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CROSSBAR SYSTEMS
NO. 3
INCOMING REGISTER CIRCUIT
MULTIFREQUENCY AND DIAL PULSING
WITH BYLINK OPERATION

CHANGES

B. Changes in Apparatus

B.1 Added

RB2 - 18AG Resistor - App Fig. 1

RB3 - 18AG Resistor - App Fig. 1

B.2

Replaced	Replaced By
RB - ½AK501 Relay	RB - AF111 Relay

D. Description of Changes

D.1 The FS1 and FS6 have been revised to show the addition of Y option. Wiring and apparatus formerly not designated has been designated Z option and rated Mfr Disc. Circuit Note 105 has been added to cover the use of Y option.

D.2 Information Note 304 Fig. 3 and Fig. 4 modified.

F. Changes in CD Sections

F.1 In SECTION I, change 2.01 to read:

2.01 A group of registers, maximum seven, appear in a single register link circuit. This link circuit has a maximum of four trunk groups. A trunk group contains a maximum of 48 trunks which appear on the horizontals of one 12-level 240-point crossbar switch and multipled to the horizontals of one 12-level 120-point crossbar switch. The horizontal mults of the 240-point switch are cut into four sections of five verticals each; the horizontal mults of the 120-point crossbar switch are cut into four sections of 2 verticals each, (the remaining two verticals are unassigned,) forming four separate electrical switches, each having 12 horizontals with one trunk appearance on each horizontal. This arrangement provides for a maximum of 48 trunk appearances. Each of the seven registers appear on one vertical of each of the four electrical switches and are multipled to corresponding verticals on the other crossbar switches. Thus, each trunk has access to any one of the seven registers.

F.2 In SECTION II, change 1.01 to read:

1.01 A maximum of seven registers and a maximum of 192 trunks are associated with a register link circuit. The link circuit has four trunk groups. Each trunk group contains one 240-point, 12-level crossbar switch and one 120-point, 12-level extension switch and the two switches accommodate up to 48 incoming trunks. Figure 4, in the SD Information Note 304, shows a block schematic indicating the arrangement of trunks and registers on the crossbar switches.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 5245-GFC

WE DEPT 25820-HAH-GWC-BT

CROSSBAR SYSTEMS
NO. 3
INCOMING REGISTER CIRCUIT
MULTIFREQUENCY AND DIAL PULSING
WITH BYLINK FEATURE

CHANGES

D. Description of Change

D.1 Minor wiring changes are made in this circuit for routing of calls to reorder due to an operator error on calls through AB-type trunks when one extra digit is received from the operator.

D.2 Sequence Charts SC28 and SC29 are changed.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 5245-HNS

WE DEPT 355-RET-KLF-JCM

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CROSSBAR SYSTEMS
NO. 3
INCOMING REGISTER CIRCUIT
MULTIFREQUENCY AND DIAL PULSING
WITH BYLINK FEATURE

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SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 The combined multifrequency dial pulse incoming register is used to receive information in the form of multifrequency or dial pulses over a trunk from another office and when the entire number is received to transfer this information to a marker so that a connection can be set up between the incoming trunk and the called line.

2. GENERAL DESCRIPTION OF OPERATION

REGISTER LINK CIRCUIT

2.01 A group of registers, maximum 5, appears in a single register link circuit. This link circuit has a maximum of two trunk groups. A trunk group contains a maximum of 48 trunks which appear on the horizontals of one 12-level 200-point crossbar switch. The horizontal mults of the switch are cut into four sections of 5 verticals each, forming four separate electrical switches, each having 12 horizontals with one trunk appearance on each horizontal. This arrangement provides for a maximum of 48 trunk appearances on one crossbar switch. Each of the five registers appears on one vertical of each of the four electrical switches and are multipled to corresponding verticals on the other crossbar switch. Thus, each trunk has access to any one of the five registers.

2.02 For each trunk group each register has in the link circuit a register preference relay, a register busy relay, and other relays to send trunk frame number and class to the register. For each trunk in the link there is a trunk preference relay.

2.03 The trunk preference relay (through a cross-connection) grounds one of three leads, BLG, DPG, or MFG, to tell the register to which type of trunk it is connected, bylink, dial pulse, or multifrequency.

TYPES OF TRUNKS

2.04 The register is arranged to receive pulsing from three different types of trunks. Bylink pulsing trunks are those originating principally in step-by-step offices on which pulsing may start soon after the trunk is seized. For these trunks an early or bylink pulsing path is established through the control relays of the link to carry the pulsing signals until the switch contacts close the regular path. Pulsing is repeated to the register from the line relay of the bylink trunk. Direct pulsing trunks are those on which pulsing will not start until a signal, either dial tone for dial pulsing or a trunk reversal for dial pulsing or multifrequency pulsing, is returned by the register. When a direct pulsing trunk is connected to the register a relay is operated in the trunk which gives the register sole access to the tip and ring from the calling office and it receives pulses directly from that source.

OPERATION WITH REGISTER LINK

2.05 When a trunk receives a call it operates in the link its preference relay which closes a start lead to the register preference relay chain. If the preferred register is idle, its register preference relay operates; but if it is busy, its busy relay will be operated advancing the start lead to the succeeding register.

2.06 The operation of the register preference relay constitutes seizure of the register. The register preference relay operates in the register an off-normal relay which prepares the register for operation. The register preference relay also operates in the register a register-busy relay which causes operation of link register-busy relays for this register in all other horizontal groups.

2.07 The link sends to the register information consisting of class of trunk and trunk switch frame number. This information will be used by the marker in processing the call. A crosspoint is closed in the link to connect the trunk to the register and the register makes a check for a possible double connection. The trunk cut-off relay is then operated to allow the register sole access to the tip and ring leads. When this connection has been established and all checks satisfactorily completed, the control relays of the register link are released. After a timed interval the register takes control of supervision and reverses the polarity of the tip and ring leads to signal that the register is ready to receive pulses.

SIGNAL RECEIVER - FOR MULTIFREQUENCY OPERATION

2.08 Permanently associated with each register is a multifrequency signal receiving circuit which receives and translates the signals transmitted over the trunk. Five frequencies are used for the transmission of the digits 0 to 9 on a 2-out-of-5 basis and a sixth frequency issued in combination with one of the five

for enabling the receiver before the start of pulsing of digits and for indicating to the receiver and register that the entire number has been transmitted. The receiver detects the enabling pulse and readies itself for receipt of the digit signals. These are received as 2-out-of-5 frequencies and the receiver grounds the corresponding 2-out-of-5 leads to the register to cause operation of relays of the digit register. At the time of receipt of the digit frequencies the receiver signals the register to prepare to advance to the next digit and the register in this preparation starts a recycle of the receiver. When the digit signals end, the receiver completes its recycle and the register completes its advance to the next digit. Succeeding digits are recorded in a similar manner.

2.09 When the entire number has been received, this information is transferred to a marker so that a connection can be set up between the incoming trunk and the calling link. The marker controls the completion of the call directly. A block diagram showing the connections of an incoming register on a completing call is shown on the SD in Information Note 303 in Fig. 1.

2.10 After all the digits are transmitted an additional combination of two frequencies is transmitted as an end signal. The receiver detects this combination and signals the register to prepare to transfer the number to the marker.

DIGIT COUNTING AND REGISTRATION - DIAL PULSING

2.11 The register counts the number of pulses in each digit and when the dialing of a digit is completed transfers this count to the digit register and recycles to make itself ready for reception of the next digit. By recognizing the start and completion of each digit it controls the progress of the register steering circuit. A digit register unit with five elements is provided for each digit and the elements operate on a 2-out-of-5 basis. A steering circuit which is controlled by a register advance relay progressively associates the register units with the counting circuit as digits are received. The steering circuit consists of one relay for each group of register relays. When all digits have been received, the register operates a marker start relay to start seizure of a marker. After the last digit an end signal is given to the marker enabling it to detect the absence of digits which might result from certain trouble conditions in the register or marker. This end signal is supplied from the steering relay of the last registered digit.

TRUNK CUT-THROUGH

2.12 Before the marker can complete the call, the trunk must be changed from its pulsing condition to its transmission condition so that it can assume supervision. When the signal is received from the receiver that all digits have been received, the register causes operation of the trunk cut-through relay, checks that it operates and then proceeds to establish a connection to a marker.

CONNECTION TO MARKER

2.13 When the register has checked that the trunk has established its transmission condition and is ready to assume supervision, it connects to a marker by means of a marker connector. The register transfers to the marker information consisting of the trunk class, the trunk switch frame number, all the registered digits and digit end signal. The marker then proceeds to establish a connection between the trunk and the called destination. This involves establishing a linkage between the trunk switch frame appearance of the trunk and the line switch appearance of the link. When a call is thus completed or the trunk is set in an overflow condition due to the marker being unable to complete the call, the marker operates a release relay in the register to disconnect the register from the marker. The register then releases the link connection between the trunk and the register. The register is then ready to serve another trunk.

OPERATOR ERRORS - MULTIFREQUENCY MODE

2.14 The register is equipped to detect certain errors by operators and to cause a reorder routing of the call rather than to have the marker block and cause a trouble record. The errors detected consist of too few or too many digits for the particular trunk class.

TROUBLE TIMERS

2.15 When the register is seized, two trouble condition timers are started. They are the link release and the overall timers. The link release timer will detect

a trouble condition which prevents the link from completing its functions and indicates this to the marker so that the appropriate action can be taken. The overall timer will detect any condition which prevents completion of the call in the normal manner. This timer is recycled on an interdigital basis and a time-out will cause release of the register. Under office overload conditions the time-out period of the overall timer is reduced.

SECTION II - DETAILED DESCRIPTION

1. REGISTER LINK CIRCUIT

REGISTERS AND TRUNKS IN THE LINK

1.01 A maximum of five registers and a maximum of 96 trunks are associated with a register link circuit. The link has two trunk groups. Each trunk group contains one 200-point, 12-level crossbar switch and each switch accommodates up to 48 incoming trunks. Figure 4a, in the SD Information Note 304, shows a block schematic indicating the arrangement of trunks and registers on the two crossbar switches.

LINK RELAYS

1.02 For each trunk group in the link, each register has a register preference relay, a register-busy relay, and other relays to send trunk frame number and class information to the register. Each trunk has in the link a trunk preference relay. The register preference relays and the trunk preference relays are arranged into preference chains that control the operation of the link.

TYPES OF PULSING

1.03 The register is arranged to receive pulsing from three different types of trunks, multifrequency (direct pulsing), dial pulse (direct pulsing), and bylink. The direct pulsing type is used on calls which await a start pulsing signal, either a line reversal or dial tone, before the start of pulsing. The bylink type is used on calls which do not await a start dialing signal and on these trunks a bylink pulsing path is established early to allow registration of any pulsing occurring before the regular path through the link crosspoints is closed. These trunks originate principally in step-by-step offices and are selected by the step-by-step selectors during interdigital intervals.

