

1A PROTECTIVE RELAYING TERMINAL DESCRIPTION AND OPERATION

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1. GENERAL

SCOPE AND PURPOSE OF PRACTICE

1.01 This practice contains a description of the 1A protective relaying (PR) terminal. The basic PR *terminal* consists of a main and a supervisory transmitter, a main and a supervisory receiver, and an interface unit. Two or more PR terminals interconnected over special leased private

line facilities constitute a 1A protective relaying *system*. (The 1A PR terminal always requires a minimum of 4 wires to the CO). The supervisory transmitter and receiver provide for testing and constant monitoring of the system.

PURPOSE OF PROTECTIVE RELAYING SYSTEM

1.02 Many power generating stations are located throughout the United States. Nearly all of these facilities are interconnected via high voltage transmission lines into a national power grid so that power may be transferred between companies and between geographic regions as the need arises. Other transmission lines are used to connect generating facilities to substations where voltages are dropped for distribution. These facilities must be protected from faults that may occur, such as a phase-to-ground short circuit. Such a short, if not almost instantly detected and isolated, could result in catastrophic damage to both generating and transmission facilities. The system is designed to protect power company high voltage transmission lines from damage caused by such faults.

1.03 The 1A protective relaying system is designed to transmit a trip signal from the power company fault detector via telephone facilities to a remote power company facility (Fig. 1). The signal is first processed by the transmitter into suitable signals for transmission and then applied to the telephone line. At the remote end, the signal is processed by the receiver and its output is delivered to the power company logic circuitry and then to circuit breakers to disconnect the faulty circuit. The back-to-back elapsed time from receipt of a fault signal by the PR transmitter to a trip signal output from the PR receiver (but excluding transmission delays in the associated telephone circuitry) is less than 10 milliseconds.

RELIABILITY

1.04 When a ground fault occurs, very high ground currents are present in the vicinity of the power company facility. The resulting ground potential rise causes carbon block or gas tube protector operation. This causes an extremely noisy environment for any type of communications equipment at the very instant when the PR terminal is required to function. The PR terminal is designed to operate reliably under such adverse conditions. Reliability as used herein is defined as follows:

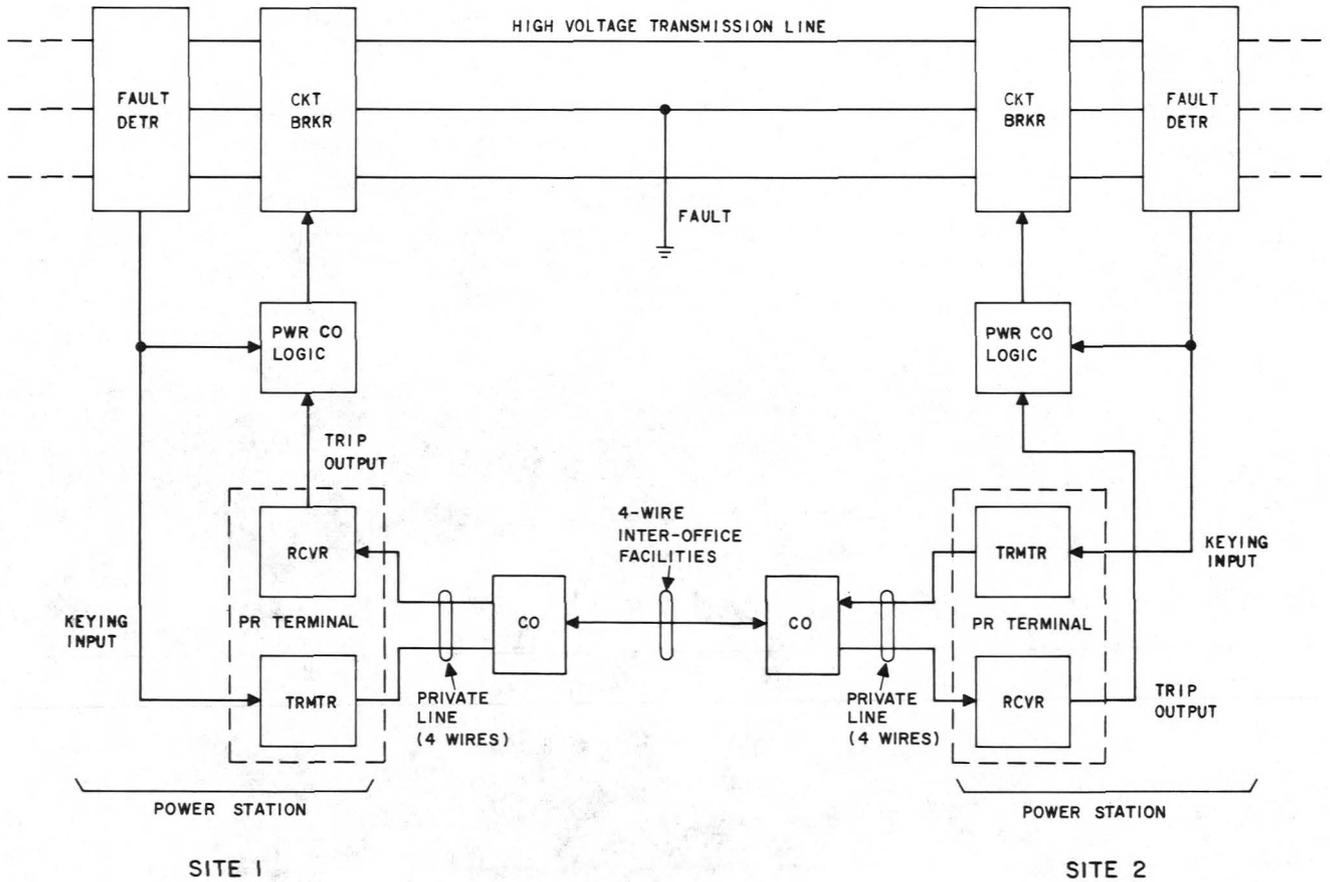


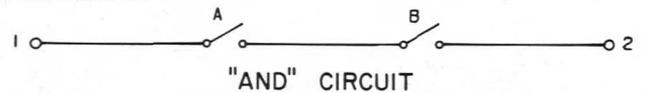
Fig. 1—Typical Bidirectional Protective Relaying Arrangement

- Dependability: Always deliver a valid trip
- Security: Never deliver a false trip.

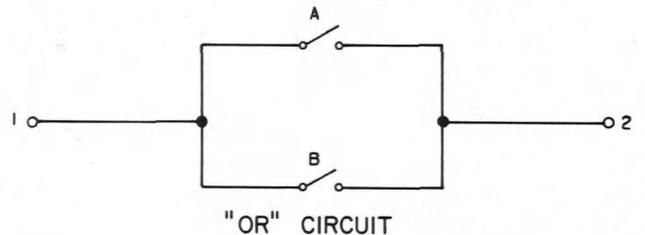
The PR terminal is composed of high reliability solid state devices, including many integrated circuits (ICs), to provide the required overall system reliability. The ICs employed are of the high threshold logic type to achieve increased noise immunity. Provision is made for constant monitoring and also for in-service testing of the system.

REDUNDANCY—DUAL ROUTING

1.05 Where extreme dependability or security is required, two separate PR systems may be operated in parallel using the same or diverse routing. The inputs are operated in parallel, while the outputs may be operated either in parallel (ORed) for added dependability, or in series (ANDed) for added security. Basic AND and OR circuits are shown in Fig. 2.



SWITCHES A AND B MUST BE CLOSED TO PROVIDE CONTINUITY FROM TERMINAL 1 TO TERMINAL 2.



SWITCH A OR SWITCH B MUST BE CLOSED TO PROVIDE CONTINUITY FROM TERMINAL 1 TO TERMINAL 2.

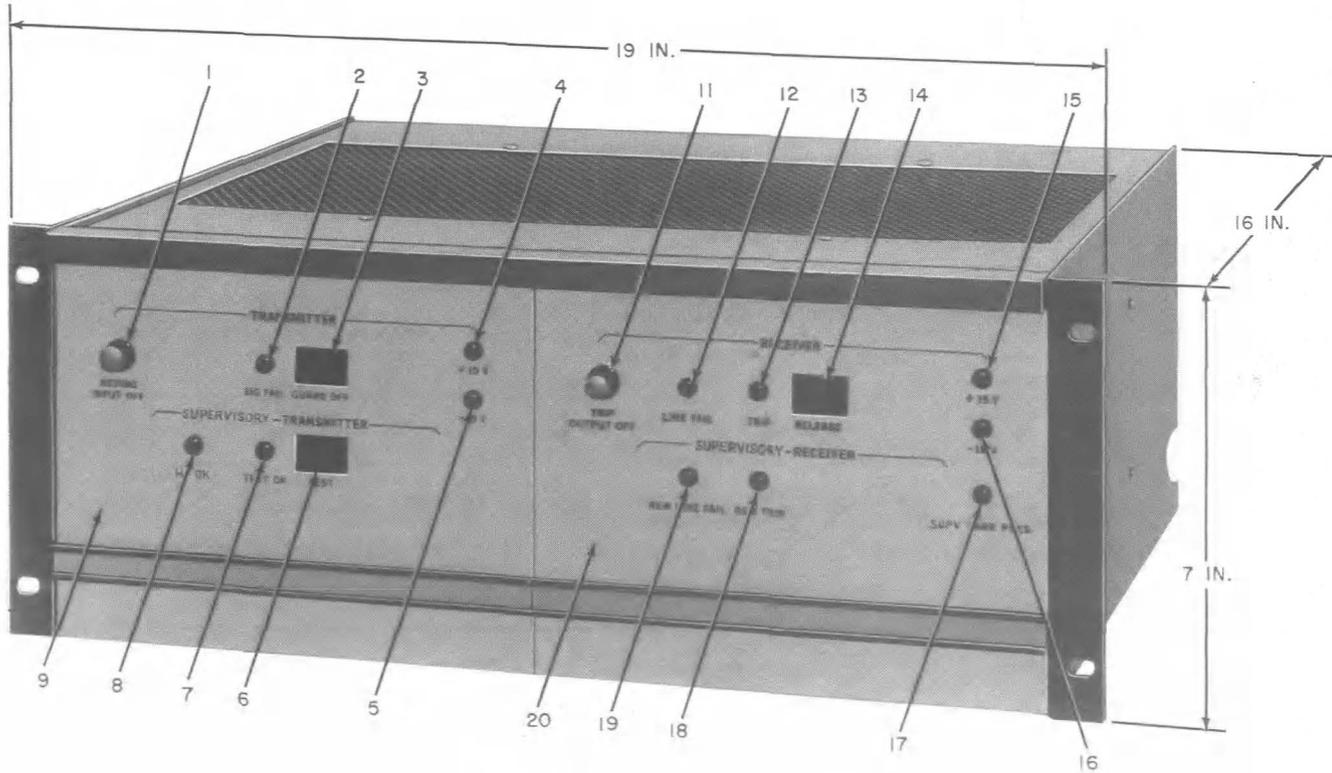
Fig. 2—Basic AND and OR Circuits

2. PHYSICAL DESCRIPTION

MAIN AND SUPERVISORY TRANSMITTER AND RECEIVER

2.01 The 1A protective relaying terminal is modular in design so that various equipment

arrangements may be implemented. A typical transmitter and receiver mounting arrangement, together with overall dimensions, controls, and indicators, is shown in Fig. 3. Weights and dimensions of apparatus are given in Table A.



