INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TCF VOICE ADAPTER

FOR TYPE TCF POWERLINE CARRIER EQUIPMENT

APPLICATION

The TCF Voice Adapter provides voice communication on a two-way TCF frequency-shift relaying system.

The Voice Adapter will provide a full duplex amplitude-modulated voice channel over the frequency-shift relaying channel. The voice system has been designed so that it will not interfere with any protective relaying operation. When a trip request is being transmitted, the voice modulation is cut off. The only time voice can be transmitted when a trip signal is being sent is when the transmitter is being keyed by a 52b contact in directional-comparison systems.

The voice adapter may be used on two or three terminal lines. In the case of a three-terminal line, the audio signals from both remote terminals are mixed in the voice adapter. The voice adapter has a pushbutton for calling the remote terminal. When this button is pushed, an alarm relay will pick up at the remote terminal to ring a bell. This will occur at all remote stations. Therefore, on a three-terminal line, one can designate which terminal is being called by using a simple code.

The TCF Voice Adapter may be used with the directional comparison unblock system, permissive overreaching transfer-trip system, and the dual phase-comparison systems. It can be used with a 1-watt/10-watt or 10-watt/10-watt TCF transmitter.

CONSTRUCTION

The TCF Voice Adapter is mounted on a standard 19" wide panel, 7 inches (4 r.u.) high, with edge slots for mounting on a standard relay rack. See Fig. 1 for the outline dimensions.

The printed circuit module boards slide and plug in from the front panel. These circuit boards are accessible after removing the front cover by loosening the two thumb-screws at each end. The boards slide into position in slotted guides at the top and bottom of each compartment. The board terminals engage a connector at the rear of the compartment. Each board and connector are keyed so that if a board is placed in a wrong compartment, it cannot be inserted into the connector. A handle on the front of each board is labeled to identify its function. See Fig. 2 for circuit board locations.

NOTE: If the voice adapter contains two input filter boards, the lower frequency board should be inserted in the Filter #2 (left) position. The receiver #1 and receiver #2 circuit modules are initially set to operate with their respective filters and should not be interchanged after this setting is made.

On the right hand side of the unit is the telephone hookswitch assembly which is mounted to the front panel by two screws located at each end of the Micarta plate. The telephone handset can be plugged into the jack and hung on the hookswitch. Transformer T101 and resistors R103 and R104 are mounted on the rear of the Micarta plate and are accessible by removing the plate from the front panel.

The calling pushbutton is located above the hookswitch assembly on the front panel.

In the rear of the voice adapter are the two connecting jacks J1 and J2 and the two rf input coaxial cable connectors J-4 and J-5. All external connections to the voice adapter are made through these rear mounted jacks.

Fig. 2 illustrates the location of several additional components which are mounted on the rear of the panel.

Step (3)

The largest positive value occurs at station #3 between the two remote signals R1 (A{1,3}) and R2 (A{2,3}).

Step (4)

Using station #3 from step (3) above Y=3, X=1, Z=2.

Step (5)

Station	F1	F2	F3	A(3,1)–Ar1	A(3,1)–A(2,1)
#1	T1	R3	R2	– 5	5
Station	F1	F2	F3	A(1,3)–Ar3	A(2,3)–Ar3
#3	R1	T3	R2	– 5	5
Station	F1	F2	F3	A(3,2)–A(1,2)	A(3,2)–Ar2
#2	R1	R3	T2	5	5

Step (6)

5 + 8 = 13db

Step (7)

From Fig. 14, ΔF = 5.5KHz.

OPERATION

For two terminal line applications the voice adapter, at each terminal, contains four circuit modules 1) Receiver input filter 2) Voice Receiver Circuit 3) Speech - amplifier circuit 4) Calling alarm circuit. On a three terminal line, the voice adapter will contain six modules. The additional two modules are a receiver input filter and a voice receiver circuit to be used at the channel frequency of the additional TCF relaying receiver at each terminal. The associated TCF Frequency Shift Transmitter for voice communication can be either a 1 watt/10 watt or 10 watt/10 watt type. In either case the transmitter output level will be 3.25 watts during voice communication. The Voice Adapter will apply a modulating signal to the TCF transmitter to amplitude modulate the guard or block frequency at the reduced power level of 3.25 watts. For phase-comparison, where the transmitter is normally keyed from mark to space frequency at a 60Hz. rate, and an output level of 10 watts, for voice transmission the output level will be reduced to 3.25 watts and amplitude modulation of voice will be applied to the frequency shift carrier. During a relaying operation, which always takes preference over voice communication, the transmitter output level is boosted to 10 watts and all modulation is prevented. During normal voice operation, modulation is limited to 50% to prevent interference with normal reception of guard or block frequency at the remote terminal.

The Voice Adapter receiver circuitry contains a wideband input filter which is connected to the input coaxial cable connectors J4 & J5. The output of this filter is fed to the voice receiver circuit and the demodulated audio output is applied to the telephone handset receiver. For a three terminal line, the audio output of the two voice receiver circuits are mixed and fed simultaneously to the handset receiver. A calling pushbutton is provided for signaling the remote terminal, when communication is desired. An alarm relay in the voice adapter is activated upon reception of the calling signal, and is de-energized when the call is acknowledged by lifting the telephone handset off the hookswitch. When the telephone handset is unplugged from the jack J3, the hookswitch contacts no longer have any effect, and the voice adapter remains in a standby condition.

With reference to the voice adapter internal schematic Fig. 6, the following is an explanation of circuit operation.

Receiver Input Filter – The input filter consists of a string of parallel resonant L-C circuits tuned to the channel frequency. The filter provides a bandwidth response of approximately 5KHz, which is adequate for voice transmission. The filter board also contains isolation transformer T1 and input attenuator R2.

NOTE: The input filter is tuned at the factory and the adjustment should not be altered.

