DIGIT PROCESSING
SOFTWARE SUBSYSTEM DESCRIPTION
NO. 3 ELECTRONIC SWITCHING SYSTEM

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1. GENERAL

1.01 This section provides a functional description of the software required to perform digit processing operations in the No. 3 Electronic Switching System (ESS) offices. The following areas are discussed:

(a) Digit receiving

(b) Digit sending

(c) Digit interpretation.

1.02 This section is being reissued to include modifications for the custom calling access codes in the No. 3 ESS 3E3 generic, Issue 4. Revision arrows are used to emphasize the more significant changes.

1.03 Part 7 contains a glossary of terms, abbreviations, and definitions necessary for comprehension of the information contained in this section.

1.04 The following Software Subsystem Descriptions may be helpful in understanding digit processing functions:

SECTION	SUBJECT
233-151-105	Call Processing, Software Subsystem Description, No. 3 ESS

SECTION	SUBJECT
233-151-125	Input Processing and Scanning, Software Subsystem Description, No. 3 ESS
233-151-130	Basic Call Processing, Software Subsystem Description, No. 3 ESS
233-151-135	Custom Calling (SO-2 Generic), Software Subsystem Description, No. 3 ESS
233-151-136	Custom Calling (3E3 Generic), Software Subsystem Description, No. 3 ESS
233-151-140	Network Path Unit, Software Subsystem Description, No. 3 ESS
233-151-150	Translations, Software Subsystem Description, No. 3 ESS
233-152-105	Recent Change Processing and Translation Data, Software Subsystem Description, No. 3 ESS
233-190-503	International Direct Distance Dialing (IDDD), No. 3 ESS.

1.05 Information contained in this section will aid in accessing the software listings, which contain detailed program functions and coded software instructions. Table A contains the acronyms, names, and program listing numbers of each program referenced in this document, as well as the major functions performed by each.

1.06 Major digit processing functions and the software required to perform the functions are shown in Fig. 1.

2. SUBSYSTEM FUNCTIONAL DESCRIPTION

BASE LEVEL AND INTERRUPT LEVEL

2.01 The base level loop is a major software loop of non-time-critical programs and includes most call processing programs and deferrable maintenance tasks. The base level loop is interrupted every 10 msec for the time necessary to perform frequently required functions such as sending and receiving tasks, immediate start and operator trunk scanning, and most peripheral control functions. After interrupt functions of the base level loop are completed, control is returned to the base level loop which continues processing from the point of interruption. Most digit receiving and sending tasks are performed during the 10-msec interrupts, while digit interpretation is performed during base level.

MAJOR STORAGE AREAS AND FLAGS FOR DIGIT PROCESSING

A. Transient Call Record

2.02 A transient call record (TCR) is a 16-word block of main store assigned to a call in the transient state. This area stores control information, terminal and path information, and receiving and sending data applicable to a call. The TCR information and format change as different call processing functions are performed for the call; however, a typical TCR format during digit processing is depicted in Fig. 2.

B. Progress Marks

2.03 A progress mark is a number stored in a TCR that indicates, via a program transfer table, the application software routine to be given control. Progress marks are used at both base level and interrupt level.

2.04 Each TCR contains three progress marks, one for base level and two for interrupt level. The ***base level progress mark*** (BASEPM) must be present in an active TCR. The associated routine is invoked (1) by the TCR scanning program (TCRSCN) when the TCR timer goes through zero, (2) by TCRSCN when the base level action (BACTION) bit in the TCR is set to one, or (3) when the input monitor reports a state change in a circuit contained in the TCR. A digit processing example of the use of progress marks follows. A digit interpretation routine at base level indicates the digits needed for translation in the signal digit area (SIGDIG) of the TCR and indicates in the BASEPM the routine to be executed after the number of digits needed are received. The interrupt receiving and sending program, DIGPRO, sets the BACTION bit at interrupt level when the necessary number of digits is received. During the TCR scan of the next base level loop, control of TCR processing is given to the routine associated with the BASEPM.

2.05 The ***interrupt level progress mark*** (INTPM) indicates whether peripheral action is needed and whether sending functions are required to be performed. The progress mark is examined by the peripheral order interpreter, POINT, and transfers control to DIGPRO for digit-sending functions.

2.06 The ***peripheral progress mark*** (PPM) is the second progress mark used at interrupt level. It indicates the beginning of the peripheral sequence to be executed and contains the sending progress marks, which point to sending routines in DIGPRO to be executed during interrupt level.

C. Digit Storage Area

2.07 Digits, when collected, are stored in the digit storage areas (DIGSTR) of the TCR. There are fifteen 4-bit fields for digit storage.

D. Signal Digit

2.08 The signal digit in the TCR indicates the location of the digit to be received before base level is alerted by setting the BACTION bit. The signal digit is also used to indicate the last digit to be sent in the sending routine.

E. Receiver Status Area

2.09 An area of temporary store (RCVRSTAT) is used to save the status of the supervisory and tone present scan points associated with the receivers when scanned. These receiver scan points [multifrequency (MF), TOUCH-TONE dialing, and customer dial pulse (CDPR)] are located in the first six rows of the master scanner (16 scan points per row). For each of the scan point rows, 20 words are required to store the status. The first word (THISLOOK) contains the scan results for each of the 16 scan points in the row (one equals off-hook). The second word (LASTLOOK) indicates the result of the last scan of the scan points. The third word (ACTIVITY) indicates the scan points that are actively receiving. The fourth word (CHANGE) indicates whether the scan point state has changed within the most recent 160-msec period. The remaining 16 words are the originating registers for the 16 receiver scan points in the row.

F. Originating Register

2.10 Each scan point in the six receiver scan rows has an associated originating register (Fig. 3) to be used in digit receiving. The originating register is one word and provides a link for the call between the receiver scan point and the TCR. This register contains the TCR number, an area to accumulate the pulse count for a digit dialed, and a receiver code. The receiver code is used to indicate the digit processing routine in the digit receiving and sending program (DIGPRO) that should be given control. Table B contains a list of the codes and definitions.

G. Dial Pulse Receiving Trunk Hopper

2.11 Each active incoming dial pulse trunk is assigned an entry in the dial pulse receiving trunk hopper in memory while the trunk is in the receiving state (Fig. 4). The 2-word entry is used for counting pulses from dial pulse trunks. Dial pulses from trunks are collected by interrogating the trunk supervisory scan point.

H. Timing Hopper

2.12 The timing hopper in writable main store provides accurate timing for real-time breaks in peripheral order processing and for sending functions. The first two words in the hopper are control words, and the remaining entries contain the TCR number and timer for the entry. The control words and the format of a slot in the hopper are shown in Fig. 5. The timing hopper monitor routine (TMON) in the network queue and timing hopper monitor program (QTMON) decrements the times of all active slots in the hopper during each 10-msec interrupt. The POINT is then given control of any entry that times out for further processing. Control of all sending function entries is passed to DIGPRO for processing.

3. DIGIT RECEIVING

SOFTWARE ORGANIZATION

3.01 Due to the accuracy and speed required for digit sending and receiving functions, DIGPRO is executed during each 10-msec interrupt. The digit receiving functions performed by DIGPRO are divided into the following categories:

(a) The functions performed during each 10-msec interrupt

(b) The functions performed every 16th interrupt; ie, every 160 msec.

3.02 Each 10-msec interrupt, DIGPRO first performs the interrupt overhead program functions, consisting of saving registers and the system status. The receiver scan points are then interrogated, and the results are stored in the receiver status for each of the receiver rows that are examined in the receiver scan 10-msec change check routine.

3.03 The program DIGPRO then examines the dial pulse receiving trunk hopper and issues a directed scan of each trunk scan point with an active entry in the hopper. During the dial pulse receiving trunk scan routine, the results are examined, the change bit is set for those entries with status changes, and the appropriate action is taken for the 10-msec interrupt. After processing the hopper, DIGPRO passes control to routine QMON in program QTMON for network queue processing. Program QTMON returns control to the 10-msec change check routine for receivers in DIGPRO after network queue processing is completed. The present scan result of the receiver is compared to the previous scan result, and the change bits are set to one in the receiver status word for any receivers with status changes. The last-look bits are updated to indicate the present scan results. The results are examined, and appropriate action is taken according to the receiver code in the originating register.

3.04 After the 10-msec functions are performed, DIGPRO determines whether the correct time has elapsed since the previous 160-msec change check routine. If not, DIGPRO stops receiving and transfers control to the interrupt level fast trunk scanning program (FASTTK) for the scanning of immediate start and operator trunks. Otherwise, control is passed to the receiver 160-msec change check routine. The routine examines the activity and change bits for each receiver scan point to determine whether any changes have occurred within the previous 160-msec period. Interdigital periods and abandonments are detected by this routine. Similar functions are performed during the 160-msec change check routine for dial pulse receiving trunks before passing control to FASTTK.

DIGIT RECEIVING FUNCTIONS

3.05 Call originations can be divided into customer line originations and trunk originations. Customer line originations may use either dial pulse dialing or TOUCH-TONE dialing methods. Trunks may be of either the dial pulse or multifrequency variety. Digit receiving functions are described in the context of these call origination types.

A. Line Originations

3.06 The scanning program (SCANS) detects a line origination and reports it to the input monitor (INPUT). The input monitor calls program LNORIG to handle the line origination including the selection of a TCR, the proper type receiver, and a network path to the receiver. Program LNORIG also supplies the DIALTON base level progress mark in the TCR.

3.07 The DIALTON is a base level progress mark routine in the digit interpretation program (DNTRP). It receives control at base level after the peripheral sequence to connect the receiver to the line is complete or after a peripheral time-out occurs (which indicates an error that is processed by the peripheral error routine in POINT). The line scan point is rescanned to detect stuck cutoff contacts that are reported in the peripheral error analysis buffer. The line is supervised through the receiver scan point during the digit receiving stage. The originating translation is repeated for the tip party on 2-party lines to obtain the correct translation information.

