

# “PULSE \* 120” – SG-1A

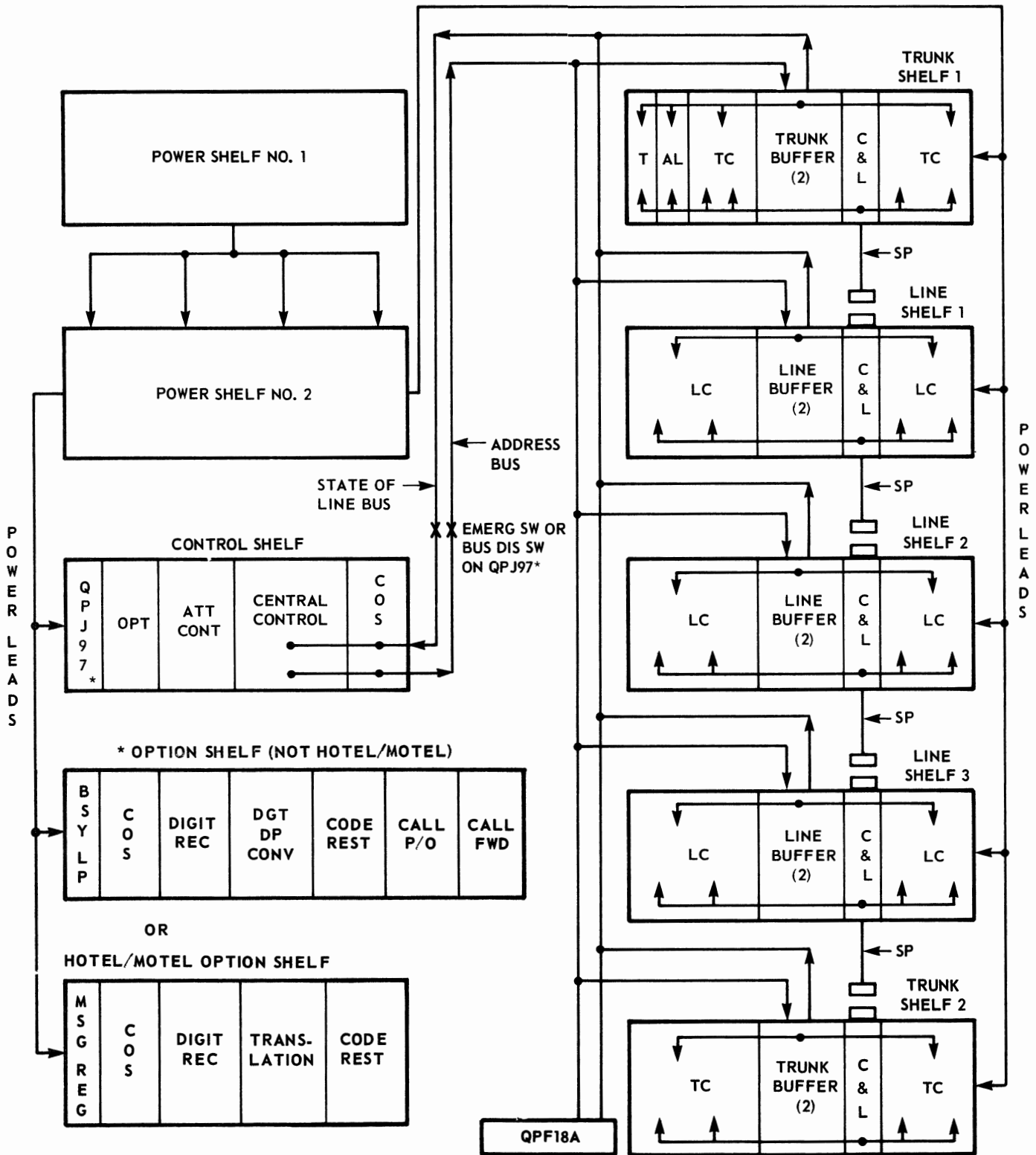
## ELECTRONIC PRIVATE AUTOMATIC BRANCH EXCHANGE