Voice Receiver Circuit – The voice adapter receiver consists of three r-f amplifier stages Q1, Q2 and Q5, a diode detector and an audio amplifier Q7. The receiver features automatic volume control whereby, if the received r-f input level varies, due to line switching or weather conditions, there will be a minimal effect on listening volume and the volume control need not be readjusted. This is accomplished using a field effect transistor Q3 connected in series with C5 across the emitter resistor R9 of the second r-f amplifier stage Q2. The drain to source resistance of Q3 varies directly with the d-c voltage applied between its gate and source (TP-A to TP-B). Therefore, controlling the d-c voltage between TP-A and TP-B will effect the drain-source resistance, thereby controlling the effective emitter bypass

impedance and the gain of Q2. The d-c voltage applied to TP-A is maintained proportional to the signal level at the output of the detector stage. Q6 serves as a d-c amplifier for feedback to the F.E.T. Fig. 7 illustrates the A.V.C. response of the receiver circuitry. Plotted simultaneously is the feedback dc voltage (TP-A to TP-B).

The demodulated audio signal is present across volume control R19. It is then fed through C13 to the audio amplifier stage Q7. The collector load of Q7 is one half of the primary winding of T101 which is used to match the impedance of the handset receiver. When two receiver circuit boards are used, for a three terminal line, the other half of the primary winding of T101 is connected to the audio amplifier of the second receiver, thereby mixing the audio outputs of the two receivers simultaneously to the handset receiver.

The receiver circuit contains an additional r-f amplifier stage Q4 and diode detector which are used to demodulate the calling-tone.

Calling Alarm Circuit

The output of the additional detector is connected to the input of the alarm circuit. Should two receivers be used, the alarm detector outputs are connected together and fed to the alarm circuit input. The alarm circuit consists of two frequency selective audio amplifier stages Q1 and Q2 which are designed to respond to the 370 Hz. alarm tone. The output of Q2 is fed through C8 to the base of Q3, which, when turned on by the alarm signal, will cause current to flow through R15 and charge C9. C9 will build up a sufficient charge to turn on Q4 and pick up the alarm relay. A form C contact on the alarm relay is wired to J2 for external connections to an alarm device.

When the telephone handset is lifted off the hookswitch 45 V.D.C. is applied to the alarm circuit board terminal–1. This potential is applied through R10 and D1 to the base of Q2 which will cause Q2 to saturate removing the input signal to Q3. C9 will now discharge until Q4 is cut-off and the alarm relay drops out.

The alarm circuit board also contains the power supply components used for the entire voice adapter. The 45 V.D.C. input to the voice adapter is taken from the 45 Volt D.C. regulated supply of the TCF transmitter. R18 and Z1 form a voltage divider to obtain a regulated 20 V.D.C. supply for the voice adapter circuitry.

Speech-Amplifier Circuit

The speech amplifier circuit is a three stage audio amplifier using transistor Q1, Q5 and Q6. The circuit features automatic level control whereby the output, applied to modulate the TCF Transmitter, is held at a constant level while the microphone input level can vary up to 25db in amplitude. This is accomplished by controlling the gain of the first amplifier stage Q1, by placing a field effect transistor Q2 in series with C3 across the Q1 emitter resistor R6. The effective drain to source resistance of Q2 varies in proportion to the d.c. voltage applied to its gate (TP-2). Therefore, controlling this dc voltage will effect the drain-source resistance, thereby controlling the effective emitter bypass impedance, and the gain of Q1. The d-c voltage at TP2 is maintained proportional to the audio signal level at the collector of the second amplifier stage Q5. This signal is applied to the base of Q3 which when turned on by the negative going peaks will cause current to flow through D1 and charge C7 applying a d.c. voltage to the gate of the F.E.T. (Q2) in proportion to the signal level. The audio signal is applied through C10 to the third amplifier Q6. The final output level can be adjusted using R24.

Transistor Q4 and the surrounding circuitry form a 370 Hz. oscillator to be used to apply a modulating tone for signaling the remote voice adapter, when voice communication is desired. Pressing the calling pushbutton will apply 45 V.D.C. to terminal 3, supplying collector voltage to key the oscillator. The pushbutton is only effective after the handset has been lifted off the hookswitch. The pushbutton will not operate when the handset is unplugged from J3.

CONNECTIONS

Figs. 12 and 13 illustrate the required connections between the TCF Voice Adapter and the associated TCF transmitter. Also illustrated in this diagram are the connections to the remote hookswitch assembly when it is used.

D.C. power to the Voice Adapter is supplied by the regulated 45 volt power supply in the TCF Transmitter.

R.F. input to the voice adapter, coming from the r-f hybrid should be connected to jack J5. R-f input to the associated TCF relaying receiver should be provided, by connecting a coaxial lead from J4 on the voice adapter rear panel.

A form C contact from the calling alarm relay is wired to J2 terminals 3, 4 and 5 for external connections to a bell or other signaling device.

SETTINGS AND ADJUSTMENTS

NOTE: Before attempting to make any settings on the voice adapter, the associated TCF relaying transmitter and receiver must be set properly as follows:

1. Using the adjustment procedures outlined in the TCF Transmitter Instruction Leaflet, the output power levels under guard, trip, and voice conditions must be set accurately to obtain proper voice modulation.

2. When a 10 watt/10 watt TCF Transmitter is used, the associated receiver sensitivity must be set for an effective 25 DB margin with the transmitter operating at 10 watts. This additional margin is required to keep the receiver operating at a 15 db margin under conditions where the instantaneous effective transmitter output power is reduced to 1 watt during voice modulation

   When a 1 watt/10 watt TCF Transmitter is used, the associated receiver sensitivity should be set for the normal 15 DB margin with the transmitter operating at 1 watt.

Voice Receiver Sensitivity

The voice receiver sensitivity must be set using the input attenuator control R2 located on the input filter circuit module. When two receiver circuits are used both should be adjusted independently using the procedure described below. This setting must be made under favorable line conditions when the channel attenuation is at a minimum.

1) Set the remote TCF Transmitter for a power output level of 10 watts.

2) Connect a DC voltmeter (0-10 volts min. sensitivity of 15,000 ohms per volt) between TP-A and TP-B on the front of the receiver circuit module.

3) Starting with R2 on the filter circuit board at max. counterclockwise slowly turn R2 clockwise, while observing the voltmeter, to a point (Fig. 7 point A) where the voltage begins to increase rapidly. This is the proper setting of the receiver sensitivity. When the TCF transmitter operates at the voice power level of 3.25 watts the voice receiver sensitivity will be set a point B Fig. 7.

