

COMMON SYSTEMS  
 10 P.P.S. PULSE CORRECTING LONG LINE CCT.  
 FOR SUBSCRIBER LINES IN PANEL, CROSSBAR  
 OR STEP BY STEP OFFICE OR FOR LONG  
 MANUALLY SELECTED TRUNKS TO PANEL  
 CROSSBAR, OR SXS OFFICE FROM P.B.X.  
 OR FOR LONG STATION LINES ASSOCIATED WITH P.B.X.

CHANGES

B. CHANGES IN APPARATUS

B.1	Added	Superseded	Superseded By
	Repeat Coils	Relay	Relay
	120CS option ZM	B604	B1154
	120DS options ZK or ZN		

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Prior to issue 7-D title was:

COMMON SYSTEMS  
 10 PPS PULSE CORRECTING LONG LINE CIRCUIT  
 FOR SUBSCRIBER LINES IN PANEL CROSSBAR  
 OR STEP-BY-STEP OFFICE OR FOR LONG  
 MANUALLY SELECTED TRUNKS TO PANEL  
 CROSSBAR OR STEP-BY-STEP OFFICE FROM P.B.X. NO. 505C,  
 506A, 506B, 550C, 550SC, 551A, 551B, 551D,  
 552A, 552D, 600C, 605A, 606A, 701A OR 702A  
 OR FOR LONG STATION LINES ASSOCIATED  
 WITH ONE OF ABOVE P.B.X.'S OR WITH P.B.X.  
 NO. 604C, 700C, 710C, 711A, 740A, 740B OR 740C

D.2 Circuit note 109 added.

D.4 ED-92554-01 added in issue  
 column on drawing.

D.3 Options ZG, ZH & ZJ are  
 designated.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 3310-CFC-RLL-DU

COMMON SYSTEMS  
10 PPS PULSE CORRECTING LONG LINE CIRCUIT  
FOR SUBSCRIBER LINES IN PANEL CROSSBAR  
OR STEP-BY-STEP OFFICE OR FOR LONG  
MANUALLY SELECTED TRUNKS TO PANEL  
CROSSBAR OR STEP-BY-STEP OFFICE FROM P.B.X. NO. 505C,  
506A, 506B, 550C, 550SC, 551A, 551B, 551D,  
552A, 552D, 600C, 605A, 606A, 701A OR 702A  
OR FOR LONG STATION LINES ASSOCIATED  
WITH ONE OF ABOVE P.B.X.'S OR WITH P.B.X.  
NO. 604C, 700C, 710C, 711A, 740A, 740B OR 740C

CHANGES

B. CHANGES IN APPARATUS

B.1 Added

309A Varistor, figure 2

B.2 Superseded

Superseded By

(L1) 239FB relay "R" option (TF) and (TS) 239FC relays "P" option (BR) 54R retard coil "U" op- tion	(L1) 280K relay "N" option (TF) and (TS) 280A relays "M" option (BR) 274R retard coil "T" op- tion
--	---

C. CHANGES IN CIRCUIT REQUIREMENTS  
OTHER THAN THOSE APPLYING TO  
ADDED OR REMOVED APPARATUS

C.1 Prior to this issue the test set preparation for the (L) relay was BAT and a note in the remarks column read "Remove (B) res. lamp and strap 3(R) to 6(R)".

C.2 Test notes 1, 2 and 3 are added applying to the (L1) relay.

C.3 The requirements shown for the (L1), (TF) and (TS) relays were:

Mech. Circuit Preparation

Apparatus Desig. Code	ESP Fig.	Block or Insul- ata	Test Clip Data		Set Prep.	Direct Wdg.	Current Flow Req.			Remarks
			Conn. Bat.	Grd.			Test	Test	Readj. Amp.	
L1 239FB or 231GF	12	(R)O (HD)NO	7(L1) 7(L1) (H)JK-S	3(L1) 3(L1) (B)JK-S	B/G B/G B/G	P1/P2 P1/P2 S	0 NO 0	.0017 .0005 .0018	.0016 .0006 0	Remove (B) and (G) res. lamps Strap 3(R) to 6(R) Remove (B) res. lamp
TF 239FC or 231FJ	12		(B)JK-S (B)JK-S (B)JK-S	(B)JK-R (B)JK-R (B)JK-T	B/G B/G B/G	P P S	0 NO 0	.0021 .0009 .0004	.002 .001 0	Insert dummy plug in (A) jack
TS 239FC or 231FJ	12		(B)JK-S (B)JK-S (B)JK-S	(A)JK-R (A)JK-R (A)JK-T	B/G B/G B/G	P P S	0 NO 0	.0021 .0009 .0004	.002 .001 0	