### MAINTENANCE AIDS DESCRIPTION

### AND MAINTENANCE TOOLS

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2. CALL PROCESSING . . . . .	1	2.02 The central control scans each station and trunk circuit in sequence by sending a signal to the line or trunk circuit on the address bus and waiting for a return signal on the State-of-Line Bus (SLB). The signal is returned on the SLB, if the station or trunk is off-hook, i.e., originating a call or already receiving service.
3. FAULT CLEARING SEQUENCE . . . . .	3	2.03 On receipt of the return signal, the central control determines whether the circuit is receiving service by performing a busy test, i.e., examining the main memories on the control shelf for a station or trunk address. If the address is not in a memory, the central control processes the call as an origination and stores the station line or trunk number in the calling memory. When a station line is originating, the control provides dial tone to the station and sets the impulse analyzer to receive dial pulses. If a trunk is originating, the control signals the console to alert the attendant.
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1. GENERAL		
1.01 This section outlines call processing in the PULSE 120 Electronic Private Automatic Branch Exchange (EPABX) and describes the maintenance aids and their use in fault-clearing procedures.		
1.02 The tools identified in this section are required to correct EPABX and console faults.		
REASON FOR REISSUE		
1.03 This section is herewith being reissued to correct Fig. 1, add a note to 2.10, and change the information in 4.17 (6).		

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LEGEND

- T - TONES
- AL - ATTENDANT LINES
- TC - TRUNK CIRCUITS
- C & L - CLAMP & LINK GATES
- LC - LINE CIRCUITS
- SP - SPEECH HIGHWAY

\* OPTION SHELF SHOWN IS A QSP6U. OPTION SHELF QSP6M DOES NOT HAVE CALL PICK UP OR CALL FWD CAPABILITY.

Fig. 1 - Basic Features of PULSE 120 EPABX Call Processing

If no address is found, then the control provides ringing tone to the calling party and generator to the called party. During the ringing process, the control monitors the SLB for an off-hook signal. When the signal is received, the control changes the state of the call in the memories to a talking connection.

2.05 The control continues to monitor the addresses of the two parties on the SLB during talking connection until one of the parties goes on-hook. The on-hook signal starts the disconnection procedure, and both party addresses are erased from the memories.

2.06 Address and SLB signals pass through buffer circuit packs located on the line and trunk shelves. A QPJ31-type circuit pack is used for trunks, and a QPJ34-type circuit pack is used for station lines. Each buffer decodes the address information sent by the central control, which is relevant to its own shelf, and applies the decoded signals to individual station lines or trunks. The buffers also reverse this operation by producing a coded signal from individual station lines or trunk signals. The coded signal is sent to the control on the SLB.

2.07 A failure in either the address or SLB system results in failure of the EPABX.

2.08 A talking connection is established on the speech highway. This highway is formed by the operation of the clamp, link gate, line, and trunk circuit packs and is controlled by address and sampling signals. These circuit packs interconnect tones and the attendant transmission connection to the speech highway.

2.09 Sampling signals are generated by buffer no. 2 (QPJ42-type circuit pack) on trunk shelf no. 1. The signals are distributed through buffer no. 1 (QPJ31-type circuit pack) to the trunk circuit packs and through the line buffers (QPJ34-type circuit packs) to the line, clamp, and link gate circuit packs.

2.10 A system with 80 station lines or less may be converted from 3-digit numbering (station lines 210-289, 310-349) to 2-digit numbering (station lines 10-89) by inserting the QPJ19-type

line conversion circuit pack in the control shelf in place of the QPJ54-type 120 line control circuit pack.

*Note:* The 2-digit numbering plan cannot be used when Call Pickup, or Call Forward, or both, are system features or incorporated in the Hotel/Motel service.

### 3. FAULT CLEARING SEQUENCE

3.01 The fault clearing sequence is:

- (a) power
- (b) control logic
- (c) station line tones
- (d) station line ringing
- (e) trunk – outgoing selection
- (f) station line transmission
- (g) attendant console operation
- (h) attendant console transmission
- (i) trunk – incoming
- (j) trunk – transmission
- (k) clearance of remaining faults in any sequence.

*Note:* Any deviation from this fault-clearing sequence may result in failure to locate the fault.

3.02 This sequence is recommended since a reported fault condition may not be indicative of the actual fault. An incorrect address or response to the SLB signal by the central control at different states of the call process creates different fault indications (e.g., a party may not have service because of an address fault during scanning; a dial tone may not be received by a calling party because of a calling address fault).

3.03 Following an initial power check, the control shelf circuit packs are the first to be checked under control logic faults in the recommended fault-clearing sequence.

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3.04 Tone faults must be cleared next in the sequence. The dial tone is the first tone restored to all stations, because in supplying dial tone, the EPABX must address station lines correctly, respond to the SLB signal, generate the dial tone, and connect the tone trunk through the speech highway to the station line.

3.05 Detailed fault-clearing procedures are given in flowchart form in Sections 553-5011-503 through 553-5011-517. These procedures are based on the recommended fault-clearing sequence (3.01).

