

12

PBX SYSTEMS  
NO. 701B  
REGISTER SENDER CIRCUIT  
ARRANGED TO CONVERT  
2 OUT OF 5 GROUND PULSES  
TO DIAL PULSES

CHANGES

B. Changes in Apparatus

B.1 Superseded

CLA Relay, AJ133,  
YS Option, App Fig. 1

Superseded by

CLA Relay, AJ152,  
XC Option, App Fig. 1

D. Description of Changes

D.1 Option YS is rated Mfr Disc., and Option XC is added and rated Standard. Option XC changes the code of relay CLA from AJ133 to AJ152 because relay code AJ133 has been rated Mfr Disc.

D.2 For Description of Operation, see CD Issue 6AC.

BELL TELEPHONE LABORATORIES, INCORPORATED

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DIAL TONE MONITORING AND		pulse train information into the connecting	
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		register sender, the attendant receives a	
		steadily lighted ready lamp (RDY) as a dial	
		start signal and, with later issues, receives	
		dial tone in addition to the lamp signal.	
		*This CD also covers drawing issues through	
		13D. For Reasons for Reissue, see Appendix	
		1D.	

2.04 Upon receiving a start dial signal, the attendant then pushbutton dials the number of the called party into the register sender.

2.05 When the attendant pushbutton dials a digit, ground is applied simultaneously to two of five leads. The five leads are designated as leads 0, 1, 2, 4, and 7.

2.06 Each 2-out-of-5 code digit is steered by the steering circuit into a register unit in the storage circuit. The storage circuit consists of seven register units (AR through GR); each register unit has five independent dry reed relays. Two of the five dry reed relays in each register are operated and represent a dialed digit in two of five codes.

2.07 The sequential digit selector now steers the 2-out-of-5 code digits out of the storage circuit, one at a time, into the translator circuit.

2.08 The translator circuit conditions the pulse counter circuit and starts an interdigital timing circuit cycle. At the end of the interdigital timing cycle, the pulse generator starts outputting over the line. These pulses are counted by the pulse counter circuit. When the pulse counter circuit counts to the same digit that is in the translator circuit, an end-of-pulse-train circuit is activated.

2.09 The end-of-pulse-train circuit stops the pulse generator which releases both the translator circuit and the pulse counter circuit. The end-of-pulse-train circuit then signals the sequential digit selector circuit causing it to step to the next storage circuit.

2.10 The above sequence is repeated for each digit dialed until an end-of-outputting code is received from the storage circuit. The end-of-outputting code causes the translator circuit to operate the release relay which releases the register sender circuit.

### 3. REGISTER SENDER FEATURES

3.01 Although the register sender storage packages are capable of storing only 7 digits, a recycling arrangement of the storage circuit permits a 14-digit number to be outputted. When used with a switchboard, this number is reduced to 13 for reasons which will be explained in the detailed description. This arrangement demands that the speed of dialing does not exceed the ability of the register sender to output and clear the storage packages to receive additional digits. The speed of dialing is regulated by flutter-flashing the RDYL lamp as a stop-dial indication when storage is not available. Because several changes have been made in this procedure a detailed explanation is made in 3 of SECTION II. Option M was

furnished on Issue 4D to arrange the register sender for 13-digit storage.

3.02 The register sender is equipped to provide outputting at 10 and 20 pps. This ability is limited in some applications and various options have been generated to provide more flexibility.

### READY LAMP FUNCTIONS

3.03 The ready lamp (RDYL) acts both as a stop and/or start dial and a trouble indicator.

(a) As a stop-dialing indicator, the ready lamp flutters at 720 ipm at the attendant position when the keypulsing speed exceeds the ability of the register sender to clear its storage packages. When storage is available, the RDYL lamp will light steadily.

(b) As a trouble indicator, the ready lamp flutters at 120 ipm as a signal to the attendant that two dial keys were inadvertently operated simultaneously, resulting in the registration of more than a 2-out-of-5 code.

3.04 The interdigital timing circuit is arranged to provide a minimum timing interval of 300 ms for the 20-pps outputting speed and a timing interval of approximately 700 ms for the 10-pps outputting speed.

3.05 With early issues of the register sender, the attendant was isolated from the transmission path during dialing. Later issues provided dial tone monitoring which allows the attendant to monitor the trunk between digits.

## SECTION II - DETAILED DESCRIPTION

### 1. SEIZURE

1.01 This circuit is seized by the operation of the start key in the position circuit. Ground on the start lead to the link circuit makes a bid for an idle register sender by the operation of an ST-relay in the link circuit. If an idle register sender is available, a select and hold magnet operation closes crosspoints on a crossbar switch closing through a group of leads between the link, the position circuit, and the register sender. The start lead is extended into the register sender operating relay CS. Relay CS closes fundamental ground to the register sender circuitry and closes lead KR, the class lead (CLA or CLA1), and lead CT to the link circuit. Because of the functional changes in the central office trunk check circuit (FS11), the various options will be taken up separately in the following paragraphs.