1.04 When the trunk preference relay TP operates in the link circuit it prepares a ground for one of three leads (MFG, DPG, or BLG) in the register to condition the register for the type of pulsing it will receive from the trunk, multifrequency, dial pulsing, or bylink. This ground extends from the TP relay chain to cross-connect terminal TP where it is cross-connected to either one of three terminals, MF, DP, or BL. When the register connector relay C in the link circuit operates, this ground is extended to the register to operate one of the register relays, MF, DP, or BL, to condition the register for the proper mode of operation.

2. SEIZURE - GENERAL

PREFERENCE RELAY OPERATION

2.01 When a trunk receives a call it operates in the link its preference relay, which closes a start lead to the register preference relay chain. If the preferred register is idle, its register preference relay operates; if it is busy, its busy relay will be operated, advancing the start lead to the succeeding register.

2.02 The operation of the register preference relay constitutes seizure of the register, but if more than one preference relay is operated simultaneously for that register, the trunk in the preferred position gets connected and the less preferred trunk will be advanced to another register by operation of the link register-busy relay.

2.03 The operation of the register preference relay locks the call in by connecting resistance battery from the register on the LK lead, in parallel with that from the trunk over lead ST, so that any momentary closure on the trunk which is long enough to operate the register preference relay will cause the connection to be locked in until the register takes control of supervision. This is illustrated in the Information Note 304 on the SD in Fig. 2A where RPO represents the trunk group in which the trunk is to be served, RP1 represents the other trunk group, TPO represents the trunk being served, and TP1 represents any other trunk in that trunk group.

2.04 As shown in Fig. 3, the register preference relay closes a shunting circuit from lead LO to its associated link register-busy relay, designated RBO, to prevent it from operating. The register relay RB operates to cause operation of the link register-busy relays, designated RB1 in Fig. 3 for this register in the other trunk group to advance the start leads.

2.05 The register preference relay also grounds lead ON to operate the register off-normal relay ON. The immediate functions of ON are to aid the link in closing the crosspoints and to operate ON1, TM1 (on multifrequency calls), and AS to prepare them for future use. The TMA is also operated by relay ON to start overall timer TM.

3. TRUNK SWITCH FRAME, TRUNK CLASS INFORMATION

TRUNK CLASS INFORMATION

3.01 On each trunk information must be recorded as to the number of digits expected on the call.

A. Trunk Classes

3.02 The trunk classes as identified by the designations of the cross-connecting terminals in the link circuit are as follows:

OA - Four-digit incoming calls are received for termination in a single office or in office A of a multi-office marker group.

OB - Four-digit incoming calls are received for termination in office B of a multioffice marker group.

AB - Five-digit incoming calls are received and the initial digit indicating the required number series office A or office B.

SPL - These calls are received on a special call basis (no hunt, no test, and trunks from the test desk).

The OA, OB, AB, and SPL classes are registered on one of four relays bearing the same designations. Each relay is operated directly from a ground on a single class lead from the link circuit. These relays provide the class mark to the marker and provide for determining the number of digits and for requesting special services of the marker.

B. Trunk Class Indication to Marker

3.03 The type of translator is indicated on one of the leads OA, OB, or AB. The OA, OB, and AB class relays ground the OA, OB, and AB translator leads, respectively.

3.04 A summary of the register classes is given in the following table.

Class Relays Operated	Translator Lead to Marker
OA	OA
OB	OB
AB	AB
SPL	SPL

3.05 Each class relay must also indicate to the register how many digits to expect on the call. For example, the OA and OB relays prepare the register for the reception of 4 digits and after the fourth digit is registered the marker is called to complete the call.

3.06 A check is made that the trunk class information is recorded in the register before the link release check relay is operated. This is done by inserting make-contacts of each of the basic class relays in the operating path of the CK relay.

3.07 The register preference relay in the link operates associated relay designated C in the link from ground on lead TF. These relays close a ground to a trunk class lead OA, OB, AB, or SPL (only one on a given call) and closes ground to one trunk link frame number lead for operation of relay TUO or TU1.

TRUNK SWITCH FRAME NUMBER REGISTRATION

3.08 One of the leads TUO or TU1 to the register link will be grounded on each call when the connecting relay of the register link trunk group associated with the selected incoming register operates. This group causes operation of one of the two TUO, 1 relays. The TU- relay in operating locks.

3.09 Either of the operated TU- relays will ground a correspondingly numbered lead to the marker connector.

3.10 Contacts of the TU- relays are placed in the CK relay operating path to insure that a TU- relay is operated before the link release check relay RLK is operated. This insures that a ground has been received on one of the TU- leads. If a ground is not present on one of the TU- leads, the link release timer will function to cause connection to a marker with a link release failure indication.

3.11 If a ground is present on the TU- lead but the TU- relay does not operate the marker will detect the condition when the marker is summoned after digit registration and the resultant trouble record will indicate the number of the incoming register in which the trouble condition exists.

4. CLOSURE OF CROSSPOINTS

4.01 The trunk preference relay also operates the select magnet associated with the trunk, using resistance battery over lead SM. The select magnet off-normal springs, in conjunction with the register preference relays, operate the hold magnet associated with the register, using ground on lead OH through back contacts of relays H and TRL and a front contact of ON. Closure of the crosspoints connects the ground from lead OH to lead HM to operate relay H. Relay H connects lead HM through the low-resistance winding of relay DCK, to the ground which operated the hold magnet and disconnects the ground from lead OH. This provides a holding circuit for the hold magnet and operates the double connection check relay DCK. Relay DCK locks on its secondary winding to the direct ground from relay ON and connects this ground to the HM lead. If a double connection had been set up another register would have been holding direct ground on lead HM shunting relay DCK so that it would not have operated, thus preventing operation of the release link relay RLK.

4.02 Relay H in multifrequency and DP in dial pulse operation ground lead CO, operating the cutoff relay CO in the trunk to disconnect the tip and ring leads from the trunk supervisory relay. For multifrequency and direct dial pulsing, the operation of the cutoff relay grounds lead BL (so designated because it is used for bylink operation). This grounds through front contacts of the frame and class relays, and the register-busy relays and operates check relay CK. Relay CK closes a ground through the front contact of the DCK relay to the release link relay RLK causing it to operate.

4.03 Relay H also connects (for multifrequency operation) the T1 and R1 leads, which are connected through the repeating coil windings to the tip and ring lead from the trunk at the signal receiver, to the winding of the supervisory relay L and, for all three types of pulsing, opens lead SM to release the select magnet.

5. RELEASE LINK

5.01 Operation of the RLK relay opens leads LK and LO, releasing the link trunk preference and register preference relays and permitting the link register-busy relay that was shunted down to operate. The register preference relay is also released. This leaves the trunk connected to the register through the crosspoint only, with the register controlling supervision and holding the connection.

6. PREPARATION FOR RECEIPT OF PULSES

DIRECT PULSING

6.01 When the link release relay RLK operates it starts the RV timer which has a time of 170 minimum, 185 nominal, and 200 maximum milliseconds delay in operating the RV relay. Operation of the RV relay reverses the polarity to the tip and ring leads, thus signaling the operator or outgoing sender that pulsing may commence.

BYLINK

6.02 The bylink type of pulsing is required on trunks from step-by-step offices where the trunk is seized during an interdigital interval after one or more digits have been dialed and it is necessary to establish an early pulsing path through the link so as to be able to register the next digit without waiting for the link select and hold magnets to operate. In this case an early pulsing path is established through the TP and RP relays of the link over the BL lead. The RV relay is not operated on bylink calls.

7. RECEIPT OF MULTIFREQUENCY PULSES

CIRCUIT PREPARATION

7.01 When the register is seized by a multifrequency trunk the register link sends a cross-connectable ground over the MFG lead to the register to operate the MF relay which, in turn, operates the MF1 relay. These two relays operated prepare the register to receive multifrequency pulses by switching in the MF signal receiver, the MF portion of the digit steering relay contact chains, and the associated MF operation control relays; disconnect the dial pulse counting and the dial pulse digit steering section of the steering relay contact chains.

7.02 The operation of relay MF1 also enables time measure relay TM1 and changes the contacts that control the abandoned call (AC) timer for multifrequency control.

SUPERVISION

7.03 Supervision is maintained in the register by the AC timer. Relay ON1 connects the AC relay to the AC timer circuit. The RV relay keeps the charge path to the AC capacitor closed and prevents the AC timer from timing until the start pulsing polarity reversal signal on the tip and ring is given. Operation of the RV relay places the AC timer under control of the L relay. The L relay may release during the line

reversal but it will immediately reoperate to hold the AC timer unless the call has been abandoned. If relay AC operates, it will cause release of the register as described in the paragraph on register release. Any seizure of the register will cause a circuit advance up to operation of RV before a start in timing by the AC timer can be affected.

FREQUENCIES AND CODE

7.04 Each digit transmitted by multifrequency consists of a pulse of 2-out-of-5 audio frequencies: 700-, 900-, 1100-, 1300-, and 1500-cycles per second, designated 0, 1, 2, 4, and 7, respectively. In addition, a keypulse using frequency two and a sixth frequency of 1700 cycles, designated 10, is transmitted as a gate opener; also, a start pulse using frequencies seven and ten is transmitted after the last digit as an end of start signal. The entire code used is as follows. This is the standard additive 2-out-of-5 code and the two frequency designations may be added to obtain the corresponding digit for digits 1 through 9.

Digit	Designations	Actual Frequency Cycles Per Second
0	4,7	1300,1500
1	0,1	700, 900
2	0,2	700,1100
3	1,2	900,1100
4	0,4	700,1300
5	1,4	900,1300
6	2,4	1100,1300
7	0,7	700,1500
8	1,7	900,1500
9	2,7	1100,1500
KP	2,10	1100,1700
START	7,10	1500,1700

INTERLOCKING OF RECEIVER AND REGISTER

7.05 The receiver is maintained in a disabled condition until it receives the keypulse or gate opener so that it will not react to unwanted signals that may appear on the line due to inductive pickup or to speech. The KP signal is received entirely by the signal receiver without any effect on the register. Each subsequent digit causes the receiver signal present relay SP to operate. The signal present relay in turn provides ground to the receiver channel relays 0, 1, 2, 4, and 7 over the leads J and L. When the channels corresponding to the frequencies received operate, the corresponding receiver channel relays operate. The operation of a channel relay grounds the corresponding lead 0, 1, 2, 4, or 7 causing operation of the corresponding digit register relay and also operates the RAMF relay over lead S. The ground operating path of the receiver relay CK2 is through contacts of the receiver channel relays. Relay CK2 operates and causes operation of register relay 2CK over lead H. Operation of RAMF operates the next digit steering relay and with 2CK operated opens the J and L leads to the receiver, releasing channel relays. The release of channel relays releases relay CK2. If by this time the signal is ended, relays 2CK and RAMF release and allow release of the steering relay for the digit just received. If however, the signal pulse is still present, relays RAMF and 2CK will be locked to the receiver signal present relay SP over lead J. These interlocking features are provided to insure that each pulse locks in until it has been recorded and that the register does not advance to the next digit until the end of a pulse.

