

# CIRCUIT EXPLANATION

M

TWO WAY TRUNK CIRCUIT  
AUTO TO AUTO - AUTO TO MANUAL  
DUPLEX SIGNALING CLR HOLDING, CLASS OF  
SERVICE TONE & REVERSE BAT OR  
FOURTH WIRE SW TRAIN SUPN  
H-610144-A

(Written specifically for circuit issue 19,  
but may also apply to later issues. Refer  
to H print for appropriate E issue number.)

## FEATURES

- (a) Optional CLR holding
- (b) Peg count and ATB indications
- (c) Test jacks for monitoring and for performing "IN" and "OUT" pulsing tests
- (d) Reverse battery or fourth wire supervision on incoming calls
- (e) Reverse battery or non-reverse battery supervision on battery searching access for outgoing calls
- (f) Class of service tone
- (g) Ring-back tone to calling subscriber
- (h) Splits and terminates the transmission facilities during pulsing on both incoming and outgoing calls
- (i) Optional pulse correction on incoming calls
- (j) Optional chain metering
- (k) Provides stubbing for Cl-EAX

Changed  
FEATURES  
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Issue 6

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APPROVED

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ISSUE

6

DRAWING NO.

E- 610144-A

100  
34P

## CIRCUIT OPERATION

This circuit provides two way automatic to automatic or automatic to manual service and is arranged for use with Polar Duplex or Lenkurt Carrier type 33 or 45 (E and M) signaling. Trunk signals are sent via lead M and are received via lead E. These methods of signaling will be explained here to avoid repetition. Reference will be made to them throughout the remainder of the explanation.

### Carrier ("Y" strap)

Signals are sent via lead M and received via lead E. In the "normal" state, lead M is open. In the "seized" state, battery via lamp L is connected to lead M. When the trunk signal lead M is in the "normal" state at one end, lead E is open at the other end. When lead M is in the "seized" state at one end, lead E is grounded at the other end.

### Polar Duplex ("X" straps)

In the "normal" state, direct ground is connected to lead M. Note, however, that with Polar Duplex signaling, ground is permanently connected to lead M via resistor R6 to prevent false operation of the Duplex signaling equipment. In the "seized" state, battery via lamp L is connected to lead M. When lead M is in the "normal" state at one end, lead E is open at the other end. When lead M is in the "seized" state at one end, lead E is grounded at the other end.

Hereafter, lead M will be referred to as being in the "normal" or the "seized" state.

#### A. Outgoing Calls

##### 1.00 Seizure

##### 1.01 From SELECTOR BANKS (REV BAT)

Resistance (resistor R7) battery on lead C marks this circuit idle to the SELECTOR BANKS. When this circuit is seized relay E is closed via a loop across leads +REV and -REV. Relay E operates, transfers lead M OR SIG OUT from its "normal" to its "seized" state to seize distant equipment, and closes relay F. Relay F operates, closes #2H

and relay J, and grounds lead RM ST (when used). Relay H operates, removes idle line termination from leads T(+) and R(-) ("Z" strap omitted: see Notes 7 and 8, H-610144-A), transfers lead C from resistance (resistor R7) battery to ground to mark the circuit busy, and either removes ground from lead CH1 (for ATB metering; use "H" & "J" wiring, omit "F" wiring) or connects ground on lead CH1 to lead CHO (for chain metering; use "H" & "F" wiring, omit "J" wiring). Relay J operates, disconnects inductance coil IND from across leads +SW and -SW, and connects lead RB TONE (if used) to lead -REV to supply ring-back tone to the calling party.

### 1.02 From SEL BANKS (NON REV BAT)

The operation is similar to that described in Section A-1.01, except the loop to relay E is closed via leads +LINE and -LINE, and lead RB TONE (if used) is connected to lead -LINE instead of lead -REV.

### 2.00 Outpulsing (Operated: Relays E, H, F, and J)

Relay E follows the dial pulses and repeats them to succeeding equipment via lead M OR SIG OUT. When at normal, relay E opens relay F and connects resistance (R5, or R5 and R8: see Note 10, H-610144-A) ground to #1E to aid the pulse repetition, closes relay C, and transfers lead MOR SIG OUT from its "seized" to its "normal" state. Relay C operates, transfers lead R(-) from lead -LINE or -REV to lead T(+) via resistor R2 or resistors R1 and R2 (see Note 8, H-610144-A) to split the transmission path and connects line termination across leads +REV and -REV. Relays C and F remain operated during pulsing due to their slow-to-release characteristics.

