4251(-) TYPE NETWORKS

DESCRIPTION

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1. INTRODUCTION

1.01 This section describes the 4251-type network, also known as the Unified Telephone Circuit (UTC).

1.02 When this section is reissued, the reason for reissue will be given in this paragraph.

1.03 The UTC is available in two versions; 4251A network and 4251B network. Both networks are identical except that Radio Frequency Interference (RFI) shielding and filtering have been incorporated into the 4251B network.

1.04 When required, the 4251A network may be field retrofitted to the 4251B network equivalent by installing a D180811 kit of parts.

1.05 The UTC is an operator position telephone circuit which serves as an interface between the operator position and 4-wire carrier or other 4-wire voice frequency operator position facility.

1.06 The UTC was originally designed for use with Automatic Intercept Systems (AISs) and Traffic Service Position Systems (TSPSs); however, it may be used in other operator position systems.

1.07 The functions and features of the UTC include:

(a) Adjustable frequency equalization and transmission level controls to permit termination of a 4-wire voice frequency operator position facility.

(b) Circuitry to permit the independent coupling of two standard operator head telephone sets with individual transmitter cutoff capability.

(c) An Automatic Gain Control (AGC) circuit to limit operator receiver levels.

(d) A Voice Switched Attenuator (VSA) to suppress operator talker echo on systems serving extended areas.

(e) An adjustable sidetone path to supply local operator sidetone.

(f) A monitor port with adjustable level control which permits a service assistant or service observer to monitor the position activities.

(g) An external 4-wire port to permit 3-way conversation between the operator position, the customer, and an external location.

(h) A regulated power converter which converts ±24V or ±48V battery to the voltages required by the various UTC circuits including transmitter talk battery.

(i) SX and SX1 leads on the 4-wire line for various status and alerting signals.

(j) A test jack for connecting a 252A adapter which permits the connection of test equipment.

Note: A jumper plug is required in the test jack for normal operation to provide continuity when the 252A adapter is not connected.

(k) Solid-state design resulting in stability and low maintenance effort.

2. PHYSICAL DESCRIPTION

2.01 The UTC shown in Fig. 1 and 2 is a package unit requiring a mounting space of approximately 4 inches wide by 8-inches high by 11 inches long.

2.02 The electrical components of the UTC are mounted on printed wiring boards which are plugged into connecting sockets located on the UTC frame.

2.03 Connections to equipment, facilities, and power are accomplished via a 50-pin KS-16671, L10 position plug, P2. A test jack (J1) is supplied to accept a 252A adapter for lineup and transmission testing, or a protective jumper plug (P1) for normal operation. Fig. 3 and Table A show the UTC terminal assignments, designations, and functions.

2.04 Thirty-two screw type switches are mounted on the face of the UTC for adjusting line impedances, equalizers, and other options.

2.05 Eight potentiometers (R1 through R8) are accessible from the face of the UTC for adjusting levels at the various ports.

2.06 Figure 4 is an exploded view of a 4251A network and a D180811 kit of parts.

2.07 The procedure for installing the RFI shielding (D180811 kit of parts) on an in-service 4251A network is as follows:

(a) Unplug the local cable from the 4251A network.

(b) Remove the 4251A network from its mounted position.

(c) Remove the two flat filister head screws from the large aluminum heat sink on the 4251A network.

(d) Place the RFI shield around the network and plug the shield connector into the 4251A network.

(e) Attach the shield assembly to the network with three 1/8″ × No. 4 screws inserted into the back surface of the shield assembly.

(f) Using eight self tapping metal screws, attach the front panel to the shield assembly. When inserting the top left screw, install the filter cover which is held in place by this screw.

(g) Replace the two flat head filister screws removed in (c) inserting them through the front panel.

(h) Place the top cover in place and secure with the four captive screws.

(j) Remount the network in its original position.

(k) Connect the local cable to the external connector of the shield assembly.

Note: The network alignment should not be affected by the addition of the D180811 kit of parts.

3. CIRCUIT DESCRIPTION

A. General

3.01 A functional block diagram of the UTC is shown in Fig. 5. The designations shown in the amplifier symbols correspond to the gain

