CALL PROGRAMS
DESCRIPTION OF SYSTEM OPERATIONS
NO. 101 ELECTRONIC SWITCHING SYSTEMS

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1. GENERAL

1.01 The stored program in the No. 101 ESS is the guiding intelligence which has been designed to enable the system to process telephone calls in up to 32 separate PBX customer locations, under the direction of a centrally located control unit referred to as central control. This control unit, guided by instructions stored in a permanent magnet twistor memory called

the program store (PS), sets up and supervises telephone calls at the individual switching units located on the PBX customers' premises.

1.02 Other sections in the series 240-100-101 to 240-108-101 describe the detailed operation of each part of the control unit and the switch unit. This section presents, from a system point of view, a description of the call processing program principles. An essential preface to this description is a knowledge of basic stored program and logic circuit concepts, an understanding of the relation of the equipment to the program, and an understanding of the languages and number systems used in the No. 101 ESS.

> ***Note:*** We emphasize at this point that the reader must have knowledge of basic stored program and logic circuit concepts at least equivalent to those concepts which are available in the Bell System Electronic Switching Prerequisite Plant Training Course No. 2.

1.03 The basic method which has been chosen to describe the call program principles is a description of an extension-to-extension call. As this call embodies the principle methods which are used in all of the call programs, once the progress of the call has been understood, the details of other call processing can be readily obtained from the program flow charts and program descriptions.

1.04 However, to illustrate the main variations from this basic call, which exist for attendant actions, we include an example of an attendant-involved call.

1.05 Furthermore, we explain a detailed flow chart and, for the reader who wishes to examine the coding, two selected examples of typical coding have been extracted and explained in detail. In 2. of this section, a functional description of the major blocks of equipment that constitute the No. 101 ESS and a discussion of the languages and number systems involved is provided.

1.06 This section also establishes a basic understanding of the flow of information between blocks of equipment. A knowledge of this flow of information and its control is paramount to a better understanding of stored program call processing.

1.07 To repeat and expand on the most important part of this section, 3. deals with the analysis of an extension-to-extension call. Beginning with an off-hook message, generated by the switch unit in response to a change in state of a customer's line, a call is placed in an otherwise idle system. The placement of this call is divided into three main parts, the first of which extends to the dialing state of the calling party. Examination of this state is followed by a discussion of the busy testing state of the called party and terminates in the third part — an examination of the ringing and talking connection. Particular emphasis is placed on the role of the stored program in establishing this connection in response to the off-hook message received from the switch unit.

2. DESCRIPTION OF OVER-ALL SYSTEM

STORED PROGRAM INSTRUCTIONS

A. General

2.01 The No. 101 ESS program is a list of stored instructions that are read, interpreted, and executed by the central control (Fig. 1)* in order to direct the operation of the system.

2.02 Each of the 32,768 words of the program store (PS) may contain one or two binary coded instructions. The type of instruction or command found in the program depends on the logical function to be performed. Commands, when executed, gate information from one place to another (Fig. 2), clear registers, shift bits, interchange information, or cause the program control to transfer to a new address to consult some other area of the store. For example, a command expressed mnemonically as CGT CØXCB means "clear the call store buffer (CB) and gate the contents of the call store output register (CO) into the CB."

B. Codes and Number Systems

2.03 Before discussing the structure of the commands it may be helpful to mention the codes and number systems which are used with the No. 101 ESS (this does not include equipment numbering schemes).

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* All figures in this section are attached at the end.

2.04 The numbering systems, codes, and their uses are:

(a) Decimal — dial pulsing

(b) 4 x 4 [4 by 4 multifrequency (mf) or 2-out-of-8] — TOUCH-TONE

(c) 2/5 (2-out-of-5) — identified outward dialing (IOD) translation

(d) Binary — No. 101 ESS system operations

(e) Binary coded decimal (BCD) — intermediate conversion step between decimal and binary

(f) Octal — convenient "human to machine" language

(g) TTY (modified teletypewriter) — teletypewriter input-output code for maintenance.

2.05 The first six of these number systems are common to telephone and stored program machines and should be familiar to the reader. The modified teletypewriter code is given in CD-1H068. It should be noted that the first 16 characters ("–" through "R") are considered the "legal" characters for use by the majority of programs and that these characters are commonly represented by only their least significant four bits.

C. Structure of Commands

2.06 PS words are divided into two parts called the operation code and the address code. By definition, the operation code tells the system what to do and the address code tells the system where to do it. In practice, the address code quite often is a constant representing some desired information that is required by the program. Two types of PS words, J and K, are used to more efficiently utilize the available word space in the store.

2.07 Fig. 3 (information enclosed in box) shows the makeup of J- and K-type words. Fig. 4 is a reproduction of the No. 101 ESS operations card which lists all of the commands used by the system. The octal column on the operations card represents the binary bit configuration of the listed command. The alpha column is its mnemonic description. The ckt ref column refers to the symbols used for names of gates on the system SD drawings to identify the wired circuitry used in connection with a particular command; eg, the command CGT SRXCØ (27_8 10_8) uses a gate with the designation "CGH" in SD-1H049. Two (or three) octal digits shown for a command represent the operation code only and are an indication that the address code is a variable quantity assigned by the programmer.

J Commands

2.08 A J-type word consists of a 5-bit operation code and a 16-bit address code. There are only seven J commands; however, the address codes of these commands vary widely depending on the work operation, information, or transfer address contained in the address code.

2.09 The 16 bits making up the address code of a J command represent a binary number large enough to permit transferring to any location in the PS. See the STA, TSA, and TRA commands in CD-1H049 as examples of such commands.

2.10 The address area of the STØ command is used to obtain needed information and constants required in call processing. The PS addressing information required to advance the program, when a STØ command is executed, is stored in the CB.

2.11 The AND and LØR commands are used to change selected bits in a binary word that has been put in the CO by the program. The AND command will change ones (if the bits in the selected bit positions are ones) to zeros at each point where a zero exists in the address area of the command. Similarly, the LØR command will change zeros to ones. The configuration of the 16 address bits in these commands is established by the programmer as required by his particular program.

2.12 The load data trunk (LDT) is a special command that performs a number of functions that might ordinarily be performed by a series of commands. When the program has performed all of the operations required to accumulate the information to make up an outgoing data message, an LDT command is called for by the program. The LDT causes the contents of the time slot (TS) counter, CO, bits 4 through 8 of the add-shift (AS) counter, and the LDT ad-

dress code to be gated to the outgoing message data store area. The address code of the particular LDT command selected by the program contains the ringing, conference, and attendant lamp information required for a complete data message. See 240-105-101, Fig. 7, for the makeup of the outgoing data message.

K Commands

2.13 Most of the system operations can be directed by means of a program instruction considerably shorter than the 21 bits making up a J command. The 10-bit K command, consisting of a 5-bit operation code and a 5-bit address code, is the system workhorse. There are 140 different K commands that direct a large part of the systems operation.

2.14 It is possible to get two K words in the space of one J word, thereby conserving considerable amount of store space. Two K commands (one 22-bit store word width) are gated from the anticipation register (AR) to the program store output register (PSOR) at a time. The call processor operates on bits 12 to 21, representing one K command, then shifts bits 2 to 11 into positions 12 to 21 to process the second K command. The second K command is identified in the detail program sheet listing by a B to the right of the octal location number. Bits 1 and 22 are not a part of the K commands, bit 1 being a transfer allowed (TA) bit and bit 22 always being a parity error (PE) bit.

2.15 The K commands include a number of multiple function commands that perform work operations that might ordinarily be performed by a number of commands assembled as a subroutine. The advance (ADV) and start (STT) commands are good examples of this type of command. Considerable space in the PS can be saved through the use of multiple function commands to perform frequently used routines. This will become evident in later paragraphs as the call processing program is followed through a typical extension call.

2.16 K commands fall into nine general categories by function. Table A lists all of the system commands, by function, including the seven J commands. Details on each command listed can be found in CD-1H049. The Y in the address field in Table A indicates that the address field is present and variable.

TABLE A — COMMANDS BY FUNCTION

CONDITIONAL* TRANSFER

1BT Y
2BT Y
4B0 Y
4B1 Y
CLF Y
CTF Y
FIL Y
MAT Y
MET Y
MRT Y
NBT Y
NØT Y
RDT Y
TIX Y

SHIFT

LSH Y
SHL Y
SHR Y
SHØ Y

MISC FUNCTIONS

AND Y (J)
EXC
FIN
INV
LDT Y (J)
LØR Y (J)
ØRI
ØRC
LSD
NØP
SCA
STA Y (J)
STT

UNCONDITIONAL TRANSFER

ADV
GPA
STØ Y (J)
TRA Y (J)
TSA Y (J)

CLEAR AND GATE

CGT CAXAS
CGT CØXAS
CGT ASXCA
CGT CBXCA
CGT CØXCA
CGT SUXCA
CGT CAXCB
CGT CØXCB
CGT TSXCB
CGT AASXCØ
CGT CBXCØ
CGT DSXCØ
CGT ERXCØ
CGT HDAXCØ
CGT IBXCØ
CGT LASXCØ
CGT LØ1XCØ
CGT LØ2XCØ
CGT PØHXCØ
CGT PØLXCØ
CGT CØXHDA
CGT CØBXIØ

CLEAR AND GATE (cont)

CGT IØXCØB
CGT PRXCØ
CGT SCXCØ
CGT SRXCØ
CGT SUXCØ
CGT CØXIB
CGT CØXLA
CGT CØXMB
CGT ØPAXØCA
CGT CAXØCA
CGT CØXØPA
CGT CØXPØH
CGT CØXPØL
CGT CØXRCT
CGT ASXSC
CGT CØXSC
CGT CØXSR
CGT CØXST
CGT CØXSU
CGT CBXTS
CGT CØXTS

* The FIL command is not in itself one of condition transfer, but may be used to form part of the transfer address for another conditional transfer command.

TABLE A (cont)

COMMANDS BY FUNCTION

CLEAR	READ	WRITE	WRITE (cont)
CLR AS	RED C	WRT C	WRT SCD
CLR CA	RED C1	WRT C1	WRT TB0
CLR CB	RED C2	WRT C2	WRT TC
CLR CØ	RED C3	WRT C3	WRT TF0
CLR IB	RED C4	WRT C4	WRT TF1
CLR MB	RED CD	WRT DF0	WRT TØC
CLR PØ	RED DDR	WRT DF1	
CLR SC	RED DS	WRT DS	
CLR SU	RED DSC	WRT DSC	
CLR TB	RED L	WRT EB1	
CLR TS	RED LØ	WRT ET1	
	RED L1	WRT FB0	
ADD	RED LQ0	WRT KL0	
AD1 ACA	RED LQ1	WRT KL1	
AD1 AS	RED LQ2	WRT LF0	
AD1 CØ	RED LQ3	WRT LF1	
AD1 HCA	RED MB	WRT MF0	
AD1 ØCA	RED ØC	WRT MF1	
AD1 SC (subtract 1 from contents of SC)	RED S	WRT MTC0	
	RED STC	WRT MTC1	
AD1 TS (subtract 1 from contents of TS)	RED TIM	WRT ØC	
		WRT PR0	
		WRT S	

PROGRAM ASSEMBLY

2.17 The instructions that pertain to each particular state of the call are assembled into sequential lists of commands called progress mark (PM) routines. In addition, short operational sequences called subroutines are used where specific jobs are done more than once and/or in different areas of the main program. These subroutines are referred to by having the PM routines transfer to them when necessary. In general, a PM routine executes many subroutines in processing its portion of a call. Additionally, certain PM routines and other sections of the program have been grouped together for easier identification and reference. While there is some overlap, this grouping results in three main categories which have been designated as: (1) beginning and end of sector (BOS and EOS) program; (2) basic and special services program; and (3) attendant call processing program. Subroutines are usually referred to by name or by the function that the subroutine performs; such as, central office trunk selection subroutine or dialing translation subroutine. A schematic representation of the arrangement of the programs in the store is shown in Fig. 5.

SWITCH UNIT FUNCTION

2.18 The primary function of the switch unit is to make the physical connections necessary to complete calls. A scanning system in the switch unit located on the customer's premises keeps track of the on-hook or off-hook state of each piece of equipment that terminates there. This includes extensions, central office trunks, tie trunks, and attendant loops. Each piece of equipment that terminates in the switch unit has a single appearance to the switch unit scanner. This appearance is referred to as a scan point and is more fully described in 3.01. Communication links are provided between the switch unit and the control unit. When a line changes state, switch unit equipment sends a message to the control unit telling the control unit what

the change was and what line was involved. Later, in response to similar data messages from the control unit to the switch unit, physical connections to time division buses are made for dialing, ringing, or talking.

2.19 Connections to a time division bus in a switch unit are made by sequentially scanning an erasable memory called the switch store. There are actually two such stores in a switch unit, each having a capacity of 25 words. Each of the 50 words are assigned a unique address called a time slot number. This time slot number is contained in the outgoing message, is sent from the control unit to the switch unit, and causes equipment numbers, also contained in the outgoing message, to be recorded in the assigned word in a switch store. When a word is sampled (read) from the switch store, the contents of which are nonzero, equipment number translators cause the associated time division gate or gates to make physical connections to a time division bus. This connection is maintained for the duration of the sampling period. Since the switch store is sampled at a 12.5-kc rate, each connection is alloted a 3.2-μsec period. Each switch unit is capable of setting up 50 such simultaneous connections.

DATA, DIGIT, AND SENDER CONTROL

2.20 Data messages such as the above, passing back and forth between the switch unit and the control unit, are temporarily stored in a data control area of the control unit. The same is true of dialed or key pulsed digits which are transmitted by digit trunks from the switch unit to the control unit. Incoming digits and data messages are given to the call processor, as it requests them, from the digit and data store (Fig. 6).

2.21 Data control has a data transmitter and a data receiver assigned to each switch unit. The operation of the digit and data store provides a scanning function which is used to interrogate this equipment. Incoming serial messages are taken from the receivers and recorded in the store. Outgoing messages are read from the store and sent to the proper transmitter. There are four 16-bit words in the store for every switch unit. One word is for temporarily storing incoming data from the switch unit. The remaining three are for temporarily storing outgoing data on its way from the program control to the switch unit. The scanning function of the digit and data store steers incoming messages, a bit at a time, from the data receiver into that switch unit's incoming word. The message is accumulated there until it is complete and the program asks for it (described in detail in 3.04 through 3.14).

2.22 Outgoing messages are handled in a similar manner. Upon execution of a particular stored program instruction by program control (known mnemonically as LDT), an outgoing message is stored in the 3-word group reserved for that purpose in the digit and data store. This message will then be transmitted serially to the proper switch unit by the data control logic. The incoming and outgoing messages are received and transmitted at bit rates of approximately 700 bits per second (bps). The two scanning processes which have been discussed have been strictly under the control of wired logic. Under control of the stored program, however, the incoming message (recorded in the digit and data store) waits until an entirely different scanning process locates it. This is done with a 3-part program called the system scan, which will be described later.

PROGRAM CONTROL

2.23 Program control keeps a continuously updated record of all activity reported to it by the satellite switch units. There is a unique record kept for each call in progress in the system. This call record (referred to as a time slot) is kept in an erasable ferrite sheet memory called the call store (CS, Fig. 7). In addition, all of the call records that pertain to a particular switch unit are grouped together and are referred to as a sector. Each switch unit has a CS sector assigned to it. The size of a sector depends upon the particular customer's traffic requirements, with the limitation that no sector may exceed 50 call records. Associated with each sector — or more correctly, with each switch unit — are certain types of changeable information which pertain to the busy-idle status of switch unit equipment (Fig. 8). This area contains the status of central office trunks, attendant consoles, digit trunks, and an 8-word group referred to as a flash line. More will be said about the flash line later. A complete description of this entire area of the CS is contained in

PD-1H099 and PD-1H080. However, it should be said in passing that this area is referred to as "Call Store — Supplementary Information per Switch Unit" and is currently 32 words in length.

2.24 When a station originates a call, the stored program assigns an idle call record from the sector assigned to the switch unit in which the call originated. This call record has a unique CS address and time slot number and represents the corresponding 1-word time slot in the switch store. As mentioned earlier, outgoing messages to the switch unit that are generated by this call record's activity contain its time slot number. When equipment numbers are contained in the same outgoing message, they are recorded in the proper switch store time slot — thus effecting a connection to the time division bus as explained earlier.

2.25 The call record (referred to as a CS time slot) consists of four sequential words of storage in the online CS. Since the contents of this record are responsible for setting up and maintaining the proper connections to the time division bus, the entire record is duplicated in the offline CS and is constantly kept in agreement with its online image by the stored program. The contents of a typical CS time slot are shown in Fig. 9.

COMBINED FUNCTIONS

2.26 Call processing (1) collects new messages from the switch unit via digit-data and sender control, (2) compares the new messages with existing information stored in the CS, and (3) takes any necessary actions and updates the call records, always according to the instructions read from the program. Call processing depends on a sequential scanning of the CS time slots to continuously review the progress of all calls in the system. The description that follows examines this process as it is used to complete an extension-to-extension call. For simplicity, equipment needed is assumed to be idle; alternate paths and no action paths are for the most part omitted.

PROGRAM-ASSOCIATED DOCUMENTS

2.27 There are a number of forms of documentation which are associated with the stored program. To find out how the program handles some particular situation, these documents should be used in the following sequence(assuming a basic knowledge of stored programs and the No. 101 ESS) :

(1) Use the ***over-all view of the entire program*** PD-1H099 to find out what piece of program is of interest.

(2) Use the ***functional (or general) flow charts*** for the specific piece of program.

(3) Use the ***detailed flow charts*** which should, in most cases, tell what happens in sufficient detail.

(4) If necessary, use the mnemonics in the ***detailed flow charts*** to find the section of coding in the program listing (PR) which pertains to the situation under consideration.

2.28 Note, the following paragraphs of this section are organized in the manner described above, ie, the basic diagram from PD-1H099 is presented along with system scan (3.02 and 3.03) ; the general flow for the extension-to-extension call has been excerpted and simplified (3.23 and 3.24) ; the general flow for the attendant call has been excerpted and the specific path has been emphasized (4.02) ; the detailed flow charts are explained; and finally, examples of detailed PLs are explained.

3. EXTENSION-TO-EXTENSION CALL

EXTENSION OFF-HOOK

3.01 At the switch unit, each extension, trunk, attendant circuit, test line, and maintenance point has an associated scan point. The electrical state of this scan point is either ground or positive battery, depending on whether the receiver is on- or off-hook. The switch unit scanner checks the state of each scan point in turn about 40 times a second, comparing it with a record kept of its previous state. When a calling extension goes off-hook, the scanner recognizes the change in the extension's scan point state and pauses in its scan. A 12-bit message consisting of the extension's scan point number, the new state of the line, and a parity bit that checks the validity of the message is sent to the data control area of the control unit. The formulation of the message and its method of transmission are given in Sections 240-101-101,

240-102-101, and 240-103-101. The message is received by the digit-data and sender control at the control unit and is recorded in the digit and data store. The reader should remember that this off-hook message will be kept there until the stored program requests it. Further progress of the off-hook message must be postponed at this point until a more detailed description of program control can be given (see Fig. 1). In general, under direction of the stored program, program control systematically interrogates its data control area for new information incoming from the switch unit. Any such new information is checked against the data currently stored in the call store (CS) time slots. Together, these data are interpreted by the program control according to instructions read from the stored program. A message is then sent to the switch unit, via data control, telling the switch unit what physical connections to make or remove to satisfy the particular state of the call.

SYSTEM SCAN

3.02 The system scan is a sequential scanning process that starts with the first switch unit sector and examines, in turn, the progress mark (PM) in each of the CS time slots allocated to each switch unit (Fig. 10). This programmed scan checks the current state of every call record in the CS by following the operational sequence of each PM, then updating the time slot record of the call to agree with its current or newly altered state. The PM, which is recorded in the first word of every CS time slot, is actually the address of a word in a transfer table in the program store (PS). The transfer instruction contained in this word will send the program control to the starting address of the programmed sequence needed to process that state of the call. These individual operational sequences are referred to as PM routines. When all of the call records have been reviewed by this programmed scan, ie, the last assigned sector has been examined, the stored program will transfer control to an end of scan program. These end of scan programs require execution once per system scan and are enumerated in 3.24. Upon completion of these routines, the stored program obtains the switch unit number of the first sector and initiates the next system scan.

3.03 The system scan may be broken down into many sector scans, as many sector scans as there are working switch units. In addition, the scan of each sector can be divided into three stored program routines: beginning of sector (BOS), sector scan (SS), and end of sector (EOS). These stored program routines are repetitively executed for each switch unit. One SS constitutes the scanning of all the CS time slots allocated to one switch unit. As the scan of the CS time slots for a given switch unit is completed, the EOS routine puts the number of the next switch unit to be scanned in a 5-bit switch unit (SU) number buffer. Then the program transfers to the PS address of the first word at the BOS sequence.

BEGINNING OF SECTOR

3.04 BOS is a programmed routine that acts as a monitor program for the sector currently being processed*. Its primary function is to delegate the work to be performed during the following SS. Its first order of business is to interrogate the data control area for new inputs from the switch unit assigned to this sector. This is accomplished by execution of the start (STT) command.

3.05 The STT command† is a special command used only at the start of a new SS. Instead of directing a single action, this command starts the BOS program with several interdependent actions. These include: clearing the message buffer (MB); gating the sector number or switch unit number to be scanned to the digit-data store address register; interrogating the digit and data store for a new input from this switch unit; reading the message found in the incoming word of the switch unit's 4-word data store group; and placing the message in the MB if a complete new input message exists.

3.06 After executing the STT command, the program clears the input buffer (IB). This buffer is a 16-bit flip-flop register which is used as an adjunct to the MB. The program then

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* As an aid in this discussion, the ***General Flow*** charts in PF-1II080 may be helpful.

† The operation of this command in relation to the program control timing is depicted in 6.28.

transfers to a subroutine* that provides the address of the first CS time slot to be looked at, and the number of time slots assigned to this switch unit. The subroutine gates this address information from the PS per switch unit supplementary information (see Fig. 11, 12, and specifically, word 1 of Fig. 13) to a temporary storage location (temporary B storage, Fig. 8) in the CS. Returning to the main routine, the program asks for the data transmitter, setting the busy-idle and reserved flip-flops in the program control to conform to the status of this switch unit data transmitter. If the data transmitter is not immediately available, the program transfers to a maintenance program that keeps requesting it until it is idle or a trouble condition is indicated. Assuming that the data transmitter is available, and that a new input exists, the program zero checks the MB (making sure it is not all zeros) to prove that a new input exists. The parity of the message is checked, and the data trunk and transmitters are reserved.

3.07 The reader may recall that an assumed off-hook message was temporarily stored in the digit and data store and left there until program control was more completely described. Execution of the STT command by the BOS program constituted a program control request for a new input from the switch unit, via data control. It may now be assumed that the off-hook message has been received by program control and placed in the MB in preparation for the SS. The first order of business of the BOS program—that of receiving new incoming messages — is now complete, but further work must be done before initiating the SS.

A. Switch Unit Maintenance Routine and Flash Line Sequence

3.08 Having already requested and, in our case, received a new incoming message, the BOS program passes control to the switch unit maintenance program (see Section 240-110-101 for more detail). This program sets up and monitors test calls in the switch unit currently being processed. By establishing connections between tone generators and detectors, causing test lines which have scan point appearances to go on- and off-hook, the operational status of the switch unit is determined. There are two CS time slots assigned to the beginning of each sector for this purpose (Fig. 14). With these time slots included, the maximum number of CS time slots that may be assigned to a switch unit is brought up to 52.

3.09 Should an error occur during this testing phase, redundant switch unit equipment is switched in and out of service in a predetermined order. Each piece of equipment that is switched by a test message constitutes a new mode of operation for the switch unit. When a working mode is established, the faulty equipment can be typed out on the teletypewriter subsystem because of the predetermined order of switching. Upon completion of this routine the BOS program resumes control and begins execution of a flash program. The purpose of the flash line program is to differentiate between an on-hook message and a flash.

3.10 In 2.23 through 2.25 the CS supplementary information per switch unit was mentioned. Eight words of this supplementary information are assigned as a flash line for each switch unit. On-hook messages, when received by program control, are recorded in this flash line and cause initiation of a programmed 1.5-second timer for each entry. As each sector is continually processed, the BOS program increments each timer. If an off-hook occurs from the same line within 1.5 seconds of an on-hook, a switch-hook flash is assumed. If there is no new input for the sector currently being processed, the BOS program will determine if an on-hook entry in the flash line has timed out. If so, the entry is taken out of the flash line and processed as an on-hook during the SS in lieu of a new input from the switch unit. If an off-hook message is received by program control, it must be matched against all entries in the flash line to insure that it is indeed an off-hook and not part of a switch-hook flash. This must be done before sector processing can begin to enable the proper message, ie, on-hook, off-hook, or flash to be used for the SS.

3.11 Since this discussion is concerned with an off-hook origination, a match will not occur when the flash line is examined by the BOS

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* Programming terminology dictates the use of the word subroutine at this point, although not previously defined. A complete description of this term is contained in 6.06 through 6.24.

program. Having determined that the off-hook message is not part of a switchhook flash, the incoming message must now be classified by the BOS program. This classification identifies the switch unit equipment that generated the message and records its identity in the IB (Fig. 15) for use during SS or EOS processing. A more detailed discussion of scan point classification follows. The diagram of the MB, which is included below for ease of reference, shows an off-hook message from scan point 48 (directory number 200).