At the end of the digit, relay E reoperates, opens relay C, removes the pre-energizing ground from #1E, and closes relay F. After its slow-to-release interval, relay C restores, transfers lead R(-) from lead T(+) to lead -REV or -LINE, and removes line termination from leads +REV and -REV.

### 3.00 Answer Supervision (Operated: Relays E, H, F, and J)

When the called party (auto-to-auto service) or distant Operator (auto-to-manual service) answers, ground via lead E OR SIG IN closes relay A. Relay A operates and closes

#2M. Relay M operates, disconnects lead RB TONE (if used) from lead -REV or -LINE, connects lead R(-) to lead "D" 2 (see Section C), transfers ground from lead RM ST (if used) to leads "D" 3 and EC (if used) for fourth wire supervision, reverses the polarity of leads +REV and -REV for reverse battery supervision, and removes idle line termination from leads R(-) and T(+) ("Z" strap used; see Notes 7 and 8, H-610144-A). Conversation may now take place.

#### 4.00 Called Line Busy (Operated: Relays E, H, F, and J)

If the called line is busy, busy tone is returned to the calling party via the repeat coil, leads R(-) and T(+), and -REV and +REV (REV BAT) or -LINE and +LINE (NON REV BAT).

#### 5.00 CLR Holding ("T" strap) (Operated: Relays A, E, H, F, M and J)

When the "T" strap is provided, release of this circuit from an outgoing call is controlled by the distant called party or Operator. Until the distant party disconnects, lead M in the distant Trunk remains in its "seized" state, holding lead E OR SIG IN grounded and relay A operated. Relay A holds relays F and M operated. Relay F holds relays H and J operated. Relay J maintains ground on lead C to hold preceding switches.

When the calling party disconnects, the loop to relay E is opened. Relay E restores, and transfers lead M OR SIG OUT from its "seized" to its "normal" state for on hook supervision. The preceding switchtrain is held by ground on lead C.

#### 6.00 Operator Recall (Operated: Relays A, E, H, F, M, and J)

When the call is terminated in the distant office at a Toll Switchboard, the calling party can signal the Operator by momentarily depressing the hookswitch. The operation of the hookswitch pulses relay E which pulses signal lead M OR SIG OUT described in Section A-2.00. Each pulse received at the distant end flashes a supervisory lamp.

7.00 Release7.01 From Completed Call (Operated: Relays A, E, H, F, M, and J)7.01.1 With CLR Holding7.01.1.1 Calling Party Disconnects First

When the calling party disconnects, the operation is described in Section A-5.00 from calling party disconnect. When the called party disconnects, ground is removed from lead E OR SIG IN opening relay A. Relay A restores and opens #2M. Relay M restores, closes relay C, opens relay F, transfers ground from leads "D" 3 and EC to lead RM ST (if used), connects lead RB TONE (if used) to leads -LINE and -REV, reverses the polarity of leads -REV and +REV for on hook supervision, and connects line termination across leads R(-) and T(+) ("Z" strap used). Relay C operates momentarily. After its slow-to-release interval, relay F restores, disconnects lead T(+) from leads +LINE and +REV, opens #2H and relay J, grounds lead PC for a peg count registration, and removes ground from lead RM ST (if used). Relay H restores, connects lead T(+) to leads +LINE and +REV, connects line termination across leads R(-) and T(+) ("Z" strap not used), and either grounds lead CH1 (for ATB metering; use "H" & "J" wiring, omit "F" wiring) or disconnects ground on lead CH1 from lead CHO (for chain metering; use "H" & "F" wiring, omit "J" wiring). After its slow-to-release interval, relay J restores, opens relay C, removes ground from lead PC, disconnects lead RB TONE (if used) from lead -LINE and -REV, connects coil IND across leads -SW and +SW, and removes ground from lead C. After its slow-to-release interval, relay C restores and connects resistance (R7) battery to lead C to mark the circuit idle. The circuit is now at normal.

7.01.1.2 Called Party Disconnects First

If the called party disconnects first, ground is removed from lead E OR SIG IN opening relay A. Relay A restores and opens #2M. Relay M restores, returns normal battery polarity to leads -REV and +REV, connects lead RB TONE (if used) to lead -REV or -LINE, transfers ground from leads "D" 3 and EC to lead RM ST (if used), and connects line termination across leads R(-) and T(+) ("Z" strap used).