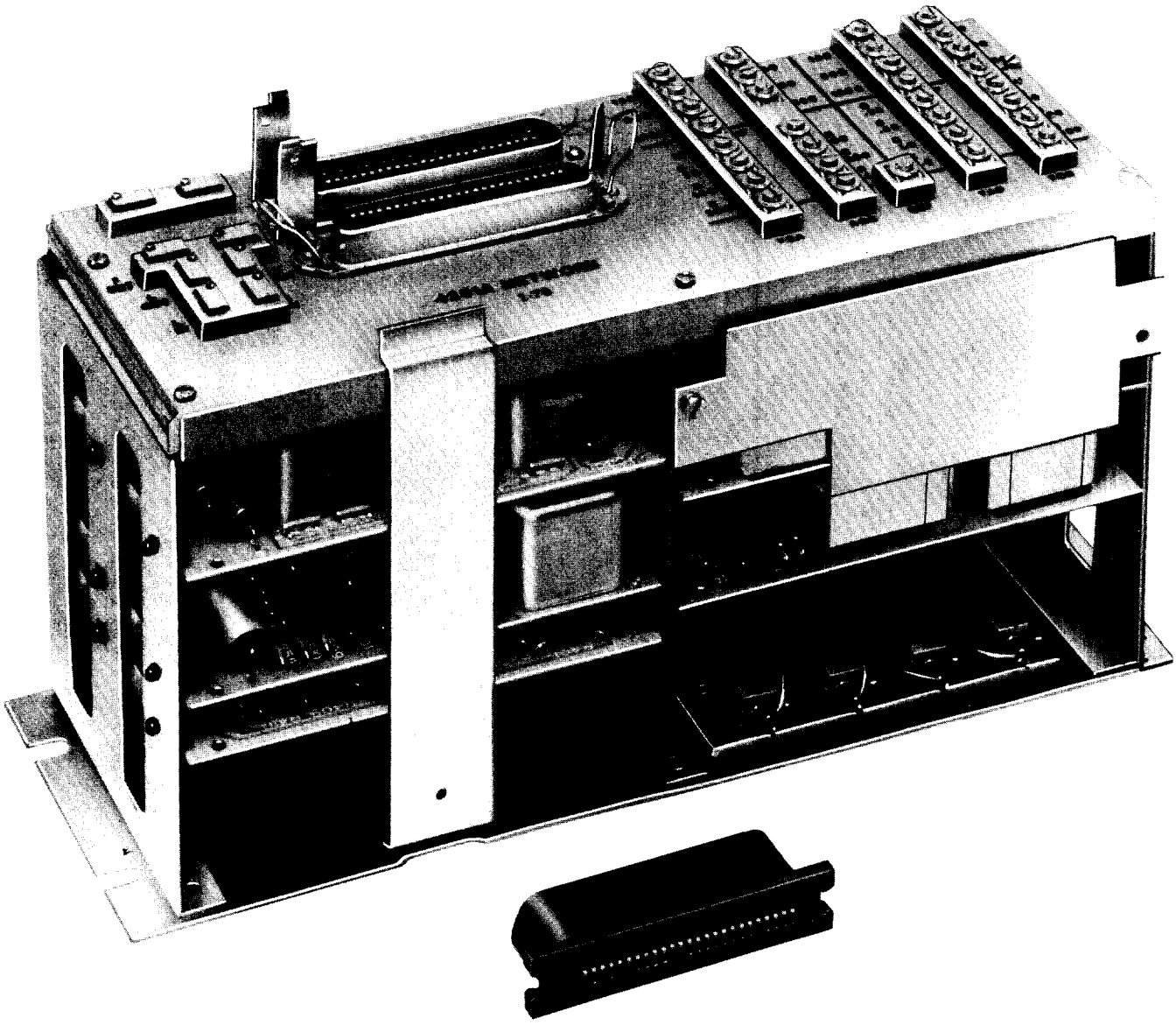


Fig. 1—UTC Without RFI Shielding (4251A Network)