3.06 Faults in the PULSE 120 EPABX are classified as described in Section 553-5011-503. Reference to Section 553-5011-503 is the starting point of all fault-clearing procedures.

3.07 The asterisk (\*) after the base code replaces the suffix letter of the circuit pack.

### 4. MAINTENANCE AIDS

#### A. QPJ97-Type Circuit Pack

4.01 The maintenance test unit QPJ97-type circuit pack permits the EPABX central control to be exercised by performing a line-to-line test or a line-to-trunk test on a logic level without using the buffer cards or without interference from any fault that might exist in the interconnecting hardware. This facility allows faults to be localized between the control shelf and the line or trunk shelves.

4.02 Complete isolation of the central control from the line or trunk shelves is achieved by the operation of the emergency (EMERG) switch (Fig. 2) on the test unit. This switch breaks the address and SLB signal paths from the control shelf to the line and trunk shelves, eliminating the effect of any external fault on the exercise of the central control. The Bus Disable (BUS DIS) switch performs a similar isolation function for station lines (2)39 and (3)46 only. When the BUS DIS switch is operated during testing, service is removed from

station lines (2)39 and (3)46. Station lines 39 and 46 are the test lines for the two-number station-line numbering systems and 239 and 346 are the test lines for the three-number station-line numbering systems.

4.03 The test unit is used to perform logic tests (see Section 553-5011-504), which are the primary steps in the fault-clearing sequence, when a fault affects more than one station. With the following basic circuit packs installed in the control shelf, a logic test is performed to verify that the power and control shelves are functioning correctly:

QPJ54*	120 LINE CTL
QPJ51*	BSY TST/RESET CTL
QPJ24*	STATE OF CALL CTL
QPJ21*	CLOCK/RING CTL
QPJ22*	IMPULSE ANALYZER
QPJ25*	SERVICE TRUNK CTL
QPJ20*	LINE ADDR MEMORY
QPJ20*	LINE ADDR MEMORY.

If any of the remaining circuit packs in the control shelf are faulty, they are identified by removing the pack from the connectors during logic tests. A fault in the control shelf wiring is also identified by failure of the logic test after the circuit packs have been proven to work correctly or have been substituted.

4.04 The maintenance test unit QPJ97-type circuit pack has no operational function in the EPABX other than as a maintenance aid. The circuit pack is inserted in connector location 2 on the control shelf.

4.05 A metal faceplate, painted pink and bearing switches, Light Emitting Diodes (LED), and test points, is riveted to the front end of the circuit pack. These LED reflect the condition and status of operations in the EPABX during logic tests.

4.06 If a test unit becomes faulty, it should be replaced. Field repairs should *not* be attempted.

4.07 The description and functions of the controls (Fig. 2) on the faceplate of the test unit follow:

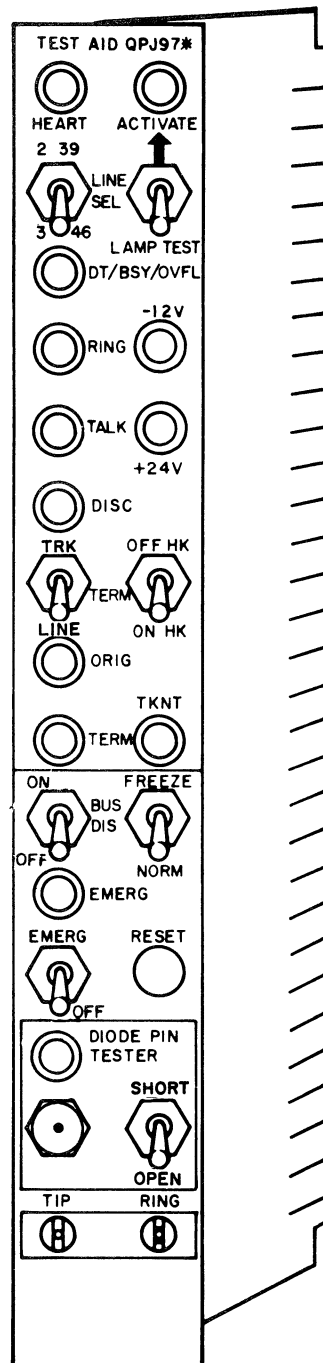


Fig. 2 — Maintenance Test QPJ97 Type Circuit Pack in Idle Condition

(1) **Heart Beat (HEART) LED** indicates, when flashing at 10 ipm, that the timing sequence in the system is correct. This LED flashes continuously even when the test unit is idle.