3.08 The DIALTON routine issues the distribute order to the receiver to give the customer dial tone. After a real-time break of one base level loop, DIALTON completes the dial tone speed measurements. The routine initializes the TCR for digit receiving by (1) zeroing the incoming digit counter, (2) clearing the digit storage words and charge index, and (3) setting the signal digit to one so that DNTRP will receive control to examine the first digit after it has been received. A subroutine (INIT_ROR) in DIGPRO is called to initialize the originating register(s) for the receiver scan point(s) ▶TOUCH-TONE dialing◀ receivers have a supervisory and a tone present scan point). The DIALTON routine sets the timer in the TCR to be used as a partial dial timer and waits (ie, takes a real-time break) for the first digit to be received. Program DNTRP regains control after the digit is received or when a digit is not received in the allotted time and the timer times out (thus creating a partial dial or permanent signal condition, in which case the line is given permanent signal treatment).

3.09 After DIGPRO (at interrupt level) receives the first digit and sets the BACTION bit in the TCR for base level action, DNTRP is given control for digit interpretation functions. In this manner, DIGPRO receives digits and DNTRP interprets digits from customer lines. (See Part 5 for digit interpretation functions.)

Dial Pulse Receiving

3.10 Receivers are scanned by DIGPRO during the 10-msec interrupt, and the scan results are saved. During the 10 msec, a change check routine detects changes, examines the receiving code in the originating register, performs the proper digit receiving functions, and updates the code for the next receiving activity. Dial pulses are detected as ***off-hook to on-hook changes*** at the receiver scan point.

3.11 The receiver status words are retrieved for each scan row, and the present scan results are compared with the last-look results to detect status changes. The last-look bits are updated with the present results, and the change bits are updated to reflect any changes. Each off-hook to on-hook change is examined, and the appropriate action is taken according to the receiver code in the originating register.

3.12 When the first off-hook to on-hook change is detected from a customer line, the distribute order to remove dial tone is issued. Next, the incoming pulse counter in the originating register is zeroed, and the on-hook is counted as a pulse by incrementing the counter by one. The same steps are performed when the first dial pulse of each digit is detected after an interdigital period with the exception of dial tone removal. Each off-hook to on-hook change detected during a digital period is counted as a dial pulse. Thus, the incoming pulse counter in the originating register is incremented, and a check is made to determine whether more than 10 pulses have been received, which is an error unless the TCR is the maintenance TCR. In the case of an error, the originating register is idled by zeroing the activity bit for the receiver in the appropriate receiver status word; then the BACTION and the disconnect return (DISCRTN) bits are set.

3.13 On-hook timing for abandons and off-hook timing for interdigital periods are performed during the receiver 160-msec change check. The 160-msec change check routine examines the change words in the receiver status area for any receiver scan points that have not changed in the past 160 msec. An on-hook time of 160 msec or greater is interpreted as an abandon.

3.14 The activity bit in the activity receiver status word and the supervisory scan point originating register are cleared. A subroutine (DISCALL) in DIGPRO examines the DISCRTN bit in the TCR to determine whether the base level program requires that control be returned upon disconnect. If control is to be returned, the BACTION bit and the INT_DISC bits in the TCR are set to indicate that a disconnect was detected during the interrupt and that base level action is needed. Otherwise, the call is failed and the proper traffic peg count is incremented (partial dial abandons, false starts, etc).

3.15 An off-hook time of 160 msec or greater is interpreted as an interdigital period (partial dial is detected via the partial dial or TCR timer). When an interdigital period is detected, the digit just dialed can be collected. The TCR for the call is then accessed. The incoming pulse count in the originating register is equal to the digit dialed and is stored in the proper digit storage area of the TCR (pointed to by the incoming digit counter). The TCR timer (partial dial) is reset to the maximum time allowed between digits before permanent signal treatment is given. The time allowed varies according to whether the office is in a light-load or a heavy-load condition (indicated by a bit in the system status area). The incoming digit counter in the TCR is incremented by one and compared to the signal digit in the TCR to determine whether the digit just received is a digit of interest to base level. The BACTION bit is set to indicate that base level action (probably digit interpretation) is needed when the signal digit equals the incoming digit counter. The routine represented by the base level progress mark in the TCR will receive control during the next base level loop.

3.16 The program DNTRP then performs further digit interpretation and routing for the call (Part 5).

♦TOUCH-TONE Service Receiving♦

3.17 When TOUCH-TONE dialing signals are being received, the dedicated scan points are the supervisory scan point (monitored for disconnect) and the tone present scan point (monitored for the presence of a tone). Therefore, two originating registers are associated with the call. Tones are detected during the 10-msec change check for receivers in DIGPRO, whereas abandons are detected during the 160-msec change check for receivers.

3.18 If an on-hook is detected at the supervisory scan point while waiting for the first tone to be received (as indicated by the receiver code in the originating register), dial pulses are assumed to be received (the customer may have both TOUCH-TONE* and dial pulse telephones). The receiver code is changed to indicate dial pulse receiving, and the tone present originating register is deactivated (ACTIVITY bit equals 0). Dial tone is removed, and processing is continued as if dial pulses are to be received. If the on-hook is an abandonment of the call, the on-hook is timed in the 160-msec change check and the disconnect is detected.

3.19 Otherwise, when the first tone is detected at the tone present scan point, dial tone is removed and the tone receiving routine (TONE_REC) is given control. The TONE_REC routine in DIGPRO first sets the ACTIVITY bit for the tone receiver in the receiver status area. The scan point number (SPN) of the eight tone bits (which represent the tone received) is obtained by calling TN_SPN, a translation routine in program XSLSPN. The tone bits are retrieved by a directed scan. The TCR for the call is accessed, and the TCR timer (partial dial timer) is set to time for partial dial situations.

3.20 The decoding of TOUCH-TONE dialing is accomplished by accessing a table (TTTABLE) defined in DIGPRO. The table is a 4-by-4 matrix in which the rows are determined by the low order tone and the columns by the high order tone. The low four bits of the tone bits represent the low tone of the two tones that make up the TOUCH-TONE dialing signal received, and the high four bits represent the high order tone. A check is made to determine whether only one of four possible low order tones is present (one-out-of-four check). The presence of more than one low order tone is an error. Similarly, a one-out-of-four check is made on the high order tone for errors.

3.21 A tone verification error is recorded in the error analysis storage buffer if the buffer is not in use. The disconnect return bit (DISCRTN) in the TCR is set to indicate that a disconnect of a transient call is needed. The BACTION bit is set to return control to base level, and the proper traffic peg counter is incremented. Thus, the call is given reorder at base level.

3.22 When no tone error is detected, the two tones are used to determine the row and column in the table; thus, the digit represented by the two tones can be found. A check is also made to detect invalid tones (for instance, the use of the fourth column of tones on the left of some telephones when such usage is not allowed). Invalid tones are processed in the same manner as other tone errors described in paragraph 3.21. A test for the reception of a special tone (* and #) is made. The special tone bit (SPLTONE) in the TCR is set when a special tone is detected and base level is alerted (BACTION bit equals 1) after the digit is collected.

*TRADEMARK of AT&T

3.23 Once the tone is decoded and verified, the digit can be collected. The decoded digit is stored in the incoming pulse counter area of the tone present originating register. The digit is transferred from the originating register to the proper digit storage area in the TCR. The TCR timer is reset to the maximum time allowed between digits. The incoming digit counter in the TCR is incremented by one and then compared to the signal digit in the TCR to determine whether the digit just received is dedicated to base level. Base level action is needed when the signal digit is equal to the incoming digit count. However, the BACTION bit in the TCR is not set until after the tone is gone (unless the tone is a special tone) or when overlap outpulsing is being used (as indicated by an interrupt progress mark specifying that sending is in progress), in which case the BACTION bit is set immediately after the digit is collected.

3.24 The end of a tone is detected during the 10-msec change check when the tone present scan point changes from on-hook to off-hook. The receiver code in the originating register is examined to determine whether the BACTION bit should be set. The BACTION bit is set when base level action is needed.

3.25 An on-hook is detected at the supervisory scan point of a TOUCH-TONE telephone receiver. On-hook timing for disconnects is done during the receiver 160-msec change check. An on-hook of 160-msec duration or greater is considered a disconnect and is handled as described in paragraph 3.14.

3.26 After the number of digits needed for interpretation has been received, DNTRP performs further digit interpretation and routing of the call at base level.

B. Trunk Originations

Immediate Start Trunks

3.27 The program FASTTK scans immediate start trunks for originations. FASTTK obtains a

TCR for the call and initializes it for digit receiving. An entry for the trunk scan point is made in the dial pulse receiving trunk hopper since immediate start trunks use dial pulsing and dial pulses are detected at the supervisory scan point for dial pulse receiving trunks. The BIOFF base level progress mark is placed in the TCR so that the base level TCR scanning program (TCRSCN) gives control to BIOFF, a routine in TKORIG (trunk origination program). BIOFF obtains trunk translation data and signal digit information. DIGPRO is already looking for digits during interrupts. When the number of digits needed by base level for translation is received, DIGPRO sets the BACTION bit so that control is returned to TKORIG for initial digit interpretation and routing. If needed, additional digit interpretations and routing of the call are accomplished in DNTRP and in TERM (Part 5).

