# SERVICE OBSERVING CIRCUIT SD-90647-01
# USED IN STEP-BY-STEP OFFICES
# TEST AND ALIGNMENT PROCEDURES

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## 1. GENERAL

1.01 This section provides test and alignment procedures along with a detailed functional description of the SD-90647-01 service observing circuit (SOC), the SD-95876-01 dial pulse monitoring circuit, the SD-31347-01 observing line circuit, and the SD-96516-01 monitoring amplifier circuit. This combination of circuitry is used for local dial service observing in step-by-step offices.

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

**1.03** This section is designed as an aid in evaluating an SOC and in clearing troubles encountered with the SOC operating independently of any service observing facilities.

**1.04** This section covers only the latest recommended equipment for SD-90647-01 and associated circuits used for service observing in step-by-step offices. Points referenced in these circuits must be determined locally for operationally equivalent circuits.

**1.05** A letter (a, b, c, etc) added to a step number in the test area of this section indicates an action which may or may not be required depending on local conditions. The condition under which a lettered step or a series of lettered steps should be made is given in the ACTION column, and all steps governed by the same condition are designated by the same letter within a test. Where a condition does not apply, all steps designated by that letter should be omitted.

## 2. DESCRIPTION

**2.01** This SOC, when used with SD-31347-01 observing line circuits, the SD-95876-01 dial pulse monitor circuit, and the SD-96516-01 monitoring amplifier circuit, provides a means for observing originating traffic on subscriber lines and/or for observing on local selectors in step-by-step line finder offices.

**2.02** The SOC provides the circuitry to prepare the observing line circuits and the dial pulse monitor circuit to lock on a subscriber's line or local selector and to report dial pulses and supervisory signals to the service observing facilities. The SOC identifies the observing line circuit over which the observation is being made and releases the observing line circuit on orders from the service observing facilities.

**2.03** The observing line circuit provides a means of connecting one of up to 100 subscriber lines and/or local selectors (plugged up for observing) to an SOC. The observing line circuit may be arranged to connect originating calls on subscriber lines, originating calls on first selectors at the time they are seized by a line switch or line finder, or incoming local calls on incoming selectors at the time they are seized over an interoffice trunk. These connections are made only when the SOC is in service and idle.

**2.04** The dial pulse monitor circuit uses high impedance detectors to respond to voltage variations on the tip and ring of the observed line caused by dial pulses and switchhook actions. The dial pulses and switchhook actions are reported to the service observing facilities with reverse battery supervision.

**2.05** The monitoring amplifier circuit is a high input impedance amplifier which amplifies the voice frequency signals from the observed line to the service observing facilities.

## 3. THEORY OF OPERATION

### A. SOC Placed in Waiting Call State

**3.01** When placed in service or after release of a call, the SOC functions to prepare itself and the observing line circuits to accept the next originated call on a line or selector that is idle and connected for observation. Any observing line circuit associated with a line or selector over which a call is in progress is eliminated so that only new originated calls can seize the SOC.

**3.02** The SOC is placed in the waiting call state by a ground on the R1 lead from the service observing facilities (Fig. 1). The ground on the R1 lead operates the R relay which completes a path to operate the RL relay. The operated RL relay operates the RLS relay to release any observing line circuit that may be attempting to lock to the SOC.

**3.03** The RLS relay in operating completes a path for operating the R1 relay. The R1 relay operated releases the RL relay. The RL relay released breaks the primary operating path of the RLS relay which releases. The SOC has now prepared all observing line circuits associated with an idle subscriber's line or selector to lock through the next new call by placing ground on the G leads and -48 volt battery on the B leads to the observing line circuits.

**3.04** All observing line circuits associated with a busy subscriber's line or selector at the time the SOC is placed in the waiting call state are prevented from seizing the SOC. This is

accomplished by the busy line or selector holding the LF (subscriber lines) or SL (selectors) relay released in the busy observing line circuit preventing the associated YK and A relays from operating to lock the observing line circuit through to the SOC.

**3.05** If an observing line circuit is seized by a subscriber's line or selector while the RLS relay in the SOC is operated, the TST relay in the SOC will operate. The TST relay operated prevents the RLS relay from releasing until the LF or SL relay has released in the respective observing line circuit.

**3.06** The DP relay in the dial pulse monitoring circuit is released in the waiting call state, connecting the balanced V electron tube grids to reference resistors M and N. The V tube is cut off and the P relay is operated over its tertiary winding.

### B. Call Originated

**3.07** When a subscriber goes off-hook on an idle line, a first selector is associated with a subscriber's line by a line finder or an incoming selector is seized over an interoffice trunk, and the line or selector is connected to an SOC that is in service and idle; the associated observing line circuit locks to the SOC. The SOC cuts off all other observing line circuits, signals the service observing equipment that a seizure has been detected, and looks for a seizure-accept signal. Upon receiving a seizure-accept signal, the SOC cuts through the call to the service observing facilities, identifies the associated observing line circuit number (loop identification), and attaches the dial pulse monitor circuit to monitor dial pulses and switchhook activity.

#### Observing Line Circuits Arranged for Subscriber Line Observing

**3.08** ***Observing Line Circuits with Option R:*** A new originated call reverse biases diode CR2 over the ring lead in the associated observing line circuit, cutting off transistor Q1 which is operated when the line is idle. Transistor Q1 off turns Q2 off. Q2 off turns on Q3. Transistor Q3 on operates relay LF.

**3.09** ***Observing Line Circuits with Option S:*** A new originated call operates the LF relay over the ring lead in the associated observing line circuit.

**3.10** The LF relay operated completes a path from the ground on the G lead to battery on the B lead through the primary winding of YK which operates. The YK relay operated prevents all succeeding observing line circuits from locking to the SOC. The YK locks on its secondary winding in multiple with the winding of relay A to ground in series with the J relay in the SOC. The A and J relays operate locking the observing line circuit to the SOC preventing any other observing line circuit from locking to the SOC. The YK relay operated also completes a path from ground on the G lead to the P lead to operate the K relay in the SOC. The operated A relay disconnects the original operate path of the YK relay through its primary winding, connects the T and R leads (voice path) from the line under observation to the SOC, and joins the TN and U leads to the SOC for identification of the observing line circuit (loop identification). The J relay in operating connects battery on the R lead and ground on the T lead at the output of the SOC to the service observing facilities as a seizure signal. The J relay operated also operates the ST relay.