B. Scan Point Classification

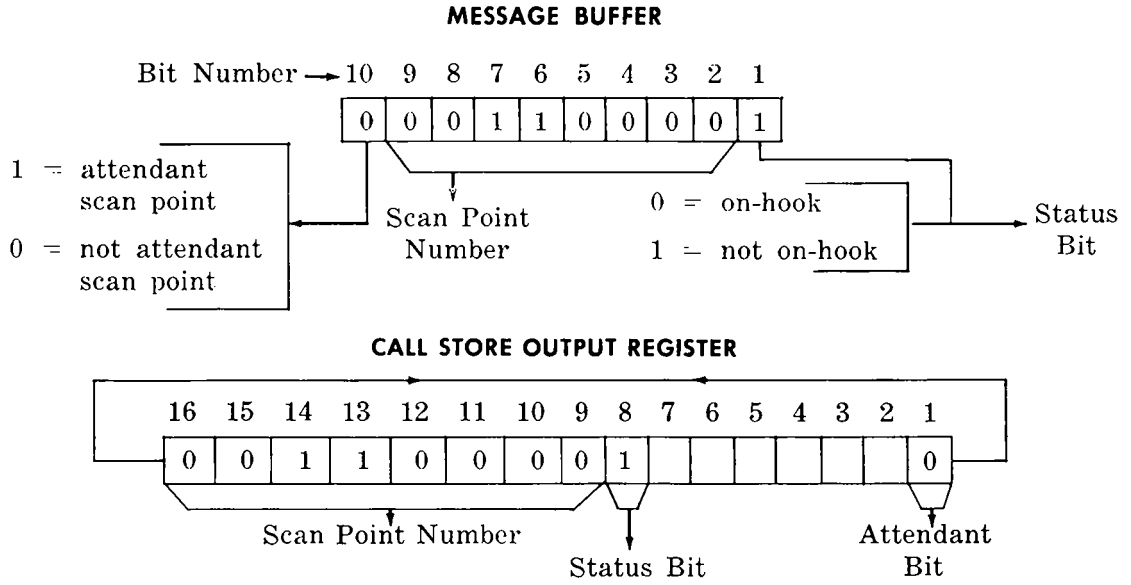
3.12 Each switch unit has 320 scan points allocated in consecutively numbered groups to trunks, attendant loops, extensions, test lines, and maintenance points (Fig. 16). This allocation method is used to tell the program control the type of equipment that originated any new input message found in the MB. For instance, all attendant scan point numbers are over 255; hence, bit 10* in the MB would be marked one if an attendant scan point originated an on-hook or off-hook message. Extension scan points fall between 48 and 247 and central office trunks are between 8 and 47.† In the call being described, an extension off-hook message is in the MB. The program gates the new input message to the call store output register (CO, a 16-bit shift register) without clearing the MB. A "not zeros" test of the 16 bits in the CO is used to check for the presence of a new message. The message in the CO is now shifted to the left by 7-bit positions. This rotates bit 10 into the bit 1 position as shown below in the diagram of the CO.

3.13 By testing the low order bit (ie, test bit 1, using the 1BT command) and finding it zero, the program control knows that the scan point number is less than 256 and, consequently, not an attendant scan point. The program shifts the message to the right by seven bits, restoring the bits to their normal position. The program control then executes an AND 0000000110000000 command which compares the 16 bits in the CO with the 16-bit constant read from the PS. If corresponding bits are both one, the CO bit remains the same. If one of the corresponding bits is a zero, the CO bit is set to zero. In effect, this particular constant clears whatever is in the CO except the eighth and ninth bit.

3.14 The eighth and ninth bits remain unchanged. Bits eight and nine are now tested. If either bit is marked one, the scan point number is greater than 63. If both are zeros the

* Since the entire new input message is gated from the incoming MB, bit one in the CO is an on-hook bit and is not part of the scan point number. Bits 2 to 9 contain scan point numbers from 0 to 255. If bit 10 equals one a number greater than 255 is indicated and implies an attendant scan point.

† The number of scan points assigned to extensions and trunks is an engineered variable.



scan point number is 63 or less. In this general way, the scan point number is found to be between 48 and 247 or 63 and 247, proving that it is an extension scan point.* Bits seven and eight of the IB are marked to define the new message as extension originated. As a final step, the BOS program sets a match required flip-flop (MRF) to one and transfers to the SS program. The function of this flip-flop will become more meaningful as it is used by the SS program in the following section.

SECTOR SCAN

3.15 The basic purpose of the SS is to provide each call record with an interval of time during which it may take appropriate actions to further the progress of the call. As each call progresses toward completion it must indicate to the stored program, on subsequent SSs, the address in the program at which to continue processing the call. The PMs, representing states of the call, perform this funciton when they are used to obtain the starting address of the PM routines.

3.16 For every call in progress there is a 4-word CS time slot assigned to handle its activity. The switch unit equipment number involved in this call is recorded in the second word of this time slot. In order to associate a new input message with a particular call in progress, the new input must be matched against the equipment numbers recorded in each time slot. The PM routines are provided with this matching capability where necessary. The need for matching (existence of a new input) is conveyed to these PM routines by means of the MRF. When a new input exists, the BOS program sets this flip-flop to one before transferring control to the SS.

3.17 In addition, when a new input exists and a match occurs during the SS, the EOS program must be notified that this match occurred so that appropriate action may be taken. This is done by setting the MRF to zero when a match occurs during the SS. When there is no input, the BOS program sets this flip-flop to zero and the time required to perform the matching sequence is saved by each PM routine.

3.18 In 3.06 it was mentioned that the data transmitter for the switch unit currently being processed must be available before sector processing can begin. It should be pointed out that only one message can be sent per SS to the switch unit because of the transmission rate of outgoing messages. When a new input exists, the transmitter for that switch unit is reserved by the BOS program so that the outgoing message can be sent in response to the new input. PM routines that request the data transmitter are unable to use it because of the reservation. The PM routine that obtains a match with the MB may use the transmitter without requesting it, since the new input is associated with the call record obtaining the match. It has been found that the number of states necessary to process a call were substantially reduced by the above technique of reserving the data transmitter.

3.19 The SS is initialized by retrieving from the PS the address of the first CS time slot and the total number of time slots plus one (see Fig. 13, word SU $\times$ 16 $-$ 1) and placing them into the call store address register (CA) and time slot counter, respectively.† The SS will compare the number in the MB with the number in the A and B area of every CS time slot whose PM requires it.‡ This matching will show whether the off-hook extension is currently anywhere in the system.

3.20 The SS skips the two maintenance time slots in the CS and goes directly to the first call processing time slot in the CS. Since the CS time slot is a 4-word group, the program skips the maintenance slots by adding four to

* In certain cases, tie trunks may be assigned between scan points 48 and 63. In any event, a word in the PS (word seven per switch unit information, Fig. 13) defines the starting point of the extension group to permit accurate classification.

† The time slot counter is reduced by one each time SS examines a time slot. When SS has looked at every time slot belonging to a switch unit, the time slot counter will have been decremented down to two and the program will transfer to the EOS routine.

‡ Certain PMs indicate a number in only the A or B or neither areas. In these cases, of course, a match with a known empty area is not attempted.

the original address in the CA and then executing an advance (ADV) command, which adds four more.

3.21 The ADV command at the same time causes the program to read the PM in the first working time slot. This PM (part of a binary address) is gated to the program store address register (PA), bits two to eight. The remaining bits in the PA are jam set to address the octal 11,400 area of the PS. Here, one of a set of transfer commands (the correct one determined by PA, bits two to eight) transfer control to the PS address of the operational sequence required by the PM. If the time slot is idle, the PM will be zero. The transfer vector for PM0 has an ADV command loaded in it, sending the program to the next time slot and so on through the sector until the time slot counter is reduced to two. (Each ADV command decrements the time slot counter by one.) If instead of a zero, some other PM is found in a time slot, the transfer vector transfers to the corresponding operational sequence.

3.22 The PM routines check the MRF to determine if a match is necessary. As stated earlier, when a new input exists, the BOS program has set this MRF equal to one to indicate the need for matching during the SS. Since in this case the MRF was set earlier to one, the program attempts to match the number in the MB with the number in the A area of the time slot and then in the B area before advancing. After cycling through all the time slots belonging to this switch unit, the program transfers to the EOS routine. EOS is in effect a cleanup routine for incompleted actions begun by BOS or SS.

END OF SECTOR

3.23 From this point in the extension-to-extension call Fig. 17 should be followed.

3.24 EOS checks the MB and finds it full for our example — full meaning there is something other than zeros in it. EOS also checks the MRF. If a match has been made during the scan, MRF previously set to one, would be set to zero when the match occurred. Since it is still one, the program determines why the match was requested and finds by examining the MB and the IB that an extension went off-hook. Because the number in the MB was not found elsewhere in the sector, the program assumes this to be an origination, not an off-hook in answer to ringing. The program transfers to a subroutine called SUBE that does its own scan through the sector to find an idle time slot. This subroutine, beginning with the highest numbered time slot assigned to this sector, checks the first word of each time slot for an "all zeros" condition. When the idle condition is found, SUBE sets up the idle time slot address and returns control to the main routine. The EOS program writes the number from the MB into the idle time slot's A area. Then a digit trunk and digit receiver are selected. A message is sent to the switch unit, via data control, causing A to be connected to the digit trunk. In addition, the digit trunk and digit receiver are connected at the control unit. A will hear dial tone and proceed to dial, and PM2 (a dialing state progress mark) will be written into the first word of the selected time slot. Note that this is the first active PM state shown on Fig. 17. Assume for brevity that there is no other activity and that the system completes EOS and proceeds to scan the remaining switch unit sectors. When it completes EOS for the last switch unit, an end of scan routine transfers control to programs that require execution once per system scan (Fig. 10). Included in this group are data control maintenance, control unit maintenance, a PM monitor program, and teletypewriter printing routines. Control is passed to these individual programs by means of a transfer table (a sequential list of transfer commands). When a program has been completely executed, it returns to the next sequential transfer command in the table, which transfers control to the next program. When the final transfer command in this list is executed, the switch unit number of the first switch unit in the system is placed in the switch unit (SU) number buffer, preparing to repeat the over-all system scan described at 3.02.

DIALING

3.25 When the SS for the switch unit in question is again performed, PM2 will be encountered. This PM will initiate the proper sequence of commands to process this dialing state. PM2 attempts to match the A party with the MB and if there is no match, the program interrogates the digit and data control to see if dialing has been completed.

3.26 To digress a moment, digit-data control has been receiving and accumulating, if necessary, the digits being dialed into the assigned digit receiver. When dialing is complete, the dialed digits are placed in the digits completed register (DCR) and the digit receiver (DR) number is placed in the receiver number register (RNR) if the DCR is idle. Interrogation is accomplished by reading the contents of the third word (C3) of the dialing CS time slot into the CO (see Fig. 9). This word contains the digit receiver number and digit trunk number that was assigned to this call. The program then executes a RED DDR command. RED DDR compares the six high order bits of the CO (the DR number) with the DR number in the RNR in digit-data control. If they match, the contents of the 12-bit DCR are read into the low order 12 bits of the CO. When dialing is completed, at least one of the low order four bits of the DCR must be a one. A 4B0 command checks these bits in the CO. If they are not zero, it means the dialed number is in the DCR and that dialing is completed.

3.27 Since the program can scan a 32 switch unit system in 64 msec, the first scan after dial tone was given could not possibly result in dialing completed. There is no match with the number in the RNR, and the ADV command sends the program to the next time slot and the next time slot, etc, finally completing SS and EOS and ultimately system scan. The system scan is repeated many times until eventually dialing is completed. In the event that A goes on-hook before dialing is completed, the matching of A with the MB at the beginning of the PM2 sequence would cause a match to occur. The program will, in this case, clear the CS record of this call after releasing the assigned equipment and send a message to clear the corresponding time slot in the switch store.

3.28 As described earlier, when dialing is completed the dialed number is gated from digit-data control to the CO (low order 12 bits) in binary coded decimal (BCD) form, ie, four bits per digit. The program must translate or convert this information into an 8-bit binary equipment or scan point number so that it may be used for matching by recording it in the B area of the time slot (assuming that another extension number was dialed). Consequently, the program transfers to a routine to translate this dialed number. The dialed number is translated and found to be a valid extension. The dialed number is then written in the time slot's B area and a bit called the MLE (to-be-matched-list-entered) bit is cleared. The program then transfers to a subroutine that releases the digit trunk and digit receiver. Returning to the main routine, the program requests the data transmitter and if found idle, sends a message to the switch unit to break the digit trunk connection. Then the MLE bit is checked. Finding the MLE bit equal to zero, the program transfers to a subroutine that tries to put B (the called number) into the to-be-matched waiting list.* If successful, the subroutine marks the to-be-matched list bit equal to one. This indicates that the entry has been made and that it need not be made again by the busy testing state of the call. Returning to the main routine, PM4 is recorded in the time slot (PM4 is defined as A party waiting for the dialed number to be busy tested). The program advances to the next time slot and so on to the EOS. The EOS routine seeing no new input in the MB (assuming an idle system) takes a no action path and the program goes to the BOS for the next switch unit. After advancing in this manner through the entire system, the program returns to the BOS for the first switch unit.

A. Busy Test

3.29 When the BOS program is executed for the sector in question and finds no new inputs from the switch unit, the BOS program once again looks for a message to be used in lieu of a new input from the switch unit. After checking the flash line and finding it empty (we are assuming that there is no other activity in the system), the BOS routine looks at the to-be-matched waiting line (word 15) in the SU# x 32 area (see Fig. 8) in the CS, zero checks the list, and puts the number found there (if any, and in this case there will be) in the MB. The to-be-matched word is then cleared.

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* Along with the dialed number to be matched, the CS address of the time slot requesting the match, the time slot number, and the identity bits are written in the to-be-matched waiting list area of the CS. The identity bits specify the reason for this entry.

3.30 The program sets the MRF equal to one and reserves the data transmitter so that it may be used for this new input when the busy test result is obtained. The identity bits are retrieved from the to-be-matched list and the IB is coded in accordance with these bits to indicate that an extension busy test is to be performed.*

3.31 The program now begins SS. SS attempts to match the dialed number (in the MB) with the A and/or B area of each time slot depending on the PM found in each.† If the called extension is not found anywhere in the system, the MRF will remain one, indicating an idle extension. The EOS routine will check the MB, the IB, and the MRF. Finding that the reason for the match was an extension busy test, EOS will return to the to-be-matched list and recover the CS address and time slot number of the busy testing time slot.

3.32 After insuring that no other action except busy test was performed by the SS, PM5 is written in the first word (C1) of the time slot and the attendant area of the time slot is checked. Since no attendant is on the call, this area will be empty. The A and B parties are retrieved from the busy testing time slot and an LDT command sends a message to the switch unit, causing A to be connected to ringback and B to continuous ringing. The ringing code (111111) is written in word C3 of the CS time slot (bits 11 to 16), and the pickup group code is put in C4 of the CS time slot (bits 7 to 11). Bits 7, 8, 9, and 10 in C3 are made zero, clearing a timer and also marking a message sent (MS) bit equal to zero. (MS equals zero means that although a message to connect continuous ringing has been sent, the message to connect interrupted ringing has not yet been sent to the switch unit.) An AND command marks bits 3 and 4 of C4 equal to 00 to define B as an extension. The program then advances to BOS for the next switch unit. System scan continues until the program returns to BOS for this switch unit.

3.33 At this point it might be well to review the events that have taken place as this call progressed to the ringing state. An off-hook origination which has come into the system via a switch unit message has been recognized by the program control. The program selected an idle interval of time and set up a temporary record in the CS to handle all further activity of this call. Dial tone was given to the originating party and PM2 was set up to wait for dialing to be completed. Upon completion of dialing, digit and data control presented the dialed digits to the program control at its request and it was determined that a valid extension number had been dialed. The program then proceeded to take the call to PM4 to await the completion of the busy test on the called party. At the end of the busy test scan, the system having found the extension to be idle, has sent a message to the switch unit to connect the calling party to ringback and the called party to ringing.

3.34 The preceding discussion was furnished to consolidate the details that have been given and emphasize again the role of the stored program in executing the proper sequences of instructions in response to messages received from the switch unit. We shall now proceed to PM5, the ringing state of the call.

B. Ringing

3.35 Assuming no new inputs to the system, the program takes mostly "no action" or maintenance paths until it again begins SS. When the program control sees PM5 in this time slot, it checks the MRF. Since there were no actions to be taken, the match flop will be zero. The program now begins to time the continuous ringing being applied to the called party. The MS bit and the ringing code bits are checked to insure that this timing function is all that is required. Since the MS bit is zero, a timer will be incremented each scan until continuous ringing has been on for 2 seconds. When 2 seconds elapse the program will request the data trans-

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* Identity bit conditions are as follows:

000	–	Extension Busy Test
010	–	Extension Busy Test with Attendant Off-Hook
1XX	–	Multiple Night Service Number Busy Test or Busy Verify
001	–	Tie Trunk Busy Test
011	–	Tie Trunk Busy Test Attendant Off-Hook

† PM4, for example, does not attempt a match with the B area since this would automatically return a false busy.

mitter. If successful, the MS bit will be marked one and the timer will be cleared (C3, bits 8 to 10). In our case, both the A and B parties involved in this ringing time slot are extensions. In order to determine the proper message to be sent to the switch unit, the definitions of the A and B parties are checked. The conference bits in the time slot are also examined to insure that this time slot is not part of a conference. Having determined the proper message, this message is sent to the switch unit, causing A to be connected to ringback and B to interrupted ringing. The program goes to a CHANGE subroutine that updates the standby CS's duplicate record of the call and advances to the next time slot. When the call is answered, the scanner at the switch unit will recognize the change in the state of the B scan point, the off-hook signal constituting a new input to the system. The processing of this new off-hook signal will proceed in exactly the same way as for the off-hook origination until the SS matches the new message in the MB with the A and/or B area of each time slot.

3.36 When the program examines the time slot containing this call, PM5 will be found. Of course the program has been finding PM5 on each scan before the call was answered. This time, however, the MRF will be set to one because of the new input to the system (the off-hook message). The B area of this time slot will match with the number in the MB. The MRF is reset to zero, and the program interrogates the IB to determine the reason for the match. An off-hook at this point can only be in answer to ringing, so the program clears the ringing code, the ringing group code (pickup group), and the timer in the time slot.The program checks 3- and 4-way conference bits, verifies that A and B are extensions, and writes PM7 (a talking state progress mark). A message is sent to the switch unit, causing A to be disconnected from ringback and B from ringing and A to be connected to B for talking.

3.37 SS, EOS, and BOS programs will continue simultaneous processing of other calls in a similar way. When either party hangs up, BOS will recognize the on-hook message and after determining that the on-hook is not part of a flash, as previously described, will begin the disconnection process.

DISCONNECTION

3.38 Assuming that the A party or "source" is the first to go on-hook (differs slightly from Fig. 17), BOS will place this message in the MB (when it times out of the flash line) in preparation for the SS as it did for the off-hook messages. If the B party went on-hook first, the program would interchange the role of A and B when the match B occurred on SS, and the A on-hook program would be applicable to B's on-hook. When PM7 is encountered by SS, the MRF again indicates that a match is required. When the match on A is obtained, the A area of the time slot (C2, bits 1 to 8) and the definition of A (C4, bits 1 and 2) are cleared. A zero check is made on the attendant area and the program, finding this empty, determines that B is an extension and moves it to the A area of the time slot. PM9 is then written in C1 of the time slot and a message is sent to clear the talking connection at the switch unit.

3.39 PM9 is essentially a timing state for the call which on subsequent SSs will increment a timer while waiting for the remaining party to go on-hook or flash his switchhook to retrieve dial tone.

3.40 Since the rest of the scanning process continues as before, we shall concern ourselves only with the SS involved in handling this call. If the A party of PM9 takes no action within a 25-second timing interval, a message will be sent to the switch unit to connect this party to reorder tone. PM25A will then be recorded in the time slot to identify this fast busy tone state.

3.41 However, in our case, assume that the second on-hook occurs within this 25-second interval. Since BOS has placed this on-hook message in the MB, a match on A will occur during the SS when PM9 is encountered. The program will then, after determining that the A party is an extension, clear the A area of the time slot. As a final step in the termination of this call the program transfers control to a subroutine (called NN5) which proceeds to clear the four sequential words of storage assigned to handle this call (the CS time slot), thus releasing it for use by another call. In the CS per switch unit supplementary information, a bit known as the time slot released bit is made equal to one and a message is sent to clear the corresponding time

slot in the switch unit. The CHANGE subroutine is then used by the program to bring the duplicate record of the CS time slot in the off-line CS up to date and the SS is continued. The system has, at this point, completely terminated this call. All equipment used for this call has been released and all temporary records of the call have been destroyed.

4. CALLS WHICH INVOLVE THE ATTENDANT

BEGINNING OF SECTOR ATTENDANT PROCEDURE

4.01 Incoming attendant messages, generated via the attendant console, are handled by the BOS program in a manner which varies slightly from the procedure described previously. This variation takes place only when an attendant is already off-hook on a call and that attendant generates an incoming message by taking some further action. When an attendant is off-hook on a call, the call store (CS) address and time slot number of the time slot in which she is off-hook is kept in a word of storage in the CS per switch unit supplementary information. The beginning of sector (BOS) program, upon receipt of an incoming attendant message, checks this word of storage to determine that she is already off-hook. If this is the case, instead of placing the message in the message buffer (MB) in preparation for the sector scan (SS), this time slot is immediately addressed and the required action is taken by the program. Upon completion of this action, the program returns to the BOS, clears the MB, and then starts the SS.

ATTENDANT-INVOLVED CALL

4.02 To illustrate the main variations from the basic extension-to-extension call, which are described in 4.01, an example is provided. This example is presented as a series of specially marked flow charts from the PF ***General Flow*** on attendant call processing, Fig. 18 through 25. This call is also useful as an introduction to the use of these general flow charts.

5. FLOW CHART SYMBOLS AND THEIR USE

GENERAL

5.01 Programming of No. 101 ESS call processing, due to the size and complexity of the required program, could not be undertaken until it became clear not only what functions the program should perform, but also when these functions should be performed. A set of call processing sequence charts, more commonly referred to as flow charts, have been produced and used for the actual writing of the program. These charts display the logical sequence of events that the program must perform for a particular state of the call. The following paragraphs describe the use of these flow charts and their symbolic notation.

SEQUENCE CHART REQUIREMENTS

5.02 A flow chart should not be too detailed since intricate details may always be obtained, when necessary, from the completely coded program. Brief statements should be used to express the main logical function to be performed. The main decision points, where the program may follow one path or another, should be shown with clarity. A system of symbolic notation, different from that used in the actual coding of the program, has been devised to clearly identify the beginning of the progress mark (PM) sequence. This notation allows easy recognition of entrances and exits into and out of the normal flow of information. For easy reference the program flow chart symbols that were adopted and their explanation are included as Fig. 26.

EXAMPLE AND DESCRIPTION

5.03 Let us assume that extension A is talking to extension B and we would like to know what will happen when either A or B takes an action such as flashing his switchhook or going on-hook. We need to know one more fact. That is, which PM represents the talking state. As described earlier in this section, an extension-to-extension call with no attendant will proceed to PM7 for the talking connection. The flow chart for PM7 is included as Fig. 27A and B and should be referred to for the following example.

5.04 The beginning of the PM sequence may be found on Fig. 27A, as described by the program flow chart symbols of Fig. 26. The configuration of the time slot assigned to this call is shown in the upper right hand corner of Fig. 27A. When PM7 is encountered during the sector scan (SS), the sequence of events shown in Fig. 27A and B will begin. If a match is not required by this particular SS, the program will

immediately advance to the next time slot, as shown by the first binary decision symbol which checks the match required flip-flop (MRF). If a match is required, we must match both the A and B parties of this call with the contents of the message buffer (MB) to determine if the message is associated with this call. If they both mismatch, we will again advance to the next time slot. This is the straight through or normal path to be followed while A and B are conversing. If the B party takes some action, a match will be required and obtained on some subsequent SS. This match will cause a transfer to RA115 which will cause A and B to be interchanged in the call store (CS) time slot. Since B is now in the A area, we may use the same program that was written for the match on A and so we return to RA55 at coordinates C-4.

5.05 Following the match on the A path the program must next determine the reason for the match. This is shown by the multiple-decision symbol which displays the five possible results for this particular state of the call.

> *Note:* The MRF is first set to zero because we obtained a match during the SS. If this were done after the decision, it would have to be written in each of the five possible results.

Assuming that the A party has flashed his switchhook, the program selects the flash path and determines next that A is an extension. Since a flash from an extension in PM7 is to be interpreted as a request for dial tone, we must select an idle digit trunk and dialed digit receiver (see Fig. 28 for status bits). The digit trunk connection will allow dial tone to be supplied to the A party when the connection is made at the switch unit via an outgoing message. At the control unit the selected digit trunk is connected to the assigned dialed digit receiver by the subroutine which selected the idle equipment. Returning to the main program at RA113, the PM must be changed to represent the new dialing state of the call and is, therefore, updated to PM10. The message sent (MS) bit is set to one. This indicates to PM10 that a message has been sent to connect A to the digit trunk. It now remains to actually send this message before advancing to the next time slot. However, we realize that this type of message followed by an advance (ADV) command is performed elsewhere in another logical sequence. We need only to transfer to that sequence to accomplish our goal. This is shown by the exit symbol, which transfers to GC114 on Fig. 27B, coordinates G3.

5.06 GC114 is seen to send the required message before advancing to the next time slot. At this point, the program has done all that it could in response to the incoming message, ie, obtain a match with the A party and determine the reason for that match. With this knowledge, the program was able to select an idle digit trunk and dial digit receiver and supply dial tone to the calling party. Having done this, the SS may now be continued and so the logical sequence of events is terminated with an ADV command.

6. DETAILED CALL PROCESSING PROGRAMS

GENERAL

6.01 The following paragraphs have been appended for those who are interested in examining portions of the call processing program in minute detail.

6.02 As these examples duplicate portions of the program listing (PR, which is the coding as printed by the assembler), a short explanation of the listing format is included at the beginning of the first example.

6.03 The first example to be analyzed is a reproduction of an actual subroutine program used in the No. 101 ESS, namely, SUBE. This subroutine selects an idle time slot. A general description of the program's function and a detailed account of its manner of execution is provided.

6.04 The second example is a much larger section of the program extending from progress mark 2 (PM2, the dial tone progress mark) to awaiting completion of outpulsing (PM15CØ) on a compressed number dialed call. This example is keyed by location numbers to the coded program but is not an exact copy of the PR.

6.05 The third example goes through the fine grain detail of several of the commands in the beginning of sector (BOS) program by clock phases in an effort to relate program operation to function of the logic circuits.

DETAILED DESCRIPTION OF IDLE TIME SLOT SELECTION SUBROUTINE

A. General

6.06 The subroutine SUBE, which selects an idle time slot, was chosen for this first detailed description.

6.07 As the reproduction of the PR must be understood, the following paragraphs briefly review the listing format and discuss items in it which are unique* to the No. 101 ESS.