DIGIT REGISTER

7.06 The digit register unit consists of a dry reed relay with five independent coils enclosed in a can and with each coil associated with two make-contacts. One terminal of each of the coils is wired internally to one of its associated contacts for locking purpose and a single lead wired to a terminal, one contact of the locking contact pair, one terminal of the coil, and both contacts of the load contact pair are wired to individual terminals. These terminals extend to both front and rear of the relay. For ease of wiring, three sets of terminals are strapped internally. These are the battery side of the coils, the locking contact of the relays, and one side of the load contacts.

7.07 The register accommodates 5 digits. The digit registers are designated alphabetically A to E. Each digit register has an associated digit steering relay.

STEERING CIRCUIT

7.08 The digit steering circuit consists of a single relay per digit. It is advanced by a contact on the register advance relay RAMF. On the seizure of the register, ON operates and operates AS which locks through series back contacts of all the steering relays. The RLK opens the operating circuit of AS. On the first operation of RAMF, BS operates through front contacts of AS. The BS locks through a back contact of CS and opens its operating circuit on one set of continuity transfer contacts. The BS, on another set of continuity transfer contacts, transfers the locking circuit of AS from the ON ground to the RAMF controlled ground so that when RAMF releases, AS will release. The next operation of RAMF will operate CS through back contacts of AS and front contacts of BS and the next release of RAMF will release BS. This action continues with each operation of RAMF operating the steering relay for the next digit and each release of RAMF releasing the steering for the digit just registered.

REGISTRATION OF THE A DIGIT

7.09 The A-digit steering relay AS is operated from ON when the register is seized. When the A-digit frequencies enter the receiver, the receiver signal present relay SP operates; SP connects ground to lead J which is connected through series back contacts on relays MST, TEN, and STS1 or STS; BS and DS to lead L to the windings of receiver channel relays. The steering relay part of this path is paralleled by a circuit through a back contact of 2CK. When the channels corresponding to the frequencies received operate, corresponding leads are connected to the register. These grounds are carried through the contacts of steering relay AS to operate the corresponding A-digit register relays which lock.

7.10 When the receiving circuit detects one or more frequencies, the corresponding numerically designated relays of the receiving circuit operate and cause operation of RAMF over lead S. When the receiving circuit detects two frequencies and two of the numerically designated relays operate, the receiver CK2 relay operates causing operation of the register 2CK relay. Both RAMF and 2CK lock to the J lead which is controlled by the signal present and the CK2 relays of the receiver RAMF in operating operate BS which opens one leg of the circuit between the J and L leads in the register and when 2CK operates the J lead is disconnected from the L lead allowing release of the channel relays of the receiver. The channel relays in turn release the receiver CK2 and numerically designated relays. If the signal pulse has ended or when it ends SP will release. With both SP and CK2 released RAMF and 2CK will release.

7.11 The RAMF in releasing completes the steering advance by causing release of AS which recloses one leg of the circuit between the J and L leads. The release of 2CK relay recloses the other leg of the circuit between the J and L leads. Either leg being closed enables the relays of the receiver to respond to the next digit signals.

REGISTRATION OF THE B DIGIT

7.12 The B digit is recorded in the same manner described for the A digit. The frequencies are detected and the receiver SP relay operates to enable the receiver channel relays, two of which operate causing operation of CK2. Register relays RAMF and 2CK operate; the steering relay CS operates to open the J and L lead circuit to release the receiver channel relays and CK2. The B-digit register relays operate from the receiver channel relays.

7.13 Subsequent digits are received and recorded in a similar manner.

PULSE CONSISTING OF MORE THAN TWO FREQUENCIES

7.14 If a trouble condition exists that causes more than two receiver channel relays to operate, the current drawn by the receiver channel relays will exceed the minimum required to operate the receiver relay CK3. Operation of CK3 grounds lead RO, operating the reorder relay RO to cause the marker to be started with a reorder indication.

SINGLE FREQUENCY PULSE

7.15 If a trouble or test condition exists that causes only one channel relay to operate, receiver relay CK2 will not operate because there will be insufficient current flow. As a result, 2CK relay in the register will remain normal, leaving relay RAMF under direct control of one of the 0, 1, 2, 4, or 7 channel relays over the S

lead. The channel relay also operates the corresponding digit register relay. The steering relay for the next digit operates from RAMF as usual. The channel relay, however, is held operated over the J and L leads through a back contact of 2CK and release only after the pulse is terminated and relay SP releases. The SP released, releases the 0, 1, 2, 4, or 7 channel relay which in turn releases RAMF. The RAMF releases the steering relay for the digit just registered. The register and the receiver are now ready for the next digit.

7.16 The single frequency pulse condition is handled in this manner to allow register steering on one frequency so that the marker can be called in a normal manner. The marker then has a chance to detect the condition as a 1-out-of-5 registration. If the steering circuit did not advance, the next digit would be recorded in the same digit register and the start pulse would ultimately appear in the wrong position and the no-operator-error (NOE) relay usually would not operate. Accordingly, the marker would be given a reorder indication and would never check for a false registration.

LAST DIGIT AND MARKER START

7.17 Two start pulse or end steering relays STS and STS1 are provided in the positions beyond the last equipped digit steering relay. The STS and STS1 relays serve to recycle the receiver after the last digit and to provide the end seven signal to the marker in case the register receives a full complement of digits.

7.18 If a full complement of digits is received before the start signal, the STS relay will be operated in preparation for the start pulse when the last digit is recorded.

7.19 This is a 5-digit register; therefore, registers A through E are provided. Relay STS is wired to operate from make-contacts of the ES steering relay and will operate when the E digit is recorded. When the start signal consisting of the frequencies 7 and 10 is received in the sixth position, the receiver grounds leads 7 and 10. The 7 lead is not used in this case but the TEN relay will operate from the ground on the 10 lead. Receiver relay CK2 operates with the receiver channel relays and operates relays 2CK and RAMF. The RAMF in turn operates STS1 which opens the J and L leads to release the receiver channel relays. When the start signal ends, RAMF releases, releasing STS and causing the operation of marker start (MST) relay. The release of STS grounds the H7 lead to the marker.

7.20 If the start pulse is received in the position of the last equipped digit register, the STS relay functions only to open the J and L leads. Assume that the start signal is received in the fourth or D position in this 5 position register. The ground on the 10 lead will operate the TEN relay and the ground on the 7 lead will operate D7 relay, which grounds the D7 lead to the marker. Ground on lead H from the receiver operates 2CK and ground from the receiver on the S lead operates RAMF. Operation of TEN relay opens the J and L leads to cause release of the receiver channel relays. The RAMF releases causing the marker to be started.

7.21 If the start signal is received in other positions ahead of the last equipped digit position, the operation is similar to that described above.

OPERATOR ERRORS

A. No Operator Errors

7.22 A no-operator-error relay, NOE, is provided so that the circuit can check the number of digits registered against the number required on each class of trunk. This provision is made so that all possible calls with an operator adding or deleting digits in error will be detected in the register and cause a reorder request from the marker rather than have the marker detect the trouble and cause a trouble record to be made. The NOE can be arranged to operate when exact numbers of digits followed by a start pulse are registered or when minimum numbers of digits are registered. The MST relay circuit is wired through a transfer contact of the NOE relay so that with NOE normal, the reorder relay RO will operate in place of MST. When NOE operates, the operate path of RO is opened and MST will operate after operation of TEN and the release of RAMF. The call thus proceeds in a normal manner. If NOE fails to operate, RO will operate after the operation of relay TEN and the release of relay RAMF. The RO operating will call in the marker with a reorder indication.

B. Four and Five Digit Classes

Exact Number of Digits

7.23 A cross-connection between terminal OE and terminal XCT arranges the register to receive pulses from a 4-digit class of trunk on an exact number of digits basis. With this arrangement relay NOE operates when the exact number of digits and a start pulse are recorded.

7.24 The 4-digit trunk class relays OA and OB are wired so that the start pulse must be in the fifth or E position for the NOE relay to operate. Assuming an OA class of call, NOE will operate from contacts of the operated relays TEN, OA, ES, RAMF, CK, and MF1 whenever the start pulse occurs in the fifth position. The NOE locks and when RAMF releases at the end of the start pulse, MST operates.

7.25 If the start pulse is transmitted before the fifth position, NOE will not operate and the release of RAMF after the start pulse is received will cause the operation of RO instead of MST.

7.26 A cross-connection between terminals NED and RO will arrange the register to connect to a marker immediately with a reorder indication if more digits than the register is equipped to handle are received. This connection connects the 0, 1, 2, and 4 leads to the RO relay winding so that if any signal other than the 7 is received in the start pulses STS digit position RO will operate. The RO causes operation of MST.

7.27 For example, this register is equipped for 5 digits; when the fifth digit is received, STS operates. Then at the end of the digit RAMF releases to release ES. If another digit is received a ground will appear on one of the leads 0, 1, 2, or 4 to cause operation of RO.

Station Digit Permitted

7.28 Some customers in a manual office may be assigned numbers which include a station digit. Where a cutover to a No. 3 crossbar office eliminates the station digit, these customers are assigned new numbers having no station digit.

7.29 In these cases it may be desirable during the period following cutover to permit anyone dialing the old number to reach an intercept operator and be informed as to the new number rather than be routed to reorder by the operator error features.

7.30 This is accomplished by permitting the marker to be connected to in the usual manner even though an extra digit is registered. For this use the terminal OE is cross-connected to terminal MIN so that NOE will operate on a minimum number of digits basis.

7.31 This situation also requires the terminal RO to be connected to the one extra digit terminal OED to take care of cases where the extra digit would be in a position one beyond the last equipped digit register position.

7.32 The station digit is recorded if the register is equipped to handle at least one more than the expected number of digits. If the register is not so equipped, the station digit is not recorded.

7.33 For example, assume an OA class of call with terminal STS cross-connected to terminal ES. Then, after the fourth digit is recorded and RAMF has operated, STS operates. With OE connected to MIN, NOE operates from contacts of the relays OA, STS, RAMF, CK, and MF1 operated. With RO connected to OED, RO will not operate on the station digit output leads since STS1 is not operated.

7.34 When the station digit is received, it is not recorded. The receiver recycles when STS1 operates, opening the J and L leads. The subsequent release of STS closes the J and L leads and the register is ready to receive the start pulse.