2. CALLS TO LINES AND TIE TRUNKS

2.01 Calls completing in the PBX to station lines and tie trunks do not require first digit recycle or a change in pulsing speed. Therefore, the circuitry in FS11 functions only to close the class lead (CLA or CLA1) and lead KR through for operation of the RDYL lamp and dial tone monitoring. With option ZR, relay CLA would not be operated under these conditions due to absence of ground on lead CLA. This would also be true in the case of option ZS or XC because ground is furnished on lead CLA1 only when the register sender is connected to a central office trunk. After a timed interval due to the delay of thermistor CSA, relay CSA will operate (option ZS or XC) and close lead KR through to its normal operating path. With option ZS or XC, lead KR performs the functions of operating the class relays during the operate time of relay CSA (when connected to a CO trunk) and controlling the RDYL lamp once relay CSA is operated. Lead CLA2 is used to control the dial tone monitoring function in the position circuit. These functions are discussed in the following paragraphs.

2.02 The dialing path for the terminating circuit is over the tip and ring leads in FS11 through DT contact 5B, DT1 contact 5B, IDC contact 3B, DT1 contact 6B, DT contact 6B, CL contact 5B, and through resistor TR. Relay IDC operates during pulsing. Contact 1M of relay P in parallel with contact 3B of relay IDC is the pulsing contact. The functions of the IDC, P, and PS relay contacts during pulsing are explained in 4.02. Other functions of the register sender are the same for either calls to lines or CO trunks. These functions are explained in separate paragraphs which follow.

3. PREDIALING AND FIRST DIGIT RECYCLE

3.01 There have been three distinct changes in the operation of the central office trunk check circuit which are described below.

READY LAMP ONLY (OPTION ZR)

3.02 In the original design, the attendant is isolated from the trunk during dialing. The RDYL lamp is the sole indication of the condition of the trunk. To give the attendant a start-dial signal it is necessary to detect the presence of the central office equipment on the pulsing tip and ring. A polarized relay is provided to detect a reversal of battery as the pulsing circuit first sees the selector battery and ground and, when the CO trunk is seized, then sees the CO battery and ground. This second battery supply is the one which must be detected. Attendant facilities such as the attendant trunk, conference trunk, 2-way position trunk, and attendant loop circuits require answer supervision for their proper

operation. Unless this answer supervision is obtained from the central office (step-by-step), the battery and ground is reversed in the central office trunk circuit. Therefore options Q and R are provided in the register sender. For proper functioning of relay DT2 and the attendant facilities when the trunks are terminated in a step-by-step central office, the tip and ring leads are reversed in the register sender. When the trunks are terminated in a crossbar or panel office, the tip and ring are straight in the register sender and the tip and ring are reversed between the selector bank and the central office trunk circuit.

3.03 The function of relay DT2 is to release relay DT when the central office equipment is on the line ready to receive dial pulses. Relay DT operates when a 9 is dialed and connects lead KR to the flutter circuit (FS3) to flash the RDYL lamp as a stop-dial signal to the attendant. When the central office equipment is attached, relay DT2 operates, releasing relay DT which transfers lead KR to ground, lighting the RDYL lamp steadily as a start-dial signal to the attendant.

3.04 If central office trunks appear on a level other than 9 and the connected central office is a type other than that on the ninth level (crossbar versus step-by-step, for instance), relay KR will operate upon digit translation. Relay TR will reverse the tip and ring connections to relay DT2 allowing the reversed polarity to operate relay DT2 when the central office is connected. This function is necessary to cancel the tip and ring reversal in the register sender since the selector bank level for the crossbar trunks will have a reversal between the bank and the central office trunk circuit.

3.05 Relay DT, in addition to its ready lamp control function, also controls the first digit recycle function. When a trunk level is dialed (9 or another level), the operation of relay DT opens the operate path of the 1 relay. The AR- digit storage package is cleared of the first digit by the operation of both relays DT and DT1. In FS3, contacts 9B of relay DT and 11B of relay DT1 remove ground from the L1 lead to FS2. This ground is the locking ground for the AR-relay package; therefore, the relays release after the first digit is translated. The second digit is then stored in the AR-package when dialed, which adds one-digit capability to the register sender or central office calls.