Speech Amplifier Output

The speech-amp output level is adjusted using R24, mounted on the front of the circuit board. The procedure is as follows:

1) Connect an oscilloscope and a-c VTVM across the TCF Transmitter output terminals.

2) Lift off the telephone handset. The voltmeter should indicate a transmitter output level of 3.25 watts (14 volts across 60 ohms).

3) Connect an audio signal generator set at 1000 Hz. at a level of 1 volt (rms) between TP-6 and circuit board terminal #9 (D.C. neg.) of the speech-amp module.

4) Adjust R24 on the speech-amp board. Starting from max. CCW., increase the level slowly while observing the modulation pattern on the scope until a point of max. undistorted modulation is reached. This is the proper setting.

Receiver Volume Control

The volume control R19 is located on the front of the receiver circuit board. This may be adjusted for a comfortable listening level. When two voice receiver modules are used, the volume controls are independently adjustable.

ACCESSORIES

1) Telephone Handset

   a) Westinghouse style – 204C892H01 – noise canceling microphone.

   b) Westinghouse style – 204C892G01 – non/noise canceling microphone.

2) Remote Hookswitch – Handset Assembly (for surface mounting)

   a) Westinghouse style – 205C246G01 – with noise canceling handset.

   b) Westinghouse style – 205C246G02 – with non/noise cancleing handset.

3) Remote Hookswitch – Handset Assembly (for panel mounting)

   a) Westinghouse style – 205C266G01 – with noise canceling handset.

   b) Westinghouse style – 204C266G02–with non/ noise canceling handset.

For mounting and wiring details of the above accessories see Figs. 3, 4, 5 and 6.

MAINTENANCE

The following tables are provided to aid in troubleshooting the voice adapter unit. The values given are typical and may vary somewhat from unit to unit. All measurements are taken with the voice adapter connected to the TCF Transmitter.

All a-c voltage measurements are measured with an a-c V.T.V.M.

TYPICAL AC MEASUREMENTS

	TEST POINT	VOLTAGE (1)
Speech amp. Circuit	TP-1	6mV
	TP-2	21mV
	TP-3	2.7V (DC)
	TP-4	.820V
	TP-5	8.6V
	Term. #1	1.16V
	Term. #1 (calling PB pressed and 1KHz. removed)	.58V

	TEST POINT	VOLTAGE (2)	
		85KHz.	295KHz.
Receiver Circuit	TP-1	.220V	.175V
	TP-2	.225V	.208V
	Term. #1	9V	9.8V
	Term. #2	90mV	103mV
	Term. #13	1.8mV	1.25mV
	Q2-C	6.1mV	3.9mV
	Q5-C	.670V	.660V
	Q6-B	33mV	37mV
Call-Alarm Circuit	TP-1	.167V	.200V
	TP-2 (hookswitch depressed)	25mV	30mV
		3.15V	3.25V
	TP-3 (hookswitch depressed)	3.5V(DC)	3.5V(DC)

(1) Transmitting – AC voltages are with respect to negative. A 1KHz. signal at 1 volt (RMS) is applied to TP-6 on the speech-amp module. The telephone handset is inserted into J3 and the hookswitch is released. R24 is set at max. CW.

(2) Receiving – AC Voltages are with respect to negative. An rf input signal at the channel frequency is applied to voice adapter input jack J4 or J5 at a level 25mV modulated 50% at 370 Hz. Input attenuator R2 on the filter module is set at max. CW. R19 on the receiver module is set at max. CW. The telephone handset is inserted into J3 and the hookswitch is released unless otherwise specified.

TYPICAL D.C. VOLTAGE MEASUREMENTS*

	TEST POINT	VOLTAGE
Speech-amp board	TP-1	16.8V
	TP-2	0
	TP-3	0
	TP-4	9.8V
	TP-5	20V
	Term. -1	0
	Term. -2 (hookswitch released)	0 (45V when pushbutton is pressed)
	Term. -16	0
	Term. -16 (hookswitch released)	40V
	Term. -18	20V
Receiver board	TP-1	6.4V
	TP-2	0
	Term. -1	7.2V
	Term. -2	0
	Term. -13	0
	Term. -18	20V
	Q2-C	18.5V
	Q4-C	8.8V
	Q5-C	11V
Alarm Board	TP-1	12.3V
	TP-2	12.8V
	TP-2 (hookswitch released)	9.2V
	TP-3	0
	Term. 1	0
	Term. 1 (hookswitch released)	44V
	Term. 4	44V
	Term. 5	20V
	Term. 7	45V
	Term. 9	0
	Term. 13	0
	Term. 18	20V
	Term. 19	45V

* DC Voltages are taken with respect to dc negative. No signals are applied to the receiver or speech-amp circuits. The telephone handset is inserted into jack J3 and the hookswitch is depressed unless otherwise specified.

ELECTRICAL PARTS LIST

SPEECH-AMP MODULE

Resistors

R1	2.7 ½W ±5%	184A763H37
R2	220 ohms ½W ±5%	184A763H11
R3	1.5K ½W ±5%	184A763H31
R4	1K ½W ±5%	184A763H27
R5	10K ½W ±5%	184A763H51
R6	20K ½W ±5%	184A763H58
R7	2.67K ½W ±5%	836A503H36
R8	2.67K ½W ±1%	836A503H36
R9	390K ½W ±5%	184A763H89
R10	39K ½W ±5%	184A763H65
R11	2.2M ½W ±5%	187A290H26
R12	220K ½W ±5%	184A763H83
R13	100K ½W ±5%	184A763H75
R14	100K ½W ±5%	184A763H75
R15	618K ½W ±5%	184A763H47
R16	10K ½W ±5%	184A763H51
R17	2K ½W ±5%	184A763H34
R18	5.6K ½W ±5%	184A763H45
R19	3.3K ½W ±5%	184A763H39
R20	3.3K ½W ±5%	184A763H39
R21	47K ½W ±5%	184A763H67
R22	3.6K ½W ±5%	184A763H40
R23	560 ohms ½W ±5%	184A763H21
R24	10K Pot ½W ±5%	880A564H01
R25	560 ohms ½W ±5%	184A763H21

