TEST CIRCUITS

DESCRIPTION

NO. 3 ELECTRONIC SWITCHING SYSTEM

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1. GENERAL

1.01 This section describes in general terms the test circuits in the No. 3 Electronic Switching System (ESS).

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

1.03 Test circuits provide the facilities for automatically or manually testing the lines, trunks, and service circuits (Table A).

2. PHYSICAL DESCRIPTION

2.01 Test circuits are mounted on type FB circuit packs in the test frame and control frame(s). False cross and ground, power cross detector, and restore verify circuits, which are part of the test vertical test circuit, are located in bay 1 of the control frame(s) (Fig. 1). The remainder of the test circuits are located in the test frame (Fig. 2).

2.02 Circuits used in manual testing are located in the test frame. These are:

- Voltmeter
- Telephone
- Transmission measuring set

- Trunk and line test panel (TLTP).

3. FUNCTIONAL DESCRIPTION

PERIPHERAL TEST CIRCUIT

3.01 The **peripheral test circuit** (SD-3H520-01) consists of the test circuits located in the test frame. Under call processing software control, the peripheral test circuit verifies the condition of the peripheral circuits, which are:

- Trunk circuits
- Junctor circuits
- Service circuits
- Network fabric.

A. Continuity and Polarity Detector—FB500

3.02 The continuity and polarity detector, in addition to checking continuity, determines the polarity of any dc voltage found on a trunk. To prevent tripping of the supervisory element of the distant office and causing a false seizure, a high impedance (1800 ohm) port is provided. Figure 3 is a functional diagram of the circuit state showing the various test conditions.

B. Dial Pulse Receiver Test Circuit—FB501, FB502

3.03 The dial pulse receiver test circuit (Fig. 4) tests customer dial pulse receivers (CDPR) by simulating loop conditions and transmitting signaling information. The test circuit is connected to the CDPR via a network appearance.

3.04 The circuit provides four basic functions:

- Testing 2-party coin detection
- Testing CDPR battery
- Simulating loop and leak conditions
- Simulating pulsing conditions.

3.05 The customer dial pulse receiver test circuit consists of two circuit packs, FB501 and FB502. The FB501 pack contains relays A, B, C, D, and E with connections to the switching network and master scanner circuit. The FB501 provides the following circuit functions:

- Tip party nonoperate
- Tip party operate
- Range extension
- Line leakage simulation
- 5 ringers simulation
- Loop resistance simulation
- Pulse logic control
- Logic circuit power supply.

3.06 The FB502 contains the following pulse control circuits:

- Clock buffer
- Pulse-per-second (PPS) rate generator
- Percent (%) break generator
- Pulse counter
- Pulse generator.

Relays F (pulse start) and P (pulse output) are on this circuit pack. An 881A ringing and tone plant supplies a 440-Hz signal which is divided down to the required pulse rates to be employed in testing.

3.07 Figure 5 shows the state of the dial pulse receiver test circuit. With 10K ohms across tip and ring simulating leakage, CDPR **test 1** simulates a 100 ohm short loop with five ringers. With 10K ohms across tip and ring, **test 2** simulates a 100 ohm short loop with no ringers. **Test 3** simulates a 1630 ohm long loop with no ringers.

3.08 There are four pulsing conditions as set by relays D and E. These are:

- 20.95 PPS, 52.38 % break
- 12.94 PPS, 50.00 % break
- 20,95 PPS, 71.43 % break

- 12.94 PPS, 70.60 % break.

A pulse cycle is 12 pulses. When the start pulsing relay (relay F) is activated, 12 pulses are sent.

3.09 The **tip-party nonoperate** test simulates a no-coin condition or ring party by providing a 10K ohm resistance between tip and ground with ring lead open. A CDPR operating correctly will not respond.

3.10 **Tip-party operate** test provides a 5100 ohm resistance between tip and ground to simulate a coin-in-slot or tip party. A CDPR operating correctly will respond.

3.11 A **CDPR reverse battery** test checks the tip for -48 volts and the ring for ground and saturates scan point SC00 when these conditions are present.

3.12 **Range extension** is a variation of the CDPR battery test and checks for -72 volts on the ring, and ground on the tip.

C. Transmission Test Termination—FB504

3.13 Transmission test termination circuit pack FB504 provides termination for trunks and lines under test. The circuit (Fig. 6) provides an ac open via an inductor when relay OP is operated or an ac short via a capacitor when relay OP is released.

D. Milliwatt and Transmission Environment Test Circuit—FB505, FB506, FB507, FB508, FB509

3.14 The milliwatt (mW) and transmission environment test circuit consists of two ports which provide mW reference signals or balanced terminations. The two ports can be used in a loop-around mode with various signal attenuation. A resistor circuit is used in tip to ring continuity checks. Figure 7 is a functional block diagram of the test circuit.

3.15 The test circuit is used primarily in transmission tests by providing the following:

- Two 0-dBm 1 kHz signal ports
- Balanced termination
- Loop-around connection
- Attenuation pads for multifrequency receiver and transmitter testing.

The loop-around test mode has a 60A control unit inserted to prevent toll fraud. Table B shows the milliwatt and transmission environment circuit state.

3.16 **FB505** is one of two milliwatt ports (Port 0). The circuit (Fig. 8) is used to connect trunks, lines, and junctors to either the milliwatt generator or the termination pads via FB507. FB505 consists of a level pad for junctor testing and a balanced termination and milliwatt connection circuit.

3.17 With the exception of the level pad used for junctor testing, **FB506** (Fig. 9) performs the same functions as FB505.

3.18 **FB507** (Fig. 10) performs two basic functions, ie, connecting the network appearance to the required circuit and supplying attenuation pads (pads A) used in multifrequency (MF) receiver testing.

3.19 The **flat-loss pad** is a 15.4 dBm attenuator which is used for testing the six tones of the MF transmitter and for marginal testing of MF receiver circuits. The **twist pad** at 700 Hz has an attenuation of 4 dBm and at 1000 Hz, 10 dBm which, with the MF receiver test circuit, tests the ability of the MF receiver to detect tone differences of 6 dBm. The **MF detect-nondetect** pad with the tone presence circuit tests the MF transmitter signal level. The detect mode provides 23.4 dBm attenuation. The tone presence circuit detects signals greater than -6.5 dBm. The nondetect mode provides 25 dBm attenuation. In this mode the tone presence circuit will not detect signals less than -5.5 dBm.

3.20 The **FB508** (Fig. 11) connects the network appearance (via FB507) to one of the following:

- Transmission environment pads A (FB507)
- 60A control unit
- Transmission environment third frequency oscillator (FB509)
- Transmission environment pads B (FB508).

3.21 Tip and ring of the network appearances are connected to pads A of FB507 when relay AA is active. With relay DD active, tip and ring are connected to pads B and the third frequency oscillator. Tip and ring are connected to the 60A control unit when all relays are released. Relay EE sets the output level of FB509 and connects pads B to the tip and ring circuit.

3.22 Third frequency oscillator, **FB509** (Fig. 12), supplies a 1100 Hz tone at -12 dBm or -21 dBm. With relays DD operated and AA released, pin 206 of FB509 is shorted to ground which enables the oscillator. Output level is controlled by shorting resistor R2 of the modulation level pad. Relay EE of FB508 released shorts R2 and the level is -21 dBm. With R2 not shorted the level is -12 dBm.

E. Loop Environment Test Circuit—FB510

3.23 The loop environment test circuit (Fig. 13) provides various terminations for tests. The types of termination are:

- Open circuit
- Trip and nontrip test
- Safety trip operate and nonoperate test
- Minimum leakage resistance detect and nondetect
- Coin relay operate and nonoperate
- Return voltage test
- Tip, ring plus and minus power cross test
- Ground or loop start restore verify test.

Figure 14 shows the state diagram of the loop environment test circuit, **FB510.**

F. Trunk and Line Test Panel—FB511, FB512, FB513, FB514, FB515

3.24 The trunk and line test panel (TLTP) (Fig. 15), voltmeter (Fig. 16), and transmission measuring set (Fig. 17) provide circuits for manually testing all trunks, junctors, lines, and service circuits. The TLTP has two network appearances (access trunks 1 and 2) to connect to two lines, trunks, or service circuits at the same time. Figure 18 is the network path used by the TLTP. However, voltmeter or tranmission tests can be performed on only one line, trunk, or junctor at a time. Jacks are provided (under writing shelf) for connecting external test equipment to the access trunks or the milliwatt generator.

3.25 Trunk, line, junctor, and service circuits can be taken out or put into service from the TLTP.

3.26 Incoming and outgoing calls to the TLTP are placed over the communication (COMM) line. Incoming calls can also be made to the access trunks.

3.27 Operation of the TLTP is covered in Section 233-135-105, Trunk and Line Test Panel, Description and Theory of Operation.

G. Tone Presence Detector—FB516, FB517

3.28 The tone presence detector detects the presence of a tone greater than a preset level for a predetermined amount of time.

3.29 In voice test mode, signals greater than -22 dBm with frequencies greater than 200 Hz and pulses less than 5 seconds in length are detected. In junctor test mode, signals greater than -1.2 dBm are detected.

3.30 Circuit pack **FB516** (Fig. 19) is the tone presence amplifier and detector, while **FB517** (Fig. 20) contains timing circuits, logic circuits, and ±12 volt and +5 volt power supply used by FB516 and FB517. Figure 21 shows the tone presence detector state of the circuit.

H. Local Test Desk and Test Cabinet Incoming Trunk Circuit—FB519

3.31 The local test desk incoming trunk circuit (Fig. 22) interfaces No. 3 ESS lines to either a No. 14 or No. 16 local test desk (LTD) or a No. 3 test cabinet (TC). An office may have up to two FB519 circuits. The LTD or TC are connected to FB519 via a dedicated pair, or if beyond the 1500 ohm loop length, an SD-99311 far-end test trunk circuit.

3.32 The **FB519** provides connections to the station ringer and TOUCH-TONE test circuits via

the switching network. The FB519 also provides line status information to the processor via ferrods. Figure 23 depicts the local test desk incoming trunk circuit states.

I. Station Ringer Test Line Circuit—FB521, FB522

3.33 The station ringer test line circuit (Fig. 24) is used with the TOUCH-TONE station test circuit (J1A033FR-1, L1) LTD or TC to check customer sets and line conditions.

3.34 The station ringer test circuit has a tip and ring network and a ringing and tone plant appearance. The test circuit is accessed at the station being tested by dialing the proper directory number. Then the test circuit will connect tip and ring of the station and LTD to the TOUCH-TONE station test circuit and return dial tone. A station TOUCH-TONE dial can be tested by depressing each TOUCH-TONE button in numerical sequence. If all frequencies are accepted, a double pulse of high tone will be returned with a dial tone. If the station switchhook is flashed, high tone is returned. When the receiver is placed on-hook, ringing current will be returned. High tone is returned when the station goes off-hook. The test circuit is dropped from the line when the station goes back on-hook. The circuit tests for low ring-ground resistance on permanent signal lines. These lines are made high and dry. Figure 25 shows the station ringer test line circuit state.

J. TOUCH-TONE Receiver Test Circuit—FB526, FB527, FB528, FB529

3.35 The TOUCH-TONE receiver test circuit (Fig. 26) generates TOUCH-TONE signals to check proper response of TOUCH-TONE receivers.

3.36 Frequencies of 672 Hz through 1692 Hz are generated to provide both inband and out-of-band frequencies. Output levels are selected as 0 dBm, -10 dBm, or -12 dBm. High and low tones can be generated separately or together. A third tone is generated to test third tone rejection. Peripheral decoder points set register bits which determine the circuit state.

K. Automatic Line Insulation Test Circuit—FB669

3.37 The automatic line insulation test (ALIT) circuit (Fig. 27) tests tip and ring for short and ring to ground (SRG), tip and ring to ground (TRG), or for foreign potential (FEMF). Figure 28 is the state diagram of the ALIT circuit.

TEST VERTICAL

A. Test Vertical Access Circuit—FB417

3.38 The test vertical access circuit (Fig. 29) provides the following six test functions:

- Test vertical network access
- Test vertical test circuit access
- No-test access
- Power cross-check
- False cross and ground check
- Restore verify check.

3.39 Access is provided to any 15B grid access point via an FB417 circuit pack on the wire side and another pack on the circuit side of the network. Two FB419 circuit packs are used to access the following test circuits:

- Tone presence detector
- Milliwatt and transmission environment
- Continuity and polarity test
- Loop environment
- TLTP circuits.

3.40 Two no-test states are provided for operator bridge-on and local test desk access via the FB417 circuits.

B. False Cross and Ground, Restore Verify Circuit—FB420

3.41 False cross and ground check (Fig. 30) tests tip and ring for resistive crosses to battery and ground and for tip and ring crosses. An **FB420** circuit pack is used on the circuit side and

another one on the wire side B-link. Restore verify checks continuity of the network to the line scanner. The restore verify circuit should saturate the line scanner.

C. Power Cross Circuit—FB422

3.42 Power cross circuit (Fig. 31) tests outside plant loop for foreign potential (FEMF). The FB420 and FB422 circuit packs are used on the wire side and another pair on the circuit side. As a part of call processing, a power crosscheck is completed on outside loops before being connected to the network to aid in preventing damage to the network by high voltage on the loop.

4. POWER

4.01 Power requirements for each circuit are provided by the frame on which each circuit is mounted except for ringing voltages, ±130 volts, +48 volts, and +24 volts, which are provided by the miscellaneous power frame. Battery boost (variable 1 to 13 volts dc) is provided by converters located on the network frame.

4.02 Except for MF receivers and TOUCH-TONE receivers which have a POWER OFF key, fuse removal is the only way to remove power from trunk, service circuit, or junctor circuit packs. Before removing a fuse all associated circuits must be removed from service via a TTY input message. Fuse failures are indicated via scan points.