Other Trunks

3.28 The base level scanning program (SCANS) reports a trunk origination to the input monitor (INPUT) which calls TKPROC (trunk/junctor/service circuit input processing program) to process the input. In addition, operator trunk originations found by FASTTK during interrupts are reported to the input monitor and are processed in the same manner as other trunk originations detected by SCANS. TKPROC calls TKORIG (trunk originations program) to supply the TCR and trunk translation data. In addition, TKORIG starts the peripheral sequence to connect the trunk to a receiver (multifrequency only) and to send the wink signal, after which the TCR is initialized to receive digits. An entry for the trunk supervisory scan point is made in the dial pulse receiving trunk hopper for dial pulse receiving trunks, or the appropriate originating register is initialized for the MF receiving trunks. From the translation data, TKORIG sets the signal digit and the base level progress mark in the TCR to indicate that control should be returned when the number of digits needed is received. DIGPRO receives the digits at interrupt level. When a significant digit is received, control is returned to TKORIG through the base level progress mark for initial digit interpretation. Further digit interpretations and routing of the call, if needed, are completed in DNTRP and TERM.

Operator Requests For Action

3.29 An operator uses either multiple wink, inband, or expanded inband signaling to request action. An operator wink is an uninterrupted on-hook in the range of 50 to 160 msec. As many as five winks are possible when multiple wink signaling is used.

3.30 When inband signaling is used, a wink precedes the inband signal. An inband signal is a burst of a pair of MF tones for 900 msec.

3.31 The program FASTTK scans operator trunks during interrupt level to detect scan point state changes. The FASTTK detects the initial wink by observing and timing the on-hook to determine if the duration is in the time range for a wink. When an operator wink is detected, FASTTK obtains a TCR and stores the base level progress mark to indicate that control is to be passed to the operator program (OPER) during the next base level loop for translation and TCR functions. In addition, FASTTK assumes that multiple winks will be received and initializes the TCR to indicate that multiple winks should be collected at interrupt level by DIGPRO. (The signaling is assumed to be multiple wink because another wink might be received before base level functions are expected.) The dial pulse receiving trunk hopper entry also indicates when one wink has been received.

3.32 During the next base level loop, OPER receives control of the TCR and obtains translation data. From the trunk group data, OPER determines whether the expected signal is inband, expanded inband, or multiple wink. Bits are then set in the TCR to show the type of signal received. In order to receive an inband or expanded inband signal, an MF receiver is selected and connected. The originating registers for the MF receiver are initialized. Multiple wink receiving does not require a receiver but is performed at the supervisory scan point and, therefore, is ready for receiving. For multiple wink and inband signaling OPER allows 6 seconds for receiving and sets the signal digit in the TCR to one. For expanded inband signaling, OPER allows 1.55 seconds for receiving. A real-time break is then taken to wait for the signal to be received.

3.33 Multiple winks are detected at the trunk supervisory scan point as on-hook/off-hook changes. A directed scan is performed on each trunk scan point with an active entry in the dial pulse receiving trunk hopper during each interrupt by DIGPRO. The last-look bit and the present scan result are examined to detect changes. When an off-hook to on-hook change is detected for trunk receiving multiple winks, the multiple wink timer in the hopper entry is cleared to begin timing the on-hook. The last-look bit in the hopper entry is set to zero to indicate the on-hook, and the change bit is set to one to indicate the change.

3.34 A multiple wink is an on-hook of 50 to 160 msec. The multiple wink timer is incremented when the last-look bit and the present scan result are both on-hook to time the on-hooks (for at least 30 msec). When an on-hook to off-hook change is detected, the multiple wink timer is examined to determine whether the on-hook was of sufficient duration to be counted as a wink or if the on-hook was a hit, which is ignored. When the on-hook is of sufficient duration for a wink, the incoming pulse counter in the hopper is incremented by one. The digit-in-progress bit, change bit, and last-look bit are also set to one. The multiple wink timer is then cleared to begin timing the off-hook period.

3.35 An interwink period is between 150 to 185 msec of off-hook time. Therefore, an off-hook period of 190 msec or greater is required to assume that all winks have been received and the signal can be collected. When an uninterrupted off-hook is detected from a multiple wink receiving trunk during the dial pulse receiving trunk 160-msec change check, the multiple wink timer is set to one. The timer is incremented during the subsequent 10-msec dial pulse receiving scans when no change is detected (still off-hook). When no change is found during the following three 10-msec trunk scans, a 190-msec off-hook period has been detected (all winks have been received) and the signal can be collected. To collect the signal, the incoming pulse counter (equal to the signal) in the trunk hopper entry is stored in the proper digit storage area of the TCR, and the BACTION bit in the TCR is set so that OPER will receive control during the next base level loop.

3.36 Disconnects (uninterrupted on-hooks of 160 msec or greater duration) during multiple wink receiving are detected by the 160-msec trunk change check. The hopper entry is then cleared, the appropriate traffic peg counter is incremented, and the call is disconnected.

Trunk Dial Pulse Receiving

3.37 Dial pulses from trunks are detected at the trunk supervisory scan point as off-hook/on-hook changes. Each entry in the dial pulse receiving trunk hopper is scanned during the 10-msec dial pulse receiving trunk scan. The last-look bit in the hopper and the present scan result are also examined. When an off-hook to on-hook change is found, the last-look bit is zeroed to indicate the on-hook, and the change bit is set to one.

3.38 When an uninterrupted on-hook (no change) of 160 msec or greater is detected during the 160-msec dial pulse receiving change check, disconnect is initiated for the call as described in paragraph 3.14.

3.39 A check is made to insure that not more than ten pulses, which is the maximum valid number, have been received. When an error is detected, the hopper entry is cleared. The error is reported in the error analysis buffer (if available), and the appropriate traffic peg counter is incremented. The BACTION bit in the TCR is set for base level action to give the call reorder.

3.40 However, when an on-hook to off-hook change is detected during the 10-msec trunk scan before 160 msec has elapsed, the on-hook is considered a pulse and the incoming pulse counter in the trunk hopper is incremented. The digits-in-progress, the change, and the last-look bits are set to one.

3.41 Interdigital periods must be off-hook periods of 160 msec or greater and, therefore, are detected during the 160-msec change check for trunks. When no change in the off-hook scan point is detected in the previous 160 msec, all pulses for the digit have been received and the digit can be collected. The incoming pulse counter (equal to the digit) in the hopper is stored in the appropriate digit storage area of the TCR associated with the call. The TCR partial dial timer is set to time for partial dial conditions, and the incoming digit counter is incremented. The signal digit is compared to the number of digits received to determine whether the BACTION bit in the TCR should be set to notify base level that action is needed during the next base loop. The bit is set only if the signal digit and digit counter are equal. The digit-in-progress bit and the change bit are zeroed, and the incoming pulse counter is zeroed by the 160-msec trunk change check routine.

3.42 After the expected number of digits has been received, the base level progress mark routine ends receiving by idling the hopper entry. It will then perform further digit interpretation and routing for the call.

Multifrequency Tone Receiving

3.43 Multifrequency receiving requires a multifrequency receiver. The inband or expanded inband operator signal is also included in multifrequency receiving. As in TOUCH-TONE telephone receiving, disconnects are monitored through the supervisory scan point of the receiver, and the detection of tones is performed at the tone present scan point. An originating register is associated with each scan point. As previously indicated, all receivers are scanned per interrupt by the receiver scanning routine in DIGPRO. Multifrequency receiving is performed by the same routines and in the same manner as TOUCH-TONE telephone receiving (described in paragraphs 3.17 through 3.25) except for the decoding of the tones (performed in the DIGPRO routine, TONE_REC) and the absence of dial tone.

3.44 Upon entry to TONE_REC, the receiving code in the supervisory scan point originating register is changed. Then the TN_SPN translation subroutine in XSLSPN is called to translate the tone present scan point number to obtain the scan point number of the tone bits representing the tone. A directed scan is performed to retrieve the six tone bits.

3.45 Decoding of MF tones is accomplished by accessing a table (MFTABLE) defined in DIGPRO. The table is a 4 by 6 matrix with the rows determined by the binary equivalent of the low order tones and the columns determined by the binary equivalent of the two high order tones. Only valid 2-out-of-6 codes are recognized. All others are errors and are processed in the manner described in paragraph 3.14.

3.46 The first tone received from a trunk must be the MF keypulse (except for inband or expanded inband signals), which signals the start of digit sending. If the first tone received is not a keypulse or if more than one keypulse is received, an error has occurred, and the call is failed in the same manner as described in paragraph 3.14. Keypulses are not stored in the TCR.

3.47 After all the expected digits are received, the base level progress mark routine represented by the base level progress mark in the TCR receives control at base level and ends receiving by idling the originating register for the receiver. Further digit interpretation and routing will then be performed for the call.

4. DIGIT SENDING

4.01 The software sending routines outpulse digits to another office. The two forms of signaling used are MF and dial pulse. Most digit sending functions are performed during the 10-msec interrupts by the sending routines in DIGPRO. A sender data word (Fig. 6) in the TCR is used for recording information needed for sending. The word contains the following information:

- OUTDIGSAV—Used as an outgoing digit save area
- OUTPLSCT—Used as a count of outgoing pulses
- TON—Transmitter-on bit used to indicate that a tone or on-hook dial pulse is being sent
- IDT—AN interdigital time period bit set during an interdigital period
- OUTDIGCT—Count of outgoing digits.

PREPARATION FOR SENDING

4.02 The outgoing call handling program (OUTCAL) initializes the TCR for sending during base level. OUTCAL indicates in the TCR which digit is to be sent first in the OUTDIGCT area of the sender word and which digit is to be sent last in the signal digit area (SIGDIG). OUTDIGCT is incremented by the sending routine in DIGPRO each time a digit is sent; thus, when OUTDIGCT is equal to SIGDIG, all digits have been sent. In addition, the interrupt level progress mark in the TCR is set to indicate that sending is to be done by DIGPRO during the 10-msec interrupts. The appropriate sending progress mark is placed in the peripheral progress mark area of the TCR. An entry is made in the timing hopper for the TCR to cause a time delay before beginning to send the digits.