**3.11** The operated ST relay opens the operating path of the slow release R1 relay which releases. If the R relay has not been released by a seizure-accept signal from the service observing facilities (removal of ground from R1 lead), the RL relay operates causing the RLS relay to operate and release the observing line circuit.

**3.12** When the subscriber's line is found by a line finder, ground is placed on the sleeve lead causing the SL relay in the observing line circuit to operate and complete a path to operate the S relay. The S relay operated releases the LF relay removing ground on the P lead to the SOC operating relay M in series with relay K. Relay S operated completes a path through make contacts of relay A to operate the SS relay which prepares the circuit to cut in the dial pulse monitor circuit for monitoring dial pulses and switchhook activity.

#### Observing Line Circuits Arranged for First Selector Observing

**3.13** When a first selector is associated with a subscriber line by a line finder, the sleeve of the selector is grounded and the SL1 relay operates in the associated observing line circuit and, in turn, operates the SL relay. The SL relay operated completes a path from the ground on the

G lead to battery on the B lead through the primary winding of YK which operates. The YK relay operated prevents all succeeding observing line circuits from locking to the SOC. The YK locks on its secondary winding in multiple with the winding of relay A to ground in series with the J relay in the SOC. The A and J relays operate locking the observing line circuit to the SOC and preventing any other observing line circuit from locking to the SOC. The YK relay operated also completes a path from ground on the G lead to the P lead to operate the K relay in the SOC. The operated A relay disconnects the original operate path of the YK relay through its primary winding, connects the T and R leads (voice path) from the line under observation to the SOC, and joins the TN and U leads to the SOC for identification of the observing line circuit (loop identification). The J relay in operating connects battery on the R lead and ground on the T lead at the output of the SOC to the service observing facilities as a seizure signal. The J relay operated also operates the ST relay.

**3.14** The operated ST relay opens the operating path of the slow release R1 relay which releases. If the R relay has not been released by a seizure-accept signal from the service observing facilities (removal of ground from R1 lead), the RL relay operates causing the RLS relay to operate and release the observing line circuit.

**3.15** The operated SL relay completed a path to operate the slow operate S relay. When the S relay operates, it breaks the operate path of the SL relay which is slow release. The operate and release time intervals of the S and SL relays allow time for the observing line circuit to lock to the SOC. The SL relay released removes ground on the P lead to the SOC causing relay M to operate in series with relay K. When relay S operated, a path was completed through make contacts of relay A to operate the SS relay which prepares the circuit to cut in the dial pulse monitor circuit for monitoring dial pulses and switchhook activity.

**Observing Line Circuits Arranged for Incoming Selector Observing**

**3.16** When an incoming selector is seized over an interoffice trunk, the LF relay operates in the associated observing line circuit. The LF relay operated operates the SL relay which completes a path from the ground on the G lead to battery on the B lead through the primary winding of YK which operates. The YK relay operated prevents all succeeding observing line circuits from locking to the SOC. The YK locks on its secondary winding in multiple with the winding of relay A to ground in series with the J relay in the SOC. The A and J relays operate locking the observing line circuit to the SOC and preventing any other observing line circuit from locking to the SOC. The SL and A relays operated cause the SS relay in the SOC to operate and prepare the circuit to cut in the dial pulse monitor circuit for monitoring dial pulses and switchhook activity. The YK relay operated also completes a path from ground on the G lead to the P lead to operate the K relay in the SOC. The operated A relay disconnects the original operate path of the YK relay through its primary winding, connects the T and R leads (voice path) from the line under observation to the SOC, and joins the TN and U leads to the SOC for identification of the observing line circuit (loop identification). The J relay in operating connects battery on the R lead and ground on the T lead at the output of the SOC to the service observing facilities as a seizure signal. The J relay operated also operates the ST relay.

**3.17** The operated ST relay opens the operating path of the slow release R1 relay which releases. If the R relay has not been released by a seizure-accept signal from the service observing facilities (removal of ground from R1 lead), the RL relay operates causing the RLS relay to operate and release the observing line circuit.

**3.18** As soon as the sleeve lead of the selector is grounded, the S relay operates and locks through its own make contacts. The LF relay releases and releases the SL relay. The SL relay released removes ground on the P lead to the SOC causing relay M to operate in series with relay K.

### C. Loop Identification

**3.19** Loop identification is transmitted to the service observing facilities to identify the observing line circuit and, from office records, the subscriber's line on which the observation is being made. Loop identification is transmitted on the T1 and R1 leads from the SOC as panel call indicator (PCI) pulsing and is composed of four types of pulses (blank, light positive, light negative, and heavy negative). The condition on the T1

and R1 for each pulse is shown in Table A. Each loop (observing line circuit) is identified by a two-digit number from 00 to 99. Each digit of the loop number is transmitted to the service observing facilities using four PCI pulses. The code for these pulses is shown in Table B.

**3.20** When the ST relay operated, a ground path was completed to set the loop identification circuitry into operation. The impulser circuit, composed of the P, POS, POS1, and NEG relays, goes through eight complete operate and release cycles during loop identification. The steering relays (W1, Z1, W2, Z2) are activated during each cycle so that the appropriate pulses to identify the loop are sent out to the service observing facilities. The pulses to be sent out are determined by the operated register relays (T1-T4, TA5, U1-U4, UA5) which are controlled by the connections at the observing line circuit. (See Table C.) The first four cycles of the impulser circuit are not sent to the service observing facilities but act as a time delay to allow the SOC time to be locked to a service observing position.

**3.21** After the fourth cycle of the impulser circuit, the BS relay operates to activate the circuitry to produce light and heavy negative pulses as required. The PC and S1 relays also operate to connect the loop identification circuit to the T1 and R1 leads. During the last four cycles of the impulser circuit, the loop identification is transmitted to the service observing facilities. A positive or blank pulse is transmitted at each operation of the POS1 relay and a negative pulse is transmitted at each release.

**3.22** During the eighth pulse, the S3 relay operates completing a path for the CO relay to operate the next time the POS relay operates. The CO relay operated breaks the ground path set up by the ST relay and releases all the register, steering, and impulser relays (including the PC relay) thus disabling the loop identification circuit.