5. MAINTENANCE

5.01 Circuits that have been removed from service by the system are indicated by a teletypewriter message as they are removed. An out-of-service list is maintained and may be requested via the teletypewriter.

5.02 Specific maintenance procedures are outlined in Task Oriented Practices (TOP). Volume 233-143-100 contains trouble analysis data and 233-142-100 provides routine maintenance procedures.

6. REFERENCES

6.01 The following Bell System Practices are pertinent and relative to this section.

SECTION	TITLE
233-000-003	No. 3 ESS General Description
233-120-100	No. 3 ESS Switching Network Description and Theory of Operation
233-121-100	No. 3 ESS Scanner Description and Theory of Operation
233-135-100	No. 3 ESS Test Equipment Description
233-135-105	No. 3 ESS Trunk and Line Test Panel Description and Theory of Operation
233-140-100	No. 3 ESS Office Maintenance Description
233-142-100	No. 3 ESS TOP Office Equipment
233-143-100	No. 3 ESS TOP Trouble Analysis Data

6.02 The following list of documents contains schematic diagrams (SDs), circuit descriptions (CDs), and circuit pack schematics (CPSs) regarding test circuits.

DOCUMENT	TITLE
SD/CD-3H520-01	Peripheral Test Circuit
CPS-FB500	Continuity and Polarity Test Circuit
CPS-FB501	DPR Test—Tip and Ring
CPS-FB502	DPR Test—Pulse Control
CPS-FB504	Transmission Test Termination
CPS-FB505	Milliwatt and Transmission Environment Test Circuit, Port 0
CPS-FB506	Milliwatt and Transmission Environment Test Circuit, Port 1

CPS-FB507	Milliwatt and Transmission Environment Test Circuit, Pads A
CPS-FB508	Milliwatt and Transmission Environment Test Circuit, Pads B
CPS-FB509	Milliwatt and Transmission Environment Test Circuit, Oscillator
CPS-FB510	Loop Environment Test Circuit
CPS-FB519	Incoming Local Test Desk Trunk Circuit
CPS-FB521	Station Ringer Test Circuit, Tip and Ring
CPS-FB522	Station Ringer Test Circuit, Dial Pulse Detector and Scanner Driver
CPS-FB526	TOUCH-TONE Receiver Test Circuit, D-Sine Converter
CPD-FB527	TOUCH-TONE Receiver Test Circuit, Output Stage
CPS-FB528	TOUCH-TONE Receiver Test Circuit, Power Supply
CPS-FB529	TOUCH-TONE Receiver Test Circuit, Divide Counter
CPS-FB669	Automatic Line Insulation Test Circuit
SD/CD-3H902-01	Control Frame Circuit
CPS-FB417	Test Vertical Access Circuit
CPS-FB420	False Cross and Ground, Restore Verify Circuit
CPS-FB422	Power Cross Test Circuit

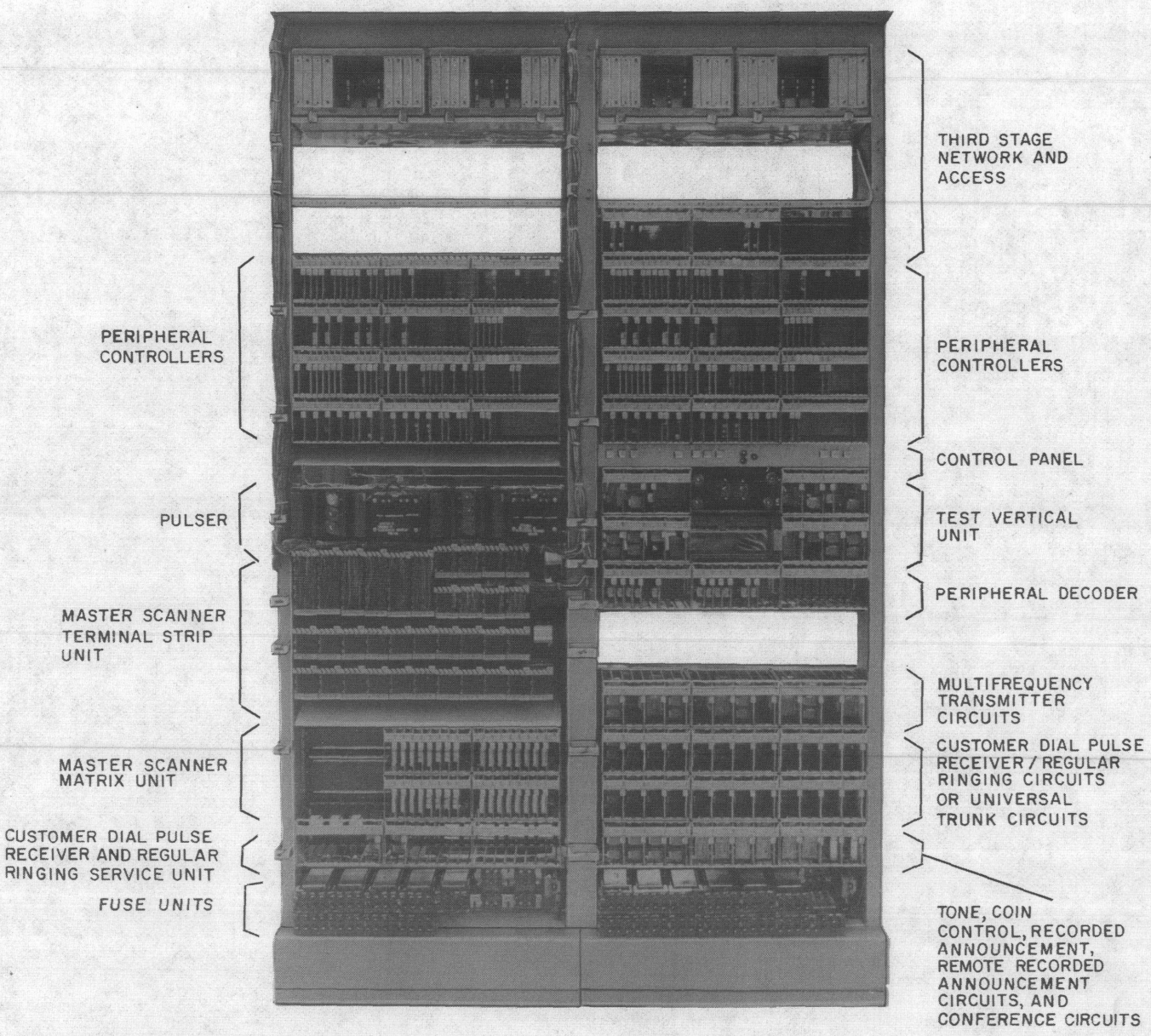


Fig. 1—Control Frame

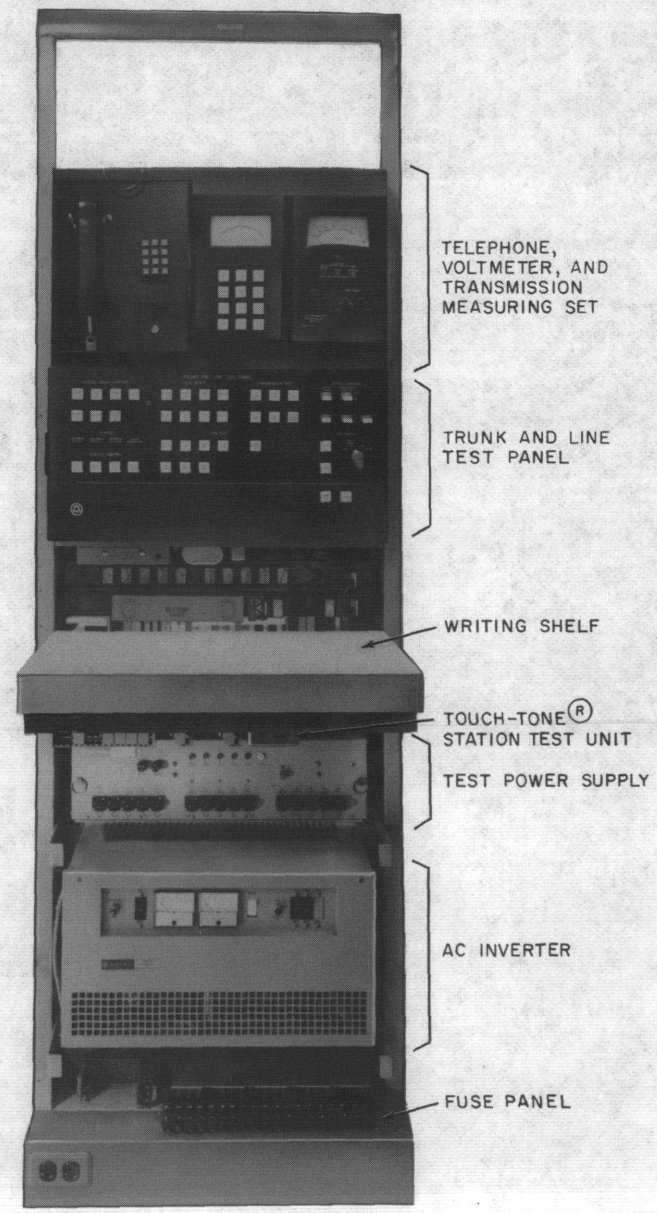
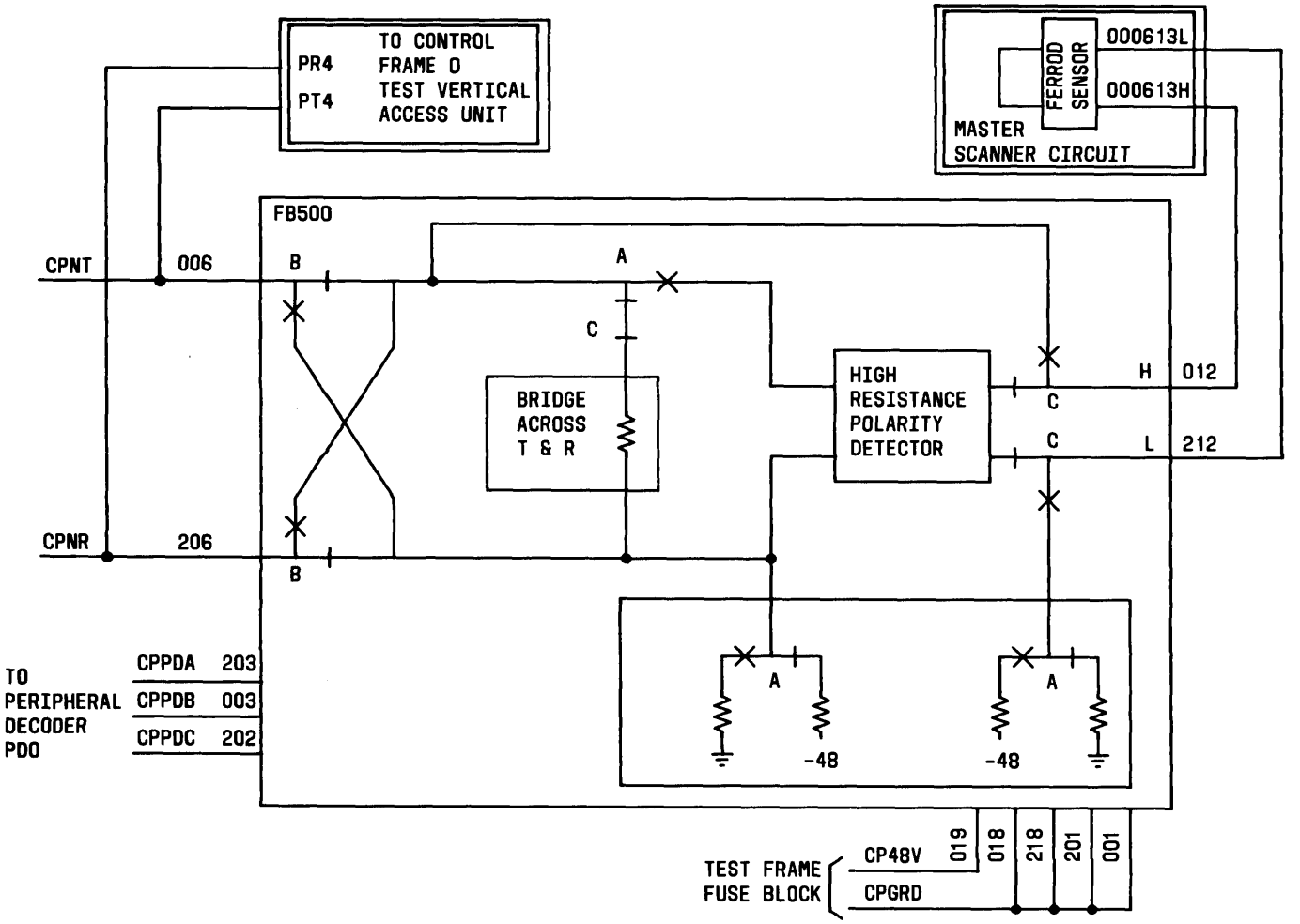


Fig. 2—Test Frame



C \ A	1800Ω BRIDGE & CONTINUITY	HIGH IMPEDANCE POLARITY DETECTION	HIGH IMPEDANCE REVERSE POLARITY DETECTION	NOT USED
LOW IMPEDANCE GROUND ON TIP RESISTANCE				
LOW IMPEDANCE BATTERY ON TIP RESISTANCE				
LOW IMPEDANCE BATTERY ON RING RESISTANCE				
LOW IMPEDANCE GROUND ON RING RESISTANCE				

B

Fig. 3—Continuity and Polarity Detector—FB500, Functional Diagram and State Table

