO–3)

c. *1180-Hz Filter Z1 and Emitter Follower A3Q1.* The break-in signal is applied to the input of the 1180-Hz filter from the primary of output transformer T3. All signals except the 1180-Hz break-in signal are rejected by the filter. The 1180-Hz output signal is applied through coupling capacitor A2C1 to the base of transistor A2Q1, an emitter follower, the output of which is develped across resistor A2R4 and is coupled through to the input of dc amplifier A2Q2. Resistors A2R1, A2R2, and A2R3, together with capacitor A2C2, provide base biasing and decoupling for transistor A2Q1. Resistors A2R5 and A2R7, with capacitor A2C3, provide base biasing and decoupling for transistor A2Q2. The output of transistor A2Q1 is coupled through capacitor A2C4 to the base of transistor A2Q2.

b. *Dc Amplifier A2Q2, A2Q3 and Emitter Follower A2Q4.*

(1) Transistors A2Q2 and A2Q3 form a dc feedback amplifier, with resistor A2R9 providing local feedback and resistors A2R10 and A2C5 providing emitter bias. The signal developed across collector load resistor A2R8 is direct-coupled to the input of transistor A2Q3, where the break-in signal is further amplified. Emitter resistors A2R12 and A2R14 provide local feedback, and resistor A2R13 provides the emitter bias. The feedback voltage developed across resistor A2R14 is coupled through resistor A2R6 to the base of transistor A2Q2 for stabilizing degeneration. Capacitor A2C6 provides a dropoff in the bandpass characteristics of the amplifier at the high frequency end to prevent the possibility of oscillation, The output of the amplifier is developed across collector load resistor A2R11 and is direct-coupled to the base of transistor A2Q4. Capacitor A2C7 is a bypass for emitter bias resistor A2R13.

(2) The break-in signal is applied to the base of emitter follower A2Q4. The output of the emitter follower is developed across emitter load resistor A2R15 and is coupled through capacitor A2C8 to the dc rectifier.

c. Rectifier A2CR1. The rectifier converts the ac break-in signal to dc. The ac voltage coupled through capacitor A2C8 is developed across resister A2R16. Diode A2CR1 acts as a positive clamp, causing a positive dc voltage proportional to the average value of the incoming signal to be applied to the base of transistor A2Q5.

d. Dc Amplifier A2Q5. The dc amplifier amplifies the voltage applied to its input. The output voltage is developed across collector load resistor A2R20. Stage gain is determined by the setting of MODE ONE-MODE TWO switch S10. The gain is established by the emitter bias, which is provided by the voltage across resistor A2R19 in voltage divider A2R18, A2R17, and A2R19. For the MODE TWO position of switch S10, resistor A2R18 is shorted out, providing a more positive voltage across resistor A2R19.

e. Time-Delay and Integrator A2CR2. This circuit prevents spurious signals from actuating the break-in circuit by requiring a capacitor to charge up to the turn-on voltage of transistor A2Q6. Capacitor A2C10 charges through resistor A2R-21, building up the required voltage to turn on transistor A2Q6 in 0.5 second or more. Local generation of the break-in signal, which requires the operating of the BREAK IN switch, connects a short circuit across capacitor A2C10, inhibiting further signal processing by the break-in circuit in the unit sending the break-in signal.

f. Emitter Follower A2Q6. With an incoming break-in signal, this circuit applies a forward-biasing voltage for diode A2CR3, causing multivibrator A2Q8-A2Q9 to change state if it is not inhibited by the BREAK-IN DISABLE strap or the output of AND gate A2Q12-A2Q13. The input is direct-coupled to the base of transistor A2-Q6. Resistor A2R22 is the emitter load across which the output voltage is developed. When a break-in signal is received, transistor A2Q6 conducts (when sufficient voltage is developed across capacitor A2C10), forward-biasing A2CR3 and allowing the emitter follower to turn on transistor A2Q9.

g. Multivibrator A2Q8-A2Q9 *and Buffer Amplifier A2Q7.*

(1) During normal operation, while the break-in signaling feature of the TH-22/TG is not being used, multivibrator A2Q8-A2Q9 is in the reset state. In this state, transistor A2Q8 is conducting and transistor A2Q9 is cut off. Assuming that the mode of operation in use permits the break-in circuit to be effective, the reception of the break-in signal causes the multivibrator to set. When the break-in signal has turned on emitter follower A2Q6, the low voltage developed at the collector of the transistor is coupled through diode A2CR3 and isolating resistor A2-R23 to the base of transistor A2Q9. The negative-going signal changes the state of the multivibrator, causing transistor A2Q9 to conduct and transistor A2Q8 to cut off.

(2) With the multivibrator set, the low voltage at the collector of A2Q8 is applied to the base of buffer amplifier A2Q7, causing A2Q7 to conduct. The conduction of A2Q7 makes the collector more positive, and this positive voltage is applied through diode A2CR4, contacts 3 and 1 of switch S5A, and resistor A1R6 to the delay amplifier in the send circuit (para 2-10b). The positive signal locks the send circuit to the space state, equivalent to a ring signal, causing the alarm to sound at both TH-22/TG units.

(3) The low voltage existing at the collector of A2Q8, when the multivibrator is set, is also applied to the base of transistor A2Q12 through contacts 7 and 5 of switch S5A and resistor A2-R40. Transistor A2Q12 constitutes one-half of AND gate A2Q12-A2Q13 in the carrier-suppression circuit (para 2-13). With a positive voltage applied to the base of transistor A2Q12, the AND gate is disabled, so that the carrier-sup pression circuit is locked out once the break-in circuit multivibrator is set.

(4) Once set, the multivibrator remains set until reset manually. Operation of the RESET switch connects the base of transistor A2Q9 to +18 volts. The positive voltage reverse-biases the transistor, causing the multivibrator to switch state so that A2Q8 again conducts and A2Q9 is cut off.

(5) The multivibrator can be disabled in two ways so that it will not set in response to a break-in signal. If the BREAK-IN DISABLE strap is connected, the collector of transistor A2-Q8 is connected to the +18-volt bus, preventing the collector voltage from changing and the multivibrator from setting. The second way is when the carrier-suppression circuit (para 2-8) is suppressing the carrier. At that time, transistor A2-Q10 is cut off. This ties the base of transistor A2Q8 to 0 volt through diode A2CR5 and resistor A2R34, inhibiting the setting of the multivibrator by preventing transistor A2Q8 from being cut off.

2-8. Carrier-Suppression Circuit
(fig. FO-3)

a. *Delay Amplifier A2Q14.* Delay Amplifier A2Q14 controls the time for which a mark frequency is transmitted before the carrier is suppressed when operating half-duplex. The delay is introduced by the buildup of charge across capacitor A2C13 sufficient to cut off AND gate transistor A2Q13, A mark input is represented by a circuit closure at SEND input jack J1 or J2, and results in the charging of capacitor A2C13 through resistor A2R42, contacts 1 and 2 of switch S3A, contacts 7 and 8 of switch SIB (contacts 4 and 6 of switch S4A are in parallel when this switch is set to 20∿), contacts 7 and 8 of switch S2A, jack J1, resistor R20, jack J2, and the +108-volt supply. A space input results in the interruption of this charge path at the SEND jack in use. When the charging path is broken, the voltage that has built up across capacitor A2C13 turns on transistor A2Q14, causing a rapid discharge of the capacitor. Resistors A2R41 and A2R42 form the base biasing network to forward-bias the transistor so long as the capacitor retains a charge while the capacitor charge path is open, The time constant of the capacitor charging path is such that a voltage sufficient to turn on transistor A2Q13 is developed across capacitor A2C13 if an uninterrupted mark input is applied to the SEND jack for more, than 2.5 seconds. For the circuit to operate in this manner, switch S3 must be at NORM, When this switch is at REC, capacitor A2C13 charges through resistor A2R42, contacts 1 and 8 of the switch, and the + 18-volt supply to a level sufficient to assure that transistor A2Q13 can conduct, resulting in suppression of the carrier if switch S5 is at 2W. When switch S3 is at SEND, capacitor A2C13 charge path is left open, resulting in the carrier-suppression feature being defeated.

b. AND Gate A2Q12&A2Q13. AND gate A2-Q12-A2Q13 is enabled when both constituent transistors are forward-biased. Transistor A2Q12 is forward-biased when the multivibrator in the break-in circuit is reset (para 2-7); transistor A2Q13 is forward-biased when capacitor A2C13 has built up a sufficient charge (a above), With both transistors forward-biased, a current flows through the AND gate, developing a voltage drop across resistors A1R28 in the send circuit (para 2-5) and A2R39. The voltage drop across resistor A1R29 biases gated amplifier A1Q6 so that the output of the send circuit is suppressed. The voltage drop across resistor A2R39 provides the input signal to dc amplifier A2Q10-A2Q11 which, in turn, supplies a signal to disable the break-in circuit multivibrator when the carrier is suppressed. This feature assures that the break-in circuit cannot be actuated while the TH-22/TG is operating half-duplex in the receive mode.

c. Dc Amplifier A2Q10-A2Q11.

(1) Base bias for transistor A2Q11 is developed by voltage divider A2R35-A2R36. When AND gate A2Q12-A2Q13 is nonconducting, the base bias forward-biases transistor A2Q11 so that it produces a voltage drop across collector load resistors A2R37 and A2R38. The voltage drop across resistor A2R38 supplies the base bias voltage to transistor A2Q10, forward-biasing the transistor. With A2Q10 conducting, the cathode of diode A2CR5 is returned to the + 18-volt bus through the transistor, back-biasing the diode and removing it from the circuit,

(2) When AND gate A2Q12-A2Q13 is enabled and conducts, the resultant voltage drop across resistor A2R39 reverse-biases transistor A2Q11, cutting the transistor off, With transistor A2Q11 cut off, transistor A2Q10 is no longer forward-biased and also cuts off. The cathode of diode A2CR5 is now returned to the 0 volt but through resistor A2R35, maintaining a forward bias on multivibrator transistor A2Q8 and preventing the multivibrator from being set,

2-9. Threshold Circuit
(fig. FO-3)

a. *Signal Detector A3CR6-A3CR7.* The signal detector samples the received signal developed across emitter load resistor A3R17 of the receive circuit and develops a dc voltage across capacitor A3C12 proportional to the amplitude of the signal. Negative-going portions of the signal are coupled through diode A3CR6 to build up a dc charge on capacitors A3C9 and A3C12. During positive-going portions of the signal, rectifier A3-CR7 causes capacitor A3C9 to discharge, while the charge on capacitor A3C12 is maintained through the blocking action of rectifier A3CR6. In this fashion, a charge gradually builds up on capacitor A3C12 proportional to the amplitude of the incoming signal, The resultant dc voltage is applied to the input of differential amplifier A3Q13-A3Q14.

b. Differential Amplifier A3Q13-A3Q14. The voltage developed across capacitor A3C12 is applied to the base of transistor A3Q14, As the voltage builds up due to increasing signal strength, conduction through transistor A3Q14 increases, developing an increased voltage drop across coupling resistor A3R41. This increased voltage drop decreases conduction in transistor A3Q13, causing the collector voltage to become less positive. The negative-going voltage is applied to the base of electronic switch A3Q12. Resistor A3R42 is the collector load for transistor

A3Q14; resistors A3R37 and A3R38 establish the base bias voltage for transistor A3Q13.

c. *Electronic Switch A3Q12.* Operation of electronic switch A3Q12 is controlled by the current through transistor A3Q13. The voltage developed across collector load resistor A3R39 is applied between emitter and baee of transistor A3Q12. With decreasing signal strength, the voltage applied to the base becomes more positive. Transistor A8Q12 is turned on when, the signal strength falls below the threshold level, causing THRESHOLD indicator lamp DS2 to light. The drop in collector voltage that takes place at this time is coupled through isolating resistor A3R35 and diode A3CR4 to the base of emitter follower A3Q9.

d. *Emitter Follower A3Q9.* Conduction through emitter follower A3Q9 is controlled by the operation of electronic switch A3Q12 and BREAK IN switch S2A. When the incoming signal strength falls below the threshold level and electronic switch A3Q12 is turned on, conduction through emitter follower A3Q9 increases as the forward bias between emitter and baee increases due to the drop in the collector voltage of transistor A3Q12. A similar result is produced by the operation of BREAK IN switch S2A, which causes the base of transistor A3Q9 to be returned to O volt through diode A3CR4, isolation resistor A3R36, and contacts 1 and 8 of the switch. The increased conduction causes the emitter to become leas positive, and this change is applied to the base of transistor A8Q10 in the receive circuit (para 2-11h). The ultimate effect is to keep electronic switch A3Q11 (para 2-11i) turned on in the receive circuit, causing the receive loop to run closed when the incoming vf signal is below threshold level or the BREAK IN switch is operated. Resistors A3R30 and A3-R31 and diode A3CR3 establish the operating point for transistor A3Q9.

2-10. Alarm Circuit (fig. FO-8)

a. *Ring Detector A3CR1.* Ring detector A3-CR1 triggers the alarm circuit upon the receipt of a 20-cycle alarm signal. The incoming alarm signal is rectified by diode A3CR1, and the resultant dc voltage which is smoothed by capacitor A3C14, is used to forward-bias transistor A3-Q16. Resistor A3R45 assures that only the 20-cycle ringing signal has sufficient amplitude to forward-bias the transistor. Vf ringing or information signals do not actuate the ring detector.

b. *Delay Amplifier A3Q15.* Delay Amplifier A3Q15 samples the detected incoming vf signal and triggers the alarm circuit if a steady space signal, used for vf ringing, is received for a period of time between 0.5 and 1.0 second. An incoming space signal causes heavy conduction by transistor A3Q8 of differential amplifier A3Q8–A3Q9 in the receive circuit. The heavy conduction makes the collector potential go positive, and causes capacitor A3C13 to charge through resistor A3R43 and transistor A3Q8. The potential developed across the capacitor is connected between emitter and base of transistor A3Q15, and is such as to make the base of the transistor positive with respect to the emitter. When the potential across the capacitor becomes great enough to overcome the reverse-bias voltage across resistor A3R47, transistor A3Q15 conducts, forcing the base of transistor A3Q16 to become less positive, the base of transistor A3Q17 to become more positive, and causing transistor A3Q16 to conduct. When a mark signal is received, diode A3-CR5 rapidly discharges the capacitor to the mark potential at the collector of transistor A3Q8, again cutting off transistor A3Q15.

c. *Differential Amplifier A3Q16–A3Q17.* Differential amplifier A3Q16–A3Q17 disables multivibrator A3Q18–A3Q19 at all times except when transistor A3Q16 conducts. As previously described, transistor A3Q16 conducts when it is forward-biased by the output of the ring detector or when time-delay circuit transistor A3Q15 conducts, conditions which correspond to the receipt of either a 20-Hz or a vf ring signal.

d. *Multivibrator A3Q18–A3Q19.* Multivibrator A3Q18–A3Q19 is a free-running multivibrator that operates in the audio frequency range. When transistor A3Q16 conducts, the multivibrator is enabled and produces a square wave output at the collector of transistor A3Q19. The portion of the output developed across resistor A3R54 is applied to the input of audio amplifier A3Q20.

e. *Audio Amplifier A3Q20.* Audio amplifier A3Q20 is an emitter follower that provides the drive for loudspeaker LS1 and matches the impedance of the loudspeaker to the output impedance of multivibrator A3Q18–A3Q19.

2-11. Power Supply Circuit (fig. FO-8)

a. *Power Source Selector Switch S8.* Selector switch S8 adapts the power supply for use with either 115-volt ac, 230-volt ac, or 26-volt dc power sources. The 115-volt ac power is applied at connector P1 through feedthrough capacitors C1 and

C2, ON-OFF switch S9, and fuse F2, to winding 1-2 of transformer T1. The 230-volt ac power is applied to the same connector, but is not applied across transformer winding 1-2 in series with winding 3-5. This doubles the primary-to-secondary turns ratio and maintains the secondary output voltages at the same level as for 115-volt ac input power. The 26-volt dc power is applied at connector J5, through ON-OFF switch S9, fuse Fl, and overvoltage protector Q1-CR1 to inverter Q2-Q3. When at 26V DC, switch S8 inteconnects the inverter circuit with primary Windbags of power transformer T1. The inverter circuit then converts the incoming dc to ac and applies this ac power to winding 4-6 in series with series winding 7-9 of the transformer.

b. Overvoltage Protector Q1-CR1. Overvoltage protector Q1-CR1 is a series voltage regulator that protects the inverter circuit, and hence the power supply, from damage if the dc input voltage rises above 27 volts. When the input voltage rises above this level, Zener diode CR1 breaks down, clamping the base of series regulator Q1 to -27 volts. As a result, the emitter of transistor Q1 cannot rise above -27 volts, and the voltage by which the input exceeds *27* volts is dropped between collector and emitter of transistor Q1. The circuits are also protected against the inadvertent application of reversed polarity. If a polarity reversal occurs, diode CR11 is forward-biased, and the resultant heavy current causes fuse F1 to open.

c. Inverter Q2-Q3. Inverter Q2-Q3 is connected to the input circuit of the power supply when switch S8 is at 26V DC so as to change the 26-volt dc input to ac. When connected through switch S8, transistors Q2 and Q3 function as an oscillator. Capacitor C8 and the inductance of transformer winding 4-6 determine the oscillator frequency, which is approximately 55 Hz. Resistors R6 and R7 are current-limiting resistors. Resistors R2 and R4 establish the base bias of transistors Q2 and Q3. Capacitor C7 provides feedback to the base of the transistors.

d. *Power Transformer T1.* Power transformer T1 provides the input ac power requirements for low voltage rectifier CR2-CR3 and high voltage rectifier CR4-CR5. The primary windings provide the flexibility to permit the 26-volt dc inverter, a 115-volt ac source, or a 230-volt ac source to provide the input power.

e. *High Voltage Rectifier CR4-CR5.* High voltage rectifier CR4-CR5 is a full-wave rectifier that provides +108 volts dc (±5v) to supply the loop current requirements of the associated teletypewriter equipment. For the receive teletypewriter, an external power source may be employed to provide the loop current. Connection of such a source at EXT. BAT connector J4 disconnects the high voltage rectifier as a source of loop power for the receive loop.

f. Low Voltage Rectifier (CR1-CR2. Low voltage rectifier CR1-CR2 is a full-wave rectifier that furnishes the internal dc power requirements of the TH-22/TG. The rectified output voltage is applied to low voltage regulator Q4-CR6 for voltage regulation.

g. *Low Voltage Regulator Q4-CR6. Low volt*age regulator Q4-CR6 provides voltage regulation and electronic ripple filtering for the low voltage power supply. Regulation is provided by Zener diode CR6, which maintains the output voltage at +18 volts dc (±1.8v). Transistor Q4 and associated components R8, R9, and C11 provide electronic filtering.