3.06 Relay DT1 locks operated for the duration of the call and opens the operate path of relay DT to prevent recycle on subsequent digits. Contact 8B of the 1 relay is placed in the operate path of relay DT to prevent its operation after the first digit is dialed (non-CO trunk level) if a subsequent digit corresponds to a trunk level digit. Contact 8B of relay PC (options ZI and ZM) is added to prevent relay DT from

operating after recycle on the seventh digit if the eighth digit corresponds to a trunk level digit.

3.07 Relay DT1 also changes the outpulsing speed to 20 pps if relay CLA is operated over lead CLA, and option T is furnished in the pulse generator circuit (FS9). Option T also places contact 12B of relay DT1 across the D1 capacitor in the interdigital timing circuit (FS7) to change the interdigital timing to approximately 300 ms when 20-pps outpulsing is used.

3.08 When two trunk levels are used for CD trunks, the pulsing speed is limited to the speed of the slower central office. When only one level is used, either speed can be used depending on the speed the connecting office can accept.

#### DIAL TONE MONITORING AND READY LAMP (OPTION ZS)

3.09 The provision of option ZS and the addition of a monitoring coil and associated relays in the position circuit eliminate the need for the DT2 relay function in the register sender. This new feature permits the attendant to monitor the trunk between dial pulses. Lead CLA2 was added to provide a simulated dial off-normal function to the position circuit to open the transmission path to the attendant during pulsing. Lead KR assumes a dual function. In addition to controlling the RDYL lamp, it is used also to operate relay CLA during the interval between the operation of relays CS and CSA. This interval is timed by the CSA thermistor which delays the operation of relay CSA by approximately 500 ms.

3.10 Relay CLA, which is operated only on calls from key-terminated trunks, opens the operate path of relay DT (contact 8B) to prevent a recycle of the first digit if this digit corresponds to a dial-selected trunk level. Because relay DT1 is no longer operated by relay CLA (contact 12M), all key-terminated trunk calls will be outpulsed at 10 pps.

3.11 Dial-selected central office trunk calls function as follows. The translation of the trunk digit results in the operation of the T-relays which close the operate path of relay DT in FS11. When relay ZX operates at the end of outpulsing, the first digit relay DT1 is operated. If option T is furnished, the sender will outpulse the subsequent digits at 20 pps. If option S is furnished, the sender will outpulse at 10 pps. This means that unless all trunks are connected to central offices capable of accepting 20 pps the outpulsing speed must be at the speed of the slower central office. When relay ZX releases, (relays DT and DT1 both operated) relay DT is released placing ground on lead KR to the position circuit as an indication to the attendant that the sender is ready to receive additional digits.

The release of relay IDC at the end of pulsing closes ground to the CLA2 lead to close the transmission path to the position circuit so that the attendant can listen for central office dial tone as a start-dial indication.

#### DIALING SPEED CONTROL (OPTIONS XC AND YT)

3.12 In previous issues the interrelationship of dial-pulse speed, first-digit recycle, and ready lamp control embodied in the DT and DT1 relay functions produced severe limitations on the dial pulse speed control capabilities. As explained in 3.09 through 3.11, the provision of option ZS limits the outpulsing speed of key-terminated trunks to 10 pps. For dial-selected trunks, the outpulsing speed is limited to 10 pps unless trunks to only 20-pps offices were furnished.

3.13 To obtain a more flexible arrangement the change of outpulsing speed control was removed from relay DT1. The DT and DT1 relays now function only in the first-digit recycle and ready lamp control features. Relay DP20 has been added in the pulse generator circuit (FS9) to change the speed of the generator from 10 to 20 pps. The strapping to adjust the speed of both 10 and 20 pulses is embodied in option YT wiring eliminating the use of options S and T. Thus, when relay DP20 is released, the circuit will function at 10 pps. When relay DP20 is operated, the circuit will function at 20 pps. This new arrangement provides one level which can be outpulsed at 20 pps for dial-selected central office trunks. This level is determined by the choice of the T-relay contacts per Table A in FS9. All other levels will outpulse at 10 pps because relay DP20 is not operated. For first-digit recycle, the level chosen other than 9 must have the T-relay contacts strapped in parallel with the T2 through T7 contacts in FS11 to operate relay DT for recycle.

#### A. Key-Terminated Central Office Trunks

3.14 The trunk circuits must be modified to provide leads DP20 and DP10 in place of lead CLA. Depending on the type of connecting central office, either the DP10 or DP20 lead is connected to the position circuit. The position circuit must be arranged to provide optional wiring to a contact of relay MA so that the DP10 leads from all 10-pps trunks are multiplied together and connected through the MA relay break contact to lead KR. Similarly, all DP20 leads from all 20-pps trunks are multiplied together and connected to the MA relay break contact through a 3000-ohm resistor. The multiplied trunk leads are treated on a per position basis; ie, all position circuit trunk leads are handled separately. In the register sender, with option XC in FS11, relay CLA has been placed in series with relay CLA1 to provide a marginal operating function on lead KR.