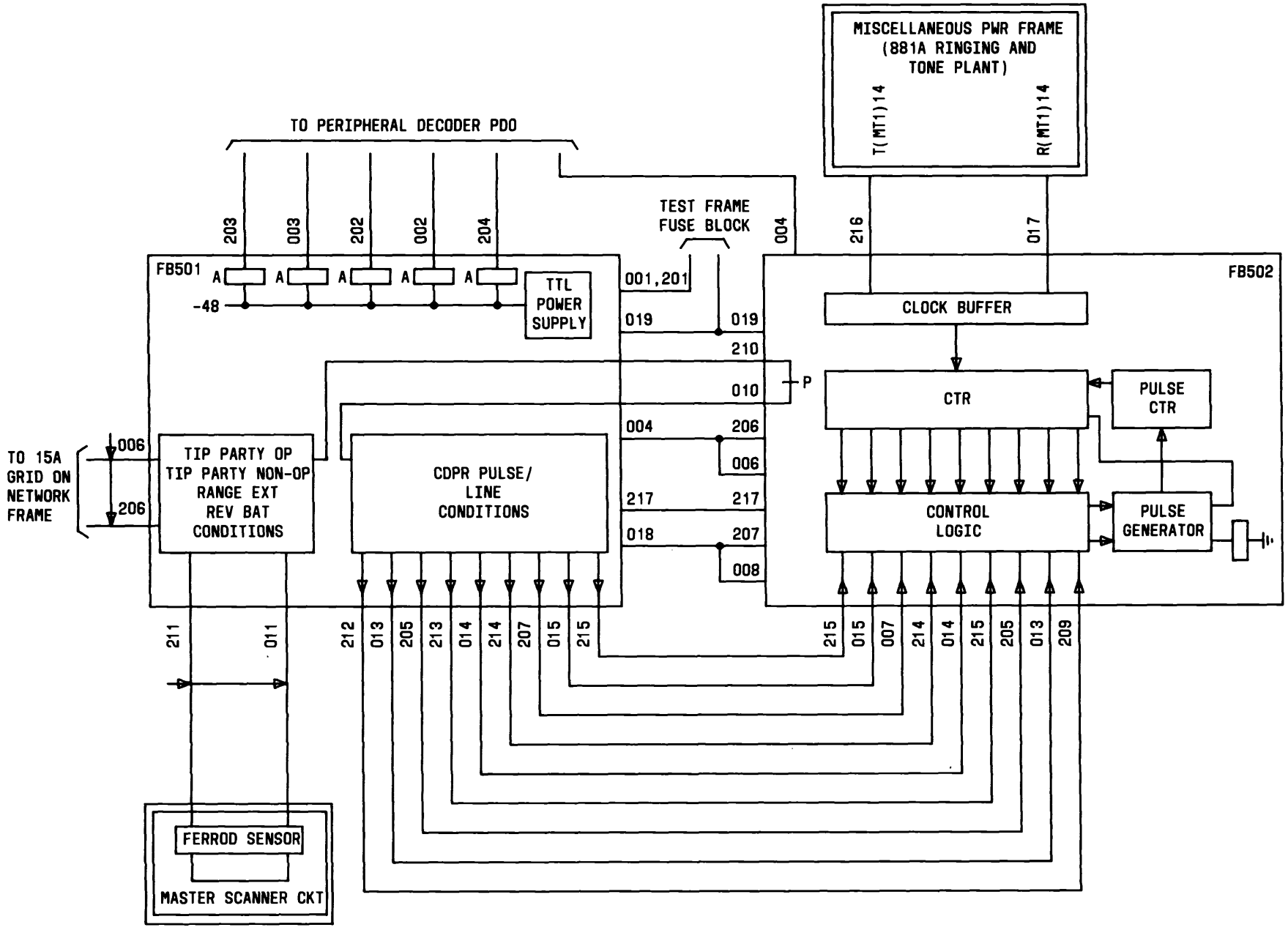


Fig. 4—Dial Pulse Receiver Test Circuit—FB501, FB502

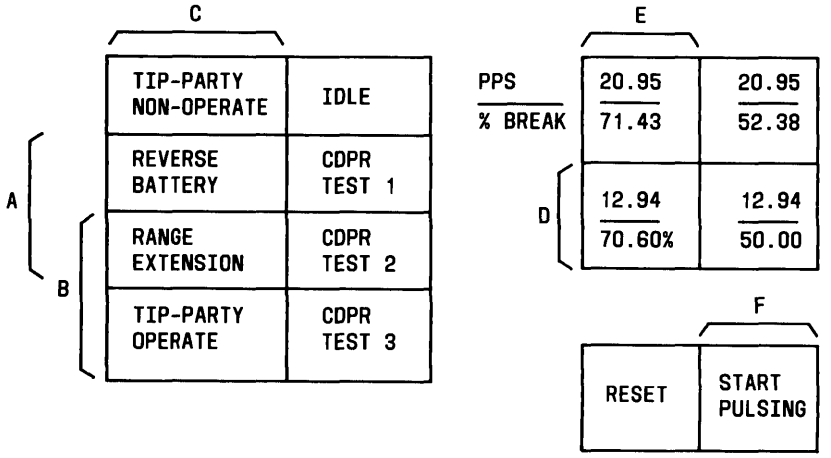


Fig. 5—Dial Pulse Receiver Test Circuit State

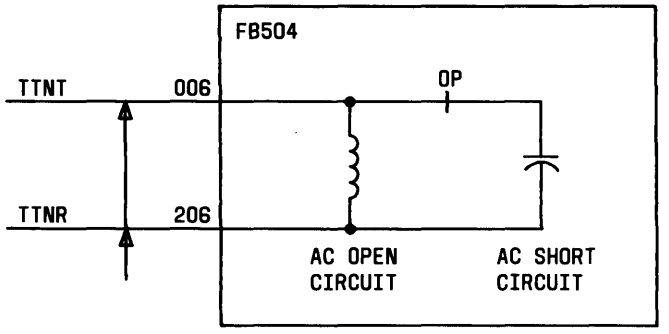


Fig. 6—Transmission Test Termination—FB504

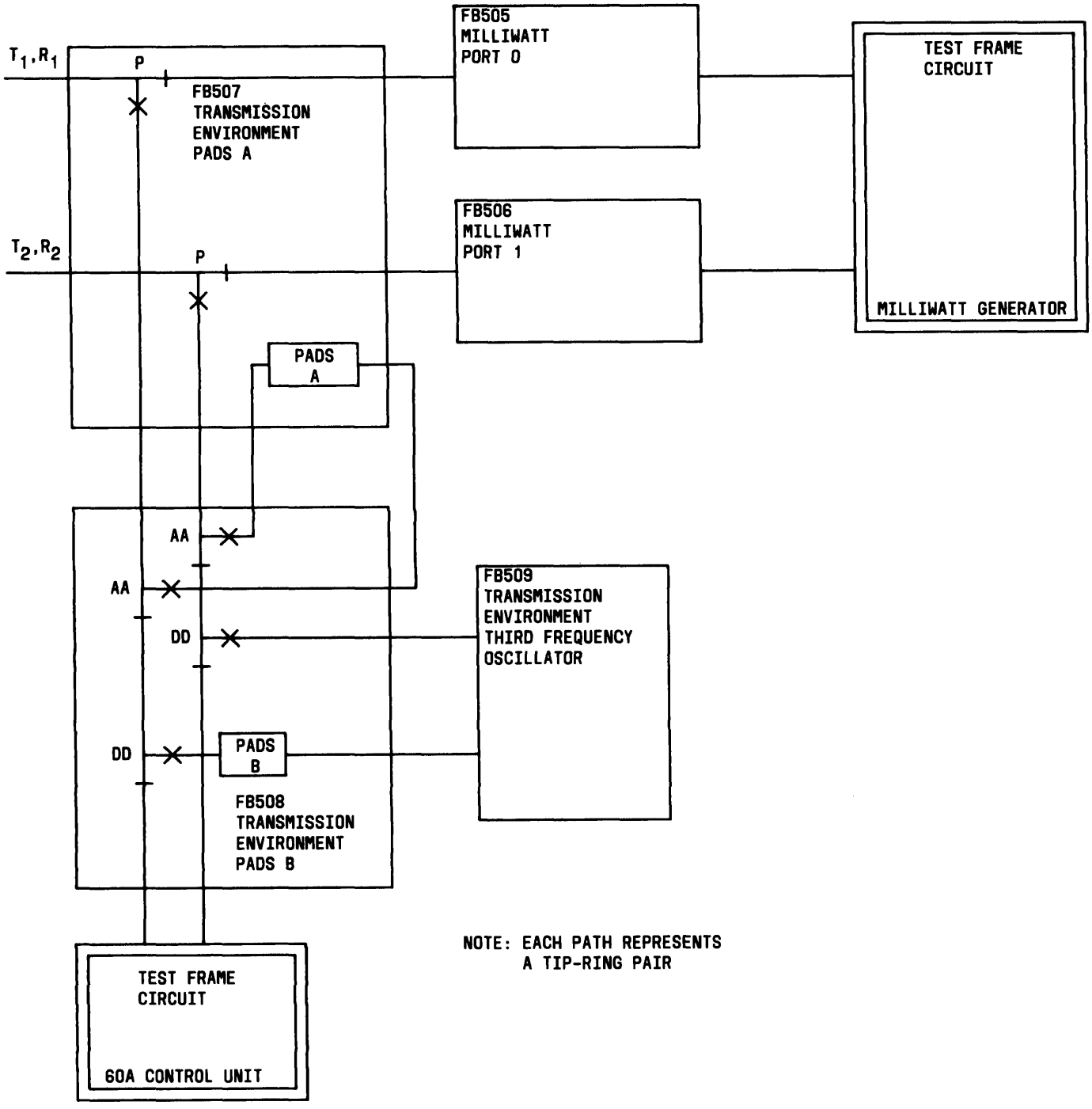


Fig. 7—Milliwatt and Transmission Environment Test Circuit Functional Diagram

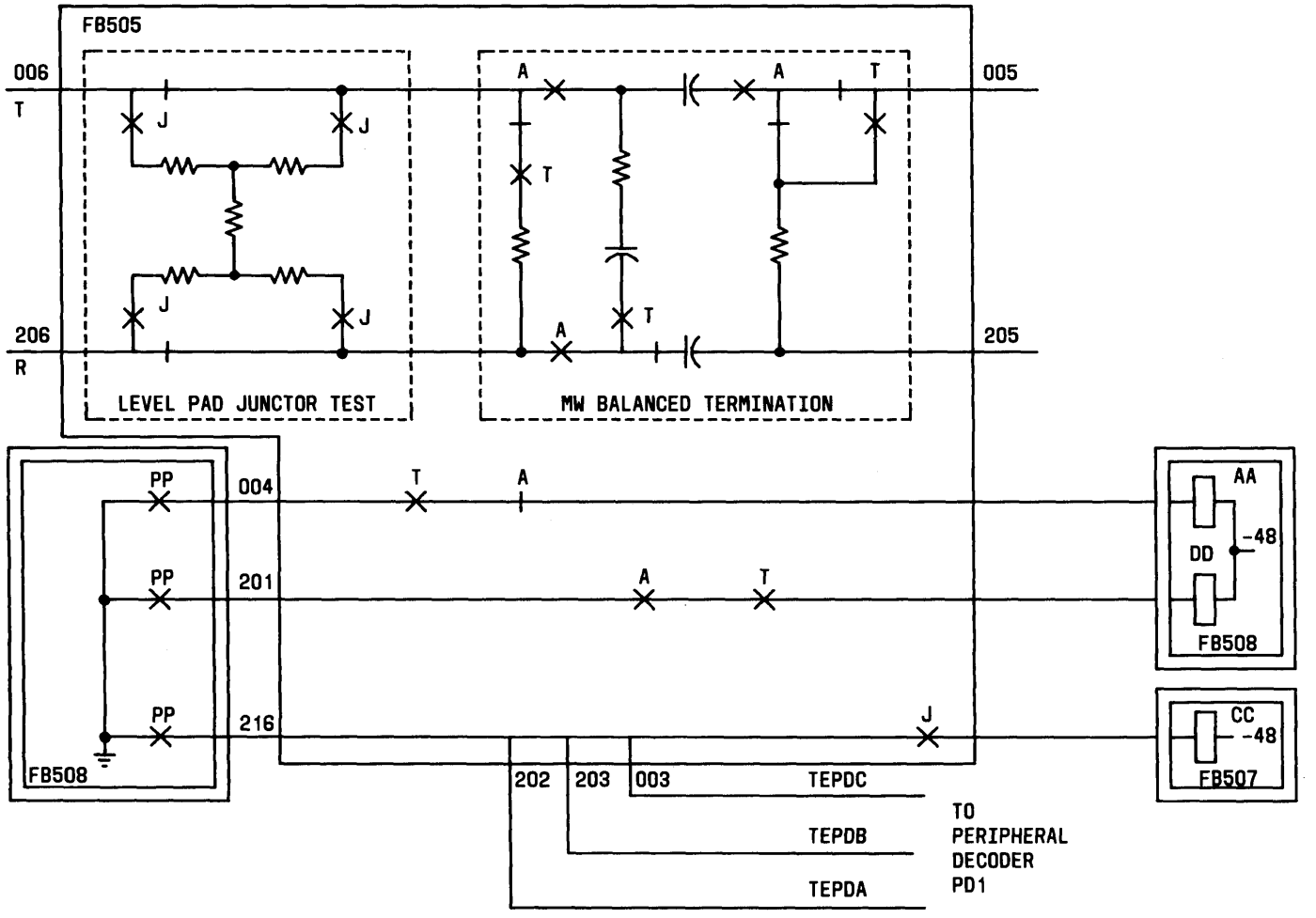


Fig 8—Milliwatt and Transmission Environment Test Circuit Port 0—FB505