### D. Dial Pulse Monitoring and Switchhook Activity

**3.23** When the J relay operates in the SOC, a path is completed to operate the DP relay in the dial pulse monitoring circuit. The DP relay transfers the grids of the V electron tube from the reference resistors to the tip and ring of the line being observed. With the customer off-hook, the voltage at grid 7, which is connected to the tip of the line, becomes more negative with respect to the cathode than it is when the circuit is normal. The voltage at grid 3, which is connected to the ring of the line, becomes less negative with respect to the cathode. This results in more current flow in the primary winding of the P relay and less current flow in the secondary, producing an excess of operating ampere turns to retain P operated. The T lead at the output of the SC/A is grounded and -48 volt battery is applied to the R lead.

#### Dial Pulses

**3.24** Each dial pulse has a duration of approximately 100 ms. The first 55 ms is an open circuit (on-hook) on the subscriber's line and the remainder of 45 ms is an off-hook. During the open period of the dial pulse, there is no current flow in the subscriber's line, so grid 3 of the V electron tube goes more negative than its cathode and grid 7 becomes less negative than its cathode. More current flows in the secondary winding of relay P and less current flows in the primary winding thereby producing more releasing ampere turns in the secondary winding than operate ampere turns in both the primary and tertiary windings. Relay P releases and P1 operates in turn operating relays PS and PS1 which reverse the potential on the T and R leads. When the dial closes to complete a dial pulse, current flow is reestablished in the subscriber's line. The P relay operates and releases relays P1, PS, and PS1. The T and R leads return to their original (off-hook) potential. The P, P1, PS, and PS1 relay operations are repeated for each dial pulse.

#### Subscriber Disconnect

**3.25** Disconnect by the subscriber is the same as the on-hook portion of a dial pulse except for duration. The P relay releases and the P1, PS, and PS1 relays operate and reverse the battery and ground on the T and R leads as an on-hook indication to the service observing facilities. This condition remains as long as the subscriber stays on-hook.

### E. Voice Path

**3.26** When the A relay operated in the observing line circuit, the T and R voice leads from the observed line were cut through to the SOC. The voice leads are routed through the high impedance input monitoring amplifier circuit in the

SOC. The monitoring amplifier circuit contains a voice frequency amplifier which is adjusted to compensate for some of the transmission loss in the SOC and in the trunk conductors to the service observing facilities.

### F. Call Release

**3.27** An observing line circuit locked to the SOC is released by grounding the T1 lead of the SOC. Ground on the T1 lead operates the T relay which completes a path to operate the RL relay. The operated RL relay operates the RLS relay, releasing the J and then the ST relays in the SOC. The A and YK relays in the observing line circuit are released, disconnecting the observing line circuit from the SOC.

**3.28** When ground is removed from the T lead, the SOC progresses to the waiting call state as described in the SOC placed in waiting call state paragraph.

## 4. TEST AND ALIGNMENT

**4.01** The test and alignment procedures provide a means to verify the operation of the SOC and associated equipment. These procedures include an equipment inspection (to assure that the latest changes are incorporated), an alignment of the dial pulse monitor circuit, and a dynamic test that includes seizures, switchhook action, dial pulses, loop identification, release, and monitoring amplifier operation. When used in conjunction with the functional description, these procedures should aid in finding and clearing troubles in the SOC, observing line circuit, dial pulse monitor circuit, and monitoring amplifier circuit.

### A. Apparatus

**4.02** One 250A dummy plug or equivalent.

**4.03** One KS-14510 volt-ohm-milliammeter (VOM) or equivalent with associated test leads.

**4.04** One Clevite, Model MARK 220, brush recorder or equivalent with at least two inputs.

**4.05** Two one-watt or greater resistors approximately 1300 and 2000 ohms; type KS-20289 L6C or equivalent.

**4.06** Four W1AP patching cord assemblies or equivalent.

**4.07** One 1014A handset or equivalent equipped with a 2W37A patching cord assembly or equivalent.

**4.08** Relay blocking tools as required.

**4.09** One J94071B milliwatt reference generator (MRG) or equivalent.

**4.10** One 1025A headset or equivalent.

**4.11** One 2P4C patching cord assembly or equivalent.

### B. Inspect Equipment

| STEP | PROCEDURE |
|---|---|
| 1 | Verify SOC conforms with latest applicable issue of SD-90647-01 and that all unused equipment is either removed or disabled per circuit note 135 on SD-90647-01. |
| 2 | Verify observing line circuits conform with latest issue of SD-31347-01 and that all unused equipment is either removed or disabled. |
| 3 | Verify dial pulse monitor circuit conforms with latest issue of SD-95876-01 and that all unused equipment is either removed or disabled. |
| 4 | Verify monitoring amplifier circuit conforms with latest issue of SD-96516-01 and that all unused equipment is either removed or disabled. |
| 5 | Verify heaters of V electron tube in dial pulse monitor circuit are lighted. |

| STEP | PROCEDURE |
|---|---|
| 6 | Verify M and N resistors of dial pulse monitor circuit are cut per equipment note 201 on SD-95876-01. |

**C. Balance Dial Pulse Monitor Tube Circuit**

| STEP | ACTION | VERIFICATION |
|---|---|---|
| 1 | At SD-95876-01—<br>Insert 250A dummy plug into A jack. | |
| 2 | Set function switch of VOM to 3 Vdc. | |
| 3 | Connect VOM across P4 and P6 pin jacks of SD-95876-01.<br>Reverse leads as required to obtain an ON scale reading. | VOM indicates 0 ±0.5. |
| 4a | If other than 0 ±0.5 is indicated—<br>At SD-95876-01—<br>Adjust A potentiometer for an indication of 0 ±0.05. | VOM indicates 0 ±0.05. |
| 5b | If A potentiometer cannot be adjusted for an indication of at least 0 ±0.5—<br>Replace V electron tube.<br>Allow 5 minutes for warm-up and readjust. | VOM indicates 0 ±0.05. (See note.)<br>***Note:*** A tube that can be adjusted to 0 ±0.5 but cannot be adjusted to 0 ±0.05 may be retained in the circuit; however, a periodic check of the adjustment should be made. |
| 6 | Disconnect VOM. | |
| 7 | Remove 250A dummy plug. | |