CHAPTER 3

DIRECT SUPPORT MAINTENANCE INSTRUCTION

Section I. GENERAL

3-1. Scope of Direct Support Maintenance

Direct support maintenance consists of troubleshooting the TH-22/TG down to the printed circuit (pc) board or a chassis mounted part. It includes making all required adjustments except for the output frequency of the send circuit. The procedures contained herein are not complete in themselves, but supplement the procedures for organizational maintenance given in TM 11-585 -256-12. Whenever possible, the organizational maintenance procedures should be exhausted before resorting to the direct support maintenance procedures.

3-2. Voltage and Resistance Measurements

a. *Voltage Data.* Voltage data for chassis mounted components are provided by figure 3-1 for components mounted directly to the chassis and by figure 3-2 for components mounted on terminal board 1TB1. The following paragraphs provide voltage data for parts mounted on pc boards. The control settings and input signals under which the data were obtained are specified. The voltages measured at the emitter and base terminals of transistors may vary by an much as 20 percent from the listed values. Collector voltages, however, should not vary by more than 10 percent. The bias (emitter-to-base) voltage obtained should remain very close to that obtained from the listed values.

(1) *Voltage readings for send card 1A1.*

(a) Terminate line terminals with 600-Ohm load.

(b) Operate switches as follows:

Position	Switch
0N-OFF	ON
NORM-REC-SEND	NORM
4W-2W-TEL	4W
VF-20∿	VF
MODE ONE-MODE TWO	MODE ONE

NOTE

The following chart lists two voltages for each transistor element. The top voltage is measured with a mark input at the SEND jack. This is obtained by leaving the SEND jacks disconnected. The bottom voltage is measured with a space input at the SEND jack. This is obtained by inserting an open telephone plug into the SEND jack.

Transistor	Voltage to ground		
	Emitter	Collector	Base
Q1 (npn)	+0.15 0	0.15 11.0	+0.75 0
Q2 (npn)	5.8 5.6	16.5 5.6	0.1 6.2
Q3 (npn)	16.0 7.4	16.0 17.5	17.4 4.8
Q4 (pnp)	16.0 16.8	8.4 8.0	16.5 16.7
Q5 (pnp)	8.6 8.4	0 0	8.4 8.56
Q6 (pnp)	16.0 16.0	9.4 9.4	16.0 16.0
Q7 (pnp)	8.4 8.6	3.2 3.2	9.2 9.4

(2) Voltage readings for break-in detector *curd 1A2.*

(a) Terminate line terminals with 600-Ohm load.

(b) operate Switches as follows:

Switch	Position
ON-OFF	ON
NORM-REC-SEND	REC
4W-2W-TEL	4W
VF-20∿	VF
MODE ONE-MODE TWO	MODE ONE

(c) Operate RESET switch for 2 seconds.

Transistor	Voltage to ground Emitter	Collector	Base
Q1 (pnp)	16.0	0	15.5
Q2 (pnp)	16.0	13.0	16.0
Q3 (pnp)	13.0	6.0	13.0
Q4 (pnp)	5.85	0	6.0
Q5 (npn)	1.15	17.5	0.5
Q6 (pnp)	17.0	0	17.5
Q7 (pnp)	16.0	0.02	16.0
Q8 (pnp)	16.0	16.3	16.0
Q9 (pnp)	16.0	2.16	16.5
Q10 (pnp)	18.0	18.0	17.5
Q11 (npn)	7.3	15.0	7.7
Q12 (npn)	7.3	15.0	0
Q13 (npn)	15.0	16.0	15.5
Q14 (pnp)	15.5	0	18.0

(9) Voltage readings for receive card 1A3.

(a) Terminate line terminals with 600-ohm load.

(b) Operate switches as follows:

Switch	*Position*
ON-OFF	ON
NORM-REC-SEND	NORM
4W-2W-TEL	4W
VF-20∿	**VF**
MODE ONE-MODE TWO	MODE ONE

NOTE

The following chart lists two voltages for each transistor element. The top voltage is measured with the controls set as specified. The bottom voltage for transistors Q1 through Q14 and Q16 is obtained with the controls set as specified, the SEND jacks left disconnected, and jumper wires connected between line terminals E3 and E5, and between E4 and E6. The bottom voltage for transistors Q15 and Q17 through Q21 is obtained with 4W-2W-TEL switch operated to 2W and the RING switch operated.

Transistor	Voltage to ground Emitter	Collector	Base
Q1 (pnp)	17.0	0	17
	17.0	0	17
Q2 (pnp)	16.0	13.0	16
	16.0	13.0	16
Q3 (pnp)	13.0	8.1	13.5
	11.4	7.5	13.5
Q4 (pnp)	8.3	0	8.1
	7.7	0	7.5
Q5 (pnp)	18.0	0.05	18.05
	18.0	0.17	19.3
Q6 (npn)	11.9	18	12.6
	15.0	18	15.7
Q7 (pnp)	12.25	0	12.1
	15.2	0	15.0
Q8 (pnp)	6.8	0	12.25
	11.0	0	15.2
Q9 (pnp)	6.5	0	6.55
	11.3	0	11.1
Q10 (pnp)	6.8	6.8	6.5
	11.0	10.9	10.9
Q11 (npn)	0	0.09	0.7
	0	0.07	0.7
Q12 (npn)	0	0.26	0.75
	0	18.0	0
Q13 (pnp)	11.6	7.9	11.4
	9.0	0	11.5
Q14 (pnp)	11.6	0	15.7
	9.0	5.6	9.3
Q15 (npn)	2.8	17.9	0
	2.9	17.9	0
Q16 (pnp)	16.5	9.7	17.96
	16.7	8.55	17.17
Q17 (pnp)	16.5	0	16.0
	16.6	0	16.0
Q18 (pnp)	8.55	0	14.5
	9.9	0.01	15.0
Q19 (pnp)	8.55	0	14.5
	9.9	0.01	15.0
Q20 (npn)	0	18.1	0
	0	18.1	0.5

b. Resistance Data. Resistance data for chassis mounted components are provided by figure 3-1 for those components mounted directly to the chassis, and by figure 3-2 for thoee components mounted on terminal board 1TB1.

c. *Dc Resistance of Transformer and Inductor Windings. The* following chart lists the ohmic resistance of transformer and inductor windings. The chart provides the conditions imposed for the measurement.

Component	Terminals	Resistance (ohms)	Conditions
Power transformer 1T1	1–2	85	115V AC–230V AC–26V DC switch at 115V AC.
	3–6	90.5	
	7–9	1	
	10–12	40	
	13–14	180	
Input transformer 1T2	1–2	100	4W–2W–TEL switch at 4W, receive card 1A3 removed from unit, and external lines disconnected.
	3–4	130	

Component	Terminals	Resistance (ohms)	Conditions
Output transformer 1T3	1-3	25	Send card 1A1 removed from unit and external lines disconnected.
	4-5	33	
Oscillator inductor 1A1L1	1-3	218	None.
Discriminator transformer 1Z2	1-2	90	Receive card 1A3 removed.
	3-6	80	
	7-10	80	

3-3. Continuity Test

The following continuity tests assure that the appropriate line terminal connections are established for the specified switch settings and strapping connections. Additional tests within the equipment may be required when troubleshooting. These tests should be made in accordance with the wiring diagram (fig. FO-4) after removing the PC boards,

CAUTION

In making continuity and resistance checks independently without following a prescribed procedure, make sure not to apply a potential between transistor elements that could destroy the transistor. The battery in the AN/PSM-45 can destroy transistors by causing excessive current through them. In some instances, 0.1 volt applied between base and emitter in the reverse direction can destroy a surface barrier transistor. Never make any continuity checks with power applied to TH-22/TG.

a. Line Facility. Test the connection of the TH-22/TG to two-wire or four-wire lines as follows:

(1) Remove all power from TH-22/TG under test.

(2) Operate the 2W-4W-TEL switch to TEL.

(3) Use the AN/PSM-45 to check for continuity between terminals E4 and E6, and between E3 and E5.

b. Radio Operation. Test the operation of the circuit closure that provides for radio operation as follows:

(1) Remove all power from the TH-22/TG under test.

(2) Operate the NORM-REC-SEND switch to SEND.

(3) Use the AN/PSM-45 to check for continuity between CONT terminals E1 and E2.

c. *Holding Coil.* Determine whether a dc closure is provided through terminals E5 and E6 for two-wire operation, in the sending mode as follows:

(1) Remove all power connections from the TH-22/TG under test.

(2) Operate the 4W-2W-TEL switch to 2W and the NORM-REC-SEND switch to SEND.

(3) Use AN/PSM-45 to measure resistance across 2W-4WR terminals E5 and E6. Resistance should be 100 ohms ±10 percent.

(4) Operate the NORM-REC-SEND switch to REC.

(5) Check for continuity between 2W-4WR terminals E5 and E6. No continuity should be indicated.

(6) Operate the NORM-REC-SEND switch to NORM.

(7) Insert the COMBAT link.

(8) Check for continuity between 2W-4WR terminals E5 and E6. Continuity should be present.

3-4. Bench Testing

The direct support maintenance procedures require access to the interior of the TH–22/TG and, in many instances, to points on or below the pc boards. Proceed as follows:

a. *Removal of Chassis From Case.* Loosen the three camlock screws on the unit front panel by turning them one-quarter turn counterclockwise; pull the chassis forward from the case.

b. Removal of Pc Boards.

(1) Loosen the three screws on the hinged panel at the rear of the chassis (fig. 3-5), and lower the panel.

(2) Use the extractor handle to pull out the pc boards from the chassis mounting rails.

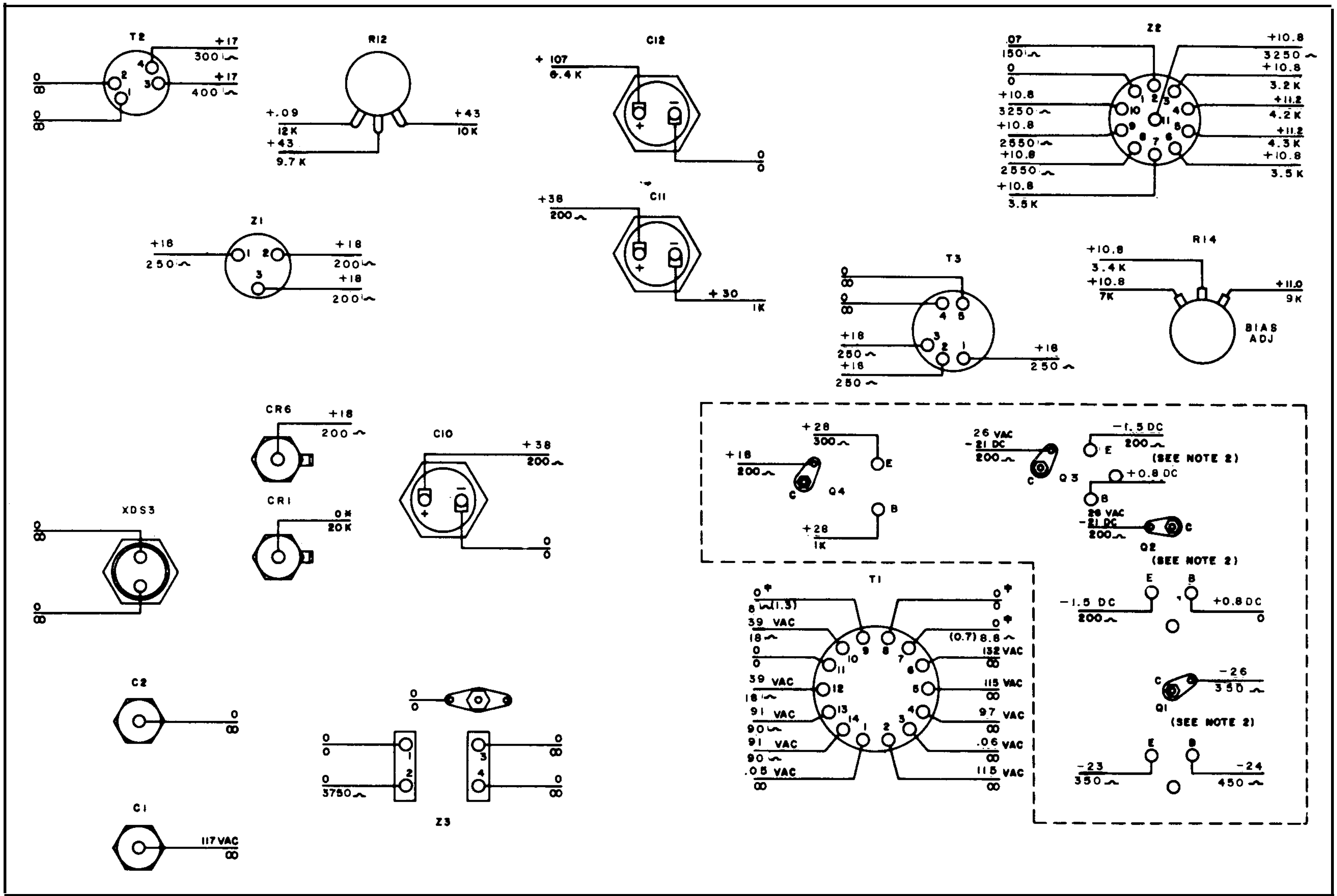
c. *Adjusting the Pc Boards to Test Position.*

(1) Remove the three pc boards from the chassis (b above).

(2) On both sides of the chassis, loosen the screws that hold the harness board connector mounting bracket.

(3) Rotate the harness board connector bracket upward so that the slotted centerpiece is straight up.

(4) Reinsert the pc boards in the harness pc board connector.



NOTES:

1. ✱ VOLTAGES ON TERMINALS 6 THROUGH 9 ARE FOR 26 VOLT OPERATION AND ARE OF NO SIGNIFICANCE WHEN 115 VOLT OPERATION IS USED.
2. VOLTAGE READINGS ON TRANSISTORS Q1, Q2, AND Q3 ARE MEASURED WITH RESPECT TO TERMINAL A OF JACK J5.
3. RESISTANCE READINGS IN PARENTHESIS ( ) ARE OBTAINED FOR 26 VOLT OPERATION ONLY.
4. ALL MEASUREMENTS TAKEN WITH TS-352/U.
5. VOLTAGE READINGS ABOVE LINE RESISTANCE READING BELOW.

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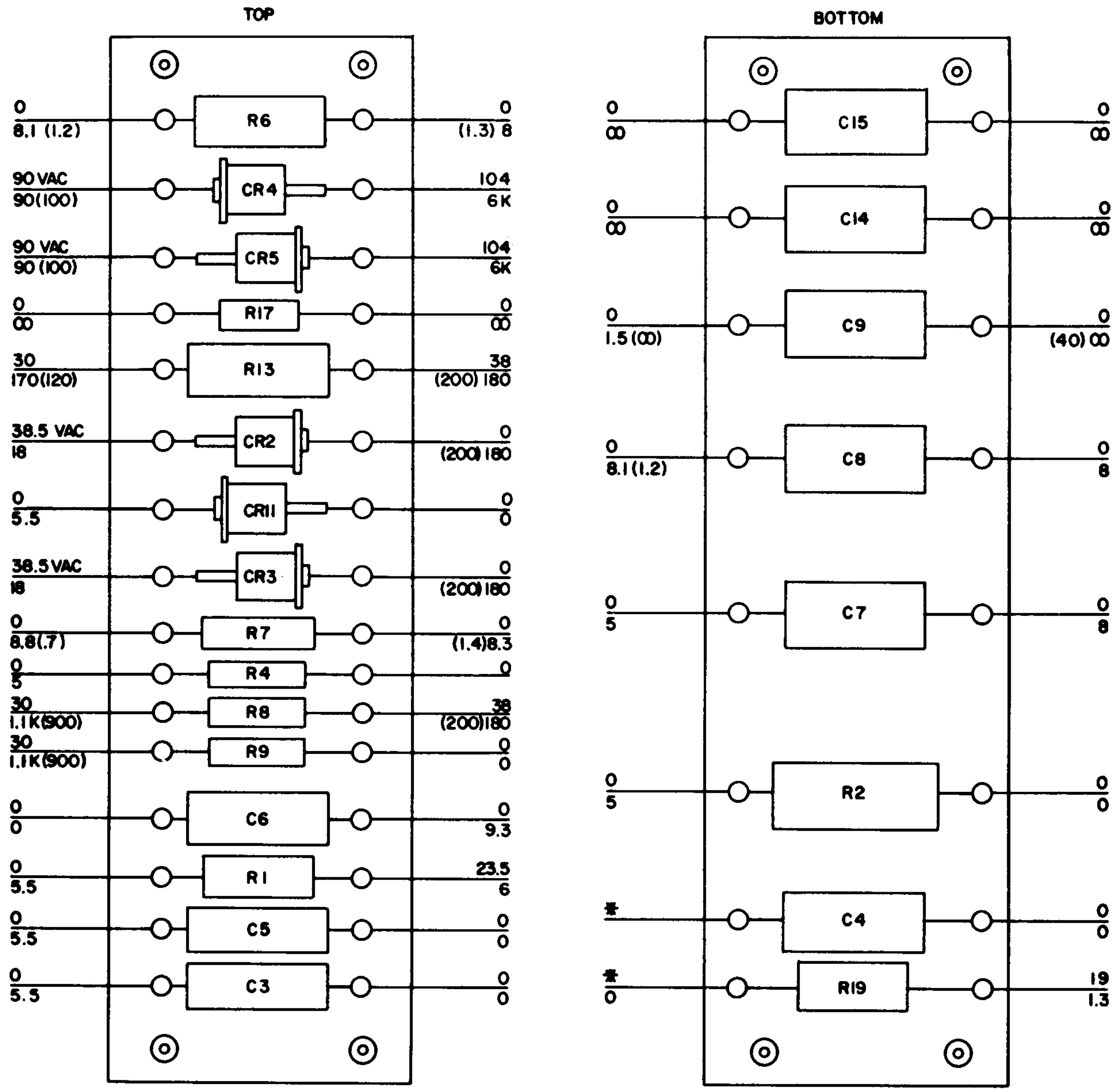
Figure 3-1. TH-22/TG chassis voltage and resistance diagram.