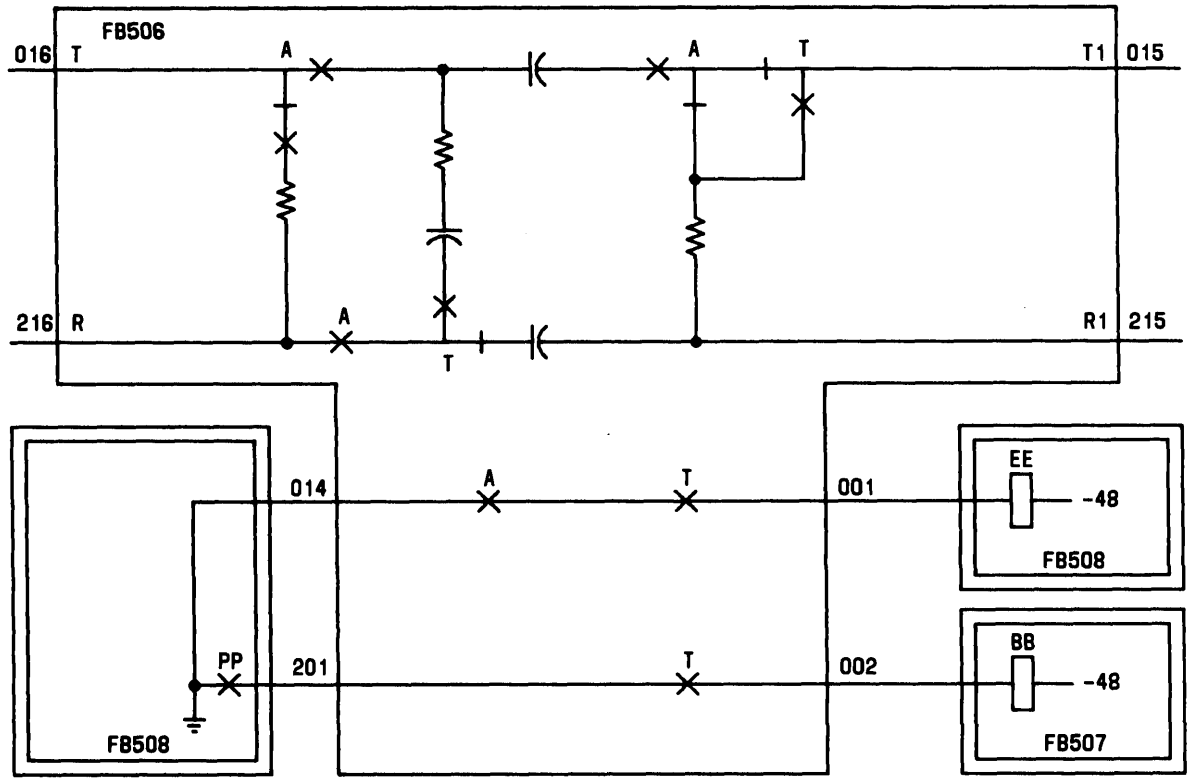


Fig. 9—Milliwatt and Transmission Environment Test Circuit Port 1—FB506

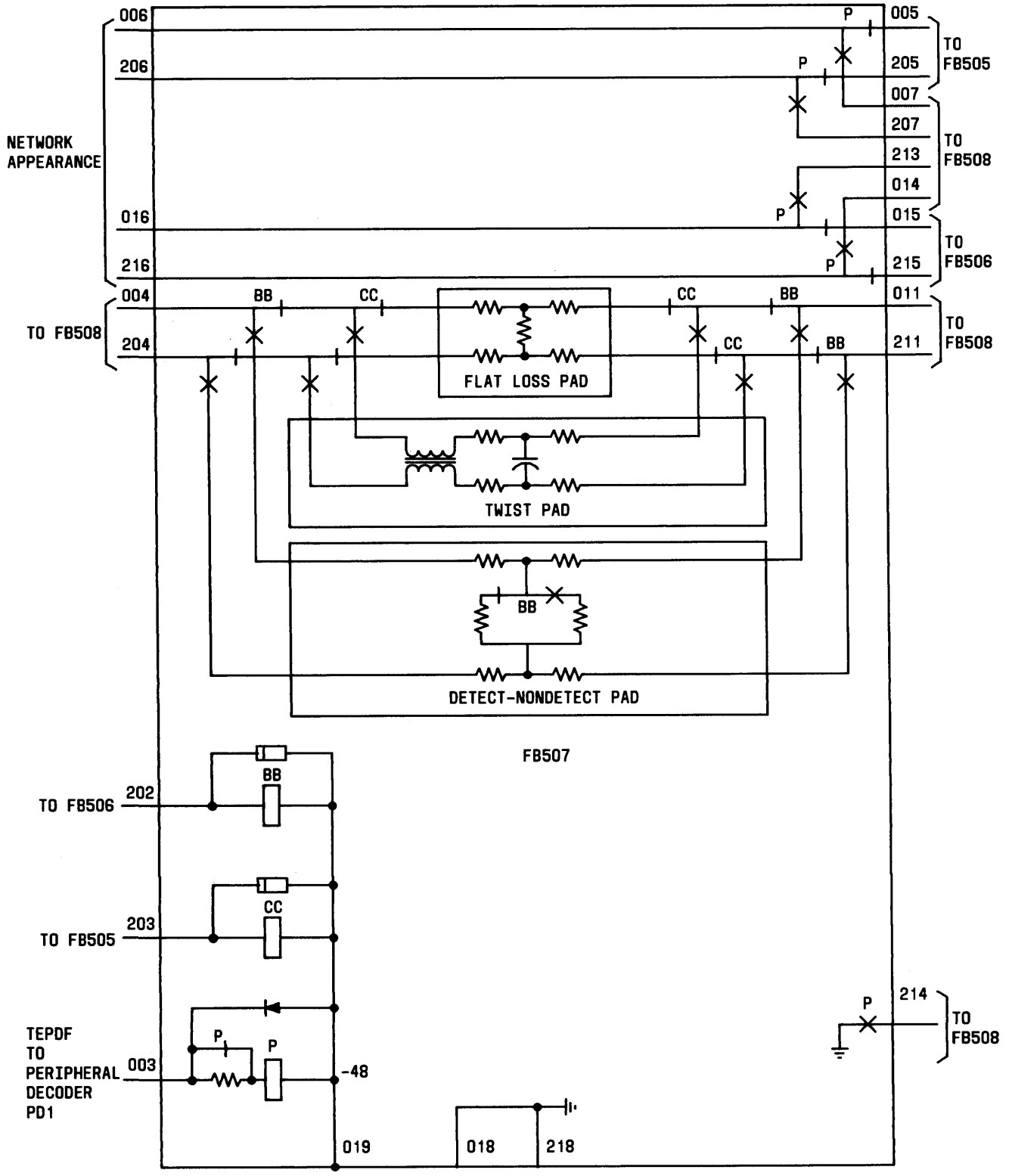


Fig. 10—Milliwatt and Transmission Environment Test Circuit Pads A—FB507

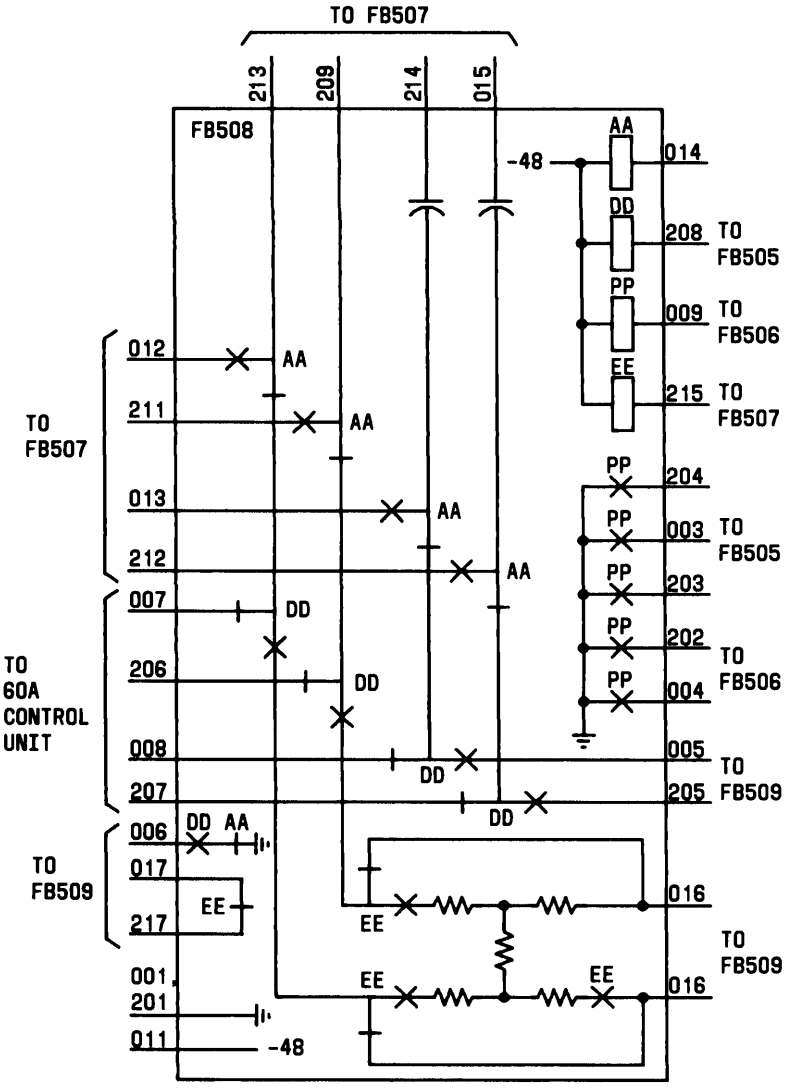


Fig. 11—Milliwatt and Transmission Environment Test Circuit Pads B—FB508

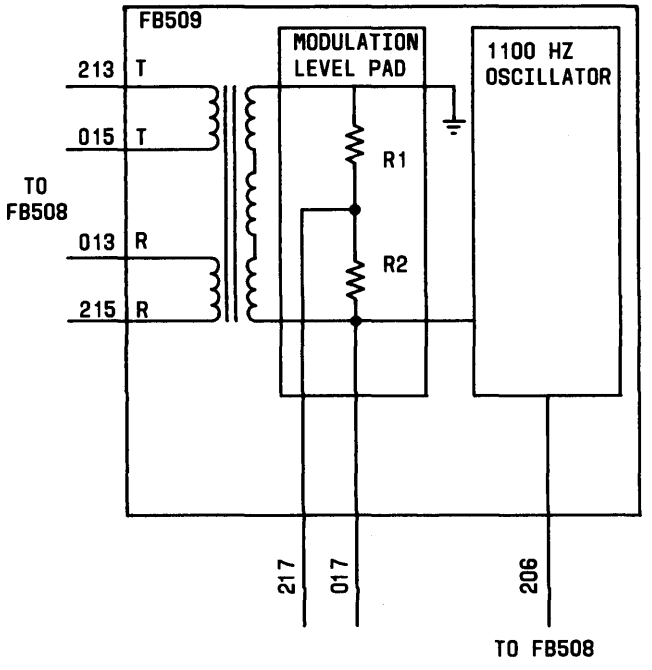


Fig. 12—Milliwatt and Transmission Environment Test Circuit Third Frequency Oscillator—FB509