B. Analysis of Detail Program Listings

Detail Program Sheet Format

6.08 Fig. 29A and B are examples of actual program sheets. The column headings have the following meanings:

(1) ***FLAGS***

Programs are assembled on large digital computers. A number of ground rules are established in the computer before it is given the job of assembling a program. If a programmer violates one of these rules in the information fed to the computer, a single letter symbol is printed in the FLAGS column by the computer to alert the programmer to the error. If the error is of no consequence, the programmer may decide to leave it in. (On some program sheets, the column headed FLAGS may contain the TTY location of the word and the actual FLAG will be printed in the far right column.)

(2) ***LOC***

This is the octal location (address) of the word in the program store (PS). A capital B to the right of this number indicates the second half of a K-type word.

(3) ***OP***

The octal representation of the 5-bit operation code of the J or K word at the location given in (2) above.

(4) ***ADDR***

The octal representation of the address part of a command, 2 octal digits (5 binary bits) for a K command, or 5 or 6 octal digits for a J command. In the case of J command transfers, the octal number is the transfer location.

* The No. 101 ESS assembler is a modification of the standard Fortran Assembly Program (FAP).

(5) ***TA***

Transfer allowed bit. The machine will give an alarm if transfer is made to a word which has no TA bit.

(6) ***ALTER NO***

Number of IBM card image location in "crunch" deck used in computer assembly program. This number may be ignored for program reading purposes.

(7) ***INSTRUCTION***

This column contains location symbols, the mnemonic command, and certain addressing information. For example, the following instruction is found at location 11026:

AT135 2BT AT137

AT135 is the entrance symbol for this part of the program. 2BT is a conditional transfer, K-type command. AT137 is the mnemonic symbol for the entrance into another part of the program that the call processor will transfer to if the 2BT condition is satisfied. See location 11034. If the condition is not satisfied, the next sequential instruction will be executed. In our example, this would be the command CGT CBXCØ at location 11026 B.

The configuration of AND and LØR command address bits would also be found in this column (there are none in this example). They may be shown here in octal or binary form. In either form, the left zeros may or may not be printed but must always be assumed as present.

This column also contains certain computer instructions required in assembling the program. For example, the symbol CØR would indicate "insertion of NØP* command not required after read command." Asterisks indicate a comment line.

The NØP command is frequently inserted by the machine to advance the program sequentially when the preceding command is a K-type word in the first half of a location and the following command is a J-type word. It also is used after a read command to ensure that adequate time is allowed for the call store (CS) write cycle.

* The NØP is a no operation command and will, therefore, be ignored throughout this discussion.

(8) *COMMENTS*

Columns used by programmer to insert clarifying statements and remarks.

Symbol Index

6.09 A symbol index will be found at the back of each PR. There also may be an EQU or equals table. The symbol index lists the location of all the symbols in the associated block of program, the symbol itself, and all of the locations of commands that transfer to the symbol location. The EQU table lists different symbols with identical meanings.

6.10 The same symbols referred to above will be found indexed in the associated program flow charts. These entrance symbols are a convenient key to various sections of the detail program. By locating an entrance symbol (or subroutine symbol) on the flow chart immediately preceding a section of the program one desires to look at and then by locating the symbol in the detailed program index, it is possible to become quickly oriented in the program.

Macros

6.11 Some programmers prefer to group frequently used series of commands under a single symbol, when assembling the program, to save time and effort and improve the accuracy of program writing. This symbol, called a MACRO, is recognized by the digital computer assembler which then inserts the required series of commands into the program automatically. MACRO symbols (there are many) are made up and assigned by the programmer. The particular symbol used and its expansion into program commands can usually be found under the term "MACRO" at the beginning of a block of program. This serves to identify the symbol when it is encountered later in the program.

6.12 The above is an explanation of the simplest form of a MACRO. Under the MACRO concept, considerably more complex programming, beyond the scope of this discussion, is possible.

Pseudo Operations

6.13 There are many types of symbols that may be found in the detail program that do not require analysis to be able to follow the program. These symbols represent computer operations that were performed in assembling the program. They can usually be identified by the lack of a location number. The symbol CØR, mentioned earlier, is a pseudo operation that told the computer to skip a NØP command. Blank lines in the program used to separate sections of the program are inserted by a pseudo operation. Although of great value to the programmer, pseudo operations can be largely ignored when following operations through the program.

C. Introduction to the Subroutine

6.14 The subroutine is a method of programming that allows multiple use of the same sequence. When a logical sequence or function is required repeatedly throughout a program, it is desirable to write this sequence only once and use it as many times as necessary, thus conserving memory allotment and avoiding duplication of effort. This multiple use of a single routine presents the problem of remembering the address in the main routine from which we came so that upon completion of the subroutine we may return to this address, if it is desired to do so, and resume the sequential execution of the main sequence. This is exactly analogous to a reader returning to a sentence after referring to a footnote. In this case, our reader has made a mental note of his return sentence. For a subroutine, we must store the return address at a place where it is readily available for examination.

D. General Description of SUBE

6.15 After storing the return address, the CS address and time slot number of the highest numbered time slot assigned to the sector currently being processed are placed in their respective registers. This information is located in the per switch unit information of the PS. Having done this, the program begins to examine the first word of each time slot in the sector until an idle time slot is found.

6.16 When an idle time slot is found, a check must be made to determine that a failure has not occurred in the switch unit that would disable this time slot. If such a failure has occurred, the program marks this time slot busy so that it will not be looked at again and continues its search. If the time slot is usable, its address is set in the call store address register

(CA), and its number is set in the time slot number counter. The routine then returns to the main sequence by adding one to the return address it was given and transfers control to that location. If no idle time slot was available, the return address itself would be used to re-enter the main sequence.

E. Program Analysis

6.17 Referring to Fig. 29A, it can be seen that the first three instructions of SUBE are clear and gate commands (CGT). The first two are used to temporarily store the contents of the CA and the time slot (TS) buffers in the call store buffer (CB), in preparation for writing them into the store. The third CGT causes the CA to address its 32-word block of supplementary information pertaining to this switch unit. The return address, given to the subroutine, was left in the call store output register (CO). The WRT C1 stores this return address in the CS memory and the following CGT and WRT C4 stores the contents of the CB in another CS memory location. Having done this, the CA, TS, CB, and CO registers are now available for further use.

6.18 In order to start the sector scan (SS) we must now obtain the address of the highest numbered time slot assigned to this sector. Since information of this nature is frequently desired from the PS, another subroutine (AA10) is called into play to place this information in the CO. Execution of the STA AT129 and TRA AA10 commands causes subroutine AA10 to be performed. Returning to location 11005 (denoted symbolically as AT129), the information needed to start the SS is placed in its respective registers by the two CGT commands. Since the first two time slots (eight words) of every sector are reserved for maintenance, they must be bypassed by call processing. The AD1-HCA command adds four (4) to the CA and must, therefore, be given twice to skip the maintenance time slots. Following the execution of the AD1-HCA at symbolic location AT130, the program reads the first word of the time slot into the CO where the NØT command checks it for an "all zeros" condition. This conditional transfer (to AT133) will be taken if the "all zeros" condition exists; otherwise the next sequential instruction (TIX) will be performed. Let us assume, for brevity's sake, that the entire sector is busy so as to examine the straight through or sequential manner of execution.

6.19 Since the TIX command is a conditional transfer command, a transfer to symbolic location AT130 will occur when TIX is executed if the time slot number buffer content is greater than two. Execution also will cause the buffer to be decremented by one so that examination of n time slots will cause TIX to transfer n minus one times. Transferring to AT130 causes AD1-HCA to step the CA to the next time slot address and the above process is then repeated n times. When the TIX command is executed for the nth time (assuming the sector is busy), the program will step sequentially to location AT132.

6.20 Having found all time slots of the sector to be busy, SUBE must now return to the main program with this information. To do this, the system registers first must be restored to the state they were in upon entry. The original CS address and time slot number are retrieved from the memory location where they were temporarily stored. This is done via the CGT command at location AT132, followed by a RED-C4. The next CGT command places this information in the CB, allowing the RED-C1 at location AT146 to place the return address in the CO. This address represents the beginning of the failure path in the main program and when control is passed to this location, instead of this location plus one, the busy status will be conveyed to the main program. All that remains to be done before passing control to this address is to restore the CA and TS buffer. The two CGT commands prior to the GPA perform this function and the GPA passes control to the return address stored in the CO.

6.21 As stated earlier, when an idle time slot is found, a check must be made to determine that a failure has not occurred in the switch unit that would disable this time slot. When this "all zeros" condition is discovered by the NØT command, the program beginning at symbolic location AT133 will be executed. At this point the address of the idle time slot is temporarily saved in the CB while the supplementary information (Fig. 8) for this switch unit is being addressed. The 15th bit of the ninth word of this information, if set to one, will mean that one-

half of the switch unit time slots are not usable. The 16th bit of this same word, when set to one, will tell us that odd-numbered time slots should not be selected. When set to zero, the even-numbered time slots are not to be used. However, when bit 15 is a zero, all is well, and any idle time slot may be selected.

6.22 The 1BT command (at location 11022) examines the 15th bit. When all is well it will step sequentially to AT134 where the program retrieves the return address, restores the idle time slot address to its respective registers, and returns to the main program via the GPA command, after adding one to the return address in the CO.

6.23 Should bit 15 be set to one, the 1BT command will transfer to symbolic location AT135 where bit 16 will then be examined by the 2BT command. Since this bit tells the program to select an odd- or even-numbered time slot, the program needs only to examine the low order bit of the time slot number to determine if this idle time slot is usable. The sequential path beginning at location AT135 must, therefore, look for an odd-numbered time slot (since bit 16 is zero for this path), while the sequence beginning at AT137 must look for an even-numbered time slot. It should be noted that regardless of which sequence is executed, if the time slot is usable, the program will return to location AT134 to successfully return to the main program. Additionally, regardless of which sequence is executed, if the idle time slot is not usable, the program will execute the sequence beginning at location AT136.

6.24 The AT136 sequence causes a PM to be written into the nonusable idle time slot and then returns to the TIX command at location AT131 to continue scanning the sector for a usable idle time slot. The purpose of this PM is to prevent a re-examination of this time slot on some future request, thus reducing the time required to find a usable time slot when one-half of the switch unit is not working. During the normal call processing SS, this PM will cause an advance to the next time slot to be performed.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
12615	TRPM2	RED C2	To see if the calling party has taken any supervisory action, such as going on-hook, getting the calling party's (A's) equipment number (eight bits) from the second word (C2) of the time slot, as recorded in the call store (CS), and putting it into the call store output register (CO).

ANALYSIS OF COMPRESSED NUMBER PROGRAM

A. General

6.25 The following example is a guide to the analysis of the call processing involved when an extension dials a compressed number. Included in this section of the program is dialing translation, selection and seizure of a central office trunk, interrogation of the line information store (LIS), loading of the data and digit store with the compressed number obtained from the LIS, and finally writing PM15CØ in the CS time slot to await completion of outpulsing.

6.26 We suggest that the program flow charts be used with this analysis. The actual PRs which are in any given No. 101 ESS will, of course, differ from this one due to improvements and changes and, therefore, cannot be specifically related to these detailed examples.

B. Example of a Compressed Number Call Sequence

6.27 This example of a segment of the No. 101 ESS program assumes that an extension in switch unit No. 1 has dialed compressed No. 471, dialing is completed, and the CS scan has reached the sector and time slot where the calling extension is located. The extension number and time slot number bits will be indicated by Xs where applicable as they play no significant part in the called number translation. The program will begin at PM2 — waiting for completion of dialing.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
		MET GC48	Compare (ie, match) the number in the message buffer (MB) with the calling party's number, which is in the CO — the result assumed here is that no match was made and thus the program control proceeds to the next sequential instruction.
			As the above mismatch indicated that the A party had taken no supervisory action, we proceed to see if the A party has completed dialing and if so what was dialed.
	RA10	RED C3	We must first obtain the digit receiver number which A is using from the third word (C3) of the time slot record which is stored in the CS. We put this digit receiver number (DGR) into the CO.
		RED DDR	We now match the DGR number of A with the DGR number, which has a complete dialed number in the digits completed register (DCR) in the digit control, and since we get a match, we transfer the bits from the DCR to the CO in binary coded decimal (BCD) form.
12617 B		4B0 GC49	The four-bits-not-zero command determines if there is a digit in the low order position of the CO, for if the RED DDR command had not found matching DGR numbers, zero would have been returned to the CO. Thus, any BCD digit would have some ones in it if it were a dialed number. Indeed here we find that the low order four bits of the CO contain 0001 and so the four bits are not all zero and we transfer to GC49.
12623	GC49	RED C4	The fourth word of the time slot is brought into the CO in order to examine the reroute (RR) bit.
		FIL RG70	The FIL command is used to extend the distance which a short transfer command may go. It adds five bits to the 5-bit transfer address, thus allowing transfers within the location range of 2^{10}. See CD-1H049 for further detail.
		SHR 5	Move the RR bit to position 2.
		2BT RG70	Check RR bit (zero).
		RED C2	Put A party in CO.
		SHL 8	Move A to 8 HOB (high ordered bit).
		CGT CØXAS	Store A in add-shift (AS) register.
12627		TSA GE0	Store return address and obtain transfer address.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
12613	GE0	WRT TF1 WRT LF1	Subroutine to check for presence of an entry in the automatic reroute list (ARL). Extends through following program up to, but not including, NN10.
12614		TRA GD46	Transfer to GD46 to check state of repair (SR) register and ARL status.
12462	GD46	CGT CAXCB CGT TSXCB	Store CS address and time slot in call store buffer (CB) to free call store address (CA) and time slot (TS) registers.
		CGT SUXCA	000000100000. Address of switch unit number times 32 temporary storage areas (SU # × 32) in CS.
		WRT C4	0001010110011000. Address left in CO by TSA command. Store in temporary storage, word 4.
		RED MB WRT C1	Store MB message (if any) in CS temporary storage, word 1, to free MB register.
		CGT SRXCØ	Load CO with information on system state of repair.
		FIL GD24	Prepare for transfer to GD24 if required.
12466		1 BT GD24	Check state of repair bit of other CS. Transfer if off-line call store (OSC) is out. (Assume OCS OK.)
		AD1 HCA AD1 HCA AD1 HCA	000000100100 000000101000 000000101100 — Advance address register to ARL area.
		RED C2	000000101101. Address of automatic reroute list full bit in CS. Read into CO.
		SHL 1	Move ARL full bit to position 1.
		1BT GD30	Check ARL full bit (assume zero).
12472		CLF GD22	Logic flop set to one by routine. GE0 to indicate no reroute.
12475	GD22	CGT SUXCØ	0000000000010000.
		SHL 5	0000001000000000.
		LØR	0011100111000000. 0011101111000000. The above assembles the SU × 32 + 924 supplementary information address of the OCS.
		CGT CØXCA	0011101111XX. Bits 1 through 6 are not gated to CA.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
		AD1 HCA	0011110000XX.
		AD1 HCA	0011110001XX.
		AD1 HCA	0011110010XX.
			Add 12 (4 + 4 + 4) to address.
		RED C4	001111001011.
			Add 3 to address.
12501B		CGT CAXØCA	Transfer address to OCA register.
12502		STA 1111	Load TS counter with 15 counts for TIX CMD (location 12516B).
		CGT CØXTS	
		FIL GD25	Load transfer buffer (TB) for possible transfer.
12504		CTF GD25	Test flop equals one (set at GE0).
12536	GD25	FIL PASS 1	Load TB.
12536B		CLF PASS 1	Logic flop equals one (set at GE0).
12505	Pass 1	AD 1 ØCA	001111001100. Address of first reroute party in ARL. Add one to this address on each TIX command. Pass one routine determines if A party appears anywhere in ARL in OCS.
		CLR CØ	
		CGT AASXCØ	Return A party to 8 HOB of CO.
		SHR 7	A party moved to bits 2 through 9.
		CGT CØXMB	Store A party in MB, bit 10 equals zero.
		RED ØC	Obtain reroute party from ARL. Address determined at location 12505. Add one on each TIX command.
		FIL GD34	
		LSH 16	Shift the contents of OCO to CO.
		MET GD34	Match A party stored in bits 2 through 9 of MB with bits 1 through 8 of CO, containing first or succeeding parties in ARL. Assume mismatch.
12511B		CLF GD35	Logic flop equals one (transfer).
12516	GD35	FIL Pass 1	
12516B		TIX Pass 1	Reduce the contents of TS by one and return to location 12505. Repeat match on second and succeeding parties in ARL list. Assume mismatch when contents of TS equals two (supplementary information, word 29 checked for match); advance to next instruction.
		WRT TF 1	Set previously — not in ARL.
12517B		CLF GC147	Failed to locate in ARL.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
12523	GC147	CGT SUXCA	Address temporary storage area in CS to retrieve stored information.
		RED C1	Retrieve MB message (if any).
		TRA 01+*+1 BSS 01	Maintenance bypass; ignore.
		CGT CØXMB	Transfer MB message back to MB.
		RED C4	Retrieve program; store return address 0, 001, 010, 110, 011, 000 (12630_8).
		CGT CBXTS CGT CBXCA	Retrieve A party CS address and time slot.
12530		CTF GC150	Test FF (TF) equals one.
12531	GC150	GPA	Return to location 12630.
12630		TRA RG73	Transfer to RG73.
12663	RG73	TSA NN10	Transfer to NN10 to mark MSG (message, see Fig. 9, word C3) sent bit equal to zero; return address will be at 12664.
03156	NN10	CGT CØXCB	Store return address.
		RED C3	Obtain C3 word containing MSG sent bit location.
		AND	1111111110111111. Mark MSG sent bit equal to zero.
		WRT C3	Write C3 word back into CS.
		CGT CBXCØ	Retrieve return address 12664.
03161		GPA	Return to 12664.
12664	GE13	TRA RG70	Transfer to 12632.
12632	RG70	RED C3	Put DGR number in CO.
		RED DDR	Match RNB (receiver number buffer) with 6 HOB of CO (match). Gate all 12 bits of DCR to 12 LOB (low ordered bit) of CO.
		CGT CØXCB	Put dialed number in CB. Dialed No. 471 is in BCD form — 0100, 0111, 0001.
12634		TSA F1	Dialed number translation routine. PS address 12635 in CO.
10000	F1	WRT C1	Store program return address 12635 in C1 area of CS.
		CGT CBXCØ AND NØT F80	Dialed number: 0000010001110001, 0000111111111101. Test for time-out — if time-out has occurred, bit 2 equals one, all other bits set to zero. AND sets 2 equal to zero.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
		CGT CBXCØ	Restore dialed number to CO.
		SHL 8	0111000100000100.
10003B		4B0 F2	Determine whether dialed number contains two or three digits.
10014	F2	RED C4	This routine stores frequently used information in the CS time slot and stores less used information in the scratch locations.
		CGT CAXCB	Store CS return address in CB.
		SCA	Jam set CA to system scratch location 1360_8 — 1011110000.
		WRT C1	Store C4 word of time slot in C1 word of system scratch.
		CGT CBXCØ	Put CS return address in CO.
10016 B	(F2)	WRT C2	Store CS return address in scratch.
		CGT CØXCA	Transfer return address to CA.
		RED C3	Obtain DGR number.
		WRT LF0	Set logic flop to zero. Logic and test flops will be used as "reminders" later in the program to identify the type of call being made.
		RED DDR	Gate dialed number into CO.
		WRT C4	Store dialed number in CS at location previously cleared by this routine.
		STA F5	Gate F5 routine address into CO.
		CGT CØXCB	Store F5 location in CB.
		CGT SUXCØ	SU X 16 equals 0000000000010000.
		LØR	Add 2 — 0000000000000010 equals 0000000000010010.
		WRT TF0	Set test flop to zero.
		GPA	To SU X 16 + 2 supplementary information in PS.
00022		STØ	Load CO with 044243_8 = 0100100010100011. Indicates normal dialing codes for this SU — 200 through 399. Gate store address in CB to program store address register (PA).
10026	F5	FIL F6	Load TB for transfer to 10051.
		SHL 2	Move 2 HOB to 2 LOB position. These bits identify normal dialing codes as follows: 01 equals 200 to 399; 11 equals 400 to 599; 10 equals 600 to 799.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
		1BT F6	A one in the first bit position indicates codes between 200 and 599.
10051	F6	2BT F12	A zero in the second bit position indicates the normal group is 200 through 399.
10051B	(F6)	RED C4	Obtain dialed number 0000, 0100, 0111, 0001.
		SHL 7	0, 0111, 0001, 0000, 010.
		2BT F14	Determine whether or not dialed number is in normal group or is a compressed number (compressed).
10055	F14	FIL F13	
		1BT F13	Is number equal to six?
		TRA F8	Number is not equal to six (equals four); compressed numbers for group 200 through 399 are 400 through 599, dialed number equals 471.
10041	F8	WRT TF1	Set test flop equal to one to indicate compressed number was dialed.
10042	F11	RED C4	Put dialed number in CO.
		SHL 8	Move hundreds digit (0100) to low order position 0111, 0001, 0000, 0100.
		1BT F9	Check to see if hundreds digit is even or odd. Even digit will be converted to 0000, odd digit to 0001. This is the first step in translating a BCD dialed number to binary. Hundreds digit must be converted to zero or one, representing actual switch unit number series 0 to 199.
		AND	1111111100000000 convert hundreds digit to 0000.
		SHR 8	Restore number to original order in CO.
10046		TRA TRANS	Transfer to location 10066.
10066	TRANS	SHL 6	00 0111 0001 0000 00 — dialed number contained in 10 IIOB. Remaining six bits may be destroyed.
		CGT CØXCB CGT TSXCB	Store dialed number and CS TS number in CB-00 0111 0001 XXXXXX.
		CLR CØ	
		LØR 5	No. 5 to CO — 0000000000000101.
		CGT CØXTS	Put 5 in TS — 000101 for TIX at FF1.
		CGT CBXCØ	Restore dialed number to CO.
		SHR 6	Dialed number in bits 1 through 10, TS in bits 11 through 16 — XXXX, XX00, 0111, 0001.
		CGT CØXCB	Store TS and dialed number.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
		LØR	0000 0000 0000 0101. Begin check to see if lowest order dialed digit was a zero (1010 BCD).
		FIL F20	
		4BI F20	3d digit equals 0001, (LOR'D to 0111).
10075	FF9	SHR 4	0111 XXXXXX00 0111.
		LØR	0000 0000 0000 0101 equals
		FIL FF7	0110 XXXX XX00 1100.
		4BI FF7	Check if second digit equals 1010.
		CGT CBXCØ	Retrieve dialed number XXXX, XX00, 0111, 0001.
		SHR 3	001, XXXX, XX00, 0111, 0.
10101	FF2	2BT F21	Test for 10, 20, 40, 80. The BCD number carries decimal weighting as follows: (before SHR 3) 100 80 40 20 10 8 4 2 1 XXXX, XX0 0, 0 1 1 1 0 0 0 1.
		2BT F21	The binary number can be assembled from the above by replacing decimal 10 with binary 8 + 2; decimal 20 with binary 16 + 4; decimal 40 with binary 32 − 8; decimal 80 with binary 64 − 16.
10103	F21	AND	1111111111111101 — remove 10.
		AD1 CØ	001, XXXX, XX00, 0110, 1 — replace 8.
		SHL 2	1, XXXX, XX00, 0110, 100.
10105		AD1 CØ	1, XXXX, XX00, 0110, 101 — replace 2.
		SHR 3	1011, XXXX, XX00, 0110.
10106	FF1	TIX FF2	Reduce TS to 00100.
10101	FF2	2BT F21	Test for 20 (bit 2 equals one).
10103	F21	AND	1111111111111101 — remove 20.
		AD1 CØ	1011XXXXXX000101 — replace 16.
		SHL 2	11XXXXXX00010110.
		AD1 CØ	11XXXXXX00010111 — replace 4.
		SHR 3	11111XXXXXX00010.
10106	FF1	TIX FF2	Reduce TS to 00011.
10101	FF2	2BT F21	Test for 40.
10103	F21	AND	1111111111111101 — remove 40.
		AD1 CØ	11111XXXXXX00001 — replace 32.
		SHL 2	111XXXXXX0000111.
		AD1 CØ	111XXXXXX0001000 — replace 8.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
		SHR 3	000111XXXXXX0001.
10106	FF1	TIX FF2	Reduce TS to 00010.
10101	FF2	2BT F21	Test for 80 (failure — find zero).
		SHR 1	1000111XXXXXX000.
10102		TRA FF1	
10106	FF1	TIX FF2	TS = 00010 = 2; execute next command.
10107	FF8	CLR AS	
		2BT FF4	Test for add 100 (failure — find zero).
		SHRS 1	01000111XXXXXX00.
		2BT FF5	Test for add 200 (failure — find zero).
10111		TRA FF6	
10120	FF6	CGT CØXAS	Store translated number (now in binary) in AS register.
10120B		CGT CBXCØ	Recover TS number TS BCD XXXX, XX 00, 0111, 0001
		SHL 6	Locate TS number in 6 LOB (low ordered bit) position.
		CGT CØXTS	Return TS number to TS register.
		FIL 23	
		CLF F23	Logic flop equals zero.
		SCA	Address CS scratch location.
		RED C1	Retrieve C4 word of time slot stored in C1 scratch.
		CGT CØXCB	Store C4 temporarily.
		RED C2	Retrieve CS return address.
		FIL F23	
		CGT CØXCA	Put CS address in address register.
		CGT CBXCØ	Retrieve C4.
		WRT C4	Restore C4 word to correct CS location.
10127		CTF F23	Indicated compressed dialing.
10210	F23	RED C1	Retrieve PS return address.
		AD1 CØ	
10211		TRA F66	
11175	F66	AD1 CØ	Add three to return address; return to PM2 transfer vector 12635 + 3 = 12640 = RET 3, compressed dialing.
		AD1 CØ	
11176		GPA	

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
12640	RET 3	TRA GC53	Compressed dialing.
12673	GC53	TSA RG76	Return address 12674.
13006	RG76	CGT CØXCB	Store return address in CB.
		RED C3	Check reroute list bit routine.
		FIL RB130	
		SHR 5	Move RR bit into check position.
13010		2BT RB130	RR list bit equals zero.
		CGT CBXCØ	Restore return address.
13011		GPA	Return.
12674	RG79	TSA GC411	Routine to mark CD bit equal to one.
12741	GC411	CGT CØXCB	Store return address 12675 in CB.
		RED C4	
		LØR	0000010000000000 — set bit 11 equal to one to indicate compressed number was dialed.
12743	16211	TRA CD171	
16211	CD171	WRT C	Write C4 back into CS (in this example = 0000010000000000).
		CGT CBXCØ	Retrieve return address.
16212		GPA	Return to 12675.
12675	GD343	RED C4	0000010000000000.
		SHL 6	0000000000000001 — CD bit.
		CGT AASXCØ	0100011100000001 — put translated dialed number (binary) in 6 HOB of CO.
		SHR 6	0000010100011100 — restore correct word bit order.
		WRT C4	Store translated number in C4 word.
12700		TRA RB131	
12703	RB131	RED C4	Check to see if A is central office trunk.
		1BT RB130	Is A central office trunk? No, the bit is equal to zero.
12704		TSA SUBA	Routine to select central office trunk.
11100	SUBA	CGT CAXCB	Store return address in CB.
		CGT TSXCB	Store TS address.
		CGT SUXCA	SU X 32 temporary storage area.
		WRT C1	Store program return address 12705.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
11102		CGT CBXCØ WRT C4	Store CS address and TS in temporary store SU X 32.
		STA AN29	Store PSOR address 11107 in CO.
		CGT CØXCB	Store 11107 in CB.
		CGT SUXCØ	SU X 16 — with LOR obtain number of central office trunks to be examined from PS.
		LØR	0000000000000011 — SU X 16 +3.
11106		GPA	To SU X 16 +3.
00023		STØ	13_8 to CO, CBXPA 11107_8.
11107	AN29	CGT CØXSC	---01011 to shift control counter (SC), group 1 of supplementary information.
		AND	0 111 111 111 100 000 clears group 1 and DID bit from CO.
		CGT CØXCB	Store remaining groups, if any.
		CGT SUXCA	SU X 32 supplementary information in CS.
		AD1 HCA	SU X 32 + 4 = 000000100100 = trunk status information.
		RED C1	Trunk status word group 1 in CS; assume all trunks idle.
			→ trunk status, trunks 15 to 18 00000 000 00000000 → group 1, trunks 13 to 8.
		LØR	0000000011111111 — bypass traffic counter.
	AN30	SHØ 0	1111111100000000 — zero in LOB position.
		1BT AN32	Zero equals idle trunk.
		RED C	Idle trunk available, restore traffic counter.
		CGT ASXSC	AS set to trunk number (assume 8) by SHO command. Store trunk number 01000 in SC.
		SHR 0	0000000000000000 set by 8 in SC.
		LØR	0000000000000001.
11121	AN30	CGT ASXSC	Reset SC to idle trunk No. 01000.
		SHL 0	0000000100000000 reposition trunk bit to bit position 9.
		WRT C	Record trunk No. 8 as busy (up dates trunk status word).