NOTES:

1. NC–NO CONNECTION.
2. * –DO NOT PERFORM MEASUREMENTS AT THESE POINTS.
3. RESISTANCES IN PARENTHESES ARE FOR 26 VOLT OPERATION WITH RIGHT SIDE OF C4 CONNECTED TO GROUND.
4. MEASUREMENTS MADE WITH TS-352/U.
5. VOLTAGE READINGS ARE ABOVE LINE, RESISTANCE READINGS BELOW.

EL5805-356-34-1-TM-5

Figure 3-2. TH-22/TG chassis terminal board 1TB1 voltage and resistance diagram.

Section II. TOOLS AND EQUIPMENT

The following chart lists the test equipment and tools required for direct support maintenance.

Test equipment and tools	Associated technical manual
Electronic Counter AN/USM-459	TM 11-6625-700-10
Digital Multimeter AN/PSM-45	No applicable
Digital Multimeter AN/USM-486	Not applicable
Oscilloscope AN/USM-281( )	TM 11-6625-1703-15 or TM 11-6625-2658-14
Telephone Set TA-312/PT	TM 11-5805-201-12
Test Set TS-2/TG	TM 11-2208
Test Set AN/USM-181	TM 11-6625-602-12
Tool Kit, Electronic Equipment TK-105/G	Not applicable

Section III. TROUBLESHOOTING

3-5. Introduction

Trouble in the TH-22/TG is isolated in three stages. The procedure starts by making operational tests on the unit to identify the malfunction, which is then referred to under a symptom in the troubleshooting chart. The troubleshooting chart lists probable troubles that can cause the noted symptom. Probable troubles are eliminated, and the trouble causing the symptom is identified by utilizing additional data supplied. The additional data comprise voltage and resistance measurements, the schematic diagram, and the wiring diagram. Reference may also be made to the circuit descriptions in chapter 2. If the trouble is isolated to a chassis mounted part, repairs are authorized at the direct support category. If the trouble is isolated to a printed card or to a part mounted on a printed card, the card must be replaced. A notation should then be made stating the defect for which the card was replaced; this notation should accompany the card when it is forwarded to a higher maintenance category for repair. After completion of repairs, the operational tests must be repeated. If any adjustments are required as a result of the repair or to correct a trouble, refer to the applicable adjustment procedure given in paragraph 3-8, 3-9 and 3-10.

NOTE

Adjustment of the oscillator output frequency on send card 1A1 is not authorized for direct support maintenance. When adjustment is required, replace send card 1A1 with an adjusted card, and forward the card requiring adjustment to higher maintenance category with appropriate notation.

3-6. Operation Tests

Perform the following operational tests in the sequence in which they are given. The tests are to be performed with the TH-22/TG chassis removed from its case. Each test provided an indication that will be obtained when the circuit is operating normally. So long as the normal indications are obtained, continue with the operational tests. Upon completion of a test, disconnect the test equipment used before continuing with the next test. When a normal indication is not obtained for one of the tests, locate the symptom that describes the failure in the troubleshooting chart (para 3-7b). Investigate the probable causes associated with the noted system and take the corrective action for the cause suggested in the chart. Upon completion of the corrective action, make sure that the trouble has been corrected by repeating the operational test and noting that a normal indication is now obtained.

a. Power Supply Output Voltage Test.

(1) Operate the TH-22/TG front panel controls as follows:

NOTE

A control for which no position is specified may be left in any position.

Control	*Position*
ON-OFF	OFF
115V AC-230V AC-26 DC	Position corresponding to power source being used.

(2) Connect TH-22/TG to a power source. (Use connector P1 for ac power, connector J5 for dc power.)

(3) Operate the ON-OFF switch to ON.

(4) Use the AN/PSM-45 (set measure 18 volts dc) to measure the voltage between ground and test point A1TP2 (fig. 3-7). The meter should indicate +18 volts dc ±1.8.

(5) Repeat (1) through (4) above for the other two power inputs with which the TH-22/TG can be used.

b. Send Loop Current Test.

(1) Operate the TH-22/TG front panel controls as follows:

NOTE

A control for which no position is specified may be left in any position.

Control	*Position*
ON-OFF	OFF
115V AC-230V AC-26V DC	Position corresponding to power source being used.

(2) Connect the TH-22/TG to a power source. (Use connector PI for ac power, connector J5 for dc power.

(3) Connect the AN/PSM-45 (set to measure 50 milliamperes (ma) dc) to SEND jack J1 or J2 by means of a telephone plug.

(4) Operate the ON-OFF switch to ON.

(5) The AN/PSM-45 indicates 16.5 maormore.

c. Receive Loop Current Test.

(1) Operate the TH-22/TG front panel controls as follows:

NOTE

A control for which no position is specified may be left in any position.

Control	*Position*
ON-OFF	OFF
115V AC-230V AC-26V DC	Position corresponding to power source being used.
4W-2W-TEL	TEL

(2) Connect the TH-22/TG to a power source. (Use connector P1 for ac power, connector J5 for dc power.)

(3) Connect the AN/PSM-45 (set to measure 50 ma) to REC J5 by means of a telephone Plug.

(4) Operate the ON-OFF switch to ON, and note that the THRESHOLD indicator lights.

(5) The AN/PSM-45 indicates 21 ma ±2.

(6) Insert an open telephone plug into SEND jack J1 or J2 and operate the 4W-2W-TEL switch to 2W. THRESHOLD indicator lights after approximately 2.5 seconds.

(7) The AN/PSM-45 indicates less than 1.0 ma.

d. *Send Circuit Output Frequency Test.*

(1) Operate the TH-22/TG front panel controls as follows:

NOTE

A control for which no position is specified may be left in any position.

Control	*Position*
ON-OFF	OFF
115 V AC-230V AC-26V DC	Position corresponding to power source being used.
MODE ONE-MODE TWO	MODE ONE
NORM-REC-SEND	NORM
4W-2W-TEL	4W
VF-20∼	**VF**

(2) Connect AN/USM-459 input to TH-22/TG 4WS-TEL binding posts. AN/USM-459 should indicate mark frequency (1317.5 Hz).

(3) Insert an open plug into TH-22/TG SEND jack. AN/USM-459 should read space frequency (1232.5 Hz).

(4) Remove plug and depress BREAK-IN switch. AN/USM-459 should read (1180 Hz).

e. *Send Circuit Output Level Test.*

(1) Operate the TH-22/TG front panel controls as follows:

NOTE

A control for which no position is specified may be left in any position.

Control	*Position*
ON-OFF	OFF
115V AC-230V AC-26V DC	Position corresponding to power source being used.
MODE ONE-MODE TWO	MODE ONE
NORM-REC-SEND	NORM
4W-2W-TEL	4W
VF-20∼	VF

(2) Connect AN/USM-181 input to TH-22/TG 4WS-TEL binding posts, AN/USM-181 should read 0 dbm).

(3) Insert open plug into TH-22/TG SEND jack. AN/USM-181 should read 0 dbm).

(4) Remove plug depress BREAK-IN switch. AN/USM-181 should read 0 dbm).

(1) Operate the TH-22/TG front panel controls as follows:

NOTE

A control for which no position is specified may be left in any position.

Control	*Position*
ON-OFF	OFF
115V AC-230V AC-26V DC	Position corresponding to power source being used.
MODE ONE-MODE TWO	MODE TWO
NORM-REC-SEND	REC
4W-2W-TEL	2W

(2) Connect the TS-2/TG signal output to either SEND jack of the TH-22/TG.

(3) Operate the TS-2/TG controls to generate an undistorted Y character.

(4) Connect the AN/USM-281 signal input to test point TP3 on send card 1A1.

(5) Connect the AN/USM-281 trigger input to test point TP1 on send card 1A1.

(6) Operate the AN/USM-281 controls so that sweep is triggered externally by a positive-going signal. Operate the sweep controls to provide a 1 millisecond per centimeter sweep speed.

(7) Connect the TH-22/TG to a power source. (Use connector P1 for ac power, connector J5 for dc power.)

(8) Operate the ON-OFF switch to ON.

(9) See that the waveform displayed on the oscilloscope is delayed 5 to 8 milliseconds.

g. Receive Circuit Sensitivity Test.

(1) Operate the TH-22/TG front panel controls as follows:

NOTE

A control for which no position is specified may be left in any position.

Control	*Position*
ON-OFF	OFF
115V AC-230V AC-26V DC	Position corresponding to power source being used.
4W-2W-TEL	4W

(2) Connect the AN/USM-181 output to the TH-22/TG 2W-4WR terminals.

(3) On receive card 1A3, note the SENS strapping used. When the following steps use more than one value, use the first value given if the strapping is H. Use the second value given in parentheses, if the strapping is L.

(4) Connect the TH-22/TG to a power source. (Use connector P1 for ac power, connector J5 for dc power.)

(5) Operate the ON-OFF switch to ON.

(6) Adjust the AN/USM-181 for a 1232.5 Hz output frequency (ring frequency) at an output level of – 40 dbm (— 18 dbm). After 1 second note that TH-22/TG alarm sounds.

(7) Slowly reduce the AN/USM-181 output level until the THRESHOLD indicator lights and the alarm stops. Note the output level. It must be less than –45 dbm (–22 dbm).

h. 20-Hz Signaling Tests.

(1) Operate the TH-22/TG front panel controls as follows:

NOTE

A control for which no position is specified may be left in any position.

Control	*Position*
ON-OFF	OFF
115V AC-230V AC-26V DC	Position corresponding to power source being used.
4W-2W-TEL	4W
VF-20~	20 ~

(2) Interconnect the TH-22/TG 4WS TEL and 2W-4WR terminals, connecting E3 to E5 and E4 to E6.

(3) Connect the TH-22/TG to a power source. (Use connector P1 for ac power, connector J5 for dc power.)

(4) Operate the ON-OFF switch to ON.

(5) Operate RING switch and note that the audible alarm sounds.

i. Break-in Circuit Sensitivity Test.

(1) Operate the TH-22/TG front panel controls as follows:

NOTE

A control for which no position is specified may be left in any position.

Control	*Position*
ON-OFF	OFF
115V AC-230V AC-26V DC	Position corresponding to power source being used.
4W-2W-TEL	2W
NORM-REC-SEND	SEND

(2) Connect the AN/USM-181 output to 1A1TP4.

(3) Adjust the AN/USM-181 output to supply a 1180-Hz frequency at a 0-dbm level.

(4) Operate the ON-OFF switch to ON. After approximately 2 seconds, note that the audible alarm sounds.

(5) Insert open telephone plug into the SEND jack and remove.

(6) Adjust the AN/USM-181 output to 0.

(7) Measure continuous 1235.5 Hz ±2 at 1A1TP4.

(8) Depress the RESET switch.

(9) Measure 1A2TP4 for no signal.

3-7. Localizing Trouble

a. General. Procedures are outlined in the troubleshooting chart (b below) for localizing troubles to the individual circuit or component. The procedures are initiated as a result of failing to obtain the indicated results when performing the operational tests (para 3-6). When the procedure results in tracing the trouble to a pc board, replace the board. If the trouble is traced to a stage on the chassis, use voltage and resistance measurements, as required, to isolate the trouble to a defective part. In the chart, the component reference designation indicates its physical location in the TH-22/TG as follows: 1 indicates the chassis assembly; 1A1 indicates send card 1A1; 1A2 indicates break-in detector card 1A2; and 1A3 indicates receive card 1A3. The physical location of components and test points is illustrated in figures 3-2 through 3-9.

b. Troubleshooting Chart

Item No.	Symptom	Probable trouble	Correction
1	Ac fuse F2 blows when ON-OFF switch is operated to ON.	a. Defective transformer 1T1 on chassis (fig. 3-6).	a. Perform resistance test (para 3-2c) on transformer 1T1. Replace defective transformer.
		b. Defective switch 1S8 on chassis (fig. 3-4).	b. Perform visual inspection and continuity test (para 3-3). Repair or replace defective switch.
		c. Defective capacitor 1C9 on chassis terminal board 1TB1 (fig. 3-2).	c. Test capacitor. Replace if defective.
		d. Defective low voltage rectifier 1CR2–1CR3 or high voltage rectifier 1CR4–1CR5 on chassis (fig. 3-2).	d. Perform resistance test (para 3-2b) to determine defective part(s). Replace defective part(s).
		e. Short on card 1A1, 1A2, 1A3, or chassis (figs. 3-3, 3-5).	e. Remove all cards and insert new fuse. Operate ON–OFF switch to ON. If fuse blows, short is on chassis. If not, replace cards one at a time, until fuse blows. Last card inserted has short and must be replaced.
	26V DC fuse F1 blows when ON–OFF switch is operated to ON, with correct polarity connected for 26-volt DC operation.	a. Defective diode 1CR11 on chassis terminal board 1TB1 (fig. 3-2).	a. Test diode 1CR11. Replace, if defective.
		b. Defective capacitor 1C6 on chassis terminal board 1TB1 (fig. 3-2).	b. Test capacitor 1C6 for short. Replace if defective.
		c. Defective high or low voltage rectifier 1CR4–1CR5 or 1CR2–1CR3, respectively on chassis (fig. 3-2).	c. Measure resistance of individual resistors and test capacitors to determine defective parts. Replace defective part(s).
		d. Defective inverted circuit or low voltage protector circuit on chassis (fig. 3-4) and terminal board 1TB1 (fig. 3-2).	d. Measure resistance of individual resistors, and test capacitors to determine defective parts. Replace defective parts.
	No vf output signal at 2W-4WR terminals when telegraph signal are present at SEND jack.	a. No + 18-volt power on send card 1A1 (fig. 3-7).	a. Check for presence of +18 volts at test point TP2 on card 1A1. If no voltage or low voltage is obtained, refer to item 20 below.
		b. Defective attenuator or output transformer 1T3 on chassis (figs. 3-4, 3-6).	b. Perform voltage check (para 3-2a) to determine defective part(s). Replace defective parts(s).
		c. Defective send card 1A1.	c. Replace card 1A1.
		d. Defective switch 1S1, 1S4 or 1S5 on chassis (figs. 3-4, 3-6).	d. Check switches and connections to each switch for all positions to isolate defective switch. Replace defective switch.
		e. Defective BOOST switch 1S6 on chassis (fig. 3-4).	e. Perform voltage test (para 3-2) to determine if defective. Replace if defective.
		f. Defective break in detector card 1A2 (fig. 3-3).	f. Replace card 1A2.
	Low vf output signal at 2W-4WR terminals.	a. Defective send card 1A1------------	a. Replace card 1A1.
		b. Defective attenuator circuit resistor 1R19, 1R21, or 1R23 or output transformer 1T3 on chassis (figs. 3-2, 3-6, 3-9).	b. Check resistance to determine faulty part.

Item No	Symptom	Probable trouble	Correction
5	Constant mark frequency at 2W-4WR terminals when SEND jack is keyed.	*a.* Defective send card 1A1 *b.* Defective or dirty switch 1S1 or 1S2 (fig. 3-4). *c.* Defective threshold circuit	*a.* Replace card 1A1. *b.* Perform inspection and continuity test on switch. Replace defective switch. *c.* Perform correction procedure given in item 15 below.
6	Constant mark input at SEND jack does not operate carrier-suppression circuit.	*a.* Defective break-in detector card 1A2 (fig. 3-8). *b.* Defective switch 1S3 or 1S5 on chassis (fig. 3-6).	*a.* Replace card 1A2. *b.* Perform inspection and continuity test on switch. Replace defective switch.
7	Constant space frequency at 2W-4WR terminals when SEND jack is keyed.	*a.* Defective send card 1A1 (fig. 3-5) *b.* Defective or dirty switches 1S1, 1S[illegible] and or jacks 1J1 and 1J2 (figs. 3-4, 3-6).	*a.* Replace card 1A1. *b.* Replace defective switch and/or jack, or clean dirty switch or jack.
8	Time delay incorrect.	Defective send card 1A1	Replace card 1A1.
9	No increase in output power when BOOST switch is operated.	Defective BOOST switch 1S6 on chassis (fig. 3-4).	Replace defective switch.
10	Difference between mark and space frequency level greater than 1.0 db.	*a.* Send bias adjustment incorrect *b.* Defective send card 1A1 (fig. 3-5)	*a.* Perform bias adjustment (para 3-9). *b.* Replace card 1A1.
11	Excessive distortion of vf signal as evidenced by high error rate in transmission with adequate output signal.	Defective send card 1A1 (fig. 3-5)	Replace card 1A1.
12	Only space output obtained at REC jack when input vf signal is present at 2W-4WR terminals.	*a.* Defective jack 1J4, resistor 1R11 or 1R12, or jack 1J3 (figs. 3-1, 3-4) *b.* Defective receive card 1A3 (fig. 3-5). *c.* Defective discriminator circuit	*a.* Check and replace defective part. *b.* Replace card 1A3. *c.* Perform voltage and resistance tests on discriminator circuit parts (1Z2, 1CR8-1CR10, 1R14-1R16). Replace defective parts.
13	Only mark output is obtained at REC jack. THRESHOLD indicator is not on.	*a.* Defective THRESHOLD indicator lamp DS2 (fig. 3-3). *b.* Defective receive card 1A3 (fig. 3-5).	*a.* Replace defective lamp. *b.* Replace card 1A3.
14	No alarm is heard when vf or 20Hz ring signal is received.	*a.* Defective receive card 1A3 (fig. 3-5). *b.* Defective speaker 1LS1 (fig. 3-4).	*a.* Replace card 1A3. *b.* Replace speaker.
15	THRESHOLD indicator does not glow and chatter occurs in receiving equipment when low input or no input signal appears at 2W-4WR terminals.	Defective receive card 1A3 (fig. 3-5)	Replace card 1A3.
16	THRESHOLD indicator glows and mark appears at REC jack when normal level signal is applied to 2W-4WR terminals.	*a.* Defective receive card 1A3 (fig. 3-5). *b.* Defective input transformer 1T2 (fig. 3-6).	*a.* Replace card 1A3. *b.* Replace transformer 1T2.
17	No home copy with 4W-HC link in place and 4W-2W-TEL switch at 4W.	*a.* Defective switch 1S5 on chassis (fig. 3-6). *b.* Defective resistor R1 on receive card 1A3 (fig. 3-9).	*a.* Inspect switch 1S5 for defects, and determine that proper connections are made when switch is operated to each position. Replace defective switch. *b.* Replace card 1A3.