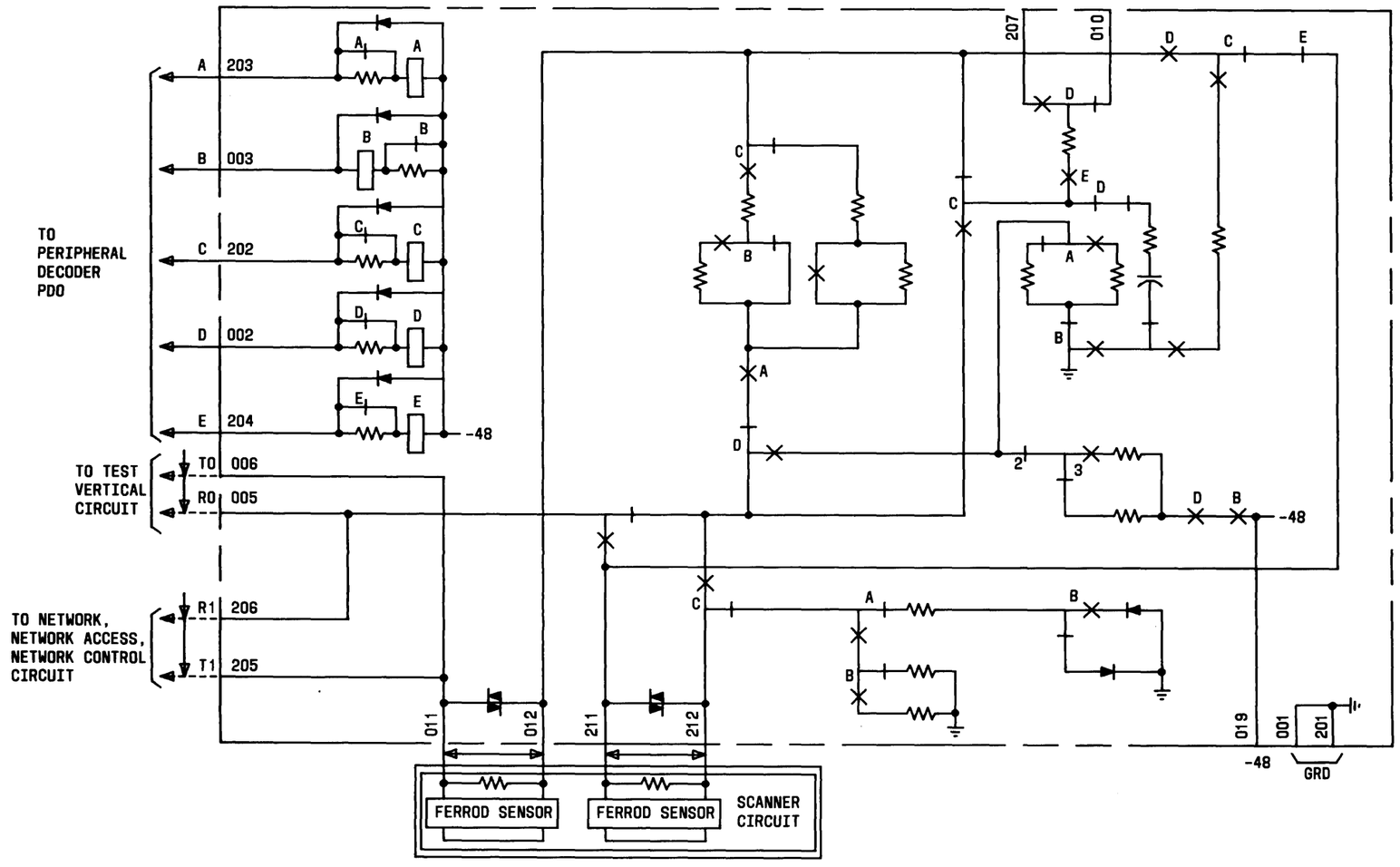


Fig. 13—Loop Environment Test Circuit—FB510

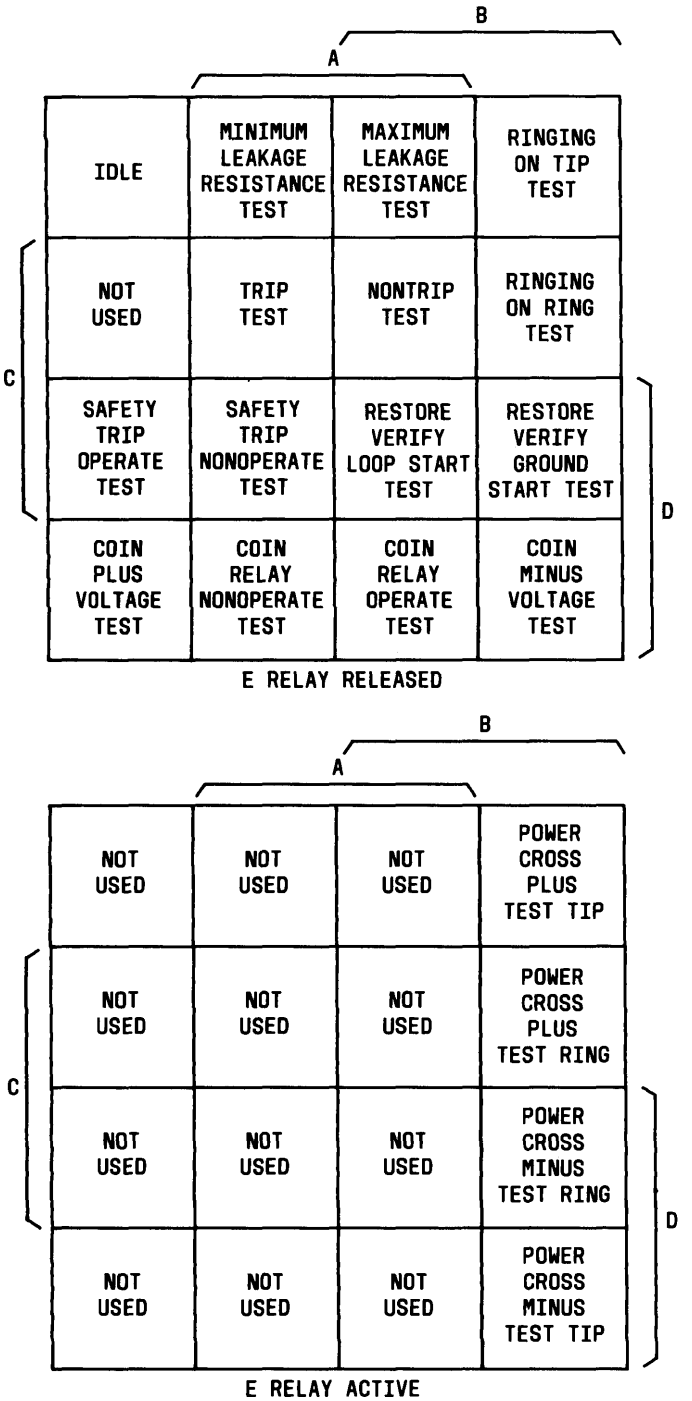


Fig. 14—Loop Environment Test Circuit States

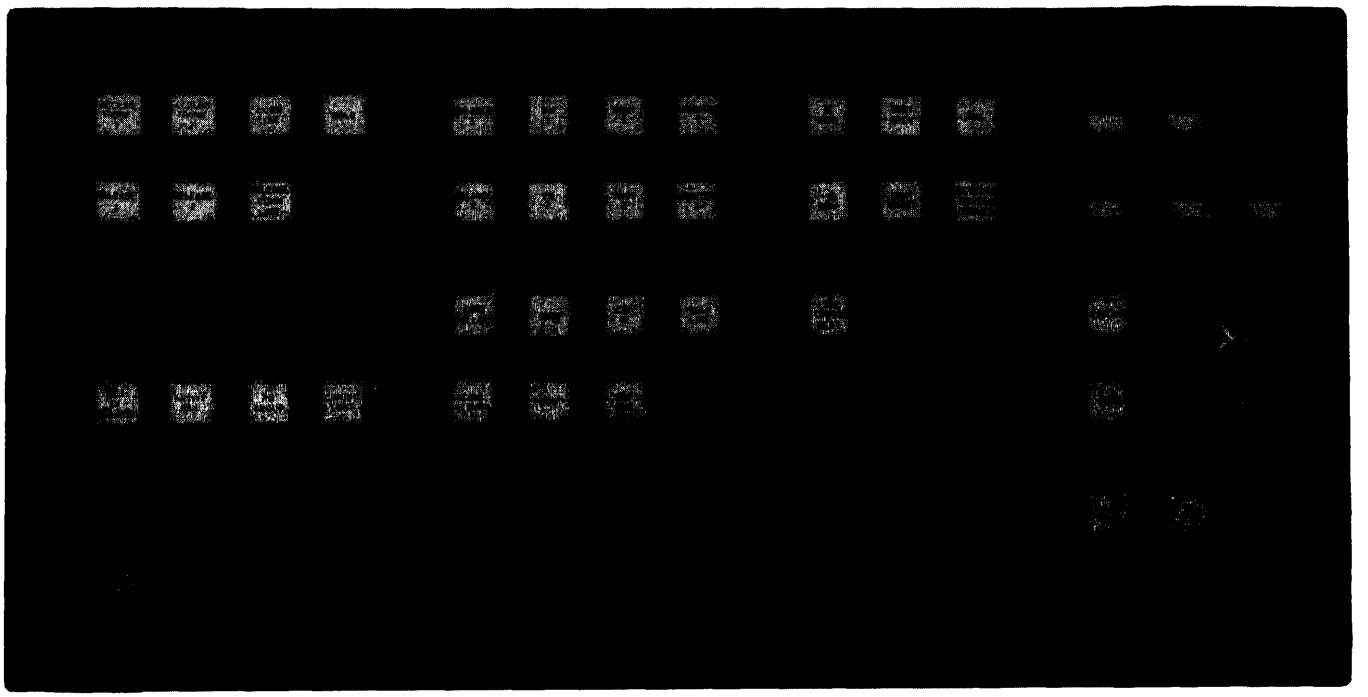


Fig. 15—Trunk and Line Test Panel

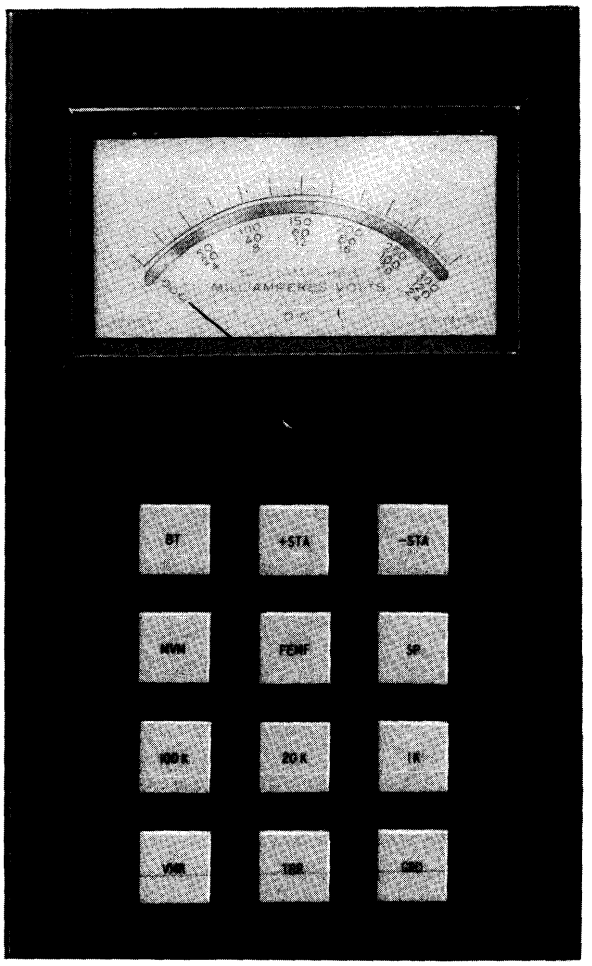


Fig. 16—TLTP Voltmeter

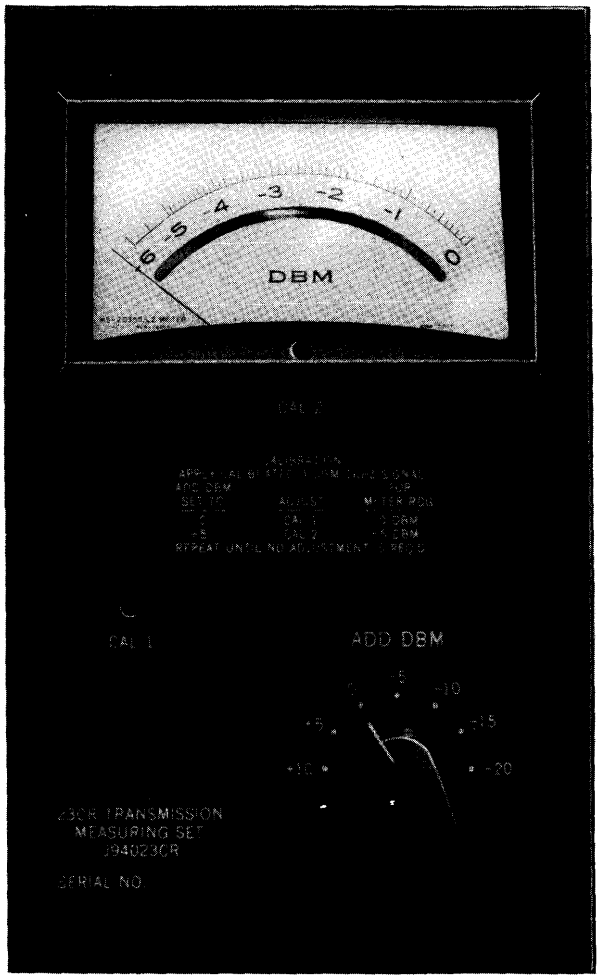


Fig. 17—TLTP Transmission Measuring Set

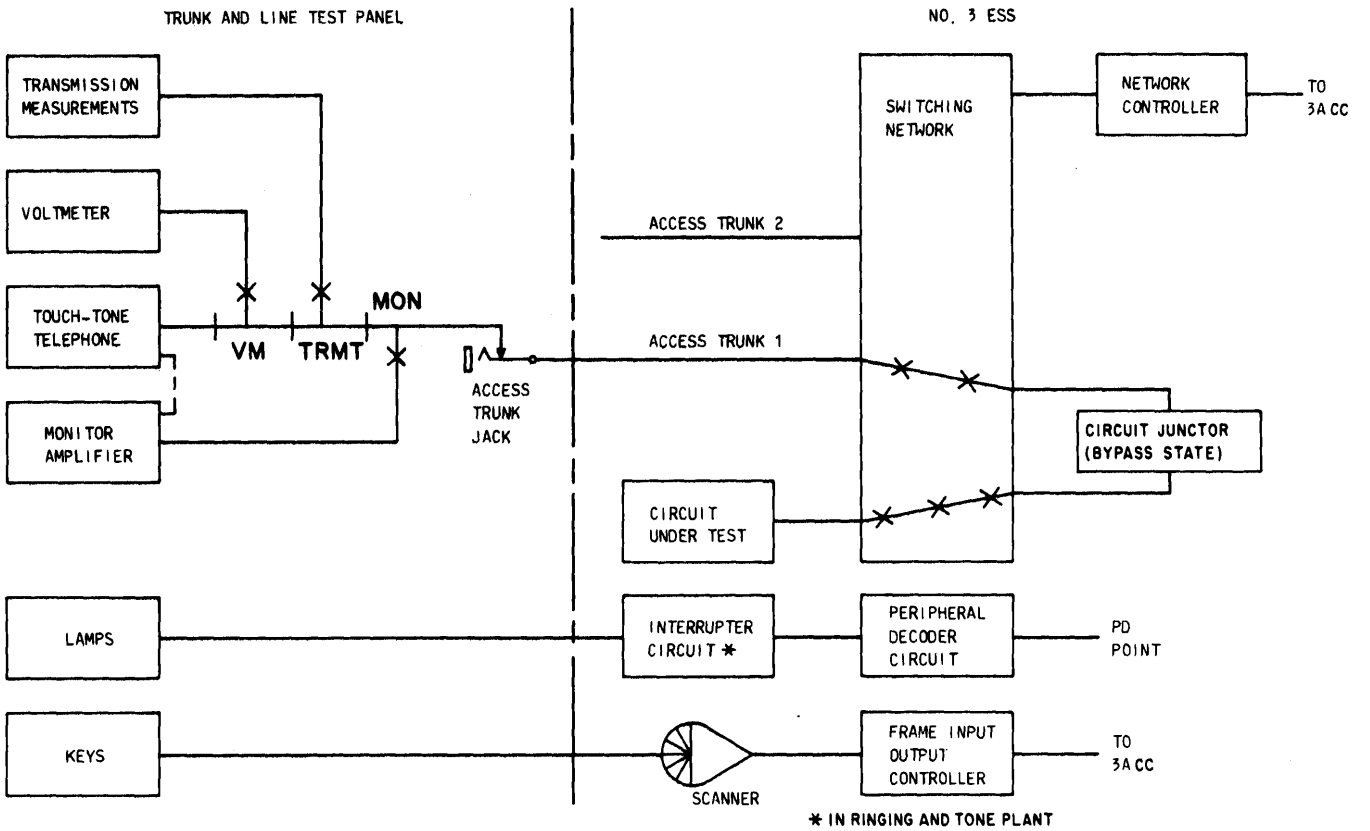


Fig. 18—TLTP Interface

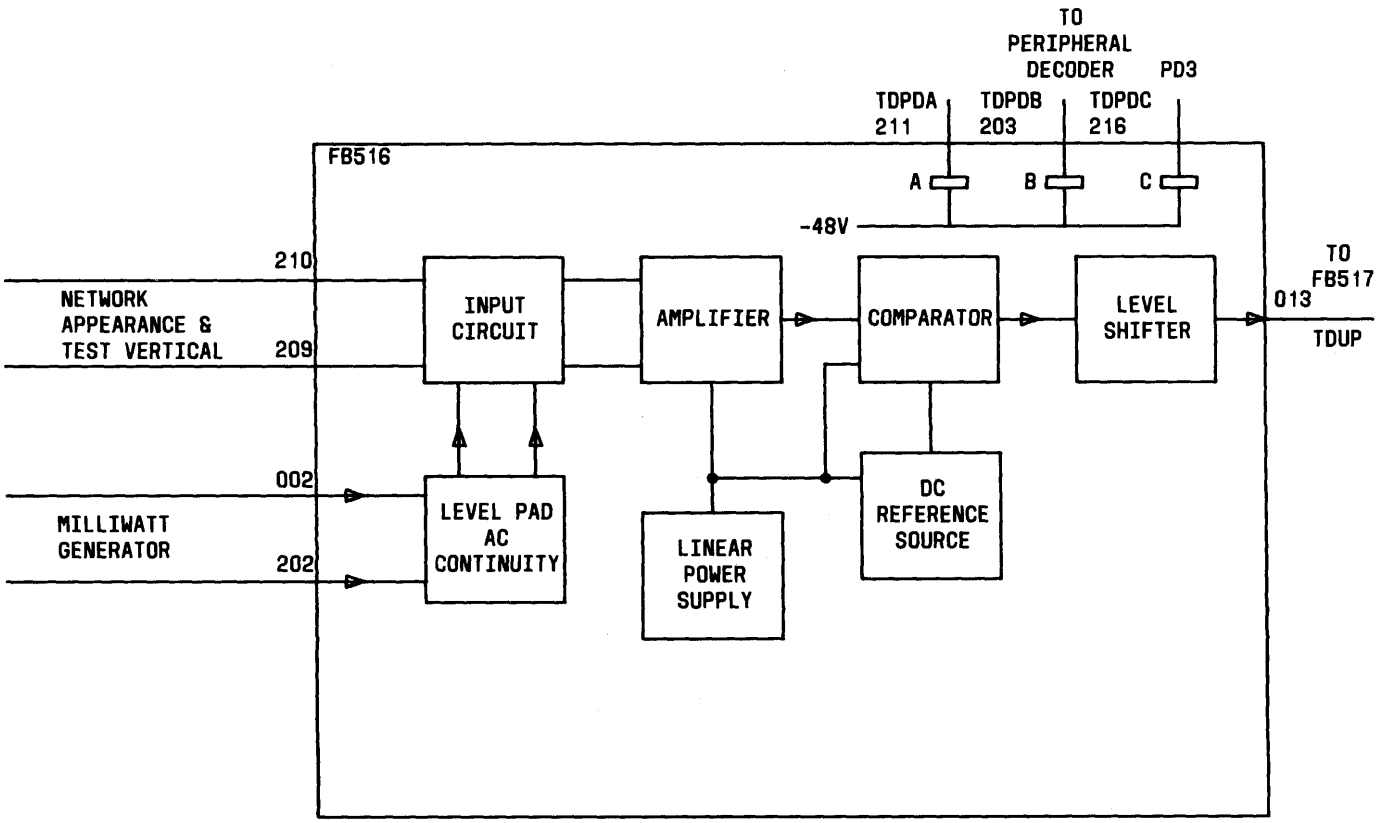


Fig. 19—Tone Presence Amplifier and Detector—FB516