D. DESCRIPTION OF CIRCUIT CHANGES

- D.1 Circuit note 108 is added.
- D.2 Options M, N, P, Q, R, S, T and U are added to circuit note 107.
- D.3 Options used table is added.
- D.4 "L" and "L1" leads of fig. 1 to fig. 2 are added.

- D.5 Prior to this issue figure 1 was not designated.
- D.6 The 239FB and 239FC relays are rated "Mfr. Disc." and are superseded by the 280 type relays to provide a polarized relay that has improved adjustment stability.
- D.7 In circuit note 101B a 1-1/3 ampere fuse was specified, prior to this issue.

D.8 The 231FG relay is designated "S" option and the 231FJ relay is designated "Q" option.

All other headings under changes,  
No change.

### 1. PURPOSE OF CIRCUIT

1.1 The purpose of this circuit is to extend the operating range of a dial subscriber line, a P.B.X. station line or a P.B.X. trunk.

### 2. WORKING LIMITS

2.1 Maximum conductor loop resistance for dialing.

2.11 When used as a P.B.X. long trunk or a subscriber long line circuit:

Toward subscriber line circuit - 525 ohms  
Toward subset or toward P.B.X. - 2,000 ohms when connected to a subset or another long line or long trunk circuit, and 600 ohms when connected to a trunk circuit at a P.B.X.

2.12 When used as a P.B.X. long station line circuit:

Toward PBX-1000<sub>w</sub> when connected to a long line circuit at the P.B.X. and 700 ohms when connected to a line circuit at the P.B.X.

Toward subset or long station line circuit - 2000 ohms.

2.2 Maximum conductor loop resistance for ringing, 2000 ohms.

2.3 Minimum insulation resistance, 15,000 ohms.

2.4 Dial speed - 8 to 11 pulses per second.

### 3. FUNCTIONS

3.1 To operate the associated subscriber line or station line circuit when a call is originated.

3.2 To provide means for correcting and repeating dial pulses.

3.3 To provide transmitter battery to the subset.

3.4 To relay switchhook supervision.

3.5 To provide a new supply of ringing current when ringing current is connected to this circuit.

3.6 To enable an operator at the central office to rering the attendant at a P.B.X.

3.7 To reduce the level of the clicks when a call is answered while ringing is connected to the circuit.

3.8 To trip machine ringing only during the silent interval.

### 4. CONNECTING CIRCUITS

When this circuit is listed on a key sheet the connecting information thereon shall be followed.

4.1 Panel or step by step subscriber line circuit - SD-21712-01 (typical).

4.2 P.B.X. station line circuit - SD-66414-01.

4.3 Trunk circuit at P.B.X. - SD-66607-01 (typical).

4.4 Long line or long trunk circuit - SD-66474-01 (typical).

### DESCRIPTION OF OPERATION

#### 5. CIRCUIT NORMAL

When this circuit is normal the (L1), (TF) and (TS) relays may have either the front or the back contacts closed since these relays will stick on either contact when there is no current flow in their windings.

#### 6. OUTGOING CALLS FROM SUBSCRIBER OR P.B.X. STATION

##### 6.1 Call Originated

When a call is originated the (L) and (L1) relays operate over the loop. The operation of the (L) relay operates the (L2) relay which connects ground from the (L) relay contact to the off-normal ground lead and thus (a) connects ground to the armature of the (L1) relay under control of the back contact of the (PL1) relay, (b) energizes both windings of the (TF) relay, (c) operates the (TS) relay on its primary winding and (d) energizes the secondary winding of the (L1) relay. The windings of the (TF) relay are connected differentially and as the secondary winding is more effective than the primary, the relay

closes its back contact. The (L1) relay remains operated with its primary windings energized over the loop and opposed by the current in the secondary winding. The operation of the (L1) relay operates the (LK) relay which operates the (HD) relay and prepares a path for locking its own winding in series with the (PL1) relay. The (PL1) relay does not operate at this time as it is short-circuited. The operation of the (HD) relay closes the talking circuit thru the (B) condenser, closes a bridge inside the repeating coil and grounds the off normal ground lead at another point. The (D) relay does not operate as it is short-circuited by the (TS) relay.