Capacitors

C1	.1 uf @200 V.D.C. ±20%	187A624H01
C2	2 uf @200 V.D.C. ±20%	187A624H05
C3	1 uf @200 V.D.C. ±20%	187A624H04
C4	.047 uf @200 V.D.C. ± 5%	849A437H04
C5	.047 uf @200 V.D.C. ± 5%	849A437H04
C6	.047 uf @200 V.D.C. ± 5%	849A437H04
C7	1 uf @200 V.D.C. ±20%	187A624H04
C8	1 uf @200 V.D.C. ±20%	187A624H04
C9	6.8 uf @ 25 V.D.C. ±10%	184A661H25
C10	.02 uf @200 V.D.C. ±10%	187A624H09
C11	.1 uf @200 V.D.C. ±20%	187A624H01
C12	.1 uf @200 V.D.C. ±20%	187A624H01
C13	47 uf @ 50 V.D.C. ±10%	862A177H06

Diodes

D1	1N457A	184A855H07
D2	1N4818	188A342H06

Transistors

Q1	2N699	184A638H19
Q2	2N5465 F.E.T.	879A876H01
Q3	2N4356	849A441H02
Q4	2N3417	848A851H02
Q5	2N657	184A638H15
Q6	2N699	184A638H19

Transformers

T1	25 C.T./600 ohm C.T.	879A875H01

ELECTRICAL PARTS LIST

RECEIVER MODULE

Resistors

R1	27K	½W ±5%	184A763H61
R2	5.6K	½W ±5%	184A763H45
R4	2K	½W ±5%	184A763H34
R5	10K	½W ±5%	184A763H51
R6	10K	½W ±5%	184A763H51
R7	10K	½W ±5%	184A763H51
R8	10K	½W ±5%	184A763H51
R9	47K	½W ±5%	184A763H67
R10	3.3K	½W ±5%	184A763H39
R11	22K	½W ±5%	184A763H59
R12	1.8K	½W ±5%	184A763H33
R13	47 ohms	½W ±5%	187A290H17
R14	10K	½W ±5%	184A763H51
R15	22K	½W ±5%	184A763H59
R16	3.3K	½W ±5%	184A763H39
R17	10K	½W ±5%	184A763H51
R18	2K	½W ±5%	184A763H34
R19	25K	½W Pot	862A649H06
R21	220K	½W ±5%	184A763H83
R22	4.7K	½W ±5%	184A763H43
R23	56K	½W ±5%	184A763H69
R24	1K	½W ±5%	184A763H27
R25	100 ohm thermistor		185A211H12

Capacitors

C1	.1 uf @200 V.D.C. ±20%	187A624H01
C2	.1 uf @200 V.D.C. ±20%	187A624H01
C3	.1 uf @200 V.D.C. ±20%	187A624H01
C4	.1 uf @200 V.D.C. ±20%	187A624H01
C5	.01 uf @200 V.D.C. ±10%	764A278H10
C6	.1 uf @200 V.D.C. ±20%	187A624H01
C7	1 uf @200 V.D.C. ±20%	187A624H04
C8	.05 uf @200 V.D.C. ±25%	187A624H08
C9	.01 uf @200 V.D.C. ±10%	764A278H10
C10	.01 uf @200 V.D.C. ±10%	764A278H10
C11	.05 uf @200 V.D.C. ±25%	187A624H08
C12	.01 uf @200 V.D.C. ±10%	764A278H10
C13	1 uf @200 V.D.C. ±20%	187A624H04
C14	47 uf @ 35 V.D.C. ±10%	187A508H12
C15	.01 uf @200 V.D.C. ±10%	764A278H10
C16	.22 uf @ 50 V.D.C. ±20%	848A646H09

Diodes

D1,D2	1N100A	182A881H07
D3,D4	1N457A	184A855H07

Transistors

Q1	2N3417	848A851H02
Q2	2N699	184A638H19
Q3	2N5465 F.E.T.	879A876H01
Q4	2N699	184A638H19
Q5	2N699	184A638H19
Q6	2N4356	849A441H02
Q7	2N4356	849A441H02