Item N	Symptom	Probable trouble	Correction
18	Low receive circuit sensitivity.	Defective receive card 1A3 (fig. 3-5)	Replace card 1A3.
19	No audible signal when break-in frequency is received.	Defective break-in detector card 1A2 (fig. 3-3).	Replace card 1A2.
20	Incorrect voltage on +18-volt line.	*a.* Defective low voltage regulator 1Q4-1CR6 on chassis (fig. 3-4). *b.* Defective transformer 1T1 on chassis (fig. 3-4). *c.* Defective low voltage rectifier 1CR2-1CR3 on chassis (terminal board 1TB1) (fig. 3-3).	*a.* Perform voltage test (para 3-2a) to determine defective part(s). Replace defective part(s). *b.* Perform resistance test (para 3-2c) on transformer and replace if found defective. *c.* Perform voltage test (para 3-2a) and check capacitor 1C10 (fig. 3-4) to determine defective part(s). Replace defective part(s).
21	Incorrect send loop current	*a.* Defective resistor 1R20 or 1R19 on chassis (figs. 3-4, 3-2). *b.* Defective transformer 1T1 on chassis (fig. 3-4). *c.* Defective high voltage rectifier 1CR4-1CR5 on chassis terminal board 1TB1 (fig. 3-2). *d.* Defective capacitor 1C12 on chassis (fig. 3-6).	*a.* Measure resistance of resistors. Replace defective resistors. *b.* Perform resistance test (para 3-2c) on transformer. Replace transformer if defective. *c.* Perform voltage test (para 3-2a). Replace defective part. *d.* Replace defective capacitor.
22	Incorrect receive loop current	*a.* Improper adjustment of INT. BAT LOOP CUR control 1R12 on chassis (fig. 3-4). *b.* Defective resistor 1R11 or INT. BAT LOOP CUR control 1R12 (fig. 3-5).	*a.* Adjust INT. BAT LOOP CUR control (para 3-10). *b.* Make voltage measurement of +108-volt bus (para 3-2a) to determine defective parts. Replace parts found to be defective.

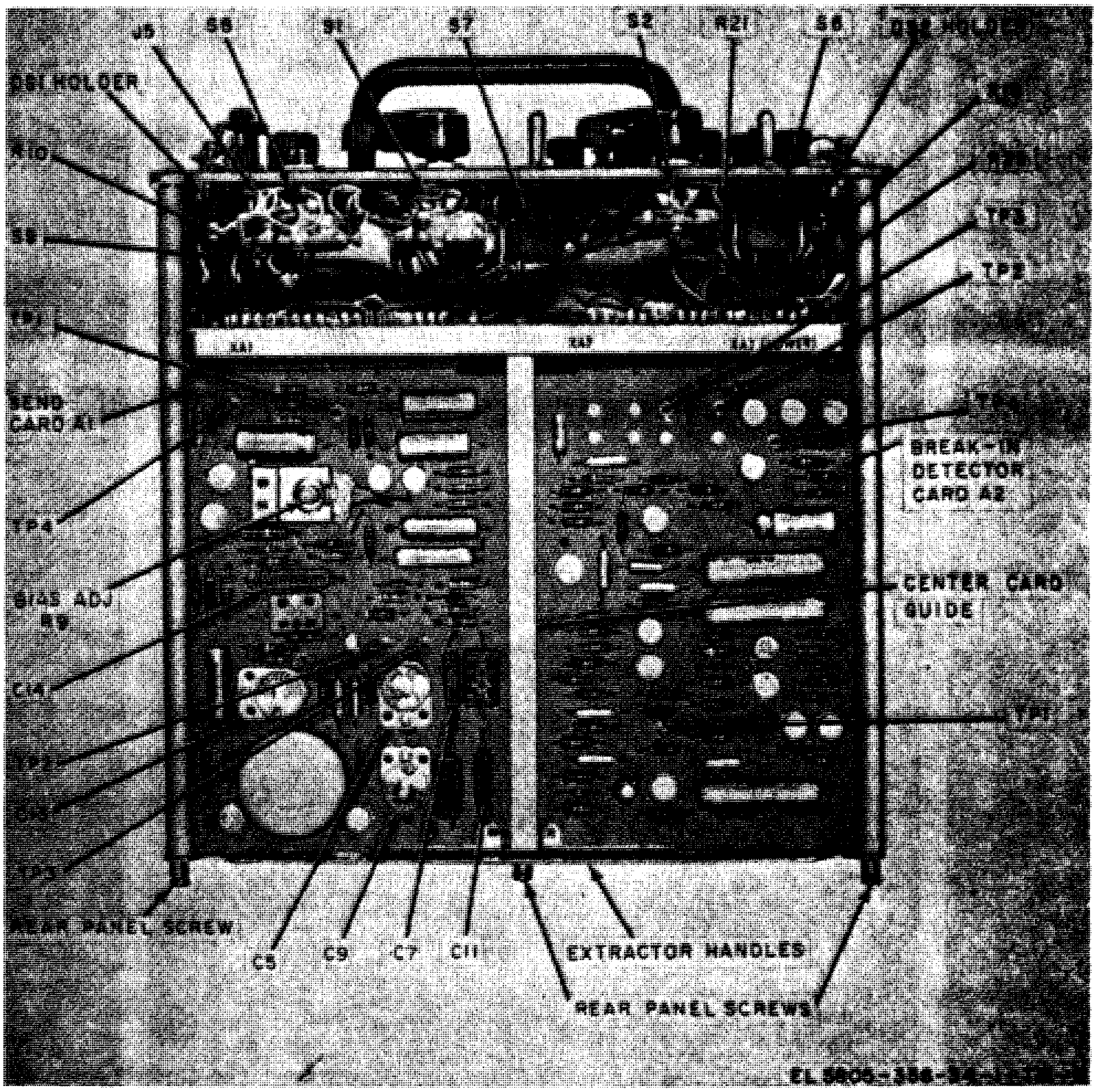


Figure 3-3. TH-22/TG chassis, top view.

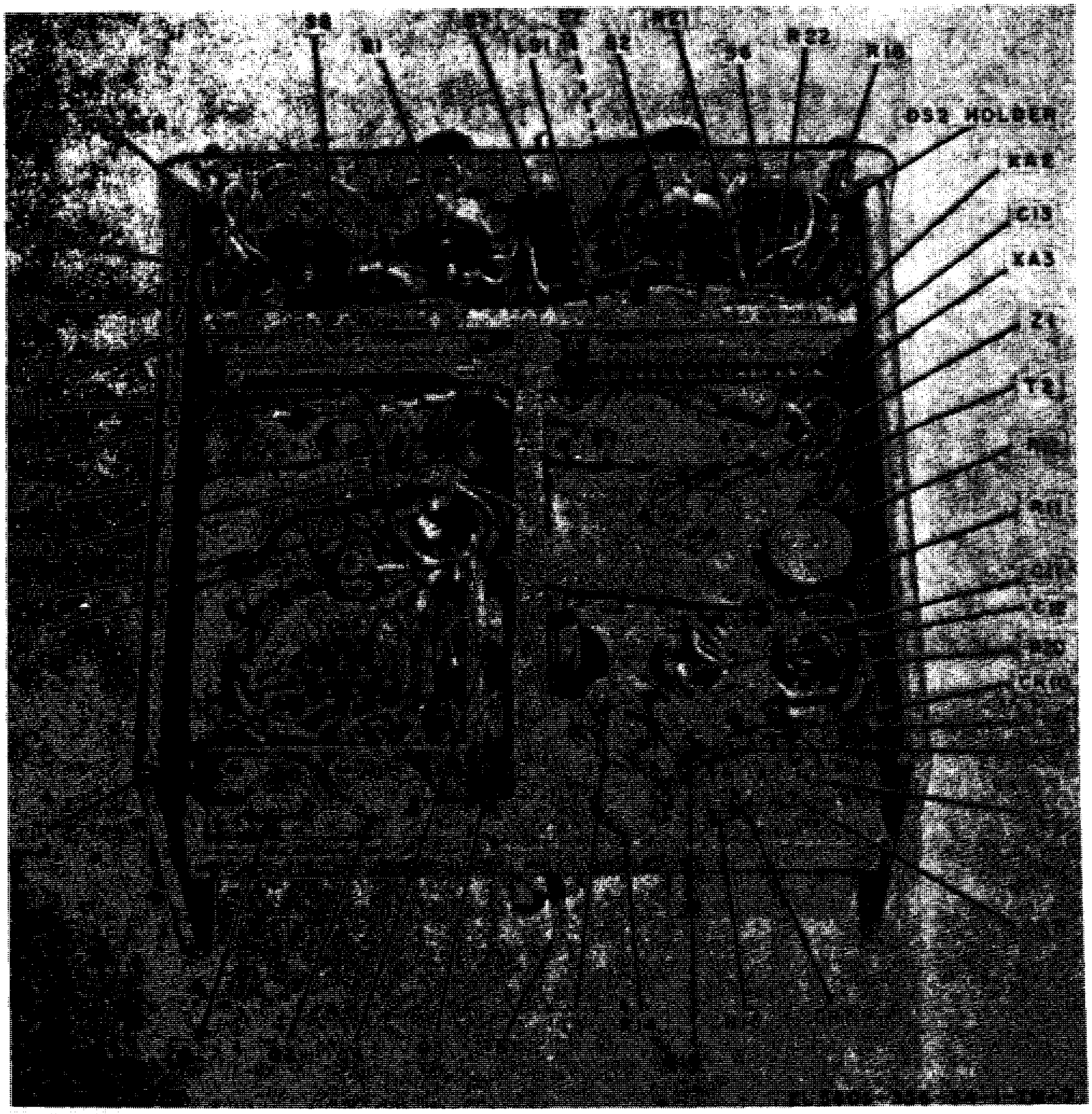


Figure 3-4. TH-22/TG chassis with pc boards removed, top view.

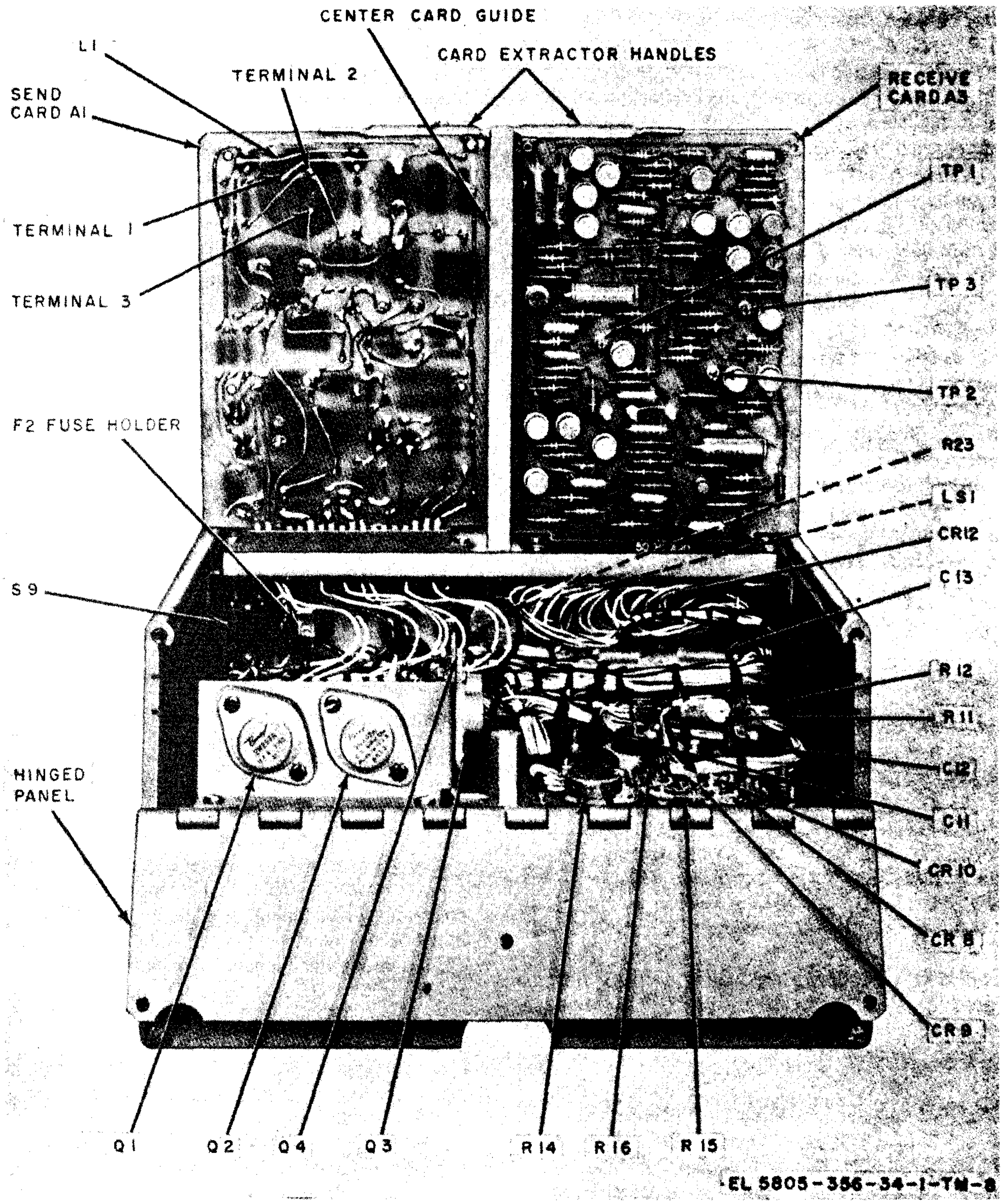


Figure 3-5. TH–22/TG chassis with pc boards in test position, rear view.

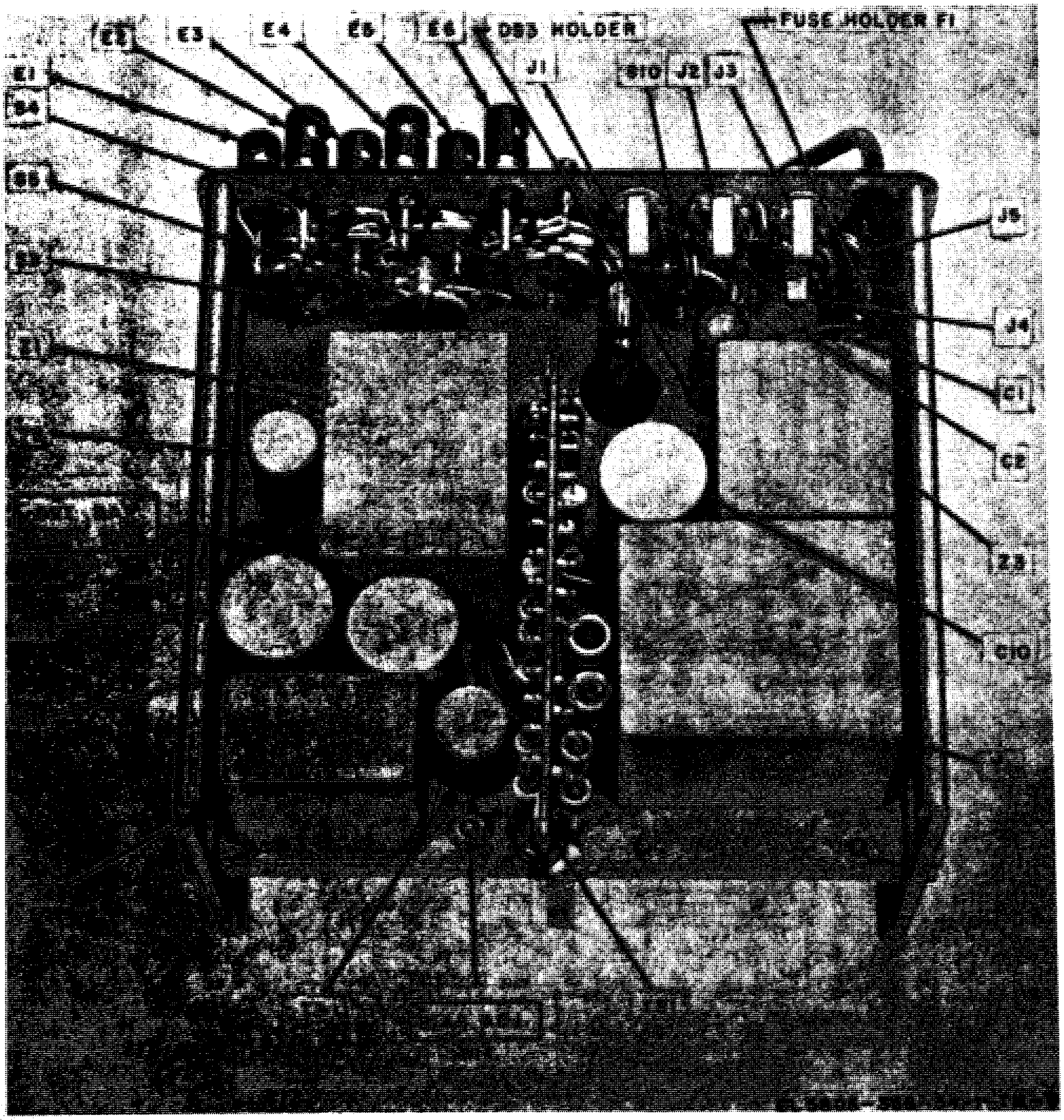


Figure 3–6. TH–22/TG chassis, bottom view.