LEGEND

TRANSMITTER

- 1 — KEYING INPUT OFF INDICATOR LAMP
- 2 — SIGNAL FAIL INDICATOR LAMP
- 3 — GUARD OFF SWITCH
- 4 — +15 VOLT INDICATOR LAMP
- 5 — -15 VOLT INDICATOR LAMP
- 6 — TEST SWITCH
- 7 — TEST OK INDICATOR LAMP
- 8 — HIGH FREQUENCY OK INDICATOR LAMP
- 9 — TRANSMITTER CONTROL PANEL

RECEIVER

- 11 — TRIP OUTPUT OFF INDICATOR LAMP
- 12 — LINE FAIL INDICATOR LAMP
- 13 — TRIP INDICATOR LAMP
- 14 — RELEASE SWITCH
- 15 — +15 VOLT INDICATOR LAMP
- 16 — -15 VOLT INDICATOR LAMP
- 17 — SUPERVISORY CARRIER PRESENT INDICATOR LAMP
- 18 — REMOTE TRIP INDICATOR LAMP
- 19 — REMOTE LINE FAIL INDICATOR LAMP
- 20 — RECEIVER CONTROL PANEL

Fig. 3—Main and Supervisory Transmitter and Receiver

TABLE A
PHYSICAL DATA OF ASSEMBLIES

UNIT NUMBER	CP NO.	NAME OF ASSEMBLY	OVERALL DIMENSIONS (IN.)			WEIGHT (LB)
			WIDTH	HEIGHT	DEPTH	
J1G030A	—	Transceiver Control Panel	8.56	6.36	1.5	0.8
B(L1)	—	Transceiver CP Mtg Unit	19.00	7.00	16.0	22.5
C	—	Transceiver Backplane	8.00	5.88	1.6	1.9
J1G030AA	1	Main Trmtr CP	2.78	5.55	12.4	1.7
BA	2	Supervisory Trmtr CP	1.70	5.55	12.4	1.3
CA	3	Main Rcvr Input CP	1.70	5.55	12.4	1.5
CB	4	Main Rcvr High Trip Dctr CP	1.56	5.55	12.4	1.1
CC	5	Main Rcvr Logic CP	1.91	5.55	12.4	1.3
DA	6	Supervisory Rcvr CP	1.79	5.55	12.4	1.6
EA	7	Multipoint Combiner CP	0.76	5.55	12.4	0.4
J1G030G	—	Interface Mtg Unit	19.00	7.00	16.0	22.9
GA	—	Keying Input Module	3.22	5.74	14.4	6.5
GB	—	Alarm Module	3.22	5.74	14.2	3.4
GC(L1&L2)	—	Converter Input Module	3.22	5.74	14.2	7.2
GD(L1)	—	Rcvr Trip Output Module	3.22	5.74	14.4	8.1
GD(L2)	—	Rcvr Trip Output Module	3.22	5.74	14.4	7.8
GE(L1&L2)	—	Fuse and Converter Module	3.38	5.74	14.4	11.8

2.02 The housing for the transmitter/receiver is the transceiver mounting unit (Fig. 4); it is actually made of three separate parts, as follows:

- Control Panel
- Circuit Pack (CP) Mounting Unit
- Backplane.

This modular design permits units to be interchanged, provided the control panel and backplane are correspondingly changed. For example, two receivers may be mounted adjacent to each other if so desired. Circuit components are mounted on printed wiring boards. The backplane provides the wiring and connectors into which the printed circuit boards are plugged.

2.03 Most of the circuit packs of the transmitter/receiver are each made up of two printed wiring boards, referred to as "mother board" and "daughter board." The boards are physically and electrically connected together as one unit, and slide into the transceiver mounting unit on nylon tracks. The mother board provides the electrical connection to the backplane. The boards plug into the backplane at the back of the mounting unit.

2.04 The front door of the mounting unit, which mounts the control panels, is hinged at the bottom and held in the closed position by magnetic latches. The mounting may be opened to gain access to the circuit packs by pulling outward on the top of the door.

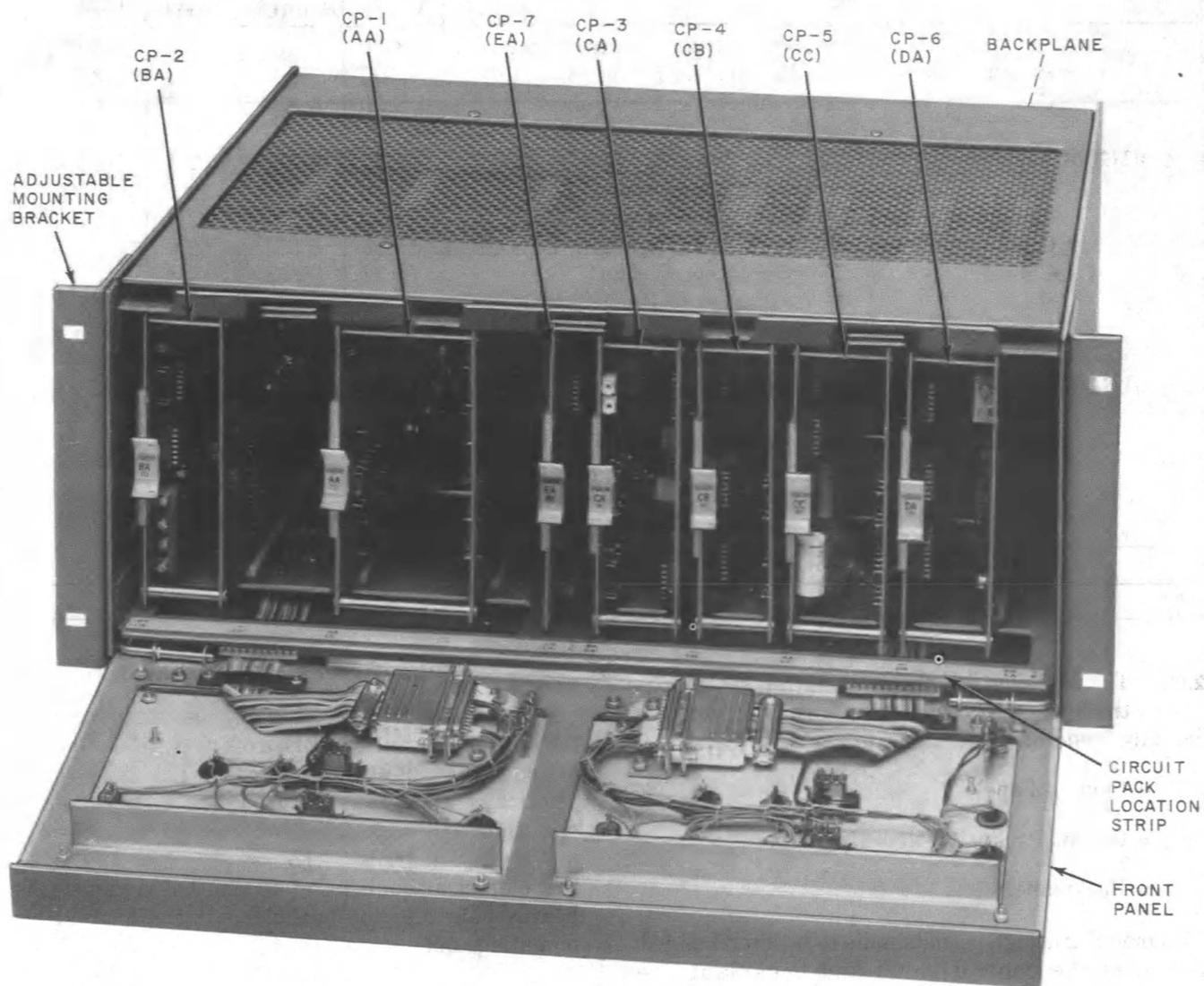


Fig. 4—Interior of Transceiver J1G030B Showing Circuit Packs

INTERFACE MOUNTING UNIT

2.05 Up to five interface modules are housed in the interface mounting unit (Fig. 5). Weights and dimensions of the mounting unit and the individual modules are given in Table A. The modules are self-contained units and are secured in the interface mounting unit by means of screws.

Each module has its own terminal strips for connecting to other units.

2.06 Controls and indicators on the individual modules are shown in Fig. 6 through 10. Two indicators, SYSTEM ALARM and ALARM DISABLE, are located on the front panel of the interface unit.