**D. Dynamic Test**

| | | |
|---|---|---|
| 1 | At terminal strip B of SD-90647-01—<br>Disconnect T, R, T1, and R1 leads from service observing facilities. (See Fig. 1.) | |
| 2 | At main distributing frame—<br>Disconnect all patching cords associated with SOC to be tested. | |
| 3 | At step-by-step office—<br>Select an unused or known subscriber's line that can be used for test purposes and can be patched for service observing. | |

| STEP | ACTION | VERIFICATION |
|---|---|---|
| 4 | At main distributing frame—<br>Connect subscriber's line selected in Step 3 to an SO jack associated with observing line circuit 39. (See note.)<br><br>***Note:*** If observing line circuit 39 is arranged for selector observing, connect subscriber's line to an SO jack associated with an observing line circuit identified by a PCI pulse code (Table B) that uses all possible pulses. | |
| 5 | At SD-90647-01—<br>Using W1AP patching cord assembly—<br>Ground R1 lead [38(B)]. | SOC progresses to waiting call state. |
| 6 | Block R1 relay operated. | |
| 7 | Remove ground from R1 lead. | R relay releases.<br>SOC remains in waiting call state. |
| 8 | Using W1AP patching cord assemblies—<br>Connect 1300 Ω resistor between T [28(B)] and R [18(B)] leads. | |
| 9 | Connect one input of brush recorder to T [28(B)] lead. | |
| 10 | Connect other input of brush recorder to R [18(B)] lead. | |
| 11 | At brush recorder—<br>Set sensitivity to 5 VOLTS/DIVISION. (See note.) | |
| 12 | Set speed to 125 MILLIMETERS/SECOND. (See note.)<br><br>***Note:*** If other types of brush recorders are used, set to measure 48-volt pulses at a speed that can be read. | |
| 13 | At 1014A handset—<br>Set TALK/MON switch to MON. | |
| 14 | At SD-31347-01—<br>Connect handset to terminal strip pins 5(T) and 6(R) of terminal strip B on RR unit. (See note.)<br><br>***Note:*** If observing line circuit 39 is not being used in test, determine T and R connections per Fig. 51 of SD-31347-01. | |

| STEP | ACTION | VERIFICATION |
|---|---|---|
| 15 | At handset—<br>Set TALK/MON switch to TALK. | At SD-31347-01—<br>LF relay operates and releases.<br>A and YK relays operate.<br>At SD-90647-01—<br>J and ST relays operate. |
| 16 | Remove block from R1 relay. | R1 relay releases.<br>SD-31347-01 remains locked to SD-90647-01. |
| 17 | With brush recorder turned on—<br>At handset—<br>Dial 919. | Dial pulse digits recorded are approximately as shown in Fig. 2. |
| 18 | With brush recorder turned on—<br>At handset—<br>Set TALK/MON switch to MON and then back to TALK repeatedly. | Recording follows switchhook action per Fig. 3. |
| 19 | Set TALK/MON switch to MON. | |
| 20 | At SD-90647-01—<br>Using W1AP patching cord assembly—<br>Ground T1 lead [48(B)] momentarily. | SD-31347-01 released from SD-90647-01. |
| 21 | At SD-31347-01—<br>Using W1AP patching cord assembly—<br>Connect 2000 Ω resistor in series with handset. | |
| 22 | At SD-90647-01—<br>Using W1AP patching cord assembly—<br>Ground R1 lead [38(B)]. | SOC progresses to waiting call state. |
| 23 | Block R1 relay operated. | |
| 24 | Remove ground from R1 lead. | R relay releases—<br>SOC remains in waiting call state. |
| 25 | Repeat Steps 15 through 19. | |
| 26 | At SD-90647-01—<br>Using W1AP patching cord assembly—<br>Ground T1 lead [48(B)] momentarily. | SD-31347-01 released from SD-90647-01. |
| 27 | Disconnect brush recorder and 1300 Ω resistor from T and R leads and connect to T1 [48(B)] and R1 [38(B)] leads. | |
| 28 | Using W1AP patching cord assembly—<br>Ground R1 lead [38(B)]. | SOC progresses to waiting call state. |
| 29 | Block R1 relay operated. | |

| STEP | ACTION | VERIFICATION |
|---|---|---|
| 30 | Remove ground from R1 lead. | SOC remains in waiting call state. |
| 31 | With brush recorder turned on—<br>At handset—<br>Set TALK/MON switch to TALK. | Recording shows PCI pulses for loop 39 per Fig. 4. (See note.)<br><br>***Note:*** If observing line circuit 39 is not being used, PCI pulse arrangement will be per Table B. |
| 32 | Set TALK/MON switch to MON. | |
| 33 | At SD-90647-01—<br>Remove block from R1 relay. | |
| 34 | Using W1AP patching cord assembly—<br>Ground T1 lead [48(B)] momentarily. | SD-31347-01 released from SD-90647-01. |
| 35 | Disconnect brush recorder and 1300 Ω resistor from T1 and R1 leads. | |
| 36 | At SD-31347-01—<br>Disconnect handset and resistor. | |
| 37 | At SD-96516-01—<br>Using 2P4C patching cord assembly—<br>Connect 600-ohm output of MRG to IN jack. | |
| 38 | Connect headset to OUT jack. | 1000 Hz tone heard. |
| 39 | Disconnect MRG and headset. | |
| 40 | At terminal strip B of SD-90647-01—<br>Reconnect T, R, T1, and R1 leads. (See Fig. 1.) | |
| 41 | At main distributing frame—<br>Reconnect service observing patching cords. | |