7.35 When the start pulse is received, relay TEN operates to open the J and L leads. At the end of the receiver cycle, RAMF releases. The MST then operates from contacts of the relays RAMF and CK2 released and relays TEN and NOE operated. The operation of MST results in a connection to the marker.

SECOND KEY PULSE SIGNAL

7.36 If a second key pulse signal consisting of the frequencies two and ten is received, the TEN relay will be operated from ground on the 10 lead and the ground on the 2 lead will cause operation of the RO relay provided NOE had already been operated. If NOE had not been operated, the operation of TEN will cause operation of RO. The RO causes the marker to be started with a reorder indication.

SIMULTANEOUS OPERATION OF TWO KEYS

7.37 Simultaneous operation of two keyset keys at the switchboard results in the operation of three or four or no receiver channel relays. If no channel

relays are operated, the error may be detected as any insufficient digit error.

7.38 Three or more channel relays in operating cause operation of receiver relay CK3. The CK3 grounds lead RO to operate relay RO which causes a marker to be started for reorder routing.

SPECIAL CODES

7.39 Since the multifrequency register always receives a start signal after the last digit, it needs no other facilities for determining when to operate the marker start relay. This being the case, any type of code (or number) may be used providing the marker can translate it, over any class of trunk.

TRUNK CUT-THROUGH

7.40 When the start pulse has been recorded, the MST relay operates. However, before the marker can be seized it is necessary to transfer supervision back to the trunk in order to provide a holding circuit for the line link and trunk link switches which the marker will operate. Therefore, relay MST opens the tip and ring leads and signals the trunk over lead CT to take supervisory control. A differential relay TC1 is used in the CT lead to permit operating a trunk relay and then checking that it operates, over a single lead.

7.41 Lead CT is connected in the trunk through the winding of trunk relay CT to battery and in the register through the secondary winding of relay TC1 to battery. To operate the trunk relay, ground is connected from a front contact of relay MST through the low-resistance primary winding of TC1 to the lead. The trunk relay operates but the TC1 does not operate because its two windings are energized in opposite directions. When the trunk relay operates, the trunk supervisory relay A operates over the trunk conductors, and in turn connects ground to the CT lead. This ground holds the CT relay and short-circuits the low-resistance winding of TC1 allowing the secondary winding to become effective so that TC1 operates. The TC1 operates relay TC2 which locks and starts a connection to the marker.

CONNECTION WITH MARKER

A. Marker Start

7.42 The operation of relay TC2 connects battery to the start (ST) lead and the connector battery supply (CBS) lead to the marker connector circuit. It also grounds timing (TM) lead to start the connector timer. The connector responds by connecting the register to an idle marker by about 40 leads.

B. General

7.43 Information transferred to the marker consists of class of trunk, trunk switch frame number, all digits which were received, and an end signal consisting of a ground on the 7 lead of the next digit beyond the last digit received. The marker expects grounds on two of the five leads for each digit registered and a single ground on the -7 lead off the next digit. This permits the marker to check that no digits were missed entirely. The marker will use this information to set up the call either directly through the trunk switch and line switch frames to a customer. The number recorded on the digit registers is transferred to the marker on a 2-out-of-5 basis.

C. Marker Release

7.44 When the marker completes its functions it grounds the marker release lead MRL, operating relay MRL. If the marker encounters trouble, it sends a trouble release signal to the connector, which disconnects from that marker and selects a second marker, usually a different one, in an effort to complete the call. If the second marker also fails, it grounds lead TRL (so called because it is used to tell originating registers to give busy tone to the calling party). The ground on lead TRL operates the register trouble release relay TRL.

REGISTER RELEASE

7.45 The operation of relay MRL or TRL is a signal that the register should release. Relay MRL or TRL locks to relay TC2 and opens leads ST and TM to the connector. This releases the connector and the marker. The MRL or TRL closes a local holding circuit for relay RB and releases relay ON. The ON releases the register link hold magnet and relays H, CK, DCK class relays, and ON1. Relay CK releases relay TEN, and this releases relay MST. The ON1 releases the trunk switch frame number relay. When CK and MST have released, relay TC2 releases to release relays MRL or TRL, and RB, and the link circuit register-busy relays in turn, thereby making the register available for reselection. The release of ON and ON1 opens the various off-normal ground leads, releasing all other operated relays.

8. RECEIPT OF DIAL PULSES

SEIZURE BY DIRECT PULSING TRUNKS

8.01 Closure of the tip and ring leads at the calling office causes operation of the line relay A of the incoming trunk. The trunk A relay connects battery to the start lead to the link causing operation of the associated register link trunk preference relay TP. The TP, in turn, closes a circuit to cause operation of a link register preference relay RP. Once the register preference relay is operated the call is locked in until the seizure of the register is complete. This lockin is controlled by the connection of resistance battery to the LK lead. Operation of the link RP relay causes operation of the link C relay of the incoming link circuit from ground on lead TF. These relays close ground to a trunk class lead for operation of one of the trunk class relays OA, OB, etc; closes ground to a trunk switch frame number lead for operation of the relay TUO or 1.

8.02 The TP- closes the battery on lead SM to cause the operation of the link select magnet associated with the trunk. The RP closes ground to lead ON to the register where off-normal (ON) and register busy (RB) operate in parallel. The RB connects resistance battery over an RB- lead to each of the two link trunk groups of trunks as a register-busy indication. Link RB relay operates in the trunk group other than the one in which the call originated. In this group the RB relay is prevented from operating by a shunting ground connected to the lockout lead LO. The function of the link RB relays is to advance the preference ground-busy registers in the link groups.

8.03 The register ON relay operates the auxiliary off-normal relay ON1 and these two relays provide off-normal grounds for all parts of the circuit. The ON operates TMA to start the timer TM timing for receipt of the first digit and ON1 starts the timer LR timing for the completion of the link functions. The ON also operates the first digit steering relay AS.

8.04 The ON closes ground through a back contact of H to lead OH to the link where it is closed through the operated select magnet off-normal contacts and through the operated RP relay contacts to cause operation of the hold magnet associated with the preferred register.

8.05 When the crosspoints close, the hold magnet operating ground is extended over lead HM to cause operation of H. The H closes the low-resistance primary winding of the double connection check (DCK) relay in series with the HM lead and removes the ground from lead OH with a continuity transfer contact. The DCK operates, locks on its high-resistance secondary winding and closes a short on its primary winding. Operation of DCK insures that no double connection at the line exists. If there were a double connection, a solid ground would have been connected to the hold magnet and to lead HM so that DCK could not operate. Such a condition would prevent completion of the link functions and would result in a link release time-out. The DCK closes ground to lead DCK to the marker connector to indicate that no double connection exists.

8.06 The H relay disconnects the battery from lead SM to cause release of the select magnet and closes the circuit to the direct pulsing relay DP which operates from ground on lead DPG from the register link.

8.07 The DP locks, operates the slow-release reversal relay RV1, closes the windings of the line relay L to the tip and ring leads, disconnects the BL lead from the L relay, and connects it to the check (CK) relay circuit and closes ground on lead CO to operate the cutoff relay of the trunk.

8.08 The cutoff relay in the trunk disconnects the trunk A relay from the tip and ring conductors thus allowing the register L relay sole access to these leads. The cutoff relay grounds lead BL to cause operation of the CK relay provided the trunk switch frame number and a completing trunk class have been registered.

8.09 The CK locks, disconnects ground from the TF lead allowing release of the link relays from which the trunk class and trunk frame number information was received, starts the line reversing RV timer, and operates the release link relay RLK provided the H, RB, and DCK relays have operated.

8.10 The RLK disconnects battery from the LK lead to allow release of the link TP relay, disconnects ground from lead LO to cause operation of the link RB relay for the selected trunk group, closes a holding circuit to the RB and ON relays and stops the LR timer by connecting a charge ground to the LR capacitor. After the operation of RLK the control relays of the link are free to serve other trunks and the only connection between the trunk and register is through the switch crosspoints.

8.11 When H operated, the L relay was connected to the tip and ring leads and at this time the trunk A relay was also connected to the tip and ring leads. The

polarity of the battery and ground supplied by the L relay, however, was in a reverse direction to that supplied by the A relay. This caused operation of L. Operation of the trunk CO removes the trunk A relay from the tip and ring but the L relay holds to the closure at the calling office. The L operates the abandon call control relay ACC, releases the register advance (RA) relay which in turn operates the register advance auxiliary relay RA1.

8.12 Relay DP causes operation of RV1 which removes the RV1 contact charge ground from the RV capacitor. With DP, RV1, and CK operated the RV timer is enabled and a circuit is prepared for discharging the RV capacitor through the RV resistor. When the charge on the capacitor decreases to a value that will turn on the transistor circuit, current will then flow to operate the RV relay. The values of the RV capacitor and the RV resistor are designed so that the RV will operate in 170 minimum, 185 nominal, and 200 maximum milliseconds after CK operates. Operation of the transistor time delay circuit is explained in CD-94820-01.

8.13 The RV locks, reverses the polarity to the tip and ring leads and opens the circuit to the slow-release relay RV1. The RV1 operated, provides a supplementary holding path for L to prevent the release of L during the tip and ring reversal and for an additional short time interval. This additional interval will prevent a false release of L and a possible false registration which might result from the reaction of the line reversal on certain types of trunks, notably those from step-by-step offices having bridged impedance-type repeaters or from manual switchboards having outtrunks with bridge impedance-type transmission. When RV1 releases the supplementary holding path to the L is removed and the back contact No. 4 of L is closed to the pulse counting P1 relay. The RV1 closes dial tone to the secondary winding of the tone coil, if required. The circuit is now ready to receive dial pulses.

SEIZURE BY BYLINK TRUNKS

8.14 The bylink type of pulsing is required on trunks from step-by-step offices where the trunk is seized during an interdigital interval after one or more digits have been dialed and it is necessary to establish an early pulsing path through the link so as to be able to register the next digit without waiting for the link select and hold magnets to operate. In this case an early pulsing path is established through the TP and RP relays of the link over the BL lead. The RV relay is not used in bylink operation.

8.15 When the trunk is selected and the repeater at the step-by-step office closes the tip and ring leads, the incoming trunk A relay operates to close battery to the start lead to the register link causing operation of the associated register link trunk preference relay TP. Relay TP in turn closes a circuit to cause operation of a link register preference relay RP. Operation of RP closes resistance battery on lead LK to operate the trunk R relay which locks and transfers the TP circuit from the ST lead to the LK lead thus locking in the call at least until the link functions are complete.

8.16 The trunk A relay connects ground to lead BL to the link and TP and RP connect BL to the register where it connects through the BL resistor to a winding of the line relay L causing its operation. The L operates the abandon call control relay ACC.