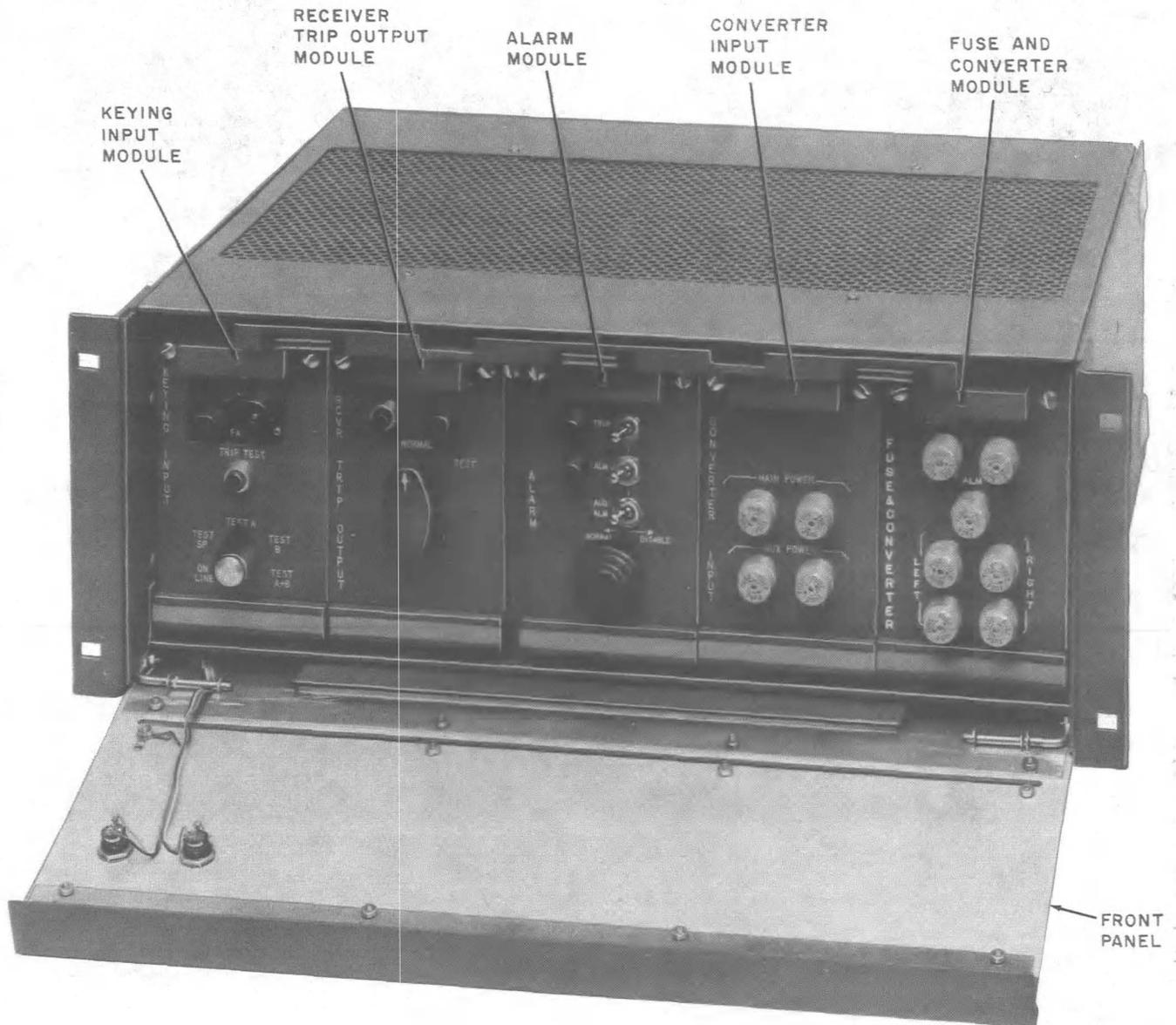


Fig. 5—Interface Mounting Unit J1G030G With Modules

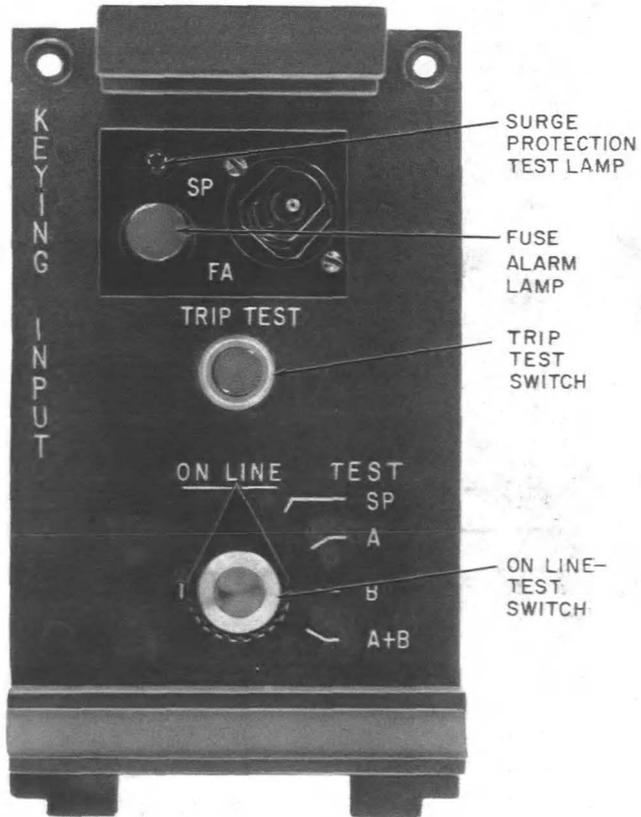


Fig. 6—Keying Input Module

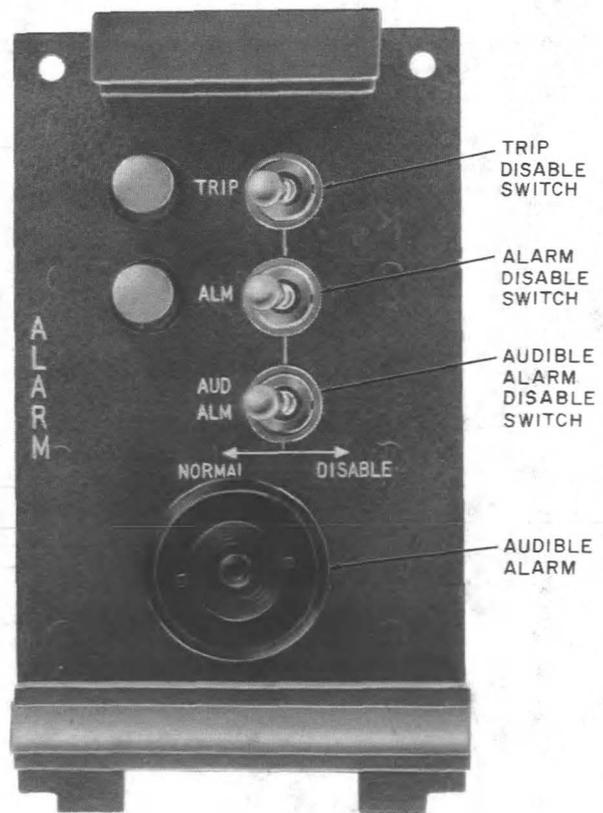


Fig. 7—Alarm Module

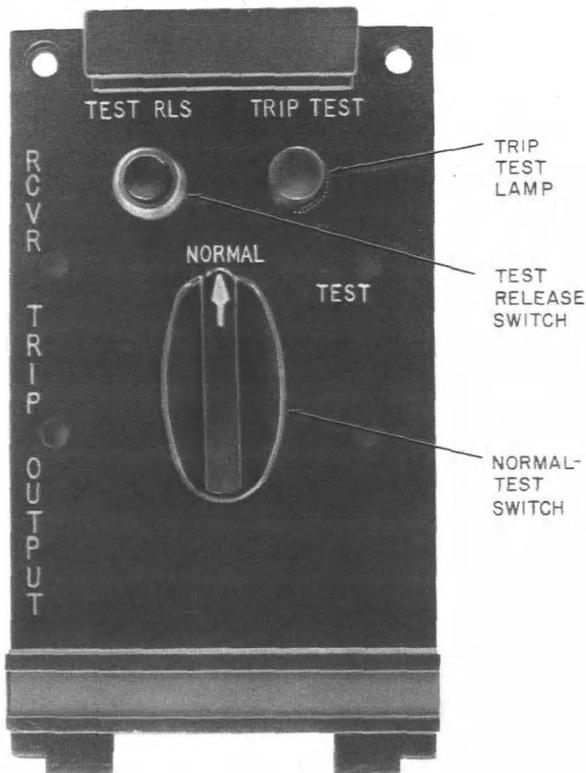


Fig. 8—Receiver Trip Output Module

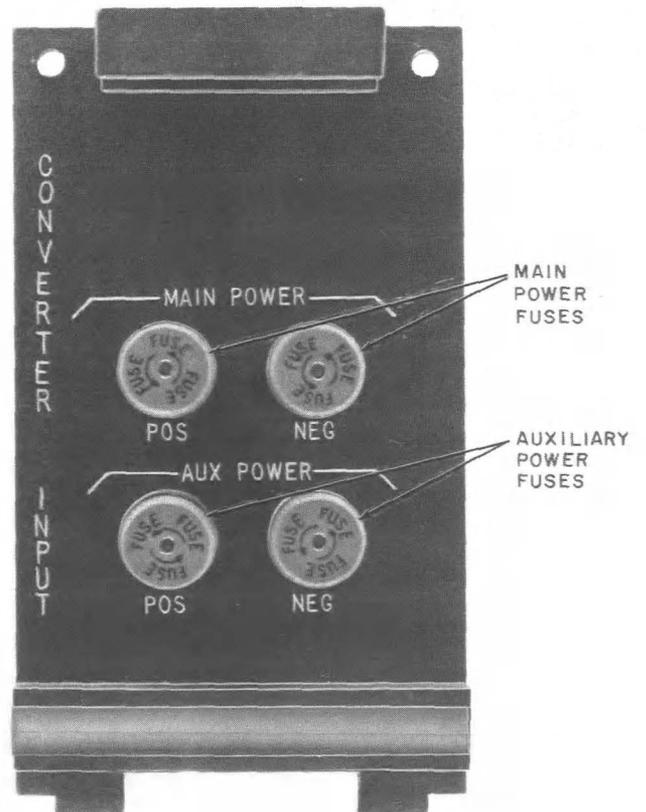


Fig. 9—Converter Input Module

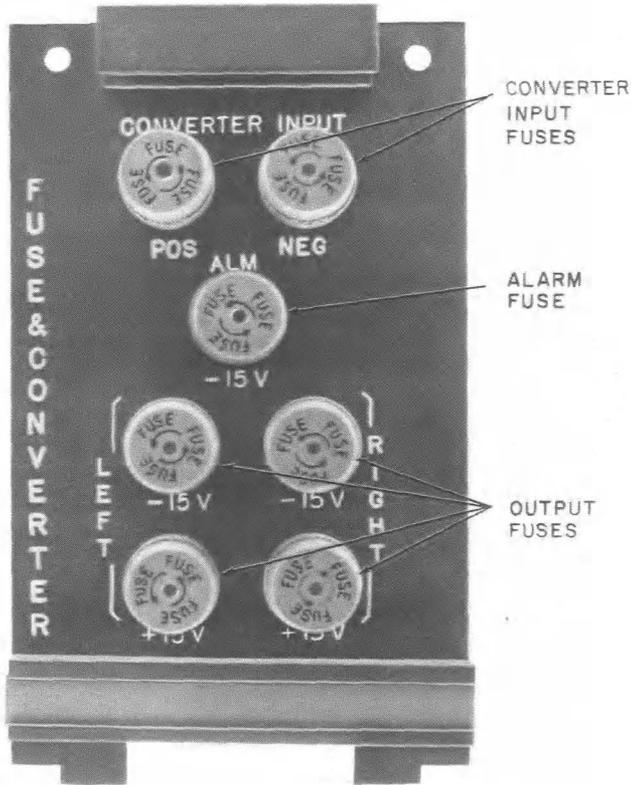


Fig. 10—Fuse and Converter Module

EXTERNAL CONNECTIONS

2.07 Terminal strips are provided on the back of the transceiver mounting unit and modules of the interface unit to interconnect the units, to make certain field wiring options, and to interface with the customer (Fig. 11 and 12, respectively).

MOUNTING

2.08 The PR terminal may be rack-mounted in a standard 19-inch rack or in a suitable cabinet. The interface unit should be mounted on top of the transceiver mounting unit because of the greater heat dissipation of the interface unit. Rack mounting is preferred to cabinet mounting, due to better heat dissipation.

ENVIRONMENT

2.09 The PR terminal is designed to operate within a temperature range of -20 to $+140^{\circ}\text{F}$ and a short term relative humidity range of 20 to 95 percent.