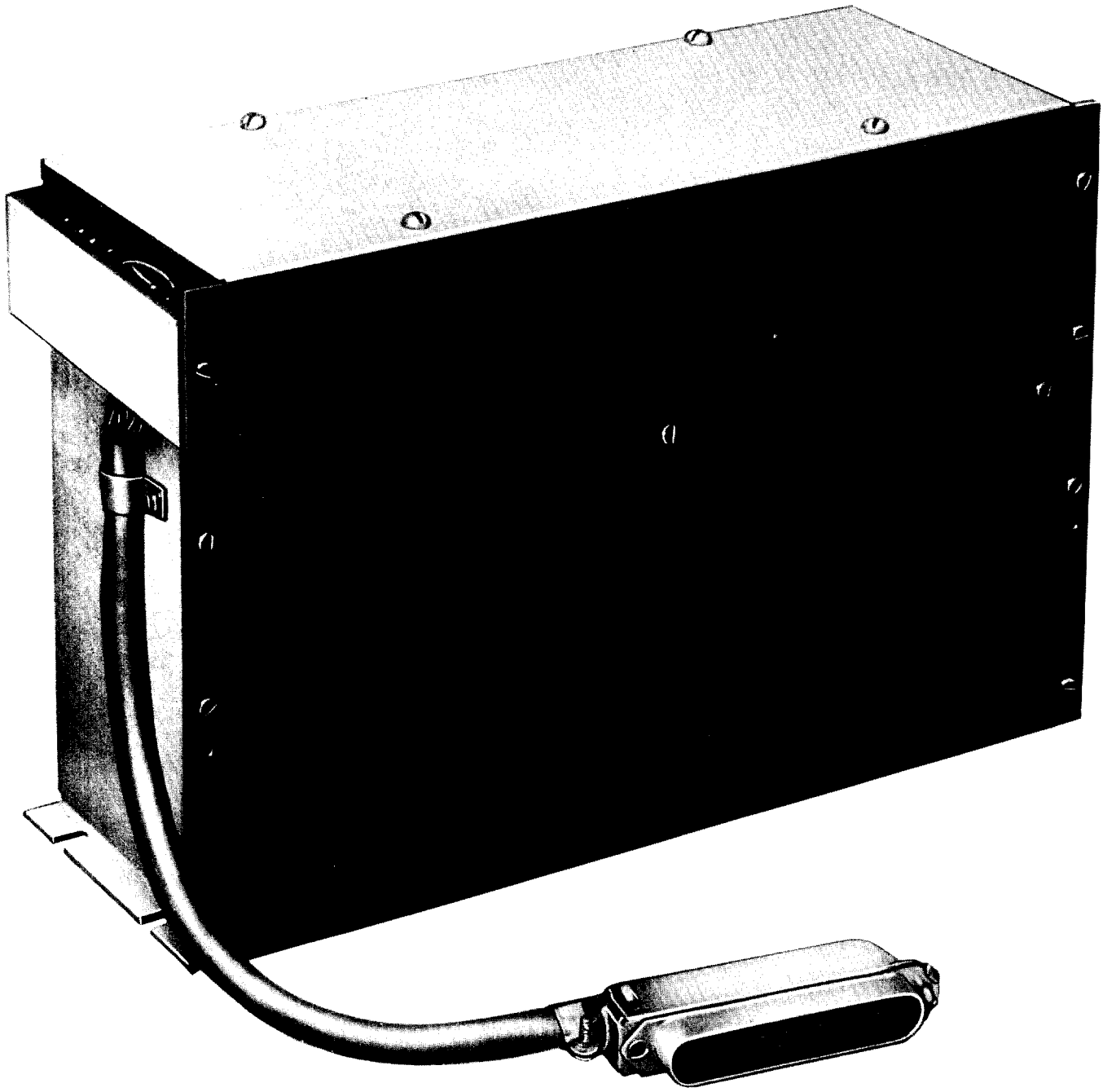
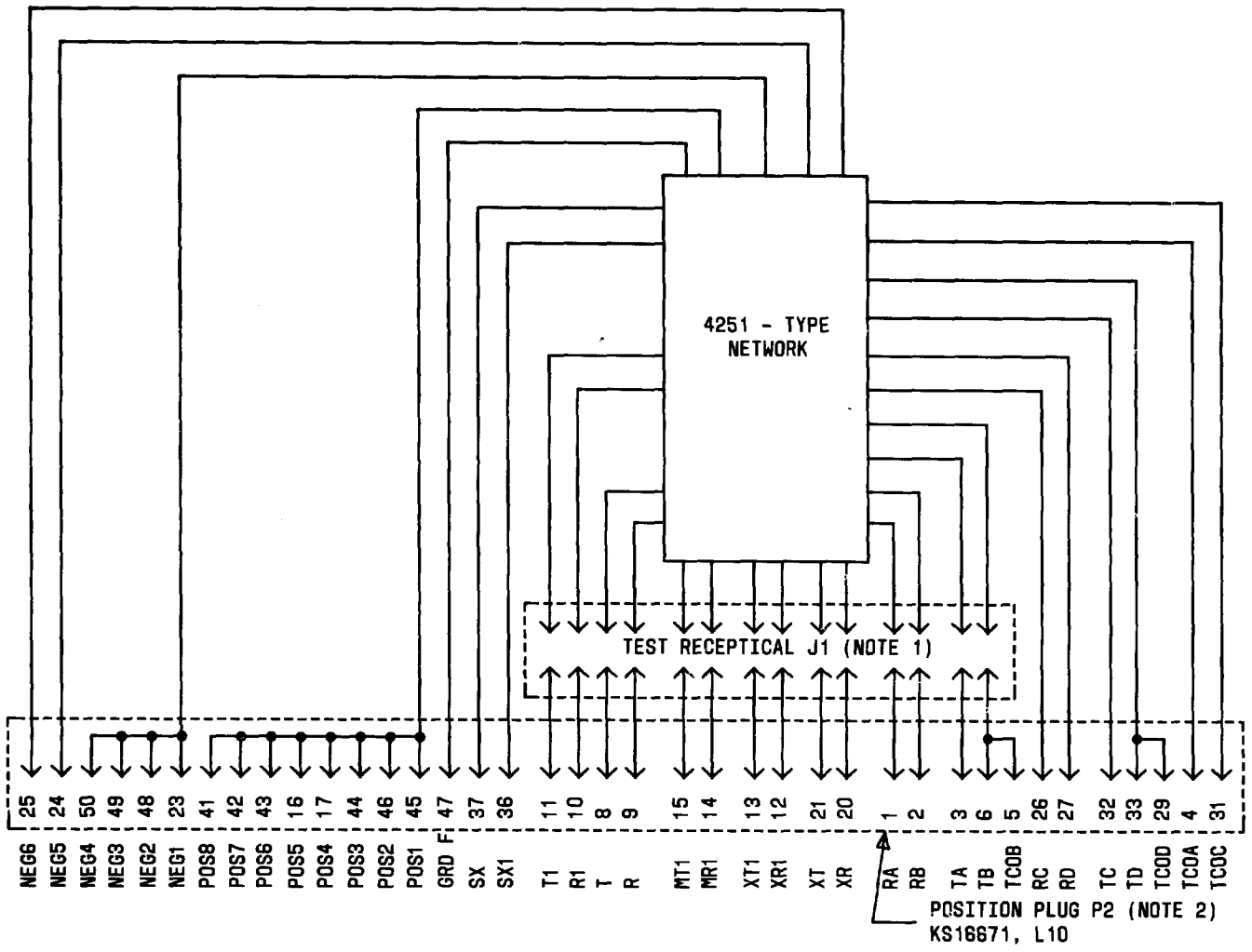


Fig. 2—UTC With RFI Shielding (4251B Network or 4251A Network With D180811 Kit of Parts Installed)



NOTES:
1. IN NORMAL OPERATION THE PROTECTIVE JUMPER PLUG PROVIDED WITH THE UTC IS USED TO BRIDGE ACROSS THE CONTACTS OF THE TEST RECEPTACLE.
2. MATE WITH USER PROVIDED POSITION RECEPTACLE KS-16690, L3.

Fig. 3—UTC Terminal Assignments

control designations located on the face of the UTC (Fig. 6).