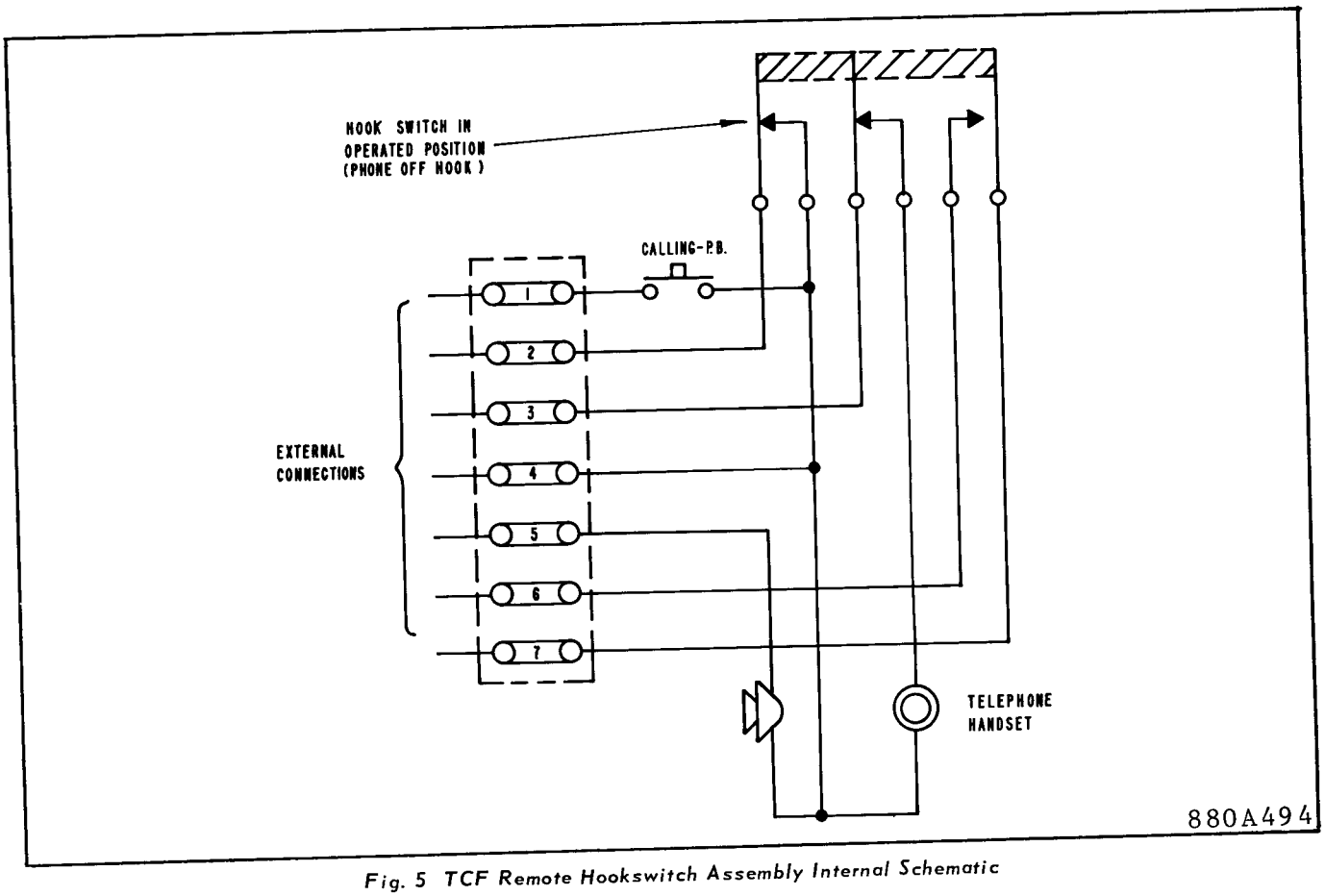
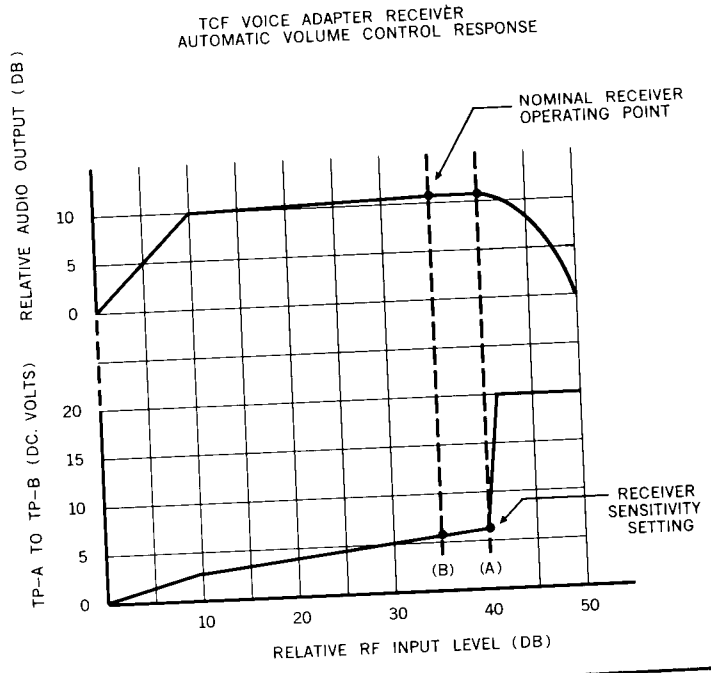
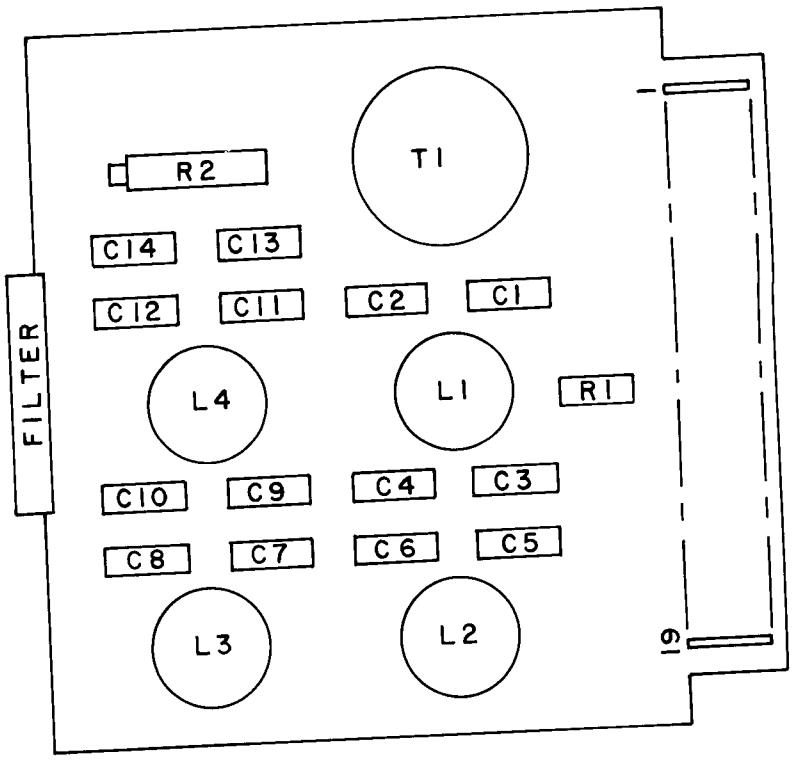


Fig. 5 TCF Remote Hookswitch Assembly Internal Schematic



880A61

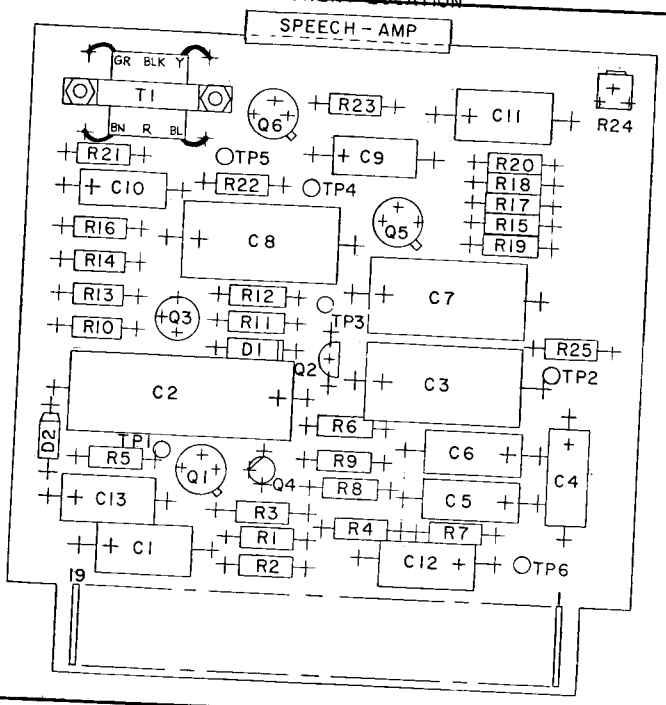
Fig. 7 Voice Receiver Automatic Volume Control Response