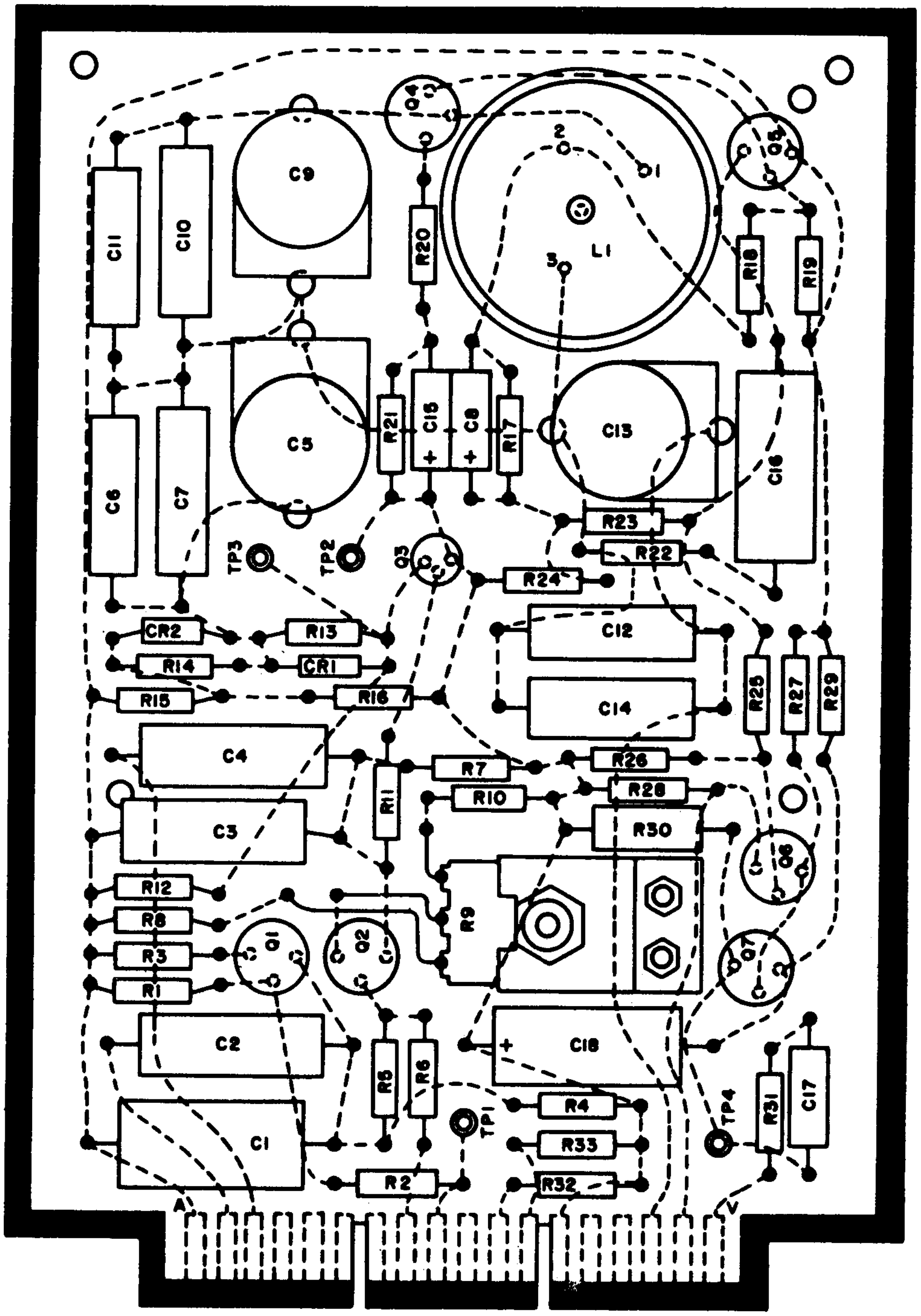


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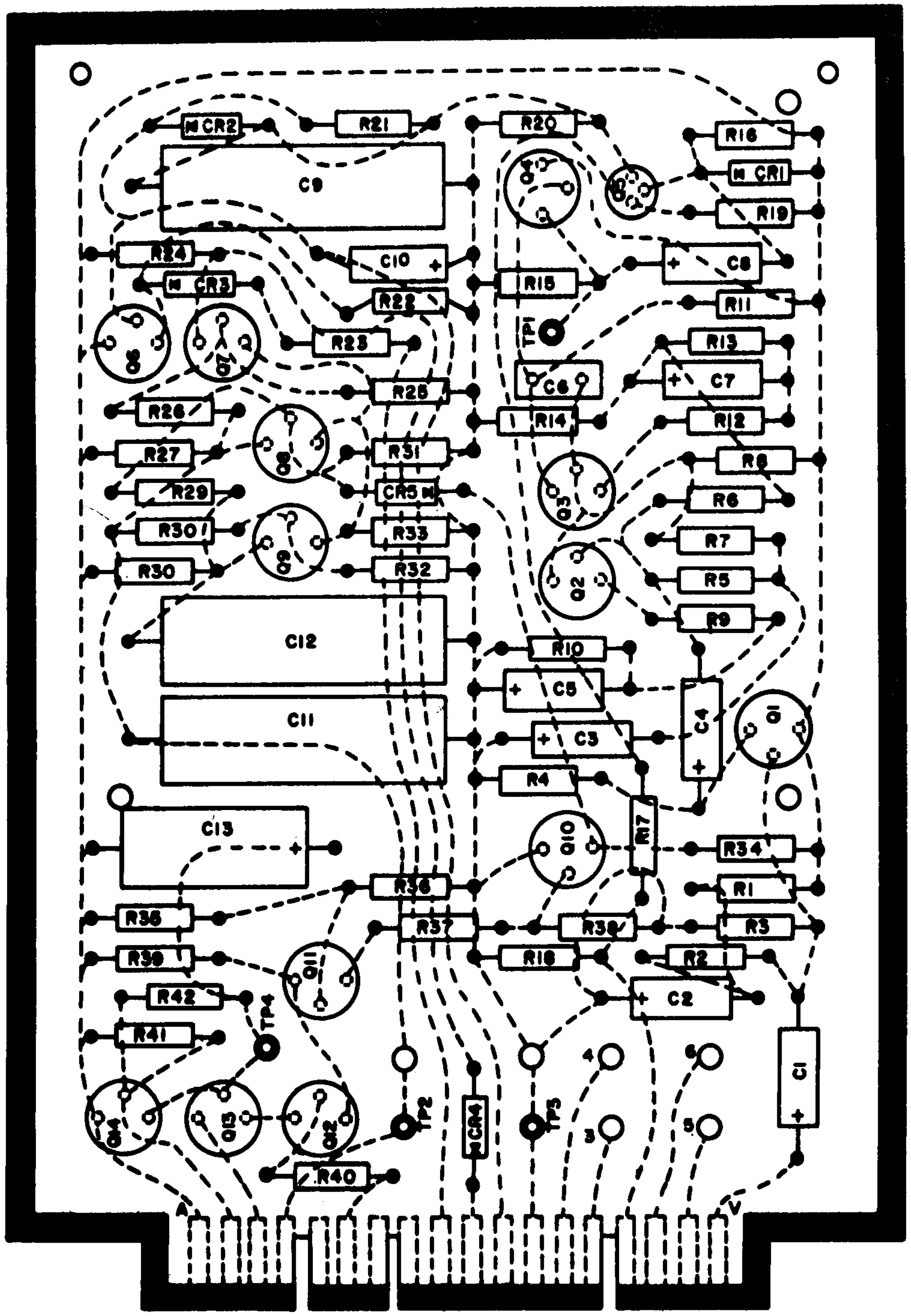
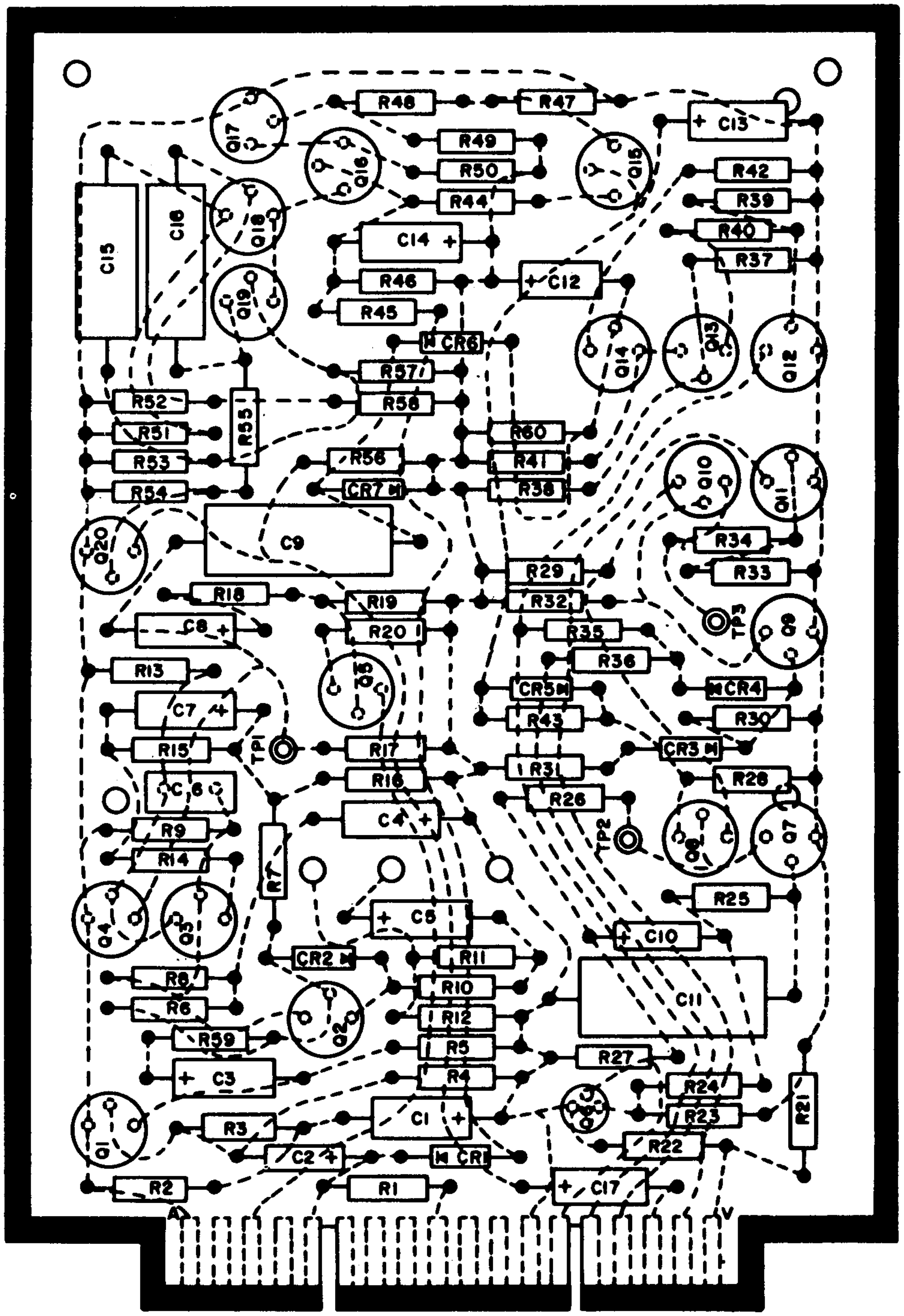
Figure 3-7. Send card 1A1, component layout and wiring diagram.



EL5805-356-34-1-TM-11

Figure 3-8. Break-in detector 1A8, component layout and wiring diagram.



EL5805-356-34-1-TM-12

Figure 3-9. Receive card 1A3, component layout and wiring diagram.

Section IV. MAINTENANCE OF TH-22/TG

3-8. Send Circuit Bias Adjustment

Remove the TH–22/TG chassis from the case and proceed as follows:

a. Provide a 600-ohm termination at 4WS-TEL line terminals.

b. Operate switches as follows:

Switch	*Position*
ON-OFF	OFF
MODE ONE-MODE TWO	MODE ONE
4W-2W-TEL	4W
115V AC-230V AC-26V DC	Position that corresponds to input power source being used.

c. Connect the AN/USM-486 between send card 1A1 test point TP3 and ground to measure a positive dc voltage at the test point.

d. Connect the TH-22/TG to the power source and operate the ON-OFF switch to ON.

e. With no connections made to either of the SEND jacks (corresponding to a mark input), note the indication of AN/USM-486.

f. Insert an open telephone plug into either of the SEND jacks (corresponding to a space input) and note the indication of the AN/USM-486.

g. Adjust resistor 1A1R9 and repeat e and *f* above until the indication obtained in e is twice that obtained in *f*.

3-9. Receive Circuit Bias Adjustment

Remove the TH-22/TG chassis from its case, position pc boards in the test position and proceed as follows:

a. Provide a 600-ohm termination at the 2W-4WR line terminals.

b. Operate switches as follows:

Switch	*Position*
ON-OFF	OFF
MODE ONE-MODE-TWO	MODE ONE
4W-2W-TEL	2W
NORM-REC-SEND	SEND
115V AC-230V AC-26V DC	Position that corresponds to input power source being used.

c. Connect the ME-26B/U between receive card 1A3 test point TP2 and ground to measure a positive dc voltage at the test point.

d Connect the TH-22/TG to the power source and operate the ON-OFF switch to ON.

e. With no connections made to either of the SEND jack (corresponding to a mark input), note the indication of AN/USM-486.

f. Insert an open telephone plug into either of the SEND jacks (corresponding to a space input) and note the indication of AN/USM-486.

g. Adjust BIAS ADJ resistor 1R14 and repeat e and *f* above until the indication obtained in e is twice that obtained in *f*.

3-10. Receive Circuit Loop Current Adjustment

Remove the TH-22/TG chassis from its case and proceed as follows:

u. Operate switches as follows:

Switch	*Position*
ON-OFF	OFF
4W-2W-TEL	TEL
115V AC-230V AC-26V DC	Position that corre.mends to input power source being used.

b. Connect the AN/PSM-45 (set to measure 50 ma) between terminal 2(+) and terminal 3(–) of EXT. BAT jack J4 (fig. 3-6), and insert an open telephone plug in the EXT. BAT jack.

c. Connect a teletypewriter to REC jack.

d. Connect the TH-22/TG to the power source and operate the ON-OFF switch to ON.

e. Adjust INT. BAT LOOP CUR control 1R12 to obtain an indication of 21 ma ±2.

CHAPTER 4

GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. GENERAL MAINTENANCE INFORMATION

4-1. Scope of General Support Maintenance

a. General support maintenance consists of troubleshooting by signal tracking (*b* below), adjustments (c below), and testing (*d* below), of the TH-22/TG and its component pc boards.

b. Troubleshooting at general support includes all the techniques outlined for organizational maintenance (TM 11–5805-356-12), direct support maintenance (ch. 3), and any special or additional techniques required to locate and isolate a defective part in the TH-22/TG circuits. These procedures are outlined in section III.

c. Adjustments at general support include all the adjustments outlined for organizational maintenance (TM 11-5805-356-12), direct support maintenance (ch. 3), and the adjustment of the oscillator output frequencies (para 4-8).

d. General support maintenance testing procedures consist of complete final testing procedures for the TH-22/TG and F-316/U. These procedures determine the acceptability of repaired equipment by testing the equipment against specific requirements. The repaired equipment must meet these requirements before it is returned to the using organization. The general support testing procedures are covered in paragraphs 4-9 through 4-12.

4-2. Fabrication of Test Cables

a. General. To perform the general support maintenance tests, fabricate three cables (two loop patch cables and a 600–ohm hookup cable). Use the materials listed in section II to fabricate the cables.

b. Loop Patch Cable.

(1) Cut two pieces of hookup wire, each 4 feet long.

(2) Strip 1/2 inch of insulation from both ends of each wire.

(3) Unscrew and remove the insulated covers from two telephone plugs.

(4) Insert wire through the back of the insulated plug covers so that they face back-to-back.

(5) Connect one wire to the tip and the second wire to the sleeve of each plug.

(6) Screw the insulated covers back on the plugs.

c. 600-OHM *Hookup Cable.*

(1) Cut two 2-foot lengths of hookup wire.

(2) Strip 1/2 inch of insulation from both ends of each wire.

(3) Connect and solder one wire to each 600-ohm resistor lead.

(4) Tape exposed wires.

Section II. TOOLS AND TEST EQUIPMENT

4-3. Test Equipment and Tools, General Support Maintenance

The following chart lists the test equipment and tools required for general support maintenance:

Test equipment and tools	*Associated technical manual*
Attenuator TS-402/U	TM 11-2044
Decade Capacitor, (NSN 6625-00-220-9441) part of Laboratory Standards, AN/ *URM-2A*	Commercial Literature
Electronic Counter AN/ USM-459	TM 11-6625-700-10
Digital Multimeter AN/ PSM-45	Not applicable
Digital Multimeter AN/ PSM-486	Not applicable
oscilloscope AN/USM-281	TM 11-6625-1703-15, or TM 11-6625-2658-14
Test Set AN/USM-181	TM 11-6625-602-12
Teletypewriter Test Set AN/ GGM-1 consisting of:	TM 11-6625-422-12

Test equipment and tools	Associated technical manual
Teletypewriter Test Set TS-1512/GGM.	
Test Pattern Generator SG-431/GGM.	
Transistor Test Set TS-1836/U.	TM 11-6625-539-15
Electronic Equipment Tool Kit TK-100/G.	Not applicable.
Electronic Equipment Tool Kit TD-105/G.	Not applicable.
Telegraph-Telephone Terminal AN/TCC-29.	TM 11-5805-356-12
Telephone Set TA-312/P.	TM 11-5805-201-12

4-4. Materials, General Maintenance Procedures

The following materials are required to perform the general maintenance procedures:

a. Hookup wire, insulated copper, 20 gage (50 ft).

b. Telephone plug (4 ea).

c. Resistor, 600 ohms ±5 percent, 2 watts (3 ea).

Section III. TROUBLESHOOTING

4-5. General

The signal substitution charts (para 4-6) help to isolate the defective stage or circuit. Voltage and other measurements taken at the defective stage will usually isolate the defective part(s). The signal substitution procedures at each step are based on the assumption that all previous steps have been completed satisfactorily.

4-6. Signal Substitution Charts

a. Signal Substitution for Send Circuits on Send Card 1A1.

(1) *Procedure.*

(a) Connect SG-431/GGM signal output to the SEND jack on the TH-22/TG under test and provide reversals at 74 bauds.

(b) Connect the oscilloscope as indicated in the chart.

(2) Signal substitution chart.

Test No.	Oscilloscope probe connections (figs. 3-3 and 3-7) Positive	Negative	Oscilloscope normal indication	Corrective action if indication is not normal
1	Test point TP1	0-volt line	Telegraph signal	Check input jacks, switches, and interconnecting wiring.
2	Base of Q2	0-volt line	Telegraph signal	Check time-delay amplifier Q1.
3	Base of Q3	0-volt line	Telegraph signal	Check gated amplifier Q2.
4	Test point TP3	0-volt line	Telegraph signal	Check emitter follower Q3.
5	Emitter of Q5	+18-volt line	Vf signal	Check oscillator Q4 and emitter follower Q5.
6	Collector of Q6	+18-volt line	Vf signal	Check gated amplifier Q6.
7	Test point TP4	+18-volt line	Vf signal	Check amplifier Q7.
8	Terminal 4 of transformer 1T3 (fig. 3-1).	Terminal 5 of transformer 1T3 (fig. 3-1).	Vf signal	Check transformer 1T3 and output circuit of amplifier Q7.

b. Signal Substitution for Receive Circuits on Receive Card 1A3.