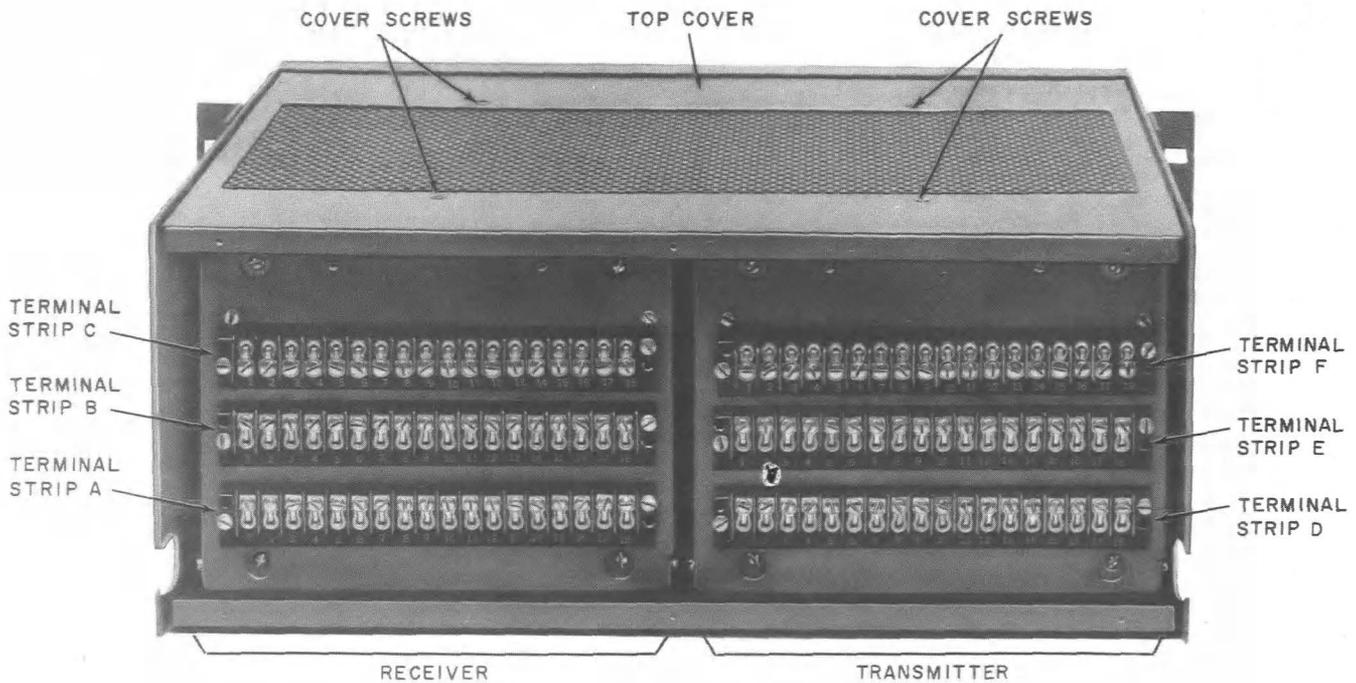


Fig. 11—Back of Transceiver With Rear Cover Removed

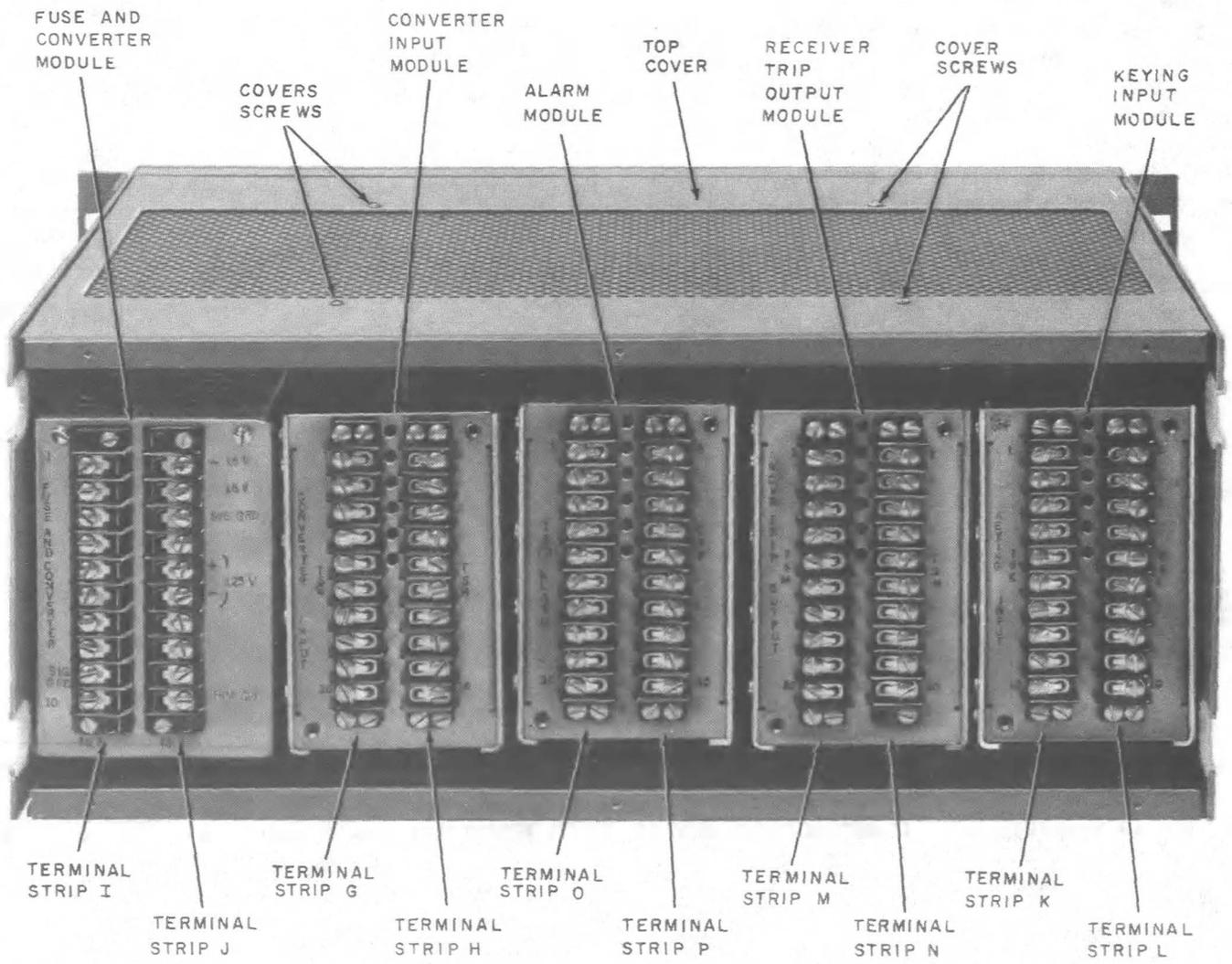


Fig. 12—Back of Interface Unit With Rear Cover Removed

3. FUNCTIONAL DESCRIPTION

GENERAL

3.01 The primary function of the 1A protective relaying terminal (Fig. 13) is to deliver a reliable trip signal. The terminal is designed so that a trip signal may be sent from any point to any other point within a symmetrical system. In addition, two supervisory functions — "monitor" and "test" — are provided. Each terminal can monitor and test all other terminals within the system when used in a symmetrical arrangement (see 3.28). Other terminals of a unidirectional system can be monitored and tested only from the transmitting site.

3.02 Monitoring functions are provided to continuously indicate the status of the system. The functions are remote trip, remote line failure, and supervisory carrier present. Signals to perform these functions share the private line channel of the main system.

3.03 Testing of the overall trip capability of the system may be performed on an out-of-service basis; however, testing of trip signal transmission may also be performed on an in-service basis. If a valid trip signal occurs during an in-service test, the test is aborted and the trip signal is sent to the remote terminal.

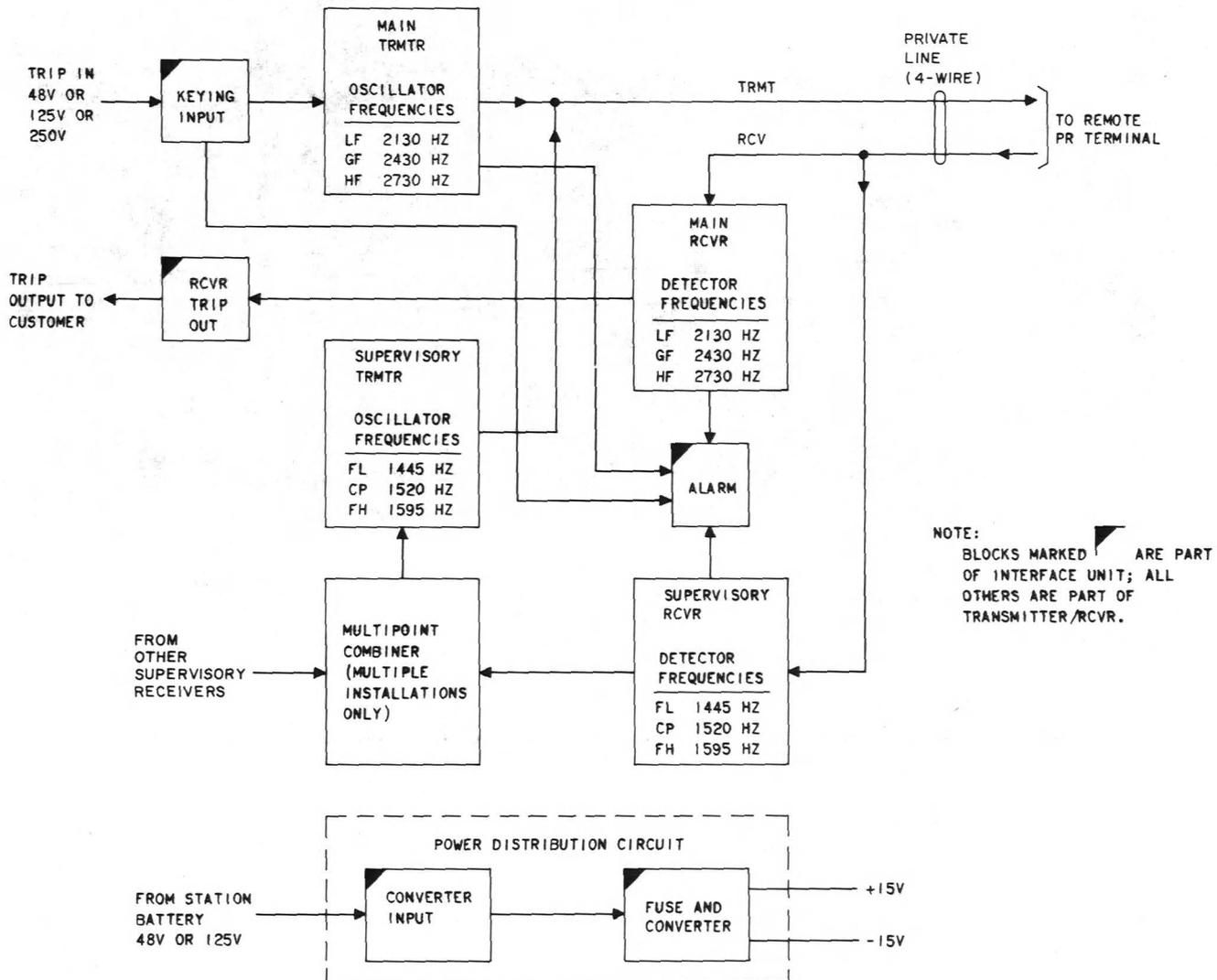


Fig. 13—Block Diagram of Basic 1A Protective Relaying Terminal

MAIN TRANSMITTER

3.04 During normal operation, the transmitter continuously sends out a guard tone of 2430 Hz (Fig. 14). When a trip signal appears at the keying input, the 2430-Hz guard tone is removed and low frequency and high frequency trip tones are transmitted (2130 Hz and 2730 Hz, respectively). The combined trip tones are initially transmitted at a combined *enhanced* level of about +14 dBm for 70 milliseconds. If the trip signal continues at the keying input beyond the initial 70 ms, the combined 2-signal transmitter output level drops to the level of the guard tone (-4 dBm). This is referred to as *trip hold*. The enhanced level is transmitted for only 70 ms; the trip-hold signal may be transmitted indefinitely, so long as a trip signal is present at the keying input. A SIG FAIL alarm is provided on the front panel to indicate failure to transmit trip or guard frequencies. A "trip record" output (contact closure) is also provided as a convenience to the customer.

MAIN RECEIVER

3.05 Five detectors in the main receiver respond to the guard frequency, the two trip frequencies at the enhanced level, and the two trip frequencies at the trip-hold level. A squelch circuit is also provided in the receiver to prevent a false trip output from the receiver, caused by extremely high noise. However, the squelch threshold is high enough to prevent squelch operation during the high noise period caused by a transmission line fault as previously mentioned. Logic circuits in the receiver require the simultaneous reception of the two enhanced trip frequencies and the absence of guard and squelch outputs to produce a trip output.

3.06 Delay is provided in the receiver to prevent premature trip turnoff due to noise. Trip turnoff may be by return to the guard status (ie, presence of guard tone and absence of trip tones) or by absence of trip hold for 100 ms. The delay

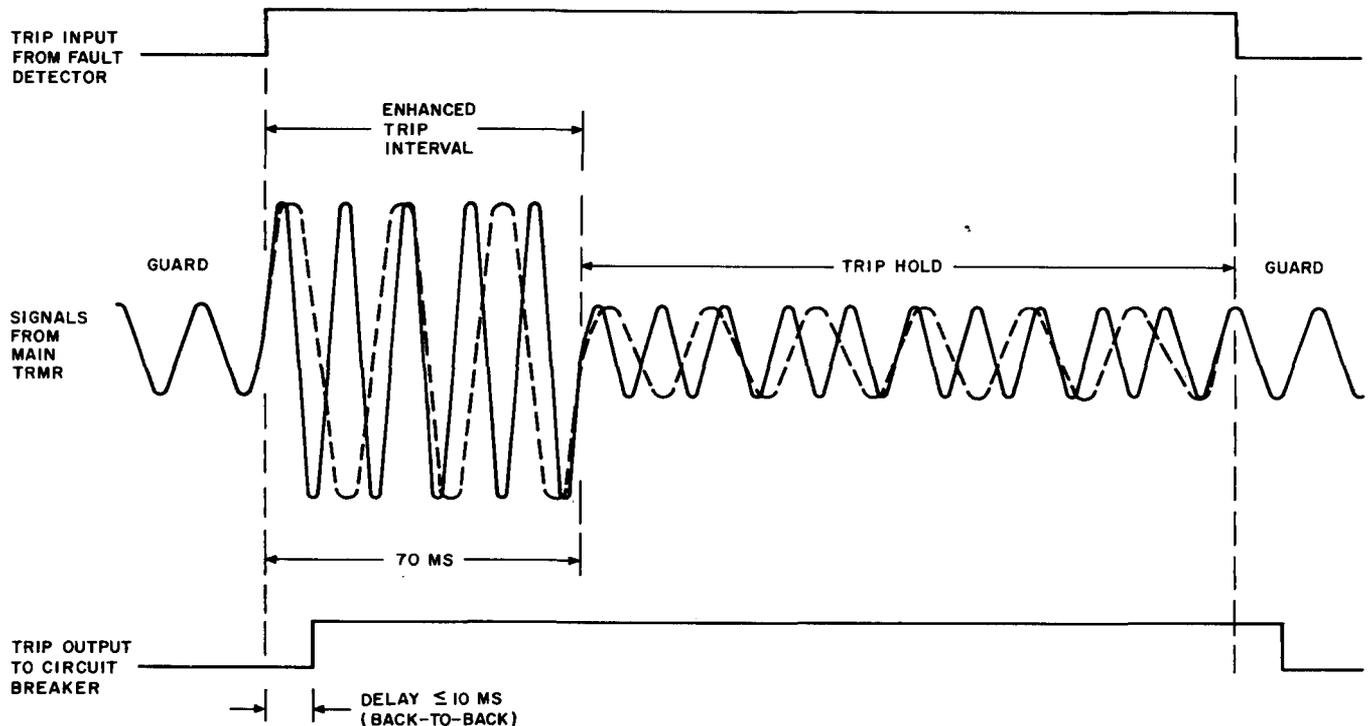


Fig. 14—Trip Signal Format

in turnoff by return of guard is optional at 5, 20, or 100 ms and is determined by customer option.