3.15 When the register sender is seized by the position circuit and the trunk is connected to a 10-pps central office, lead DP10 is grounded in the trunk by operation of relay SAR. This ground appears in the register sender on lead KR during the operate time of relay CSA. Relays CLA and CLA1 are both operated and locked to ground at contact 8M of relay CS. Relay CLA1 operated opens the operate path of relay DP20 (contact 7B in FS9). With relay DP20 normal the pulse generator will function at the 10-pps rate. When slow-operate relay CSA operates, lead KR is cut through to ground at contact 2B of relay 6 (FS3). At the same time, lead CLA2 is grounded (contact 1M of relay CSA). Relay M is operated in the position circuit which in turn operates relay MA. Relay MA operated transfers lead KR from lead DP10 to lead CLA1 which is connected to the RDYL lamp. Lead KR is used to control the RDYL lamp because relay MA is locked operated. Relay M also closes the M transformer to the attendant transmission circuit to allow central office dial tone to be heard. The combination of a steady ready lamp and dial tone is a start-dial signal to the attendant.

3.16 If the central office to which the trunk is connected requires 20 pps, the ground on lead DP20 through the 3000-ohm resistor in the position circuit operates relay CLA only in the register sender due to the marginal characteristics of relay CLA1. With relay CLA operated and relay CLA1 normal, operation of relay CSA operates relay DP20 (FS9). With relay DP20 operated, the pulse generator produces pulses at the 20-pps rate. Relay DP20 also opens the shunt around capacitor D1 in FS7 (contact 12B) to change the interdigital timing to 300 ms.

#### OPERATION WITH CORD SWITCHBOARD

3.17 When option R is furnished in the position circuit (608D switchboard), a high sleeve on the front cord grounds lead CLA to the register sender. With option ZR, ground on lead CLA operates relay DT1 (contact 12M) to change the outpulsing speed to 20 pps. With the addition of option ZS, outpulsing was limited to 10 pps because option ZV was applied to prevent the false operation of relay DT if the first digit corresponded to a trunk level digit. With the provision of options XC and YT, outpulsing may be either 10 or 20 pps, depending on whether or not option R is furnished in the position circuit.

3.18 Those trunks dial-selected by the attendant (switched loop operation) have their pulsing speed determined by the cross-connect in the pulsing speed control circuit on a trunk level basis. The translation of the first digit may be used to change to 20 pps on one level only. Level 9 is permanently wired in FS11 and is used for 10-pps operation. The level used for 20 pps must be wired per Table A in FS2.

#### 4. INTERDIGITAL TIMING (INITIAL OR PREFIXING DIGIT REGISTRATION)

4.01 Removal of -48 volts from the start anode of the T1 interdigital timing tube by operation of one or more of translator relays T0, T1, T2, T4, and T7 starts the interdigital timing circuit. The 1.08- $\mu$ F capacitor D connected from the start anode to ground through 1000-ohm, current-limiting resistor L is charged by 130-volt battery through 0.383-megohm resistor E and the 2.5-megohm potentiometer D in series. Potentiometer D is adjusted so that it takes approximately 5.5 seconds for the register sender to stop pulsing from the time the TS sender test key is operated momentarily. This corresponds to an interdigital time of approximately 700 ms. On calls to direct-dial central office trunks the short circuit (option T) around capacitor D1 in series with capacitor D is removed upon completion of outpulsing of the central office trunk level selecting digit. This reduces the effective capacitance and lowers the interdigital timing to approximately 300 ms when the associated central office is capable of accepting this faster pulse speed. Option S is provided when associated with central offices requiring slower pulse speed. When breakdown voltage is obtained across the start gap of the T1 tube, it becomes ionized. The interdigital timing control relay IDC is energized by the current flowing through the main anode. Relay IDC operated:

- (a) Extinguishes the T1 tube by opening the main anode.
- (b) Places -48 volts on the start anode.
- (c) Opens the shunt across the make contacts of pulsing relay P during pulsing.
- (d) Starts the pulse generator.