(2) **(2)39/(3)46 (LINE SEL) Switch.** This 2-position switch permits the selection of either station line number (2)39 or (3)46 as the calling party for testing purposes. The unselected number automatically becomes the terminating party. These station numbers have been specifically chosen to exercise the central control memories, to buffer registers, and to check the ability of the impulse analyzer to decode dial pulse digits, when a line-to-line logic test is performed from and to these numbers, or a line-to-trunk test is performed from either of these numbers.

(3) **Dial Tone/Busy/Overflow (DT/BSY/OVFL) LED** indicates, when steadily illuminated, that a dial tone request has been made to the central control. When a dialed station line is busy, the LED flashes at 60 ipm to indicate busy tone. When a dialed station line is unassigned, or assigned as an access code, the LED winks at 120 ipm to indicate overflow tone.

(4) **Ring (RING) LED** indicates, when illuminated, that the central control has originated a command for ringing to be applied to a terminating party and ringing tone to a calling party. The LED illumination is interrupted at the same rate as the ringing intervals, i.e., 2.0 seconds on and 4.0 seconds off.

(5) **Talk (TALK) LED** indicates, when illuminated, that the called station (2)39, (3)46, or the trunk is in talking mode. This LED illuminates during both line and trunk testing.

(6) **Disconnect (DISC) LED** indicates, when illuminated, that either the calling or terminating party has disconnected or is in the on-hook mode following the completion of a call. If either party remains in the off-hook mode for more than 19 seconds, dial tone is returned to the line.

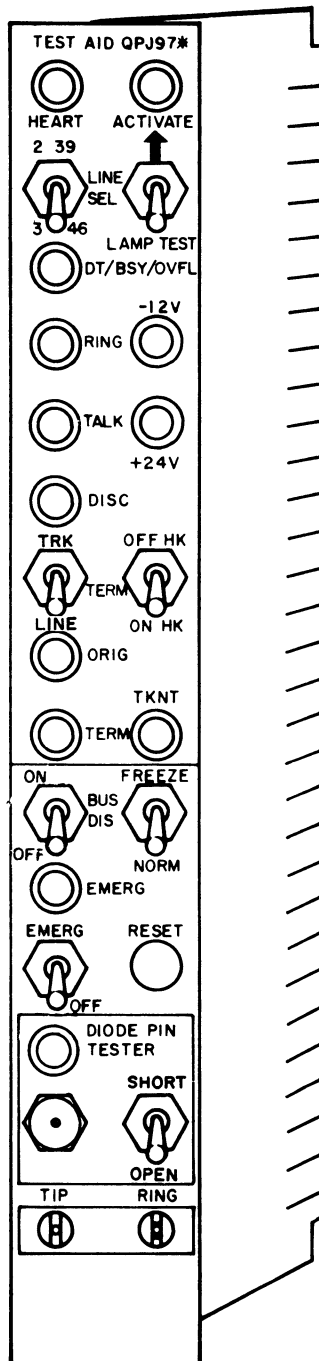


Fig. 2 — Maintenance Test QPJ97 Type Circuit Pack in Idle Condition (Repeated)

(7) **Station Line or Trunk Selection (LINE/TRK TERM) Switch.** This 2-position switch permits the selection of station line testing in the 'down' position and trunk testing in the 'up' position. The central control only responds to valid trunk logic access code numbers (see Table A).

(8) **Originating (ORG) LED** indicates, when illuminated, that the central control has acknowledged a request for service from either test station line (2)39 or (3)46.

(9) **Terminating (TERM) LED** indicates, when illuminated, that a connection between the calling station line (2)39 or (3)46 and the terminating station line (3)46 or (2)39 has been established.

(10) **Activate (ACTIVATE) LED** indicates, when illuminated, that both station lines (2)39 and (3)46 are idle, and that the test can be performed from the QPJ97-type circuit pack.

(11) **Lamp Test/Activate Switch.** This nonlocking 3-position switch, when held in the 'down' position, illuminates all the LED on the maintenance test circuit pack, except the Diode Pin Tester LED. When momentarily operated in the 'up' position, the switch energizes the QPJ97-type circuit pack and disconnects service to stations (2)39 and (3)46, when they are idle as indicated by the illuminated ACTIVATE LED. An illuminated ORG or TERM LED, or both, before operating the ACTIVATE switch, indicate that station line (2)39 or (3)46, or both, are in use. The QPJ97-type circuit pack is deactivated as described in (20).