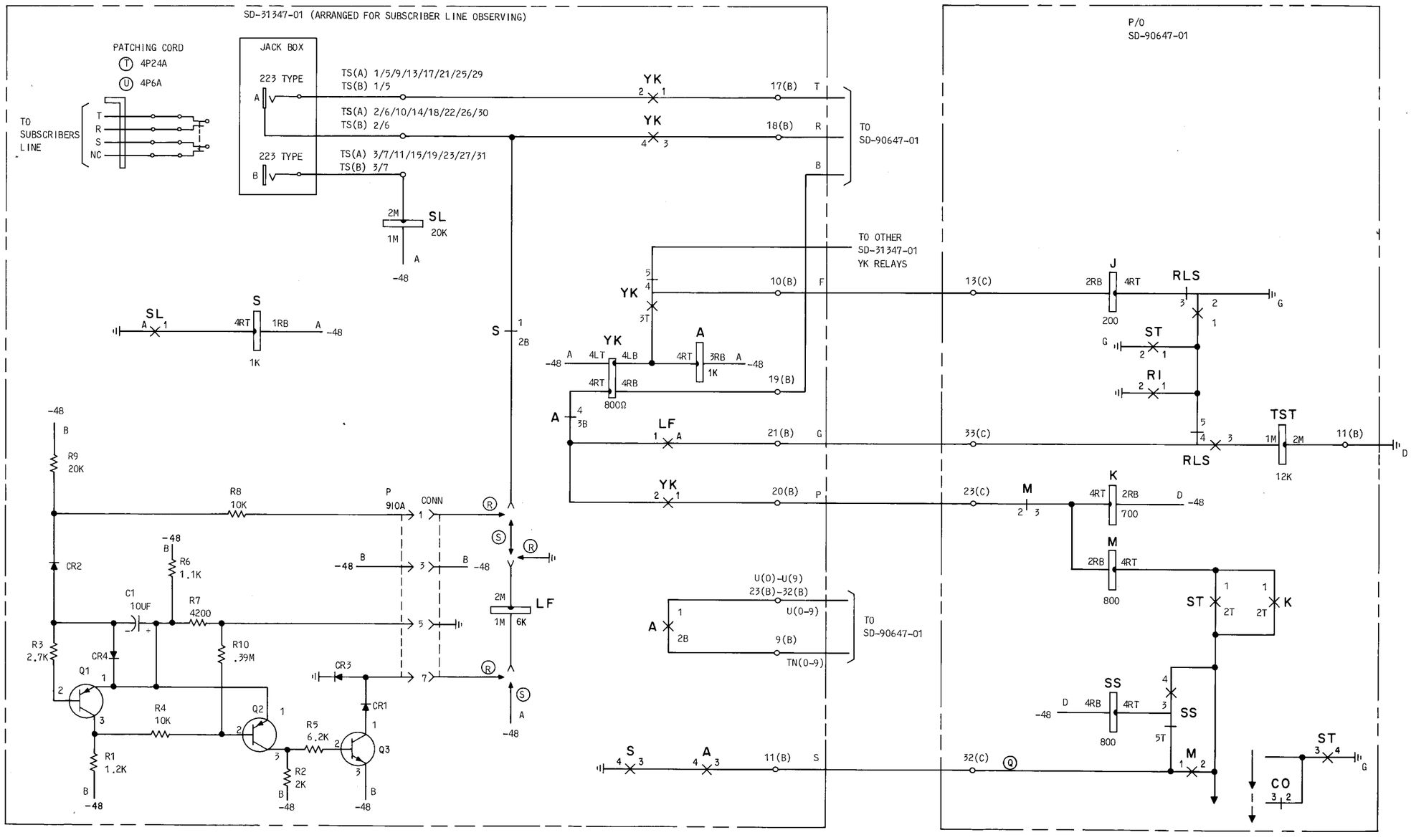


**Fig. 1—Step-by-Step Service Observing Circuitry (Sheet 1 of 5)**

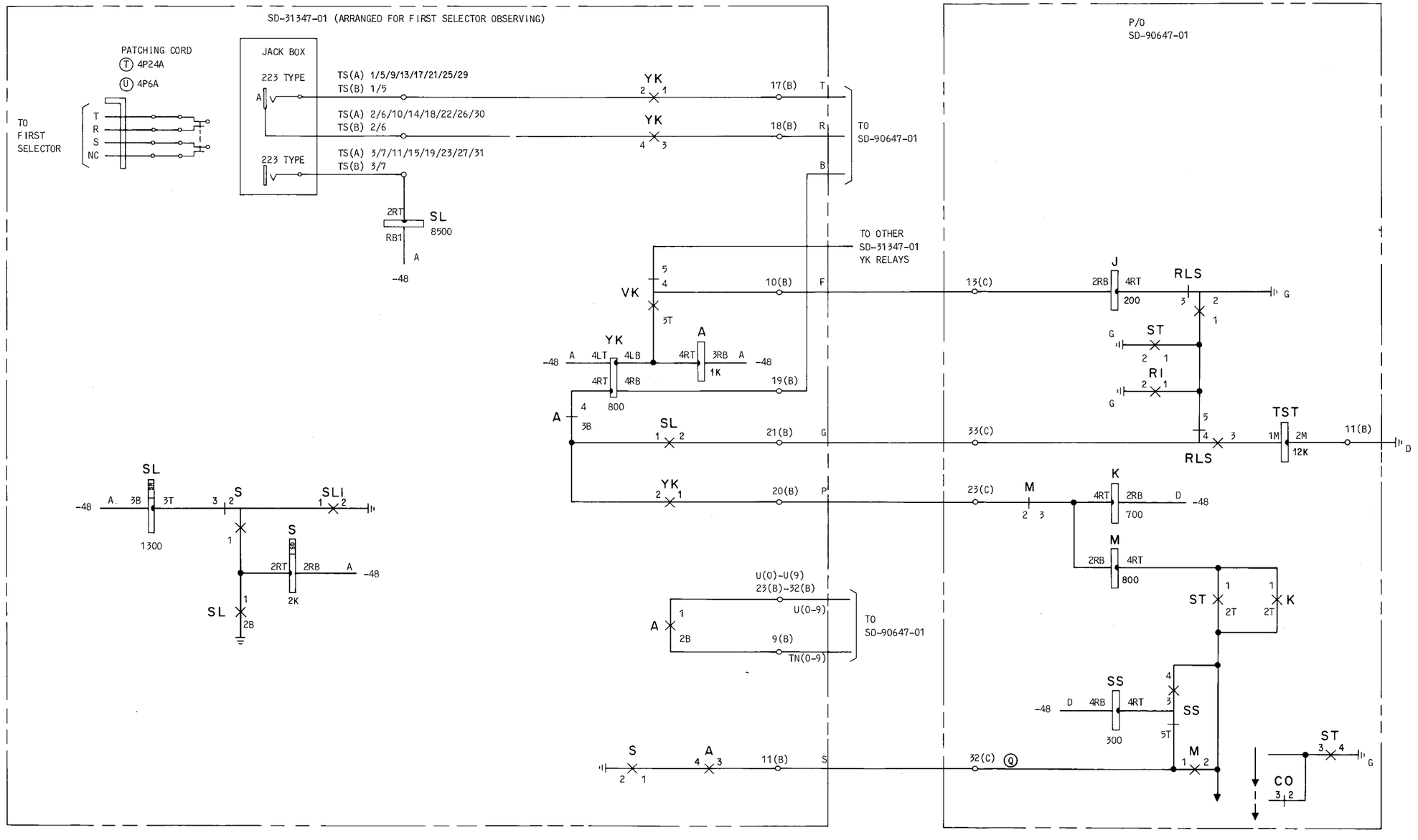


**Fig. 1—Step-by-Step Service