3.07 The main receiver provides line failure and trip-received alarms, which are indicated on the front panel of the receiver as LINE FAIL and TRIP, respectively. The TRIP lamp locks up under control of the trip RELEASE switch on the front panel. A "trip record" output (contact closure) is also provided as a convenience to the customer.

SUPERVISORY TRANSMITTER

3.08 The supervisory transmitter is provided to transmit the signals for the monitor and test functions discussed in 3.01 through 3.03.

3.09 The monitoring function requires that one of two supervisory tones, either 1445 Hz or 1595 Hz, be transmitted to the other PR terminals to indicate remote trip or remote line failure. A third tone, 1520 Hz, is transmitted continuously in the absence of the other two signals to maintain continuity of the supervisory transmission channel (Table B). These three tones are generated by a sinusoidal oscillator in the supervisory transmitter. Only one frequency is produced at a given time, in response to two keying control signals. The oscillator output also provides a clock signal for the logic circuitry in the supervisory transmitter and receiver.

TABLE B
MAIN AND MONITORING FREQUENCIES

FREQ, HZ	FUNCTION
2130	LF Trip
2430	Guard
2730	HF Trip
1445	Remote Trip
1520	Supv Carrier Present
1595	Remote Line Fail, Test

3.10 The supervisory transmitter provides a test tone and logic for the in-service test feature of the supervisory system. The front-panel TEST pushbutton is used to initiate the test. Sequential operation of lamps HF OK and TEST OK provide visual indication of completion of the test.

SUPERVISORY RECEIVER

3.11 The supervisory receiver is provided to recognize the three supervisory frequencies (1445, 1520, and 1595 Hz). The receiver decodes the monitoring frequencies and initiates appropriate alarms as they are transmitted from the distant supervisory transmitter. These are remote line failure and remote trip, designated REM LINE FAIL and REM TRIP respectively, on the front panel of the supervisory receiver. The remote trip output is locked up under control of the remote main receiver and is released by operation of that receiver's front-panel trip RELEASE pushbutton. The SUPV CARR PRES indicator lamp monitors the continuous reception of the supervisory tone, thus ensuring continuity of the supervisory channel.

INTERFACE MODULES

3.12 The interface between the PR terminal and the power company is provided by four modules housed in the interface mounting unit (Fig. 5). A fifth module provides dc operating voltages for the terminal.

3.13 Converter Input Module: This module provides protection from surges on the station battery input. The unregulated dc input may be either 48 volts or 125 volts, positive ground, negative ground, or ungrounded. Appropriate options provide the voltage choices. When used on 125 volts, options within the converter input module provide for positive ground, negative ground, or ungrounded operation. Both input leads of the converter input module are fuse-protected. Output voltages from this module provide the input to the dc-to-dc converter.

3.14 Fuse and Converter Module: This module consists of a dc-to-dc converter and a fuse panel. It changes the station battery input into +15 volts and -15 volts to provide the operating potentials for the various units in the PR terminal. All leads into and out of the dc-to-dc converter, except ground leads, are fuse-protected.

3.15 Keying Input Module: This module accepts a keying signal from the power company of 48 volts, 125 volts, or 250 volts and changes it into a suitable input voltage for the PR terminal main transmitter. This input voltage must be compatible with the transmitter. Operation on either of the three voltages is provided by orderable option. The keying input is normally operated by

the power company fault detector. A rotary switch is used to transfer the keying input from ON LINE to TEST to provide manual pushbutton (TRIP TEST) keying for system test purposes on an out-of-service basis. Input surge protection and low-pass filtering are provided to prevent false trip signals due to noise. The TRIP TEST pushbutton, in conjunction with an indicator lamp (marked SP), is used to verify continuity of the surge protection network. A fuse is also provided in the circuit; loss of the fuse is indicated by alarm lamp FA.

3.16 Receiver Trip Output Module: This module receives the main receiver trip output signal and delivers an appropriate trip signal to the power company. The output may be either a relay contact closure or the output of a solid state relay, as selected by orderable option. Surge protection and noise filtering circuitry are provided in both cases. A NORMAL-TEST switch on the front of the module permits the trip output to be removed from the power company circuit breaker and operate the TRIP TEST indicator lamp instead, to provide for manual system testing. With the solid-state relay option, the lamp is locked up under control of the TEST RELEASE pushbutton switch.

3.17 Alarm Module: This module provides two alarm lamps and an audible alarm to give indications of a received trip and other alarmable conditions. Switches are provided to disable each of the alarms. When any alarm is disabled by operation of a switch, an ALARM DISABLE lamp lights on the front panel of the interface unit.

IN-SERVICE TESTING

3.18 Two in-service tests are provided:

- Trip-tone transmission and detection capability
- Remote line fail.

These tests are discussed in the following paragraphs.

3.19 Trip-tone Transmission and Detection Capability: This test is accomplished by sending the trip tones one at a time *with* guard tone present (Fig. 15). A frequency shift in the supervisory tones is also sent to inform the supervisory control logic that a test is in progress. Enhanced levels and normal levels of each of the individual trip tones are sent sequentially.

3.20 After the test is initiated by pushing and releasing the TEST pushbutton on the front panel of the supervisory transmitter, an appropriate response from the remote station is received, dependent on system configuration.

3.21 A timer in the supervisory transmitter returns the terminal to normal after a 2-second interval. The 2-stage test (HF OK and TEST OK) is designed to aid in locating trouble within the system.

3.22 Remote Line Fail: This test verifies the operation of line failure detection at the remote terminal(s), and provides a REM LINE FAIL indication at the local supervisory receiver. The test is initiated by operating the GUARD OFF switch on the local transmitter.

OUT-OF-SERVICE TESTING

THINK *No attempt shall be made to perform tests on an out-of-service basis until customer approval has been obtained for removing the protective relaying system from service.*

3.23 Overall out-of-service system testing requires personnel at all sites within the system, and a voice communication circuit between sites. After permission has been received from the customer, the selector switch on the keying input module is operated to the TEST position. Testing from any transmitter requires placing all distant receiver trip output modules in the system to TEST position, so that a trip test signal will not cause an actual trip of the power company circuit breaker.

3.24 The person initiating the test establishes voice communication with all other sites within the system, and coordinates the out-of-service testing. Upon completion of tests, the system is returned to on-line mode.

3.25 Details of in-service and out-of-service testing are given in Section 024-195-500.

MULTIPOINT COMBINER

3.26 In symmetrical multipoint systems, one transmitter and two, three, or four receivers are located at each site. The multipoint combiner is used to combine the multiple signals from the supervisory receivers and present the inputs to

the supervisory transmitter. The combiner is provided by option in multipoint systems only (Fig. 13).

INTERFACE LEADS AND DESIGNATIONS

3.27 Interface leads are provided for making connections external to the PR terminal for the various functions of the terminal. These leads are summarized in Table C.

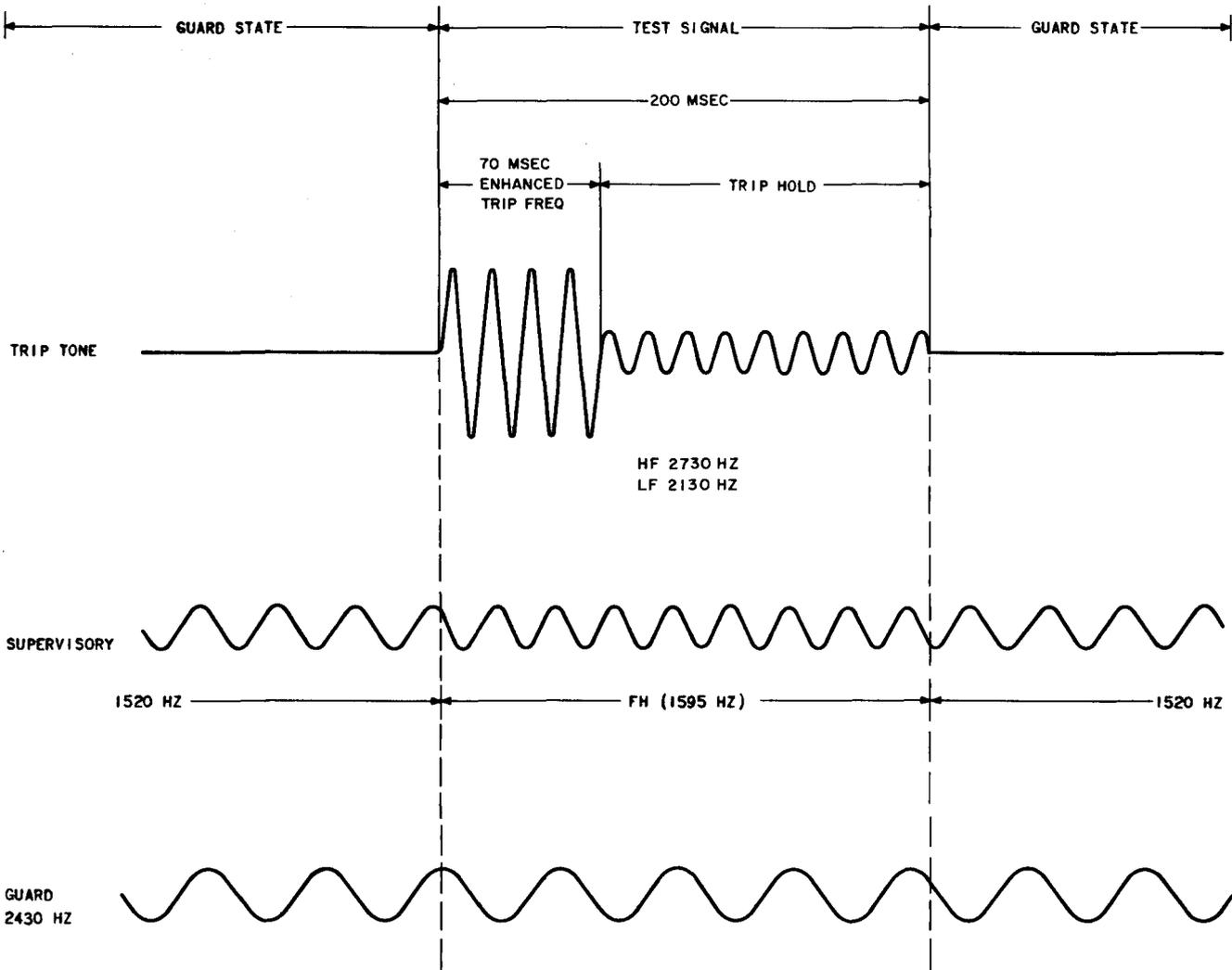


Fig. 15—Test Signal Format

TABLE C
CUSTOMER AND TELCO INTERFACE LEADS

TERMINAL STRIP & NO.	DESIGNATION	MEANING	NOTES
<i>TS C</i>			
7	RMA	Receiver Output to Trip Recorder	1
8	RMB	Receiver Output to Trip Recorder	1
9	CLFA	Power Co. Line Fail Alarm	1
10	CLFB	Power Co. Line Fail Alarm	1
11	CTA	Power Co. Trip Alarm	1
12	CTB	Power Co. Trip Alarm	1
13	CRLA	Power Co. Remote Line Fail Alarm	1
14	CRLB	Power Co. Remote Line Fail Alarm	1
15	CRTA	Power Co. Remote Trip Alarm	1
16	CRTB	Power Co. Remote Trip Alarm	1
17	R	Receiver Telephone Line (Ring)	2
18	T	Receiver Telephone Line (Tip)	2
<i>TS F</i>			
7	TMA	Transmitter Output to Trip Recorder	1
8	TMB	Transmitter Output to Trip Recorder	1
9	TFA	Transmitter Fail Alarm	1
10	TFB	Transmitter Fail Alarm	1
17	R	Transmitter Telephone Line (Ring)	2
18	T	Transmitter Telephone Line (Tip)	2
<i>TS G</i>			
1	POS	Customer Battery, Positive (48 or 125V)	2
2	NEG	Customer Battery, Negative (48 or 125V)	2
3	POS A	Customer Battery, Positive (250V)	2
4	NEG A	Customer Battery, Negative (250V)	2
8	GRD	Station Ground	2
<i>TS K</i>			
3	K1 (+)	Trip Keying Input Circuit	2
4	K2 (-)	Trip Keying Input Circuit	2
<i>TS L</i>			
4	FA4	Fuse Alarm to Power Co.	1
5	FA5	Fuse Alarm to Power Co.	1
6	FA6	Fuse Alarm to Power Co.	1
<i>TS M</i>			
8	L2	To Customer Logic	1
9	L1	To Customer Logic	1