#### PULSE GENERATING

4.02 Operation of relay IDC starts the pulse generator which pulses until the end-of-pulse-train circuit is operated by the pulse counter circuit. When relay IDC operates, ground is applied via break contacts of relay P to relay PG which is a double-wound, mercury contact, polar relay. The P and PG relays constitute a self-interrupting pulsing circuit, the timing of the pulses being controlled by capacitors PG1 and PG2 and resistors PG1 through PG3. The secondary winding of relay PG is connected at both ends to battery through network resistors. The negative terminal of the primary winding is connected to the positive terminal of the secondary winding. The positive terminal of the primary winding is connected to capacitors PG1 and PG2. The primary and secondary windings are wound in opposition to each other. Thus, with ground on the armature of the P relay control contact and relay P normal, current is applied to the secondary winding of relay PG, in the direction to

operate relay PG, but the current in the primary winding charging capacitor PG opposes the operation of relay PG. As the charging current reduces toward zero, the secondary winding will overcome the opposing primary winding and relay PG operates. Operation of relay PG operates relay P which, in effect, transposes the battery and ground connections to both the primary and secondary circuits. The current in the secondary circuit is now in a direction to cause the PG relay armature to return to its break contact, but since capacitors PG1 and PG2 charge in the reverse direction, which in this case is the direction to hold the relay armature on its make contact, the relay armature action is delayed until the secondary current is greater and causes relay PG to release, in turn releasing relay P. When this occurs, the closure of ground through the P relay break contact restores the initial condition in which the current in the PG relay secondary is in the direction to operate relay PG. Relay PG operated closes its make contact, and pulsing continues. The duration of closure of the PG relay contact in either direction depends upon the values of the resistances, which also determine the pulsing speed. Specifically, increasing resistors PG2 and PG4 decreases the pulse speed while increasing resistor PG5 decreases the percent break.

#### FIRST PULSE SHORTING

4.03 The first pulse issuing from the pulse generator is distorted since capacitors PG1 and PG2 are starting to charge from zero voltage. The pulsing contacts of relay P are shorted out during this initial pulse interval by the make contacts of relay PS. Relay PS is released by the operation of relay P and remains released for the duration of the pulse train, at which time it is again operated through the make contacts of relays P and PC in series. Break contacts of relay PS in the input lead of the pulse counter circuit prevent the counter from counting the distorted pulse.

#### PULSE COUNTING

4.04 Pulses issuing from the pulse generator are divided by the pulse counter dividing relays W and Z before they are counted by the counting relays. The pulse dividing relays are enabled to function by applying ground through the make contacts of relay IDC and the break contacts of relay PS in series. The relays continue to divide pulses issuing from relay P until relay PC operates at the end of the pulse train. Relay W operates when relay P operates and relay Z operates when relay P releases. Then relay W releases on the second operation of relay P, and relay Z releases on the second release of relay P. The whole process repeats. Thus, when relay Z operates, an odd pulse is sent to the counter; when relay Z releases an even pulse is sent. The counter is a 10-pulse partially recycling one which

uses six relays (E1-7, E2-8, E3-9, E4-0, E5 and E6) that are designated according to the pulses which operate them. Relay E5 holds during the sixth pulse and releases during the seventh pulse when the E1-7 relay operates. A make contact on the E6 relay recloses the operating path of the E1-7 relay to the odd control lead during the sixth pulse so that it may operate during the seventh pulse. The transfer on the E1-7 relay in the even control lead is necessary to prevent a backup path from locking ground on relay E6. Relay E6 remains operated until the entire counter circuit is released by relay PC operated. Ground from the translator is connected to relay PC when the corresponding relay (or relays if the digit is over 5) in the counter operates. By arranging the circuit so that relay PC is energized during the last pulse break interval and by having it provide a locking path for relay P, a complete cycle of make interval plus break interval is made available for ending the pulse train, thereby increasing the maximum potential counting speed.

#### 5. TRANSLATION AND END-OF-PULSE-TRAIN OPERATION

5.01 The translator circuit consists of contacts on relays T0, T1, T2, T4, and T7 which are operated in a 2-out-of-5 code from the code information registered in the storage circuit and supplied under the control of the sequential digit selector circuit. It translates the 2-out-of-5 code information into 1-out-of-10 code information which is applied to the pulse counter circuit. The only valid dial code information which is not on a 2-out-of-5 basis consists of either end-of-code ground on the 4 dial code lead or release forward (RLS FWD) ground on the 7 dial code lead.

5.02 After the completion of each digit relay PC operates and:

- (a) Removes the common battery supply from all the translator and pulse counter relays causing them to release.
- (b) Operates the PCS relay.

When relay P operates to complete the last pulse of the digit, it operates relay PS through make contacts on relay PC, which in turn release relay IDC.