Observing Circuitry (Sheet 2 of 5)**

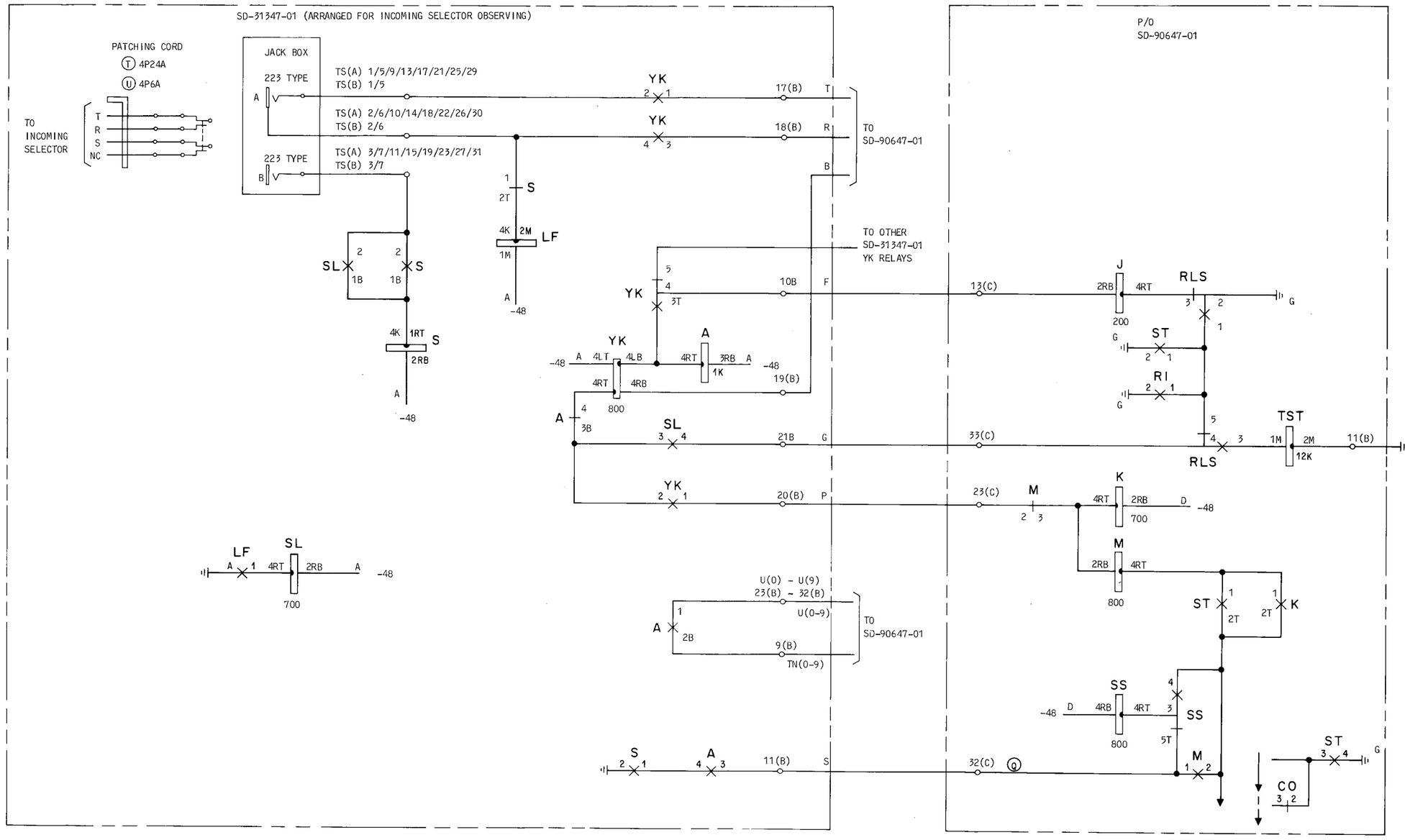


**Fig. 1—Step-by-Step Service Observing Circuitry (Sheet 3 of 5)**

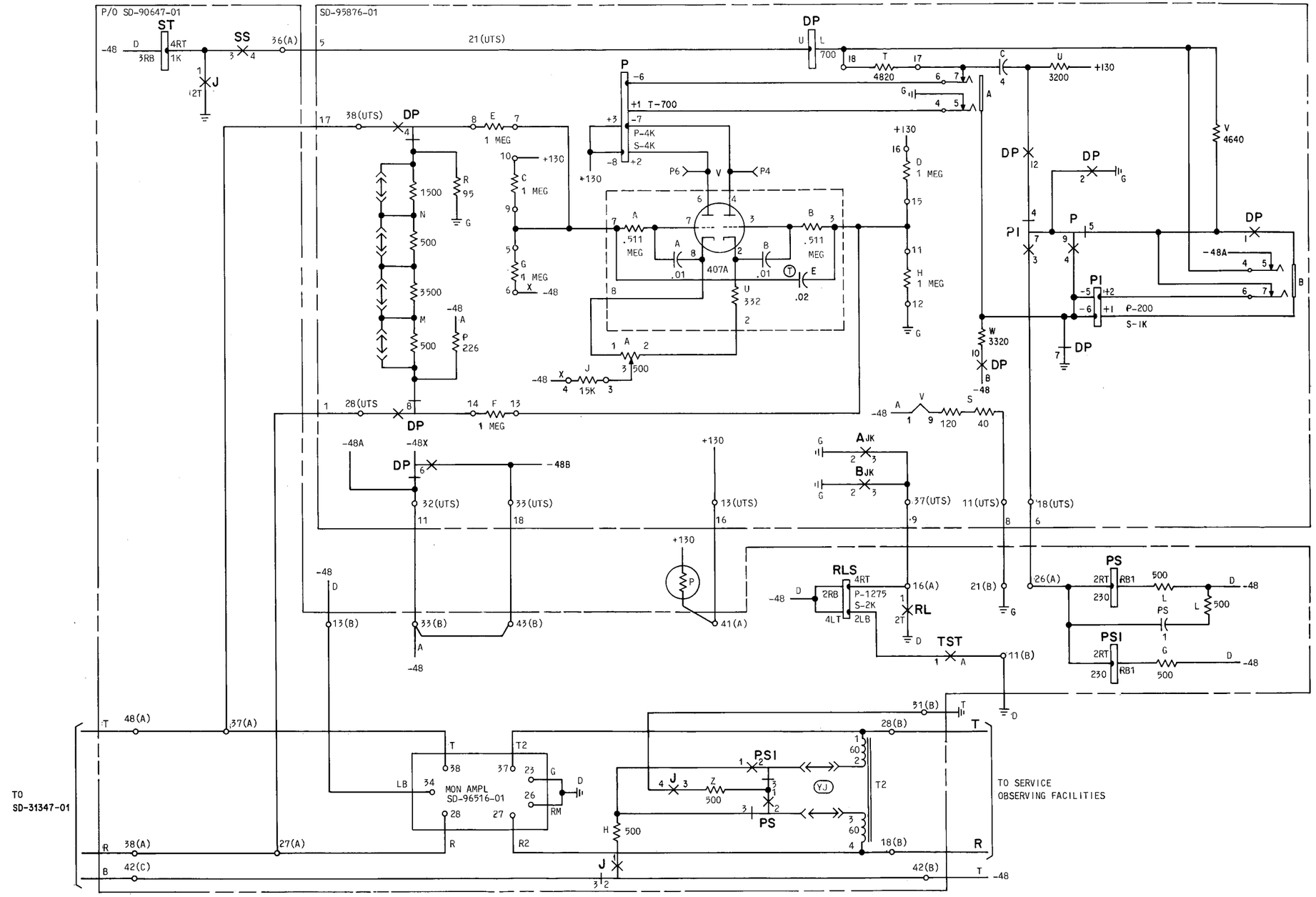