3.02 The following is a brief description of each of the transmission path ports of the UTC:

(a) Line Input and Line Output—This 4-wire port is for connection to the voice frequency operator position facility. The impedance of this port may be set to 150, 600, or 1200 ohms by the adjustment of screw type switches. An adjustable frequency equalizer is available to equalize metallic facilities as required. The line transformers are centertapped to derive SX and SX1 leads from the 4-wire facility. Amplifiers L-IN and L-OUT allow adjustment of input and output levels at this port.

(b) External Output and External Input—This 4-wire 600-ohm port is for connection to external talk paths, recorded announcements, emergency access to a class 5 office, supervisor

TABLE A

UTC TERMINAL DESIGNATIONS AND FUNCTIONS

TERMINAL DESIGNATION	FUNCTION
TA-TB	Transmitter connection for headset 1.
TC-TD	Transmitter connection for headset 2.
RA-RB	Receiver connection for headset 1.
RC-RD	Receiver connection for headset 2.
T1-R1	Connection to signaling circuit or line facility, transmit direction of position trunk.
SX1	Simplex tap for insertion of 4-wire loop simplex signals in the line-out (transmit) direction.
T-R	Connection to signaling circuit or line facility, receive direction of position trunk.
SX	Simplex tap for insertion of 4-wire loop simplex signals in the line-in (receive) direction.
MT1-MR1	Connection to external monitoring circuit. During lineup, this port is used as a signal reference level.
XT1-XR1	Connection to external talk path, signaling circuit or facility, transmitting direction from position. No simplex tap provided.
XT-XR	Connection to external talk path, signaling circuit or facility, receiving direction to position. No simplex tap provided.
POS 1 to 8	Positive electrical connection to low-impedance console or office power or ground depending on option strapping.
GRDF	Ground lead for console frame and building ground.
NEG 1 to 6	Negative electrical connection for office battery or ground depending on option strapping.
TCOA-TCOB	Transmitter cutoff leads for headset 1.
TCOC-TCOD	Transmitter cutoff leads for headset 2.

position, etc. No equalization or SX leads are available at this port. Adjustable amplifiers X-IN and X-OUT allow adjustment of input and output levels at this port.

(c) Receiver A and Receiver B—These two 300-ohm output ports connect to the operator position head telephone set jacks A/B and C/D (receiver leads). Each of these output ports is served by a separate output transformer, however one amplifier, R-OUT, serves both ports simultaneously.

(d) Transmitter A and Transmitter B—These two input ports are connected to the operator position head telephone set jacks A/B and C/D (transmitter leads). Each of these inputs has its own individual talk battery supply and transmitter cut-off feature. The transmitter cut-off function is accomplished by shorting the transmitter leads and not by removing battery or opening the transmitter path as in most other circuits of this type. The impedance of these ports may be set at either 50 ohms or 300 ohms. The 300-ohm impedance option is used in those cases where the UTC cannot be mounted in the operator console and the loop resistance between the UTC and the console exceeds 5 ohms. The 300-ohm option is limited to loop resistances of 30 ohms or less and/or 500 feet