8.17 Operation of RP causes operation of the link C relay from ground on lead TF. Operation of C will cause operation of bylink relay BL. This relay also closes ground to a trunk class lead for operation of one of the trunk class relays OA, OB, etc; closes a ground to trunk switch frame number lead for operation of relay TUO or TU1.

8.18 The BL locks and closes the back contact No. 4 of L to the pulse counting relay P1 and connects resistance battery to the T lead for holding the trunk RL relay when the crosspoints close.

8.19 The RP closes the battery on lead SM to cause operation of the link select magnet associated with the trunk and closes ground on lead ON to the register where ON and RB operate in parallel. The RB connects resistance battery over an RB- lead to each of the link trunk groups as a register busy indication. Link RB relays operate in the trunk group other than the one in which the call originated. In this group the RB relay is prevented from operating by a shunting ground connected to the lockout (LO) lead. The function of the link RB relays is to advance the preference ground-busy registers in the link groups.

8.20 The register ON relay operates the auxiliary off-normal relay ON1 and these two relays provide off-normal grounds for all paths of the circuit. The ON operates TMA to start the timer TM timing for receipt of the first digit and ON1 starts the timer LR timing for the completion of the link functions. The ON also operates the first digit steering relay AS.

8.21 The ON closes ground through a back contact of H to lead OH to the link where it is closed through the operated select magnet off-normal contacts to cause operation of the hold magnet associated with the preferred register.

8.22 When the crosspoints close, the hold magnet operating ground is extended over lead HM to cause operation of H. The H closes the low-resistance primary winding of the double connection check relay DCK in series with the HM lead and removes the ground from lead OH with a continuity transfer contact. The DCK operates, locks on its high-resistance secondary winding and closes a short on its primary winding. Operation of DCK insures that no double connection at the link exists. If there were a double connection a solid ground would have been connected to the hold magnet and to lead HM so that DCK could not operate. Such a condition would prevent completion of the link functions and would result in a link release time-out. The DCK closes ground to lead DCK to the marker connector to indicate that no double connection exists.

8.23 The H relay disconnects the battery from lead SM to cause release of the select magnet.

8.24 The circuit is ready to receive pulses as soon as ON and BL operate. The ON is necessary since it controls the register advance relay RA, and BL is necessary since it connects the back contact of the L to the P1 relay. The trunk is arranged so that if there is a delay in selecting a register and pulsing starts before the trunk RL relay operates from RP, the trunk-busy relay will operate to return overflow to the calling line.

8.25 When BL and H have operated a circuit is closed to cause operation of CK provided the ACC has operated and the trunk switch frame number and a completing trunk class have been registered.

8.26 The CK locks and disconnects ground from the TF lead allowing release of the link release relays from which the trunk class and trunk frame number information was received, operates the release link relay RLK provided the H, RB, and DCK relays have operated, and disconnects the bylink lead check relay BLK from the R lead and connects the R lead in parallel with the BL lead to the L relay.

8.27 The BL lead check relay BLK is for checking that the BL lead is continuous through the link and BLK normally does not operate. The BL lead is closed through the link relays to obtain an early pulsing path and if this lead were open and the first closure came over the R lead, a part of the first digit might not be detected. The circuit is arranged so that on each call that is not abandoned a closure is required on the BL lead. When this closure occurs, L operates to operate ACC. The CK cannot operate until ACC operates and with CK normal the R lead is connected to BLK. If no closure appears on the BL lead, a closure on the R lead will operate BLK. The BLK connects a ground on the AC capacitor to prevent the abandoned call timer from functioning and since CK is not operated, RLK will not operate and the LR timer will function to cause a connection to a marker for the appropriate action.

8.28 The RLK disconnects battery from the LK lead to allow release of the link TP relay, disconnects ground from lead LO to cause operation of the link RB relay for the selected trunk group, closes a holding circuit to the RB and ON relays and stops the LR timer by connecting a ground to the LR capacitor. After the operation of RLK the control relays of the link are free to serve other trunks and the only connection between the trunk and register is through the switch crosspoints.

8.29 Pulsing is repeated by the A relay of the trunk over the R lead to the L relay and digit registration, marker start and other register functions are the same as for a direct pulsing call.

DIAL PULSE COUNTING AND REGISTRATION

A. General

8.30 The dial pulse counting circuit counts the number of pulses in each digit and when the dialing of the digit is completed, transfers this count to the digit register, then recycles to make itself ready for reception of the next digit. For any digit, a train of pulses consisting of from one to ten approximately equally spaced momentary line openings is generated at the calling office for direct pulsing trunks or repeated by the incoming trunks for bylink trunks. By recognizing the start and completion of these pulses for each digit the circuit controls the digit registration, the progress

of the digit steering circuit, the recycling of the register timing circuit, and the functioning of the marker start circuit.

B. Pulsing Relay

8.31 The L relay is a magnetically biased polarized mercury contact type relay with four windings. This relay has a single armature spring, number 3, making contact with two independent front contacts, numbers 1 and 2, and two independent back contacts, numbers 4 and 5. The primary and secondary windings are balanced and are connected to the tip and ring leads so that pulsing on direct trunks is controlled by both the tip and ring. This tends to minimize any reaction due to longitudinally induced currents in the cable pair. The quaternary winding is a bias winding and is wired so that it causes the relay to be stiffer or easier to release when the front contacts are closed and weaker or easier to operate when the front contacts are open. The value of the L resistor is chosen so that the optimum benefit is obtained from this winding. The tertiary winding is a pulse help winding and is wired in series with the PH capacitor so that whenever the front contact of L closes, the capacitor will charge and the current in the T winding will be in a direction to hold the front contacts closed. This current decreases to zero as the capacitor charges. Whenever the front contacts of L open, the capacitor will discharge and the current in the T winding will be in a direction to hold the front contacts open and the back contacts closed. This current decreases to zero as the capacitor discharges. The net result is a pulse correcting action which causes the L relay, once it operates, to remain on the front contact for a definite minimum interval and, once it releases, to remain on the back contact for a definite minimum interval.

C. Pulse Counting Relays

8.32 The pulses of each digit as detected by the release and reoperation of the L relay are counted on the P1 to P5 relays. The P1 and P2 relays are wired as a pulse divider and contacts on these relays control the P3, P4, and P5 relays. The first release of L closes ground through L contacts No. 3 and 4 and through a break-contact of P2 to operate P1. The P1 locks to an ON contact. When L reoperates, ground through L contacts No. 3 and 2 through a P1 make-contact operates P2. The P2 locks to the ON ground and opens its operating circuit on a continuity contact and transfers the holding circuit for P1 on a continuity contact from the ON ground to the ground at the L No. 2 contact. On the next release of L, P1 releases. The P1 in releasing opens the holding circuit to the ON ground for P2, but P2 is held to the ground at the L No. 4 contact. When L reoperated on the second pulse P2 releases. This cycle will then repeat with P1 and P2 remaining operated at the end of each odd number of pulses and remaining normal at the end of each even number of pulses.

8.33 At the beginning of the second pulse when P1 releases with P2 operated, P3 is operated. The P4 and P5 operate at the end of the third and sixth pulses, respectively. A separate and distinct combination of these five relays remain operated at the end of each digit. The sequence of operation for these relays is given in the following table and is given in graphical form on sequence chart SC7.

Pulse		L	P1	P2	P3	P4	P5	Counting Relays Remaining Operated	Register Leads Grounded
1	BK	R	O						
	MK	O		O				P1, P2	0,1
2	BK	R	R		O				
	MK	O		R				P3	0,2
3	BK	R	O						
	MK	O		O		O		P1, P2, P3, P4	1,2
4	BK	R	R						
	MK	O		R				P3, P4	0,4
5	BK	R	O		R				
	MK	O		O				P1, P2, P4	1,4
6	BK	R	R						
	MK	O		R			O	P4, P5	2,4
7	BK	R	O						
	MK	O		O				P1, P2, P4, P5	0,7
8	BK	R	R		O				
	MK	O		R				P3, P4, P5	1,7
9	BK	R	O						
	MK	O		O		R		P1, P2, P3, P5	2,7
10	BK	R	R						
	MK	O		R				P3, P5	4,7
11	BK	R	O		R				
	MK	O		O				P1, P2, P5	0
12	BK	R	R						
	MK	O		R				P5	0

It should be noted from this table that if due to some trouble condition the counting circuit counts more than ten pulses it grounds the single O lead.

8.34 The P2A is connected to operate in parallel with P2 during the counting of the first pulse. The P2A locks and opens its operating circuit on a continuity transfer contact.

REGISTER ADVANCE RELAYS

8.35 The register advance relay RA is a fast-operate, slow-release relay which operates during the first pulse, remains operated during pulsing, and then releases during the interdigital interval. This relay is equipped with two windings. The primary winding is used for energizing the relay and is controlled by the No. 5 back contact of the L relay through a contact on the ON relay. The secondary winding is used to delay the release of the relay by retarding the decay of flux when the circuit to the primary winding is opened when L operates. This winding is precision wound with a resistance tolerance of only ± 3 percent so that the release timer variation is held to reasonably close limits.

8.36 When RA operates, the secondary winding is short-circuited by a contact on RA to cause this reaction. By having the

short circuit removed during the operation of the relay the operating time is reduced. The RA operates at the start of a digit to provide a locking circuit for the P- relays and releases at the end of a digit to cause transfer of the count from the counting relays to the digit registers. The auxiliary register advance relay RA1 works in reverse to RA, operating when RA is normal between digits and releasing when RA is operated during the counting of a digit. The RA1 aids in holding the counting relays and in transferring the count to the digit registers, controls the steering advance from one digit to the next, controls the digit timing circuit and recycles the register timing circuit at the start of each digit.

DIGIT STEERING CIRCUIT

8.37 The digit steering circuit consists of a single relay per digit and is wired so as to connect the five output leads from the counting circuit progressively to the digit register units. When ON operates, AS is operated through a back contact of P2A. The AS locks through a back contact of BS and through the contacts of all the steering relays to an ON ground. When P2A operates it opens the operating path of AS and closes a path to operate BS when RA1 operates at the end of the A digit. The BS operates, locks on its continuity transfer contact, and opens its operating circuit. The BS on a continuity contact transfers the locking circuit for AS from the ON ground to the front contact of RA1. When RA1 releases at the start of the B digit, AS releases closing the digit leads to the B-digit register through the operated BS relay. On subsequent digits when RA1 operates, the next steering relay is operated through contacts on the operated steering relay and when RA1 releases, the steering relay for the digit last registered releases. In this manner the circuit advances under control of RA1.