(1) Procedure. Perform the procedure given in *a (1)* above.

(2) Signal substitution chart.

Test No.	Oscilloscope probe connections (fig. 3-9) Positive	Negative	Oscilloscope normal indication	Corrective action if indication is not normal
1	Base of Q1	+18-volt line	Vf signal	Check transformer 1T2 on chassis, and capacitor C2.
2	Base of Q2	+18-volt line	Vf signal	Check emitter follower Q1.
3	Base of Q3	+18-volt line	Vf signal	Check limiter-amplifier Q2.
4	Test point TP1	+18-volt line	Vf signal	Check dc amplifier Q3 and emitter follower Q4.

Test No.	Oscilloscope probe connections (figs. 3-3 and 3-7) Positive	Negative	Oscilloscope normal indication	Corrective action if indication is not normal
5	Collector of Q5	0-volt line	Vf signal	Check discriminator driver Q5 and discriminator transformer Z2.
6	Base of Q6	Ground	Telegraph signal	Check discriminator CR7 to CR10 and associated components.
7	Test point TP2	+18-volt line	Telegraph signal	Check emitter follower Q7.
8	Test point TP3	+18-volt line	Telegraph signal	Check differential amplifier Q8–Q10.
9	Terminal U of connector XA3.	Ground	Telegraph signal	Check electronic switch Q11.

c. Signal Substitution for Vf Alarm Circuits on Receive Card 1A3.

(1) *Procedure.*

(a) Perform the procedure given in a (1) above.

(*b*) Operate the VF–20∿ switch on both TH–22/TG units to 20∿.

(c) Operate the RING switch on standard TH–22/TG and note that the alarm does not sound. (If the alarm sounds, the circuits are opcrating normally.)

(d) Connect the oscilloscope as indicated in the chart ((2) below).

(2) *Signal substitution chart.*

Test No.	Oscilloscope probe connections (fig. 3-9) Positive	Negative	Oscilloscope normal indication	Corrective action if indication is not normal
1	Terminal T of connector 1XA3.	Ground	Audio signal	Check speaker LS1.
2	Base of Q20	Ground	Audio signal	Check af amplifier Q20.
3	Collector of Q20	Ground	Audio signal	Check capacitor C17 and resistor R56.
4	Collector of Q16	Ground	Refer to voltage chart for proper indications.	Check multivibrator Q18–Q19 and differential amplifier Q16–Q17.
5	Base of Q16	+18-volt line	Refer to voltage chart for proper indications.	Check ring detector CR1.

d. Signal Substitution for Vf Circuits on Break-In Detector Card 1A2.

(1) *Procedure.*

(a) Perform the procedure given in *a* (1) above.

(b) Operate the BREAK-IN switch on the standard TH-22/TG.

(2) Signal substitution chart.

Test No.	Oscilloscope probe connections (figs. 3-3 and 3-8) Positive	Negative	Oscilloscope normal indication	Corrective action if indication is not normal
1	Terminal 2 of break-in filter 1Z1.	+18-volt line	Vf signal	Check break-in filter 1Z1.
2	Base of Q2	+18-volt line	Vf signal	Check emitter follower Q1.
3	Base of Q4	+18-volt line	Vf signal	Check dc amplifier Q2–Q3.
4	Test point TP1	+18-volt line	Vf signal	Check emitter follower Q4.

Section IV. MAINTENANCE OF TH-22/TG

4-7. Repair Procedures

The general support repair procedures consist of replacing transistors and parts, and repair of the TH-22/TG pc boards. These procedures require the use of Electronic Tool Kits TK-100/G and TK-105/G. Follow the procedures in a below when replacing transistors, *b* below when replacing parts, and c below when repairing pc boards.

a. *Transistor Replacement.*

(1) Use a pencil-type soldering iron with a 25-watt maximum capacity.

CAUTION

Never bring the soldering iron into direct contact with the transistor body or any heat conductor which is in direct contact with the transistor body. The excessive temperature will destroy the transistor.

(2) When soldering transistor leads, solder quickly; use a heat sink (such as a long-nose pliers) between the soldered joint and the transistor.

(3) Use approximately the same length and dress for transistor leads as used originally.

b. Part Replacement.

(1) Remove the part by cutting the leads approximately 1/16 inch from the printed circuit board.

CAUTION

Never bring the soldering iron into direct contact with the printed circuit. Excessive heat will damage the printed circuit.

(2) Remove the leads from the printed circuit by applying the iron to the lead until the solder melts at the junction.

(3) Remove the excess solder from junction on the printed circuit board with a small drill. Always drill from the printed circuit side of the board to prevent loosening of the printed circuit foil.

(4) Use approximately the same length and dress for part leads as was used originally.

(5) Solder the component leads to the printed circuit by applying the soldering iron to the component lead and removing the iron as soon as the solder flows into the junction.

c. *Pc Board Repair.* Follow the procedures given below if the foil of the pc board is loose or broken.

(1) Remove the loose or broken foil by cutting it as close to the board as possible.

(2) Cut a piece of tinned 20-gage copper wire 1/2 inch longer than the span of the removed section of foil.

(3) Bend each end of the copper wire 1/4 inch from the ends until its shape resembles a stapled.

(4) Drill a small hole in the board at each end of the span where the loose or broken foil was removed. If the foil at each end of the span is 1/4 inch or more in width, drill the hole directly into the foil.

(5) Insert the ends of the copper wire from the component side of the board and bend the ends across the foil.

(6) Solder the junctions of the foil and copper wire by applying the soldering iron to the copper wire.

4-8. Send Oscillator Frequency Adjustment

The test equipment and materials required to perform the following procedure are listed in section II.

a. Provide 600-ohm load at line terminals.

b. Operate the switches as follows:

Switch	*Position*
ON-OFF	OFF
MODE ONE-MODE TWO	MODE ONE
VF-20 ∼	VF
4W-2W-TEL	4W
NORM-REC-SEND	SEND
115V AC-230V AC ±26V DC	Position that corresponds to input power source.

c. Connect the AN/USM-459 to 4WS-TEL line terminals E3 and E4.

d. Operate the TH-22/TG ON-OFF switch to ON.

e. Be sure the frequency at the line terminal is 1,317.5 Hz ±3, which is the mark frequency. If the correct frequency is not indicated, adjust trimmer capacitor A1C9 (fig. 3-3) to obtain the correct frequency indication. If unable to bring frequency into range, send TH-22/TG to higher category of maintenance.

f. Insert an open plug into the SEND jack, providing space input.

g. Be sure the frequency at the line terminal is 1,232.5 Hz ±3, which is the space frequency. If the correct frequency is not obtained, adjust trimmer capacitor A1C5 (fig. 3-3) to obtain the correct frequency. If unable to bring frequency into range, send TH-22/TG to higher category of maintenance.

h. Remove the open plug, and be sure the VF-20∼ switch is at VF.

i. Operate the RING switch, and be sure the frequency, while the switch is held operated, is 1,232.5 Hz ±3. If not, troubleshoot the VF-20∼ and RING switches.

j. Operate the BREAK IN switch, and be sure the break-in frequency of 1,180 Hz ±3 is indicated. If the correct frequency is not indicated, adjust trimmer capacitor A1C13 (fig. 3-3) to obtain the correct frequency. This action completes the send circuit adjustment. If unable to bring frequency into range, send TH-22/TG to higher category of maintenance.

Section V. GENERAL SUPPORT TESTING PROCEDURES

4-9. Physical Test and Inspection

a. *Test Equipment and Materials.* None required.

b. Test Connections and Conditions. Remove the TH-22/TG from its case.

c. *Procedure.*

Step No.	Control settings: Test Equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	N/A	Controls may be in any position.	*a.* Inspect all controls and assemblies for missing screws, bolts, and nuts.	*a.* Screws, bolts, and nuts are tight; none missing.
			b. Inspect all connectors, sockets, and receptacles, including the fuse holder, for looseness and damage.	*b.* No looseness or damage evident.
			c. Inspect case and chassis for damage missing parts, condition of finish, and panel lettering. *Note.* Touchup painting is recommended in lieu of refinishing whenever practicable. Screwheads, binding posts, receptacles, and plated fastener parts will not be painted or polished with abrasives.	*c.* No damage or missing parts evident. External surfaces intended to be painted do not show bare metal. Panel lettering legible.
2	N/A	N/A	Check pc boards that has been disturbed and repaired, for missing epoxy coating.	All repaired or distributed electrical components and surfaces are covered. *Note.* Equipment surfaces that had no coating do not require treatment during general support repair.
3	N/A	N/A	Check the equipment for applicable modification work orders.	None.

4-10. TH-22/TG 2-Wire Operational Test

a. Test Equipment and Materials.

(1) Test Set, Teletypewriter AN/GGM-1.

(2) Teletypewriter (TTY) or other telegraph receiving device.

(3) Terminal, Telegraph TH-22/TG (standard).

(4) Patch cords (2).

(5) Hookup wire (6 ft).

b. Test Connections and Conditions. Connect TH-22/TG under test (position A), TH-22/TG standard (position B), AN/GGM-1, and TTY as shown in figure 4-1. Connect one pair of hook-up wires (designated 2-wire test. hookup wire) between TH-22/TG's as shown. *Omit all other hookup wires shown.*

c. Initial Test Equipment Settings. None.

d. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	SG-431/GGM. DISTORTION: OFF. BAUDS: Same as TTY.	TH-22/TG (position A). 4W-2W-TEL: 2W.	TTY prints FOX message	Printout contains no errors.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
	PATTERN SELECTOR: FOX CHARACTER RELEASE: FREE RUN. TH-22/TB (position B). 4W-2W-TEL: 2W MODE ONE--MOD TWO: MODE ONE. NORM-REC-SEND: NORM	MODE ONE-MODE TWO: MODE ONE. NORM-REC-SEND: NORM.		**NOTE** On some equipments, when using the shortwire hookup of figure 4-1, a break-in condition at position A or position B of the TH-22/TG will occur as the RING switch is released. This produces an audible tone in both speakers. Operate the appropriate RESET switch to silence the speakers and return the equipment to normal. (Refer to steps 4 and 5.)
2	Same as above.	Same as above.	Depress BREAK-IN switch on TH-22/TG (position B).	TTY stops printing, and speakers at both TH-22/TG's produce audible tones.
3	Same as above.	Same as above.	Set VF-20 ~ switch to VF and depress RING switch on TH-22/TB (position A).	Speaker at TH-22/TG (position B) produces audible tone.
4	Same as above.	Same as above.	Set VF-Z20 ~ switch to 20 ~ and depress RING switch on TH-22/TG (position A).	Speaker at TH-22/TG (position B) produces audible tone.
5	Same as above.	Same as above.	Set VF-20 ~ switch to 20 ~ and depress RING switch on TH-22/TG (position B).	Speaker at TH-22/TG (position A) produces audible tone.
6	Same as above except for setting of NORM-REC-SEND switch on TH-22/TG (position B).	Same as above except for setting of NORM-REC-SEND switch on TH-22/TG (position A).	Set NO RM-REC-SEND switch on TH-22/TG (position A) to REC. Set NORM-REC-SEND switch on TH-22/TG (position B) to SEND.	TTY prints message.
7	Same as above except for setting of NORM-REC-SEND	Same as above except for setting of NORM-REC-SEND switch on TH-22/TG	Set NO RM-REC-SEND switch on TH-22TG (position B) to REC with NORM-REC-SEND switch on TH-22/TG (position A) set to REC.	TTY prints message.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
	on TH–22/TG (position B).	(position A).		
8	Same as above except for setting of NORM–REC–SEND switch on TH–22/TG (position B).	Same as above except for setting of NORM–REC–SEND switch on TH–22/TG (position A).	Set NORM–REC–SEND switch on TH–22/TG (position B) to REC. Set NORM–REC–SEND switch on TH–22/TG (position A) to SEND.	TTY prints message.

4-11. TH-22/TG 4-Wire Operational Test

a. *Test Equipment and Materials.*

(1) Test Set, Teletypewriter AN/GGM-1.

(2) Teletypewriter (TTY) or other telegraph receiving device.

(3) Terminal, Telegraph TH-22/TG (standard).

(4) Patch cords (2).

(5) Hookup wire (12 ft).

b. Test Connections and Conditions. Connect TH-22/TG under test (position A), TH-22/TG standard (position B), AN/GGM-1 and TTY as shown in figure 4-1. Connect 4 hookup wires (designated 4-wire test hookup wire) between the TH-22/TG's as shown. *Omit all other hookup wires shown.*

c. *Initial Test Equipment Settings. None.*

d. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	SG–431/GGM. DISTORTION: OFF. BAUDS: Same as TTY. PATTERN SELECTOR: FOX CHARACTER RELEASE: FREE RUN. TH–22/TG (position B). 4W–2W–TEL: 4W.	TH–22/TG (position A). 4W–2W–TEL: 4W. MODE ONE–MODE TWO: MODE ONE. NORM–REC–SEND: NORM.	TTY prints FOX message	Printout contains no errors.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
	MODE ONE-MODE TWO: MODE ONE. NORM-REC-SEND: NORM.			
2	Same as above except for setting of NORM-REC-SEND switch on TH-22/TG (position B).	Same as above except for setting of NORM-REC-SEND switch on TH-22/TG (position A).	Set NORM-REC-SEND switch on TH-22/TG (position A) to REC. Set NORM-REC-SEND switch on TH-22/TG (position B) to SEND.	TTY does not print message.
3	Same as above except for setting of NORM-REC-SEND switch on TH-22/TG (position B).	Same as above except for setting of NORM-REC-SEND switch on TH-22/TG (position A).	Set NORM-REC-SEND switch on TH-22/TG (position B) to REC with NORM-REC-SEND switch on TH-22/TG (position A) set to REC.	TTY does not print message.
4	Same as above except for setting of NORM-SEND switch on TH-22/TG (position B).	Same as above except for setting of NORM-REC-SEND switch on TH-22/TG (position A).	Set NORM-REC-SEND switch on TH-22/TG (position B) to REC. Set NORM-REC-SEND switch on TH-22/TG (position A) to SEND.	TTY prints message.

4-12. F-316/U Operational Test

a. Test Equipment and Materials.

(1) Test Set, Teletypewriter AN/GGM-1.

(2) Teletypewriter (TTY) or other telegraph receiving device.

(3) Terminal, Telegraph TH-22/TG (2).

(4) Filter Assembly Electrical F-316/U (standard).

(5) Telephone Set TA-312/U (2).

(6) Patch cords (2).

(7) Hookup wire (30 ft).

b. Test Connections and Conditions. Connect both TH-22/TG's, AN/GGM-1, and TTY as shown in figure 4-1. Using five pairs of hookup wires (designated filter test hookup wire) connect F-216/U standard (position B) and F-316/U under test (position A) as shown, *Omit all other hookup wires shown.*

c. Initial Test Equipment Settings. None.

d. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	SG-43/GGM. DISTORTION: OFF. BAUDS: Same as TTY. PATTERN SELECTOR: REVERSAL. CHARACTER RELEASE: FREE RUN. TH-22/TG: (2) 4W-2W-TEL: 2W. MODE ONE-MODE TWO: MODE ONE. NORM-REC-SEND: NORM.	N/A	IMPLEMENT tacway conversation via the two TA-312/U's.	TTY printout should contain no errors and voice communications should not be disrupted by telegraph vf signal.
2	Same as above.	N/A	Operate ringer on TA-312/U associated with F-316/U (position B).	Bell on TA-312/U associated with F-316/U (position A) rings.
3	Same as above.	N/A	Operate ringer on TA-312/U associated with F-316/U (position A).	Bell on TA-312/U associated with F-316/U (position B) rings.

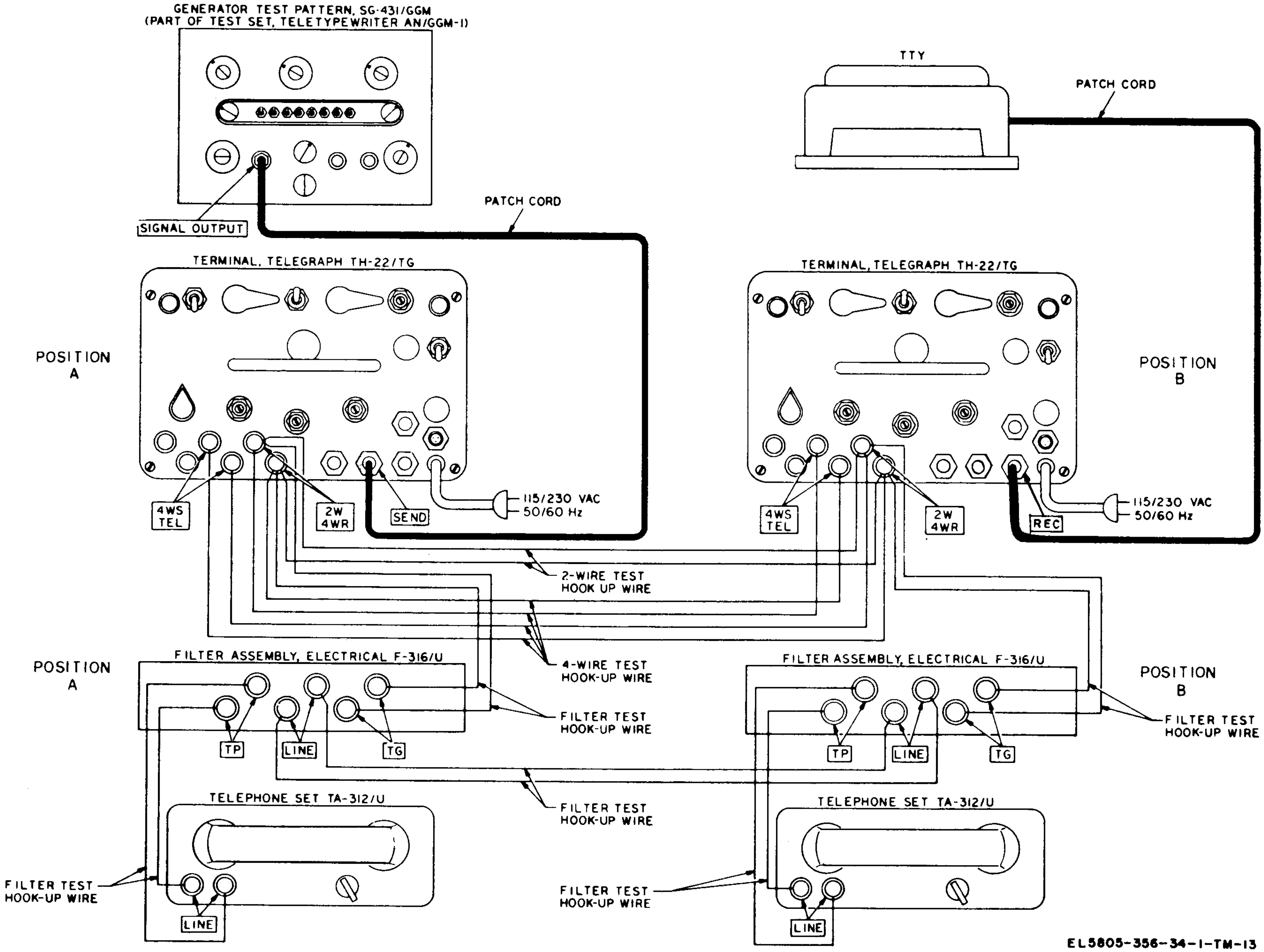


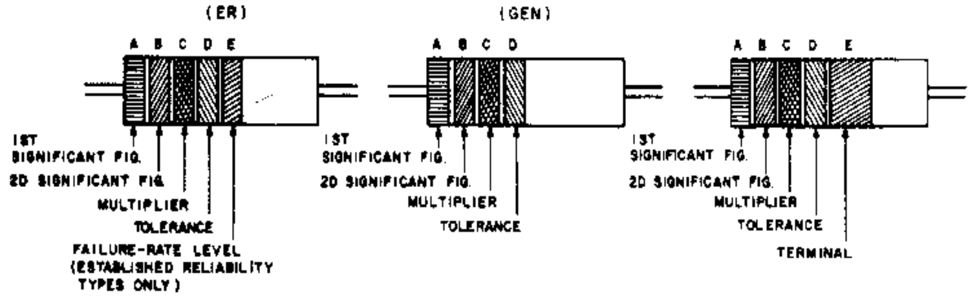
Figure 4-1. Operational test setup.