When the calling party disconnects, the loop is opened to relay E. Relay E restores, opens F, closes relay C, and transfers

lead M OR SIG OUT from its "seized" to its "normal" state. Relay C operates as described in Section A-2.00. After its slow-to-release interval, F restores, disconnects lead T(+) from leads +LINE and +REV, removes ground from lead RM ST (if used), grounds lead PC for peg count, and opens #2H and J. Relay H restores, either grounds lead CH1 (for ATB metering; use "H" & "J" wiring, omit "F" wiring) or disconnects lead CH1 from lead CHO (for chain metering; use "H" & "F" wiring, omit "J" wiring), connects line termination across leads R(-) and T(+) ("Z" strap omitted), and connects leads +REV and +LINE to lead T(+). After its slow-to-release interval, J restores, opens C, removes ground from lead PC, removes lead RB TONE (if used) from -LINE and -REV, puts coil IND across leads +SW and -SW, and removes ground from lead C. After its slow-to-release interval, C restores and connects resistance (resistor R7) battery to lead C to mark the switch idle. The circuit is now at normal.

#### 7.01.2 Without CLR Holding

##### 7.01.2.1 Calling Party Disconnects First

When the calling party disconnects, the loop to E is opened. Relay E restores, opens F, and transfers lead M OR SIG OUT from its "seized" to its "normal" state for on hook supervision. After its slow-to-release interval, F restores, disconnects lead T(+) from leads +LINE and +REV, opens #2H and J, grounds lead PC for a peg count registration, and removes ground from leads "D" 3 and EC. Relay H restores, connects lead T(+) to leads +REV and +LINE, connects line termination across leads R(-) and T(+), and either grounds lead CH1 (for ATB metering; use "H" & "J" wiring, omit "F" wiring) or disconnects lead CH1 from lead CHO (for chain metering; use "H" & "F" wiring, omit "J" wiring). Ground is removed from lead E OR SIG IN, opening A. Relay A restores, and opens #2M. Relay M restores, closes relay C, connects lead RB TONE to lead -REV and -LINE, and returns normal battery polarity to leads +REV and -REV. Relay C operates. After its slow-to-release interval, relay J restores, and subsequent operation is as described in Section A-7.01.1 from the restoration of relay J.

##### 7.01.2.2 Called Party Disconnects First

The operation is the same as described in Section A-7.01.1.

## 7.02 Called Line Busy (Operated: Relays E, H, F, and J)

When the calling party disconnects after receiving busy tone, the loop is opened to E. Relay E restores, and subsequent operation is as described in Section A-7.01.1 from the restoration of E.

### B. Incoming Calls

#### 1.00 Seizure

##### 1.01 Seizure When Incoming Switch is arranged for Reverse Battery Supervision ("A" WRG and APP)

When seized, ground via lead E OR SIG IN closes A. Relay A operates, closes B, and closes a loop via lead +SW, inductance coil IND, resistor R4, #1D, and lead -SW to seize the succeeding switch. When the succeeding switch is seized, #1D is closed. Relay B operates, closes #1H, opens the +LINE toward the Selector banks to prevent false answer from being sent to the distant office should 500 ohms from an associated paystation adapter come on trunk, and connects leads R(-) and T(+) to leads -SW and +SW, respectively. Relay H operates, grounds lead C to mark this circuit busy, disconnects lead T(+) from leads +LINE and +REV, removes idle line termination from leads T(+) and R(-) ("Z" strap omitted), closes #2D, grounds lead CSW to hold the succeeding switch, and either removes ground from lead CH1 (for ATB metering; use "H" & "J" wiring, omit "F" wiring) or connects lead CH1 to lead CHO (for chain metering; use "H" & "F" wiring, omit "J" wiring). Relay D does not operate because its windings are closed in magnetic opposition.

##### 1.02 Seizure When Incoming Switch is Arranged for EC Lead Supervision Only ("E" WRG)

Seizure is similar to that described in Section B-1.01, except that "A" WRG and APP are omitted ("D" is not closed).