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
	AN31	CGT SUXCA	SU X 32.
		RED C4	Read CS plus TS address.
		CGT CØXCB	Store CS and TS address in CB.
		CGT CØXCA	Load CS address in CA.
		RED C2	A party and B area in CO — trunk number will be recorded in B area.
		CGT AASXCØ	Enter trunk number in CO.
			Trunk: 00001000 — A party: XXXXXXXX
		WRT C2	Write trunk number and A party in CS.
		LØR	0100000000000000. A one in bit position 15 is required to seize the central office trunk.
		WRT TC	Load the trunk connector with seize bit, SU number, and trunk number. Initiate trunk seizure.
			SU No. 100001 TK No. 001000 — Seize Bit
		CGT DSBXCØ	Gate the trunk double seizure bit to bit 1 of the CO.
		FIL CKDSB	
		1BT CKDSB	Assume zero, trunk is clear.
11132	TKCT	TRA TRAF2	Central office trunk including peg count routine.
21033	TRAF2	CGT CBXCA	Save contents of CB.
		CGT CBXTS	
21034		TSA TEMP	Subroutine to identify variable planes.
23270	TEMP	CGT CØXCB	Store return address in CB.
23271		TRA 37376	
37376		STØ 10	Assume TRACE variable plane. Set CO to binary 2, and return to 21035_8.
21035		FIL TRF2	
21035 B		1BT TRF2	Check for traffic (bit 1 equals zero).
21036		CGT CAXCB	Restore CB contents.
		CGT TSXCB	
21037		TRA AT134	Return.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
11023	AT134	CGT SUXCA	SU X 32 temporary storage area.
		RED C1	Obtain return address 12705_8.
		CGT CBXTS	Save CB.
		CGT CBXCA	Save CB.
		AD1 CØ	Return address + 1 (12706_8).
		GPA	
12706	RE39	NØP	Former routine entrance point — word location retained to ensure that none of the exits to this entrance were overlooked.
12707	GD371	TRA GOUT2	
13336	GOUT2	TSA NN10	Routine to mark ATND dialed bit equal to zero.
03156	NN10	CGT CØXCB	Store return address in CB.
		RED C3	Transfer C3 word to CO.
		AND	1111111110111111 — set ATT bit equal to zero.
	N252	WRT 3	Write C3 word with ATT bit equal to zero back into CS.
		CGT CBXCØ	Retrieve return address 13337.
		GPA	Return to 13337.
13337	GTA 8	STA RPM4CØ	Routine to write PM4CØ in C1.
		WRT C1	0000111000001111 — PM4CØ from STA command (007017_8).
13340		ADV	Advance to next time slot or end of sector (EOS) routine. Subsequent scans through this sector will encounter PM4CØ in this time slot. No action will be taken unless some change has occurred since the previous scan. When the central office attaches an originating register to the selected central office trunk, it connects ground on the LS lead, operating the S relay in the No. 101 ESS central office trunk. S operating operates S1 which operates the T relay, sending a simplexed battery "off-hook" signal to the switch unit. The switch unit scanner then formulates a message to the control unit containing the off-hook and scan point information. This is loaded into the MB and becomes the basis for the following action which takes place when this particular time slot is addressed again.

PM4CØ — A dialed central office or FX trunk, waiting for trunk off-hook. Assume central office trunk off-hook signal received.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
16432	TRPM4C	FIL GD110	
		MRT GD110	Match FF equal to one — a match with the A party will be made to determine whether or not the A party is still off-hook.
16501	GD110	RED C2	Obtain A and B party words.
		MET GD115	No match — A still off-hook.
		SHL 8	Move B party into A area.
		FIL GD116	
		WRT LF1	
16503		MET GD116	B party (central office trunk) matches indicating originating register connected.
16465	GD116	WRT MF0	Set the match required flip-flop (MRF) to zero.
16465		CGT IBXCØ	Beginning of sector (BOS) routine entered the definition of B in bit position 8 and 7 (01) and the off-hook in bit positions 6, 3, 2, and 1 (all zeros). 0000000001000000.
		AND ØFFHK	0000000000100111 AND command "masks" or wipes out all bits except off-hook bits. In this case, assume off-hook which results in all bits set to zero.
		WRT TF0	
16467 B		NØT GD130	All zeros off-hook signal.
16472	GD130	TSA DØRMTØ	Check for time-out — save PS return address 16473.
15361	DØRTMØ	CGT CØXCB	Store return address 16473.
		RED C3	DGR number in bits 11 to 16.
		FIL GPZI	
		RED DDR	Match RNB with 6 HOB of CO — assume match.
		2BT GPZI	Check time-out bit (no time-out).
	GPZ3	CGT CBXCØ	Retrieve return address.
		GPA	Return to 16473.
16473	GGD130	TRA DLTNE	
16606	DLTNE	CGT IBXCØ WRT C1	Save contents of input buffer (IB), definition of B, and off-hook.
16607		CALL RG6	This is what is known as a MACRO routine, the symbol CALL being sufficient to indicate to the IBM 7090 computer all of the elements necessary to this routine. Execute as a TSA command to location 17206. Save return address 16610.
17206	RG6	CGT CØXCB	Store return address 16610 in CB.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
17206 B		CLF RG19	Set to one at 16501.
17212	RG19	CTF RG21	Set to zero at 16467.
		RED C3	To obtain digit trunk number.
		SHL 1	Move digit trunk LØB position from 8 to 9.
		CGT CØXAS	Store digit trunk in AS.
		RED C2	Obtain A party.
		CGT LASXCØ	A party in bit positions 1 to 8, digit trunk (and some DGR bits) in positions 9 to 14.
		AND	0000011111111111 — set bits 12 to 16 of the CO to zero.
17217		TRA RJPAT1	
17772	RJPAT1	CGT CØXIB	Save A party and digit trunk.
		RED C4	Get compressed dialing bit and attendant number (if any).
		CGT CØXAS	Store in AS.
17774		TRA RG21	
17220	RG21	CGT CBXCØ	Obtain return address 16610.
17220 B		GPA	
16610		CGT IBXCØ	Obtain A party and digit trunk.
16610 B		WRT TF1	
		LDT	Connect A party to digit trunk.
		RED C1 CGT CØXIB	Restore definition of B and off-hook to IB.
			The above routine results in the connection of the calling party to a digit trunk without dial tone. This call was to a compressed number so no dial tone connection is required; however, it would require more program space to identify the call as compressed than to permit the program to advance to a digit trunk connection without a digit receiver. The DGR number must be retained in the CS to provide access back to the DDS (data-digit store) to load the DDS with the compressed number obtained from the LIS.
16613		TRA NE70	
03702	NE70	RED C4	Compressed dialing bit 0000010100011100.
		FIL NE76	
		SHL 6	Move compressed dialing bit to LOB position.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
03703 B		1BT NE76	CD bit equal to one — transfer.
03737	NE76	RED S	Put sender trunk register bit in position 2.
		FIL NE72	
		2BT NE72	IDLE STR bit equals zero.
		CGT SRXCØ	Routine to check state of repair of LIS.
		FIL NE72	
		2BT NE72	Assume LIS ok, bit No. 2 equals zero.
	NE78	RED C3	Dialed digit received number in bits 11 through 16.
		CGT CØXAS	Bits 9 through 16 to AS 1 to 8.
		RED C2	Obtain A party and trunk No. 8.
03744		SHR 8	A party: XXXXXXXX; TK No. 8: 0000 1000
		CGT AASXCØ	DGR No.: XXXXXXXX; TK No. 8: 00001000
		AND	1111111110111111 — set bit No. 7 equal to zero to indicate compressed dialing.
		WRT S	Load sender trunk register with DGR number, switch unit number, and central office trunk number — "zero" in bit No. 7 equals compressed dialing (CD). DGR: XXXXXX; CD: 0; TK No.: 001000; SU No.: 00001
		RED C1 CGT CAXCB CGT SUXCA WRT C1	Store contents of C1 in SU X 32 temporary store. Central office (identity): 00000000; off-hook: 01 0 00 000
		CLR CØ	
03751		CTF AT164	TF set to one at 16610.
03766	AT164	AD1 CØ	0000000000000001.
03766 B		1BT AT165	Bit equals one — transfer.
03752	AT165	WRT C4	Store LOB equal to one in SU X 32, C4 word.
		CGT CBXCA	Retrieve CS address.
03753		TSA F51	Return address 03754 — begin routine to outpulse CD digits. Store return address 03754 in PM of CS.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
10246	F51	WRT C1	
		RED C4	ATND (00000) CD (1) COMP No. (01000111) XT (00)
		WRT TF1	With LFO, means compressed number outpulsed.
		SHL 6	Compressed No. (01000111) XT (00) ATND (00000) CD (1)
		CGT CØXAS	Store compressed number in AS — 01000111.
		WRT LF0	See WRT TF1.
10251		TRA F4	
10133	F4	CLF F3	LF (logic flop) equals zero.
		CGT SRXCØ	Routine to check if LIS is working.
		FIL FF10	
10134 B		2BT FF10	Bit No. 2 equals zero, LIS ok.
		STA F31	10143.
		CGT CØXCB	Store address 10143 in CB.
		CGT AASXCØ	Retrieve compressed number from AS.
		FIL F32	Compressed No. (1000111)0 — Hundreds Digit (EVEN)
		SHL 1	
		1BT F32	Check for hundreds digit, ODD or EVEN.
		CGT SUXCØ	SU X 16 information.
		LØR	0000000000000100 — select SU X 16 + 4 word (LIS location).
		GPA	To location SU X 16 + 4 (location 00024).
00024		STØ	3403 -- 0000011100000011. Go to address stored in CB.
10143	F31	CGT CØXCB	Store 0000011100000011 in CB.
		CGT AASXCØ	Compressed number into CO — 01000111.
		SHL 2	00011101 — test next highest bit of AS to select LIS plane.
		FIL F34	
10145		1BT F34	Bit equals one, wants left half.
10217	F34	CGT CBXCØ	
		SHR 8	00000011 LIS (00000111) L. H.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
10220		TRA F35	
10146	F35	FIL F16	
		CLF F16	LF equals zero.
		FIL F36	
10147		CTF F36	Desired plane number in right of CO. TF equals one.
10221	F36	FIL READLI	
		2BT READLI	Second bit equals one.
10153	READL1	SHR 4	0111000000110000.
			6 LOB Compressed No. / Assembling LIS address*
		CGT LASXCØ	01000111 / 00110000
		SHR 8	0011000001000111.
		CGT CØXLA	00000111000111.
		FIL DCD	
		CLF DCD	LF equals zero.
10156		CTF F39	TF equals one.
10163	F39	RED LQ2	Compressed number information desired.
		FIL INT	
		CGT LØ1XCØ	Load compressed number digits into CO.
		NØT INT	Check to ensure that a number was read out of LIS and received in CO.
10165		TRA PATCH	
11260	PATCH	CLR CB	End code in CB — all zeros for this call.
		CGT LØ2XCØ	Bits 17 to 21 of LO (LIS output register) in 12 to 17 of CO.
		SHL 4	
11262	TRA FPAT1		How many digits?
10166	FPAT1	FIL F40	
		4B0	Routine to determine if number contains 7, 10, or 13 digits. 0000 equals 7 or 13 digits.
		SHL 1	
		FIL F48	
		1BT F48	Zero equals seven digits.

* Refer to PD-1H099 for LIS organization.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
	F42	CGT LØ1XCØ	7-digit number — D1, D2, D3, D4.
		RED LQ3	Read D5, D6, D7, perhaps D8.
		LSD	Prepare data control* to receive digits.
		WRT SCD	Load sender with D1, D2, D3, and D4.
10174		CGT LØ1XCØ	Load CO with D5, D6, and D7.
		WRT SCD	Load sender with D5, D6, and D7.
		CGT CBXCØ	All zeros.
		WRT SCD	All zeros — end of digits code to sender.
		CGT AASXCØ WRT SCD	End code from CB prevents transmission of any further digits. These two commands are effective only if 13 digits are to be outpulsed.
10176		TRA F41	
10162	F41	RED C1	Retrieve return address 03754 which was stored in C1 by WRT C1 command in location 10246.
10162 B		GPA CØXPA	
03754		TRA NE73	
03757	NE73	CGT CAXCB	Store CS address in CB.
		CGT SUXCA	SU X 32 temporary storage in CS.
		RED C4	See location 03752.
		FIL AT168	
03761		IBT AT168	One in LOB position established at 03752.
03767	AT168	WRT TF1	
		CTF AT169	
03762	AT169	RED C1	IDENTITY OFF-HOOK 0000000001000000
		CGT CBXCA	Retrieve CS address.
		WRT C1	Write central office trunk identity and off-hook in C1.
03764		TSA GC4X9B	
16142	GC4X9B	CGT CØXCB	Save return address 03765 in CB.
		RED C4	Compressed number and CD bits, positions 3 to 11.
		AND	1111100000000011. Clear compressed number and CD bit.

* See PD-1H099 for additional explanation.

LOCATION	ROUTINE DESIG	COMMAND	COMMENTS
16144		TRA GD171	
16211	GD171	WRT C	Write C4 word less compressed number and CD bits back into CS.
		CGT CBXCØ	Get return address 03765.
16212		GPA	
03765	N1060	TRA TRAF10	Traffic subroutine at 23763 — at completion of routine return to NE82.
03722	NE82	CTF AT160	TF equals one.
03734	AT160	STA RPM15C	Load PM15CØ into CO.
		WRT C1	Write PM15CØ in C1.
03736	N1061	ADV	Advance to next time slot or to EOS routine.
			PM15CØ is "awaiting completion of outpulsing." When outpulsing is completed, the dialing completed bit in the DCR (bit No. 1) will be set to one by the sender control. This is identified during the processing of PM15CØ, thus initiating the action which will result in closing a time division connection at the switch unit between the calling party and the central office trunk. If nothing occurs to prevent completion of the connection, PM7 will be left in the CS time slot.

RELATION OF THE BEGINNING OF BEGINNING OF SECTOR TO PROGRAM CONTROL TIMING

6.28 Fig. 30A and B portray the fine grain detail of command processing by the call processor. The figure is arranged to follow the execution of commands by system clock phases. The circuit operations can be followed on SD-1H049, SD-1H050, and SD-1H035.

7. CONCLUSION

7.01 For the sake of brevity and clarity, an attempt was made to minimize some of the details and include others which, in the opinion of the authors, were either necessary to formulate an over-all picture or emphasize a specific point.

7.02 This section does not set forth a complete description of the call processing program, but provides an insight to the organization and structure of the stored program and its manner of execution.

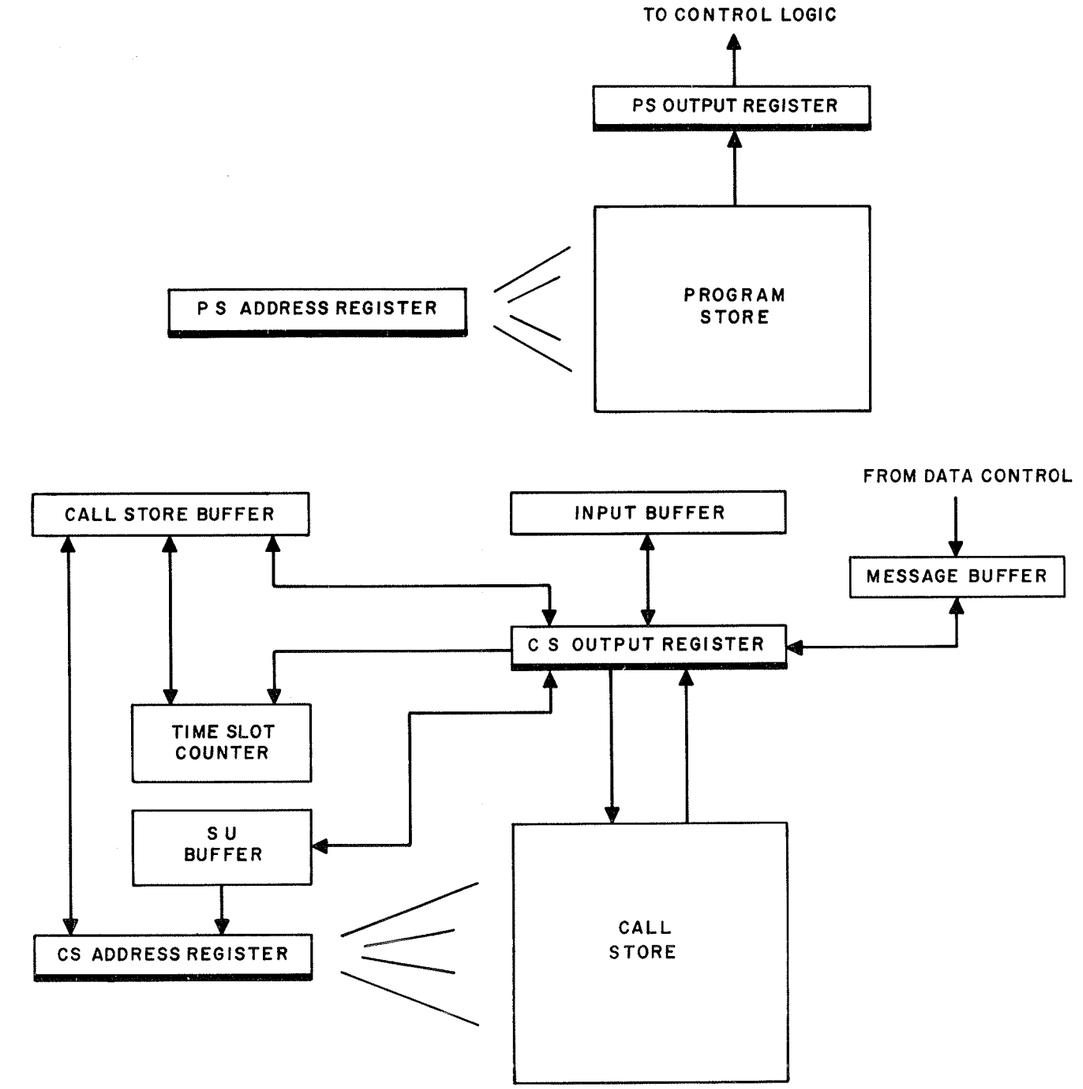
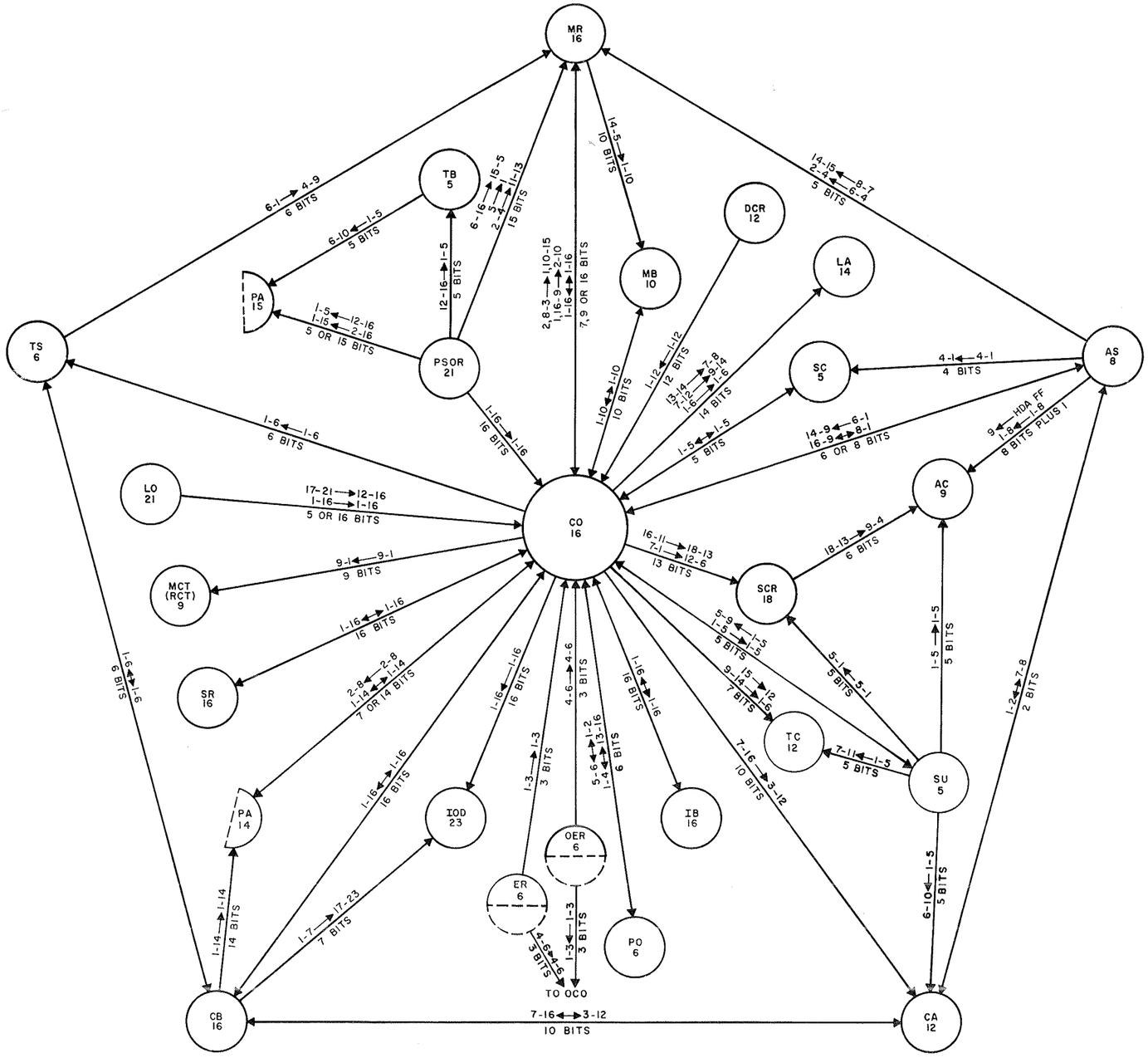


Fig. 1 – Simplified Block Diagram of Program Control from Viewpoint of Programmer



NOTES:

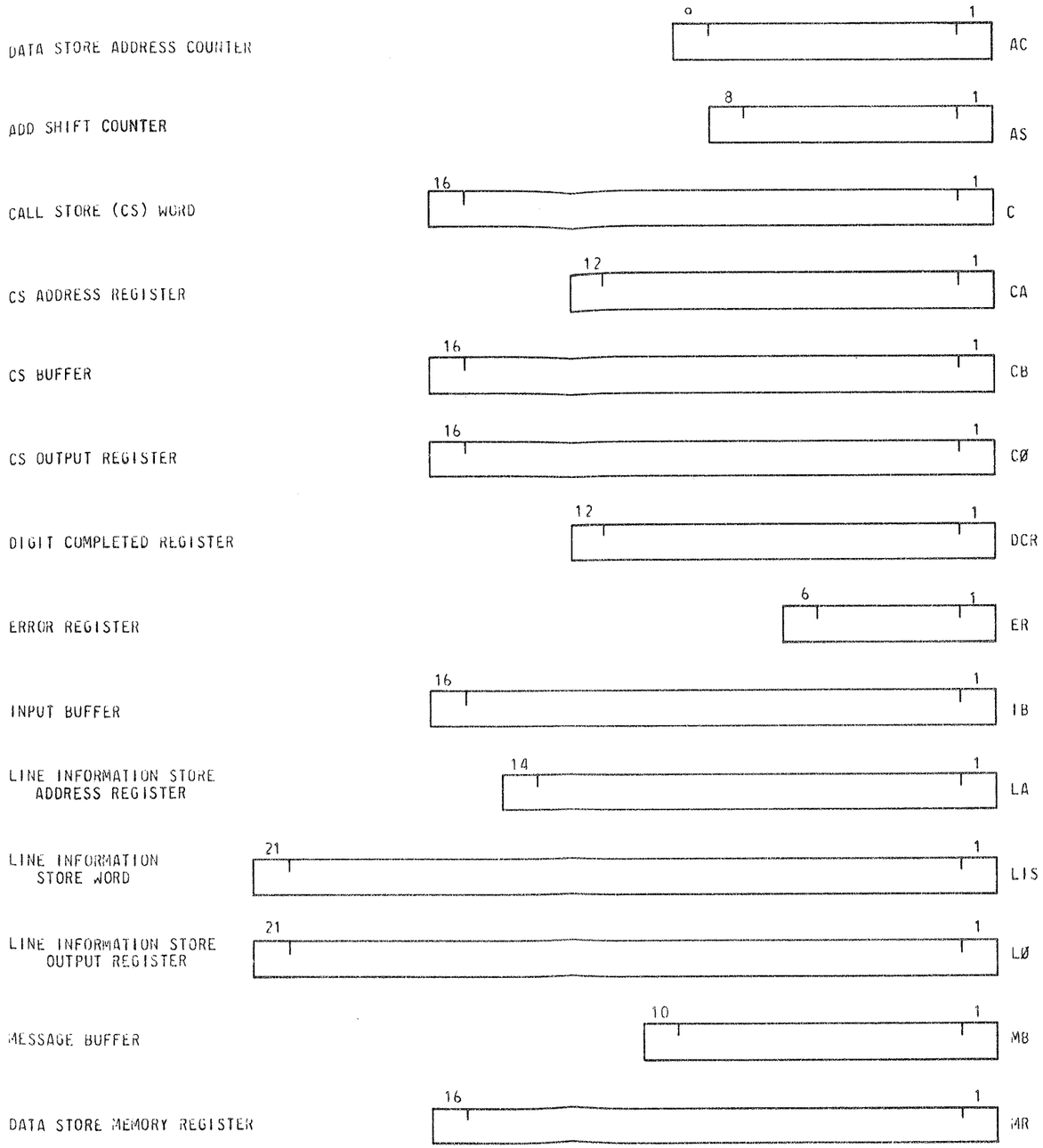
1. THE NUMBER CONTAINED IN A CIRCLE REPRESENTING A REGISTER IS THE BIT LENGTH OF THE REGISTER; ARROWS INDICATE DIRECTION OF GATING BETWEEN REGISTERS. A DOUBLE ENDED ARROW INDICATES BI-DIRECTIONAL GATING.
2. THE VARIOUS BIT GATING ORDERS ARE SHOWN BY THE NUMERALS AND ARROWS ABOVE THE REGISTER CONNECTING ARROWS.