880A4

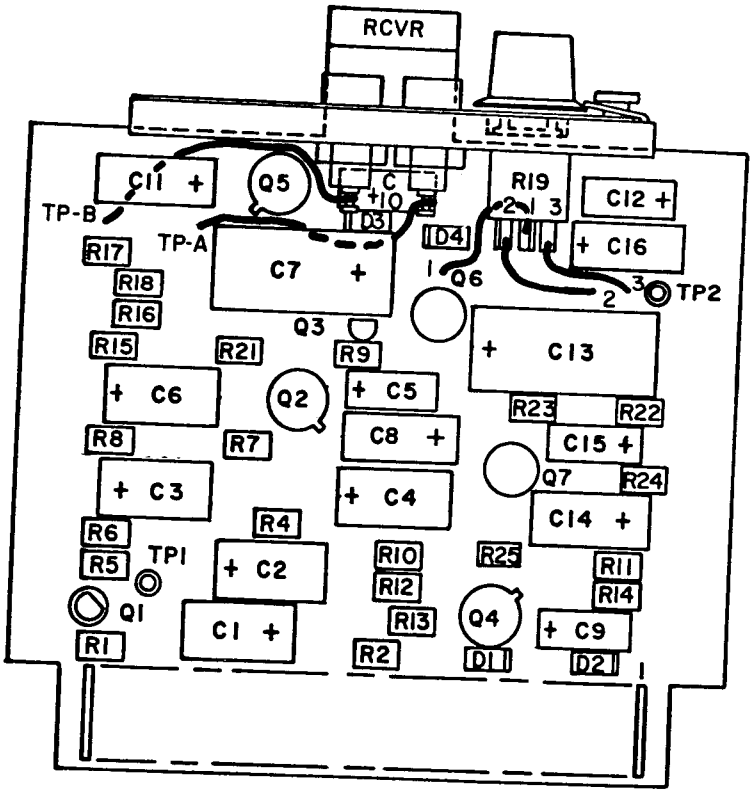
Fig. 8 Receiver Input Filter Component Location