4.03 The timing hopper provides accurate timing for real-time breaks and on and off periods for sending functions. When a sending function must be timed, the TCR number and the time are stored in the hopper entry. The timing hopper monitor routine (TMON) in program QTMON decrements the timers of all active slots in the hopper each 10-msec interrupt. The timer in the timing hopper entry is hereafter referred to in this section as the sender timer.

Program POINT is given control of any entry which times out. POINT examines the interrupt progress mark in the TCR to determine whether sending functions are needed. When the interrupt progress mark indicates sending, control of the call and TCR is passed to the SENDER_ entry point in DIGPRO for the appropriate sending function.

4.04 The SENDER_ progress mark routine in DIGPRO is the sending progress mark distributor. The routine examines the sending progress mark in the peripheral program mark area of the TCR and transfers control to the specific sender tasks. The sending progress marks are as follows:

- ENDSEND, which checks for sending completion and, if not completed, stores the new sender data in the TCR and TCR number and the timer in the timing hopper
- MFKPSET, which prepares to send the MF keypulse
- GET_DIGIT, which obtains the next digit to be sent and checks for overlap outpulsing
- SEND_KP, which sends the MF keypulse
- TIME_DELAY, which causes a delay (used in interdigital periods)
- DPSEND, which sends dial pulses
- STOP_GO, which processes stop and go signals sent from the other office.

MULTIFREQUENCY SENDING

4.05 When multifrequency tones are used to outpulse digits to another office, each digit is composed of a unique combination of two-out-of-six frequencies. The tone pairs are defined in the MFENCODE table, which is accessed for the proper tone relay states. The tones for each digit are sent for an on period of 70 msec followed by an off period (no tones) of 70 msec.

A. MF Keypulse Sending

4.06 Before digits may be sent to another office, an MF keypulse signal must be sent to alert the other office to prepare for digit reception. The signal consists of 100 msec of tone followed by a 70-msec period. The tone consists of the 1100- and 1700-Hz tones.

4.07 The MFKPSET progress mark routine is given control to begin the MF keypulse sending. The six tone relays necessary to send an MF tone have an operate and release time of between 20 and 30 msec, while the seventh control relay has an operate and release time of 1 or 2 msec. Therefore, an entry is made in the timing hopper for a delay of 30 msec between the order to set the six tone relays and the order to set the seventh control relay. In addition, the sender progress mark is set to SEND_KP. The distribute orders to set the six tone relays are then sent. If any order to set the relays fails, base level is alerted (BACTION bit equals 1, and DISCRTN equals 1). The interrupt progress mark is zeroed, and the call is given reorder at base level.

4.08 After the 30-msec delay caused by the sender timer in the timing hopper, the SEND_KP progress mark routine is given control. It sets the sender timer to 70 msec to allow a 70-msec tone to be sent. The order to set the control relay on is sent, and the TON bit in the TCR sender word is set to one to indicate that the transmitter has been turned on. The SEND_DIGITS interrupt progress mark is also entered into the TCR. When the timer reaches zero, indicating that the tone has been sent for 70 msec, the SEND_DIGITS progress mark routine is given control.

B. MF Digit Sending—Off Period

4.09 The SEND—DIGITS progress mark routine examines the TON bit in the TCR to determine whether the transmitter is on or off as an indication of whether the next period to be sent is an off or on period. When the TON bit is one, indicating the transmitter is on, the timer is set to time a 70-msec off period. The transmitter is then verified to be operating properly. Transmitter failures are reported in the error analysis buffer (if available), and the call is given reorder. When the transmitter operation is verified, the order is sent to turn off the control relay (thus ending the on period), and the TON bit is set to zero to indicate that the transmitter is being turned off. The outgoing digit counter in the sender word contains the number of digits sent. The signal digit area indicates the last digit to be sent. Therefore, the outgoing digit counter is compared to the signal digit to determine whether the last digit (start signal) has been sent. When sending is completed, the BACTION bit in the TCR is set to one to signal base level, and the interrupt progress mark is zeroed.

4.10 However, when sending is not complete, the outgoing digit counter is incremented by one to point to the next digit to be sent. Because of the difference in the operation times of the tone relays and the control relay, the six relay states for the next digit to be sent are obtained, and the orders to set the tone relays are sent at this time.

C. MF Digit Sending—On Period

4.11 After the sender timer reaches zero (ie, a 70-msec off period has been sent), the SEND_ DIGITS progress mark routine again receives control to send the next digit. The TON bit is zero at this time (indicating that the transmitter is off); therefore, it is changed to a one to show that the transmitter will be turned on. The timer is set to time the sending of the tone for 70 msec. An order is transmitted to operate the control relay, thus beginning the on period of the next digit tone.

D. Start Signal Sending

4.12 A start signal must be sent to the other office to indicate that the last digit has been sent and that the processing of the call at the receiving office can be started. The signal to be sent is placed in the digit storage area by the program OUTCAL, and the signal digit is set to point to the start signal as the last digit to be sent. The signal is sent in the same manner as any other digit but is detected because the outgoing digit count is equal to the signal digit. After the start signal has been sent, the BACTION bit is set to signal base level and the interrupt level progress mark is zeroed to end interrupt level processing on the call. The sequence of functions for multifrequency sendings is shown in Fig. 7.

DIAL PULSE SENDING

4.13 Dial pulse sending (DPSEND) is the process of outpulsing a string of pulses to another office. The pulses are generated by a dial pulse transmitter, which is turned on and off by the DPSEND routine. The pulses are generated at a rate of 10 pulses per second. Each pulse is composed of an on-hook period of 60 msec and an off-hook period of 40 msec. Interdigital periods consist of approximately 760 msec. Figure 8 is an example of how the digits 2 and 1 would be outpulsed.

4.14 The E&M trunks send dial pulses by operating and releasing the trunk circuit relays. The distributor address and the relays used are the only differences between E&M trunk circuit dial pulse sending and dial pulse sending using a transmitter.

4.15 The following relays and relay states are used in sending. The between-digit relay serves two functions. When the relay is operated, it amplifies the state changes of the pulsing relay. When released, the outgoing trunk can be supervised. When the receiving office can use stop/go signaling, the relay must be released during each interdigital period so that supervision for the signals can be performed.

RELAY	STATE
Pulsing relay (C-relay)	Off-hook = operated On-hook = released
Between digit relay (B-relay)	Operated during digit pulsing Released during interdigital periods

4.16 The program OUTCAL initiates sending by providing in the TCR the necessary sending information, setting the interrupt progress mark to sending, and providing the DPSEND_ sending progress mark in the peripheral progress mark area.

A. Dial Pulse Off-Hook Period Sending

4.17 The TON bit is equal to one to show that the transmitter is on when the routine to send the off-hook period is entered. The sender timer has reached zero after timing a 60-msec on-hook period. The outgoing pulse count is initially set equal to the digit to be sent; therefore, it is decremented by one to indicate that a pulse has just been sent. It is then tested for a zero to determine if a whole digit has been sent.

4.18 If the off period to be sent is not an interdigital period, it is an interpulse period; therefore, the sender timer is set to time the 40-msec off period. The TON bit is set to zero to indicate that the transmitter will be turned off. The relay states are set to turn off the transmitter, and the order to operate and release the relays is sent. If the order fails, the call is given reorder.

4.19 If the outgoing pulse count is zero, the off-hook period to be sent is an interdigital period.

The IDT bit in the TCR is set to indicate that the off-hook will be an interdigital period, and the TON bit is set to zero to show that the transmitter is to be turned off. A timing hopper entry is made to time part of the interdigital period, and the sender progress mark is changed to TIME_DELAY to provide the timing for the second part of the off period. The relay states to turn the transmitter off are retrieved, and the order is sent. (If the order fails, the call is given reorder.)

4.20 After 200 msec, the TIME_DELAY progress mark routine receives control to time the remaining part of the interdigital period. The sender timer is set for another 560 msec. The sender progress mark is then changed to GET_DIGIT. Supervision is provided for an outgoing trunk to a step-by-step office by releasing the between digit relay. Also, when only one digit remains to be sent, the ONE bit is set in the TCR.

4.21 After the 560-msec delay, the GET_DIGIT progress mark routine receives control. When overlap outpulsing is being used, a check is made to determine whether the next digit to be sent has been received. If the digit has not been received, control is relinquished and another check is made during the next interrupt for the digit. However, when overlap outpulsing is not in effect or the needed digit has already been received, one is added to the outgoing digit count to point to the next digit to be sent. The digit is placed in the outgoing pulse counter in the sender word.

B. Dial Pulse On-Hook Period Sending

4.22 The transmitter is off when the on-hook period sending routine is entered (TON bit equals 0). The sender timer is set to time the 60-msec on-hook period.

4.23 If the previous off-hook was not an interdigital period (IDT equals 0), the TON bit is set to one to indicate that the transmitter will be turned on. The relay states to turn on the dial pulse transmitter are retrieved, and the order is sent to set the relays. A failure in the distribute order results in the call being given reorder.

4.24 If the previous off-hook period is an interdigital period, a check must be made for a possible stop or go signal. Step-by-step toll or tandem offices may use stop/go signaling. A stop signal is a continuous off-hook, which tells the sending office to stop sending until a go signal is received. The go signal is a continuous on-hook, which tells the sending office that sending can be started again.

4.25 The transmitter is scanned for a stop signal from offices that may send one. If a stop signal is not present, the pulse is sent as described in paragraphs 4.22 and 4.23.

4.26 If a stop signal is present, sending is stopped. The timer (TIMER) in the TCR is set to wait for a go signal, and the sender function progress mark is set to STOP_GO. In addition, a time delay is initiated in the sender timer in the timing hopper entry.