(12) **Off-Hook/On-Hook (OFF HK/ON HK) Switch.** This 2-position switch permits the initiation of an off-hook or on-hook condition at the terminating station line (2)39 or (3)46. Since most systems do not have a full complement of station lines and allow a full off-hook check, this switch, when used with station lines (2)39 and (3)46, checks the performance of the central control portion of the EPABX. During trunk tests, operating the switch to the off-hook position seizes the trunk selected by the access code.

(13) **Trunk Terminating (TKNT) LED** indicates, when illuminated, that the test station line (2)39 or (3)46 is connected to a valid trunk number.

(14) **BUS Disable (ON/OFF BUS DIS) Switch.**

This 2-position switch, in the 'up' position, isolates station lines (2)39 and (3)46 from the central control. The switch is used during logic tests which are unaffected by either station user lifting the receiver.

(15) **Emergency (EMERG) LED** indicates, when steadily illuminated, that the EMERG switch is in the 'up' position and that the EPABX is out of service.

(16) **Emergency (EMERG/OFF) Switch.** This 2-position switch, in the 'up' position, isolates the central control from the line and trunk shelves. The switch is used when tests are performed on the central control, and to reset the system by canceling all the signals in the central control. When in the 'up' position, the switch disconnects all established calls in the EPABX.

(17) **Call Hold (FREEZE/NORM) Switch.** This 2-position switch, in the 'up' position, holds all established calls in the EPABX during substitution of a buffer circuit pack in a line or trunk shelf. Although the calls are held, conversations are interrupted when the switch is in the 'up' position. Operation of the switch is not recommended when substitution of a buffer circuit pack is required on line shelf no. 2 and no. 3, or trunk shelf no. 2, and only a few lines or trunks are in use.

(18) **Time Slot Reset (RESET) Button.** This button, when pressed, cancels all signals from the test unit and has the same effect on the system as operating the NE-QSE4B-type handset switch to the monitor mode. Only the signals from the test unit are erased from the central control.

(19) **Diode Pin Tester.** The diode pin test consists of an LED, a jack to insert the diode pin, and an OPEN/SHORT switch. With a diode pin in the jack and the switch in the 'up' position, the LED remains extinguished, if the pin is shorted. A

diode pin is tested for an open circuit condition by inserting the pin in the jack and operating the switch in the 'down' position. When the pin is open-circuited, the LED remains extinguished. The LED illuminates during both tests, if the pin is NOT defective.

(20) **Test Points (TIP and RING)** provide a termination facility for the NE-QSE4-type handset when central control logic tests are performed. There is no transmission path from the handset when connected to these test points. Station lines (2)39 and (3)46 are the only numbers used as the calling and terminating stations for station line logic tests. A trunk logic test is performed by using either station line (2)39 or (3)46 and dialing any desired trunk logic access code (Table A). The QPJ97-type circuit pack is deactivated by operating the NE-QSE4-type handset switch to monitor mode or removing the handset clips from the test points.

(21) **-12 V LED** indicates, when steadily illuminated, that the -12 V supply is present on the control shelf.

(22) **+24 V LED** indicates, when steadily illuminated, that the +24 V supply is present on the control shelf.

4.08 The transmission test points (T and R) on the front end of line shelf no. 1 provide a termination facility for the NE-QSE4-type handset when performing logic tests. When the station line numbering consists of two digits, the speech test points for lines 39 and 46 are located on the front support of line shelf no. 1. With three-digit station line numbering, the speech test points for lines 239 and 246 are mounted on line shelf no. 1. Calls from the speech test points of station line 246 on the end panel of line shelf no. 1 are not monitored by the QPJ97-type circuit pack, when the system uses three-digit station line numbering.

4.09 When an option or feature is tested from T and R shelf test points, diode pins must be inserted or removed in the Class-Of-Service (COS) block to provide station (2)39 or (3)46 with access to the appropriate option or feature.

**TABLE A  
TRUNK ACCESS CODES**

TRUNK NO.	CONNECTOR NO. IN TRUNK SHELF NO. 1	LOGIC ACCESS CODE
1	15	77
2	16	76
3	17	75
4	18	74
5	19	73
6	20	72
7	21	71
8	22	68
9	23	67
10	24	66
11	5	65
12	6	64
13	7	63
14	8	62
15	9	61
<b>TRUNK SHELF NO. 2</b>		
16	15	57
17	16	56
18	17	55
19	18	54
20	19	53
21	20	52
22	21	51
23	22	48
24	23	47
25	24	46
26	5	45
27	6	44
28	7	43
29	8	42
30	9	41

4.10 The maintenance test aid is in the idle condition, when the ACTIVATE and EMERG LED are extinguished.

#### B. QPJ47-Type Circuit Pack

4.11 The power fail transfer control, QPJ47-type circuit pack, monitors the voltages in the EPABX and controls the Power Fail Transfer (PFT) relays to connect emergency service in the system. The release of PFT relays connect station lines (2)10 through (2)19 to trunks 1 through 10.