**Fig. 1—Step-by-Step Service Observing Circuitry (Sheet 4 of 5)**

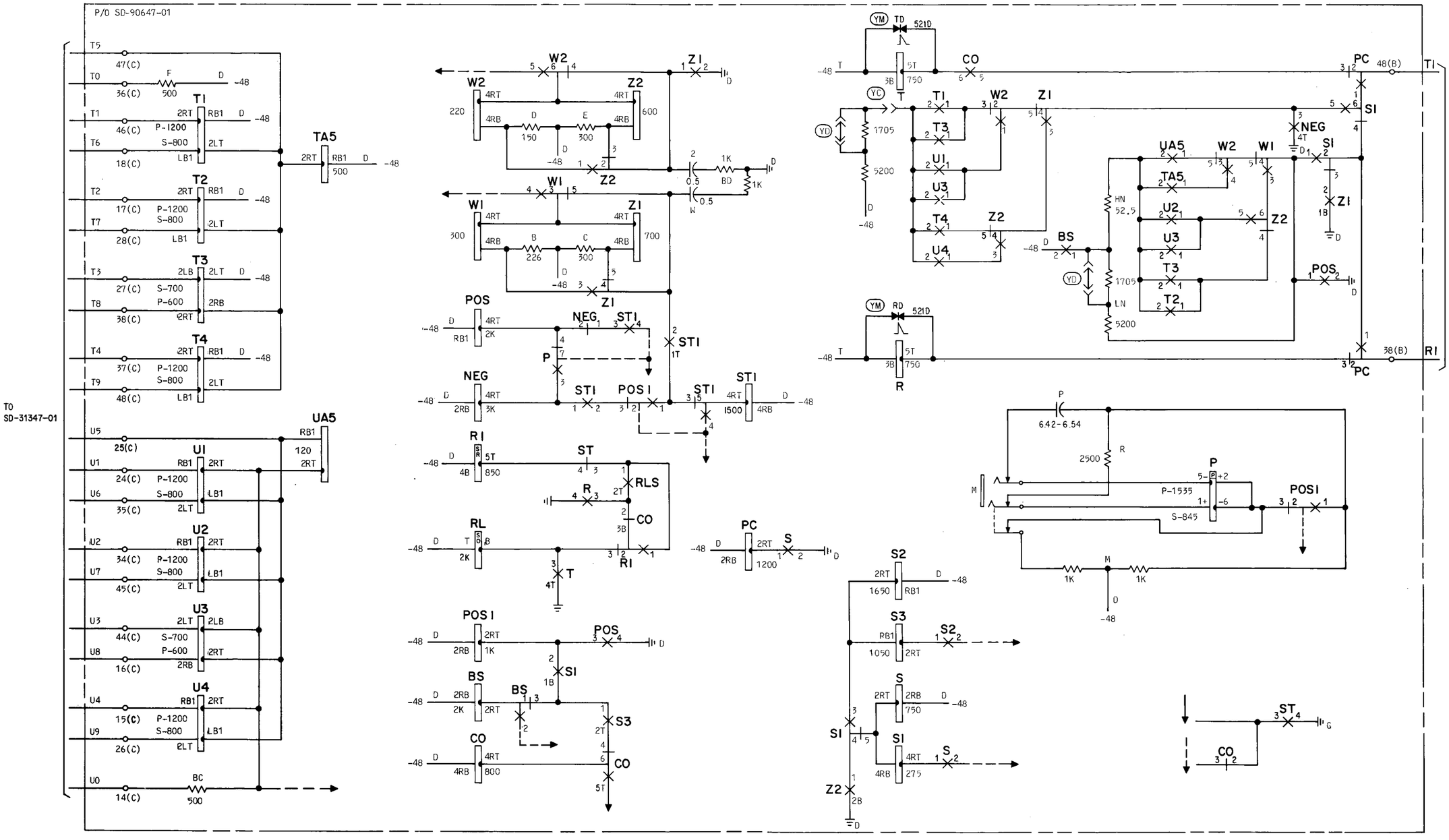


Fig. 1—Step-by-Step Service Observing Circuitry (Sheet 5 of 5)