TYPE TCF - VOICE ADAPTER
COMPONENT LOCATION



204C635

Fig. 9 Speech-amplifier Component Location



204C786

Fig. 10 Receiver Component Location

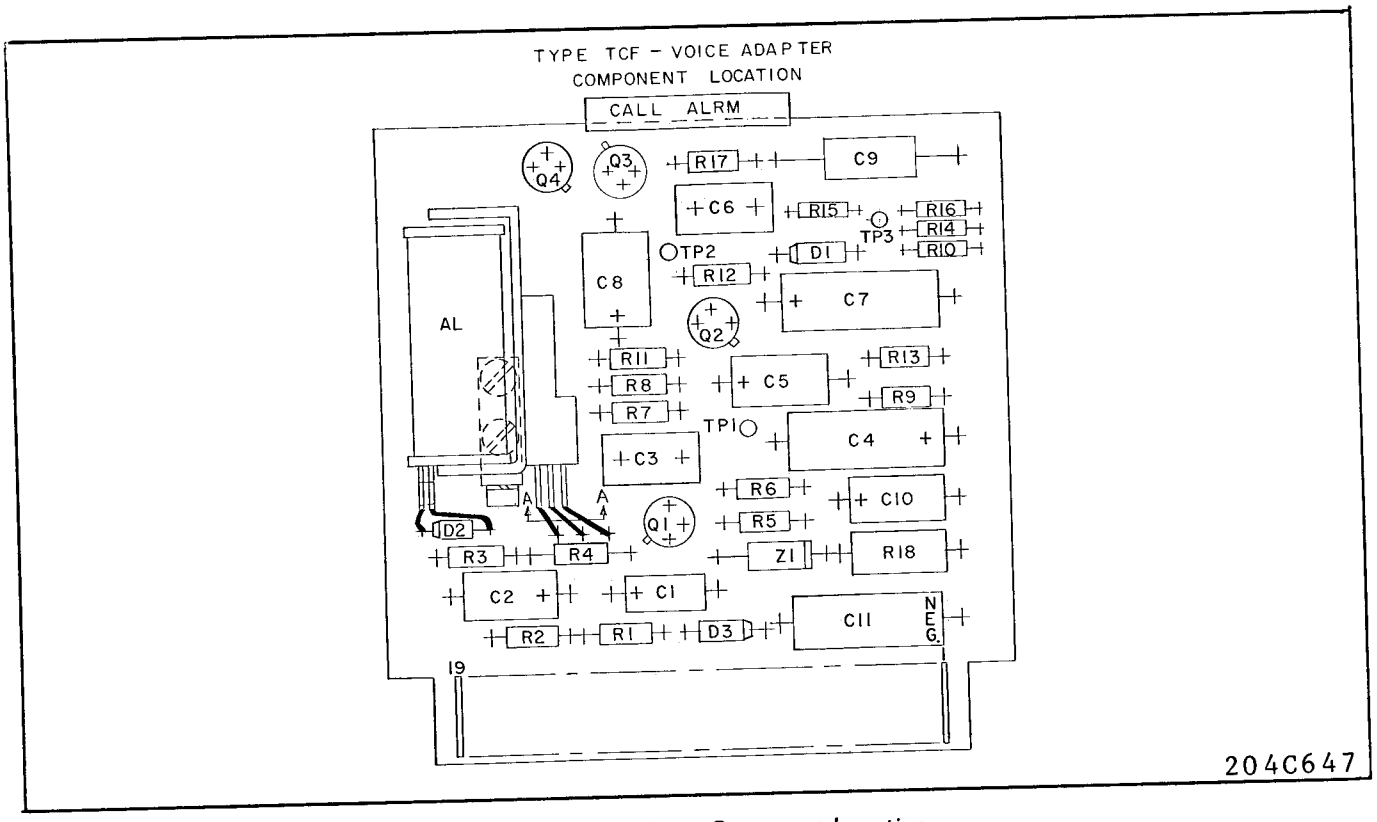


Fig. 11 Calling Alarm Component Location

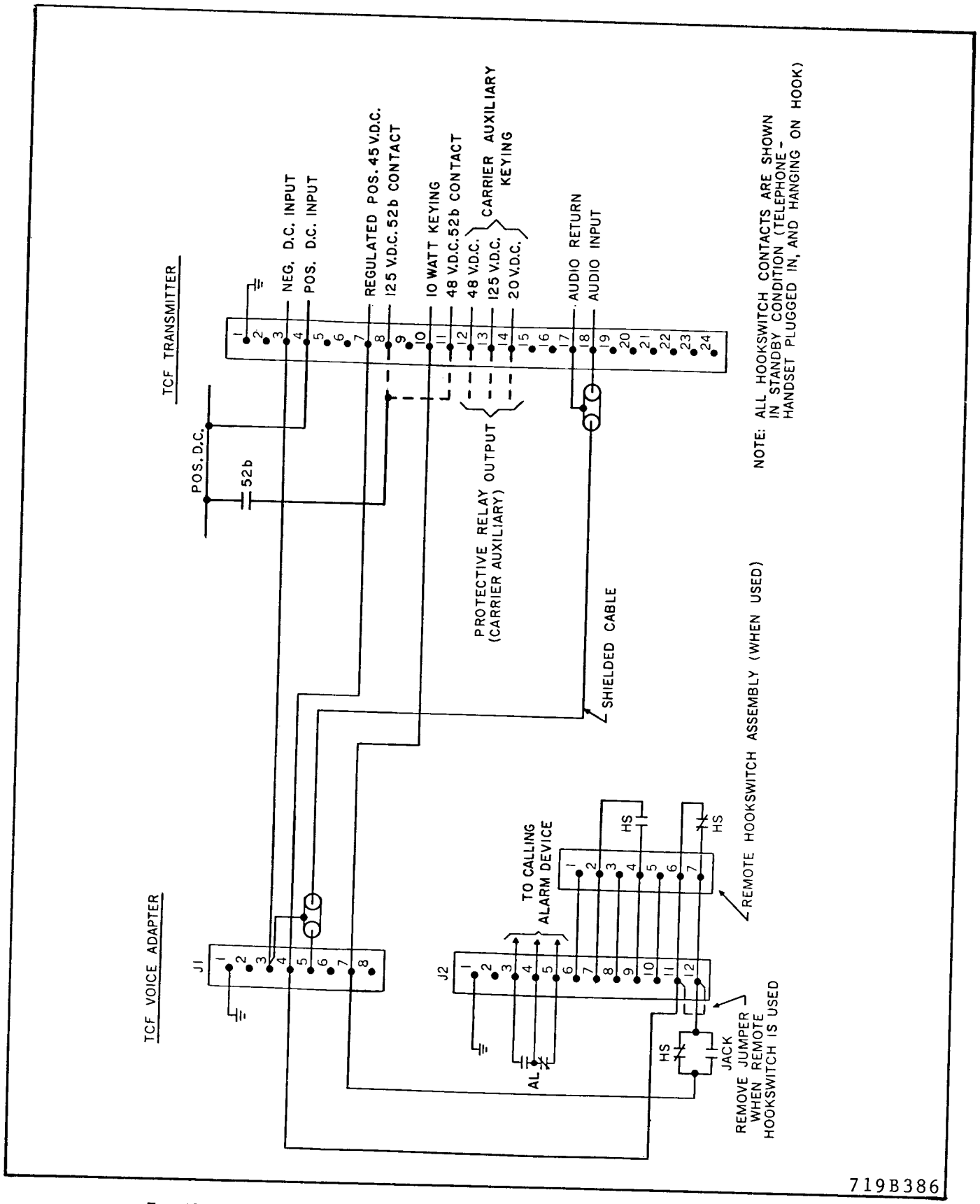


Fig. 12 TCF Voice Adapter-Transmitter Interconnections for Directional Comparison Relaying