#### 2.00 Pulse Repeating (Operated: Relays A, B, and H)

Pulses from the distant CX SIG CKT OR TRK CHANNEL CKT are received via lead E OR SIG IN. Relay A follows the pulses and repeats them as loop pulses to the INC SW. When

at normal, A opens B and closes C. Relay C operates similarly to that described in Section A-2.00, except line termination is not connected across leads +REV and -REV or +LINE and -LINE. Relays B and C remain operated during pulsing due to their slow-to-release characteristics. At the end of each digit A re-operates, closes B and opens C. After its slow-to-release interval, C restores similarly to that described in Section A-2.00, except line termination is not removed from leads +REV and -REV or +LINE and -LINE.

### 3.00 Called Party Answers (Operated: Relays A, B, and H)

If the INC SW is arranged for reverse battery supervision, the INC SW returns reverse battery when the called party answers, closing the windings of D magnetically aiding. Relay D operates, grounds lead EC (1), and closes #1M. Relay M operates and closes E via resistor R3. Relay E operates and changes lead M OR SIG OUT from its "normal" to its "seized" state.

If the incoming switch is arranged for EC supervision only, ground is returned from the INC SW via lead EC (1) when the called party answers, closing #2M. Relay M operates and subsequent operation is described in the preceding paragraph.

### 4.00 Called Party Busy (Operated: Relays A, B, and H)

If the called party is busy, busy tone is returned to the calling party via the repeat coil.

### 5.00 CLR Holding ("T" strap) (Operated: Relays A, B, E, H, M, and possibly D)

If the incoming call is from a Toll Operator in the distant office, the Toll Operator has CLR holding supervision over this Trunk, and the succeeding switch train. When the called party restores, normal polarity is restored to leads +SW and -SW, closing the windings of D magnetically opposing (reverse battery supervision, "A" WRG and APP). Relay D restores, if operated, opening M, or ground is removed from lead EC(1) (fourth wire supervision) opening M. Relay M restores, opening E. Relay E restores and transfers lead M OR SIG OUT from its "seized" to its "normal"



state to return on hook supervision to the calling Operator. The succeeding switchtrain is held by ground on lead CSW, or by the loop closed by A until the distant Operator disconnects and releases this and succeeding circuits.

6.00 Recall to the Distant Toll Operator (Operated:  
Relays A, B, E, H, M and possibly D)

If the called party wishes to signal the calling Operator in the distant office, the hook switch is momentarily depressed. Normal polarity is momentarily restored to #1D, closing its windings magnetically opposing (reverse battery supervision, "A" WRG and APP). Relay D restores opens M, or momentarily removes ground from lead EC(1) (fourth wire supervision), opening M. Relay M restores and opens E. Relay E restores and changes lead M OR SIG OUT from its "seized" to its "normal" state to flash a supervisory lamp at the Operator's position.

7.00 Release

7.01 From a Completed Call (Operated: Relays A, B, E,  
H, M and possibly D)

7.01.1 Calling Party Disconnects First

If the calling party disconnects first, ground is removed from lead E OR SIG IN opening A. Relay A restores, opens the loop to succeeding equipment, opens #1D and relay B.

After its slow-to-release interval, relay B restores, removes ground from lead CSW (if used) and lead PC, and opens #1H, and #2D. Relay H restores, removes ground from lead C, connects resistance (resistor R7) battery to lead C, connects line termination across R(-) and T(+), connects lead T(+) to leads +LINE and +REV, and either grounds lead CH1 (for ATB metering; use "H" & "J" wiring, omit "F" wiring), or disconnects ground on lead CH1 from lead CHO (for chain metering; use "H" & "F" wiring, omit "J" wiring). Relay D restores and opens #1M (reverse battery supervision).

Succeeding switches restore and remove ground from lead EC(1) (fourth wire supervision if used), opening #1M.

Relay M restores and opens E. Relay E restores and changes lead M OR SIG OUT from its "seized" to its "normal" state. The circuit is now at normal.

#### 7.01.2 Called Party Disconnects First

If the called party disconnects first, operation is similar to that described in Section B-5.00, up to the restoration of the "normal" state of lead M. When the calling party restores, ground is removed from lead E, opening A. Relay A restores, opens the loop to #1D, and opens relay B. After its slow-to-release interval, relay B restores, removes ground from lead CSW (if used) and lead PC, and opens #2D, and #1H. Relay H restores, connects line termination across R(-) and T(+), closes +LINE to the Selector banks, connects lead T(+) to leads +LINE and +REV, removes ground from lead C, connects resistance (resistor R7) battery to lead C, and either grounds lead CH1 (for ATB metering; use "H" & "J" wiring, omit "F" wiring), or disconnects lead CH1 from lead CHO (for chain metering; use "H" & "F" wiring, omit "J" wiring). The circuit is now at normal.