   EXAMPLES:

   A. THE SYMBOL "1-6 → 1-6" BETWEEN THE CO AND TS REGISTERS SAYS "GATE BITS 1 TO 6 OF THE CO TO BITS 1 TO 6 OF THE TS, RESPECTIVELY."

   B. THE SYMBOL "15-5 → 6-16" BETWEEN THE PSØR AND MR REGISTERS SAYS "GATE BITS 15 TO 5 OF THE PSØR TO BITS 6 TO 16 OF THE MR, RESPECTIVELY." IN THIS CASE, BIT 15 OF THE PSOR IS GATED TO BIT 6 OF THE MR, ETC.
3. SEE FIG. 3 FOR EXPLANATION OF REGISTER AND BUFFER ABBREVIATIONS.

Fig. 2 – Major Gating Paths Involved in Call Processing



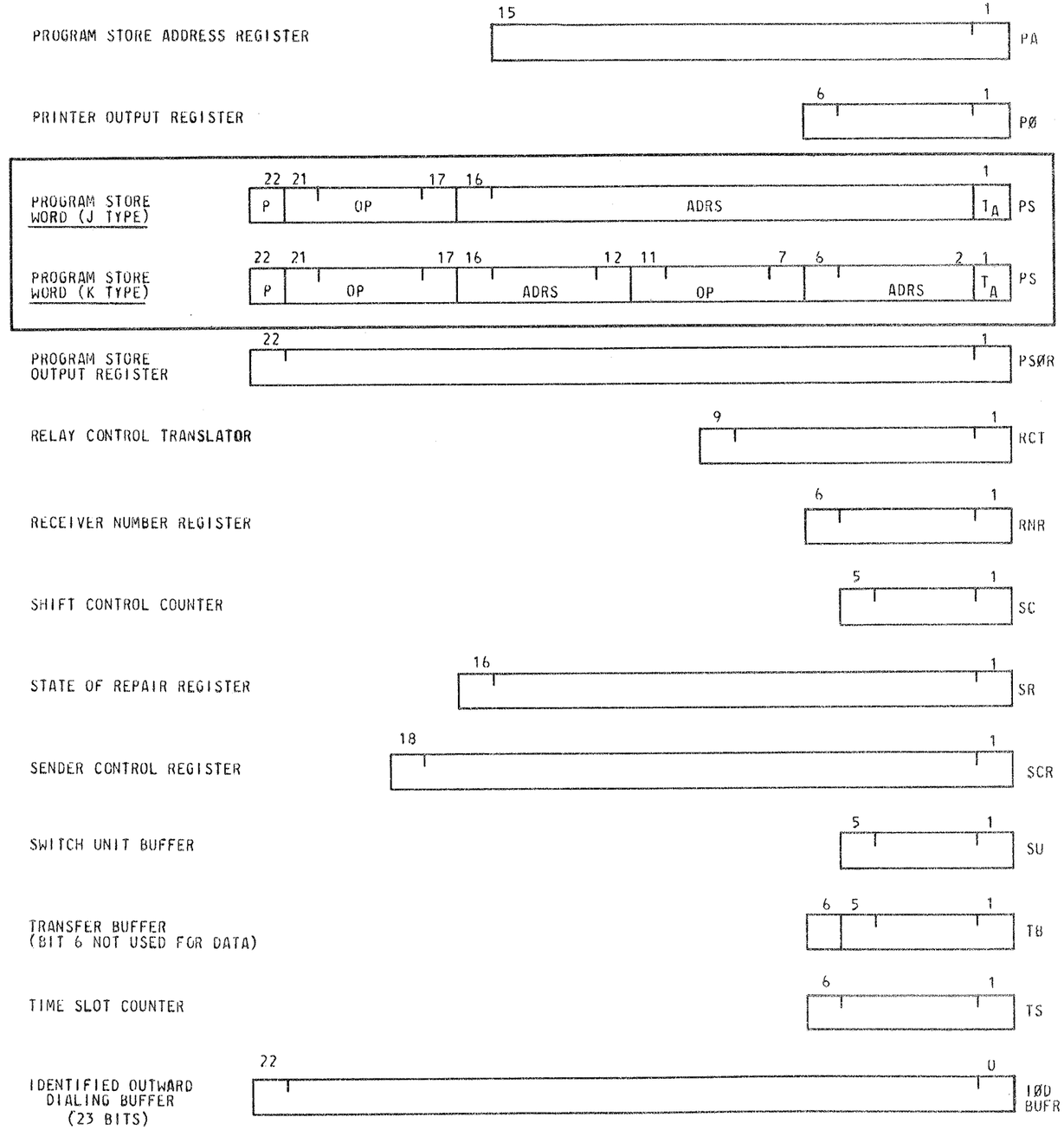


Fig. 3 – Word and Register Sizes in Bits

LIST OF COMMAND CODES

NO. 101 ESS OPERATIONS CARD

OPERATION CODE			OPERATION CODE		
OCTAL	ALPHA	CKT REF	OCTAL	ALPHA	CKT REF
00	1BT		2720	CGT CØXSU	p
01	2BT		2721	CGT CØXST	q
02	4B0		2722	CGT CØXRCT	r
03	4B1		2723	CGT CØXPØL	s
04	MRT	a	2724	CGT CØXPØH	s1
05	CTF	b	2725	CGT CØXSR	t
06	MET	a	2726	CGT CØXMB	t1
07	MAT	b	2727	CGT CØXLA	t2
10	RDT		2730	CGT ASXSC	u
11	NBT	a	2731	CGT CAXØCA	v
12	NØT	b	2732	CGT SUXCA	w
13	TIX	c	2733	CGT TSXCB	x
14	CLF		2734	CGT CBXTS	y
20*	STA		2735	CGT CAXCB	z
21*	AND		2736	CGT LØ1XCØ	h2
22*	LØR		2737	CGT LØ2XCØ	h3
23*	TSA	a	30	LSH	
24*	LDT		31	SHO	
25	FIL		3200	CLR CØ	a
26(0)	SHR		3201	CLR CB	b
26(1)	SHL		3202	CLR IB	c
2700	CGT LASXCØ	a	3203	CLR AS	d
2701	CGT AASXCØ	b	3204	CLR SC	e
2702	CGT SCXCØ	c	3205	CLR TS	f
2703	CGT CBXCØ	d	3206	CLR CA	g
2704	CGT SUXCØ	e	3207	CLR SU	h
2705	CGT IBXCØ	f	3210	CLR TB	i
2706	CGT PØLXCØ	g	3211	CLR PØ	j
2707	CGT PØHXCØ	g1	3212	CLR MB	k
2710	CGT SRXCØ	h	3213	CGT CØXHDA	t14
2711	CGT PRXCØ	h1	3214	CGT HDAXCØ	t15
2712	CGT CØXCB	j	3215	CGT CØBXIØ	z1
2713	CGT CØXIB	k	3216	CGT IØXCØB	z2
2714	CGT CØXAS	L	3230	CGT ASXCA	t6
2715	CGT CØXSC	m	3231	CGT CAXAS	t7
2716	CGT CØXCA	n	3232	CGT CBXCA	t8
2717	CGT CØXTS	Ø	3233	CGT CØXØPA	t9

*INDICATES TYPE J WORD; ALL OTHERS ARE TYPE K

SIDE 1

NO. 101 ESS OPERATIONS CARD

OPERATION CODE			OPERATION CODE		
OCTAL	ALPHA	CKT REF	OCTAL	ALPHA	CKT REF
3234	CGT ERXCØ	t10	3406	EXC	
3235	CGT DSBXCØ	t11	3407	SCA	
3237	CGT ØPAXØC	t13	3410	ØRI	
3300	WRT C	a	3411	ØRC	
3301	WRT C1	b	3412	INV	
3302	WRT C2	c	3414	RED DS	
3303	WRT C3	d	3415	WRT DS	
3304	WRT C4	e	3420	ADI AS	a
3305	WRT ØC	f	3421	ADI CØ	b
3306	WRT MTC1	g	3422	ADI TS	c
3307	WRT MTC0	h	3423	ADI SC	d
3310	WRT DSC	i	3424	ADI ACA	e
3311	WRT TC	j	3425	ADI HCA	f
3312	WRT S	k	3426	ADI ØCA	g
3313	WRT MF1	L	3500	RED C	a
3314	WRT MF0	m	3501	RED C1	b
3315	WRT TF1	n	3502	RED C2	c
3316	WRT TF0	ø	3503	RED C3	d
3317	WRT DF1	p	3504	RED C4	e
3320	WRT DF0	q	3505	RED ØC	f
3321	WRT TØC	r	3506	RED L	g
3322	WRT KL1	s	3507	RED LØ	g1
3323	WRT KL0	t	3510	RED L1	g2
3324	WRT PR0	u	3511	RED LQ0	g3
3325	WRT SCD	k1	3512	RED LQ1	g4
3326	WRT LF1	v	3513	RED LQ2	g5
3327	WRT LF0	w	3514	RED LQ3	g6
3330	WRT EB1	X	3515	RED DDR	h
3331	WRT FB0	X1	3516	RED MB	i
3332	WRT ET1	y	3517	RED DSC	j
3333	WRT TB0	y1	3520	RED S	k
3400	GPA	L	3521	RED CD	k1
3401	ADV		3522	RED STC	L
3402	STT		3523	RED TIM	m
3403	NØP		36*	STØ	
3404	FIN		37*	TRA	
3405	LSD				

* INDICATES TYPE J WORD; ALL OTHERS ARE TYPE K

SIDE 2

Fig. 4 – No. 101 ESS Operations Card

OCTAL WORDS	OCTAL LOCATIONS			DECIMAL WORDS
2000	0 01777	PER CONTROL UNIT SUPPLEMENTARY INFORMATION PER SWITCH UNIT SUPPLEMENTARY INFORMATION PLUS GROWTH FOR SPLIT AND SEMI-REDUNDANT SWITCH UNIT		1024
6000	02000 07777	CALL PROCESSING	ATTENDANT CALL PROCESSING AND PER CONT UNIT INFO IN LOCATIONS SHOWN ON FIG. 11	10752
1400	10000 11377		DIALING TRANSLATION AND EQUIPMENT SELECTION	
200	11400 11577		TRANSFER VECTOR: BASIC AND SPECIAL SERVICES	
160	11600 11757		TRANSFER VECTOR: ATTENDANT CALL PROCESSING	
20	11760 11777		TRANSFER VECTOR: END OF SCAN	
6000	12000 17777		PART OF BASIC AND SPECIAL SERVICES	
3000	20000 22777		BEGINNING AND END OF SECTOR	
1000	23000 23777		PART OF BASIC AND SPECIAL SERVICES	
3000	24000 26777		GROWTH	
2000	27000 30777	TELETYPEWRITER CONTROL		1024
2000	31000 32777	TRAFFIC MEASUREMENTS INCLUDING GROWTH FOR NEW MEASUREMENTS		1024
5000	33000 37777	MAINTENANCE	MAINTENANCE REQUESTS INCLUDING GROWTH FOR NEW REQUESTS	2560
7000	40000 46777		CALL PROCESSOR MAINTENANCE INCLUDING GROWTH FOR ADDITIONS	3584
11000	47000 57777		SWITCH UNIT AND DATA CONTROL MAINTENANCE INCLUDING GROWTH FOR ADDITIONS	4608
2000	60000 61777		MISCELLANEOUS MAINTENANCE MONITOR, TEST POINT READER TRACE, ETC AND GROWTH FOR ADDITIONS	1024
1000	62000 62777		PART OF SWITCH UNIT AND DATA CONTROL MAINTENANCE	512
15000	63000 77777	FUTURE GROWTH		6656

Fig. 5 – Program Store Area Layout

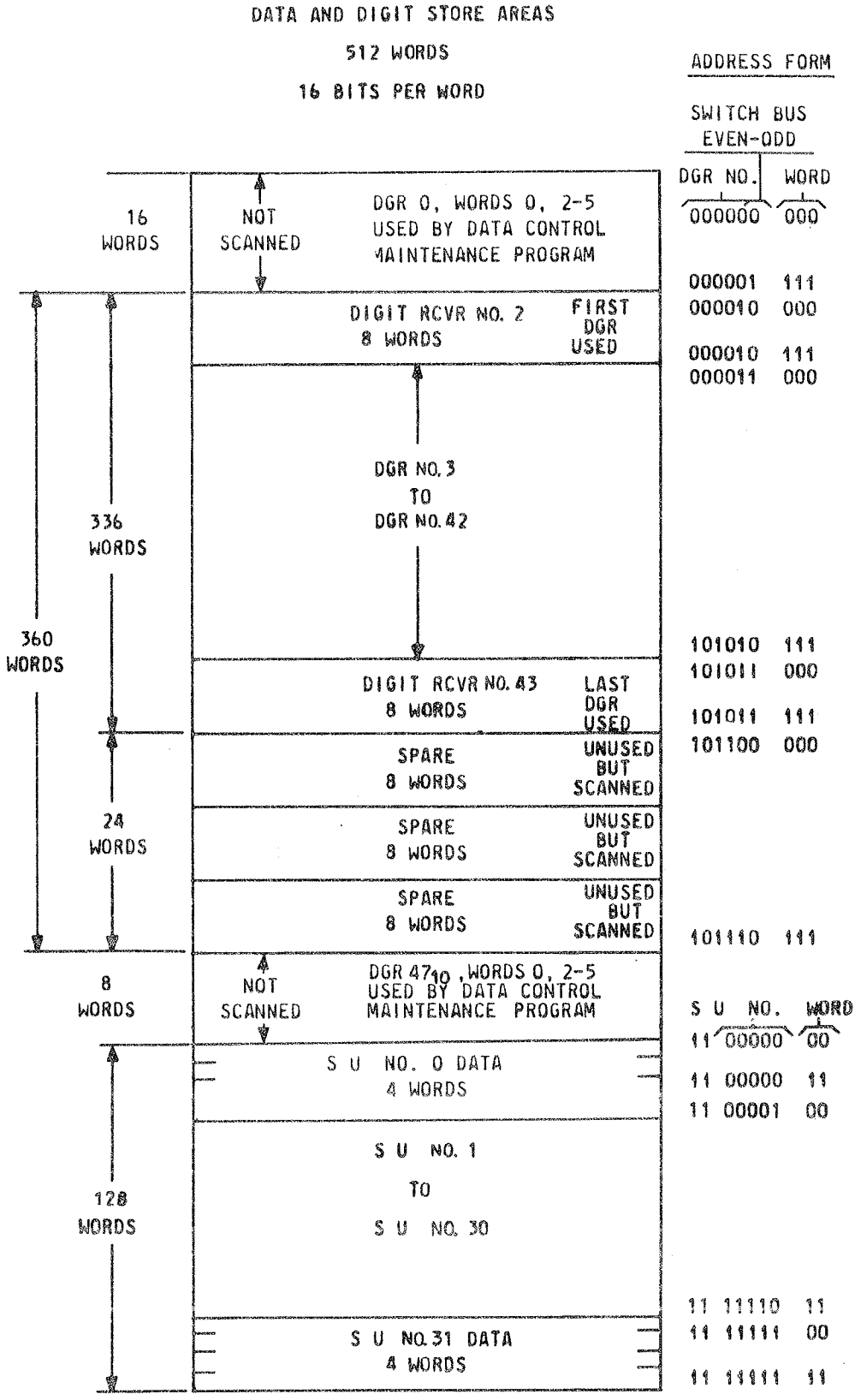


Fig. 6 – Data and Digit Store (DDS) Area Layout

CALL STORE AREAS (ON LINE)

ITY	LOCATION OCTAL	LOCATION DEC	16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1	NO. OF WORDS (DEC)
----	0	0	SUPPLEMENTARY INFORMATION SU NO. 0	32
--2-	40	32	SUPPLEMENTARY INFORMATION SU NO. 1	32
--4-	100	64	SUPPLEMENTARY INFORMATION SU NO. 2 TO SU NO. 31 MAXIMUM	960 MAX
VARIABLE	2000 MAX.	1024 MAX.	TIME SLOTS FOR SU NO. 0 MAX = 50 FOR CALL PROC. PLUS 2 (8 WORDS) FOR MTCE TIME SLOT	208 MAX
			TIME SLOTS FOR SU NO. 1 MAX = 50 FOR CALL PROC. PLUS 2 (8 WORDS) FOR MTCE TIME SLOT	208 MAX
			TIME SLOTS FOR SU NO. 2 TO NO. 31 MAXIMUM NO. OF TIME SLOTS AVAILABLE FOR CALL PROCESSING DEPENDS ON THE TOTAL NO. OF SWITCH UNITS (SEE NOTE 1 BELOW)	
-R--	7400	3840	SUPPLEMENTARY INFORMATION PER CONTROL UNIT	32
-R2-	7440	3872	SYSTEM SCRATCH (TEMPORARY STORAGE)	8
-R28	7450	3880	MAINTENANCE MESSAGE FORMATION AREA	8
-R3-	7460	3888	PROGRAM CONTROL MAINTENANCE RECORD	4
-R34	7464	3892	STORE GROUP FOR PRINTER	8
-R3S	7474	3900	WAITING LIST FOR PRINTER	128
-RMS	7674	4028	MISCELLANEOUS MAINTENANCE RECORD	12
-RS8	7710	4040	REQUESTED ROUTINES RECORD	8
-RC-	7720	4048	DATA CONTROL MAINTENANCE RECORD	28
-RTS	7754	4076	TRAFFIC TIME SLOT	20
-RRR	7777	4095		

TOTAL 4096 WORDS

NOTES:

1. MAXIMUM NO. OF TIME SLOTS AVAILABLE FOR CALL PROCESSING- TS_M = 960 -10 X NO. OF SU

EXAMPLE: NO. OF SU	TS_M	TS_M PER SU
32	640	20
18	780	43
16	800	50
10	860	50

CALL STORE AREAS (OFF LINE)

ITY	LOCATION OCTAL	LOCATION DEC	16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1	
----	0	0	DUPLICATE RECORD OF ON LINE CALL STORE EXCEPT AS NOTED BELOW THE LAST EIGHT TIME SLOTS (32 WORDS) OF EACH SWITCH UNIT ARE RESERVED FOR TIME SLOT WAITING LINE AND AUTOMATIC REROUTE LIST DUPLICATE AREAS INCLUDE: 1. SUPPLEMENTARY INFORMATION PER SU AND PER CONT UNIT 2. TIME SLOTS EXCEPT AS NOTED 3. PROGRAM CONTROL MAINTENANCE RECORD THE REMAINING AREAS OF THE ON LINE CALL STORE ARE NOT DUPLICATED.	3892
-R34	7464	3892	VACANT	12
-R4-	7500	3904	1ST REQ SU	
-R6-	7540	3936	2ND REQ SU	
-R8-	7600	3968	3RD REQ SU	
-RO-	7640	4000	TRAFFIC RECORDS	192
-RS-	7700	4032	4TH REQ SU	
-RT-	7740	4064	5TH REQ SU	
-RRR	7777	4095	6TH REQ SU	

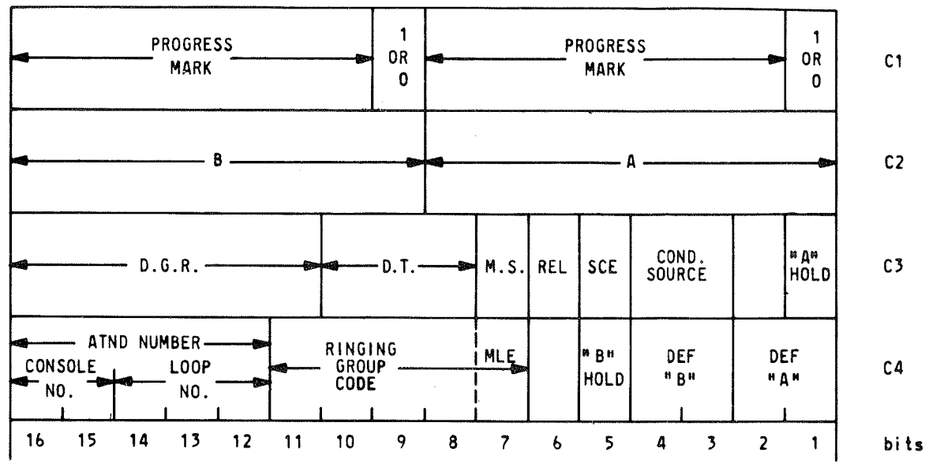
Fig. 7 – Call Store Area Layout

ADDRESS

SUX32 OCTAL	DEC	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	COMMENT
0	0	AVAILABLE FOR USE AS TEMPORARY STORAGE																TEMPORARY STORAGE
1	1	CS ADDRESS										TIME SLOT NO.						ADDRESS OF TIME SLOT IN WHICH ATTENDANT ON CONSOLE NO. 1 IS OFF-HOOK
2	2	CS ADDRESS										TIME SLOT NO.						ADDRESS OF TIME SLOT IN WHICH ATTENDANT ON CONSOLE NO. 2 IS OFF-HOOK
3	3	AVAILABLE FOR USE AS TEMPORARY STORAGE																TEMPORARY STORAGE
4	4	15	14	13	12	11	10	9	8	ALL ZEROS								CENTRAL OFFICE TRUNK STATUS WORD 1
5	5	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	CENTRAL OFFICE TRUNK STATUS WORD 2
6	6	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	CENTRAL OFFICE TRUNK STATUS WORD 3
7	7	ACCUMULATED DIGIT TK. RELEASES								ACCUMULATED DIGIT TK. SEIZURES								DIGIT TRUNK STATUS WORD
		6	5	4	3	2	1			6	5	4	3	2	1			
10	8	WHICH HALF OUT 1=ODD	HALF SU OUT 1=YES	T.S. RELEASE	TSWL ENTRY	CONFERENCE ALLOWED	SPARE		WHICH CONS. IS ON; 0=2	SPARE	LAST CONSOLE SELECTED	ATND W.L. FULL	SPARE		ENTRY IN ATND W.L.	N.S. ENABLE	ATND UNREC ACT	CONTROL WORD FOR ATTENDANT WAITING LINE
11	9	ATND HELD	ATND OFF HK	UNANSWERED CALL INDICATED						STATUS OF LOOPS						NEW CALL ALLOWED	POS. ATTENDED	INFORMATION ON ATTENDANT CONSOLE NO. 1
				6	5	4	3	2	1	6	5	4	3	2	1			
12	10	ATND HELD	ATND OFF HK	UNANSWERED CALL INDICATED						STATUS OF LOOPS						NEW CALL ALLOWED	POS. ATTENDED	INFORMATION ON ATTENDANT CONSOLE NO. 2
				6	5	4	3	2	1	6	5	4	3	2	1			
13	11	CS ADDRESS										TIME SLOT NO.						ADDRESS OF TIME SLOT IN WHICH NOS AT PERMANENT SIGNAL ARE STORED
14	12	CS ADDRESS OF TIME SLOT REQUESTING MATCH										NO. OF TIME SLOT REQUESTING MATCH						INFORMATION ON NUMBER BEING MATCHED (BEING-MATCHED-WAITING-LINE)
15	13	ARL FULL	ARL EMPTY	SPARE			AUTO. RER MATCH	IDENTITY OF BUSY TESTING PM.	BUSY OR BUSY VERIFY	NUMBER BEING MATCHED								
16	14	CS ADDRESS OF TIME SLOT REQUESTING MATCH										NO. OF TIME SLOT REQUESTING MATCH						INFORMATION ON NUMBER TO BE MATCHED (TO-BE-MATCHED-WAITING-LINE)
17	15	SPARE						IDENTITY OF BUSY TESTING PM.	BUSY OR BUSY VERIFY	NUMBER TO BE MATCHED								
20	16	CS ADDRESS										TIME SLOT NO.						
21	17	CS ADDRESS										TIME SLOT NO.						
22	18	CS ADDRESS										TIME SLOT NO.						ATTENDANT WAITING LINE
23	19	CS ADDRESS										TIME SLOT NO.						
24	20	SPARE						ATND	MESSAGE IN INCOMING MESSAGE BUFFER LINE NUMBER								ON. OFF HOOK	LAST INCOMING MESSAGE IN INCOMING MESSAGE BUFFER
25	21	SPARE																UNUSED
26	22	CS ADDRESS										TIME SLOT NO.						CONSTANT USED BY IDLE TIME SLOT CLEARING PROGRAM
27	23	SPARE																UNUSED
30	24	ON-HK ENTRY IN LINE =1	SEIZE BIT 1 = SEIZE	TRUNK NO.						TRK FLASH TIMER			MASTER TIMER					CONTROL WORD FOR FLASH LINE AND TRUNK FLASH
31	25	FLASH LINE TIMER				SPARE		LINE DEF. 10 = EXT 00 = T.TRK		LINE NO.								
32	26	(LAYOUTS FOR LOCS +26 THRU +31 ARE SAME AS SHOWN FOR +25)																FLASH LINE
33	27																	
34	28																	
35	29																	
36	30																	
37	31																	
		16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	BIT NO.