DIGIT REGISTRATION

8.38 After a short interval, long enough to insure that no more pulses are to be received after L operates for the last closure of a digit, RA releases and through two separate break-contacts closes an ON1 ground to the translating contacts of the P- relays. The contacts of the P- relays are wired so that two of the output leads 0, 1, 2, 4, and 7 will be grounded depending on which combination of relays is operated. These five leads are carried through separate transfer contacts on the steering relays to the register unit where two of the relays will be operated and locked. Another back contact on RA operates RA1 which opens the five leads at the output of the counting relay translating contacts and releases the counting relays. The register relays are required to operate during the operate time of RA1. The RA1 operates the next steering relay and reoperates TMB in preparation for recycling the TM timer. The RA1 also may perform certain functions with regard to operation of the marker start relay. This is described in detail in the paragraph on determination of number of digits to be received. The pulsing circuit is now ready to count the next digit and when the L relay releases on the first pulse, RA operates and releases RA1. The RA1 releases the steering relay for the digit just registered and releases TMA and TMB to recycle the TM timer. This timer is described in detail in the paragraph on register timers.

END 7 SIGNAL

8.39 The 2-out-of-5 method of registration represents a self-checking means for transferring the number from one circuit to another. In the transfer of a series of digits the number of which may be variable, an additional checking feature is incorporated. This is the so-called end 7 signal, which is a single -7 in the digit position one beyond the position of the last registered digit, and is used for checking that all the digits have been transferred properly and that none have been omitted entirely. This end 7 is registered by the operation of the marker start relay in connection with the steering relays. When MST operates at the end of digit registration, it closes a circuit through the steering relays, to ground the single seven lead of the digit one beyond the last registered digit. For example, if MST operates after four digits have been registered DS would remain operated and lead E7 would be grounded.

DETERMINATION OF NUMBER OF DIGITS TO BE RECEIVED

8.40 When all digits have been received the register operates the MST relay to start seizure of a marker. The steering relays are used to indicate when particular digits have been registered. As these relays operate they ground the A to D cross-connect terminals with the terminal designation corresponding to a digit being grounded following registration of that digit. For example, when the D digit is registered the ES relay is operated to ground the D terminal. These terminals with their cross-connections, and in some cases permanent wiring to contacts of the class relays, under varying degrees of

intermediate control are used to operate MST. Since the register does not receive the same number of digits from all incoming trunks, the operation of MST is controlled either directly or indirectly by the class relays. For instance, for a 4-digit locally completing incoming trunk with the OA class relay operated, MST will be operated when ES operates after the fourth digit is registered.

8.41 The MST terminal is connected directly to the MST relay winding and a ground at this terminal will cause selection of the marker without delay.

TRUNK CUT-THROUGH AND MARKER SEIZURE

A. General

8.42 When all digits have been received the register starts selection of a marker. However, before the marker can complete the call, the trunk must be changed from its pulsing condition to its transmission condition. This trunk cut-through function is completed by the register before the marker is seized. When connected to a marker by the marker connector the register transfers to the marker the dialed number, trunk class information, trunk frame number, and translation to be used. The marker then proceeds to gain access to the trunk and establishes a connection between it and the called line.

B. Marker Start Relay

8.43 When all digits have been received the marker start relay operates. The MST opens the circuit from the front contact of L to the P1 and P2 relays to prevent any further counting of pulses and closes a circuit to hold RA1 operated to prevent any further advance of the steering circuit in case an additional digit is dialed in error. The MST also closes a circuit through the contacts of the steering relays to ground the single seven lead of the digit beyond the last registered digit. The MST recycles the TM timer circuit.

C. Cut-Through of Direct Dial Pulsing Trunks

8.44 The MST closes ground through the primary winding of the TC1 relay to the CT lead to the register link. The TC1 secondary winding is connected in parallel with the trunk D relay to the ground through the primary winding. The ampere turns of these two windings oppose each other and TC1 does not operate under this condition. The trunk D relay operates and reconnects the trunk A relay to the trunk conductors. The MST also opens the holding path of DP and the release of DP disconnects the register L relay from the tip and ring leads. The trunk A relay operates and connects a ground to lead CT to hold D and to short the TC1 primary winding so that TC1 operates on its secondary winding. The TC1 operates TC2 which locks to MST and to H and opens the primary winding of TC1. The TC2 closes ground to the TM lead to the marker connector or marker preference and control circuit to start the connector timer and connects battery to the CBS lead and to the ST lead to cause the connector to connect the register to a marker. The TC1 also connects a charge circuit around the AC capacitor to stop the abandoned call timer. The TC1 is held under direct control of the trunk supervisory relay and TC1 controls the abandoned call timer until the register releases.

D. Cut-Through on Bylink Pulsing Trunks

8.45 On these trunks the trunk link relay was not disconnected from the trunk, pulsing being repeated from this relay over the ring lead to the register L relay. The MST closes ground through the primary winding of the TC1 relay to the CT lead to the register link. The TC1 secondary winding is connected in parallel with the trunk D relay to the ground through the primary winding. The ampere turns of these two windings oppose each other and TC1 does not operate on this condition. The trunk D relay operates and establishes the transmission condition and locks to a contact on the trunk B relay which is held by the trunk A. This locking ground is returned on the TC lead to short the primary winding of the TC1 and TC1 operates on its secondary winding. The TC1 operates TC2 which locks to MST and H and opens the primary winding of TC1. The TC2 closes ground to the TM lead to the marker connector or marker preference and control circuit to start the connector timing and connects battery to the CBS lead and ST lead to cause the connector to connect the register to a marker. The L is held from the trunk A relay and exercises supervision until the register releases.

REGISTER RELEASE

8.46 When a marker has completed the connection to the called line or trunk or has established a busy or overflow condition in the trunk it operates the marker release relay MRL over lead MRL. The MRL locks to TC2, opens the battery from the ST lead to release the marker connector and marker. The MRL opens the circuit to

ON but closes a circuit to hold RB. The ON opens the circuit to H, DCK, and the link hold magnet and opens the CT lead to prevent the TC1 circuit being broken at the crosspoints. The ON also opens the T and R leads to prevent any breaking of current at the crosspoints on these leads. This might occur on a bylink trunk or on certain prematurely released direct pulsing calls. The ON releases ON1 and these relays release most of the operated relays of the register. The ON also releases H, TC1, and the operated steering relay which releases MST. The last one of these to release causes release of TC2 which releases MRL and in turn RB and RLK. The RB releases the register-busy relays of the link and the register can be selected for use on another call.

8.47 If the marker encounters trouble and cannot disconnect itself from the register by the regular release path or if the marker is seized as a result of the link release time-out, it will ground the TRL lead, so-called because of its busy tone function in the originating register, to cause operation of the trouble release relay TRL. The TRL performs the functions described for the MRL relay and in addition opens the link select and hold magnet circuits. This aids the release of the register in case the control relays of the link have not released. The TRL also operates RLK if it is not already operated to aid the release of the register.

8.48 The MRL may also be operated from TM as a result of a time-out or from AC as a result of an abandoned call.

9. REGISTER TIMING CIRCUITS

GENERAL

9.01 There are four timing circuits in this register. These are listed in the following table which gives the minimum, nominal and maximum times based on allowable voltage limits and include the time of operation of the timing relay.

Timer	Function	Time in Milliseconds Minimum	Nominal	Maximum
AC	Abandon Call	180	195	215
LR	Link Release	385	415	450
RV	Start Dial Reversal	170	185	200
TM	Overall (Interdigital) Timer	16,200	17,500	19,000

All of these timing circuits work on the same basic principle (refer to CD and SD-94820-01, Time Delay Control Circuit).

ABANDONED CALL

A. Direct Pulsing Trunks

9.02 The calling party may release the register at any time after the start pulsing tip and ring polarity reversal has been transmitted by the register. Supervision is under control of the abandoned call timer. An abandoned call is recognized by the operation of the AC relay, which may occur at various times as described in the following paragraphs.

Multifrequency Operation

9.03 When the register is seized relays MF and MF1 operate to switch the register to the multifrequency mode of the operation. The ON1 relay operates and connects the grounded AC relay to the timing circuit. The AC capacitor is charged and kept charged through back contacts of RV and TM relays and make-contacts of the operated MF1 relay.

9.04 When RV operates to reverse the polarity on the tip and ring it opens the charge circuit, but relay L should operate to establish a parallel holding path for the AC timer. Should the calling party disconnect, relay L will not operate or will release if operated, causing the AC timer to start timing and after a timed interval the AC relay operates.

9.05 When relay MST operates, it releases relay L. However, MST also operates the cut-through relay in the trunk over the CT lead. This relay connects the trunk supervisory relay to the tip and ring leads causing it to operate and this grounds lead CT, operating TC1. The TC1 closes a new holding path for the timer through a back contact of TM. In order to prevent the timer from operating before TC1 operates, a path is provided to hold through series front contacts of relays TM1, MST, and MF1. The operation of MST releases TM1 which is sufficiently slow-release to hold the timer until TC1 operates. If the calling party abandons after this stage, the trunk supervisory relay will release, releasing relay TC1 which will operate the AC timer.

9.06 When the AC timer operates from any of the above causes, it operates MRL from ground on a front contact of relay RV. The MRL releases the register.

Dial Pulse Operation

9.07 When the register is seized ON1 operates and connects the grounded AC relay to the timing circuit. The AC capacitor is charged and kept charged by the path through back contacts of relays BL, CK, and MF1 until CK relay operates. The break-contacts of CK are shorted by make-contacts of ACC and ACC will operate before CK operates to maintain the capacitor in a charged state. After the line reversal start dialing signal is transmitted, the L is under control of the calling office and L controls ACC. During the dialing of each digit L will release to open the circuit to ACC. The ACC may or may not release depending on the length of the open pulse, but if it does release it will reoperate on the next closure. The time of the timer is such that it will not operate on the longest dial open but will operate if L and ACC remain normal somewhat longer than the time of the longest dial open indicating that the call has been abandoned.

9.08 After all the digits have been registered L and ACC will release but TC1 will operate to prevent the timer from functioning. If the call is abandoned after TC1 operates, the release of TC1 will cause operation of the timer.

9.09 If the charge path to the AC capacitor is opened for a nominal time of 195 milliseconds, the AC relay operates. The AC operates MRL to cause release of the register. The release of CK will recharge the AC capacitor.

B. Bylink Pulsing Trunks

9.10 When the register is seized, ON1 connects the grounded AC relay to the timing circuit. Relay BL will operate and open the charge path to the AC capacitor. At this same time L will operate to operate ACC to close the charge path on the AC capacitor to prevent its discharging. The capacitor is charged between calls through normal contacts on the BL and CK relays and the operation of BL removes this path. During the dialing of each digit L will release to release ACC but ACC operates during the next dial closure. The time of the timer is such that it will not operate on the longest dial open but will operate if L and ACC remain normal somewhat longer than the time of the longest dial open pulse. For bylink type trunks L and ACC retain supervision even after the operation of TC1.

9.11 If the discharge shunt around the AC capacitor is removed for a nominal time of 195 milliseconds, the AC relay operates. The AC operates MRL to cause release of the register.