## 6.2 Dialing

### 6.21 Timing Relays

The (TF) and (TS) relays control the outgoing pulses and are wired so that when both windings are energized the back contacts are closed. When ground is removed from the secondary winding, the associated (TF) or (TS) condenser charges in series with the relay winding. While the condenser is charging the charging current gradually decreases and when it has decreased sufficiently, the current in the primary winding causes the relay to operate. In other words, these relays act as slow operating relays, the operating time being controlled accurately by the associated timing condenser.

When a slow dial is used the (TS) relay times the open period of the outgoing pulses. The (TS) relay starts to operate under control of the (TS) condenser at the same time that the bridge on the outgoing side of the circuit is opened and when the (TS) relay operates the bridge is again closed. If a fast dial is used the (TF) relay times the closed interval between pulses. The (TF) relay starts to operate under control of the (TF) condenser at the same time that the bridge on the outgoing side of the circuit is closed and when the (TF) relay operates the bridge is again opened. The detailed operation follows:

6.22 When dial tone is heard the dial is operated and the (L1) relay repeats the dial pulses. The (L) relay may also follow dial pulses but it performs no useful function. The release of the (L1) relay at the first impulse of the digit operates

the (PL1) relay by removing the short circuit from its winding and prepares part of the locking circuit for the (PL) relay. The (LK) relay remains operated in series with the (PL1) relay. The 3500 ohm winding of the (K) resistance is provided in order to aid the (LK) relay in holding while the current is building up in the winding of the (PL1) relay. The operation of the (PL1) relay (a) bridges the back contacts of the (PL) relay in order to maintain the closure of the loop on the outgoing side of the circuit when the (PL) relay operates as described below, (b) disconnects ground from the armature of the (L1) relay and thus opens its own short-circuiting path at another point so that when the (L1) relay reoperates the (PL1) relay will not release, (c) energizes the secondary winding of the (TS) relay causing the relay to release immediately, (d) discharges the (TS) condenser through part of the (A) resistance, (e) disconnects ground from the secondary winding of the (TF) relay thus allowing that relay to operate under control of the (TF) condenser, and (f) operates the (RL) relay. The (RL) relay opens the circuit of the secondary winding of the (TF) relay at another point and disconnects ground from the (K) resistance in order to aid the release of the (LK) relay as described below. The release of the (TS) relay (a) removes the short-circuit from the (D) relay winding thus allowing that relay to operate in series with the (D) resistance, and (b) operates the (PL) relay. The operation of the (D) relay closes a locking path for holding the (HD) relay, short-circuits windings on the (A) repeating coil, disconnects the (B) condenser and the (RU) relay and (RU) condenser from inside the repeating coil, and places part of the (L) resistance in multiple with the (BR) retard coil in order to aid dialing. The operation of the (PL) relay serves no useful purpose at this time. When the (TF) relay operates it opens the locking circuit of the (LK) and (PL1) relays and these relays release. The release of the (LK) relay opens its own locking circuit at another point and short-circuits part of the (K) resistance so that subsequently the (LK) relay will operate very quickly when the (L1) relay reoperates. The release of the (PL1) relay (a) opens the bridge inside the repeating coil thus starting the open period of the outgoing pulse, (b) removes ground from the secondary winding of the (TS) relay thus starting the timing of the

outgoing pulse, (c) connects ground to the armature of the (Ll) relay, and (d) releases the (RL) relay. The release of the (RL) relay releases the (TF) relay by energizing its secondary winding, discharges the (TF) condenser through part of the (A) resistance, and connects ground to the 3500 ohm winding of the (K) resistance. The (LK) relay, however, does not operate in series with this resistance.