TABLE C (Cont)
CUSTOMER AND TELCO INTERFACE LEADS

TERMINAL STRIP & NO.	DESIGNATION	MEANING	NOTES
<i>TS N</i>			
1	T+	To Customer Trip Circuit	2
2	T-	To Customer Trip Circuit	2
<i>TS O</i>			
1	TCT	Alarm to Telephone Co.	1
2	TCR	Alarm to Telephone Co.	1
3	PCT	Alarm to Power Co.	2
4	PCR	Alarm to Power Co.	2

Notes:

1. Optional
2. Always Required

SYSTEM CONFIGURATIONS

3.28 The PR terminal may be connected in any one of five different symmetrical system configurations, as well as many nonsymmetrical configurations. The various symmetrical system arrangements and three typical nonsymmetrical arrangements are illustrated in Fig. 16 through 23. In multipoint systems, a 2-wire bridge circuit at the central office is used to connect the transmit pair to the receive pair of each remote receiver. Only one pair is used to connect the transmitter to the central office. This is illustrated in the 3-point symmetrical system shown in Fig. 17. Interoffice connections are made by 4-wire private line facilities. In the case of a unidirectional system, a 4-wire circuit is still required because of the supervisory transmitter return path (Fig. 21). The 4-point and 5-point symmetrical systems and the 3-point unidirectional system (Fig. 18, 19, and 23, respectively) also require the bridge circuit, but the bridge is omitted in the illustrations for clarity. Each site of a symmetrical multipoint system requires a multipoint combiner. Orderable options must be provided as required for each site. (Orderable and field options are discussed in Section 024-195-200).

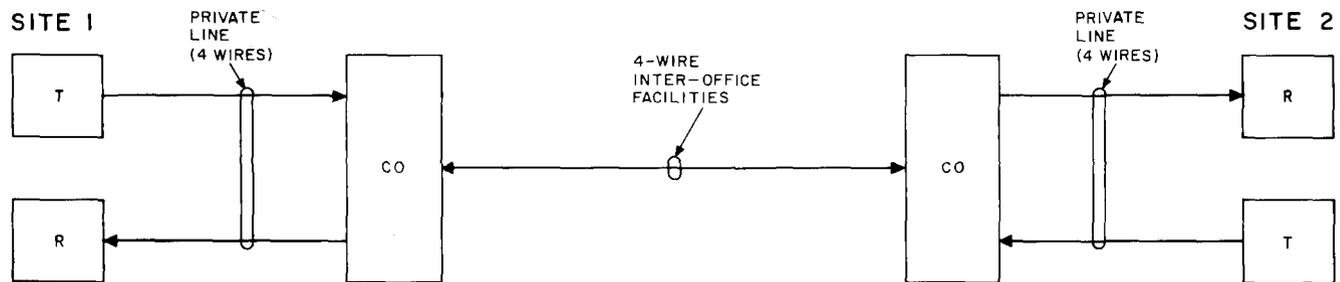
Note: Nonsymmetrical systems may be designed in a large number of configurations for specialized cases. Three examples are presented here as representative of the more

common arrangements. No attempt has been made to cover all possible arrangements; systems not covered herein must be locally engineered, with sufficient detail to facilitate option installation and connections.

INPUT REQUIREMENTS

3.29 Station Battery: The PR terminal is powered from the power company station battery. This voltage may be either 48 or 125 Vdc. Current drain is a maximum of 2A using 48V battery and 1A using 125V battery. Limits on the input voltage are 40 to 54 volts and 100 to 145 volts, respectively. The input voltage may be either positive ground, negative ground, or ungrounded. The converter input module must be selected to match the station battery voltage by orderable option. When the converter input module is equipped for 125V supply, field options are provided for positive ground, negative ground, or ungrounded operation. These options are discussed in detail in Section 024-195-200.

3.30 Keying Input: A fault as detected by the power company fault detector produces a keying input signal of either 48, 125, or 250 volts dc. This keying signal is applied to the keying input module of the interface unit. The keying input module is equipped to accept any one of the three input voltages by orderable option. These options are discussed in detail in Section 024-195-200.



NOTES:

1. EACH T REPRESENTS MAIN AND SUPERVISORY TRANSMITTER.
2. EACH R REPRESENTS MAIN AND SUPERVISORY RECEIVER.

Fig. 16—2-Point Symmetrical System

OUTPUT REQUIREMENTS

3.31 The outputs of the PR terminal consist of guard, trip, trip-hold, and test frequencies, plus various alarms. These signals are discussed individually in the following paragraphs.

3.32 *Guard:* This frequency is produced continuously while the system is in operation and not in the trip or trip-hold mode. The guard frequency is a single 2430-Hz tone transmitted at a level of -4 dBm. The guard tone serves to assure circuit continuity in the idle state.

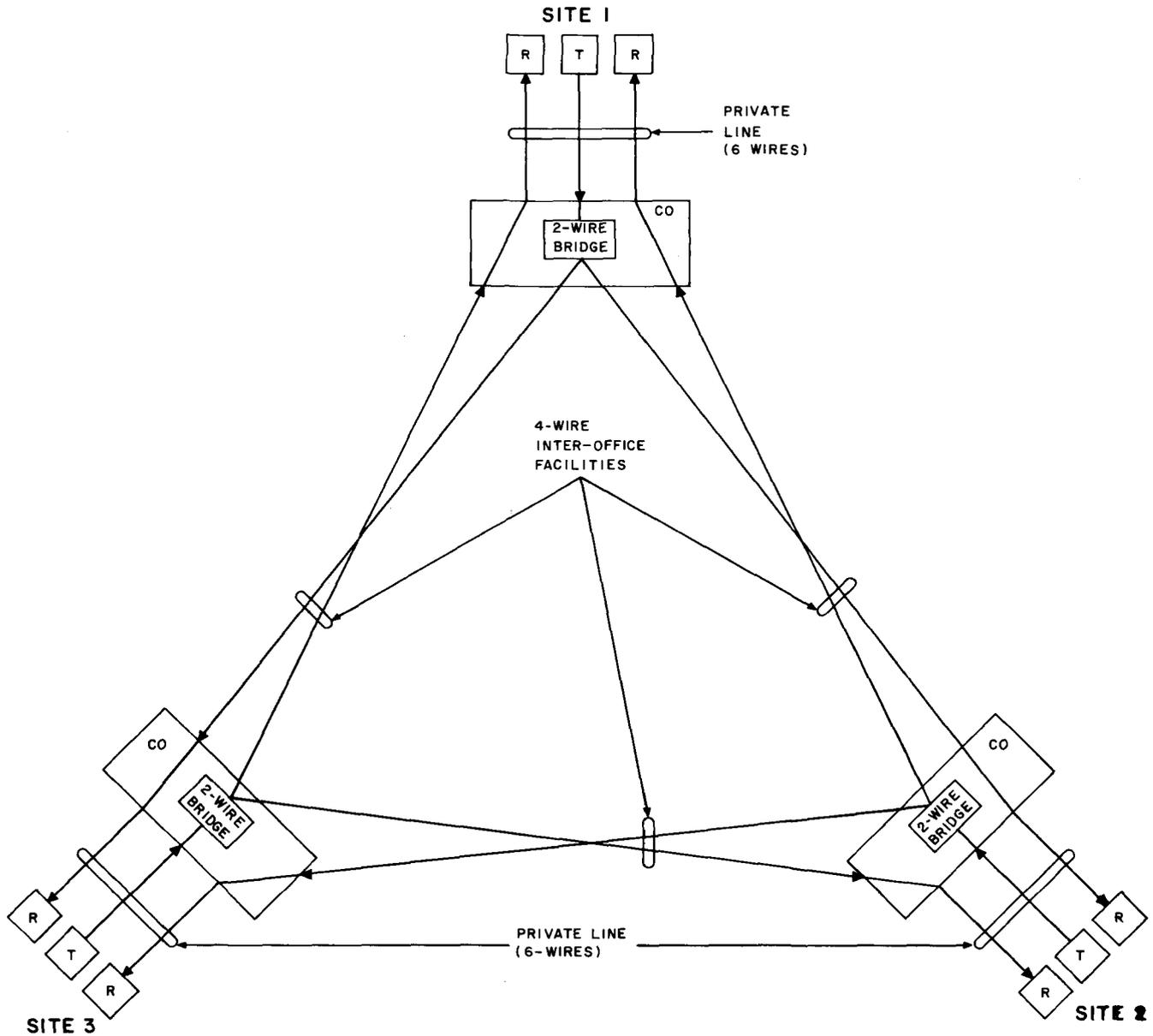
3.33 *Enhanced Trip:* The trip signal is transmitted by the PR terminal in response to a keying input signal from the power company or by operation of the TRIP TEST switch during out-of-service testing. The trip signal is composed of a low frequency (2130 Hz) and a high frequency (2730 Hz) in the absence of the guard frequency. Enhanced trip is transmitted for a timed 70-ms interval at a combined level of $+14$ dBm.

3.34 *Trip Hold:* At the end of the timed (enhanced trip) interval, if the keying input is still present, the combined trip signal is reduced to a level of -4 dBm. Trip hold may be transmitted

indefinitely, so long as the keying input signal remains.

3.35 *HF Test:* This signal is one of two test signals used for in-service testing of the PR terminal. The HF test signal is composed of HF (2730 Hz) and GF (2430 Hz) signals from the main transmitter and 1595 Hz from the supervisory transmitter. The HF (2730 Hz) frequency is transmitted for a timed 70 ms at the enhanced ($+11$ dBm) level, and then reduced to the trip hold level (-7 dBm) for an additional 130 ms. Successful transmission of and response from the HF test causes the HF OK lamp to light and initiates the LF test.

3.36 *LF Test:* This signal is the second test signal used for in-service testing. The LF test signal is composed of LF (2130 Hz) and GF (2430 Hz) signals from the main transmitter and 1595 Hz from the supervisory transmitter; it can only be generated after completion of the HF test. As in the case of the HF test, these signals are transmitted for a timed 70 ms at the enhanced level, and then at the reduced level for an additional 130 ms. Successful transmission of and response from the LF test causes the TEST OK lamp to light.



NOTES:

1. EACH **T** REPRESENTS MAIN AND SUPERVISORY TRANSMITTER.
2. EACH **R** REPRESENTS MAIN AND SUPERVISORY RECEIVER.
3. MULTIPOINT COMBINER REQUIRED AT EACH SITE.

Fig. 17—3-Point Symmetrical System

ALARMS

3.37 Various alarms are used to indicate trouble within the PR system. Both visual and audible alarms are used. A total of ten alarms are located on the PR terminal. The various alarms are discussed individually in the following paragraphs.

Receiver

3.38 **LINE FAIL:** This alarm lamp is illuminated when noise on the line precludes reliable trip reception, and is activated by the squelch circuit. It is also activated when both guard and trip frequencies are simultaneously absent.