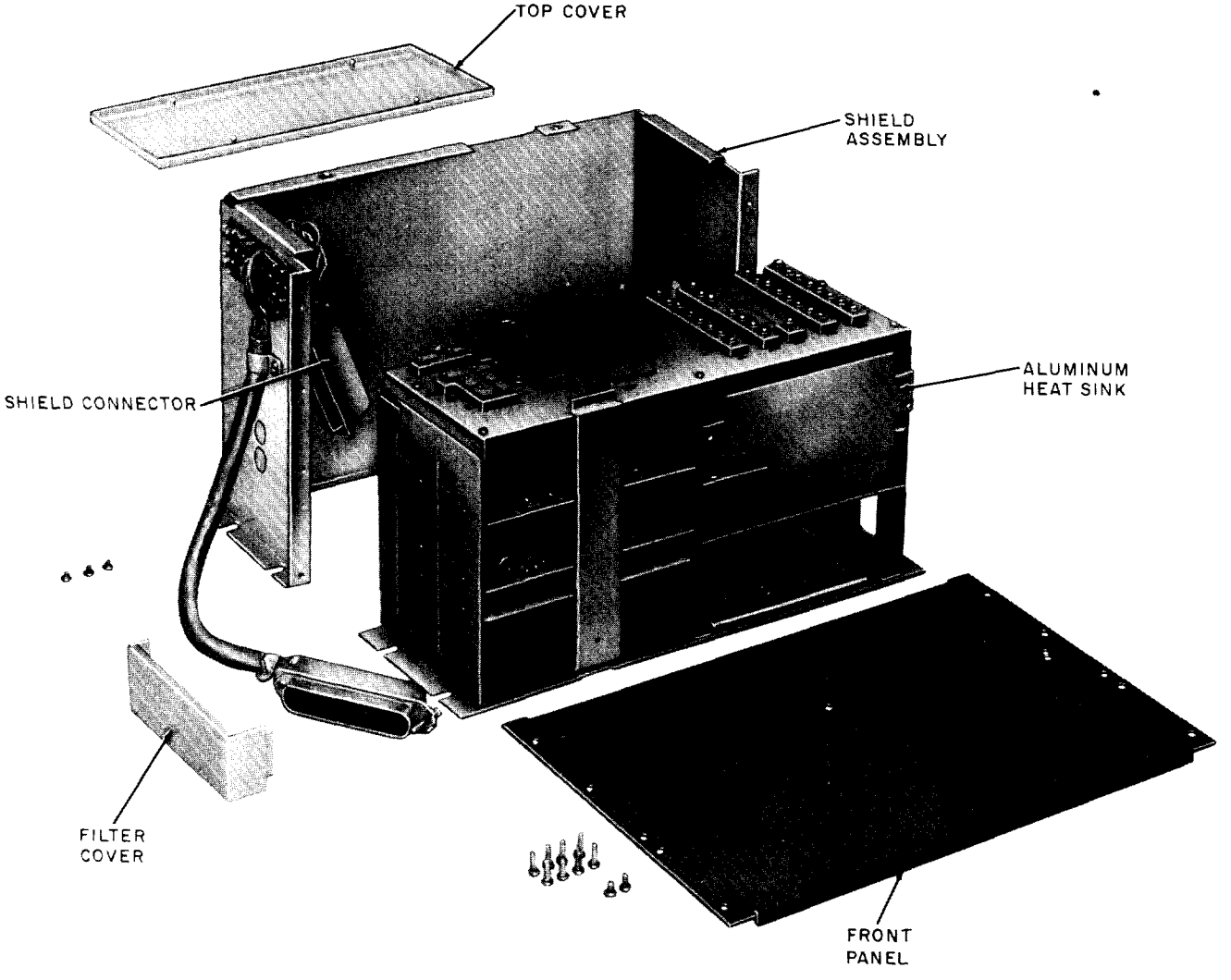


Fig. 4—Exploded View of 4251A Network and D180811 Kit of Parts

of cable between the UTC and the console. When the 300-ohm option is used, headset impedance matching transformers, isolation capacitors, talk battery and ground must be supplied externally. The transmitter A and B inputs share a common amplifier, T-IN, which is used to set the input levels from the operator telephone head set transmitters.

(e) Monitor Output—This 600-ohm transmit-only port permits monitoring of the operator position by a service evaluator or service assistant.

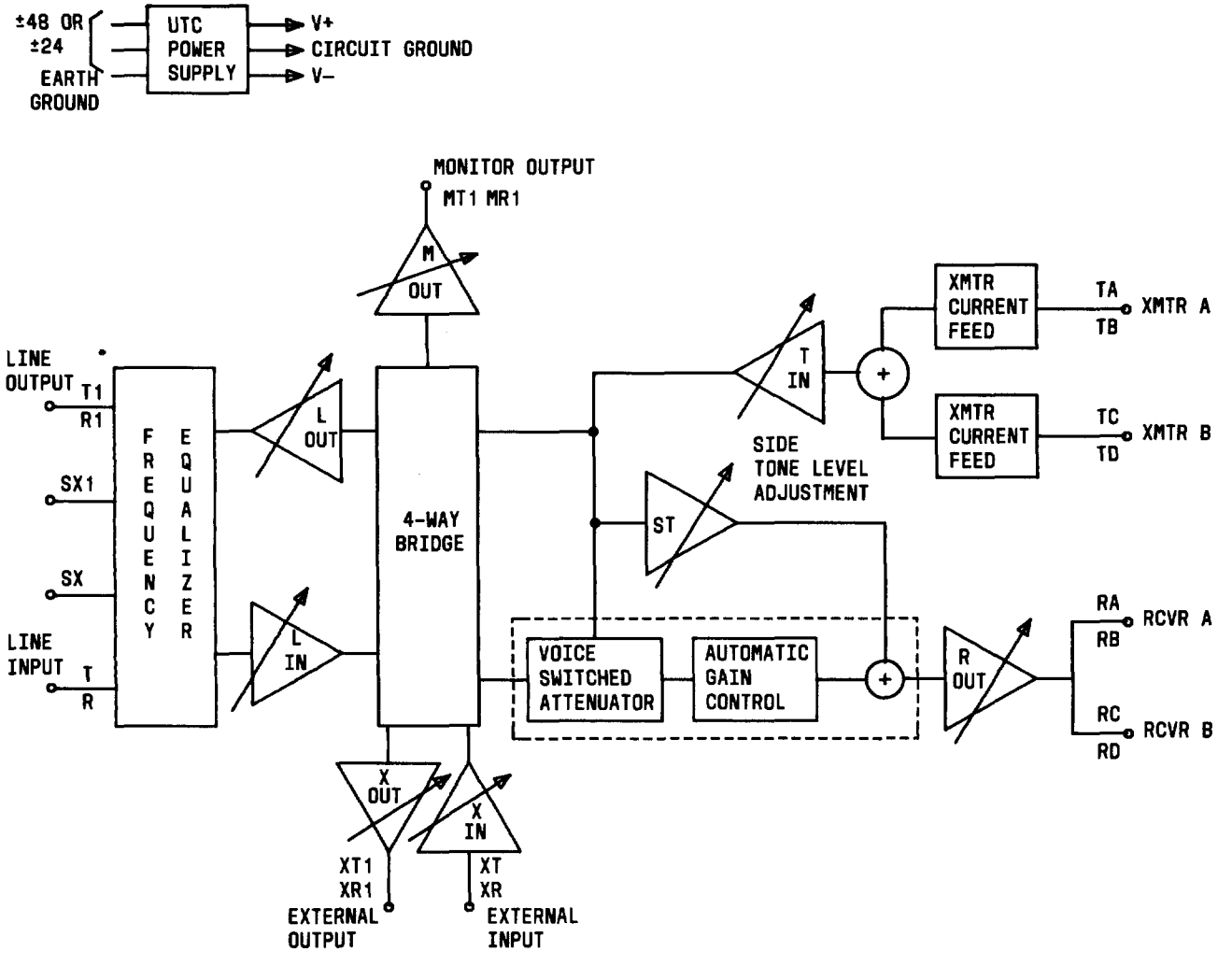


Fig. 5—Functional Block Diagram of the 4251-Type Network

Amplifier M-OUT is used to set the level at the monitor output. This port is also used as a reference port when adjusting the input and output levels of other ports.