4.12 When a voltage failure affects the complete system, the QPJ47-type circuit pack detects the major failure, releases the PFT relays, and lights the major alarm lamp on power shelf no. 2 and the lamp ET on the attendant console. The EPABX is restored to normal service by placing ground on the lead PF through either the RESET button on power shelf no. 2 or PF button on the attendant console. The ground operates a relay on the QPJ47-type circuit pack, and the make contacts provide a ground to operate the PFT relays.

4.13 Voltage failures, which disable features or part of the system, are detected by the QPJ47-type circuit pack. This circuit pack lights the Fuse Alarm (FA) lamp on the console. The FA lamp extinguishes when the voltage is restored.

4.14 The QPJ47-type circuit pack is inserted in connector 5 on power shelf no. 2.

4.15 A two-position switch (Fig. 3) is mounted on the component side of the QPJ47-type circuit pack to permit either manual or automatic system reset during momentary power failures. With the switch in the lower MANUAL (MAN) position, the EPABX is reset for normal operation by pressing the RESET or PF button. When the switch is in the upper AUTOMATIC (AUTO) position, the EPABX resets automatically, if all voltages are present and within limits; otherwise the system remains in PFT mode.



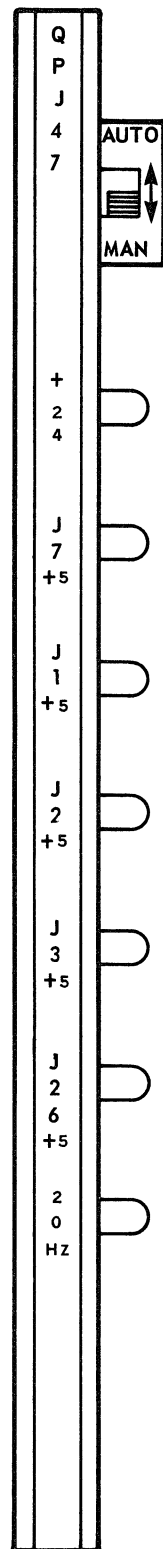


Fig. 3 – LED Arrangement on QPJ47-Type Circuit Pack

4.16 Aligned with the handle on the component side of the circuit pack, are seven LED monitoring power supplies from both power shelves. The LED indicates a failure of power when lit. Markings next to the LED on the handle (Fig. 3) indicate the voltage monitored by each LED.

4.17 The function of each LED:

- (1) **+24 V**. Monitors the +24 V supply on power shelf no. 2 to the +5 V Regulators on both power shelf no. 2 and option shelf. Failure of the +24 V lights the MAJOR ALARM lamps.
- (2) **+5 V(J7)**. Monitors the +5 V supply to the control shelf, generated by the QPJ43-type circuit pack in connector 7 on power shelf no. 2. Failure of this regulator lights the MAJOR ALARM lamps.
- (3) **+5 V(J1)**. Monitors the +5 supply to the control and option shelves, generated by the QPJ43-type circuit pack in connector 1 on power shelf no. 2. Failure of this regulator lights the FUSE ALARM lamps.
- (4) **+5 V(J2)**. Monitors the +5 V supply to trunk and line shelves no. 1, generated by the QPJ43-type circuit pack in connector 2 on power shelf no. 2. Failure of this regulator lights the MAJOR ALARM lamps.
- (5) **+5 V(J3)**. Monitors the +5 V supply to the line shelves no. 2 and no. 3 and trunk shelf no. 2, generated by the QPJ43-type circuit pack in connector 3 on power shelf no. 2. Failure of this regulator lights the FUSE ALARM lamps.
- (6) **+5 V(J26)**. Monitors the +5 V supply generated by the QPJ43-type circuit pack either in connector 26 of the QSP6M or QSP6R option shelf, or in connector 29 of the QSP6U fully-wired option shelf. Failure of this regulator lights the fuse alarm lamps.
- (7) **20 Hz**. Monitors the 86 V, 20 Hz ringing supply on the ringing distribution QPJ46-type circuit pack. Failure of the 20 Hz lights the MAJOR ALARM lamps.