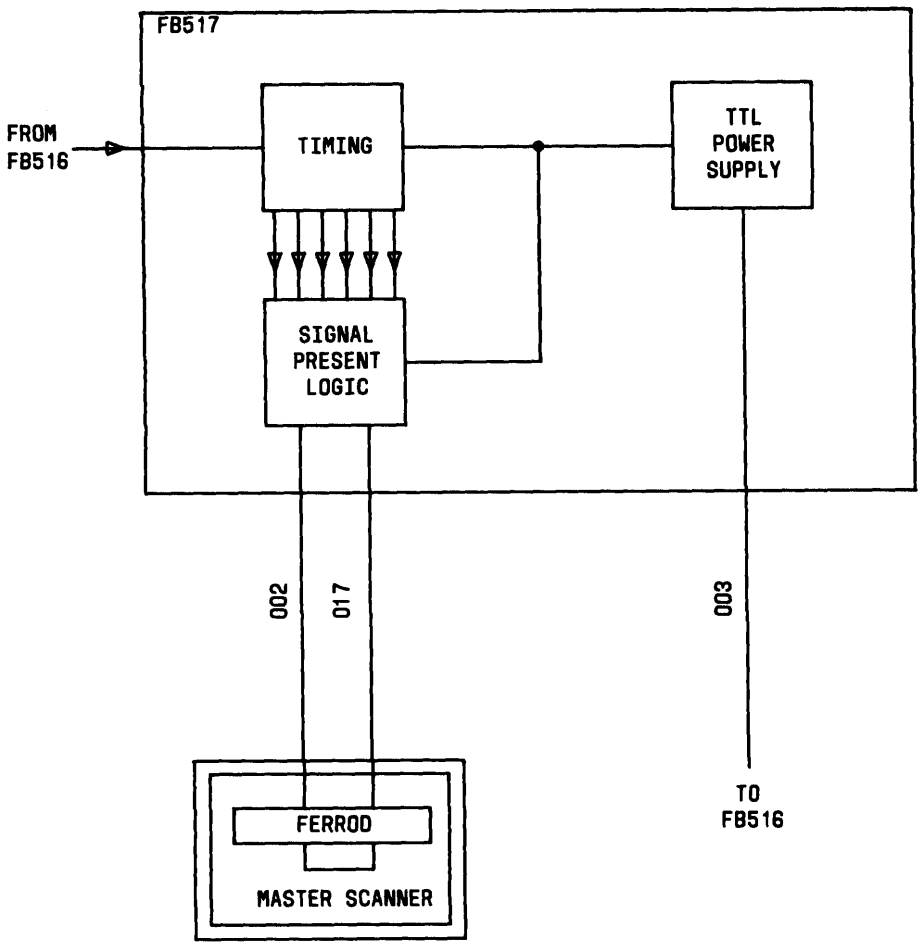


Fig. 20—Tone Presence, Timing, Logic, and Power Circuits—FB517

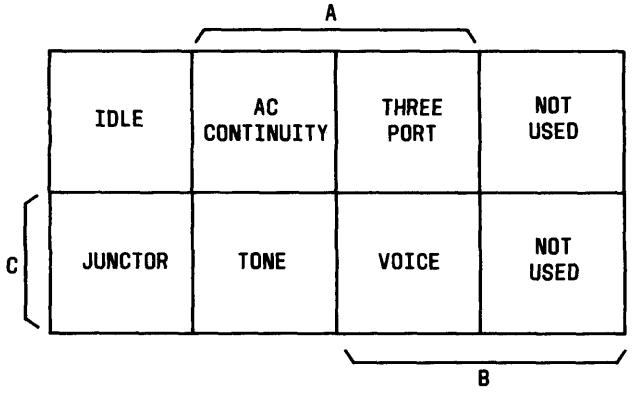


Fig. 21—Tone Presence Detector State

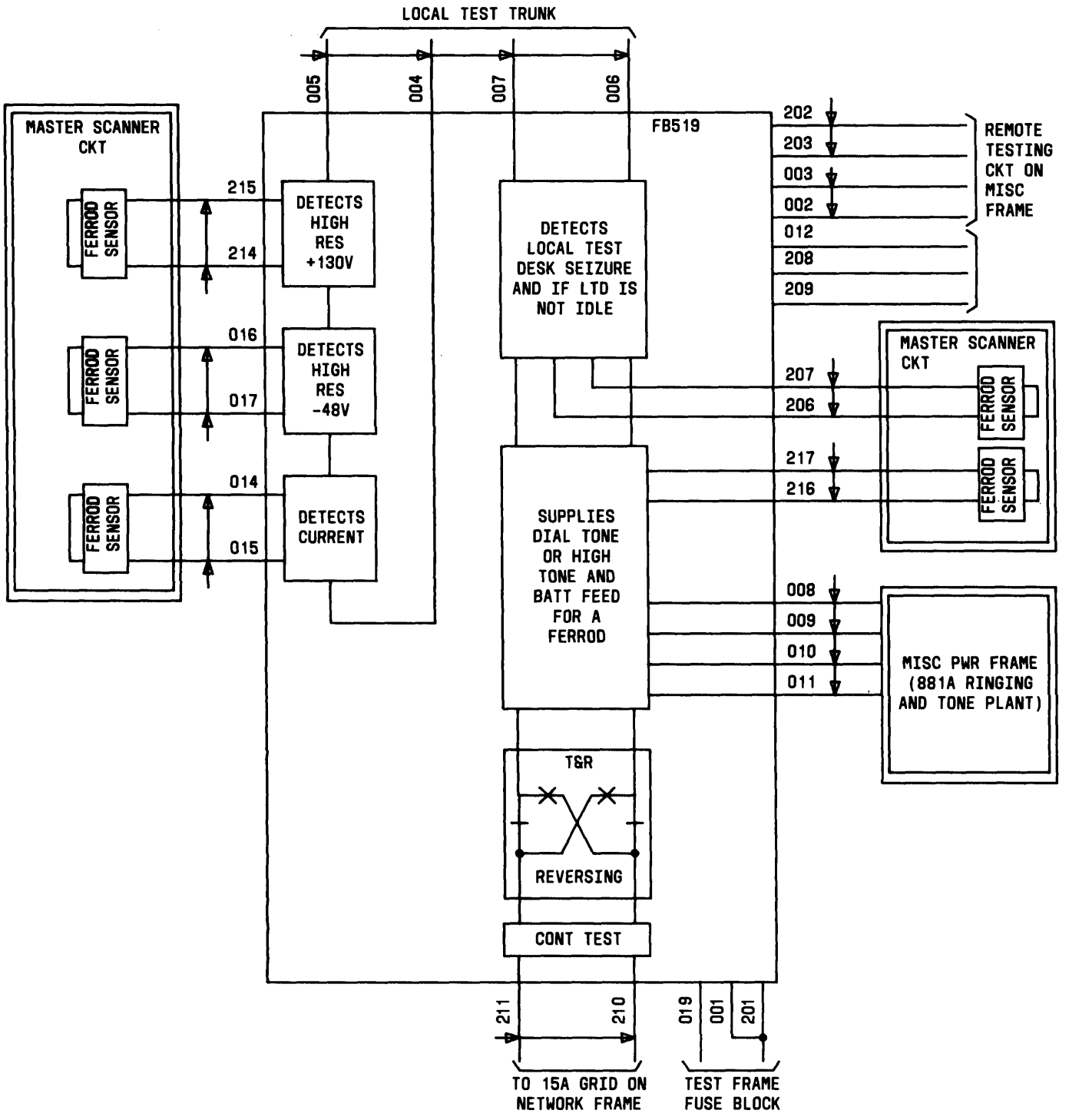


Fig. 22—Incoming Local Test Desk Trunk—FB519

TRUNK STATE

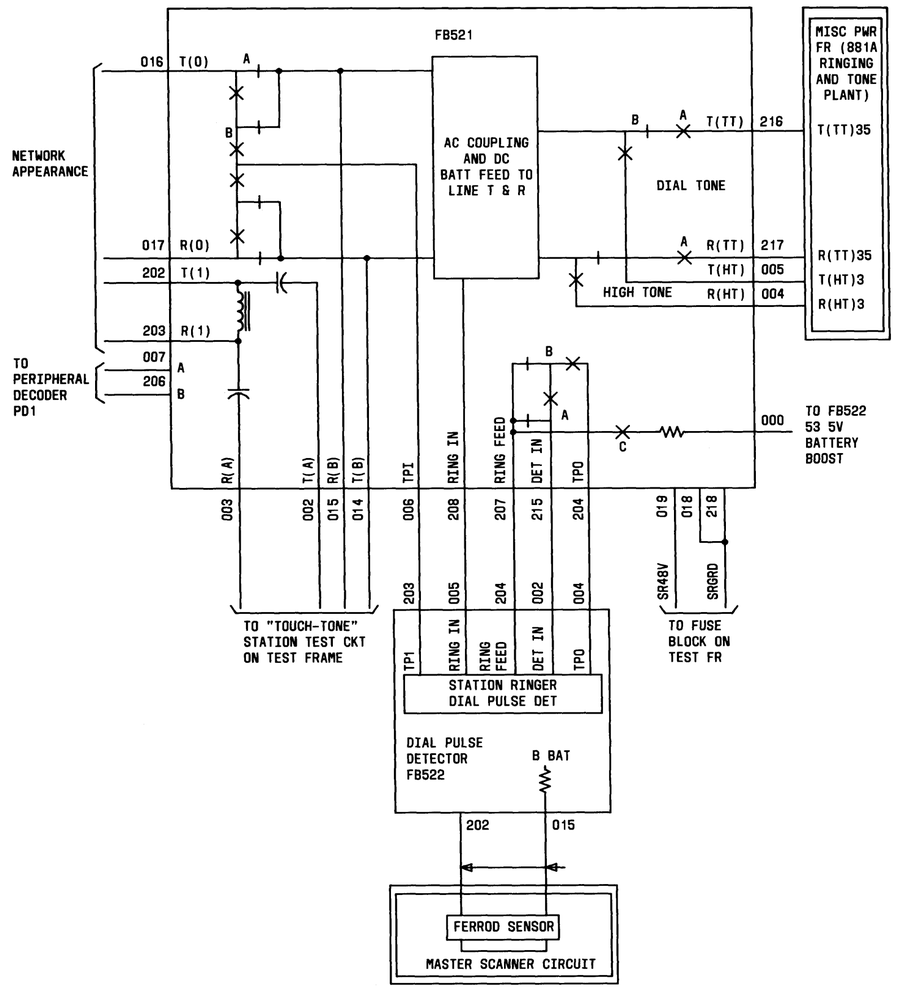
	A	B		
	IDLE AND CONTINUITY CHECK	NOT USED	NOT USED	NOT USED
C	NOT USED	NOT USED	NOT USED	NOT USED
	NOT USED	BYPASS AND TIP-RING REVERSE	HIGH TONE	NOT USED
D	NOT USED	BYPASS AND TEST	DIAL TONE	NOT USED