Fig. 8 – Call Store — Supplementary Information Per Switch Unit

CALL STORE (CS)



M.S. = MESSAGE HAS BEEN SENT
REL. = RELEASE
COND. = CONDITION OF
D.T. = DIGIT OR DIAL TRUNK NUMBER
D.G.R. = DIGIT RECEIVER NUMBER (SEE NOTE 1)
DEF. = DEFINITION OF
MLE = MATCH LIST ENTERED
ATND = ATTENDANT
OCS = OTHER CALL STORE
A = SCAN POINT NUMBER OF "A" PARTY
B = SCAN POINT NUMBER OF "B" PARTY
SCE = SOURCE

C1 BIT 1 - SET TO ZERO WHEN PROGRESS MARK IS LOADED INTO OCS
BIT 9 - SET TO ONE AFTER TRACE PRINT OUT

THE ABOVE IS THE MORE USUAL USE OF THE CS BITS AND THIS USE IS NOT NECESSARILY FOUND IN ANY ONE PROGRESS MARK. SOME COMMON ALTERNATE USES FOR THE BITS ARE:

C3 BIT 3-3 WAY CONFERENCE BIT
BIT 4-4 WAY CONFERENCE BIT
BIT 6-EXCLUDE SOURCE
BIT 7-EXCLUDE DESTINATION
BITS 8-15- HUNT NUMBER AREA
BITS 11-16- HOLD, OR RINGING CODE

C4 BIT 7- TOLL OPERATOR (T.OP) OR MATCH LIST ENTERED (MLE) BIT
BIT 11- COMPRESSED DIALING (C.D.) BIT
BITS 3-10- LINE INFORMATION STORE (LIS) ADDRESS OF COMPRESSED NUMBERS

VARIOUS COMBINATIONS OF BITS OF C3 AND C4 ARE ALSO USED AS TIMERS OR AS TEMPORARY STORAGE FOR PARTICULAR PROGRESS MARKS. SEE SEQUENCE CHARTS FOR TIME SLOT LAYOUT FOR INDIVIDUAL PROGRESS MARKS.

NOTES:

1. THE DIGIT RECEIVER (DGR) IS ALSO REFERRED TO AS DIALED DIGIT RECEIVER (DDR) IN THE PROGRAM FLOW CHARTS AND PROGRAM LISTINGS.

Fig. 9 – Call Processing Time Slot Layout

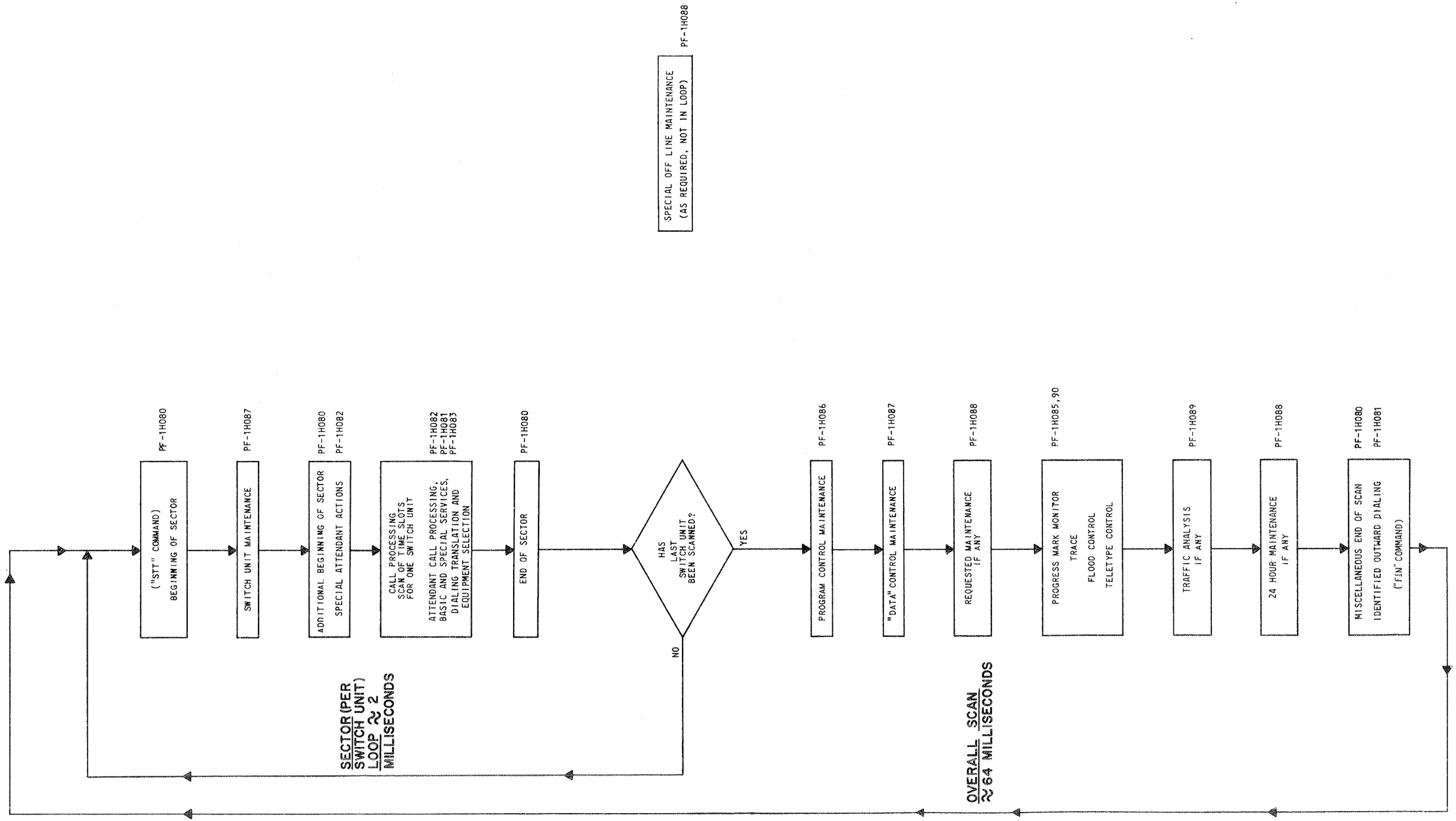


Fig. 10 – Over-All View of the Entire Program — Main Normal Flow between All No. 101 ESS Programs (Showing Major Linkages Only)

INTERLEAVING OF PROGRAM STORE ALLOTMENT OF
"SUX16+0" LOCATIONS OF PER CONT UNIT INFORMATION
WITH "SUX16+(1 TO 15)" LOCATIONS OF PER SW UNIT INFORMATION

PROGRAM STORE

P S ADDRESS OCTAL	P S ADDRESS DEC	CONTENTS
0	0	SU NO. 0X16+0 PER CONT UNIT INFO (ALL ZEROS)
		SU NO. 0X16+(1 TO 15)
17	15	
20	16	SU NO. 1X16+0 PER CONT UNIT INFO (SPARE)
21	17	SU NO. 1X16+(1 TO 15)
37	31	
40	32	SU NO. 2X16+0 PER CONT UNIT INFO (SPARE)
41	33	SU NO. 2X16+(1 TO 15)
57	47	
60	48	SU NO. 3X16+0 PER CONT UNIT INFO (TRA TO EOS PROG)
61	49	SU NO. 3X16+(1 TO 15)
77	63	
100	64	SU NO. 4X16+0 PER CONT UNIT INFO (TRA TO 1 SEC. TIMEOUT PROG)
101	65	SU NO. 4X16+(1 TO 15)
117	79	
ETC TO	ETC TO	ETC
760	496	SU NO. 31X16+0 PER CONT UNIT INFO | STØ | NO. OF DGR IN CS: WORD 3 (+2) | WORD 2 | WORD 1
		SU NO. 31X16+(1 TO 15)
777	511	
1000	512	SU NO. 0X2+512 ("DID" TRUNKS)
1001	513	SU NO. 0X2+513 (DIAL REPEATING TIE TRUNKS)
		SU NO. X2+512(ALL EVEN LOCATIONS) ("DID" TRUNKS)
		SU NO. X2+513(ALL ODD LOCATIONS) (DIAL REPEATING TRUNKS)
1101	577	

PROGRAM STORE (PS)

EACH OCTAL ADDRESS BELOW IS THE LOCATION OF
PER CONT UNIT INFORMATION

P S ADDRESS OCTAL	P S ADDRESS DEC	PARITY	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
2060	1072		TRA						TO END OF SECTOR PROGRAM															
2100	1088		TRA						TO 2 SEC TIME-OUT PROGRAM															
2120	1104		TRA						TO 20 MIN TIME-OUT PROGRAM															
2140	1120		TRA						INITIALIZE BOTH CALL STORES															
2200	1152		TRA						{ MAINTENANCE COMPARATOR }															
2240	1184		TRA						RETRY FOR ON-LINE ERROR															
2300	1216		TRA						TIME-OUT { LSD LDT RDT STT } COMMANDS															
2340	1248		TRA						INITIALIZE EXCEPT ØCS															

Fig. 11 – Program Store Interleaving of Per Control Unit and Per Switch Unit Information

PROGRAM STORE (PS)

EACH OCTAL ADDRESS BELOW IS THE LOCATION OF PER-CONT UNIT INFORMATION IMMEDIATELY PRECEDING THE PER-SU INFORMATION

PS ADDRESS OCTAL	PS ADDRESS DECIMAL	CONTENTS
400	*256	ALL ZERO
420	*272	SPARE
440	*288	SPARE
460	304	TO END OF SECTOR PROGRAM
500	320	TO 2 SEC TIME-OUT PROGRAM
520	336	TO 20 MIN TIME-OUT PROGRAM
540	352	INITIALIZE BOTH CALL STORES
560	368	SPARE
600	384	[MAINTENANCE COMPARATOR]
620	400	SPARE
640	416	RETRY FOR ON-LINE ERROR
660	432	SPARE
700	448	TIMEOUT [LSD RDT / LDT STT] COMMANDS
720	464	SPARE (NØP,NØP,TA = 0)
740	480	INITIALIZE EXCEPT ØCS
760	496	SPARE (NØP,NØP,TA = 0)

AMONG OTHERS, LOCATIONS $300\text{-}377_8$ AND 700_8 MUST BE NON-ZERO FOR PC MTC TESTS

16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

PARITY

CONTENTS

	SPARE
	SPARE
	SPARE
	SPARE
	SPARE
	SPARE
	SPARE
STØ	FIRST 4 DIGITS OF COMPRESSED DIGITS OUTPULSING TEST
STØ	SECOND 3 DIGITS OF COMPRESSED DIGITS OUTPULSING TEST
	SPARE
	SPARE
	SPARE
STØ	0 (14) TOTAL NO. OF DGR'S +2 IN SYSTEM (9) (8) (4) 0 (2) (1)
STØ	(16) TENS HRS (13) (12) UNITS HRS (9) (8) TENS MIN (5) (4) UNITS MIN (1)
STØ	(11) NO. OF SUS (-1) (7) 0 (5) SU NO. OF FIRST ACTIVE SW UNIT (1)
STØ	NO. OF DGR'S IN CS + 2 — WORD 3 / WORD 2 / WORD 1

22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

*JAM SET ADDRESS

"TOUCH-TONE" OUTPULSE OPTION
1 = "TOUCH-TONE" OUTPULSING TO CØ
0 = NO "TOUCH-TONE" OUTPULSING TO CØ

STATIONS DELAY OPTION
1 = NO STATIONS DELAY
0 = STATIONS DELAY

24 HR TEST TIME

Fig. 12 – Program Store Allotment of "SU × 16 + 0" Locations of Per Control Unit Information

PROGRAM

EACH OCTAL ADDRESS BELOW IS THE
IMMEDIATELY PRECEDI

PS ADDRESS OCTAL	PS ADDRESS DECIMAL	CONTENTS
0	0	ALL ZERO
20	16	SPARE
40	32	SPARE
60	*48	TRA — TO END OF SECTOR PROGRAM
100	*64	TRA — TO 2 SEC TIME-OUT PROGRAM
120	*80	TRA — TO 20 MIN TIME-OUT PROGRAM
140	*96	TRA — INITIALIZE BOTH CALL STORES
160	112	SPARE
200	*128	TRA — [MAINTENANCE COMPARATOR]
220	144	SPARE
240	*160	TRA — RETRY FOR ON-LINE ERROR
260	176	SPARE
300	*192	TRA — TIMEOUT — [LSD RDT / LDT STT] — COMMANDS
320	208	SPARE (NØP,NØP,TA = 0)
340	224	TRA — INITIALIZE EXCEPT ØCS
360	240	SPARE (NØP,NØP,TA = 0)

PARITY

22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

AMONG OTHERS LOCATIONS $300\text{-}377_8$ AND 700_8 MUST BE NON-ZERO FOR PC MTC TESTS

PROGRAM STORE "SUx16+(1-15)" LOCATIONS

THIS ILLUSTRATES THE USE OF BITS 16-7 OF SUX16+1

12 … 3	2	1
CALL STORE ADDRESS REGISTER	0	0

VIA CØ

ADDRESS SUX16+ OCTAL	DEC	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	BIT NO
1	1	PARITY			STO 1	1	0	CS ADDRESS OF FIRST MAINTENANCE TIME SLOT IN THIS SU-10 HIGH BITS (TO OBTAIN FIRST CALL RECORD TIME SLOT, ADD ONE TO BIT 8 OF THIS WORD) BITS 16-1 = ZERO FOR NON-EXISTENT SUS											TOTAL NO. OF SU TIME SLOTS -1 (TRAFFIC + SU MTCE)						
2	2							NORMAL SU DIAL GROUP SEE NOTE 1	SPARE	NIGHT SERVICE NO. --- FOR EXT, AND UNASSIGNED TRUNKS									NUMBER OF SU DIGIT TRUNKS					
3	3							SPARE	NUMBER OF C.O. TRUNKS GIVEN IN THIRD TRUNK STATUS WORD IN CS					NUMBER OF C.O. TRUNKS GIVEN IN SECOND TRUNK STATUS WORD IN CS					NUMBER OF C.O. TRUNKS + 8 GIVEN IN FIRST TRUNK STATUS WORD IN CS IF NO C.O. TRKS PACK WITH 8						EXTENSIONS USE WORD 3 FOR C.O. TRKS
4	4							SU'S SECOND LIS PLANE NUMBER EQUIP NOS 64 - 127					PLANE HAS COMP INFO	PLANE HAS LINE INFO	SU'S FIRST LIS PLANE NUMBER EQUIPMENT NOS 0-63 COME HERE TO FIND THE LIS PLANE TO LOOK IN					PLANE HAS COMP INFO	PLANE HAS LINE INFO				EQUIP. NO. +152 = DIALED NO. FOR DIAL GROUP 01 EQUIP. NOS LIE IN QUADRANTS 0 & 1 COMPRESSED NOS LIE IN QUADRANTS 2 & 3
5	5							SU'S FOURTH LIS PLANE NUMBER EQUIP NOS 192 - 255					PLANE HAS COMP INFO	PLANE HAS LINE INFO	SU'S THIRD LIS PLANE NUMBER EQUIP NO.S 128 - 191					PLANE HAS COMP INFO	PLANE HAS LINE INFO				
6	6							SPARE	NUMBER OF C.O. TRUNKS GIVEN IN THIRD TRUNK STATUS WORD IN CS					NUMBER OF C.O. TRUNKS GIVEN IN SECOND TRUNK STATUS WORD IN CS					NUMBER OF C.O. TRUNKS + 8 GIVEN IN FIRST TRUNK STATUS WORD IN CS						ATTENDANTS USE WORD 6 FOR C.O. TRKS
7	7							SCAN POINT NUMBER OF FIRST EXTENSION (ZERO OR ANY NUMBER BETWEEN 48_{10} AND 64_{10})											SCAN POINT NUMBER OF FIRST TIE TRUNK (ZERO OR ANY NUMBER BETWEEN $32-47_{10}$)						ZERO INDICATES C.O. TRK 8-31, T.TRK 32-47, EXT 48-247
10	8							SPARE 16 … 7										1=LAST SU 0=OTHER SU	NUMBER OF NEXT SU 5 … 1						
11	9																	PBX LISTED NO. FOR 'DID' (BIN) (USED FOR 'DID') 8 … 1							
12	10																	TOTAL NO. C.O. TRUNKS + 8, BUT ZERO FOR NO C.O. TRKS							
13	11							NO. -32 OF FIRST TIE TRUNK IN LIS GROUP 81					TYPE OF TRUNK X Y Z		NO. -32 OF FIRST TIE TRUNK IN LIS, GROUP 82					TYPE OF TRUNK X Y Z					FOR X, Y, Z, SEE NOTE 2
14	12							SEE ABOVE, GROUP 83					TYPE OF TRUNK X Y Z		SEE ABOVE, GROUP 84					TYPE OF TRUNK X Y Z					
15	13							SEE ABOVE, GROUP 85					TYPE OF TRUNK X Y Z		SEE ABOVE, GROUP 86					TYPE OF TRUNK X Y Z					
16	14							SEE ABOVE, GROUP 87					TYPE OF TRUNK X Y Z		SEE ABOVE, GROUP 88					TYPE OF TRUNK X Y Z					
17	15							SEE ABOVE, GROUP 89					TYPE OF TRUNK X Y Z		SEE ABOVE, GROUP 80					TYPE OF TRUNK X Y Z					
		22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	

NOTES:

1. LINE (DIALED) NOS. | NORMAL S U DIAL GROUP
   - 200-399 | 0 1
   - 400-599 | 1 1
   - 600-799 | 1 0

2. DEFINITION OF CODES IN WORDS 11-15, BITS 11-9 AND 3-1 ARE SHOWN BELOW.

TYPE OF TRUNK	X	Y	Z
NO ENTRY	0	0	0
FX T. TRK EQUALS CO. TRK FOR SUPERVISION	0	0	1
AUTO T. TRK (DOUBLE ENDED), ON-HOOK, OFF-HOOK, FLASH.	0	1	0
RINGDOWN T. TRK (SINGLE ENDED), OFF-HOOK ON ORIGINATION ONLY NO DIALING EXISTS TO OR FROM TRK.	0	1	1
DIAL REPEATING	1	0	0
TELEPHONE DICTATION TRK	1	0	1
CODE CALL ANSWER CODE	1	1	0
CODE CALL TRUNK	1	1	1

BIT DEFINITIONS:

- DEF 1. 1 = SU HAS "DON'T ANSWER TRANSFER" SERVICE.
- DEF 2. 1 = SU HAS BUSY LINE TRANSFER" SERVICE.
- DEF 3. 1 = CONFERENCE CONSULTATION
- DEF 4. 1 = SU IS RESTRICTED FROM "CAMP ON" INDICATIONS.
- DEF 5. 1 = SU IS RESTRICTED FROM 'CAMP ON" SERVICE.
- DEF 6. 1 = SU IS RESTRICTED FROM "CONFERENCE AND DIAL TRANSFER."

PROGRAM STORE "SU x 2 + 512(513)" LOCATIONS

$512_{10} = 1000_8$

		16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SUX2 + 512	PARITY	STO 1	1	1	1	0	NO. OF FIRST "DID" TRUNK					NO. OF "DID" TRUNKS				NO. OF ATTENDANT CONSOLES		DEF 1	DEF 2
SUX2 + 513							NO. OF FIRST DIAL REPEATING TIE TRUNK					NO. OF DIAL REPEATING TIE TRUNKS				DEF 3	DEF 4	DEF 5	DEF 6

Fig. 13 – Program Store Per Switch Unit Infromation

CALL STORE

SWITCH UNIT MAINTENANCE TIME SLOT (MTS)

WORD	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
C1	INHIBIT BIT	POWER FAILURE BIT	ERROR BIT	REQUESTED ROUTINES BIT	ERROR COUNTER 2ND PHASE OF LOOKING FOR A WORKING MODE. 9-12				DISPATCH BITS (SIMILAR TO PROGRESS MARK)								
C2	SCRATCH——GENERALLY USED BY COUNTERS (TIMERS)																
C3	SCANNER IN USE 1 = 2 0 = 1	VERIF OF TRANSFER	TRANSFER RETRY "SEND"	SPECIAL RETRY BIT	RETRY BIT	USED BY "NØTRA" SUBROUTINE "FORTH" VERIF	USED BY "NØTRA" SUBROUTINE "BACK" VERIF	SPARE IN USE DATA TRANS	DATA LINK	BUS 2	BUS 1	SCANNER 2	SCANNER 1	TEST CONFIGURATION DIRECTION 1 = B→A 0 = A→B	TEST CONFIGURATION BUS 1 = 2 0 = 1	TEST CONFIGURATION SCANNER 1 = 2 0 = 1	
C4	RECORD OF CURRENTLY USED TIME SLOT OR LAST ONE USED FOR TEST CALL BITS 3-12 OF CS ADDRESS OF TIME SLOT												7 | 6	TIME SLOT NUMBER			← NORMAL CONTENTS
	DGR NUMBER						10									1	← DURING C.O. TRUNK TEST
	SCRATCH——GENERALLY USED FOR 1ST LEVEL SUBROUTINE RETURN ADDRESSES																← NORMAL CONTENTS
C5	DGR NUMBER					10	DIGIT TRK NUMBER		7	DIGIT TRK OR DGR NO. 5				DURING DIAGNOSIS		1	← DURING DIGIT TRK TEST
C6	SCRATCH——GENERALLY USED TO HOLD C2, C3, OR C4 TEMPORARILY																
C7			NO. OF LAST C.O. TRUNK TESTED OR ONE CURRENTLY BEING TESTED						EXTRA ERROR BIT (SEE NOTE 2)	STATUS OF DIGIT TRUNKS 1 = BAD; 0 = GOOD DT NO. 6	DT NO. 5	DT NO. 4	DT NO. 3	DT NO. 2	DT NO. 1	SPECIAL ATTENTION BIT	
C8	USED ONLY WHEN LOOKING FOR A WORKING MODE (ie, C1 (14=1)) ERROR WORD ERROR CODE IND. CROSS-TALK, TRANSMISSION OR RINGING SIGNAL FAILURES						C4 (1-6) AT TIME OF FAILURE TIME SLOT NUMBER						C3 (1-4) AT TIME OF FAILURE				← CONTENTS DURING A SWITCH UNIT FAILURE
	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	

C8	DIGIT TRUNK OR DGR FAILURE (PER SU) M						2(TTY)						FAILURE CODE (SEE TTY MANUAL) PD-1H099				← CONTENTS DURING A DIGIT TRK OR DGR FAILURE
	16			13 | 12			9 | 8					5 | 4				1	
C8	0	0	TRUNK NO.				0	0	0	1			FAILURE CODE (SEE TTY MANUAL) PD-1H099				← CONTENTS DURING A C.O. TRK FAILURE
	16		15 | 14				9 | 8		7 | 6			5 | 4				1

NOTES:

1. THE SWITCH UNIT MAINTENCE TIME SLOT APPEARS AS THE FIRST TWO TIME SLOTS OF A SWITCH UNIT'S ALLOTED CALL STORE AREA.
2. THIS BIT IS USED FOR INTERRUPTED RINGBACK.