#### 6. DIGIT SELECTING AND RECYCLE

6.01 The sequential digit selecting circuit is used to connect the translator circuit to the storage circuits in a controlled sequence. The sequence control is accomplished with relays WX and ZX of the sequential digit selector circuit and relays RC and R01 of the recycle circuit. The first digit path extends from ground stored on two of the five reed switches of the AR register relay through break contacts of digit selecting

relay 1 to the translator circuit relay windings. The second digit path extends from ground stored on two of the five reed switches of the BR register relay through operated contacts of the first digit selecting relay 1 and break contacts of the second digit selecting relay 2 in series with the corresponding translator circuit relay windings. The third digit path extends from ground stored on two of the five reed switches of the CR register relay through operated contacts of the second digit selecting relay 2 and break contacts of the third digit selecting relay 3 in series with the corresponding translator circuit relay windings. The paths of digits 4 through 7 are similar to those described above. In cases where the dialing information exceeds seven digits, such as a direct distance dialed call requiring ten digits or registering the end-of-code digit on seven-digit calls, the recycle circuit functions when the digit steering circuit relay D7 operates to release and clear the AR through FR storage circuits. To guard against a premature release of the AR through FR storage circuits when the attendant pushbutton dialing speed is faster than the register sender outpulsing speed, the recycle circuit will cause the RDYL lamp at the attendant position to flutter when the sixth digit is pushbutton dialed before the fourth registered digit is being outpulsed. When the register sender is outpulsing the fourth digit, the recycle circuit again causes the RDYL lamp to light steadily as an indication to resume dialing. On an 11- or 13-digit call the recycle circuit will cause the RDYL lamp at the attendant position to flutter when the ninth digit is dialed before the sixth registered digit has been outpulsed (option Y0). When the sender has completed outpulsing the fifth digit, the recycle circuit will cause the RDYL lamp to light steadily as an indication for the attendant to complete dialing. Registration of the seventh digit will cause the steering circuit relay D7 to operate, in turn operating relay RC. Operation of relay RC causes the release of the AR, BR, CR, DR, ER, and FR storage circuit relays and the D1, D2, D3, D4, D5, and D6 steering circuit relays by opening their lock paths. Release of the D1, D2, D3, D4, D5, and D6 steering circuit relays causes the operation of the AL1, AL2, AL3, AL4, and AL5 recycle circuit relays which provide an auxiliary lock path for the storage circuit relays. These will be reoperated when the remaining digits are pushbutton dialed. On a 7-digit central office call, the end-of-code digit 4 will normally be registered in the AR storage circuit. On an 11-digit direct distance dialed code, the end-of-code digit 4 will normally be registered in the DR storage circuit. On a 13-digit direct distance dialed code, the end-of-code pulse is automatically registered by the register sender. In this case, operation of the END key by the attendant performs no useful function. The pulse-dividing WX and WZ relays operate in response to operation of relays PC and PCS in the end-of-pulse-train circuit. Initial operation of the PCS relay causes operation

of the sequential digit-selector circuit relay ZX which causes operation of sequential digit selector relay 1. The digit selector then steers the second digit to the translator circuit. Release of relay PCS causes operation of relay WX which provides a lock path for relay ZX. Upon completion of outpulsing of the second digit, the end-of-pulse-train circuit relay PCS operates and causes release of relay ZX. Release of relay ZX closes an operate path for the digit selector relay 2 which steers the third digit to the translator circuit. Release of relay PCS causes release of relay WX, preparing the operate path of relay ZX for the next operation of relay PCS. Subsequent digit selection operation proceeds in a similar manner.

## 7. SENDER RELEASE

7.01 When the attendant has completed pushbutton dialing code information to the register sender, the END key is depressed as an end-of-code indication. Operation of the END key grounds the 4 lead and operates a storage circuit register relay. When the translator receives the end-of-code information from the sequential digit selector circuit, translator relay R4 operates. Operation of relay T4 closes an operate path for relay RLS through break contacts of the T0, T1, T2, and T7 relays. On a 13-digit call the register sender automatically registers the end pulse by locally operating relay RLS. In this case, operation of the END key by the attendant performs no useful function. Relay RLS operated:

- (a) Locks to parallel contacts of operate relays CS and PCS.
- (b) Removes ground from lead CT to the register sender link circuit.
- (c) Maintains a ground on lead MB to the register sender link.

7.02 Removal of ground from lead CT to the register sender link causes the register sender circuit to function and remove ground from lead CS (to the register sender) and causes the attendant position lamp RDYL to go dark.

7.03 Removal of ground from lead CS causes the release of relay CS which:

- (a) Removes battery supply for pulse counter, interdigital timing, end-of-pulse-train, and clear circuits.
- (b) Removes ground supplies for central office trunk check, pulse generator, sequential digit selector, recycle, and all-sender-busy register circuits.

7.04 Release of relay PC in the end-of-pulse-train circuit causes release of slow-release relay PCS. Release of relay PCS causes the release of slow-release relay RLS which removes ground from lead MB to the

register sender link. The register sender is now in an idle condition.