### 6.23 Operation with a Slow Dial

6.231 If a slow dial is being used, for instance one which operates about 8 p.p.s., the (Ll) relay will usually reoperate over the loop before the (TS) relay operates. The operation of the (Ll) relay opens the locking circuit of the (PL) relay and reoperates the (LK) relay. The (PL) relay, however, remains operated under control of the (TS) relay. The operation of the (LK) relay removes the short-circuit from the 500 ohm winding of the (K) resistance in order to decrease the current drain and prepares a path for locking itself in series with the (PLl) relay. When the (TS) relay operates under control of the (TS) condenser it releases the (PL) relay which closes a bridge inside the repeating coil and thus terminates the open period of the outgoing pulse. In other words, the outgoing pulse starts when the (PLl) relay releases, it is timed by the (TS) relay, and it terminates when the (PL) relay releases. Subsequent pulses are repeated in a like manner. Each time the (TS) relay operates it momentarily short-circuits the (D) relay but the short-circuit is removed so quickly that the (D) relay remains operated until the end of the digit. The (D) relay when released removes the short-circuits from windings on the (A) repeating coil and again bridges the (B) condenser and the (RU) relay and (RU) condenser inside the repeating coil. The (HD) relay remains operated under control of the (LK) relay.

6.232 If the open interval of the incoming pulse should be very long so that the (Ll) relay does not reoperate before the (TS) relay operates, the length of the outgoing pulse will be somewhat greater than described above. The operation of the (TS) relay in this event will not release the (PL) relay since that relay is locked operated under control of the back contact of the (Ll) relay. When the (Ll) relay reoperates it operates the (LK) relay and releases the (PL) relay which closes the loop on the outgoing side of the circuit.

### 6.24 Operation with a Fast Dial

If a fast dial is being used, for instance one that operates about 11 p.p.s., the circuit functions as described in paragraph 6.22. However, at the higher dial speeds the incoming pulses are received so rapidly that the (Ll) relay reoperates over the loop and again releases on the next pulse before the (TS) relay has operated. When the (Ll) relay has reoperated and the (PLl) relay has released, the (LK) relay operates and prepares a locking path for locking in series with the (PLl) relay. The (PLl) relay, however, does not reoperate at this time as it is short-circuited. When the (Ll) relay releases it removes the short-circuit from the (PLl) relay and that relay operates in series with the (LK) relay. The operation of the (PLl) relay (a) closes the bridge inside the repeating coil thus starting the closed interval between pulses, (b) disconnects ground from the secondary winding of the (TF) relay thus starting the timing of the closed interval between pulses, (c) disconnects ground from the armature of the (Ll) relay thus opening the path by which its own winding was short-circuited, (d) energizes the secondary windings of the (TS) relay and discharges the (TS) condenser through part of the (A) resistance and thus prevents the (TS) relay from operating and (e) operates the (RL) relay. (With a fast dial the successive operations of the (PLl) relay follow each other so quickly that the (TS) relay does not operate until the end of the digit.) The operation of the (TF) relay under control of the (TF) condenser releases the (LK) and (PLl) relays. The release of the (PLl) relay opens the bridge inside the repeating coil thus terminating the closed interval between pulses. In other words, the closed interval between outgoing pulses starts when the (PLl) relay operates, it is timed by the (TF) relay, and it terminates when the (PLl) relay releases. Subsequent pulses are repeated in a like manner until the last pulse of the digit. The last pulse is terminated by the release of the (PL) relay under control of the (TS) relay as described in paragraph 6.231. As the (TS) relay remains on its back contact until the end of the digit, the (D) and (PL) relays remain operated until the end of the digit when they function as described in paragraph 6.231.

### 6.3 Talking

When the call is answered no change takes place in this circuit. Transmitter

battery is supplied to the sub-set through windings of the (L) and (L1) relays and the (A) repeating coil.

#### 6.4 Disconnection

If the called party disconnects first no change takes place in this circuit. When the calling party disconnects the (L) and (L1) relays release. The release of the (L1) relay operates the (PL1) relay by removing the short-circuit from the winding of that relay. The operation of the (PL1) relay releases the (TS) relay by energizing it on its secondary winding and operates the (TF) relay by opening the circuit to its secondary winding. The release of the (TS) relay operates the (PL) relay and permits the operation of the (D) relay, through one winding of the (D) resistance. The operation of the (D) relay locks the (MD) relay in local circuit. The operation of the (TF) relay releases the (LK) and (PL1) relay. The release of the (PL1) relay (a) opens the bridge inside the repeating coil, thus releasing the connection at the central office or in the case of a call to an operator, providing a disconnect signal, (b) closes a locking path for holding the (PL) relay, (c) releases the (RL) relay, and (d) disconnects ground from the secondary winding of the (TS) relay. The (TS) relay operates and short-circuits the (D) relay which releases. The release of the (D) relay releases the (HD) relay. The release of the (HD) relay releases the (L2) relay and disconnects ground from the off-normal ground lead, thus returning the circuit to normal.