Fig. 14 – Call Store Switch Unit Maintenance Time Slot

CALL STORE

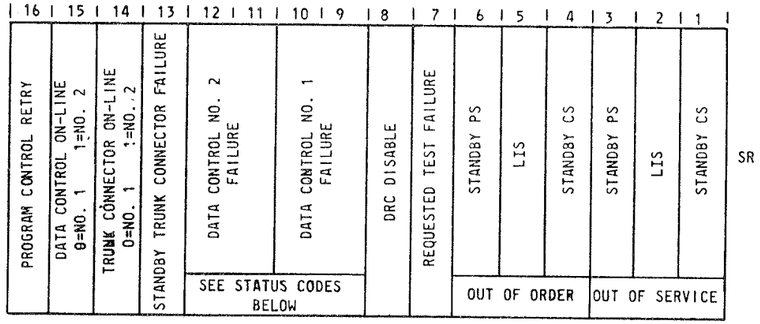
SWITCH UNIT MAINTENANCE TIME SLOT

WORD																
C1	INHIBIT BIT 16	POWER FAILURE BIT 15	ERROR BIT 14	REQUESTED ROUTINES BIT 13	ERROR COUNTER 2ND PHASE OF LOOKING FOR A WORKING MODE. 9-12 12 9				8							
C2	SCRATCH——GENERALLY USED BY COUNTERS (TIMER															
C3	SCANNER IN USE 1 = 2 0 = 1 16	VERIF OF TRANSFER 15	TRANSFER RETRY "SEND" 14	SPECIAL RETRY BIT 13	RETRY BIT 12	USED BY "NØTRA" SUBROUTINE "FORTH" VERIF 11	"BACK" VERIF 10	SPARE IN USE DATA TRANS 9	DATA LINK 8	BUS 2 7	FAILURE					
C4	RECORD OF CURRENTLY USED TIME SLOT OR LAST ONE USED F BITS 3-12 OF CS ADDRESS OF TIME SLOT 7															
C1 C5	16 DGR NUMBER 11	10 DIGIT TRK NUMBER 8	7 DIGIT	SCRATCH——GENERALLY USED FOR 1ST LEVEL SUBROUTINE RET												
C2 C6	SCRATCH——GENERALLY USED TO HOLD C2, C3, OR C4 TE															
C3 C7	16	15	NO. OF LAST C.O. TRUNK TESTED OR ONE CURRENTLY BEING TESTED 14 9					EXTRA ERROR BIT (SEE NOTE 2) 8	DT NO. 6 7							
C4 C8	USED ONLY WHEN LOOKING FOR A WORKING MODE (ie, C1 ERROR WORD ERROR CODE IND. CROSS-TALK, TRANSMISSION OR RINGING SIGNAL FAILURES 16 11							C4 (1-6) AT TIME OF FAIL TIME SLOT NUMBER 10								
	16	15	14	13	12	11	10	9	8	7						

ALTERNATE FORMS OF C8

C8	DIGIT TRUNK OR DGR FAILURE (PER SU)															
	M 16	13	12	9	8											
C8	C.O. TRUNK FAILURE															
	0	0	TRUNK NO.								0	0				
	16	15	14	9	8	7										

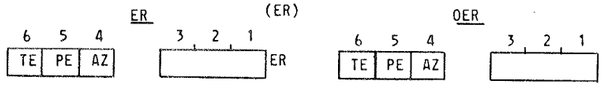
STATE OF REPAIR REGISTER
(SR)



STATUS CODES FOR DATA CONTROLS (B10-9 & B12-11) ARE AS FOLLOWS:

00 - NO FAILURE
01 - TRIVAL FAILURE (ie, 24-SEC TIMER FAILED)
10 - MAJOR FAILURE (ie, ONE OR MORE SW UNIT FAILURES)
11 - CATASTROPHE (NO CALL PROCESSING POSSIBLE)

ERROR REGISTERS



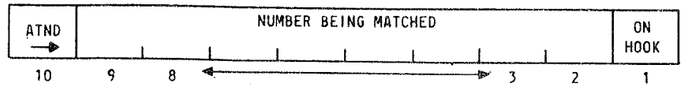
BIT	ON-LINE ER	OFF-LINE ER
1	SET BY ON-LINE ERROR MARKING COMMAND, WRT EB1 (ON-LINE RETRY IN PROGRESS)	———
2	SET BY OFF-LINE TEST MARKING COMMAND, WRT ET1	SET BY ON-LINE TEST MARKING COMMAND WRT ET1
3	SET BY OFF-LINE ERROR MARKING COMMAND, WRT EB1	SET BY ON-LINE ERROR MARKING, COMMAND WRT EB1
AZ	SET BY ALL "0" OUTPUT IN ON-LINE PS	SET BY ALL "0" OUTPUT IN OFF-LINE PS
PE	SET BY PARITY ERROR IN ON-LINE PS	SET BY PARITY ERROR IN OFF-LINE PS
TE	SET BY ILLEGAL-TRANSFER IN ON-LINE PS	SET BY ILLEGAL TRANSFER IN OFF-LINE PS

THE COMMAND "CGT ERXCO" GATES BITS 1-3 OF THE ON-LINE ER TO BITS 1-3 OF THE CO AND GATES THE AZ, PE AND TE BITS OF THE OFF-LINE ER TO BITS 4-6 OF THE ON-LINE CO.

THE COMMAND "WRT FBO" SETS BIT 1 OF THE ON LINE ER = 0

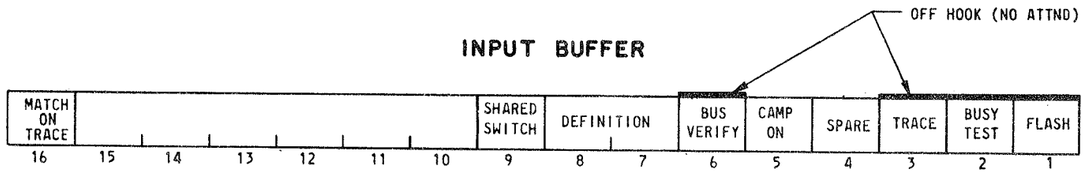
THE COMMAND "WRT TBO" SETS BITS 2 AND 3 OF THE ON LINE ER=0 AND THE AZ, PE, AND TE BITS OF THE OFF LINE ER=0.

INCOMING MESSAGE BUFFER



BIT 1 = 0 IF MESSAGE IS ON HOOK.
= 1 IF ANY OTHER MESSAGE (OFF HOOK FOR ATND)
BIT 10 = 1 IF BITS 2-9 IS AN ATND NUMBER.

INPUT BUFFER



THE FOLLOWING STATED CONDITIONS EXIST WHEN BITS ARE EQUAL TO 1 AND THEY PERTAIN TO THE NUMBER IN THE MESSAGE BUFFER:

BIT 1 - FLASHED
BIT 2 - BUSY TESTED
BIT 3 - TRACED
BIT 4 - SPARE
BIT 5 - CAMP IS TO BE DENIED
BIT 6 - NO. BEING BUSY VERIFIED
BIT 7,8 - DEFINITION OF NO..
BIT 9 - SHARED SWITCH

8,7	8,7
00=EXT	10=T. TRK
01=C.O. TRK	11 NOT USED IN IB, = SINGLE ENDED TIE TRUNK IN TIME SLOTS

BITS 9-15 ARE NOT PRESENTLY USED.
BIT 16=1 IF A SUCCESSFUL MATCH IS MADE WHEN A TRACE IS MADE ON THE NUMBER IN THE MESSAGE BUFFER.
BITS 1,2,3,6=0 IF THE NUMBER IN THE MESSAGE BUFFER WENT OFF-HOOK.

Fig. 15 – Layout of Error and State of Repair Registers, and During Sector Scan, Layout of Message and Input Buffers

ULE OUTPUTS TO PRESENT-STATE CIRCUITS IN STATION LINES, TRUNKS, ATTENDANT PUSHBUTTONS, TEST POINTS, ETC.

IN THE LIST PERTAIN TO NOTES AT THE BOTTOM OF THIS PAGE. COLUMN 1: SCAN-POINT NUMBER.
, GIVEN IN THIS ORDER: SUBMODULE (A OR B), CORE-CARD NUMBER, AND CONNECTOR TERMINAL NUMBER FOR THE CORE CARD.

ASSIGNMENT	COL 1	COL 2	ASSIGNMENT	COL 1	COL 2	ASSIGNMENT
33RD LINE CIRCUIT+	160	B-3-1	113TH LINE CIRCUIT+	240	B-7-17	193RD LINE CIRCUIT+
34TH	161	B-3-2	114TH	241	B-7-18	194TH
35TH	162	B-3-3	115TH	242	B-7-19	195TH
36TH	163	B-3-4	116TH	243	B-7-21	196TH
37TH	164	B-3-5	117TH	244	B-7-22	197TH
38TH	165	B-3-6	118TH	245	B-7-23	198TH
39TH	166	B-3-7	119TH	246	B-7-24	199TH
40TH	167	B-3-8	120TH	247	B-7-25	200TH LINE CIRCUIT+
41ST	168	B-3-9	121ST	243	B-7-26	TEST LINE CIRCUIT
42ND	169	B-3-10	122ND	249	B-7-27	UNUSED*
43RD	170	B-3-11	123RD	250	B-7-28	
44TH	171	B-3-12	124TH	251	B-7-29	
45TH	172	B-3-13	125TH	252	B-7-30	
46TH	173	B-3-14	126TH	253	B-7-31	
47TH	174	B-3-15	127TH	254	B-7-32	
48TH	175	B-3-16	128TH	255	B-7-33	
49TH	176	B-3-17	129TH	256	A-8-1	
50TH	177	B-3-18	130TH	257	A-8-2	
51ST	178	B-3-19	131ST	258	A-8-3	
52ND	179	B-3-21	132ND	259	A-8-4	
53RD	180	B-3-22	133RD	260	A-8-5	
54TH	181	B-3-23	134TH	261	A-8-6	UNUSED*
55TH	182	B-3-24	135TH	262	A-8-7	"TRANSFER" KEY ON 1ST ATTENDANT CONSOLE
56TH	183	B-3-25	136TH	263	A-8-8	"NIGHT-SERVICE" KEY ON 1ST ATTENDANT CONSOLE
57TH	184	B-3-26	137TH	264	A-8-9	PARITY-FAILURE IN DATA DISTRIBUTOR INDICATION*
58TH	185	B-3-27	138TH	265	A-8-10	FAILURE OF EITHER S.U. CLOCK INDICATION*
59TH	186	B-3-28	139TH	266	A-8-11	BLOWN FUSE INDICATION*
60TH	187	B-3-29	140TH	267	A-8-12	UNUSED*
61ST	188	B-3-30	141ST	268	A-8-13	RING GENERATOR DISABLE
62ND	189	B-3-31	142ND	269	A-8-14	UNUSED**
63RD	190	B-3-32	143RD	270	A-8-15	VERIFICATION OF TRANSFER INDICATION*
64TH	191	B-3-33	144TH	271	A-8-16	"BUSY-VERIFICATION" KEY ON 1ST ATTENDANT CONSOLE*
65TH	192	B-5- 1	145TH	272	A-8-17	1ST ATTENDANT CONSOLE: "EXCLUDE DESTINATION" KEY*
66TH	193	B-5- 2	146TH	273	A-8-18	"EXCLUDE SOURCE" KEY*
67TH	194	B-5- 3	147TH	274	A-8-19	"RELEASE DESTINATION" KEY*
68TH	195	B-5- 4	148TH	275	A-8-21	"RELEASE SOURCE" KEY*
69TH	196	B-5- 5	149TH	276	A-8-22	"SIGNAL SOURCE" KEY*
70TH	197	B-5- 6	150TH	277	A-8-23	"SIGNAL DESTINATION" KEY*
71ST	198	B-5- 7	151ST	278	A-8-24	"POSITION-BUSY" KEY
72ND	199	B-5- 8	152ND	279	A-8-25	"HOLD"KEY*
73RD	200	B-5- 9	153RD	280	A-8-26	"RELEASE" KEY*
74TH	201	B-5-10	154TH	281	A-8-27	"PICKUP 1" KEY*
75TH	202	B-5-11	155TH	282	A-8-28	"PICKUP 2" KEY*
76TH	203	B-5-12	156TH	283	A-8-29	"PICKUP 3" KEY*
77TH	204	B-5-13	157TH	284	A-8-30	"PICKUP 4" KEY*
78TH	205	B-5-14	158TH	285	A-8-31	"PICKUP 5" KEY*
79TH	206	B-5-15	159TH	286	A-8-32	"PICKUP 6" KEY*
80TH	207	B-5-16	160TH	287	A-8-33	1ST ATTENDANT CONSOLE: "START" KEY*
81ST	208	B-5-17	161ST	288	B-9- 1	2ND ATTENDANT CONSOLE: "EXCLUDE DESTINATION" KEY*
82ND	209	B-5-18	162ND	239	B-9- 2	"EXCLUDE SOURCE" KEY*
83RD	210	B-5-19	163RD	290	B-9- 3	"RELEASE DESTINATION" KEY*
84TH	211	B-5-21	164TH	291	B-9- 4	"RELEASE SOURCE" KEY*
85TH	212	B-5-22	165TH	292	B-9- 5	"SIGNAL SOURCE" KEY*
86TH	213	B-5-23	166TH	293	B-9- 6	"SIGNAL DESTINATION" KEY*
87TH	214	B-5-24	167TH	294	B-9- 7	"POSITION-BUSY" KEY
88TH	215	B-5-25	168TH	295	B-9- 8	"HOLD" KEY*
89TH	216	B-5-26	169TH	296	B-9- 9	"RELEASE" KEY*
90TH	217	B-5-27	170TH	297	B-9-10	"PICKUP 1" KEY*
91ST	218	B-5-28	171ST	298	B-9-11	"PICKUP 2" KEY*
92ND	219	B-5-29	172ND	299	B-9-12	"PICKUP 3" KEY*
93RD	220	B-5-30	173RD	300	B-9-13	"PICKUP 4" KEY*
94TH	221	B-5-31	174TH	301	B-9-14	"PICKUP 5" KEY*
95TH	222	B-5-32	175TH	302	B-9-15	"PICKUP 6" KEY*
96TH	223	B-5-33	176TH	303	B-9-16	2ND ATTENDANT CONSOLE: "START" KEY*
97TH	224	B-7- 1	177TH	304	B-9-17	3RD ATTENDANT CONSOLE: "EXCLUDE DESTINATION" KEY*
98TH	225	B-7- 2	178TH	304	B-9-18	"EXCLUDE SOURCE" KEY*
99TH	226	B-7- 3	179TH	305	B-9-19	"RELEASE DESTINATION" KEY*
100TH	227	B-7- 4	180TH	307	B-9-21	"RELEASE SOURCE" KEY*
101ST	228	B-7- 5	181ST	308	B-9-22	"SIGNAL SOURCE" KEY*
102ND	229	B-7- 6	182ND	309	B-9-23	"SIGNAL DESTINATION" KEY*
103RD	230	B-7- 7	183RD	310	B-9-24	"POSITION-BUSY" KEY
104TH	231	B-7- 8	184TH	311	B-9-25	"HOLD" KEY*
105TH	232	B-7- 9	185TH	312	B-9-26	"RELEASE" KEY*
106TH	233	B-7-10	186TH	313	B-9-27	"PICKUP 1" KEY*
107TH	234	B-7-11	187TH	314	B-9-28	"PICKUP 2" KEY*
108TH	235	B-7-12	188TH	315	B-9-29	"PICKUP 3" KEY*
109TH	236	B-7-13	189TH	316	B-9-30	"PICKUP 4" KEY*
110TH	237	B-7-14	190TH	317	B-9-31	"PICKUP 5" KEY*
111TH	238	B-7-15	191ST	318	B-9-32	"PICKUP 6" KEY*
112TH LINE CIRCUIT +	239	B-7-16	192ND LINE CIRCUIT+	319	B-9-33	3RD ATTENDANT CONSOLE: "START" KEY*

R; FOR EXAMPLE, THE FIRST C.O. TRUNK IS
R 25TH C.O. TRUNK IS CALLED "TRUNK NO. 32".

400 OR 600); THE SECOND STATION LINE HAS
THAT THE 200TH (LAST) STATION LINE HAS

DIALING INFORMATION

SERVICE	ROTARY DIAL STATION	"TOUCH-TONE" STATION
STATION TO STATION OR IN DIALED STATION CALL.	2XX---7XX	2XX---7XX
ATTENDANT	0	0
CENTRAL OFFICE	9	9
TIE TRUNK	8X	8X
HOLD	1,8	KEY 11 OR 1,8
PICK-UP	1,9	KEY 12 OR 1,9
SPARE	1,0	KEY 13 OR 1,0
ABBREVIATED	(1,1)(1,2)(1,3)(1,4)(1,5)OR(1,6)	KEY 14 PLUS 1,2,3,4,5 OR 6 OR 1 PLUS 1,2,3,4,5 OR 6
COMPRESSED	2XX---5XX	2XX---5XX
AUTOMATIC REROUTE	1,7	KEY 15 OR 1,7

PERMISSIBLE MESSAGES

MESSAGE	EXT	C.Ø. TK	FX TK	TIE TK
OFF HK	✓	✓	✓	✓
ON HK	✓	✓	✓	✓
FLASH	✓			✓
BUSY TEST (1)	✓		✓	✓
BUSY VERIFY	✓			✓
TRACE	✓	✓	✓	✓

BCD DIGIT ENTRIES FROM THE DIGITS COMPLETED REGISTER (CALLED BY "RED DDR")

ENTRY	KIND
XXXX XXXX XXXX	EXT, COMPRESSED, SPECIAL SERVICE (SEE ABOVE)
0000 0000 1010	"ZERO" DIALED OR KEYED
0000 0000 0000	NO COMPLETE MESSAGE YET AVAILABLE
0000 0000 0001	SENDING COMPLETE (USE FOR DIAL "9" & COMPRESSED CALLS)
0000 0000 0010	TIME-OUT (NO FURTHER DIGITS WILL BE ACCEPTED BY THE DIGIT RECEIVERS SINCE A GIVEN STATION TOOK TOO LONG TO DIAL)
1010 0000 0000	ZERO DIALED OR KEYED AFTER 9

"IDENTITY BITS" FOR NOS. APPEARING IN THE "TO BE MATCHED WAITING LIST" IN SUPPLEMENTARY INFORMATION

CODE	MEANING	
000	EXT BUSY TEST	(ATT NOT OFF HK)
001	TIE TK BUSY TEST	(ATT NOT OFF HK)
010	EXT BUSY TEST	(ATT OFF HK)
011	TIE TK BUSY TEST	(ATT OFF HK)
100	BUSY VERIFY	
101	(AVAILABLE)	
110	MULTI-NIGHT SERVICE BUSY TEST	
111	(AVAILABLE)	

POSSIBLE S U EXT. NOS. AND THEIR CORRESPONDING COMPRESSED DIALING GROUP

NORMAL S U DIAL GROUP	PBX EXT. NUMBER	COMPRESSED NO. RANGE.
01	200-399	400-599
11	400-599	200-399
10	600-799	200-399

CONFIGURATION OF CERTAIN CODES IN THE CS AND CO

CODE	BINARY	OCT	
HOLD	111101	75	WORD C3, BITS 16-11 IN CO
RINGING	111111	77	
BUSY TONE	11111110	376	SPECIAL CONNECTIONS
FAST BUSY	11111101	375	USED WITH LDT CMD,
SOFT TONE	11111100	374	BITS 16-9 OF CO

(1) EXT, TIE TK AND FX TK BUSY TESTS ARE PERFORMED BY EXAMINING ALL THE TIME SLOTS (FOR A GIVEN S.U.) FOR THE EXISTENCE OF THE DIALED PARTY IN A TIME SLOT OTHER THAN THE TIME SLOT REQUESTING THE BUSY TEST.

C.Ø. TK, BUSY TESTS ARE PERFORMED BY CHECKING THE "STATUS BIT" IN THE SUPPLEMENTARY INFORMATION (WORDS SU X 32 + 4,5,6). A "ONE" IN ANY POSITION DEFINES A BUSY TK; A "ZERO" IN ANY POSITION DEFINES AN IDLE TK.

Fig. 16 – Scan Points and Miscellaneous Information

ASSIGNMENT OF SCANNER MEMORY SUBMODULE OUTPUTS TO PRESENT-STATE CIRCUITS IN STATION LINES, TRUNKS, ATTENDANT PUSHBUTTONS, TEST POINTS, ETC.

SYMBOLS USED IN THE LIST PERTAIN TO NOTES AT THE BOTTOM OF THIS PAGE. COLUMN 1: SCAN-POINT NUMBER.
COLUMN 2: SOURCE OF INTERROGATING SIGNAL, GIVEN IN THIS ORDER: SUBMODULE (A OR B), CORE-CARD NUMBER, AND CONNECTOR TERMINAL NUMBER FOR THE CORE CAR