9.12 The bylink lead check relay BLK is also wired to control the charge path of the AC capacitor as explained under the paragraph on pulsing. On bylink trunks the BLK relay does not remain operated unless there is an open BL lead through the link. If BLK does remain operated, it prevents operation of AC to prevent an abandoned call release and allows the LR timer to function to call a marker for the appropriate action.

LINK RELEASE TIMER LR

9.13 Since the register link is common to a large number of trunks and to a group of up to five registers it is important that link troubles be detected as quickly as possible so that remedial action can be taken. Since the link has no common control circuit, timing, 415 milliseconds nominal, for the completion of the link functions is done in the register.

9.14 The link release timer is started when ON1 operates at the start of the register seizure. The ON1 opens the charge path to the LR capacitor and connects ground to the LR relay. When all the functions of the link are completed the release check relay RLK is operated as described under seizure of register. The RLK reconnects the charge path to the LR capacitor thus preventing any further discharging and consequently any operation of the LR relay.

9.15 In the event there is trouble in the link, RLK will not operate and the timer will function to operate LR. The LR locks through the LR1 resistor to 48 volts and connects ground to the CT lead to the link. This ground operates TC1 and if the crosspoints have been closed, operates the trunk D relay to establish the trunk transmission condition. The TC1 operates TC2 which causes the marker connector to establish a connection to a marker. The LR also grounds lead LR to indicate that the marker seizure is a result of an LR time-out. If the DCK relay has operated on the seizure this condition is indicated to the marker by the connection of ground on lead DCK. If the marker receives ground on this lead and on the LR lead, it attempts to set the trunk in a reorder condition. If a trouble

record of the condition is caused to be taken by the marker, information as to the link switch in trouble is furnished directly to the marker from the register link circuit.

9.16 When the marker has made the proper disposition of the call, it usually operates the register trouble release relay TRL although in some cases it may operate the regular release relay MRL. The operation of either TRL or MRL will release the marker and the ON relay followed by the release of all operated relays. The RLK is operated by either MRL or TRL to simulate a release check so as to free the link. The TRL opens the link select magnet path and the link hold magnet path to cause the early release of these magnets on the majority of the calls when TRL operates.

RV TIMER

9.17 The RV timer provides a nominal time interval of 185 milliseconds to assure that the register has time to be ready to receive pulses. At the end of the time interval it operates relay RV to reverse the line polarity, as a signal to the operator or outgoing sender to start pulsing.

A. Multifrequency

9.18 When the register is seized relays MF1 and ON1 operate and connect the grounded RV relay to the timing circuit. Back contacts of relay CK keep the charge path of capacitor RV closed, preventing the timer from timing until all check paths in the operate path of the CK relay are satisfied. Relay CK then operates, placing the start of timing under control of back contacts relay RLK. When relay RLK operates at the completion of the link functions it opens the charge circuit which starts the discharge of capacitor RV. After an interval of 185 milliseconds nominal reversing relay RV operates and locks through its own contacts and resistor RV2.

B. Dial Pulse

9.19 When the register is seized relays DP and ON1 operate and connect the grounded RV relay to the timing circuit. Back contacts of relay CK keep the charge path of capacitor RV closed, preventing the timing circuit from timing until all check paths in the operate path of CK relay are satisfied. Relay CK then operates, placing the start of timing under control of back contacts of relay RV1. When RV1 operates it opens the charge path of capacitor RV, which starts the timing interval. After an interval of 185 milliseconds, reversing relay RV operates and locks through its own contacts and resistor RV2.

C. Bylink

9.20 The RV timer is not operated when the register is in the bylink mode of operation since the receipt of pulses from the step-by-step office must begin immediately over the bylink path. When the register is seized, forward contacts on the BL relay are closed to maintain the charge path to capacitor RV, thus preventing any timing starts by the RV timer.

OVERALL TIMER TM

9.21 This timer serves to prevent any trunk from holding the register out of service for a long period of time. It is recycled on an interdigital basis so as to keep its time reasonably short and yet allow sufficient time for normal functions.

9.22 The timer is controlled by the auxiliary timing relay TMA which when operating, removes the charge shunt from the TM capacitor and connects the grounded TM relay to the transistor circuit.

9.23 A period of 17.5 seconds nominal is allowed for all digits to be recorded. If relay MST does not operate within this interval, after register seizure, the register will time out and call in a marker for a reorder connector. Once MST has operated, a second period of 17.5 seconds nominal is allowed for completion of the marker functions and register release. If the register does not release within this interval, an abandoned call is simulated in an attempt to release the register. In case the register fails to release, the office alarm is brought in.

9.24 The overall timing in the register is accomplished by relay TM, the associated resistor-capacitor network, and the transistor circuit. The discharge rate of the TM capacitor is controlled by the value of the capacitor and the value of the discharging resistor TM. These are chosen to give a time of 16.2 minimum, 17.5 nominal, and 19 maximum seconds delay in the operation of relay TM.

9.25 Capacitor TM is normally charged by a circuit through a back contact of relay TMA to ground and to battery through the transistor circuit. When TMA operates at the beginning of a call it opens the capacitor charging ground path and to start the capacitor discharge through the TM or TM1 resistor and the transistor circuit.

A. Multifrequency

9.26 The timer is recycled when relay MST operates. When MST operates, the TM

relay, the capacitor, and the charge circuit are connected across the capacitor through a front contact of relay TM1 which was operated at the beginning of the call by the ON relay. The TM1 is released when MST operates, but is sufficiently slow-release to allow time to charge capacitor TM. When TM1 releases, it opens the charge circuit and reconnects for another timing cycle.

9.27 If the timer operates before relay MST operates, it operates relay TM. The TM grounds lead LP to light the time-out lamp for the register at the test frame, grounds lead ALM to start an office alarm timing circuit, and operates reorder relay RO. The RO locks and operates marker start relay MST. The MST grounds lead CT to the trunk through a winding of relay TC1. The trunk relay D operates and connects direct ground to lead CT, operating relay TC1. The TC1 operates relay TC2, calling in a marker. Since relay RO is operated, the marker finds ground on lead RO and no ground on the class of translator leads; therefore, it sets the trunk in the reorder or overflow position. The operation of MST also releases relays TM and TM1 and recycles the timer.

9.28 If the TM timer operates after relay MST has operated, relay TM operates. With MST operated, TM opens the charge circuit of the AC timer allowing it to operate to cause operation of MRL to effect the release of the register.

B. Dial Pulse

9.29 The TMA operates initially on its primary winding from ON when the register is seized. The ON1 operates RA1 to energize the secondary winding locking circuit of TMA and to operate TMB. The TMB opens the primary winding operating circuit of TMA. When the first open of the first digit occurs, RA1 releases and allows TMA and TMB to release in parallel. The TMB is a slow-release relay and allows time for TMA to release and to charge the TM capacitor before releasing to reclose the operating circuit for TMA. When TMB releases TMA reoperates to start a new timing cycle. The TMB will reoperate at the end of each digit. Thus, the timer is recycled at the start of each digit. When all digits have been received, MST operates to release TMA and TMB to cause an additional recycle so that a full timed interval will be allowed for the marker functions and release of the register.

9.30 In the event the seizure interval or any of the interdigital intervals exceed the allowable time, the TM relay will operate to operate the reorder relay RO. The RO locks and releases TMA and TMB to cause a recycle of the timer and the release of TM. When TM releases with RO operated MST operates to cause connection with a marker. The RO will ground the RO lead to the marker to indicate that a time-out has occurred. The RO also removes the ground from the translator and class indications to the marker. The MST locks independently of TM and closes a circuit for the reoperation of TMA for timing the register release interval.

9.31 In the event the timer functions after MST operates, the operation of TM will cause operation of MRL to effect release of the register.

9.32 With TM operated the LP lead to the test circuit is grounded to cause a lamp individual to the register to be lighted. With TM operated and MB normal a ground is placed on the ALM lead to start a common timing circuit and if the ground persists for a timed interval an alarm will be brought in.

9.33 A make-contact on the RB relay of each register of a group is wired in a chain circuit to cause operation of an alarm in the alarm circuit in case all RB relays are operated simultaneously.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

1.01 L Relay

Maximum External Circuit Loop	4600 Ohms 45 Volts 5000 Ohms 48 Volts
Minimum Insulation Resistance	30,000 Ohms 45 Volts 30,000 Ohms 48 Volts

1.02 L Relay - The use of this circuit is limited as the loop toward the originating end by the operating limits of the L relay. The operating limits of this relay are as follows:

PPS	Max Ext Ckt Loop	Max Trk Cond Res	Max Cable Mileage	Allowable Bridge Cap.	Minimum Ins Res	See Note
10-20	4500 Ohms	4200 Ohms	42	0	30,000 Ohms	2
10-20	4500 Ohms	4200 Ohms	42	2 µF	30,000 Ohms	1,3, and 7
10-20	4500 Ohms	3800 Ohms	32	2 µF	30,000 Ohms	4 and 7
10-20	2400 Ohms	1800 Ohms	20	2 µF	30,000 Ohms	6 and 7
10	4500 Ohms	3800 Ohms	32	2 µF	30,000 Ohms	5 and 7
10	4500 Ohms	3900 Ohms	35	0	30,000 Ohms	3

Notes

1. Source of Pulses - Dial or equivalent from DSA boards using SP R1 3 or DL E330 cord relay and equipped with a cord test set circuit with a false pulse generation test loop resistance of 2800 ohms.

2. Source of Pulses - Dial or from S522 repeater relay or equivalent. Holding Bridge - 54AB inductor in series with 206 FF relay or equivalent.

3. Source of Pulses - Dial or equivalent. Holding Bridge - Noninductive resistance of 300 ohms or less or polar relays with no inductors.

4. Source of Pulses - Dial or equivalent. Holding Bridge - 54H inductor (windings in series) in series with 206C relay or equivalent.

5. Source of Pulses - Any repeater relay used in existing subscriber switchboard No. 1, or equivalent relay. Holding Bridge - 54C inductor in series with 206C relay or equivalent, for use in switchboard No. 1 only.

6. Source of Pulses - Dial or equivalent from DSA boards equipped with SP R183 or DL E330 cord relay.

7. Bridged capacity must be a capacitor of 2 µF or less in series with noninductive resistance. Bridged capacity of 2 µF to be used with 10-PPS dials.

8. Source of Pulsing - UA37 repeater relay with 1 µF in series with 160 ohms around its winding, receiving 9 minimum to 11 maximum pulses per second with 41 to 72 percent-break from CX or SX signaling circuit.

1.03 Battery Voltages

-45 to -50

1.04 Maximum resistance in the CT lead from incoming register to incoming trunk - 10 ohms.

2. FUNCTIONAL DESIGNATIONS

2.01 The functional meanings of the designations of the operating elements of the register are given in the following list.