3.03 With the exception of the transmitter A and B input ports, all ports of the UTC are transformer coupled to assure satisfactory longitudinal balance. When the UTC is remotely located, ie, more than 5 ohms loop resistance to the operator position, longitudinal balance for the transmitter A and B ports is assured by the use of external headset impedance matching transformers.

3.04 Table B gives the terminal designation, characteristic impedance, and the minimum return loss that should be expected at each UTC port when measured against a standard impedance with all other UTC ports terminated in their characteristic impedance.

B. Transmission Levels

3.05 The UTC design permits a relatively large range of input and output levels at the various ports. Table C gives the permissible level ranges at the various input ports and the levels obtainable at the various output ports. The values given assume ideal impedance matches at all ports.

3.06 The output levels obtainable are given in terms of maximum and minimum levels which can be produced when a 1 kHz test signal of specified level is applied. The output levels are

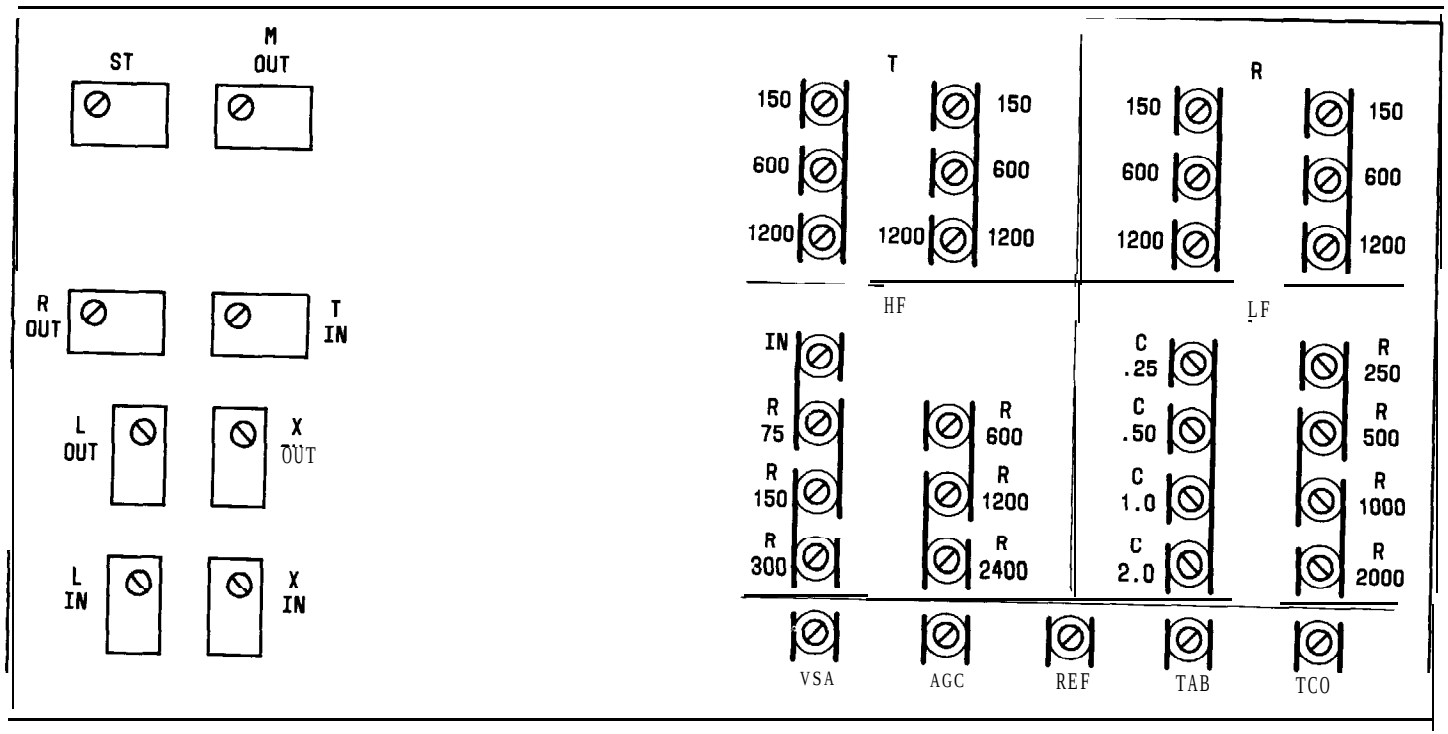


Fig. 6—Sketch of UTC Face Showing Relative Position of Controls and Designations

TABLE B

4251A NETWORK IMPEDANCE CHARACTERISTICS

REFERENCE AND TERMINATING IMPEDANCES		
UTC PORT	TERMINAL DESIGNATION	IMPEDANCE (OHMS)
Trans-A Input	TA-TB	50 or 300*
Trans-B Input	TC-TD	50 or 300*
Monitor-Output	MT1-MR1	600
External-Input	XT-XR	600
External-Output	XT1-XR1	600
Rcvr-A Output	RA-RB	300
Rcvr-B Output	RC-RD	300
Line Input	T-R	1200/600/150†
Line Output	T1-R1	1200/600/1500†

RETURN LOSS FOR EACH PORT	
FREQ. (kHz)	R.L. (dB)
0.2	21
0.3	24
0.5—2.5	26
3.0	24
3.4	21

* Depends on setting of TAB/TCD impedance selection screw switches: down (closed) = 50Ω, up (open) = 300Ω.