8. CLEAR OPERATION

8.01 The clear relay CL is shunted by ground on any of the dial code leads 0, 1, 2, or 4. However, when the attendant depresses the RLS DEST, RLS FWD, or TRK RLS key, ground is applied only to the 7 lead. Ground on the 7 lead causes the operation of relay CL which:

- (a) Removes -48 volts from the T1 tube start anode.
- (b) Opens the pulsing loop.
- (c) Increases the timing (capacitor C) of tube T1 to cause a clearing time (loop open) of approximately 2 seconds.
- (d) Transfers the main anode circuit of tube T1 to relay CLL.

8.02 After the 2-second clearing interval, the T1 tube ionizes and causes relay CLL to operate. Operation of relay CLL:

- (a) Extinguishes the T1 tube by opening the main anode and restoring -48 volts to the start anode.
- (b) Operates relay RLS.

Operation of relay RLS causes the circuit to release as described in 7.01 through 7.04.

9. INVALID CODE CHECK

9.01 An invalid code check circuit consisting of contacts on relays T0, T1, T2, T4, and T7 causes the TF (trouble finder) relay to operate whenever a code other than 2-out-of-5, excepting the codes 4 and 7, is transmitted to the translator circuit. A code other than 2-cut-of-5 could be created by:

- (a) Improper keying (dial pushbuttons depressed simultaneously).
- (b) A short between code leads.
- (c) An open code lead (4) or a short between a code lead and ground.
- (d) A stuck steering relay, register relay, or translator relay.

9.02 The TF relay operated:

- (a) Causes the RDYL lamp at the attendant position to flash at 120 ipm.
- (b) Places -48 volts on the T1 tube start anode to prevent any further pulsing.

9.03 The flashing RDYL lamp will indicate a trouble condition to the attendant. To

clear the position the attendant depresses the RLS FWD or TRK RLS key which causes the sender to release as described in 8.01 and 8.02.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

1.01 The maximum external loop resistance between the register sender and the keyset is 900 ohms.

1.02 Voltage Limits

Supply	Range
-48	-44 to -52
+130	125 to 135

2. FUNCTIONAL DESIGNATIONS

Designation	Meaning	Primary Function
1,2,3,4,5,6,7	Digit Selection	To select digit information in proper sequence for connection to translator
1A	Auxiliary to Relay 1	
6A	Auxiliary to Relay 6	
AL1-5	Auxiliary Lock Relays	To provide lock path for register storage relays on recycle
AR0,1,2,4,7	A Digit Register Relays	To store pushbutton dialed digit information
BR0,1,2,4,7	B Digit Register Relays	To store pushbutton dialed digit information
CL	Clear Relay	To release register sender on signal from attendant
CLA	Class Relay	To detect resistance ground on lead KR for 20-pps operation
CLA1	Class Auxiliary Relay	To detect solid ground on lead KR for 10-pps operation
CLL	Clear Auxiliary Relay	To release register sender on signal from attendant

CPO, 1, 2, 4, 7	C Digit Register Relays	To store pushbutton dialed digit information	IDC	Inter-digital Control Relay	To indicate inter-digital timing functions
CS	Circuit Seizure Relay	To indicate seizure of register sender	K	Recycle Signal Relay	To send timing recycle indication to register sender link circuit
D1-7	Digit Steering Relays	To steer pushbutton dialed digit information to proper digit register storage circuit	P	Pulsing Relay	To send pulses by opening and closing pulsing loop
DP20	Dial Pulse 20 pps	To change pulsing speed to 20 pps	PC	Pulse Counter Relay	To indicate when correct number of pulses have been sent
DRO, 1, 2, 4, 7	D Digit Register Relays	To store pushbutton dialed digit information	PCS	Pulse Counter Auxiliary Relay	To provide auxiliary contacts for pulse counter relay functions
DT	Detection Relay	To detect dialed digit request for central office trunk	PG	Pulse Generator Relay	To generate pulses
DT1	Detection Auxiliary Relay	To connect central office trunk condition relay toward central office	PS	Pulse Shorting Relay	To short-circuit the first pulse
DT2	Detection Auxiliary Relay	To indicate condition of central office trunk circuit	RC	Recycle Relay	To recycle and clear digit register storage circuits
E1-7	Pulse Counting Relay	To count first and seventh pulse	RC1	Recycle Auxiliary Relay	To provide auxiliary contacts for recycle relay
E2-8	Pulse Counting Relay	To count second and eighth pulse	RLS	Release Relay	To release register sender
E3-9	Pulse Counting Relay	To count third and ninth pulse	RT	Registration Timing Relay	To prevent double digit registration
E4-0	Pulse Counting Relay	To count fourth and tenth pulse	TO, 1, 2, 4, 7	Translator Relay	To translate 2-out-of-5 code information into 1-out-of-10 decimal code information
E5	Pulse Counting Relay	To count fifth pulse	TF	Trouble Finder Relay	To detect invalid conditions
E6	Pulse Counting Relay	To count sixth pulse	TR	Trunk Reversal Relay	To reverse panel or crossbar CD trunks appearing on au selector level from 1 to 8 when step-by-step CD trunks appear on selector level 9
ERO, 1, 2, 4, 7	E Digit Register Relay	To store pushbutton dialed digit information			
FRO, 1, 2, 4, 7	F Digit Register Relay	To store pushbutton dialed digit information			
GRO, 1, 2, 4, 7	G Digit Register Relay	To store pushbutton dialed digit information	W	Pulse Counter Dividing Relay	To follow pulsing relay and condition pulse counter circuit