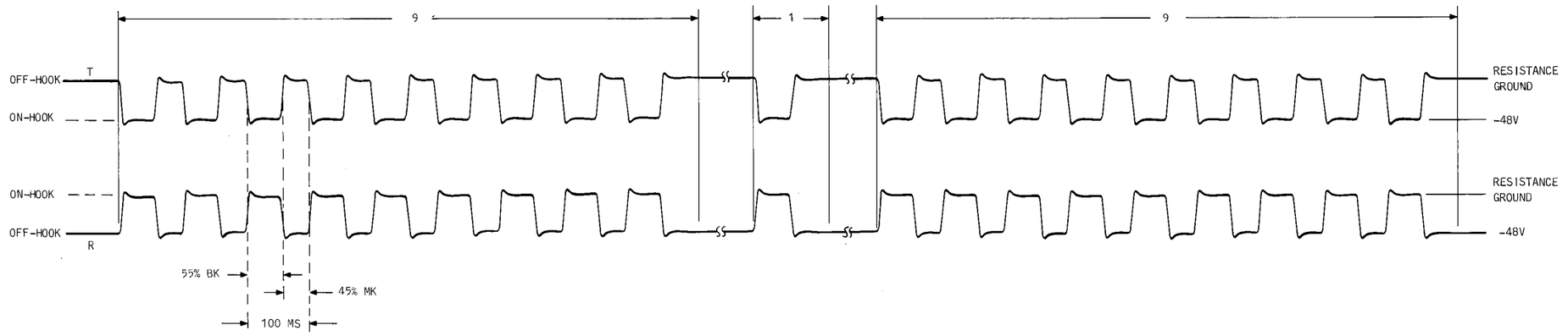


**Fig. 2—Dial Pulses**

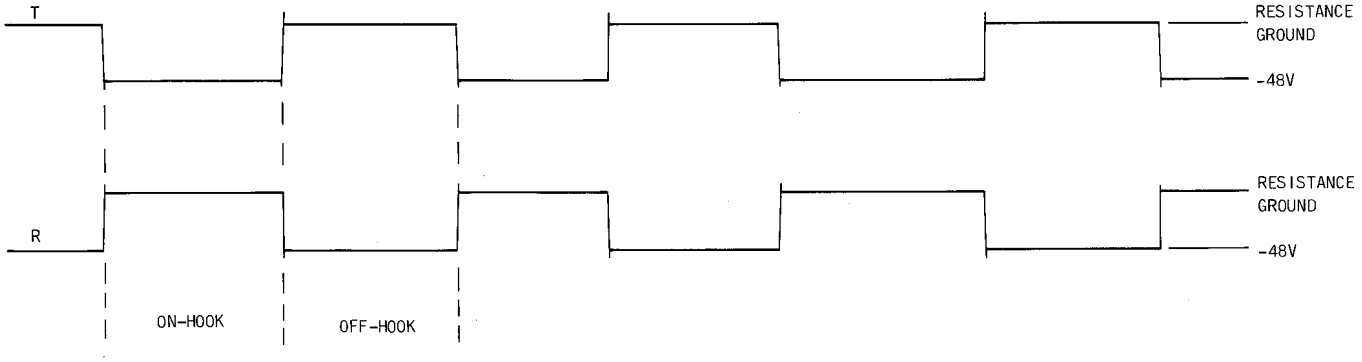


**Fig. 3—Switchhook Actions**

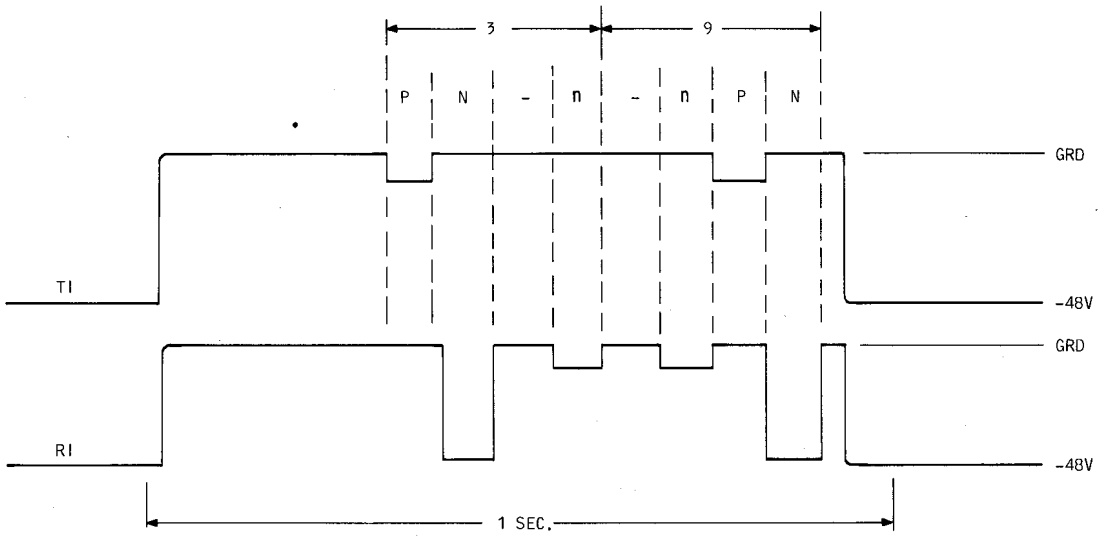


**Fig. 4—Loop Identification (Loop 39)**

## TABLE A

### PCI PULSES

| PULSE | TIP CONDITION | RING CONDITION |
|---|---|---|
| Blank | Open | Ground |
| Light Positive | High Resistance Neg Bat | Ground |
| Light Negative | Ground | High Resistance Neg Bat |
| Heavy Negative | Ground | Low Resistance Neg Bat |

TABLE B

PCI PULSE CODES

| DIGIT | TENS DIGIT PULSES | | | | UNITS DIGIT PULSES | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| 0 | - | n | - | n | - | n | - | n |
| 1 | P | n | - | n | P | n | - | n |
| 2 | - | N | - | n | - | N | - | n |
| 3 | P | N | - | n | P | N | - | n |
| 4 | - | n | P | n | - | n | P | n |
| 5 | - | n | - | N | - | n | - | N |
| 6 | P | n | - | N | P | n | - | N |
| 7 | - | N | - | N | - | N | - | N |
| 8 | P | N | - | N | P | N | - | N |
| 9 | - | n | P | N | - | n | P | N |

- Blank
P Light Positive
n Light Negative
N Heavy Negative

TABLE C

REGISTER RELAY COMBINATIONS REQUIRED FOR LOOP IDENTIFICATION DIGITS

| DIGIT | RELAYS OPERATED | |
|---|---|---|
| | TENS | UNITS |
| 0 | | |
| 1 | T1 | U1 |
| 2 | T2 | U2 |
| 3 | T3 | U3 |
| 4 | T4 | U4 |
| 5 | TA5 | UA5 |
| 6 | TA5+T1 | UA5+U1 |
| 7 | TA5+T2 | UA5+U2 |
| 8 | TA5+T3 | UA5+U3 |
| 9 | TA5+T4 | UA5+U4 |