APPENDIX A

REFERENCES

Following is a list of useful references available to the repair technician of the AN/TCC-29.

AR 310-25	Dictionary of United States Army Terms.
AR 310-50	Authorized Abbreviations and Brevity Codes.
AR 750-1	Army Materiel Maintenance Concept and Policies.
DA Pam 310-1	Consolidated Index ofArmy Publications and Blank Forms.
TM 11-2044	Attenuators TS-402/U and TS-402A/U.
TM 11-2088	Test Sets: TS-2/TG, TS-2A/TG, TS-2B/TG, and TS-2C/TG (Teletypewriter Signal (Distortion)).
TM 11-5805-210-12	Operator and Organizational Maintenance Manual Telephone Set, TA-312/PT (NSN 5805-00-543-0012) (TO 31W1-2PT-291) (Reprinted W/Basic Incl C1-3).
TM 11-5805-201-20P	Organizational Maintenance Repair Parts and Special Tools List for Telephone Set TA-312/PT (NSN 5805-00-543-0012) (Reprinted W/Basic Inc. C1).
TM 11-5805-201-34P	Direct Support and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools) for Telephone Set TA-312/PT (NSN 5805-00-543-0012) (Reprinted W/Basic Incl C1-2).
TM 11-5805-201-35	Direct Support, General Support and Depot Maintenance Manual: Telephone Set TA-312/PT (NSN 5805-00-543-0012) (TO 31W1-2PT-292) (Reprinted W/Basic Incl C1-2).
TM 11-5805-356-12	Operator and Organizational Maintenance Manual (Including Repair Parts and Special Tools Lists) Terminal, Telegraph-Telephone AN/TCC-29 (NSN 5805-00-902-3087) (Including Terminal, Telegraph TH-22/TG (NSN 5805-00-907-8300) and Converter, Telegraph-Telephone Signal CV-425/U (NSN 5805-00-985-9088).
TM 11-6625-251-15	Organizational, Direct Support, General Support and Depot Maintenance Manual: lkst Set TS-140/PCM; Signal Generators SG-15/PCM and SG-15A/PCM and Decibel Meters ME-22/PCM and ME-22A/PCM (Reprinted W/Basic Incl C1).
TM 11-6625-422-12	Organizational Maintenance Manual (Including Repair Parts and Special Tools Lists) for Test Sets, Teletypewriter AN/GGM-1, AN/GGM-2, AN/GGM-3, AN/GGM-4 and AN/GGM-5.
TM 11-6625-539-15	Operator, Organizational, Field and Depot Maintenance Manual for Transistor Set TS-1836/U.
TM 11-6625-700-10	Operator Manual: Digital Readout, Electronic Counter AN/USM-207 (NSN 6625-00-911-6363).
TM 1l-6625-1703-15	Operator, Organizational, Direct Support, General Support and Depot Maintenance Manual: Oscilloscope AN/USM-281A (NSN 6625-00-228-2201) (Reprinted W/Basic Incl C1-2).
TM 11-6625-2658-14	Operator, Organizational, Direct Support, and General Support Maintenance Manual for Oscilloscope, AN/USM-281C (NSN 6625-00-106-9622).



COLOR CODE MARKING FOR COMPOSITION TYPE RESISTORS.

COLOR-CODE MARKING FOR FILM-TYPE RESISTORS.

TABLE I
COLOR CODE FOR COMPOSITION TYPE AND FILM TYPE RESISTORS.

BAND A		BAND B		BAND C		BAND D		BAND E		
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)	COLOR	FAILURE RATE LEVEL	TERM.
BLACK.....	0	BLACK.....	0	BLACK	1			BROWN..	M=1.0	
BROWN.....	1	BROWN.....	1	BROWN..	10			RED.....	P=0.1	
RED........	2	RED.....	2	RED........	100			ORANGE..	R=0.01	
ORANGE....	3	ORANGE,...	3	ORANGE...	1,000			YELLOW..	S=0.001	
YELLOW....	4	YELLOW...	4	YELLOW	10,000	SILVER	±10 (COMP. TYPE ONLY)	WHITE ..	.	SOLD-ERABLE
GREEN.....	5	GREEN.....	5	GREEN..	100,000	GOLD...	±5			
BLUE......	6	BLUE......	6	BLUE.....	1,000,000	RED ...	±2 (NOT APPLICABLE TO ESTABLISHED RELIABILITY).			
PURPLE.... (VIOLET)	7	PURPLE.. (VIOLET)	7							
GRAY......	8	GRAY. ..	8	SILVER	1.01					
WHITE....	9	WHITE. ..	9	GOLD	0.1					

BAND A — THE FIRST SIGNIFICANT FIGURE OF THE RESISTANCE VALUE (BANDS A THRU D SHALL BE OF EQUAL WIDTH.)

BAND B — THE SECOND SIGNIFICANT FIGURE OF THE RESISTANCE VALUE.

BAND C — THE MULTIPLIER (THE MULTIPLIER IS THE FACTOR BY WHICH THE TWO SIGNIFICANT FIGURES ARE MULTIPLIED TO YIELD THE NOMINAL RESISTANCE VALUE.)

BAND D — THE RESISTANCE TOLERANCE.

BAND E — WHEN USED ON COMPOSITION RESISTORS, BAND E INDICATES ESTABLISHED RELIABILITY FAILURE-RATE LEVEL (PERCENT FAILURE PER 1,000 HOURS). ON FILM RESISTORS, THIS BAND SHALL BE APPROXIMATELY 1-1/2 TIMES THE WIDTH OF OTHER BANDS, AND INDICATES TYPE OF TERMINAL.

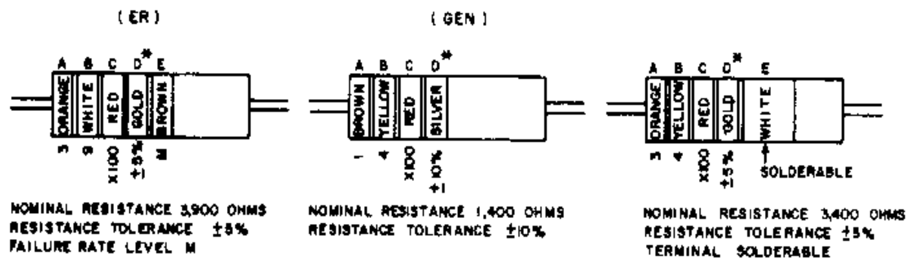
RESISTANCES IDENTIFIED BY NUMBERS AND LETTERS
(THESE ARE NOT COLOR CODED)

SOME RESISTORS ARE IDENTIFIED BY THREE OR FOUR DIGIT ALPHA NUMERIC DESIGNATORS. THE LETTER R IS USED IN PLACE OF A DECIMAL POINT WHEN FRACTIONAL VALUES OF AN OHM ARE EXPRESSED. FOR EXAMPLE:

2R7 = 2.7 OHMS 10R0 = 10.0 OHMS

FOR WIRE-WOUND-TYPE RESISTORS COLOR CODING IS NOT USED, IDENTIFICATION MARKING IS SPECIFIED IN EACH OF THE APPLICABLE SPECIFICATIONS.

EXAMPLES OF COLOR CODING

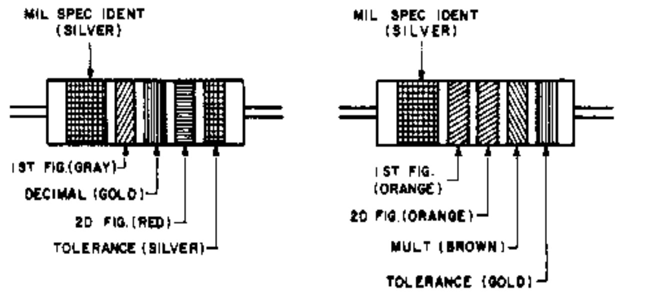


COMPOSITION-TYPE RESISTORS

FILM-TYPE RESISTORS

* IF BAND D IS OMITTED, THE RESISTOR TOLERANCE IS ±20% AND THE RESISTOR IS NOT MIL-STD.

A. COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS.



(A) 8.2UH ± 10%

(B) 330UH ± 5%

COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES. AT A, AN EXAMPLE OF OF THE CODING FOR AN 8.2UH CHOKE IS GIVEN AT B, THE COLOR BANDS FOR A 330 UH INDUCTOR ARE ILLUSTRATED.

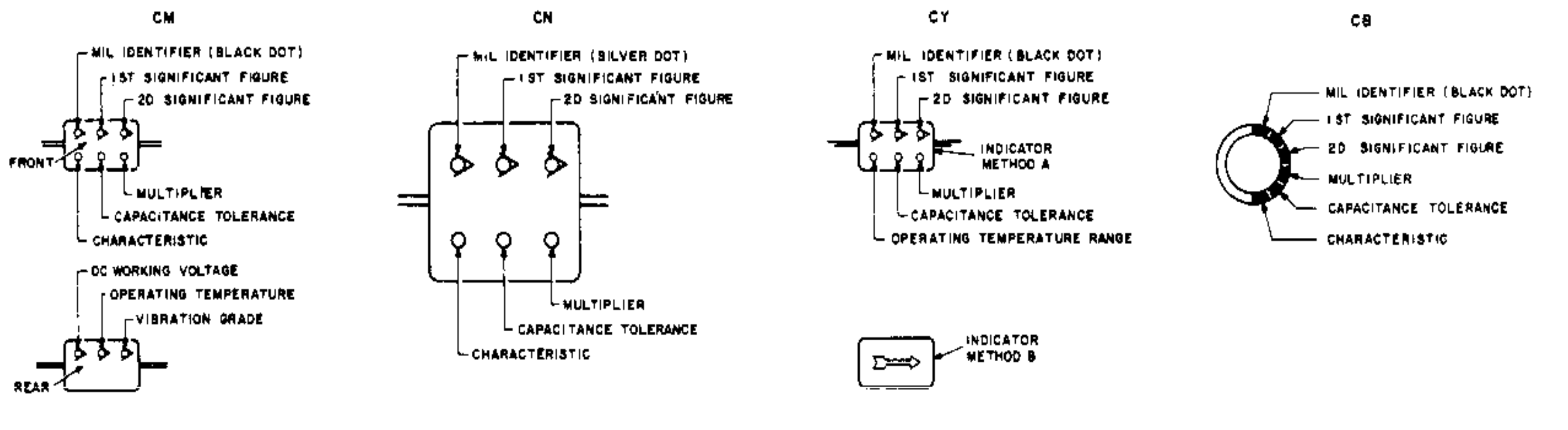
TABLE 2
COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	INDUCTANCE TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	1
RED	2	100	2
ORANGE	3	1,000	3
YELLOW	4		
GREEN	5		
BLUE	6		
VIOLET	7		
GRAY	8		
WHITE	9		
NONE			20
SILVER			10
GOLD	DECIMAL POINT		5

MULTIPLIER IS THE FACTOR BY WHICH THE TWO COLOR FIGURES ARE MULTIPLIED TO OBTAIN THE INDUCTANCE VALUE OF THE CHOKE COIL.

B. COLOR CODE MARKING FOR MILITARY STANDARD INDUCTORS.

CAPACITORS, FIXED, VARIOUS-DIELECTRICS, STYLES CM, CN, CY, AND CB.

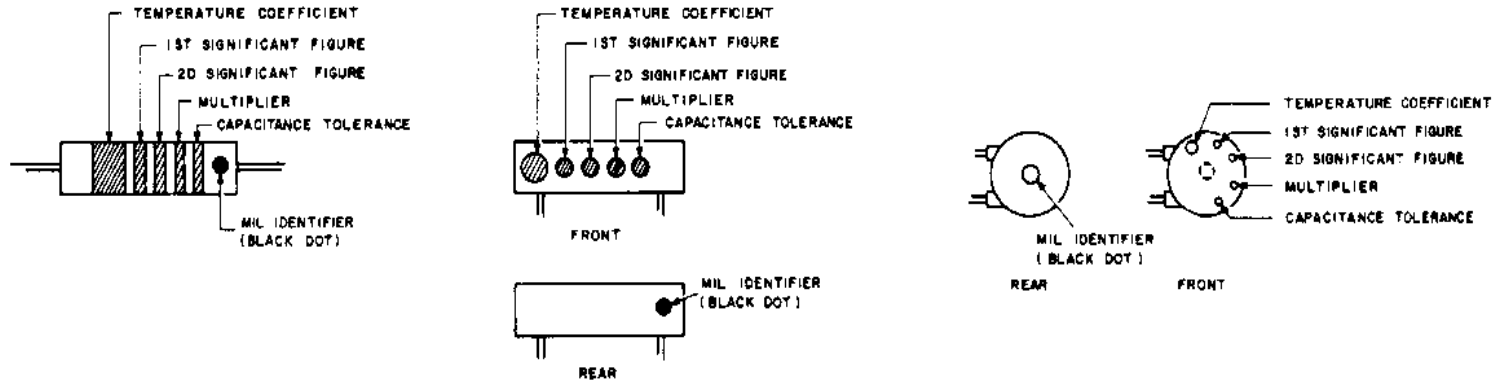


MICA-DIELECTRIC

PAPER-DIELECTRIC

GLASS-DIELECTRIC, GLASS CASE

MICA, BUTTON TYPE



AXIAL LEAD

RADIAL LEAD

DISK-TYPE

TABLE 3— FOR USE WITH STYLES CM, CN, CY AND CB.

COLOR	MIL ID	1ST SIG FIG.	2D SIG FIG.	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]			DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CB	CM	CY, CM	CM
BLACK	CM, CY CB	0	0	1			±20%	±20%		A			-55° TO +70°C	10-55 Hz
BROWN		1	1	10					B	E	B			
RED		2	2	100	±2%		±2%	±2%	C				-55° TO +85°C	
ORANGE		3	3	1,000		±30%			D		D	300		
YELLOW		4	4	10,000					E				-55° TO +125°C	10-2,000Hz
GREEN		5	3		±5%				F			500		
BLUE		6	6										-55° TO +150°C	
PURPLE (VIOLET)		7	7											
GREY		8	8											
WHITE		9	9											
GOLD				0.1			±5%	±5%						
SILVER	CN				±10%	±10%	±10%	±10%						

TABLE 4— TEMPERATURE COMPENSATING, STYLE CC.