#### 7.02 From Busy Condition (Operated: Relays A, B, and H)

When the calling party restores after receiving busy tone, ground is removed from lead E, opening A. Relay A restores, and subsequent operation is described in Section B-7.01.2 from the restoration of A

#### C. Operation With Class of Service Tone (FIG CSB, "D" wiring)

##### 1.00 Seizure

Seizure is the same as that described in Section A-1.00.

##### 2.00 Answer Supervision (Operated: Relays E, H, F, and J)

The operation is similar to that described in Section A-3.00, except that when M operates, lead "D"2 is connected to leads -LINE and -REV, and ground via lead "D"3 closes relay K. After its slow-to-operate interval, K operates and closes relay G via capacitor C8.

Capacitor C8 discharges through relay G. Relay G operates and connects #2L across leads +LINE and -LINE, or +REV and -REV via capacitor C7. The rate of discharge of capacitor C8, and therefore the length of time relay G is operated is controlled by the potentiometer R13. When capacitor C8 has fully discharged relay G restores and disconnects #2L from leads +LINE and -LINE or +REV and -REV.

The normal operated time of relay G is approximately 2 seconds. This gives the operator enough time to hear the class of service tone signal.

### 3.00 Release

Release is the same as described in Section A-7.00, except when M restores, it removes ground from lead "D" 3 opening K. Relay K restores, connects ground to capacitor C8, and opens relay G. The circuit is now at normal.

### D. Pulse Correction (FIG PC, "PC" wiring)

#### 1.00 Seizure

Figure PC provides optional pulse correction on incoming calls. Seizure is similar to that described in Section B-1.00, except ground from the distant Trunk via lead E OR SIG IN seizes the Pulse Corrector via lead 1, ground via lead 3 closes relay A, and when B operates, it also grounds lead 2 to the Pulse Corrector via diode CR2.

#### 2.00 Impulsing (Operated: Relays A, B, and H)

The operation is similar to that described in Section B-2.00, except the Pulse Corrector follows the pulses on lead E OR SIG IN via lead 1 and forwards the corrected pulses to A via lead 3.

#### 3.00 Release

Release is similar to that described in Section B-7.00, except when ground is removed from lead E, the Pulse Corrector removes ground from lead 3, opening A, and when B restores, it also removes ground from Pulse Corrector lead 2.

### E. Test Facilities

The operation of the BUSY KEY removes ground from lead CH1 (ATB metering) or connects lead CH1 to lead CHO (optional chain metering) and grounds lead C to mark the circuit busy.

To perform an outpulsing test of E, a hand test telephone is first connected to LEFT TEST JK springs 1 and 2 (MON) to monitor the line to determine if the switch is idle or busy. When idle, the OPT KEY is operated, the BUSY KEY is operated to mark the circuit busy, and the SW Test Cord of Varying Machine Circuit (H-85681 or equivalent) is inserted into RIGHT TEST JACK springs 1 thru 4. A Pulse Speed and Per Cent Break test set (or equivalent device) is then connected to PULSE MEAS. RIGHT TEST JK. springs 7 and 8. Pulses under variable loop and leak conditions are introduced to E via PULSE INPUT springs 1 and 2. Relay E follows the pulses and repeats them to the Pulse Speed and Per Cent Break test set via PULSE MEAS RIGHT TEST JK. springs 7 and 8.

After testing the test equipment is disconnected and the BUSY KEY and OPT KEY are restored. The circuit is now at normal.

To perform a local impulsing test of A, the line is monitored as described above to determine if the switch is idle or busy. When idle, the BUSY KEY is operated, the IPT key is operated, and the six conductor cable of Toll Pulse Repeating Test Set Circuit (H-85388 or equivalent) is inserted into springs 3 thru 8 of the LEFT TEST JACK. Pulses are introduced to A via springs 3 and 4 (PULSE INPUT) of the LEFT TEST JACK. Relay A follows the pulses and repeats them for measuring as loop pulses to springs 7 and 8 of the PULSE MEAS LEFT TEST JACK.

When tests have been completed, the test equipment is disconnected and the IPT KEY and BUSY KEY are restored. The circuit is now at normal.