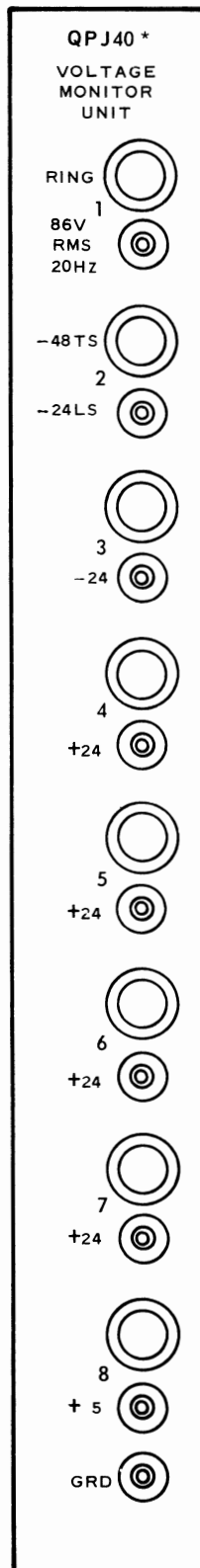


Fig. 4 – LED and Test Point Arrangement on QPJ40-Type Circuit Pack

4.18 When QPJ43-type circuit packs are not required in connectors of power shelf no. 2 and the option shelf, the strap on TB-3 on power shelf no. 2 deactivates both the alarm circuit and the LED indication for the missing regulator.

### C. QPJ40-Type Circuit Pack

4.19 The voltage monitor unit QPJ40-type circuit pack is inserted in any station line or trunk connector to indicate the presence of voltages at the connector. The test point below each LED simplifies voltmeter connections to perform voltage tests.

*Note:* QPJ40-type circuit pack is inserted in station line and trunk connectors only.

4.20 The voltage monitor unit has no operational function in the EPABX, except as a maintenance aid. The QPJ40-type circuit pack is stored in any spare station line or trunk connector in a line or trunk shelf, but preferably in a spare trunk shelf connector.

4.21 The function of each LED and test point on the QPJ40-type (Fig. 4) circuit pack is:

- (1) **86 V RMS.** The fluctuating LED monitors the 86 V, 20 Hz station line ringing supply when inserted in line shelves. A steadily lit or extinguished LED denotes a fault with the 86 V, 20 Hz. The LED and test point have no function in the trunk shelves.
- (2) **-48 TS, -24 LS.** Monitors the -48 V supply when inserted in trunk shelves or -24 V station line transmission supply, when inserted in the line shelves.
- (3) **-24 V.** Monitors the +24 V supply on the trunk and line shelves.
- (4) **+24 V.** Monitors the +24 V station line transmission supply on line shelves or supply in the trunk shelves.
- (5) **+24 V.** Monitors the +24 V supply on the trunk and line shelves.

(6) **+24V**. Monitors the +24 V supply on the trunk shelf. The LED and test point have no function in the line shelves.

(7) **+24V**. Monitors the +24 V supply which energizes the station-line ringing relays and trunk relays on the line and trunk shelves.

(8) **+5 V**. To monitor the +5 V supply on the trunk and line shelves.

(9) **GRD (on Test Point)**. Provides meter connection when reading voltages from other test points on the QPJ40-type circuit pack.

4.22 Some voltages are distributed through the line and trunk shelves by individually fused branches serving groups of station line and trunk connectors. To perform a thorough voltage test, insert the QPJ40-type circuit pack in each of the line and trunk groups. The station line and trunk groups are given in Tables B and C respectively.

#### D. QPJ37-Type Circuit Pack

4.23 The QPJ37-type circuit pack (Fig. 5) contains the decoupling capacitor for the +24 V, -24 V, and +5 V supply on the line shelves.

4.24 This circuit pack can be inserted in any line shelf connector 11 and performs the following functions when present in line shelf no. 1:

(a) Bridges the TIP and RING leads from the test points on line shelf no. 1 through to the QPJ97-type circuit pack;

(b) Removes the ground on the NG lead to revert one-way incoming-only trunks to two-way trunks during flexible night service.