3.39 **TRIP:** This alarm lamp illuminates when a trip signal has been received. Although the trip signal turns off when the guard state returns, the trip alarm remains until manually reset by the trip RELEASE switch on the receiver control panel.

3.40 **REM LINE FAIL:** The remote line fail alarm lamp illuminates when a line fail condition exists at a remote terminal, as detected by the main receiver at that remote site. (See 3.38).

3.41 **REM TRIP:** The remote trip alarm lamp illuminates when a trip has been received at a remote terminal, as detected by the main receiver at that remote site. (See 3.39).

Transmitter

3.42 **SIG FAIL:** The signal fail alarm lamp illuminates when none of the transmitter signals (LF, GF, HF) are present.

Alarm Module

3.43 **TRIP:** The trip alarm lamp on the alarm interface module illuminates when a local or

remote trip signal is received by any receiver in the system, providing a visual alarm. It may be disabled by the TRIP DISABLE switch.

3.44 **ALM:** This alarm lamp illuminates when any other alarm condition exists except the TRIP alarm. It may be disabled by the ALARM DISABLE switch.

3.45 **AUD ALM:** The audible alarm is actuated and produces a loud audible signal when any alarmable condition occurs. It may be disabled by the AUD ALARM DISABLE switch.

Interface Module Panel

3.46 **SYSTEM ALM:** This alarm lamp illuminates whenever any other alarm is actuated.

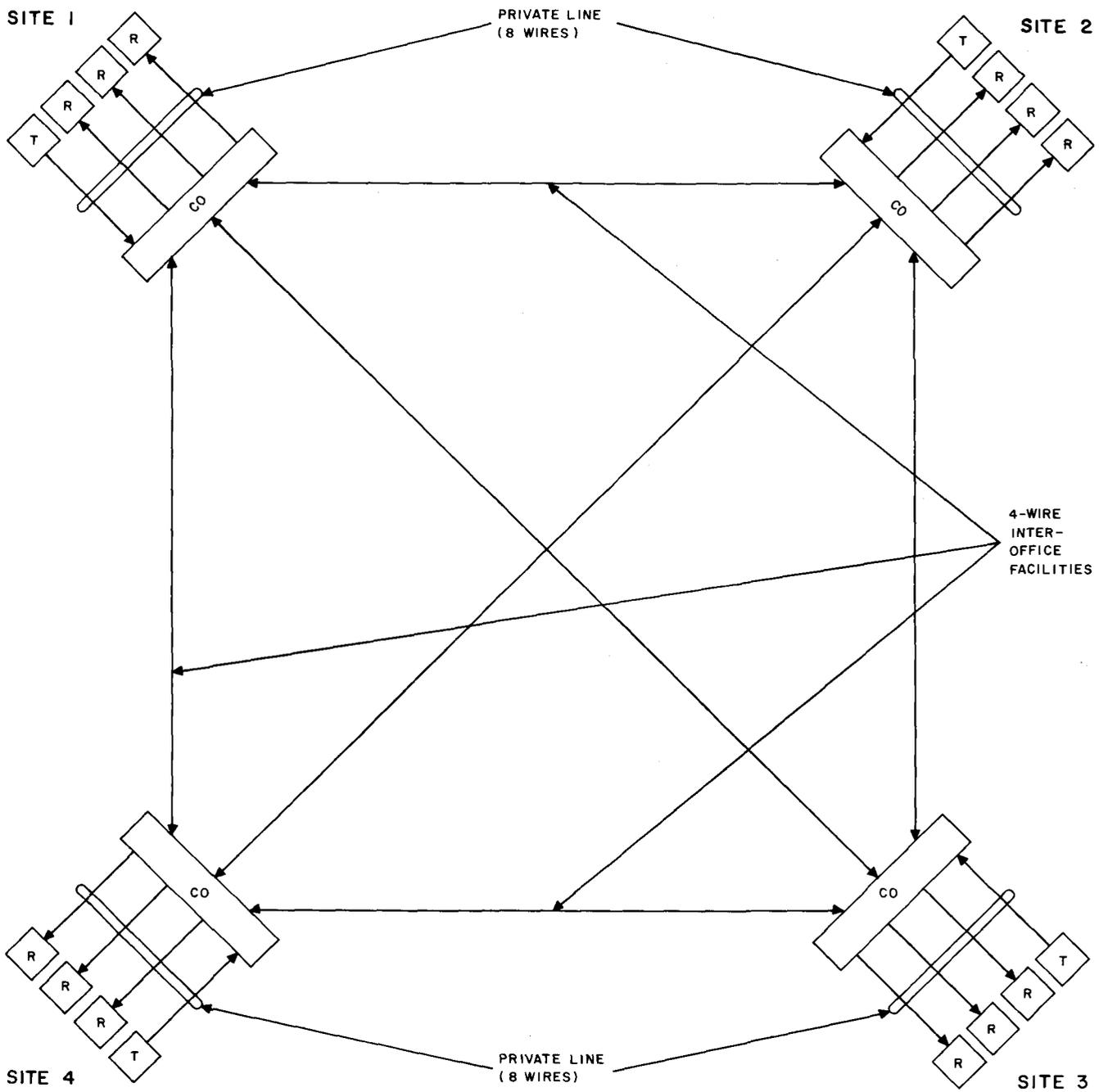
3.47 **ALM DISABLE:** When the TRIP or ALM signal on the alarm module is disabled by operating the associated DISABLE switch, the ALARM DISABLE lamp illuminates.

3.48 In addition to the alarms located on the PR terminal, some of the alarms are presented to the customer on interface leads to provide alarms external to the PR terminal (see Table C).

4. OPERATION

4.01 The PR terminal is designed to operate continuously and unattended. There are no operational procedures requiring personnel unless a fault occurs. The PR terminal performs its primary function only during an actual power company fault, or during testing, which is covered in Section 024-195-500.

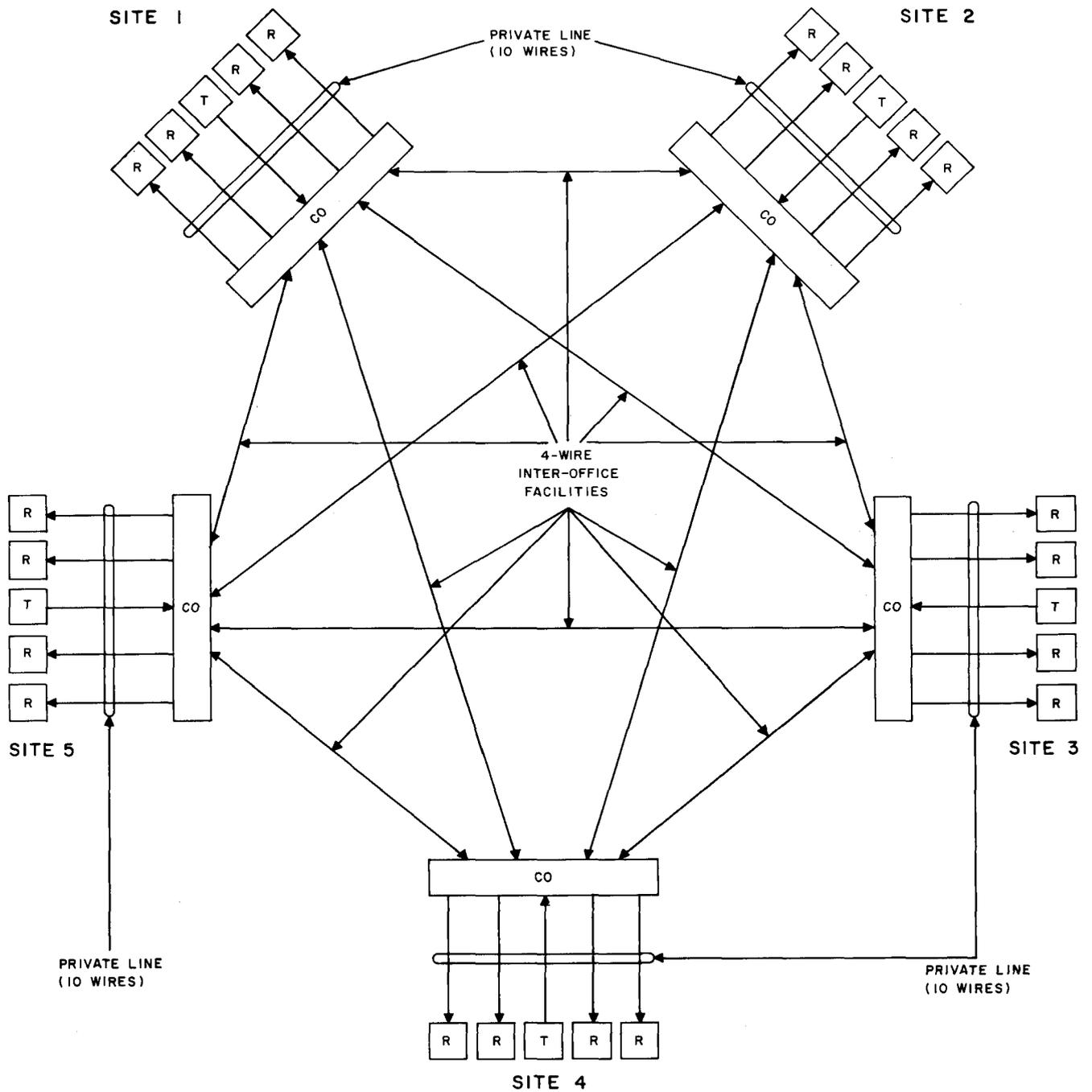
4.02 For a general discussion of the operation of the PR terminal under fault conditions, see Part 3 of this section.



NOTES:

1. EACH T REPRESENTS MAIN AND SUPERVISORY TRANSMITTER.
2. EACH R REPRESENTS MAIN AND SUPERVISORY RECEIVER.
3. MULTIPOINT COMBINER REQUIRED AT EACH SITE.

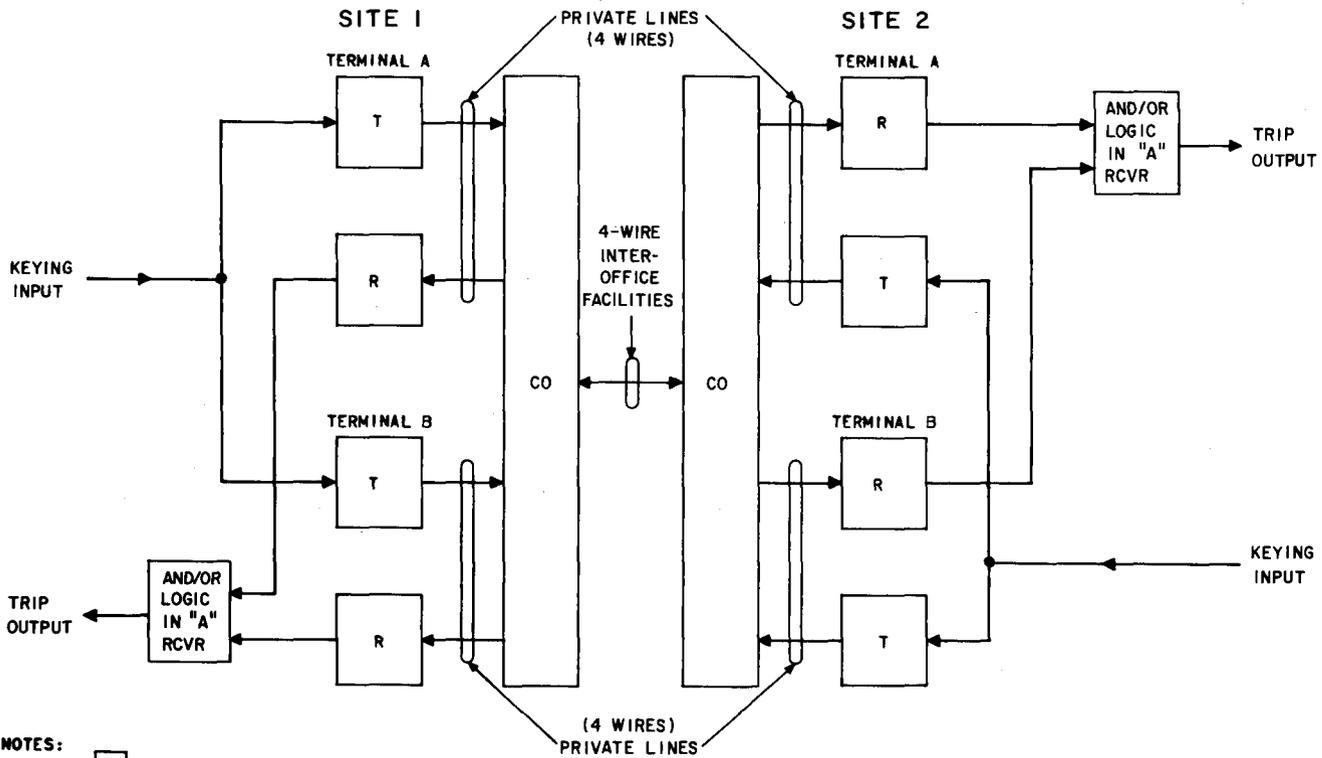
Fig. 18—4-Point Symmetrical System



NOTES:

1. EACH **T** REPRESENTS MAIN AND SUPERVISORY TRANSMITTER.
2. EACH **R** REPRESENTS MAIN AND SUPERVISORY RECEIVER.
3. MULTIPOINT COMBINER REQUIRED AT EACH SITE.