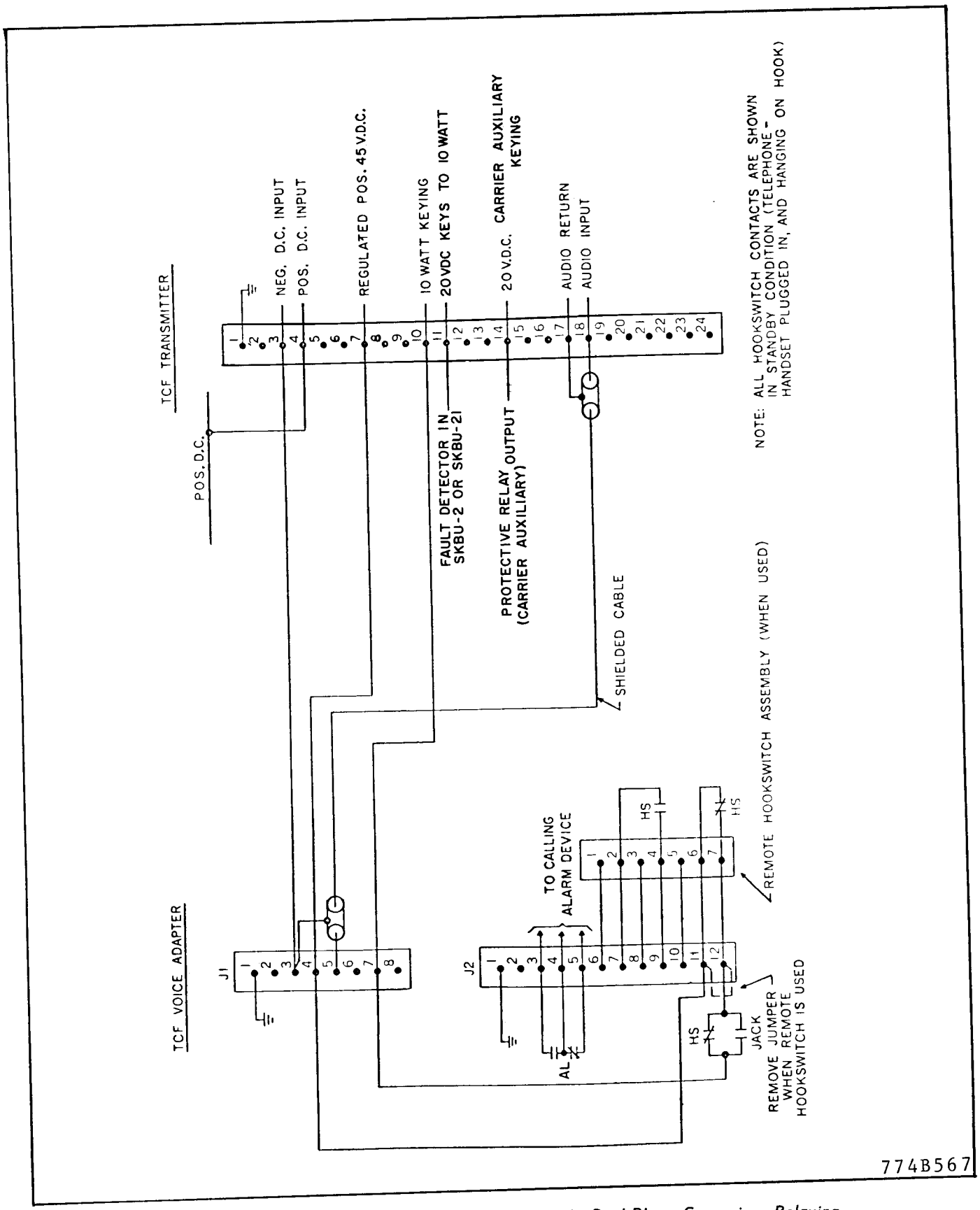
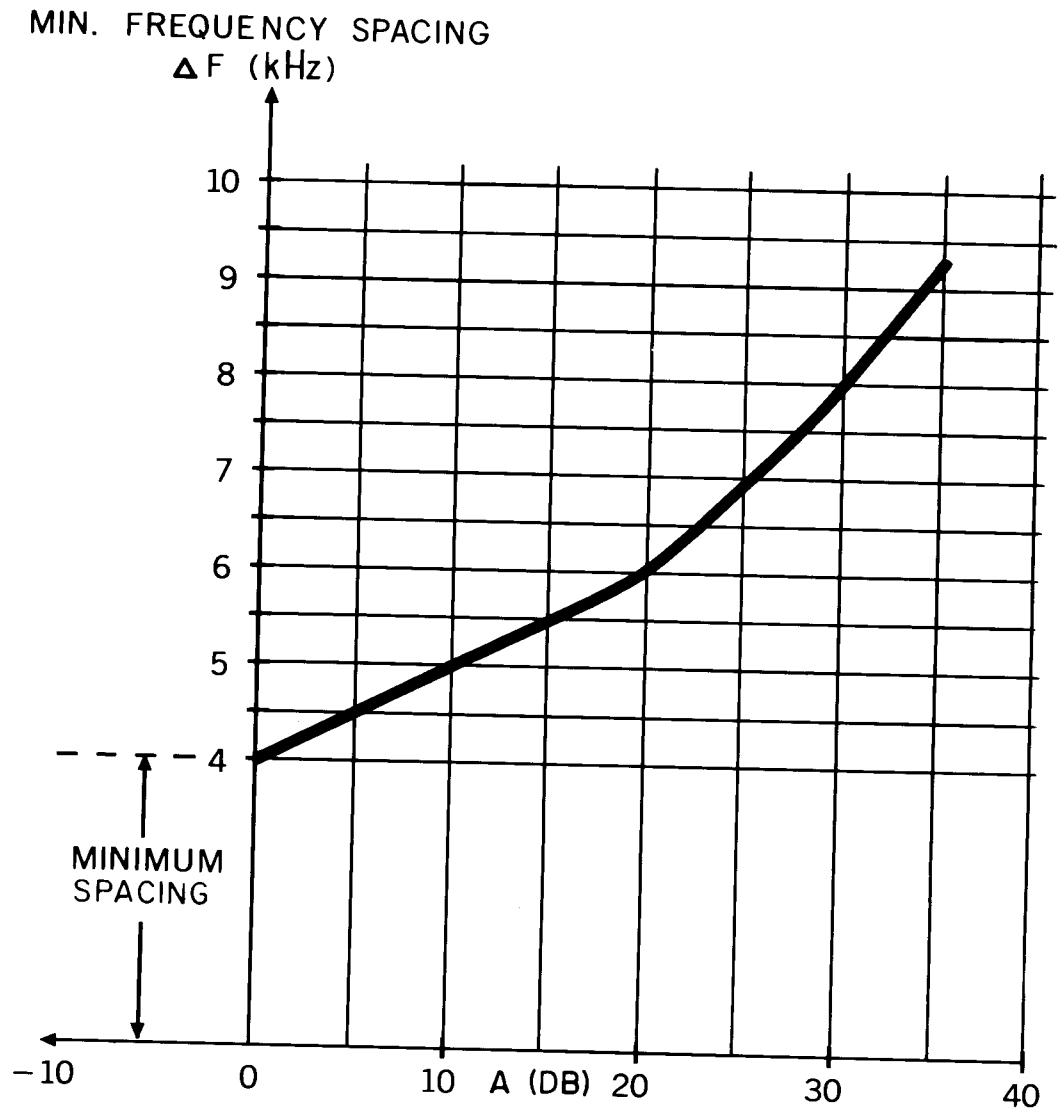


Fig. 13 TCF Voice Adapter-Transmitter Interconnections for Dual Phase Comparison Relaying



A=RATIO (DB) : INTERFERING SIGNAL LEVEL* (ADJACENT EQUIPMENT) / DESIRED SIGNAL LEVEL* (REMOTE TRANSMITTER ▲)

* MEASURED AT VOICE ADAPTER RF INPUT JACK.
▲ REMOTE TRANSMITTER OPERATING AT VOICE POWER LEVEL.

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Fig. 14 TCF Voice Channel Frequency Spacing

WESTINGHOUSE ELECTRIC CORPORATION

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