D

SLEEVE LEAD STATE

	SC(04)	H	
IDLE	MF PULSING COMPLETED TERMINATION OF LINE FERROD TEST	MF PULSING KEY PULSE DISCONNECT	NOT USED
T NOT USED	TOUCH-TONE TEST	NOT USED	NOT USED

Fig. 23—Local Test Desk Incoming Trunk Circuit States



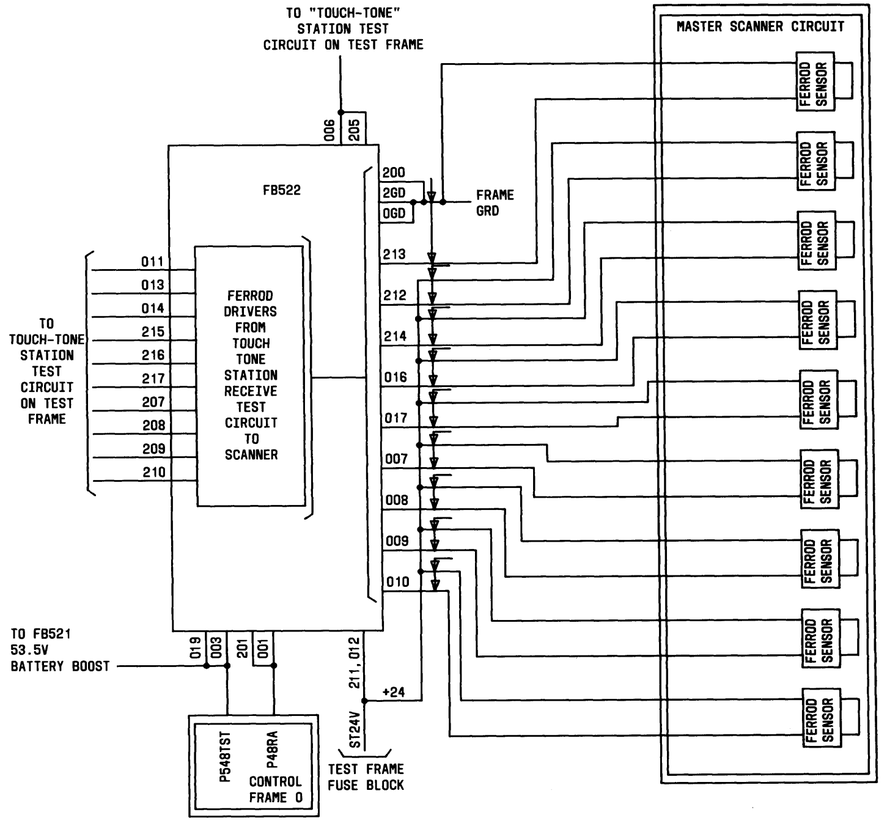


Fig. 24—Station Ringer Test Line Circuit—FB521, FB522

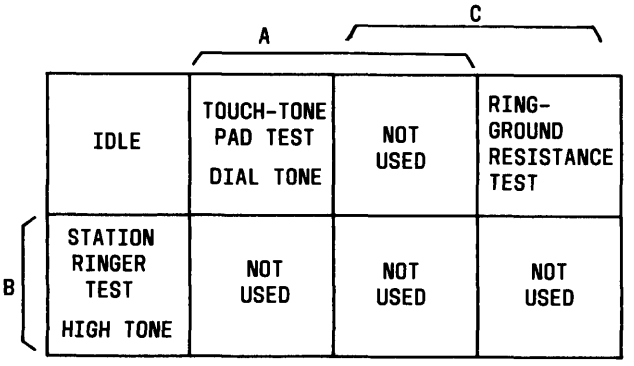


Fig. 25—Station Ringer Test Line Circuit State

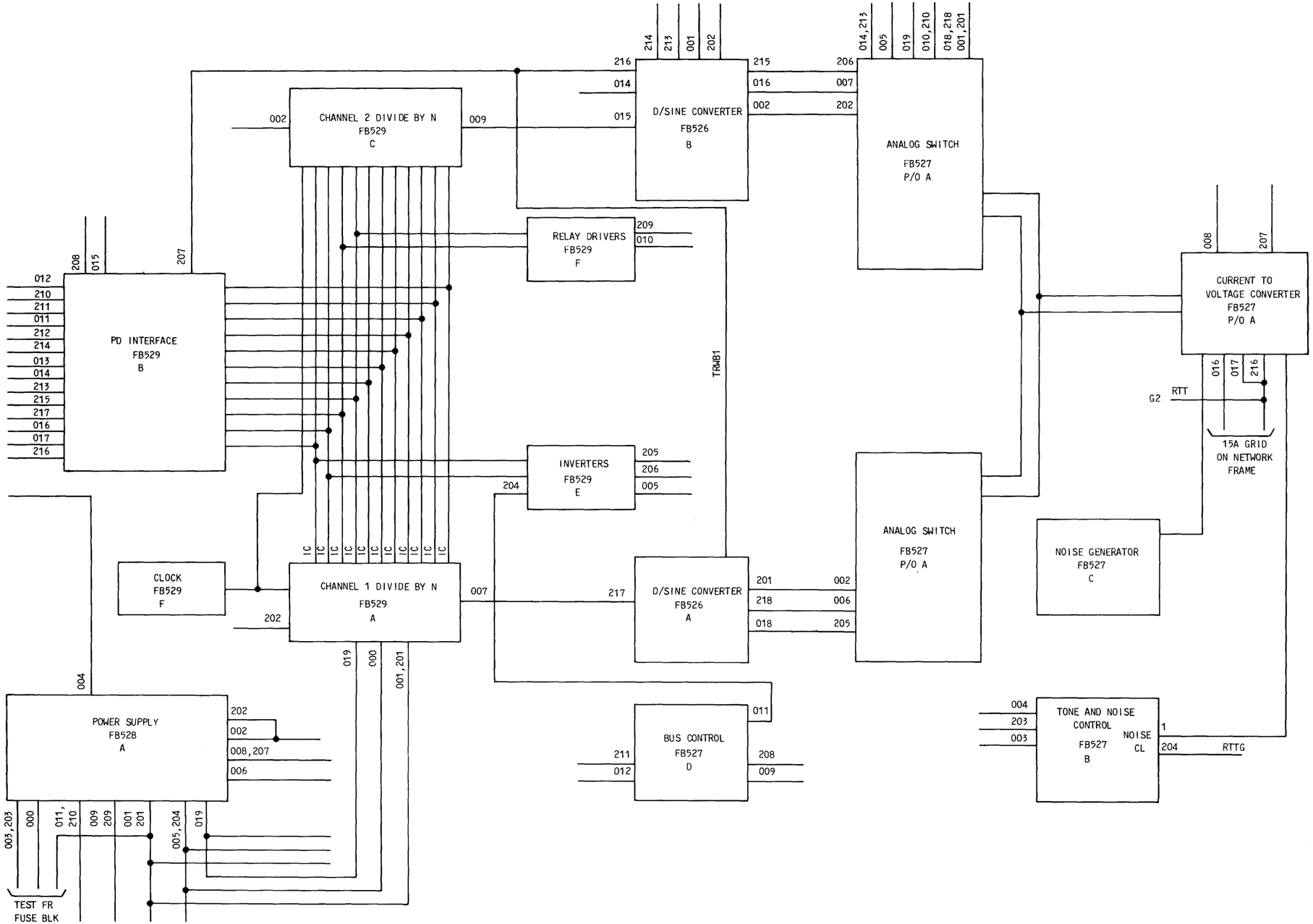


Fig. 26—Functional Block Diagram, TOUCH-TONE® Receiver Test Circuit

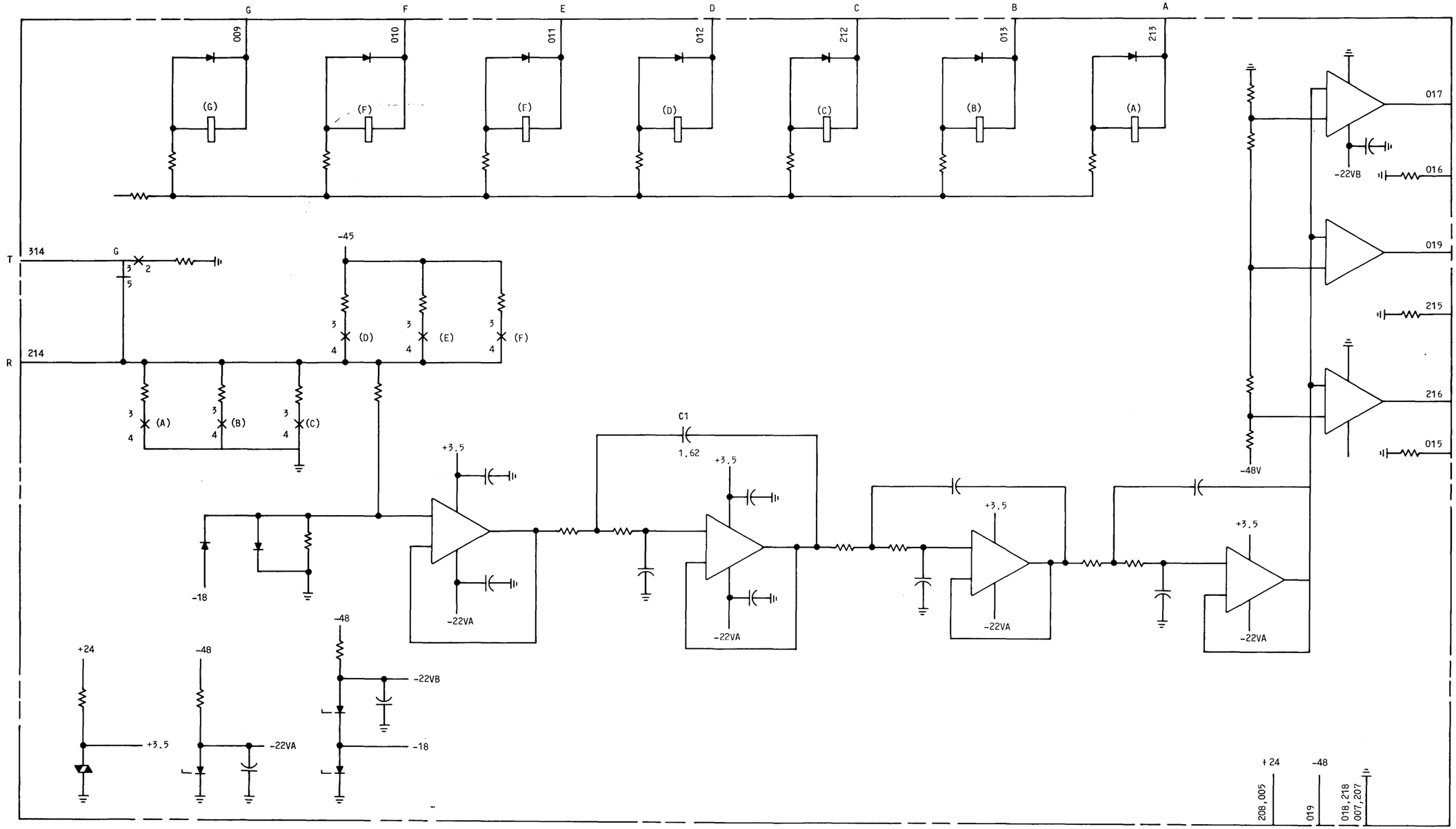


Fig. 27—Automatic Line Insulation Test Circuit—FB669

TESTS		RELAYS X-OPERATED							*SCAN POINTS EXPECTED RESULTS		
		A	B	C	D	E	F	G	SC2	SC1	SC0
SELF CHECK	80K RANGE	X			X				0	1	1
	320K RANGE	X				X			0	0	0
	80K RANGE		X		X				1	1	1
	2.56M RANGE			X			X		0	0	1
FEMF									0	0	0
SRG	80K RANGE				X			X	1	1	1
	320K RANGE					X		X	1	1	1
	2.56M RANGE						X	X	1	1	1
TRG	80K RANGE				X				1	1	1
	320K RANGE					X			1	1	1
	2.56M RANGE						X		1	1	1