WX	Pulse Dividing Relay	To condition digit selector circuit	(b) Short between code leads.
Z	Pulse Counter Dividing Relay	To operate pulse counter relays	(c) Open code Lead. (d) Grounded code lead.
ZX	Pulse Dividing Relay	To follow end-of-pulse circuit signals and advance digit selector circuit	(e) A stuck steering relay, register relay, or translator relay.

3.08 To flash the pushbutton dial ready lamp whenever invalid dial codes are registered.

3.09 To remove stored digit information from the register sender whenever the RLS FWD or TRK RLS key is operated at the attendant position.

3.10 To restore itself to normal after the last digit is outpulsed.

3.11 To restore itself to normal whenever the associated link time-out circuit operates.

3.12 To open the loop to the central office or local switch train for approximately 2 seconds whenever an attendant operates the TRK RLS or RLS FWD key.

3.13 To provide a minimum 0.6-second interdigital time.

3.14 To outpulse each digit immediately to conserve register sender busy time.

3.15 To permit measurement of accumulative interdigital time for seven digits when the sender test key is operated.

### 3. FUNCTIONS

3.01 To recognize a seizure from connecting equipment.

3.02 To make itself busy when seized.

3.03 To light the pushbutton dial ready lamp when the register sender is ready to receive dial codes.

3.04 To register a maximum of 13 digits from a pushbutton dial.

3.05 To convert registered digit information into 10-pps pulse trains of lengths corresponding to the digit dialed on calls to local dial switching equipment.

3.06 To recognize a central office call and:

(a) To cause the pushbutton dial ready lamp to flutter until the central office trunk is ready to receive pulses from the register sender.

(b) To recognize a signal from a central office trunk that it has been conditioned to receive pulses and cause the pushbutton dial ready lamp to light steadily.

(c) To convert registered digit information into 20-pps pulse trains of lengths corresponding to the digit dialed.

(d) To recycle and clear digit register storage circuits when the seventh digit is dialed in order to prepare for any additional dial codes offered.

(e) To change the interdigital timing rate.

(f) To reverse panel or crossbar CD trunks appearing on a selector level from 1 through 8 when step-by-step CD trunks appear on selector level 9.

3.07 To detect invalid dial codes created by:

(a) Improper keying.

### 4. CONNECTING CIRCUITS

4.01 When this circuit is listed on a keysheet the connecting information thereon is to be followed.

4.02 This circuit will function with the following circuits.

(a) Register Sender Link Circuit - SD-65820-01.

(b) Ringing Leads Circuit - SD-65771-01 (typical).

(c) Signal Circuit - SD-69327-01.

(d) Traffic Register Circuit - SD-65774-01 (typical).

(e) Flutter Circuit - SD-66867-01.

(f) Register Sender Test Circuit - SD-65827-01.

(g) Traffic Measuring System 1A - Remote Scanner - SD-3B200-01 (typical).

5. MANUFACTURING TESTING REQUIREMENTS

5.01 This circuit shall be capable of performing all the functions specified in this CD. It shall also meet all the requirements of the Circuit Requirements Table.

6. TAKING EQUIPMENT OUT OF SERVICE

6.01 Operation of the register sender MB key removes ground from lead SMB to the register sender link circuit making the register sender busy to the register sender link. Operation of the MB key also lights the MB lamp at the register sender circuit as a visual indication and closes a contact in the all-senders-busy register chain circuit.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 3224-RCL-RVL

SECTION IV - REASONS FOR REISSUE

D. Description of Changes

D.1 Option YZ is rerated from Mfr Disc. to Standard, and option X. is now rated Mfr Disc. This change is made to correct a first-digit recycle failure when the attendant dials the central office trunk level.

Note: This reissue also covers information authorized by the following appendix to Issue 6AC of this CD.

APPX 1D - DWG ISS 13D