Fig. 19—5-Point Symmetrical System



- NOTES:
1. EACH T REPRESENTS MAIN AND SUPERVISORY TRANSMITTER.
 2. EACH R REPRESENTS MAIN AND SUPERVISORY RECEIVER.

Fig. 20—2-Point Dual Channel Symmetrical System

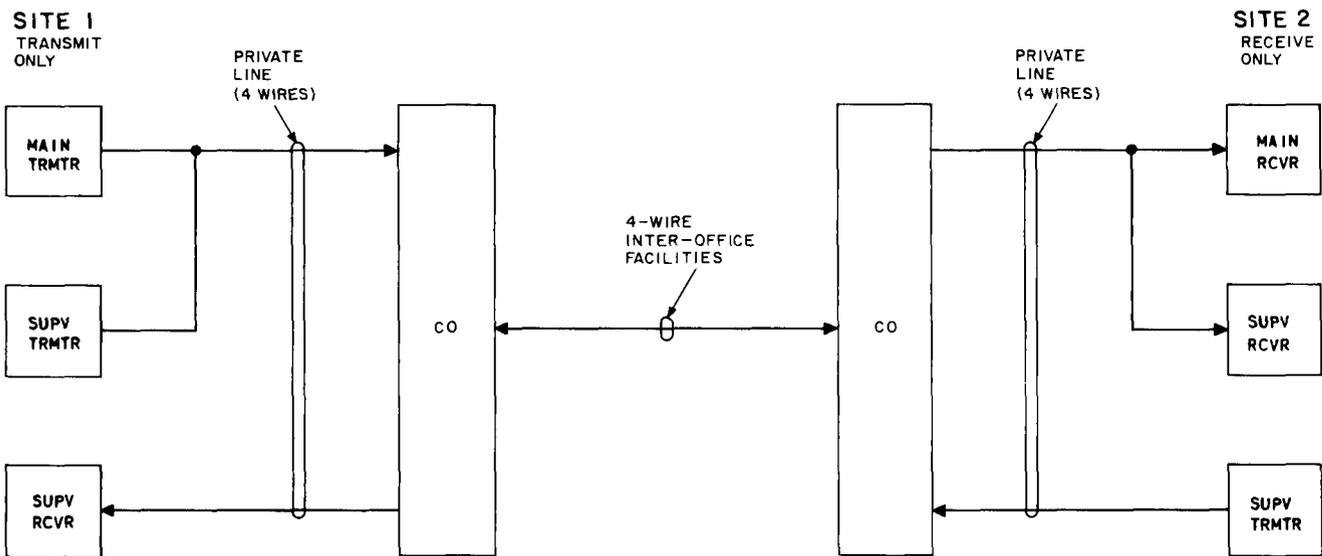


Fig. 21—2-Point Unidirectional Single Channel System

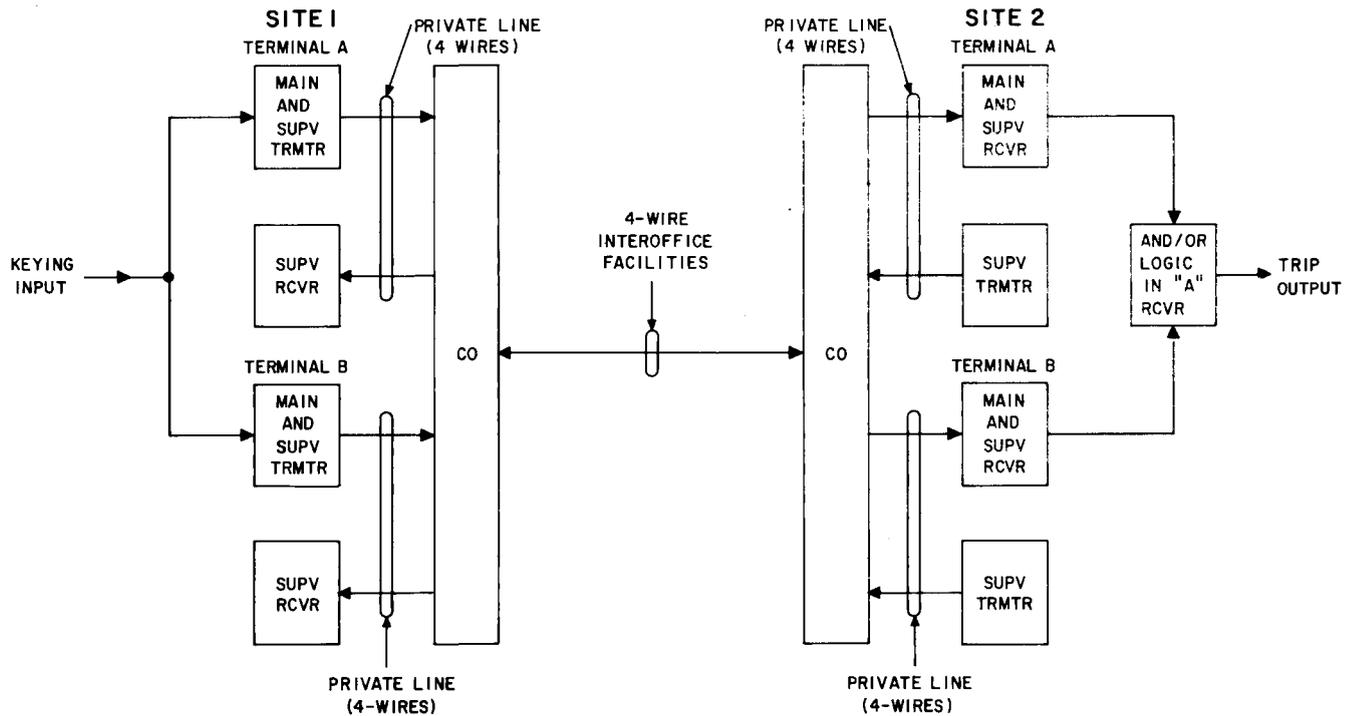


Fig. 22—2-Point Unidirectional Dual Channel System

5. REFERENCES

5.01 The following documents provide additional information on the 1A protective relaying terminal.

SECTION	TITLE
024-195-200	1A Protective Relaying Terminal—Installation and Connections
024-195-300	1A Protective Relaying Terminal—Maintenance
024-195-500	1A Protective Relaying Terminal—Test Requirements
310-540-100	Protective Relaying Channel—Description and Initial Lineup
310-540-500	Protective Relaying Channel—Maintenance and Test Requirements

SECTION

TITLE

800-612-154	Connecting and Soldering Individual Conductors
851-201-100	1A Protective Relaying Terminal—System Considerations
851-201-101	1A Protective Relaying Terminal—Transmission Considerations
876-310-100	Electrical Protection of Wire Plant Communication Facilities Serving Power Stations
811-025-150	1A Protective Relaying Terminal—Facilities Serving Power Industry—Equipment Design Requirements—Private Service Systems
SD-&CD-1G267-01	Private Service Systems—1A Protective Relaying Terminal—Facilities Serving Power Industry

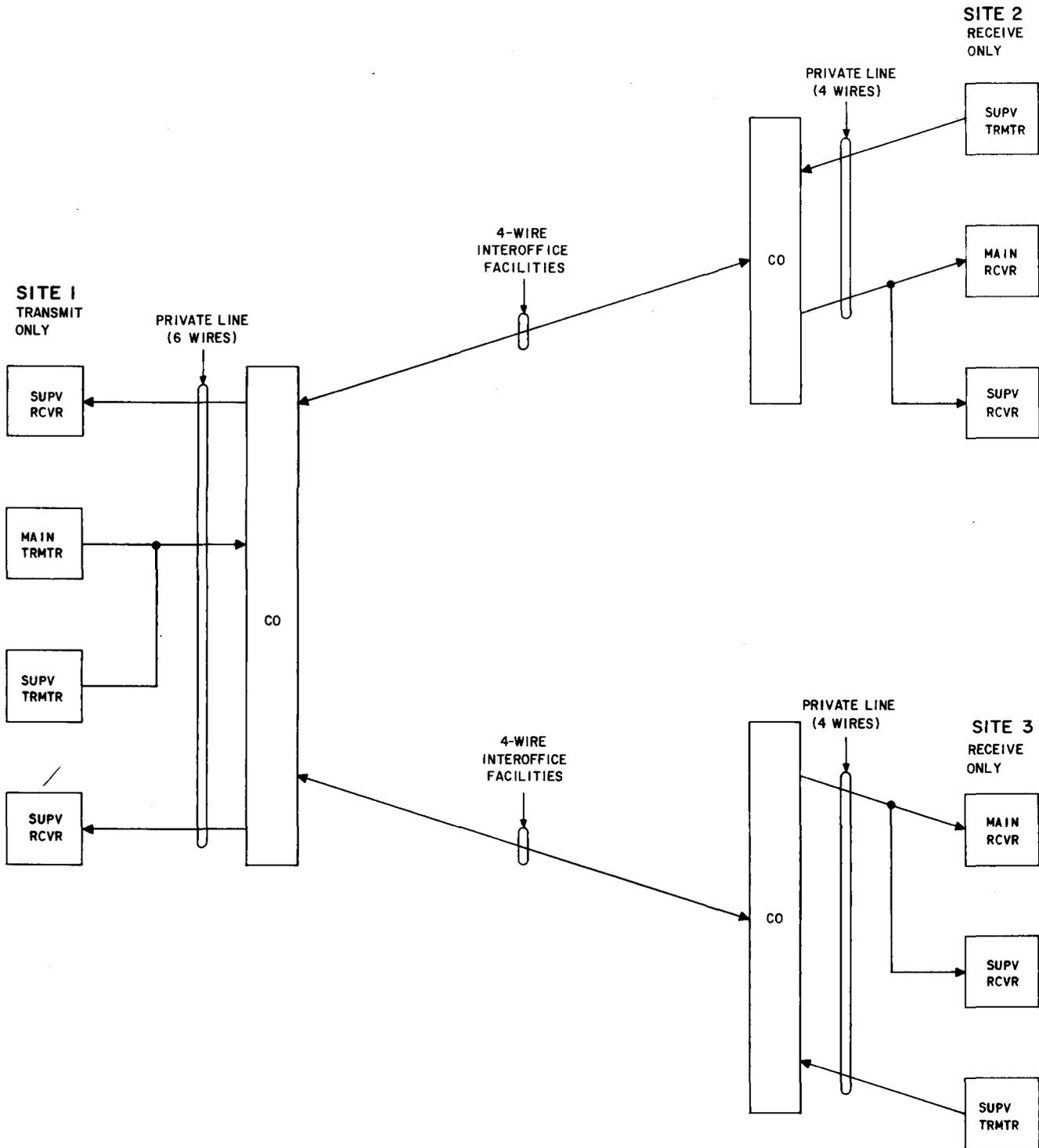


Fig. 23—Unidirectional Transmitter With Two Receivers