† Depends on setting of input/output transformer impedance selection screw switches: down (closed) selects desired option.

such as to supply a standard interface with the facilities, monitoring equipment, headsets, etc. that are connected to the UTC.

3.07 The UTC has been designed for the electro-acoustic efficiencies of the W.E. Co. 60A head telephone set; however, the UTC adjustments may be modified to work with other types of head telephone sets.

C. Frequency Response

3.08 The frequency response characteristics of the UTC are given in Table D. The losses given are in terms of loss deviation relative to 0.0 dB at 1 kHz.

3.09 The high frequency rolloff at the external output port reflects the additional loss caused by a 648A or equivalent low-pass filter. This

TABLE C

UTC LEVEL ADJUSTMENT RANGES*

UTC PORT	1 kHz INPUT SIGNAL LEVEL RANGE	OUTPUT LEVELS OBTAINABLE
Headset Trans. 1/Trans. 2	−19 dBm to −1 dBm	
Line input	−41 dBm to −15 dBm	
External input	−33 dBm to −10 dBm	
Line output		−33 dBm to −10 dBm
External output		−33 dBm to −10 dBm
Headset Recvr 1/Recvr 2		−40 dBm to −25 dBm
Monitor		−23 dBm to −9 dBm

* Line up reference level for a WE 60A reference head telephone set: −17 dBm test signal at 50-ohm transmitter port, T-in adjusted to produce −26 dBm signal at monitor reference port, R-out adjusted for −33 dBm at receiver terminals.

TABLE D

FREQUENCY RESPONSE CHARACTERISTICS

FREQUENCY (KHZ)	LINE-OUT, MONITOR RECEIVER 1, 2		EXTERNAL OUT	
	MIN. LOSS DB	MAX. LOSS DB	MIN. LOSS DB	MAX. LOSS DB
0.2	−0.1	0.3	−0.1	0.3
0.3	−0.1	0.2	−0.1	0.2
3.0	−0.1	1.0	−0.1	1.0
3.1	−0.1	0.3	*2.0	
3.4	−0.1		*8.0	
4.0			*20.0	

Note: These measurements are made from any output port other than the same channel as the input port. All ports are terminated in their characteristic impedance.

* These losses reflect the effects of a 648A filter or other low-pass filter connected to the 2-wire external output port.

characteristic is needed to prevent the UTC from singing at the upper end of the voice band when the 4-wire line and external ports are connected to certain 2-wire circuits via hybrids. The rolloff effect may be supplied by carrier channels in which case, the external low-pass filter is not required.

D. Compression Characteristics

3.10 The compression characteristics of the UTC are determined by the power handling capability of its amplifiers and the operation of internal limiting circuitry. Table E gives the minimum output levels for which 0.1 dB compression and absolute limiting will occur on a 1 kHz signal.

E. Harmonic Distortion

3.11 Harmonic distortion contributed by the UTC with a -10 dBm signal at 0.2 kHz or 1.0 kHz applied at any input is less than -60 dBm of second harmonic and -70 dBm of third harmonic at the appropriate output ports.

F. Noise Characteristics

3.12 Noise characteristics of the UTC are given in Table F.

4. OPERATIONAL FEATURES

A. Voice Switched Attenuator (VSA)

4.01 The VSA circuit in the UTC suppresses operator talker echo. The VSA is enabled or disabled by a screw switch designated VSA on the face of the unit. The circuit is enabled, or operative, when the screw is turned up (open) and disabled when the screw is turned down (closed).

4.02 When enabled, the VSA inserts loss into the operator head telephone set receive path upon the presence of sufficient signal power at the UTC transmitter input port.

4.03 Signal levels less than -23 ±2 dBm at the transmitter input port will not operate the VSA circuit. Signal levels greater than -23 ±2 dBm at the transmitter input port will operate the VSA circuit, and the loss in the receiver path will increment until, at input levels of -13 ±2 dBm, the maximum loss of 15 ±3 dB is attained.

4.04 The ratio of receiver loss change to transmitter input change is approximately 3:2 for transmitter inputs in the -23 dBm to -13 dBm range.

B. Operator Sidetone Circuit

4.05 Local operator sidetone is generated by the sidetone circuit. This circuit consists of a variable gain amplifier which feeds a portion of the transmitter input signal to the receiver output.

4.06 The electrical loss in the sidetone path (transmitter in to receiver out) is continuously adjustable between approximately 22 dB and 42 dB.

TABLE E

UTC COMPRESSION CHARACTERISTICS

PORT	0.1 dB COMPRESSION	ABSOLUTE LIMITING
RCVR-1/RCVR-2 OUT	—2 dBm	+0 dBm (AGC disabled) —27 dBm (AGC enabled)
MON-OUT	+7 dBm	+8 dBm
EXT-OUT	+7 dBm	+8 dBm
LINE-OUT	+7 dBm	+8 dBm

TABLE F

UTC NOISE CHARACTERISTICS

TYPE WEIGHTING OR MEASUREMENT	LEVEL AT LINE-OUT, EXTERNAL-OUT, RECEIVER-1, 2
C-Message	Less than 13 dBrnc
3 kHz Flat	Less than 24 dBrn
Impulse	No counts above level of 36 dBrnc on WE 6F impulse noise measuring set, or equivalent

Note: (a) Gain settings at Line-Out and External-Out ports are set to maximum signal levels of Table C (ie, −10 dBm).