4.27 After each time delay, a test is made to determine if the go signal has arrived via the STOP_GO progress mark routine. If the signal does not arrive in the allotted time (the TCR timer times out), control is returned to the outgoing call handling program via the base level progress mark for disposal of the call.

4.28 When the signal is detected within the allotted time, the sender function progress mark is restored to DPSEND. The TCR timer is restored, and the sender timer is set for a delay of 70 msec before continuing to send pulses.

C. Last Digit Sent

4.29 All digits have been sent when the outgoing digit count is equal to the signal digit. The BACTION bit is then set to one to signal base level that dial pulse sending is complete. The interrupt level progress mark is zeroed to stop interrupt level processing, and the dial pulse transmitter is set to the off-hook state.

5. DIGIT INTERPRETATION

GENERAL

5.01 Digit interpretation must be accomplished on each incoming call (trunk origination) and on each line origination in the office whether terminating in this office or outgoing to another office.

5.02 Digit interpretation functions include obtaining trunk or line translation data to determine the type of service allowed, obtaining information such as the number of digits to expect, setting the signal digit to tell the digit receiving routines when to signal base level, and routing calls once sufficient interpretation has been completed to determine the next call processing functions to be performed.

TRUNK ORIGINATIONS

5.03 Trunk originations, after being detected and validated by the scanning programs and the input monitor, are handled by the trunk origination program (TKORIG), which is run at base level. Upon entry into the program, bylink trunk originations already have a TCR assigned, which is ready to accept trunk translation data. Other trunks, however, do not have a TCR so the first step is to obtain a TCR for the call.

5.04 Translation data for the trunks is obtained by calling routine DATCKT in which the scan point number (SPN) is passed. The circuit type, terminal equipment number, distribute point address, and address of the group data block are returned by the routine. Incoming digit type and number are retrieved from the group data block and placed in the TCR. This information is used to determine the number of digits to expect and is thus an aid in the digit interpretation effort.

5.05 After the trunk translation data is stored in the TCR, bylink trunk originations are ready for digit interpretation. Other trunks may require selection and connection of the proper type of receiver and sending of the wink signal before the digit reception and interpretation can begin.

5.06 The incoming digit translation code is used to indicate the number of digits expected and the pretranslation routine that should be used. Depending on the code, the signal digit is set to indicate the number of digits to receive before signaling base level and control is passed to one of the following routines:

- An error routine, which terminates the call.
- TERMX in TERM, which initiates 4-digit translation for a terminating call (see paragraphs 5.28 through 5.31).
- 3DTRE in DNTRP, which initiates the 3-digit translation (see paragraph 5.24).
- The one-digit translation routine in TKORIG, which calls translation subroutine 1DIGIT in XSL3DG. 1DIGIT is used when a variable number of digits are expected. It returns the number of digits expected and auxiliary information, if the type of call can be determined at that time. A locally terminating call is routed to TERM. A tandem call is sent to OUTCAL, and ROUTE in DNTRP (see paragraph 5.24) is used to route invalid digits. When the results of the translation are inconclusive, ie, enough digits have not been received to route the call, the one-digit translation entry point in TKORIG is reentered after the next digit has been received. This process is continued until enough digits have been received to determine the type of call and to route it.

LINE ORIGINATIONS

A. Software Organization

5.07 After being detected and validated by the scanning program and the input monitor, line originations are handled by DNTRP, the digit interpretation program, which is run at base level. DNTRP is a set of routines which interpret the customer digits until sufficient information is available to define the call as terminating or outgoing. Once the type of call is known, control is passed to program OUTCAL for outgoing call completion, to TERM for terminating call completion, or to some special call handling routine.

5.08 For a line origination, DNTRP is first entered at the DIALTON progress mark routine. This routine may obtain originating party translation data and place it in the TCR. It prepares the TCR for receiving digits and sets the signal digit to one to look at the first digit. Also, this routine issues the dial tone order and sets the TCR timer.

5.09 The program then waits for the first digit to be received. The digit is used to help determine how many digits are needed for translation and the possible type of call and treatment (ie, 1+, 0+, invoking of a custom calling feature, etc.)

5.10 Three digit interpretation sections (A, B, and C) are in DNTRP. The symbol SDxPMy (where x is equal to the signal digit value and y is equal to the digit interpretation section) is used to identify the next section of DNTRP to be given control for more interpretation after the necessary digits are received as indicated by the signal digit. Each section, in turn, calls PROGCKA (a subroutine in DNTRP) which stores the signal digit, waits for the desired digits to be received, and returns control to the appropriate digit interpretation section. Additional tests are then completed in the section for the handling of such items as special tones dialed and invoking of special customer features. Barring obvious customer dialing errors, DNTRP either passes the call to the custom calling program or routes it via translation results.

5.11 Two entry points, 3DTRE and ROUTE, in DNTRP are used both by DNTRP and other programs to obtain routing information for calls. Subroutine 3DIGIT is called in the 3DTRE routine, and route index expansion subroutine RI_EXP is called in the ROUTE routine. Both return a code that is used in conjunction with the route index branch table (RIBT) to route the call. In addition, a destination code branch table is used to route the call if a destination code is returned by RI_EXP or 3DIGIT.

5.12 Two subroutines in DNTRP are used by DNTRP and other programs when they are waiting for digits to be received. The purpose is to detect the possibility of the received digits being greater than the signal digit since the interrupt detects only equality. Both routines store the signal digit in the TCR and zero the BACTION bit. PROGCKA uses the TCR WAIT subroutine to wait for the number of digits indicated in the signal digit and returns control to the calling routine. PROGCKB waits for digits by storing the base level progress mark supplied by the calling routine in the TCR and returning to the TCR scanning routine (TCRSCN) or the input monitor. To continue processing, PROGCKA returns to the caller while PROGCKB branches to PMXFER in TCRSCN, which transfers control to the given progress mark.

B. Initial Call Classification

First Digit Equals Asterisk "*"

5.13 ➧If an "*" is dialed as the first digit, then a custom calling change access code will be dialed. The signal digit is set to three (3) so the access code can be determined. The "*" is the prefix for TOUCH-TONE telephones. The prefix for dial pulse phones is "11".➧

First Digit Equals Zero

5.14 If the first digit is zero and zero plus (0+) dialing is allowed by the office (as indicated in the office data word) (Fig. 9), the international direct distance dialing (IDDD) routine in the DNTRP program is given control. The IDDD routine checks the second digit for an IDDD attempt. If an IDDD attempt is not being made, control is returned to the domestic call processing routines. Paragraphs 5.20 and 5.21 describe IDDD. The TCR timer is now set to wait for more digits, and the signal digit is set to four. After the next three digits are received, 3-digit translation is performed as described in paragraph 5.25. If no other digits are dialed (the timer times out) or if 0+ dialing is not allowed, the call is routed to an operator via calling for a route index expansion passing control according to the route index branch table (RIBT). The route index expansion and branch table are described in paragraphs 5.24 and 5.26.

11X Code Dialed

5.15 ➧If the first digit is a one (1), the signal digit is set to three (3) so that a check can be made for a 11x code or a custom calling prefix. If the second digit is a one, then the third digit checked is a seven (7). If it is, then the signal digit is set to four (4) to get the last digit of the custom calling access code. If it is not a seven then it is a 11x code and 3-digit translation is performed on the first three digits.➧

One Prefix Dialed

5.16 If the first digit was a one but the second digit was not, a one prefix is indicated and the signal digit is set to four to wait for another digit. Three-digit translation is then accomplished on the second, third, and fourth digits received (paragraph 5.25).

Coin Return Checks

5.17 The program DNTRP examines all 0−/0+ /11x/x11 calls from coin lines for possible coin functions to be performed. The charge index in the TCR for the call is examined. When the charge index indicates that the call is not free, the coin is not returned. When the charge index indicates that the call is to be free and the call is a 0-, x11, or 11x, control is passed to the coin program (COIN) which returns the coin and returns control to DNTRP. A 0+ or 1+ call is marked for coin return after dialing is complete.

Custom Calling Features

5.18 Checks are made to determine if customers with custom calling features are attempting to invoke them. If they are not, the call is usually routed to obtain 3-digit translation when three digits have been received (paragraph 5.25). When the 1-digit or 2-digit speed-calling feature is invoked by an originating customer with the feature, the call is sent to the appropriate custom calling routines in CUSTOM (SO-2 generic) for further processing. In the 3E3 generic the program SPDCAL handles speed-calling features.

5.19 The program DNTRP also looks for custom calling feature access codes (72, 73, 74, and 75) dialed by customers with custom calling features. A code of 72 indicates the invoking of call forwarding, 73 is a call forwarding cancellation, 74 means a short speed-calling list change attempt, and 75 indicates a long speed-calling list change attempt. In the SO-2 generic if one of the custom calling feature access codes is detected from a customer with the custom calling feature, the call is routed to an appropriate custom call handling routine in CUSTOM. For the 3E3 generic the codes 72 and 73 are routed to CL4WRD and 74 and 75 are routed to SPDCAL.

International Direct Distance Dialing

5.20 The IDDD feature allows customers served by a No. 3 ESS to place calls outside the North American continent without operator assistance.

5.21 The IDDD routine in the DNTRP program is given control during IDDD. After receiving the IDDD prefix (01 for operator-assisted, 011 for station-to-station, and 010 for international operator) the routine determines if the call is an international operator call (010). If so, the call is routed to an operator. When a valid IDDD call is received, the system is set to wait for three digits, the maximum size of a country code. Translations are then called in to validate the country code and specify a maximum and minimum number of digits to be expected for that code. If the number of digits expected is a fixed value, the minimum and maximum values will be equal. If the country code is invalid, the customer is given an error treatment specified by the telephone company. Normal interdigital timing applies until the minimum number of digits have been dialed. Four-second critical timing is then performed after each succeeding digit until a time-out occurs or the maximum number of digits is reached. After determining that dialing is complete, the call is passed via a branch table to the outgoing trunk start routine (in OUTCAL) for outpulsing to a TSPS.