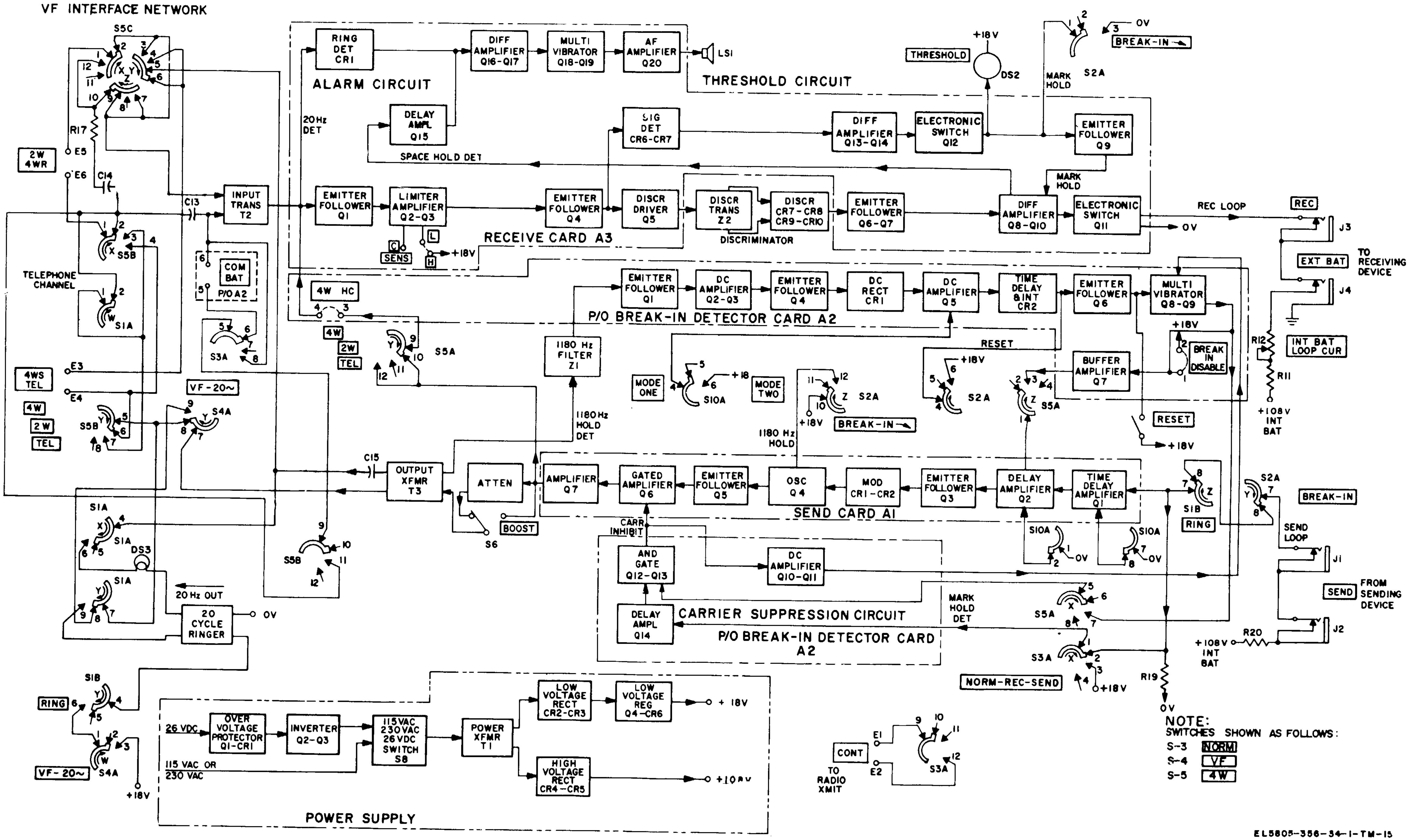
COLOR	TEMPERATURE COEFFICIENT[4]	1ST SIG FIG.	2D SIG FIG.	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					CAPACITANCES OVER 10 UUF	CAPACITANCES 10 UUF OR LESS	
BLACK	0	0	0	1		±2.0 UUF	CC
BROWN	-30	1	1	10	±1%		
RED	-80	2	2	100	±2%	±0.25 UUF	
ORANGE	-150	3	3	1,000			
YELLOW	-220	4	4				
GREEN	-330	5	5		±5%	±0.5 UUF	
BLUE	-470	6	6				
PURPLE (VIOLET)	-750	7	7				
GREY		8	8	0.01			
WHITE		9	9	0.1	±10%		
GOLD	+100					±1.0 UUF	
SILVER							

1. THE MULTIPLIER IS THE NUMBER BY WHICH THE TWO SIGNIFICANT (SIG) FIGURES ARE MULTIPLIED TO OBTAIN THE CAPACITANCE IN UUF.
2. LETTERS INDICATE THE CHARACTERISTICS DESIGNATED IN APPLICABLE SPECIFICATIONS: MIL-C-5, MIL-C-20D, MIL-C-11272B, AND MIL-C-10950C RESPECTIVELY.
3. LETTERS INDICATE THE TEMPERATURE RANGE AND VOLTAGE-TEMPERATURE LIMITS DESIGNATED IN MIL-C-11015D.
4. TEMPERATURE COEFFICIENT IN PARTS PER MILLION PER DEGREE CENTIGRADE.

C. COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS.

ESC-FM 1794-71

Figure FO-1. MIL-STD color code marking for resistors, inductors, and capacitors.



EL5805-356-34-1-TM-15

Figure FO-2. Terminal, Telegraph TH-22/TG, detailed blocq diagram.

Figure FO-3. Terminal, Telegraph TH-22/TG, schematic diagram.

NOTES:

1. REFERENCE DESIGNATIONS ARE ABBREVIATED. PREFIX THE DESIGNATIONS WITH UNIT NO. AND DESIGNATION OF ASSEMBLY ON WHICH PART IS MOUNTED.
2. UNLESS OTHERWISE SPECIFIED, ALL RESISTANCES ARE IN OHMS, 1/4 WATT, ±5% TOL., CAPACITANCES ARE IN UUF.
3. ROTARY SWITCHES ARE SHOWN IN EXTREME COUNTERCLOCKWISE POSITION AND ARE VIEWED FROM THE FRONT OR KNOB END. SECTION "A" IS WAFER NEAREST CONTROL KNOB.
4. * DENOTES FACTORY SELECTED COMPONENT.
5. O— DENOTES COMMON TIE POINT OR VOLTAGE BUS.
6. ▭ INDICATES EQUIPMENT MARKING.
7. UNLESS OTHERWISE SPECIFIED, ALL TRANSISTORS ARE TYPE 2N404.
8. DIODE USED IN SERIAL NUMBERED UNITS ABOVE 3651
9. ALL TRANSISTORS ARE JAN TYPE EXCEPT AQ11.

EL5805-356-34-1-TM-16-A

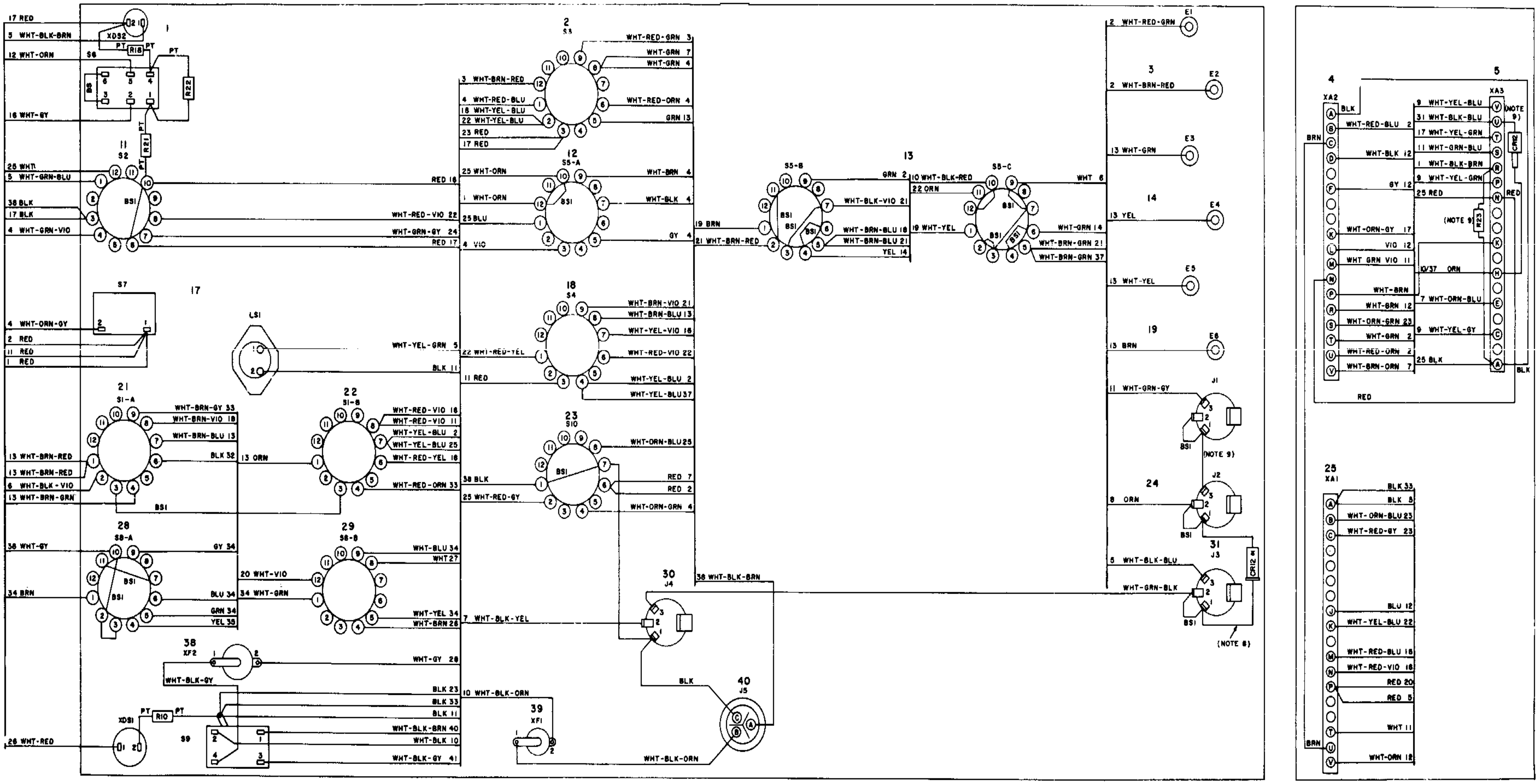
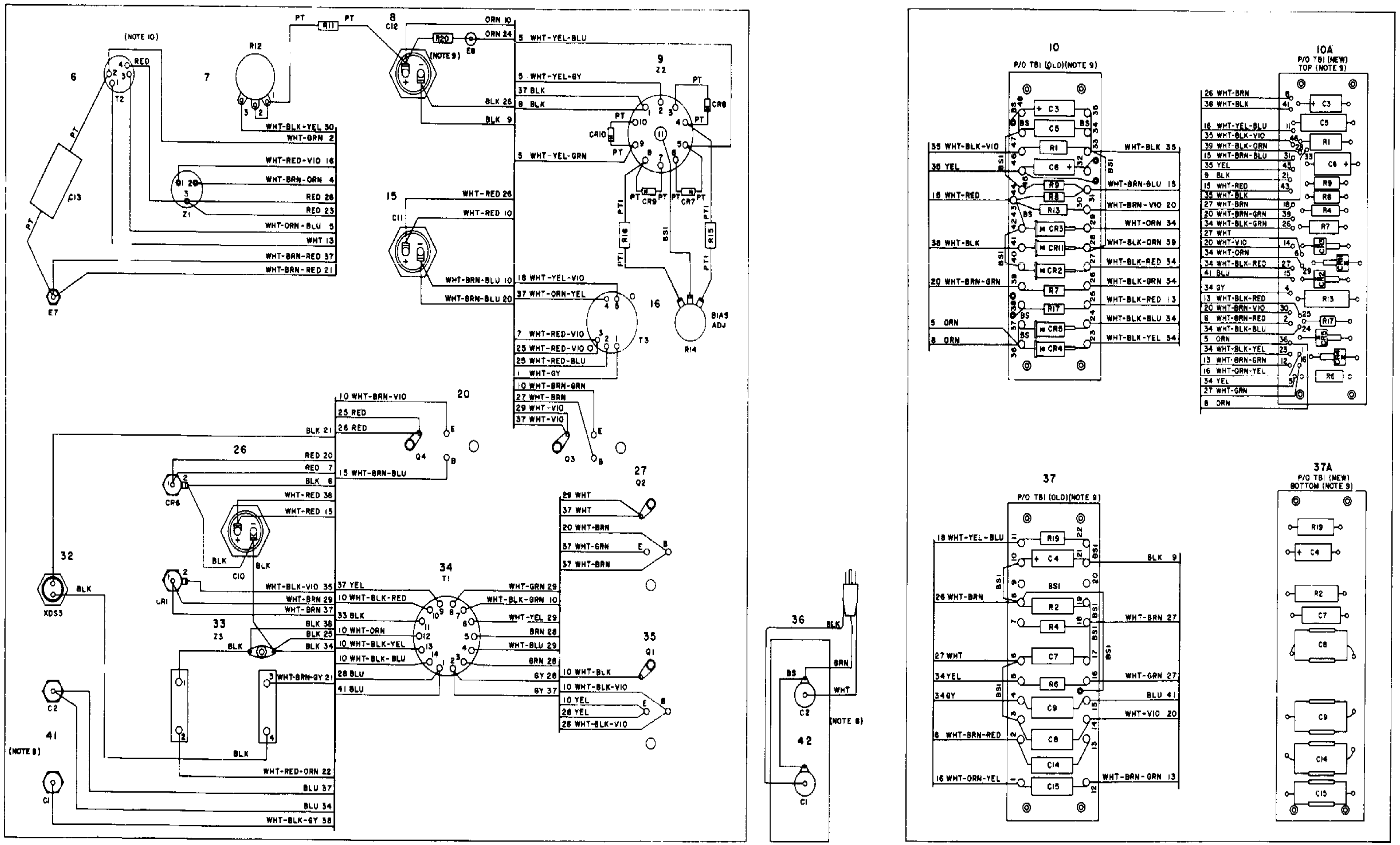


Figure FO-4(1). Terminal, Telegraph TH-22/TG, wiring diagram (sheet 1 of 2).



NOTES:

1. THE SMALL NUMBER ON EACH WIRE (ADJACENT TO THE COMMON OR BASE LINE) CORRESPONDS TO THE LARGE NUMBER ADJACENT TO THE STATION TO WHICH THE WIRE RUNS.
2. WIRES NOT OTHERWISE SPECIFIED ARE 22 GAGE WITH PLASTIC JACKET.
3. BS DENOTES 22 GAGE TINNED, ANNEALED COPPER WIRING.
4. BSI DENOTES 22 GAGE TINNED, ANNEALED COPPER WIRING INSULATED WITH SILICON IMPREGNATED FIBER-GLASS SLEEVING.
5. PT DENOTES PIGTAIL LEAD.
6. PTI DENOTES PIGTAIL LEAD INSULATED, WITH SILICONE IMPREGNATED FIBER-GLASS SLEEVING.
7. WIRING NOT OTHERWISE SPECIFIED IS DRESSED BACK TO THE PANEL AND RUN AT RIGHT ANGLES IN THE MOST CONVENIENT MANNER.
8. OPPOSITE ENDS OF FEEDTHRU CAPACITORS C1 AND C2 ARE SHOWN AT STATIONS 41 AND 42 RESPECTIVELY.
9. THIS DRAWING REFLECTS THE LATEST MODEL TH-22/TG. THE FOLLOWING DIFFERENCES MAY BE PRESENT IN OLDER UNMODIFIED UNITS:

ITEM	NEW	OLD
TB1	PRINTED CIRCUIT COMPONENT BOARD. TERMINAL NUMBERS SAME AS OLD TB1.	HARDWIRED COMPONENT BOARD. TERMINAL NUMBERS SAME AS NEW TB1.
R20	R20 CONNECTED BETWEEN C12(+) AND E8 AT STATION 8.	
	ORANGE WIRE CONNECTED BETWEEN E8 AT STATION 8 AND J2-2 AT STATION 24.	ORANGE WIRE CONNECTED BETWEEN C12(+) AT STATION 8 AND J2-2 AT STATION 24.
	JUMPER CONNECTED BETWEEN J1-1 AND J2-3 AT STATION 24.	R20 CONNECTED BETWEEN J1-1 AND J2-3 AT STATION 24.
CR12	CR12 CONNECTED BETWEEN XA3-U AND XA3-H AT STATION 5.	CR12 NOT PRESENT.
	ORANGE WIRE CONNECTED BETWEEN XA3-H AT STATION 5 AND TB1-36 AT STATION 10.	ORANGE WIRE NOT PRESENT.
R23	R23 CONNECTS BETWEEN XA3-A AND XA3-R AT STATION 5.	R23 NOT PRESENT.

EL5805-356-34-1-TM-17 ②

Figure FO-4(2). Terminal, Telegraph TH-22/TG, wiring diagram (sheet 2 of 2).

BY Order of the Secretary of the Army:

CREIGHTON W. ABRAMS,
General, United States Army,
Chief of Staff.

Official:

VERNE L. BOWERS
Major General, United States Army,
The Adjutant General.

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USAMB (10)
USACDC (2)
USACDC Agcy (1)
AMC (1)
CONARC (5)
ARADCOM (2)
ARADCOM Rgn (2)
OS Maj Comd (4)
USARYIS (4)
LOGCOMDS (5)
MICOM (4)
TECOM (2)
USASTRATCOM (4)
USAESC (70)
MDW (1)
Armies (2)
Corps (2)
1st Cav Div (3)
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USAADS (2)
USAFAS (2)
USAARMS (2)
USAIS (2)
USAES (2)
USAINTS (3)
WRAMC (1)
USACDCEC (10)
USASTRATCOM-EUR (10)
USASTRATCOM-PAC (10)
USASTRATCOM-SO (5)
USASTRATCOM-A (5)
USASTRATCOM-SIG-GP-T (5)
MAAG (1)
USARMIS (1)
USACRREL (2)
Instl (2) except
  Fort Gordon (10)
  Fort Huachuca (10)
  WSMR (3)
  Fort Carson (10)
Ft Richardson (ECOM Ofc) (2)
Army Dep (2) except
  LBAD (14)
  SAAD (30)
  TOAD (14)
  LEAD (7)
  NAAD (5)
  SVAD (5)
  ATAD (10)
USA Dep (2)
Sig Sec USA Dep (5)
Sig Dep (10)
Sig FLDMS (2)
ATS (1)
USAERDAA (2)
USAERDAW (5)
USAOC&S (2)
USATSCH (2)
USAQMS (2)
USAAESWBD (2)
Units org under fol TOE:
  (2 cys each unit)

11-15	29-5
11-17	29-6
11-32	29-11
11-38	29-15
11-45	29-16
11-46	29-21
11-97	29-25
11-98	29-26
11-117	29-35
11-127	29-36
11-158	29-51
11-215	29-55
11-216	29-106
11-217	29-134
11-218	29-136
11-225	29-137
11-227	29-139
11-228	29-205
11-237	29-206
11-247	29-207
11-302	29-215
11-327	29-216
11-347	29-217
11-367	29-245
11-500 (AA-AC)	29-246
29-1	29-500

NG:. None.
USAR: None.
For explanation of abbreviations used, see AR 310-50.

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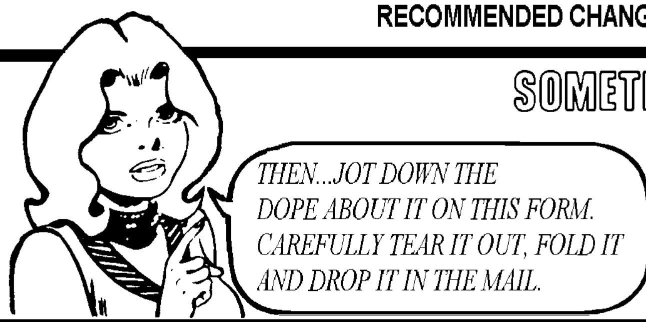

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PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.	

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