### 7. INCOMING CALLS

#### 7.1 Line or Trunk Selected

When this line or trunk is selected and ringing current is connected to the tip and ring the (RU) relay operates, operating the (R1) relay. The operation of the (R1) relay operates the (C) relay on its primary winding. The (C) relay locks under control of the (RU) relay, opens the circuit to the (R1) relay, prepares part of the path for operating the (R2) relay on its primary winding, disconnects the (C) condenser from battery and ground, bridges the (C) condenser across the tip and ring, and prepares the path for operating the (R) relay. The (R1) relay is slow to release and remains operated momentarily after the

(C) relay operates. When the (R1) releases the (R2) relay operates on its primary winding and locks under control of the (RU) relay. The operation of the (R2) relay closes part of the path for connecting ringing current to the ring, operates the (R) relay by removing the short-circuit from its winding, and reoperates the (R1) relay. The operation of the (R) relay disconnects the tip and ring leads from the (A) repeating coil, connects ringing current under control of the (R2) relay to the trunk, and holds the (C) and (R2) relays on their secondary windings. The (C) and (R1) relays are slow acting relays and insure that the (R) relay does not operate falsely in case the (RU) relay kicks up momentarily. When ringing current is disconnected from the circuit the (RU) relay releases, releasing the (R1) relay which releases the (R2) relay. The release of the (R2) relay disconnects ringing current from the ring, connects battery to the ring through the (C) resistance, and releases the (R) relay by short-circuiting it. As ground is connected to the tip and battery is connected to the ring while the (R) relay is releasing, any charge left by the ringing current on the (C) condenser is removed and the condenser is charged to 48 volts. This prevents the (L) and (L1) relays from kicking-up and falsely tripping machine ringing when the (R) relay releases and again closes the tip and ring through to the repeating coil. The release of the (R) relay also releases the (C) relay which disconnects the (C) condenser from the tip and ring.

#### 7.2 Call Answered

If the call is answered during the ringing interval, no change takes place in this circuit. The (C) condenser, which is bridged across the tip and ring, prevents the attendant at a PBS from receiving severe clicks. At the end of the ringing interval the (RU), (R1), (R2), (R) and (C) relays release. The (L) and (L1) relays then operate as described in paragraph 6.1. If the call is answered during the silent interval the above relays operate immediately. The operation of the (HD) relay closes a bridge inside the repeating coil which trips machine ringing.

#### 7.3 Disconnection

If the calling party disconnects first no change takes place in this

circuit. When the subscriber disconnects the circuit functions as described in paragraph 6.4.

#### 8. RERINGING THE PBX

On a call to a toll or DSA operator the operator can rering the PBX. The operation is the same as described in paragraph 7.1, the (RU) relay operating on ringing current while it is shunted by the (BR) retard coil. The operation of the (R) relay also connects a ground to the ring in order to hold the (L) and (L1) relays. The purpose of this is to prevent the (D) relay from operating which in turn would open the circuit to the (RU) relay and falsely cutoff the ringing current from the PBX. The (C) condenser which is bridged across the tip and ring reduces the level of the clicks to the PBX attendant in case she is listening on the connection.

#### 9. FLASHING

If the switchhook is moved up and down in order to flash an operator at

the central office or the PBX attendant the circuit functions as described under "Disconnection" in paragraph 6.4 when the switchhook is moved downward and as described under call originated in paragraph 6.1 when the switchhook is moved upward.

#### 10. RESISTANCES AND CONDENSERS

The (A) resistance provides a path for discharging the (TF) and (TS) condensers. The (B) resistance and the (PL) condensers prevent excessive sparking at the contacts of the (PL) and (PL1) relays which repeat dial pulses. The (F) and (G) resistances control the current in the primary windings of the (TS) and (TF) relays, respectively, and therefore control the time of operation of these relays. The (J) resistance is provided in order to protect the contacts of the (R) relay when they connect ringing current to the (C) condenser which is bridged across the tip and ring.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 3330-MHK-AJB-NM