"#" Dialed

5.22 A valid "#" dialed is interpreted as an end-of-dialing signal. Invalid uses are sent to the reorder routine.

All Other Originations

5.23 If the originating customer does not have the speed calling features and has not dialed a one, zero, *, or # as the first digit, the signal digit is set to 3 to await two more digits. The 3-digit translation is then performed on the three digits received.

C. Call Routing

Route Index Expansion—ROUTE Entry Point

5.24 Entry point ROUTE in DNTRP takes the route index and calls for a route index expansion (RI_EXP in XSL3DG). The code returned is used with the route index branch table (RIBT) in routing the call as described in paragraph 5.26.

Three-Digit Translation—3DTRE Entry Point

5.25 Entry point 3DTRE in DNTRP sets up for and calls the 3-digit translation subroutine (3DIGIT in XSL3DG). The subroutine returns a code to be used with the route index branch table in routing the call; therefore, the result of the ROUTE and 3DTRE entry points is the same. ROUTE is used when the route index is already available, and 3DTRE is used when the digits must first be translated to obtain the route index.

Route Index Branch Table

5.26 The RIBT uses the return code obtained from the route index expansion or the 3-digit translation to route the call for further call processing action. The codes, definitions, and actions taken are listed in Table C. This table can change; therefore, the DNTRP program listing should be referenced for more accurate information.

Destination Code Branch Table

5.27 If the return code from the route index expansion is six, the destination code returned is used with the destination code branch table to further determine the call processing functions to be performed. The codes, definitions, and actions taken are listed in Table D. This table can change; therefore, the DNTRP program listing should be referenced for more up-to-date information.

Four-Digit Translation

5.28 The terminating program TERM is invoked on intraoffice and terminating calls after the dialed digits have been received. It is run at base level.

5.29 As indicated previously, when a call is thought to be terminating in this office, the base level progress mark in the TCR is set to TERMX. Control is passed via the TCR scanning routine (TCRSCN) to the TERMX entry point of TERM for the translation of the last four digits.

5.30 The program TERM calls 4DIGIT, a translation subroutine in XSL4DG, to translate the last four digits to obtain the terminal equipment number and major class of the called line.

5.31 If the major class is 1 (which indicates denied service) and the return code is greater than 2, the call is sent to ROUTE in DNTRP. As described in paragraph 5.24, the call is then routed by using the route index and calling a route index expansion. The return code provided by the route index expansion is used to route the call via the route index branch table. Otherwise, determination of the next functions required for completing the call is made using the return code provided by the 4DIGIT translation. Table E lists the return codes, definitions, and actions taken.

6. ABNORMAL OPERATION

6.01 Checks are made throughout the software for customer errors, translation errors, possible equipment errors, and any other errors that might occur. These errors are usually handled by error routines.

6.02 Routine PARTDIAL in CUSTER is used to dispose of a call when the timer (TIMER) in the TCR times out before all the necessary digits are received.

6.03 FAIL, a macro, calls FAILSUB to provide a teletypewriter message (optional) indicating the type of failure and to replace the TCR in a state that causes the call to be disconnected by the FAILURE progress mark. This routine is used when certain equipment failures or translation failures occur.

6.04 A routine in CUSTER, REORDER, is used to handle several types of errors detected by the digit processing software. For instance, REORDER is accessed by the dial pulse receiving routine in DIGPRO to dispose of a call when more than ten pulses are detected for a number dialed. Both invalid MF tones and ▶TOUCH-TONE service-detected tones◀ are sent to REORDER. These errors are also recorded in a maintenance buffer if one is available for later error analysis. Failure of an order to set tone relays to send tones results in the use of this routine. REORDER handles customer mistakes in dialing such as an "*" dialed when no ▶custom calling access code◀ is allowed or a "#" (the end-of-dialing signal) dialed before sufficient information has been dialed to complete a call. When the timer times out during the receiving of digits from trunks, the call is often given to REORDER.

6.05 Many errors are routed through the route index branch table. A destination code returned from the route index expansion is used to further route the call by using a destination code branch table. Refer to Table D for the distribution of these errors.

7. GLOSSARY

7.01 The following terms, abbreviations, and definitions are used frequently in this section.

Bit—The binary unit of information that is represented by one of two possible conditions, such as the digits 0 and 1, on or off

Clear—To restore a storage device to the ***zero*** state

High and Wet—The state in which the trunk or line is monitored for an on-hook only

Hoppers—Dedicated areas of writable memory into which entries with a fixed format are made

Immediate Start Trunk—A trunk that does not wait for a signal before beginnning to send dial pulses (usually from a step-by-step office)

MF—Multifrequency

O+—Direct dialing with operator assistance

Overlap Outpulsing—The process of outpulsing digits to another office as they are received rather than waiting until all digits have been received before beginning to outpulse

Partial Dial—The off-hook period that is longer than allowed between digits being received before all digits expected have been received.

Progress Marks—Areas in the TCR that indicate the next software routine to be executed for the call

Scan Point—Ferrod sensor used in scanners for supervisory purposes

SPN—Scan point number

Subroutines—A sequence of instructions that perform a well-defined function and are called by another section of instructions

Tandem—Trunk-to-trunk call

TCR—Transient Call Record

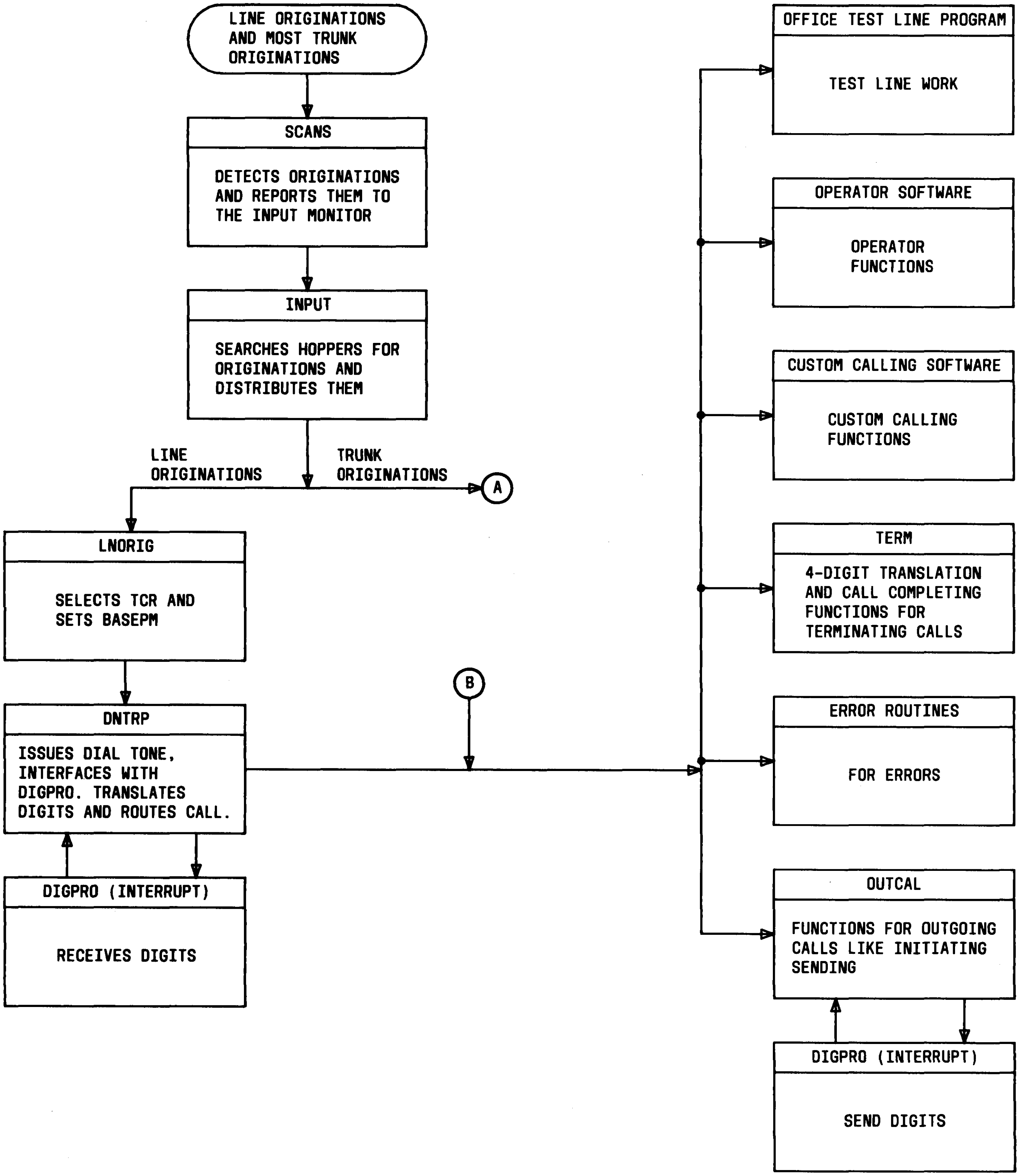


Fig. 1—General Digit Processing Flowchart (Sheet 1 of 2)