**TABLE B**  
**STATION LINE GROUPS**

STATION LINE GROUPS SERVED	SHELF LOCATION
(2)10 to (2)19 (2)50 to (2)59 310 to 319	Line Shelf No. 1 Line Shelf No. 2 Line Shelf No. 3
(2)20 to (2)29 (2)60 to (2)69 320 to 329	Line Shelf No. 1 Line Shelf No. 2 Line Shelf No. 3
(2)30 to (2)39 (2)70 to (2)79 330 to 339	Line Shelf No. 1 Line Shelf No. 2 Line Shelf No. 3
(2)40 to (2)49 (2)80 to (2)89 340 to 349	Line Shelf No. 1 Line Shelf No. 2 Line Shelf No. 3

**TABLE C**  
**TRUNK GROUPS**

TRUNK CONNECTOR GROUPS SERVED	SHELF TRUNK SERVED
5 to 9	Trunk Shelf No. 1
15 to 19	Trunk Shelf No. 1
20 to 24	Trunk Shelf No. 1
5 to 7	Trunk Shelf No. 2
8,9,15, and 16	Trunk Shelf No. 2
17 to 20	Trunk Shelf No. 2
21 to 24	Trunk Shelf No. 2

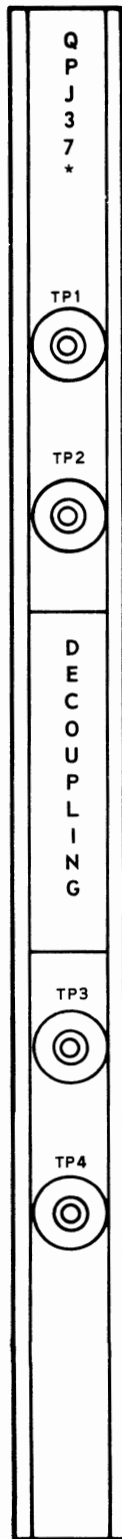


Fig. 5 — Test Point Arrangement on QPJ37-Type Circuit Pack

4.25 Four test points provide voltmeter connections to the following 86 V, 20 Hz ringing supplies:

- (1) **TP1.** Ringing generator from fuse F35 serving station line groups (2)10 through (2)19, (2)50 through (2)59, and 310 through 319.
- (2) **TP2.** Ringing generator from fuse F36 serving station line groups (2)20 through (2)29, (2)60 through (2)69, and 320 through 329.
- (3) **TP3.** Ringing generator from fuse F37 serving station line groups (2)30 through (2)39, (2)70 through (2)79, and 330 through 339.
- (4) **TP4.** Ringing generator from fuse F38 serving station line groups (2)40 through (2)49, (2)80 through (2)89, and 340 through 349.

#### E. Bussman Fuse LED

4.26 The voltage supplies generated on power shelf no. 1 are fused by Bussman-type fuses to prevent circuit overload. The illuminated LED mounted next to the Bussman fuses indicates that power is present on the load side of the fuse. The operating voltage limits can be verified from test points on the fuse panel.

4.27 The Bussman fuses, on power shelf no. 2, protect the ringing supply and the +24 V to the five +5 V regulators. The illuminated LED above the Bussman fuse indicates that the fuse is capable of conducting current to the load. The LED does not indicate that current is flowing through the fuse. An output voltage fault illuminates the corresponding output LED on QPJ47-type circuit pack. The ring bias fuse F2 is not equipped with an LED.

## 5. MAINTENANCE TOOLS

5.01 The tools required to correct EPABX and attendant console faults are listed in Table D.

**TABLE D  
MAINTENANCE TOOLS**

DESCRIPTION	PURPOSE
Maintenance test unit QPJ97-type circuit pack.	To perform logic tests.
Voltage Monitor unit QPJ40-type circuit pack.	To monitor power supplies on the line and trunk shelves.
Emergency connector cable (P0519592).	To bypass power fail transfer (PFT) relays and connect the stations assigned to emergency service directly to CO trunks when line shelf no. 1, trunk shelf no. 1, or the PFT panel is changed.
Handset NE-QSE4-type or equivalent handset.	To perform tests on QPJ97-type circuit pack and operations test.
Lamp extractor tool (NE-553A).	To remove NE-51A lamps from the console.
Lamp extractor tool (NE-553QA).	To remove NE-51A lamps from the fuse panel on power shelf no. 2.
Screwdrivers, diagonal pliers, pliers long nose, terminating tool (NE-714).	For the replacing of apparatus and equipment and connection of wiring.
Diode pin extractor (P096G817).	To remove diode or shorting pins from the COS selection blocks.
Volt-ohm-milliammeter (NS-14510 List 1).	For voltage and resistance measurement.
Test Probe (NS-14510 List 7)	For use with voltmeter to prevent shorting of pins.
Wire wrapping tool	To replace wiring connections.
Wire unwrapping tool	To remove wiring connections.