* 0 - NO CURRENT, 1 - CURRENT

Fig. 28—Automatic Line Insulation Test Circuit States

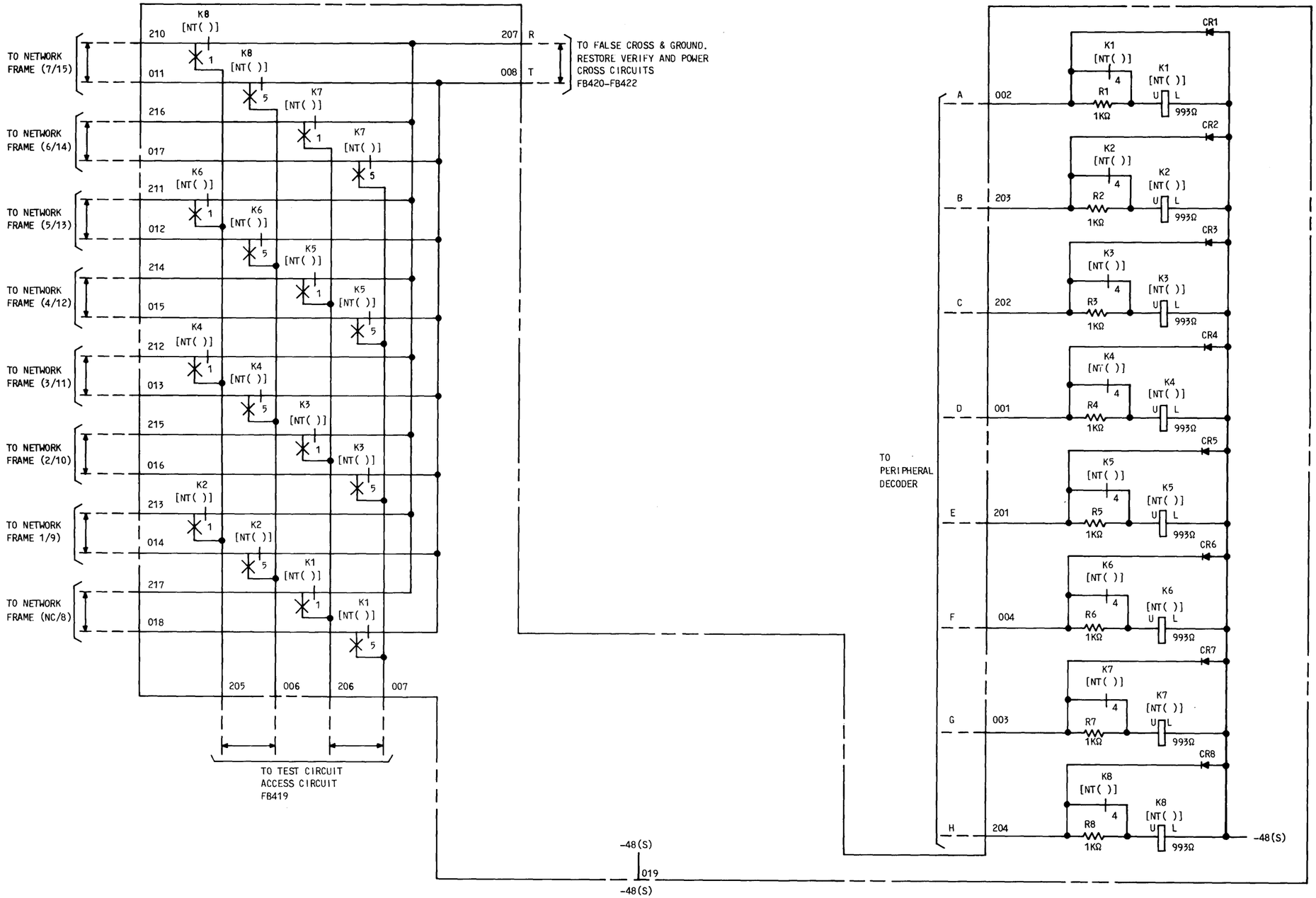


Fig. 29—Test Vertical Access Circuit—FB417

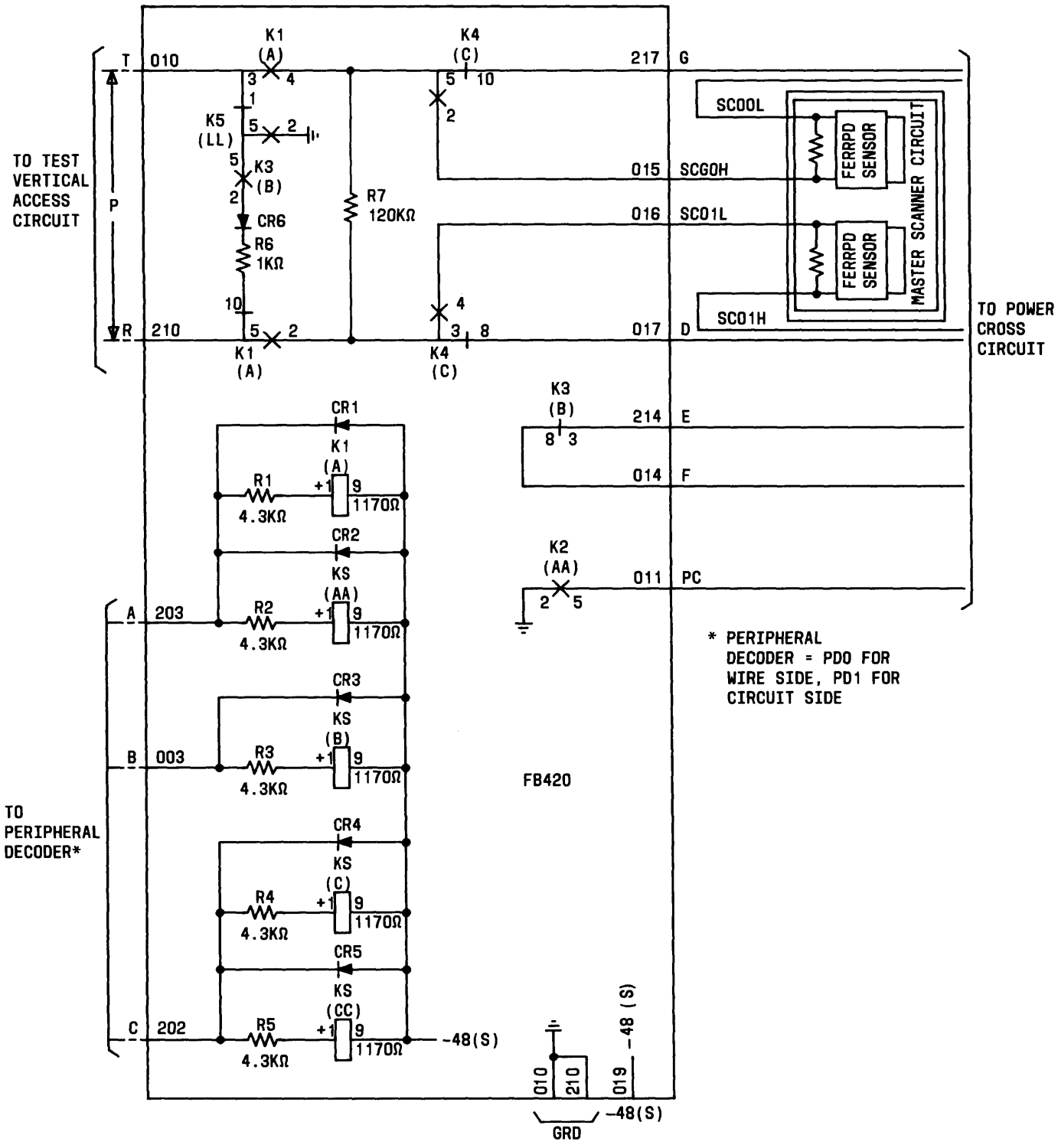


Fig. 30—False Cross and Ground, Restore Verify Circuit—FB420

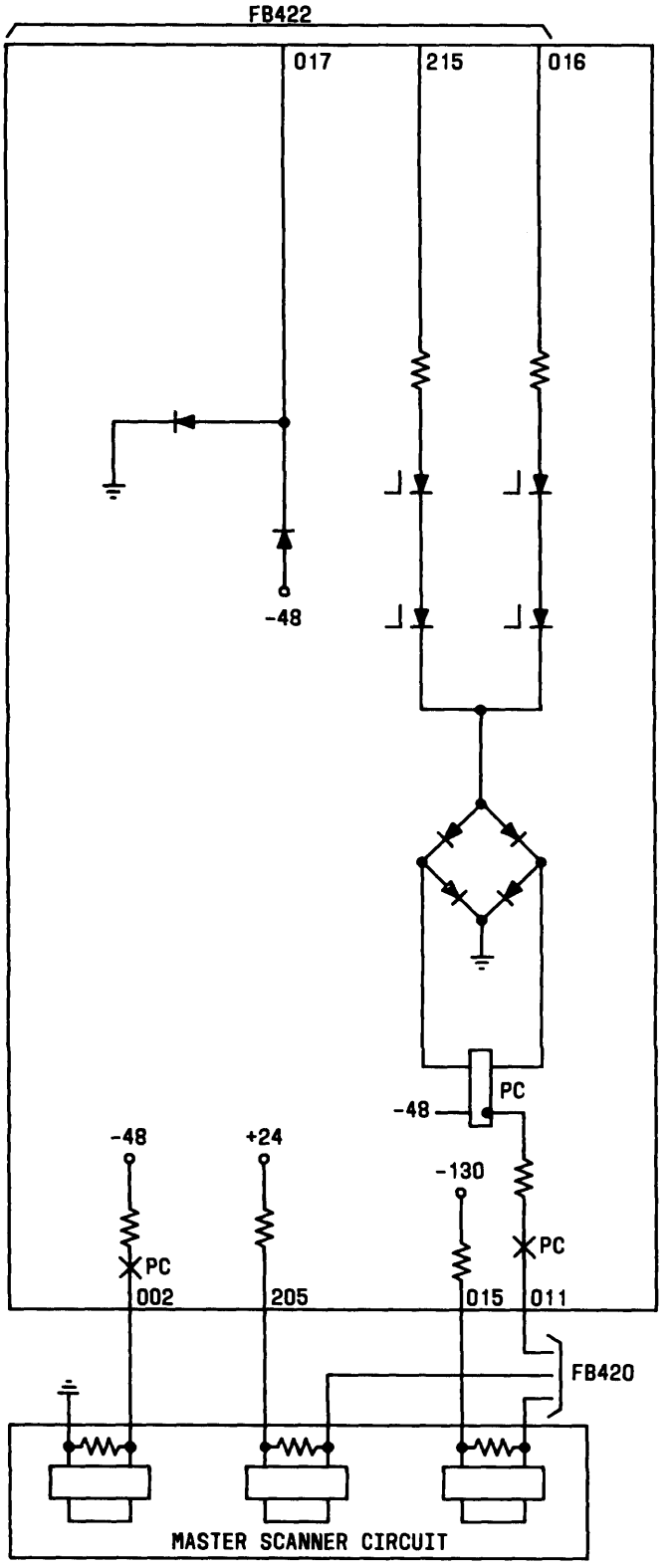


Fig. 31—Power Cross Circuit—FB422

TABLE A

TEST FRAME TEST CIRCUITS

TYPE OF CIRCUIT BEING TESTED	TEST CIRCUIT	CIRCUIT PACK
Line	Local Test Desk or Test Cabinet Line Insulation Station Ringer Test Line Trunk and Line Test Panel	FB519 FB669 FB521, FB522 FB511 through FB515
Trunk	Transmission Test Termination Continuity and Polarity Test Trunk and Line Test Panel Milliwatt and Transmission Environment Test	FB504 FB500 FB511 through FB515 FB505 through FB509
Service Circuit	Dial Pulse Receiver Test TOUCH-TONE® Receiver Test Continuity and Polarity Test Tone Presence Detector Test• Loop Environment Test Trunk and Line Test Panel Milliwatt and Transmission Environment Test	FB501, FB502 FB526 through FB529 FB500 FB516, FB517 FB510 FB511 through FB515 FB505 through FB509
CONTROL FRAME TEST CIRCUITS		
Test Vertical Access Circuit False Cross and Ground, Restore Verify Power Cross		FB417 FB420 FB422

TABLE B

MILLIWATT AND TRANSMISSION ENVIRONMENT CIRCUIT STATE TABLE

TEST FUNCTION	FB505			FB506		FB507			FB508			
	A	T	J	A	T	P	BB	CC	AA	DD	EE	PP
IDLE	R	R	R	R	R	R	X	X	X	X	X	X
0 dBm MILLIWATT CONNECTION	A	R	R	A	R	R	X	X	X	X	X	X
BALANCE TERMINATION	A	A	R	A	T	R	X	X	X	X	X	X
TRUNK-LINE CONTINUITY	R	A	R	R	A	R	X	X	X	X	X	X
JUNCTOR	A	R	A	R	R	R	X	X	X	X	X	X
LOOP-AROUND	X	R	X	X	X	A	X	X	R	R	X	X
FLAT-LOSS PAD	R	A	R	X	R	A	R	R	A	X	X	A
TWIST PAD	R	A	A	X	R	A	R	A	A	X	X	A
MF DETECT	R	A	R	X	A	A	A	R	A	X	X	A
MF NONDETECT	R	A	A	X	A	A	A	A	A	X	X	A
DOUBLE KEYLINE	A	A	X	R	X	A	X	X	R	A	R	A
MODULATION PRODUCT	A	A	X	A	A	A	A*	X	R	A	A	A

A = Active
R = Release
X = Do Not Care-Released
* = Do Not Care-Active