(b) Gain settings at Line-In and External-In ports are set to minimum signal levels of Table C (ie, −41 dBm, −33 dBm respectively.)

(c) Bridge reference level (monitor port) see at −26 dBm.

C. Automatic Gain Control (AGC)

4.07 The UTC is equipped with an AGC which limits the level of signals at the receiver output to a maximum of -28 ±2 dBm.

D. Attenuation Distortion Equalizer

4.08 The 4-wire line port (L-OUT, L-IN) is equipped with an equalizer network to control the attenuation distortion of a 4-wire voice frequency metallic facility. Integral to the equalizer network circuit are tapped line transformers which permit 150-, 600-, or 1200-ohm line impedances to be selected.

4.09 The equalizer network, adapted from 359-type equalizer and 849-type network designs, permits the attenuation distortion equalization of a nominal operator position facility consisting of a 24V4 repeater, 4-wire facility, and the UTC.

E. Power Supply Circuit

4.10 The UTC may be powered by low resistance operator position or central office dc sources supplying 24 volts (20 to 27 volts) or 48 volts (42.0 to 52.5 volts) at a maximum of 400 mA. The dc source may be positive, negative, or floating.

4.11 Strapping options must be furnished at the position receptacle which mates with the UTC to obtain the proper voltage and polarity configuration. The required strapping options are shown in Table G.

4.12 Transmitter current leads (TA-TB) and (TC-TD) for the two head telephone set ports are independent of each other and are equivalent to that supplied by a 400 ohm, 48 volt supply.

5. CONTROLS

5.01 All controls necessary to adjust and configure the UTC are located on the face of the unit. Fig. 6 is a sketch of the UTC face showing the potentiometers and screw-type switches.

5.02 The function of each potentiometer is described as follows. Reference to Fig. 5 will aid in understanding function and location in the UTC circuitry.

(a) ST—Adjusts the sidetone amplifier gain. This adjustment establishes the amount of transmitter signal fed back to the receiver.

(b) M OUT—Sets the level at the monitor port of the UTC when the REF screw switch is turned out (open).

(c) R OUT—Sets the level at the A and B receiver output ports. It should be noted that the A and B output ports are not independently adjustable.

TABLE G

UTC POWER CIRCUIT STRAP OPTIONS

BATTERY VOLTAGE	SUPPLY GROUND	PINS TO BE STRAPPED ON THE USER RECEPTACLE (KS-16690, L3)
48 VDC	Positive	46 to 47
	Negative	47 to 48
	Floating	47 to external lead from frame ground
24 VDC	Positive	16 to 41, 17 to 42, 24 to 49, 25 to 50, 43 to 44, 46 to 47
	Negative	16 to 41, 17 to 42, 24 to 49, 25 to 50, 43 to 44, 47 to 48
	Floating	47 to external lead from frame ground, 16 to 41, 17 to 42, 24 to 49, 25 to 50, 43 to 44

Notes: (1) For all applications, positive battery supply lead connects to POS 1 (pin 45), negative battery supply lead connects to NEG 1 (pin 23) of UTC connector (KS-16671, L10). See Fig. 2 for UTC terminals.

(2) Internal circuitry limits the maximum potential difference between headset terminals and frame or console ground (GRDF) to 60 volts.

(3) Transmitter current leads (TA-TB, TC-TD) are indepedent and equivalent to that provided to a headset by a 400-ohm, 48 volt supply. Included are provisions for transmitter cutoff keys (ie, externally shorting TOCA and TC0B cuts off the headset 1 transmitter; externally shorting TCOC and TCOD cuts off the headset 2 transmitter.

(d) T IN—Adjusts the gain of an amplifier that interfaces the A and B operator transmitter ports with the four-way bridge. This adjustment sets the level at the bridge input as necessary based on input signals at the transmitter input port. It should be noted that the A and B transmitter inputs are not independently adjustable.

(e) L OUT—Sets the transmission level at the line-out port.

(f) L IN—Sets the level at the bridge input based on input signals at the line input port.

(g) X OUT—Adjusts the transmission level at the external output port.

(h) X IN—Sets the level at the bridge input based on input signals at the external input port.

5.03 Line input and output port impedances, equalizer adjustments, and other options are established by the positioning of screw-type switches located on the right side of the UTC face.

5.04 The screw switch designations and functions are given in Table H.

TABLE H

UTC SCREW SWITCH DESIGNATIONS AND FUNCTIONS

DESIGNATION	FUNCTION
T-150, - 600, - 1200	Sets the impedance for the transmit side of the 4-wire line port
R-150, - 600, - 1200	Set the impedance for the receive side of the 4-wire line port
HF IN	Enables (down) or disables (up) the high frequency portion of the frequency equalizer associated with the 4-wire line port
HF R75, R150, R300, R600, R1200, R2400	Inserts (up) or removes (down) resistance corresponding to the designation in the high frequency portion of the frequency equalizer
LF C.25, C.50, C1.0, C2.0	Inserts (down) or removes (up) shunt capacitance (in μF corresponding to the designation) in the low frequency portion of the frequency equalizer
LF R250, R500, R1000, R2000	Inserts (up) or removes (down) resistance (in ohms corresponding to the designation) to the low frequency portion of the frequency equalizer
VSA	Disables (down) or enables (up) the voice switched attenuator circuit
AGC	Disables (down) or enables (up) the automatic gain control circuit
REF	Disables (down) or enables (up) the gain adjustment associated with the monitor port. The disable position is used primarily for lineup procedures.