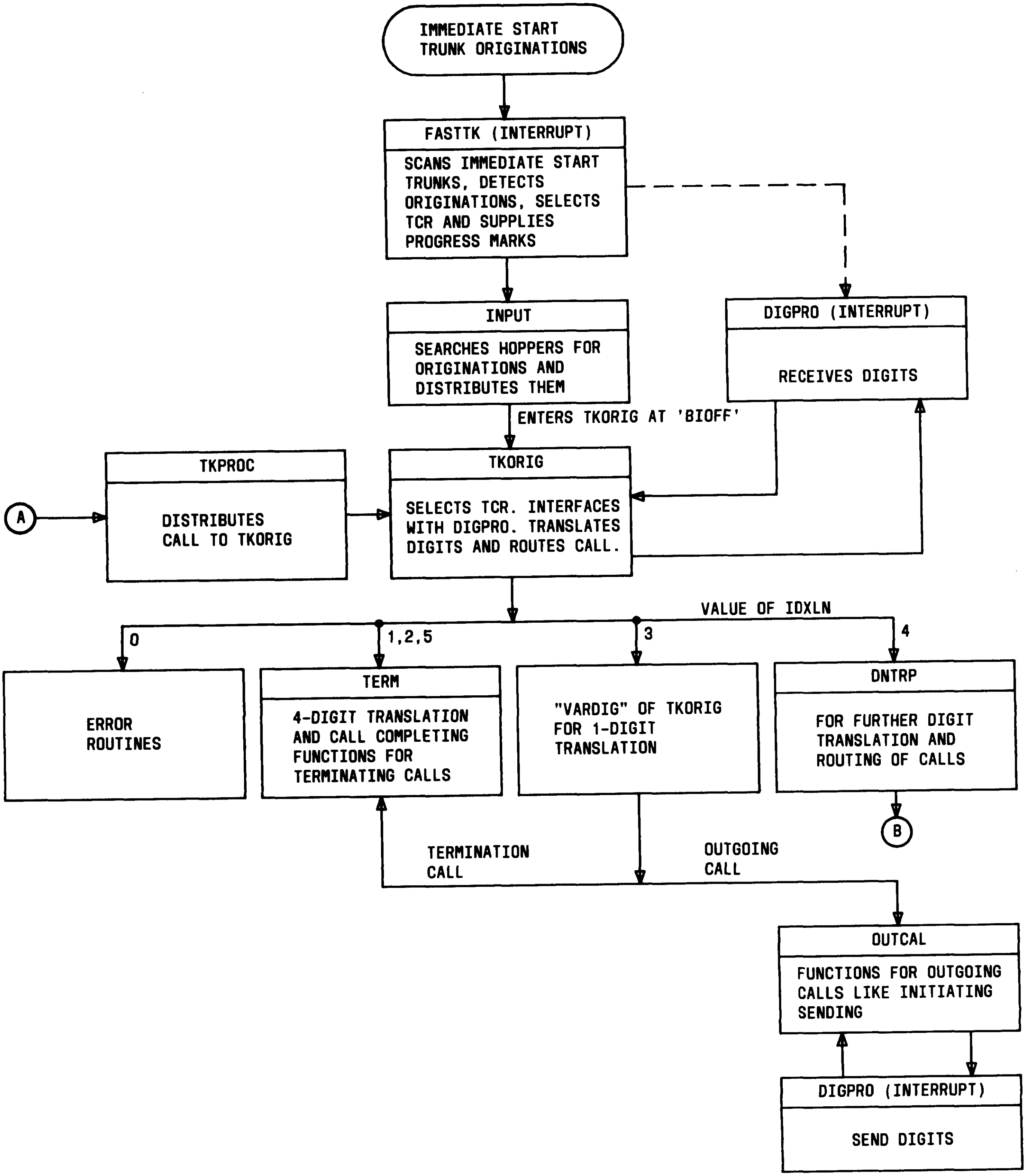


Fig. 1—General Digit Processing Flowchart (Sheet 2 of 2)

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	ACTIVE	PERTN								SPM			DISCRTN	CC	INTPM	
1	SPLTONE	2NTRY	SPLAUD	TPTH	BPTH	APTH	BACTION	PERM	BASEPM							
2	TIMER															
3	SNDRDATA															
4	XMIT_DTA															
5	LKSRA	LLA	LINEA	APARTY												
6	RVRSA	AJCTR							ASVC							
7										TTONE	SCREENING CLASS					
8	RVRSB	BJCTR							BSVC							
9	RVRST	TJCTR							TIPTY	TOPTY	CN	OVOP	EM	MFSND	2WAY	LLLOP
10	INCDIGCT				SPARE	CDPR_DTA										
11																
12	DIGSTR				DIGSTR				DIGSTR				DIGSTR			
13	DIGSTR				DIGSTR				DIGSTR				DIGSTR			
14	DIGSTR				DIGSTR				DIGSTR				DIGSTR			
15	DIGSTR				DIGSTR				DIGSTR				SIGDIG			

INTPM	INTERRUPT PROGRESS MARK
CC	CUSTOM CALLING BIT
DISCRTN	DISCONNECT RETURN
SPM	SENDER PROGRESS MARK
PERTN	PERIPHERAL ERROR RETURN
ACTIVE	TCR ACTIVE
BASEPM	BASE LEVEL PROGRESS MARK
PERM	PERMANENT SIGNAL
BACTION	BASE LEVEL ACTION NEEDED
APTH	ASVC PATH
BPTH	BSVC PATH
TPTH	TALK PATH
SPLAUD	SPECIAL AUDIT
2ENTRY	BASE LEVEL SECOND TRY BIT
SPLTONE	SPECIAL TONE PRESENT
TIMER	UNIT = 10 MS
SNDRDATA	SENDING DATA
XMIT_DTA	TRANSMITTER DISTRIBUTE TRIPLET ADDR.
APARTY	A-PARTY SPN OR TEN
LINEA	A-PARTY IS LINE
LLA	LONG LOOP LINE
LKSRA	"A" IS LINK SHARED
ASVC	A-PARTY SVC NUMBER
AJCTR	A-PARTY JUNCTOR SWITCH NUMBER
RVRSA	A-PARTY REVERSAL
TTONE	TOUCH-TONE
BSVC	B-PARTY SVC NUMBER
RVRSB	B-PARTY REVERSAL
LLOOP	LONG LOOP LINE
2WAY	2-WAY TRUNK
MFSND	MF SENDING
EM	E AND M TRUNK
OVOP	OVERLAP OUTPULSING
CN	COIN LINE
TOPTY	2-PARTY
TIPTY	TIP PARTY
TJCTR	TALK JUNCTOR SWITCH NUMBER
RVRST	TALKING PATH REVERSAL
CDPR_DATA	CDPR DISTRIBUTE TRIPLET ADDR.
INCDIGCT	INCOMING DIGIT COUNT
DIGSTR	DIGIT STORAGE AREA
SIGDIG	SIGNAL DIGIT-RETURN TO BASE LEVEL

Fig. 2—TCR Format During Digit Processing

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
CODE INDICATING DIGIT RECEIVING FUNCTION NEEDED NEXT				TCR NUMBER								INCOMING PULSE COUNT			

Fig. 3—Originating Register Format

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ACTIVE	LAST LOOK	CHANGE	SCAN POINT NUMBER												
MULTIPLE WINK TIMER (ON-HOOK TIMER)		MULT. WINK	DIGIT IN PROG.	TCR NUMBER								INCOMING PULSE COUNT			

Fig. 4—Trunk Dial Pulse Receiving Hopper

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
LAST-SCAN		MONITOR SCAN START FOR REMOVING TCRS FROM HOPPER							SCAN START FOR PLACING TCRS IN HOPPER						
HOPPER SLOT NUMBER OF SLOTS = TABLESIZE - N (HOPPER SLOT)															

A. Control Words

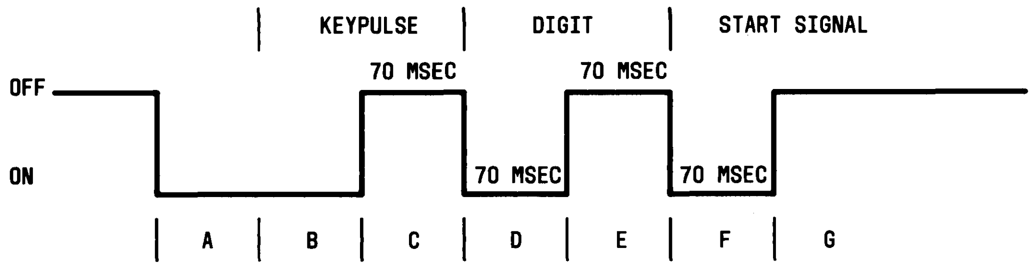
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SLOT TIMER								TCR NUMBER							

B. Slot Format

Fig. 5—Timing Hopper Control Words and Slot Format

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OUTDIGCT				ONE	SXS	IDT	TON	OUTPLSCT OUTGOING PULSE COUNT				OUTDIGSAVE			

Fig. 6— Sender Data Word



A. 30 MSEC OPERATE TIME FOR 6 MF TRANSMITTER TONE RELAYS
B. 100 MSEC ON PERIOD OF MF KEYPULSE SIGNAL
C. 70 MSEC OFF PERIOD OF MF KEYPULSE SIGNAL
D. 70 MSEC ON PERIOD OF A DIGIT
E. 70 MSEC OFF PERIOD OF A DIGIT
F. 70 MSEC ON PERIOD OF MF START SIGNAL
G. OFF PERIOD OF MF START SIGNAL

Fig. 7—MF Sending

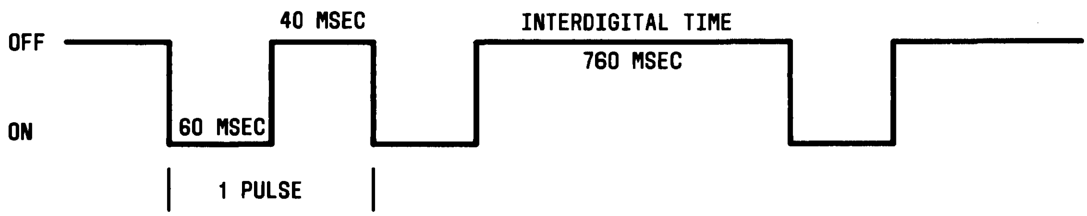


Fig. 8—Dial Pulse Sending

	OCANN	SUP	OPLUS	ABBR_AREA_CODE										
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Fig. 9—Office Data Word Format