2.02 Relays

Designation	Meaning
2CK	Two Check
A 2/5	A-Digit Register
AB	(Trunk Completing to) A and B Offices
AC	Abandoned Call
ACC	Abandoned Call Control
AS	A-Digit Steering
B 2/5	B-Digit Register
BL	Bylink
BLK	BL Lead Check (On Bylink Trunk)
BS	B-Digit Steering
C 2/5	C-Digit Register
CK	Class Check
CS	C-Digit Steering
D 2/5	D-Digit Register
DCK	Double Connection Check
DP	Direct Pulsing (Trunk)
DS	D-Digit Steering
E 2/5	E-Digit Register
ES	E-Digit Steering
H	Hold Magnet
L	Line Relay
LR	Link Release (Trouble)
MB	Make Busy
MF, MF1	Multifrequency Operation
MRL	Marker Release
MST	Marker Start
NOE	No Operator Error
OA	(Trunk Completing To) Office A
OB	(Trunk Completing To) Office B
ON, ON1	Off-Normal
P1-5, P2A	Pulse Counting
RA, RA1	Register Advance (DP)
RAMF	Register Advance (MF)
RB	Register Busy
RLK	Release Link Check
RO	Reorder
RV, RV1	Reversal (Of Tip and Ring Polarity)
SPL	Special Class Trunks
STS, STS1	Start Pulse Steering
TC1, TC2	Trunk Cut-Through
TEN	TEN Frequency
TU0,1	Trunk Switch Frame Number
TM, TM1	Time Measure
TMA, TMB	Time Measure Auxiliary
TRL	Trouble Release

2.03 Timers

Designation	Meaning
AC	Abandoned Call Timer
LR	Link Release Timer
RV	Reversal Timer (Of Tip and Ring Polarity)
TM	Register Timer

3. FUNCTIONS

3.01 To operate register-busy relays in the register link circuit whenever the register is either plugged busy or is busy in service.

3.02 To prepare for functioning with either multifrequency pulsing, bylink dial pulsing, or direct dial pulsing trunks as indicated by one of three ground leads.

3.03 To supply battery for operating the select magnet and ground for operating the hold magnet in the register link circuit.

3.04 To recognize closure of a crosspoint in the link.

3.05 To release the select magnet in the link.

3.06 To check for a double connection in the link and then provide direct ground for locking the hold magnet.

3.07 To operate the cutoff relay in the incoming trunk circuit and to check that it operates.

3.08 To receive from the register link the class of incoming trunk and the number of the trunk switch frame on which the trunk appears.

3.09 To supply supervisory battery and ground to the tip and ring conductors of the incoming trunk in one direction for a timed interval and then to reverse the polarity as a signal that pulsing may begin.

3.10 To accept control of supervision after the link functions have been completed and the polarity of the tip and ring has been reversed as a start pulsing signal.

3.11 When a register is seized, to prevent advancing the start lead at the active appearance of the register in the link, but to advance the start leads at all other appearances of the register.

3.12 When a register is first seized, to lock in the connection until all link functions have been completed.

3.13 When all link functions have been completed, to allow the last register-busy relay in the link to operate and to unlock the connection so that the register will be held under control of supervision.

3.14 To time for all link functions to be completed; if they are not completed within a given interval, to call in the marker and indicate the nature of the trouble to the marker.

3.15 To supply battery to the multifrequency signal receiving circuit.

3.16 To record digits received by the multifrequency signal receiver locking in those received for each digit.

3.17 To steer from digit to digit under control of the multifrequency signal receiver, not completing a step until the end of a multifrequency pulse.

3.18 In case the multifrequency receiver signals that it has received more than two frequencies simultaneously to call in the marker and ask for reorder.

3.19 To request a reorder routing by the marker when:

(a) A second key pulse signal is received.

(b) More or less than 4 digits followed by start signal are received on any 4-digit trunk class call with terminals OE and XCT cross-connected.

(c) More or less than 5 digits followed by start signal are received on any 5-digit trunk class call with terminals OE and XCT cross-connected.

(d) More or less than a predetermined number of digits followed by a start signal are received on a trunk with terminals OE and XCT cross-connected.

(e) Less than 4 digits followed by a start signal are received on any 4-digit class trunk with terminals OE and MIN cross-connected.

(f) Less than 5 digits followed by a start signal are received on any 5-digit class trunk with terminals OE and MIN cross-connected.

(g) Less than a predetermined number of digits followed by a start signal are received on a trunk with terminals OE and MIN cross-connected.

3.20 To cause steering advance when only a single frequency digit indication is received from the signal receiving circuit.

3.21 To furnish dial tone to dial pulse trunks.

3.22 To count the number of dial pulses in each digit.

3.23 To register this count on a digit register on a 2-out-of-5 basis.

3.24 To steer each digit count to the digit register corresponding to the digit being received.

3.25 To determine when all digits have been received:

(a) By an indication received from the trunk class relay in the link circuit.

(b) By registering the last equipped digit.

3.26 To ground, as an end signal, the -7 lead to the completing marker of the next digit beyond the final digit received on a call.

3.27 To operate the trunk cut-through relay before calling for a marker.

3.28 To check that the trunk cut-through relay operates.

3.29 To select a marker when the required number of digits has been received.

3.30 To establish the transmission condition in the trunk when all digits have been registered.

3.31 To prevent the register from responding to extra digits.

3.32 To transmit to the marker the class of trunk, the number of the trunk switch frame where the trunk appears, all digits received over the trunk, and an end signal.

3.33 To release when the marker operates the marker release relay MRL.

3.34 To provide a regular and an alternate release circuit by which the marker can release itself from the register.

3.35 To release when the marker operates the trouble release relay TRL.

3.36 To release if the call is abandoned before the trunk cut-through relay has been operated.

3.37 To release if the call is abandoned after the trunk cut-through relay has been operated.

3.38 To hold the register-busy relays of the link circuit operated until the MRL and TRL relays have released.

3.39 To call for a marker and ask for reorder if relay MST has not operated within a measured time after register seizure.

3.40 To release if normal release has not occurred within a measured time after relay MST operates.

3.41 To light a lamp and start a common alarm timing circuit if the register fails to release.

3.42 To prevent starting the common alarm timing circuit when the register is plugged busy.

3.43 To call for a special marker function on calls from special trunks, ie, no-test or no-hunt trunks or trunks from the test desk.

3.44 To transmit a group-busy signal to the traffic register circuit whenever all registers of a group are busy because of either make-busy plugs or service calls.

3.45 To provide for functioning with 5-digit terminating class trunks.

3.46 To provide for operation with the traffic usage recorder circuit.

3.47 To provide peg count and all register-busy indications.

3.48 To provide for functioning with up to 4-digit terminating class trunks.

4. CONNECTING CIRCUITS

4.01 When this circuit is listed on a key-sheet, the connecting information thereon is to be followed. This circuit will function with the following Crossbar System circuits.

(a) Signal Receiving - SD-99493-01.

(b) Incoming Register Link Circuit - SD-26394-01.

(c) Incoming Register Marker Connector - SD-26389-01.

(d) Test Circuit - SD-26411-01.

(e) Traffic and Plant Register Circuit - SD-26437-01.

(f) Incoming Trunk Circuit (Typical) - SD-26399-01.

(g) Marker Circuit - SD-26384-01.

(h) Traffic Usage Recorder Circuit (Typical) - SD-99359-05.

(i) Incoming Trunk Circuit from SXS Office Bylink - SD-26418-01 (Typical).

(j) Power, Ringing and Tone Distributing Circuit - SD-26414-01.

(k) Time Delay Control Circuit - SD-94820-01.

5. MANUFACTURING TESTING REQUIREMENTS

5.01 The combined multifrequency dial pulse incoming register shall be capable of performing all the service functions specified in this Circuit Description and meeting all the requirements of the Circuit Requirements Table. In the dial pulse mode of operation, the register shall also be capable of functioning under test conditions listed below.

5.02 The dial pulsing and counting functions of the register shall be checked with the following conditions.

(a) A precision pulse generating circuit such as SD-25680-0114 (or equivalent) capable of generating dial pulses within the limits of accuracy given by Fig. 4 in Information Note 305 in the SD.

(b) Trunk loop circuits (or equivalent) as shown by Fig. 5 in Information Note 305 in the SD.

5.03 Nominal circuit conditions may be employed in these tests except as specified in the following paragraphs.

(a) The pulsing and counting features of the register circuit under test shall be checked using the pulsing loop and leak condition covered by the Fig. 4 and 5 for at least 4 digits; 2 digits of less than 5 pulses, preferably ones or twos, followed by 2 digits of more than 5 pulses, preferably nines or zeros, shall be dialed under each condition and all digits dialed shall be correctly registered.

(b) The test circuit shall provide an interdigital interval of 183 ±13 milliseconds for the pulsing conditions covered in Fig. 4D. For other pulsing conditions this time may be exceeded.

6. TAKING EQUIPMENT OUT OF SERVICE

METHOD OF TAKING EQUIPMENT OUT OF SERVICE

6.01 In order to take the register circuit or any of its associated apparatus out of service, operate the associated (IRMB) key at the test frame.

GENERAL PRECAUTIONS TO BE FOLLOWED WHEN WORKING ON THE APPARATUS

6.02 When working on the apparatus, the register should be made busy by operating the associated IRMB key at the test frame. No further precautions are necessary unless otherwise specified in the Circuit Requirements Table.

7. ALARM INFORMATION

TIME-OUT ALARM

A. Condition

7.01 If an incoming register encounters a delay in the progress of a call, the register timing circuit will function and attempt to release the register as described in SECTION II, 9.

B. Indication

7.02 If the register releases satisfactorily, the only indication of the condition will be the momentary lighting of the time-out IRMB lamp on the test circuit. If the register is unable to release, the IRMB lamp will remain lighted and the common alarm timing circuit will begin to function and, after a time interval of 10 to 15 seconds, operate the major alarm and light the register and sender time-out alarm (RS-TOA) lamp.

C. Action Required

7.03 If, in response to a major alarm, a lighted IRMB- lamp is found, operate the key associated with the IRMB lamp to silence the alarm and to remove the register from service.

D. Link Release Time-Out

7.04 In addition to the time-out feature covered under 7. ALARM INFORMATION, there is also a link release and double connection check feature provided to check that the link functions are completed in

the allotted time and that there is no double connection in the link path. The operation of this feature causes seizure of the marker for appropriate action which may result in a trouble recorder alarm.

E. Fuse Alarm

7.05 If in response to a major alarm an FA lamp is lighted at an incoming register fuse panel on IRORO frame, it is an indication that a fuse has been operated by the associated incoming register frame.

7.06 Replace the operated fuse to restore the alarm and extinguish the FA lamp.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 5245-LCB

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