TABLE A

PROGRAM IDENTIFICATION

NAME	TITLE	NUMBER	FUNCTION
CALLW8	Call Waiting	PR-3H190	Processes call waiting calls.
CL4WRD	Call Forwarding	PR-3H189	Processes call forwarding requests.
CW8STB	Call Waiting Stable	PR-3H191	Processes call waiting stable calls.
CUSTER	Customer Error Program	PR-3H151	Administers such error treatment as partial dial and permanent signal.
CUSTOM	Custom Calling Program	PR-3H152	Processes special customer calling features such as call forwarding, speed calling, etc.
DIGPRO	10-Millisecond Interrupt Program — Digit Receiving and Sending	PR-3H153	Performs digit receiving and sending functions during interrupt level.
DISCON	Disconnect Progress Marks	PR-3H154	Performs disconnect functions for calls.
DNTRP	Digit Interpretation Progress Marks	PR-3H155	Performs digit interpretation functions and routes calls to other routines once sufficient interpretation has been completed to determine the next call processing function needed.
FASTTK	Fast Trunk Scanning	PR-3H159	Scans immediate start and operator trunks for scan point state changes.
INPUT	Input Monitor Program	PR-3H160	Processes inputs from trunk and line scan points and schedules the base level scans.
LNORIG	Line Originator Program	PR-3H162	Processes line originations.
OFFTL	Office Test Line Program	PR-3H253	Performs test line functions.
OPER	Operator Calls Program	PR-3H164	Processes operator calls.
OUTCAL	Outgoing Call Program	PR-3H165	Performs outgoing functions for calls.
PATHNT	Network Path Hunt, Busy and Idle	PR-3H166	Finds or idles paths through the network.
POINT	Peripheral Order Interpreter	PR-3H168	Processes peripheral orders and distinguishes between peripheral work in the TCR and digit sending work. Transfers control to DIGPRO for digit sending.
QTMON	Network Queue and Timing Hopper Monitor	PR-3H171	Processes the network queue and timing hopper for peripheral work. Also performs timing functions for digit sending via the timing hopper. Executed during interrupt level.
SCANS	Base Level Scanning Program	PR-3H173	Scans trunks (except immediate start and operator), junctors, and lines for scan point state changes.

TABLE A (Contd)

PROGRAM IDENTIFICATION

NAME	TITLE	NUMBER	FUNCTION
SPDCAL	Speed Calling	PR-3H188	Processes speed calling requests.
TERM	Completion of Incoming and Intraoffice Calls	PR-3H175	Performs terminating functions for calls. Performs 4-digit interpretation on digits.
TKORIG	Trunk Origination Program	PR-3H176	Performs originating functions for trunks, initializes TCR, and performs some digit interpretation on the digits dialed.
TKPROC	Trunk/Junctor/Service Circuit Input Processing	PR-3H177	Processes inputs from trunks, junctors, and service circuits.
XSL3DG	Three-Digit Translation Program	PR-3H181	Performs 3-digit translations on digits dialed.
XSL4DG	Four-Digit Translation Program	PR-3H182	Performs 4-digit translations on digits dialed.
XSLSPN	Scan Point Number Translation	PR-3H179	Performs scan point number translations to provide the scan point number of a terminal.

TABLE B

RECEIVER CODES

CODE	DEFINITION
0	Invalid.
1	This originating register belongs to the supervisory scan point of a tone receiver that is waiting for the first tone.
2	Invalid.
3	Invalid.
4	Invalid.
5	This originating register belongs to a dial pulse receiver that is waiting for the first dial pulse.
6	This originating register belongs to a dial pulse receiver that is waiting for the start of a new digit (interdigital period).
7	Invalid.
8	This originating register belongs to a dial pulse receiver that is working on a digit.
9	Invalid.
10	This originating register belongs to the supervisory scan point of a tone receiver that has already received the first tone.
11	This originating register belongs to the tone present scan point of a tone receiver that is waiting for the first tone.
12	Invalid.
13	This originating register belongs to the tone present scan point of a tone receiver that has already received the first tone.
14	Invalid.
15	This originating register belongs to the tone present scan point of a tone receiver that is waiting for the end of the last tone.

TABLE C

ROUTE INDEX BRANCH TABLE

RETURN CODE	DEFINITION	ACTION TAKEN
0	Error	The call is failed.
1	Intraoffice call	Four is added to the signal digit (SIGDIG) to wait for four more digits. The base level progress mark (BASEPM) is set to TERMX for transfer of control to TERM (the terminating call program) by the TCR scanning program (TCRSCN) after all digits have been received. TERM initiates the 4-digit translation on the last four digits.
2	10-digit interoffice call (nonoverlap outpulsing)	Seven is added to SIGDIG to wait for the remaining digits. The BASEPM is set to OGTST for transfer of control to OUTCAL (the outgoing call program) when the digits have been received. OUTCAL initiates the sending of the digits.
3	10-digit interoffice call (overlap outpulsing)	Seven is added to SIGDIG, and control is passed immediately to the routine OGTOV in OUTCAL (the outgoing call program) for overlap outpulsing.
4	7-digit interoffice call (nonoverlap outpulsing)	Four is added to SIGDIG to wait for the remaining digits. The BASEPM is set to OGTST for transfer of control to OUTCAL (the outgoing call program) when the digits have been received. OUTCAL initiates the sending of the digits.
5	7-digit interoffice call (overlap outpulsing)	Four is added to SIGDIG, and control is passed immediately to the routine OCTOV in OUTCAL (the outgoing trunk program) for overlap outpulsing.
6	Destination code	The destination code is obtained from the route index expansion and is used to further determine the routine that will receive control of processing the call by using the destination code branch table (Table B).
7	Outgoing call with dialing complete	The call is sent to OUTCAL immediately. OUTCAL initiates sending of the digits.
8	10-digit call with foreign area translation required	Three is added to SIGDIG,and the need for foreign area translation is indicated in the TCR. After the foreign area translation is performed, another routing attempt is made.
9	Conflicting office and area codes requiring timing for seven or ten digits	The program waits for seven digits to be received. After the seventh digit, critical timing is performed to determine if the call is a 7-digit or a 10-digit call. If the call is a 7-digit call (no eighth digit was received), the 3-digit translation subroutine is reentered at the 7DIGIT entry point. The 3-digit translation subroutine is reentered at entry point 10DIGIT for a 10-digit call. Another attempt to route the call is then made.

TABLE D

DESTINATION CODE BRANCH TABLE

DESTINATION CODE	DEFINITION	ACTION TAKEN
0	Vacant circuit group	A branch is made to a customer error handling routine (NONE) in CUSTER.
1	Vacant code operator	A branch is made to a routine (VCOP) in the operator program (OPER).
2	No outpulsing trunk group	Control is passed to the NOTRK routine in OPER.
3	Tones that time out	Control is passed to the ANTON routine in CUSTER.
4	Tones that do not time out	Control is passed to the ANTON routine in CUSTER.
5	Local announcement	Control is passed to the ANTON routine in CUSTER.
6	Route to reorder	Control is passed to the REORDER routine in CUSTER.
7	Station ringer test	A branch is made to the STARING routine in MAINT.
8	Convert dialed digits to a 4-, 5-, 6-, or 7-digit number and retranslate	A branch is made to the CONVERT routine in CUSTER.
9—19	Test line work	A branch is made to the office test line program, OFFTL.
20	Autoconnect work	A branch is made to the AUTOCON routine in CUSTER.
21	Remote Office Test Line	A branch is made to the remote office test line program, ROTLA

TABLE E

FOUR-DIGIT TRANSLATION RESULTS

RETURN CODE	DEFINITION	ACTION TAKEN
0	Error.	The call is failed (sent to FAIL).
1	Number is not assigned.	The control is passed to ROUTE in DNTRP for routing of the call.
2	Special routing of the call is required.	Control is passed to ROUTE in DNTRP for routing the call.
3	Call is to a PBX.	PBX information is stored in the TCR,words 5 and 6. Further translation is performed to get the PBX group data by GRPX in EQPSEL. TERM continues processing the call until completion.
4	The called line has the series completion feature.	The terminal equipment number and series completion directory number are provided by the translation. TERM sets the series completion counter and continues processing the call. If the line is found busy, the first series completion number is translated by 4DSCX in XSL4DG and the resulting return code is used to route the call as indicated in this table. This process is continued until a line in the series completion list is found available or all numbers in the list have been tried.
5	The called line has a key scan point.	If the key scan point is set, the calling line is connected to busy tone. If the key scan point is not set, the call is processed in TERM as if it is an assigned line.
6	The called line has a key scan point and series completion.	The series completion counter is set. If the key scan point is set, the calling line is connected to busy tone. Otherwise, the call is processed in TERM as if it is a normal line.
7	The called line is assigned.	Call processing continues by checking for such information as custom calling features, private lines or party lines, whether the call is free or to be charged, etc. A call forward or speed call change is turned over to the custom calling program for further processing. For a reverting call with superimposed ringing, the signal digit is increased by one, and dial tone is returned to the calling customer. The timer is set, and PROGCKA in DNTRP is called to wait for the ID digit. When the digit is received, the major class of the calling party is calculated from the ID digit to determine if the caller is trying to call himself which is invalid. If this is the case, a busy signal is returned. Otherwise, the functions required to complete the call are continued in TERM.