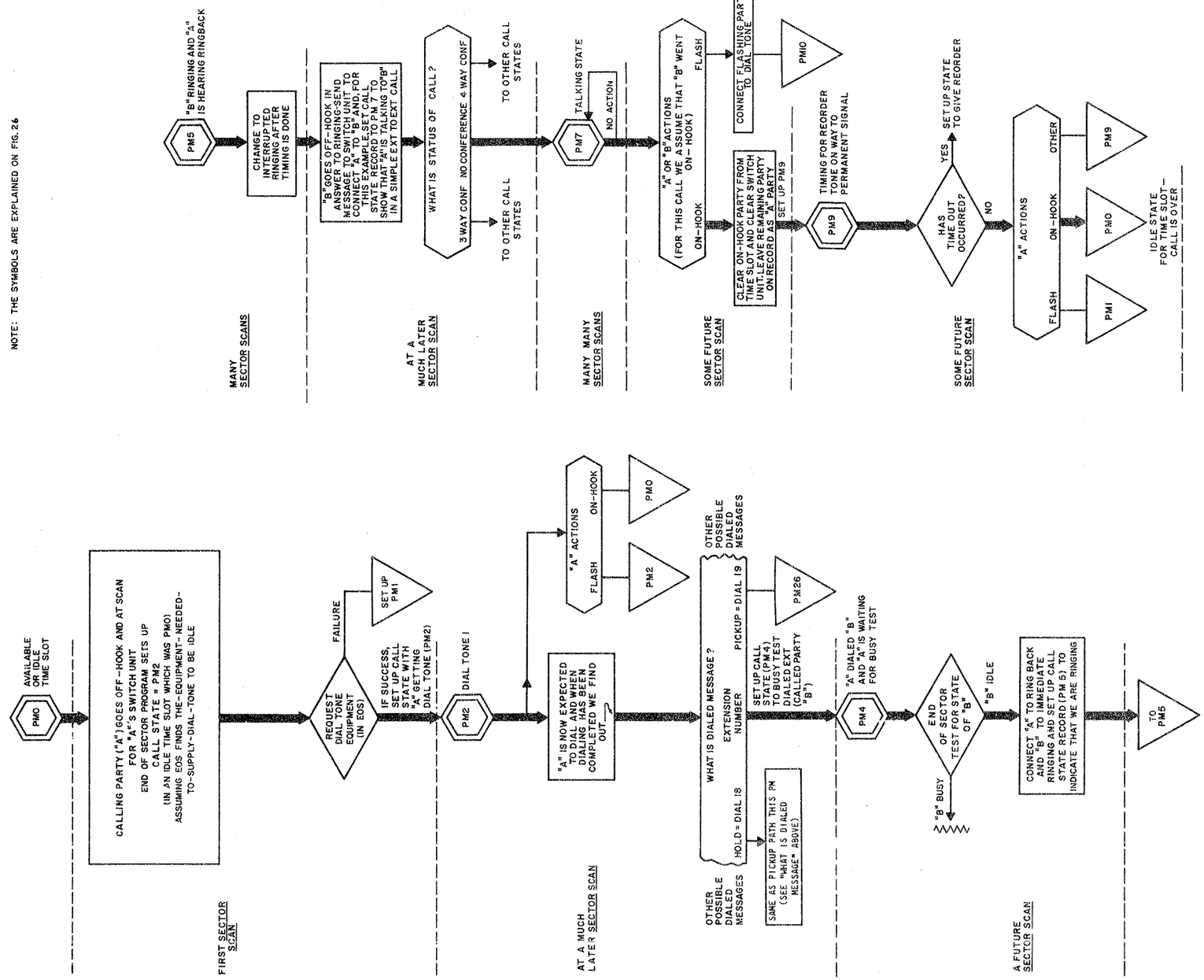
COL 1	COL 2	ASSIGNMENT	COL 1	COL 2	ASSIGNMENT	COL 1	COL 2	ASSIGNMENT	COL 1	COL 2	ASSIGNMENT
0	A-0-1	UNUSED	80	A-4-17	33RD LINE CIRCUIT+	160	B-3-1	113TH LINE CIRCUIT+	240	B-7-17	193RD LINE CIRCUIT+
1	A-0-2	UNUSED*	81	A-4-18	34TH	161	B-3-2	114TH	241	B-7-18	194TH
2	A-0-3	↕	82	A-4-19	35TH	162	B-3-3	115TH	242	B-7-19	195TH
3	A-0-4	↕	83	A-4-21	36TH	163	B-3-4	116TH	243	B-7-21	196TH
4	A-0-5	↕	84	A-4-22	37TH	164	B-3-5	117TH	244	B-7-22	197TH
5	A-0-6	UNUSED*	85	A-4-23	38TH	165	B-3-6	118TH	245	B-7-23	198TH
6	A-0-7	TEST LINE OUTPUT	86	A-4-24	39TH	166	B-3-7	119TH	246	B-7-24	199TH
7	A-0-8	TEST LINE CIRCUIT	87	A-4-25	40TH	167	B-3-8	120TH	247	B-7-25	200TH LINE CIRCUIT+
8	A-0-9	1ST TRUNK CIRCUIT†	88	A-4-26	41ST	168	B-3-9	121ST	248	B-7-26	TEST LINE CIRCUIT
9	A-0-10	2ND ↑	89	A-4-27	42ND	169	B-3-10	122ND	249	B-7-27	UNUSED*
10	A-0-11	3RD ↑	90	A-4-28	43RD	170	B-3-11	123RD	250	B-7-28	↕
11	A-0-12	4TH ↑	91	A-4-29	44TH	171	B-3-12	124TH	251	B-7-29	↕
12	A-0-13	5TH ↑	92	A-4-30	45TH	172	B-3-13	125TH	252	B-7-30	↕
13	A-0-14	6TH ↑	93	A-4-31	46TH	173	B-3-14	126TH	253	B-7-31	↕
14	A-0-15	7TH ↑	94	A-4-32	47TH	174	B-3-15	127TH	254	B-7-32	↕
15	A-0-16	8TH ↑	95	A-4-33	48TH	175	B-3-16	128TH	255	B-7-33	↕
16	A-0-17	9TH ↑	96	A-6-1	49TH	176	B-3-17	129TH	256	A-8-1	↕
17	A-0-18	10TH ↑	97	A-6-2	50TH	177	B-3-18	130TH	257	A-8-2	↕
18	A-0-19	11TH ↑	98	A-6-3	51ST	178	B-3-19	131ST	258	A-8-3	↕
19	A-0-21	12TH ↑	99	A-6-4	52ND	179	B-3-21	132ND	259	A-8-4	↕
20	A-0-22	13TH ↑	100	A-6-5	53RD	180	B-3-22	133RD	260	A-8-5	↕
21	A-0-23	14TH ↑	101	A-6-6	54TH	181	B-3-23	134TH	261	A-8-6	UNUSED*
22	A-0-24	15TH ↑	102	A-6-7	55TH	182	B-3-24	135TH	262	A-8-7	"TRANSFER" KEY ON 1ST ATTENDANT CONSOL
23	A-0-25	16TH ↑	103	A-6-8	56TH	183	B-3-25	136TH	263	A-8-8	"NIGHT-SERVICE" KEY ON 1ST ATTENDANT C
24	A-0-26	17TH ↑	104	A-6-9	57TH	184	B-3-26	137TH	264	A-8-9	PARITY-FAILURE IN DATA DISTRIBUTOR IND
25	A-0-27	18TH ↑	105	A-6-10	58TH	185	B-3-27	138TH	265	A-8-10	FAILURE OF EITHER S.U. CLOCK INDICATIO
26	A-0-28	19TH ↑	106	A-6-11	59TH	186	B-3-28	139TH	266	A-8-11	BLOWN FUSE INDICATION*
27	A-0-29	20TH ↑	107	A-6-12	60TH	187	B-3-29	140TH	267	A-8-12	UNUSED*
28	A-0-30	21ST ↑	108	A-6-13	61ST	188	B-3-30	141ST	268	A-8-13	RING GENERATOR DISABLE
29	A-0-31	22ND ↑	109	A-6-14	62ND	189	B-3-31	142ND	269	A-8-14	UNUSED**
30	A-0-32	23RD ↑	110	A-6-15	63RD	190	B-3-32	143RD	270	A-8-15	VERIFICATION OF TRANSFER INDICATION*
31	A-0-33	24TH TRUNK CIRCUIT† ↑	111	A-6-16	64TH	191	B-3-33	144TH	271	A-8-16	"BUSY-VERIFICATION" KEY ON 1ST ATTENDA
32	A-2- 1	TIE TRUNK OR 25TH TRUNK CKT † ↑	112	A-6-17	65TH	192	B-5- 1	145TH	272	A-8-17	1ST ATTENDANT CONSOLE: "EXCLUDE DESTIN
33	A-2- 2	26TH TRUNK CKT † ↑	113	A-6-18	66TH	193	B-5- 2	146TH	273	A-8-18	"EXCLUDE SOURCE
34	A-2- 3	27TH TRUNK CKT † ↑	114	A-6-19	67TH	194	B-5- 3	147TH	274	A-8-19	"RELEASE DESTIN
35	A-2- 4	28TH TRUNK CKT † ↑	115	A-6-21	68TH	195	B-5- 4	148TH	275	A-8-21	"RELEASE SOURCE
36	A-2- 5	29TH TRUNK CKT † ↑	116	A-6-22	69TH	196	B-5- 5	149TH	276	A-8-22	"SIGNAL SOURCE"
37	A-2- 6	30TH TRUNK CKT † ↑	117	A-6-23	70TH	197	B-5- 6	150TH	277	A-8-23	"SIGNAL DESTINA
38	A-2- 7	31ST TRUNK CKT † ↑	118	A-6-24	71ST	198	B-5- 7	151ST	278	A-8-24	"POSITION-BUSY"
39	A-2- 8	32ND TRUNK CKT † ↑	119	A-6-25	72ND	199	B-5- 8	152ND	279	A-8-25	"HOLD"KEY°
40	A-2- 9	33RD TRUNK CKT † ↑	120	A-6-26	73RD	200	B-5- 9	153RD	280	A-8-26	"RELEASE" KEY°
41	A-2-10	34TH TRUNK CKT † ↑	121	A-6-27	74TH	201	B-5-10	154TH	281	A-8-27	"PICKUP 1" KEY°
42	A-2-11	35TH TRUNK CKT † ↑	122	A-6-28	75TH	202	B-5-11	155TH	282	A-8-28	"PICKUP 2" KEY°
43	A-2-12	36TH TRUNK CKT † ↑	123	A-6-29	76TH	203	B-5-12	156TH	283	A-8-29	"PICKUP 3" KEY°
44	A-2-13	37TH TRUNK CKT † ↑	124	A-6-30	77TH	204	B-5-13	157TH	284	A-8-30	"PICKUP 4" KEY°
45	A-2-14	38TH TRUNK CKT † ↑	125	A-6-31	78TH	205	B-5-14	158TH	285	A-8-31	"PICKUP 5" KEY°
46	A-2-15	39TH TRUNK CKT † ↑	126	A-6-32	79TH	206	B-5-15	159TH	286	A-8-32	"PICKUP 6" KEY°
47	A-2-16	40TH TRUNK CKT † ↑	127	A-6-33	80TH	207	B-5-16	160TH	287	A-8-33	1ST ATTENDANT CONSOLE: "START" KEY°
48	A-2-17	1ST LINE CKT † + ↑	128	B-1- 1	81ST	208	B-5-17	161ST	288	B-9- 1	2ND ATTENDANT CONSOLE: "EXCLUDE DESTIN
49	A-2-18	2ND LINE CKT † + ↑	129	B-1- 2	82ND	209	B-5-18	162ND	289	B-9- 2	"EXCLUDE SOURCE
50	A-2-19	3RD LINE CKT † + ↑	130	B-1- 3	83RD	210	B-5-19	163RD	290	B-9- 3	"RELEASE DESTIN
51	A-2-21	4TH LINE CKT † + ↑	131	B-1- 4	84TH	211	B-5-21	164TH	291	B-9- 4	"RELEASE SOURCE
52	A-2-22	5TH LINE CKT † + ↑	132	B-1- 5	85TH	212	B-5-22	165TH	292	B-9- 5	"SIGNAL SOURCE"
53	A-2-23	6TH LINE CKT † + ↑	133	B-1- 6	86TH	213	B-5-23	166TH	293	B-9- 6	"SIGNAL DESTINA
54	A-2-24	7TH LINE CKT † + ↑	134	B-1- 7	87TH	214	B-5-24	167TH	294	B-9- 7	"POSITION-BUSY"
55	A-2-25	9TH LINE CKT † + ↑	135	B-1- 8	88TH	215	B-5-25	168TH	295	B-9- 8	"HOLD" KEY°
56	A-2-26	9TH LINE CKT † + ↑	136	B-1- 9	89TH	216	B-5-26	169TH	296	B-9- 9	"RELEASE" KEY°
57	A-2-27	10TH LINE CKT † + ↑	137	B-1-10	90TH	217	B-5-27	170TH	297	B-9-10	"PICKUP 1" KEY°
58	A-2-28	11TH LINE CKT † + ↑	138	B-1-11	91ST	218	B-5-28	171ST	298	B-9-11	"PICKUP 2" KEY°
59	A-2-29	12TH LINE CKT † + ↑	139	B-1-12	92ND	219	B-5-29	172ND	299	B-9-12	"PICKUP 3" KEY°
60	A-2-30	13TH LINE CKT † + ↑	140	B-1-13	93RD	220	B-5-30	173RD	300	B-9-13	"PICKUP 4" KEY°
61	A-2-31	14TH LINE CKT † + ↑	141	B-1-14	94TH	221	B-5-31	174TH	301	B-9-14	"PICKUP 5" KEY°
62	A-2-32	15TH LINE CKT † + ↑	142	B-1-15	95TH	222	B-5-32	175TH	302	B-9-15	"PICKUP 6" KEY°
63	A-2-33	TIE TRUNK OR 16TH LINE CKT † + ↑	143	B-1-16	96TH	223	B-5-33	176TH	303	B-9-16	2ND ATTENDANT CONSOLE: "START" KEY°
64	A-4- 1	17TH LINE CIRCUIT + ↑	144	B-1-17	97TH	224	B-7- 1	177TH	304	B-9-17	3RD ATTENDANT CONSOLE: "EXCLUDE DESTIN
65	A-4- 2	18TH ↑	145	B-1-18	98TH	225	B-7- 2	178TH	304	B-9-18	"EXCLUDE SOURCE
66	A-4- 3	19TH ↑	146	B-1-19	99TH	226	B-7- 3	179TH	305	B-9-19	"RELEASE DESTIN
67	A-4- 4	20TH ↑	147	B-1-21	100TH	227	B-7- 4	180TH	307	B-9-21	"RELEASE SOURCE
68	A-4- 5	21ST ↑	148	B-1-22	101ST	228	B-7- 5	181ST	308	B-9-22	"SIGNAL SOURCE"
69	A-4- 6	22ND ↑	149	B-1-23	102ND	229	B-7- 6	182ND	309	B-9-23	"SIGNAL DESTINA
70	A-4- 7	23RD ↑	150	B-1-24	103RD	230	B-7- 7	183RD	310	B-9-24	"POSITION-BUSY"
71	A-4- 8	24TH ↑	151	B-1-25	104TH	231	B-7- 8	184TH	311	B-9-25	"HOLD" KEY°
72	A-4- 9	25TH ↑	152	B-1-26	105TH	232	B-7- 9	185TH	312	B-9-26	"RELEASE" KEY°
73	A-4-10	26TH ↑	153	B-1-27	106TH	233	B-7-10	186TH	313	B-9-27	"PICKUP 1" KEY°
74	A-4-11	27TH ↑	154	B-1-28	107TH	234	B-7-11	187TH	314	B-9-28	"PICKUP 2" KEY°
75	A-4-12	28TH ↑	155	B-1-29	108TH	235	B-7-12	188TH	315	B-9-29	"PICKUP 3" KEY°
76	A-4-13	29TH ↑	156	B-1-30	109TH	236	B-7-13	189TH	316	B-9-30	"PICKUP 4" KEY°
77	A-4-14	30TH ↑	157	B-1-31	110TH	237	B-7-14	190TH	317	B-9-31	"PICKUP 5" KEY°
78	A-4-15	31ST ↑	158	B-1-32	111TH ↓	233	B-7-15	191ST	318	B-9-32	"PICKUP 6" KEY°
79	A-4-16	32ND LINE CIRCUIT +	159	B-1-33	112TH LINE CIRCUIT +	239	B-7-16	192ND LINE CIRCUIT+	319	B-9-33	3RD ATTENDANT CONSOLE: "START" KEY°

* MAY BE ASSIGNED AS DESIRED.

° S.U. SENDS ONLY "OFF-HOOK" MESSAGES TO C.U.

† TRUNKS ARE NAMED ACCORDING TO THEIR SCAN-POINT NUMBER; FOR EXAMPLE, THE FIRST C.O. TRUNK IS CALLED "C.O. TRUNK NO. 8", AND THE FIRST TIE TRUNK OR 25TH C.O. TRUNK IS CALLED "TRUNK NO. 32".

+ THE FIRST STATION LINE HAS DIRECTORY NUMBER 200 (OR 400 OR 600); THE SECOND STATION LINE HAS DIRECTORY NUMBER 201 (OR 401 OR 601); AND SO ON, SO THAT THE 200TH (LAST) STATION LINE HAS DIRECTORY NUMBER 399 (OR 599 OR 799).

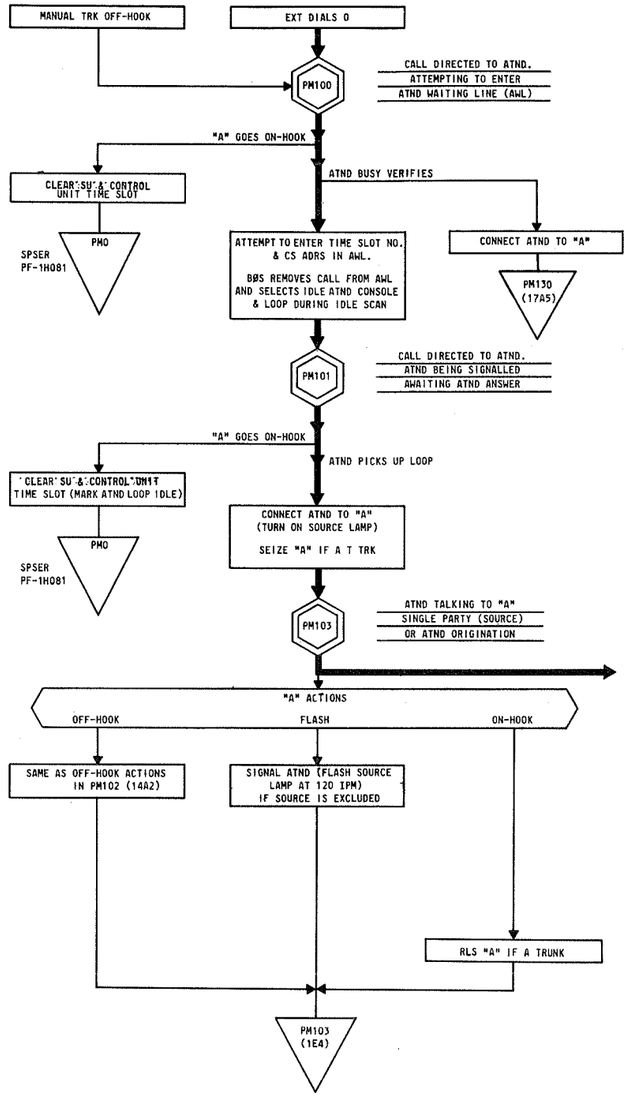


NOTE: THE SYMBOLS ARE EXPLAINED ON FIG. 26

Fig. 17 – Simplified Functional Flow Chart for Extension-To-Extension Call (Extracted from PF-1H081)

EXAMPLE OF AN ATTENDANT-INVOLVED CALL

1. EXTENSION DIALS ATTENDANT TO GET AN OUTSIDE NUMBER.
2. THUS ATTENDANT DIALS 9 AND THE REQUESTED NUMBER.
3. AND ATTENDANT RELEASES FROM CALL AFTER CALLED PARTIES ARE CONNECTED.
4. FINALLY THE CALLED PARTY HANGS UP AND CALL PROCEEDS AS IT WOULD WITHOUT ATTENDANT.



NOTE: WHEN ATND IS OFF-HOOK ON A CALL, THE ATND ACTIONS ARE SHOWN IN THE FLOW CHARTS LABELED "FROM BØS".

MESSAGE COMES FROM SWITCH UNIT TO INDICATE THAT ATTENDANT HAS PUSHED THE "START KEY". B.O.S-NOTING THAT THIS IS AN ATTENDANT ACTION AND THAT THIS ATTENDANT IS OFF HOOK ON A CALL * GOES DIRECTLY TO THE TIME SLOT FOR THIS OFF HOOK CALL WHICH IN THIS EXAMPLE LEADS US TO PROGRESS MARK 103.

* ATTENDANT MAY ONLY BE OFF HOOK ON ONE CALL AT A TIME AND RECORD OF SUCH CONDITION IS STORED IN CALL STORE PER SWITCH UNIT SUPPLEMENTARY INFORMATION.

PART OF GENERAL FLOW

ELECTRONIC SWITCHING SYSTEMS
NO.101
CALL PROCESSING PROGRAM FLOW CHARTS
ATTENDANT CALL PROCESSING

PF-1H082-01-C1

BELL TELEPHONE LABORATORIES INCORPORATED

DWG SIZE 6S

PRINTED IN U.S.A.

DRAWING ISSUE 1

Fig. 18 – Example of an Attendant-Involved Call, Sheet C1

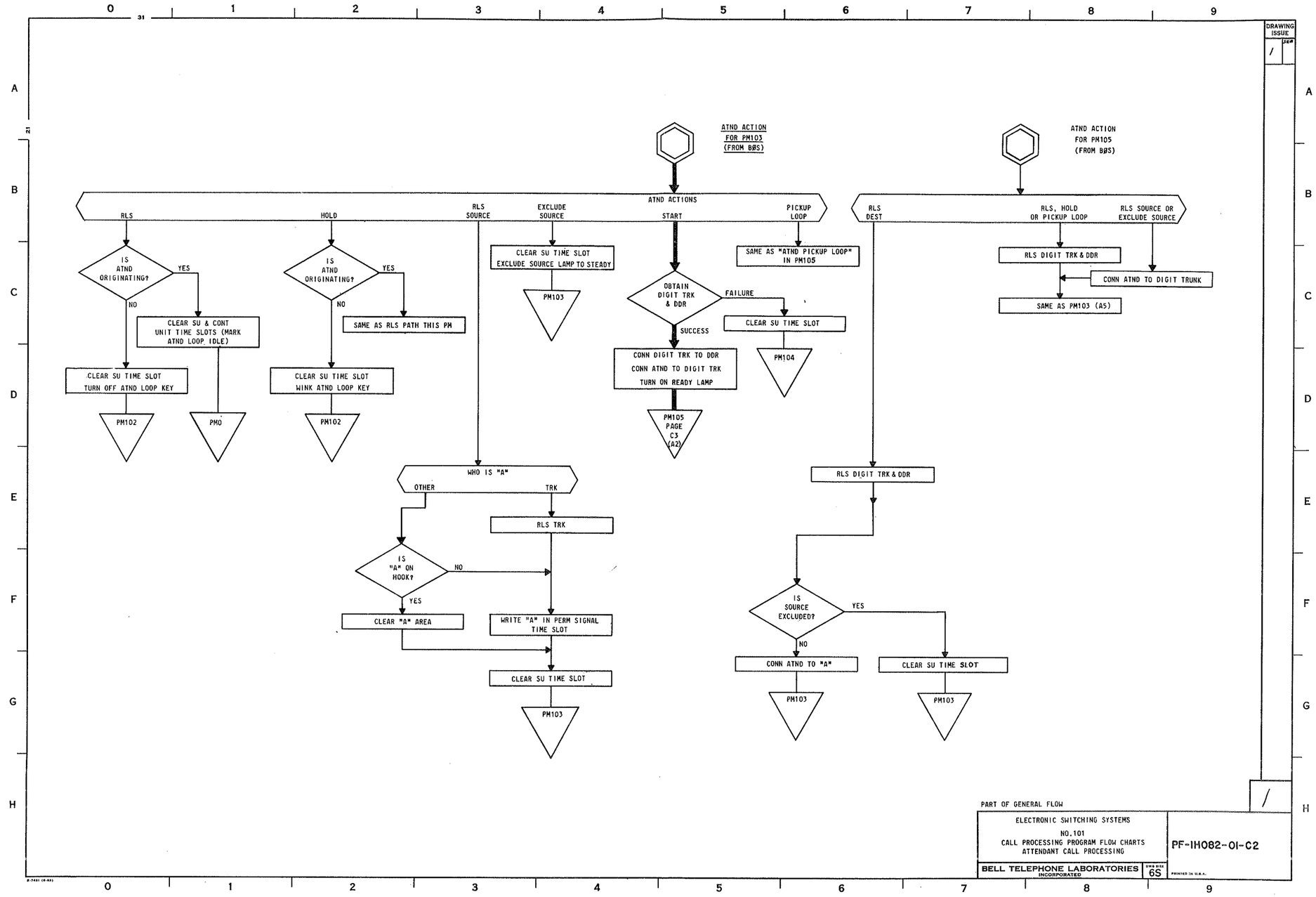


Fig. 19 – Example of an Attendant-Involved Call, Sheet C2

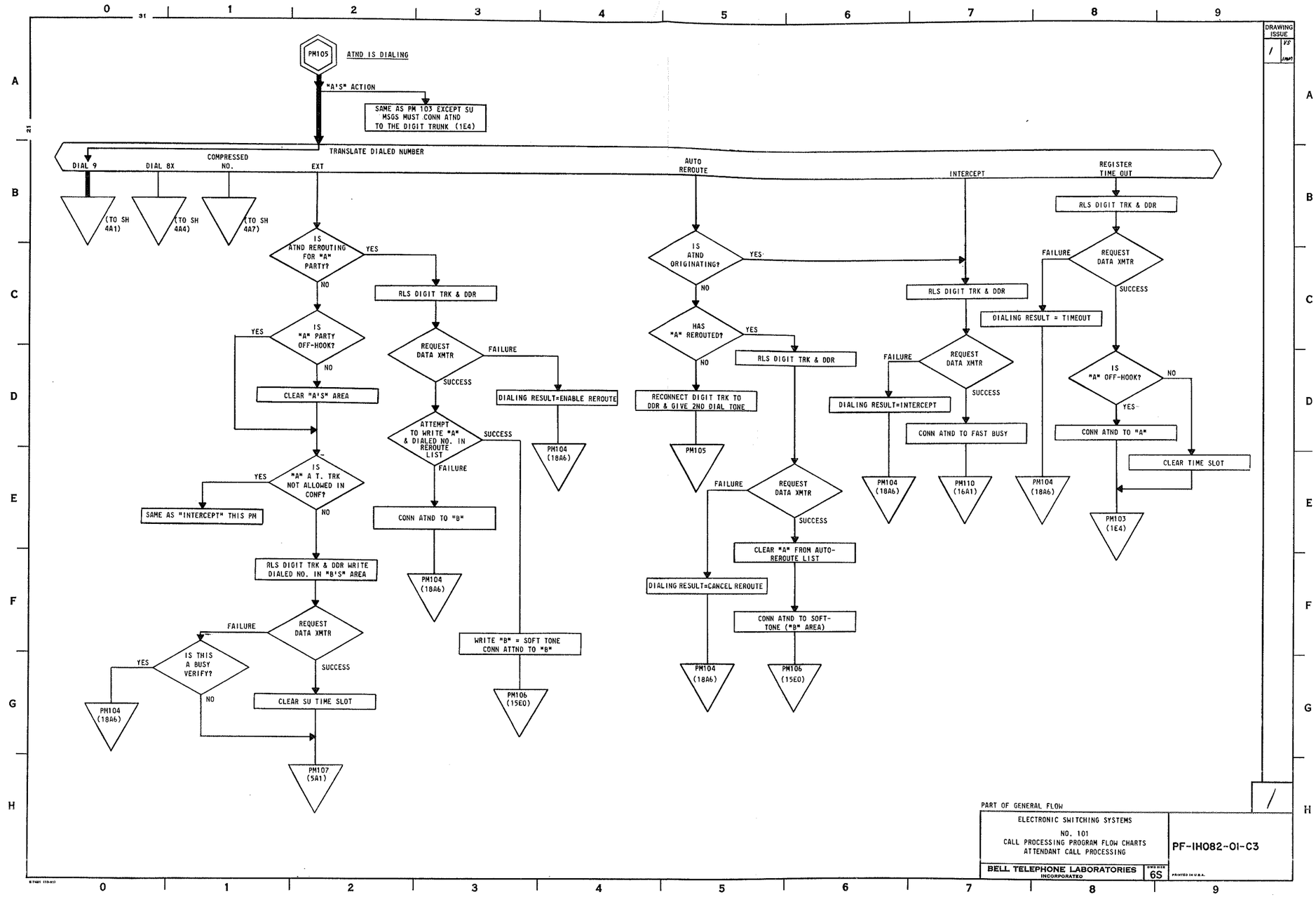


Fig. 20 – Example of an Attendant-Involved Call, Sheet C3

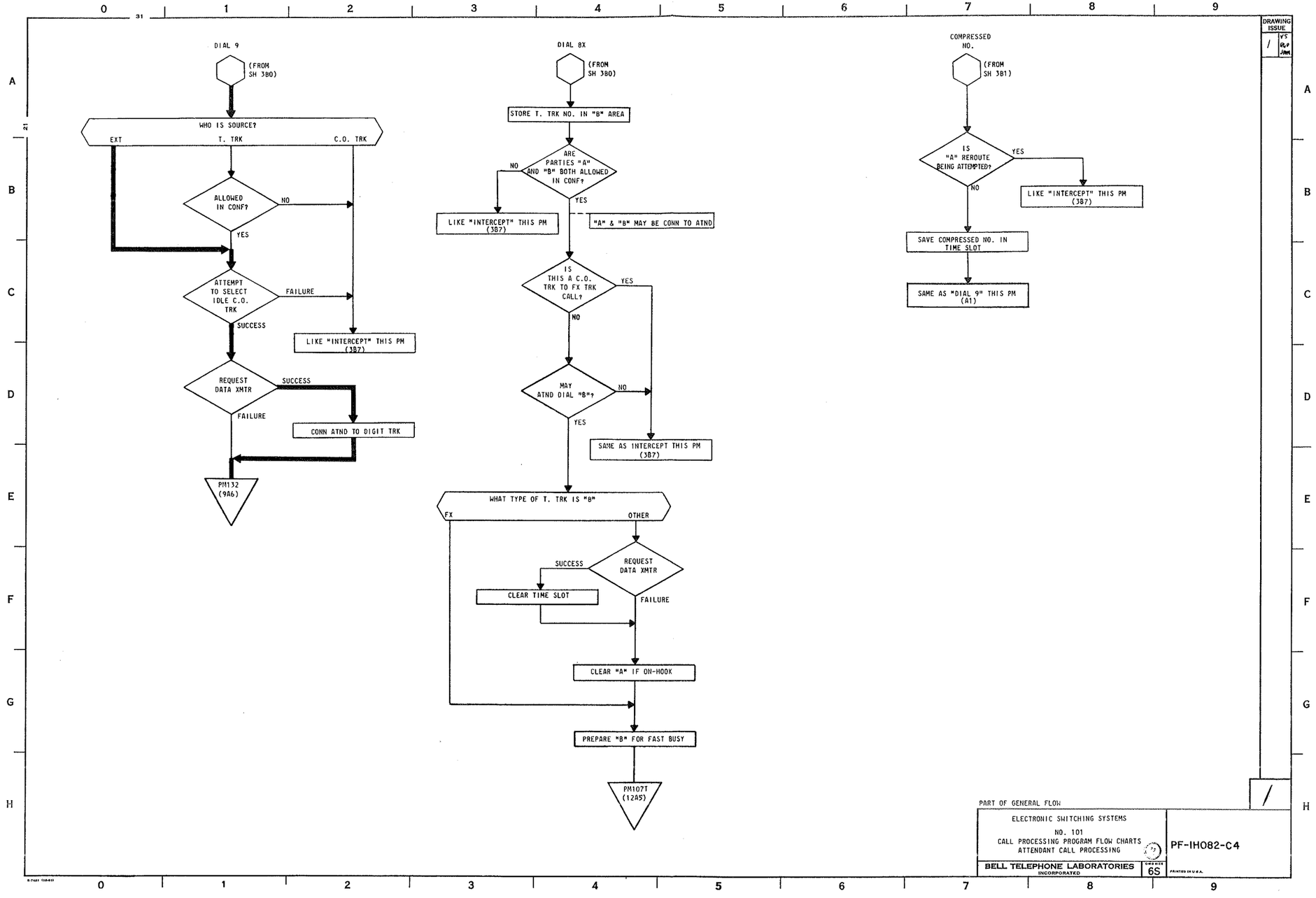


Fig. 21 – Example of an Attendant-Involved Call, Sheet C4

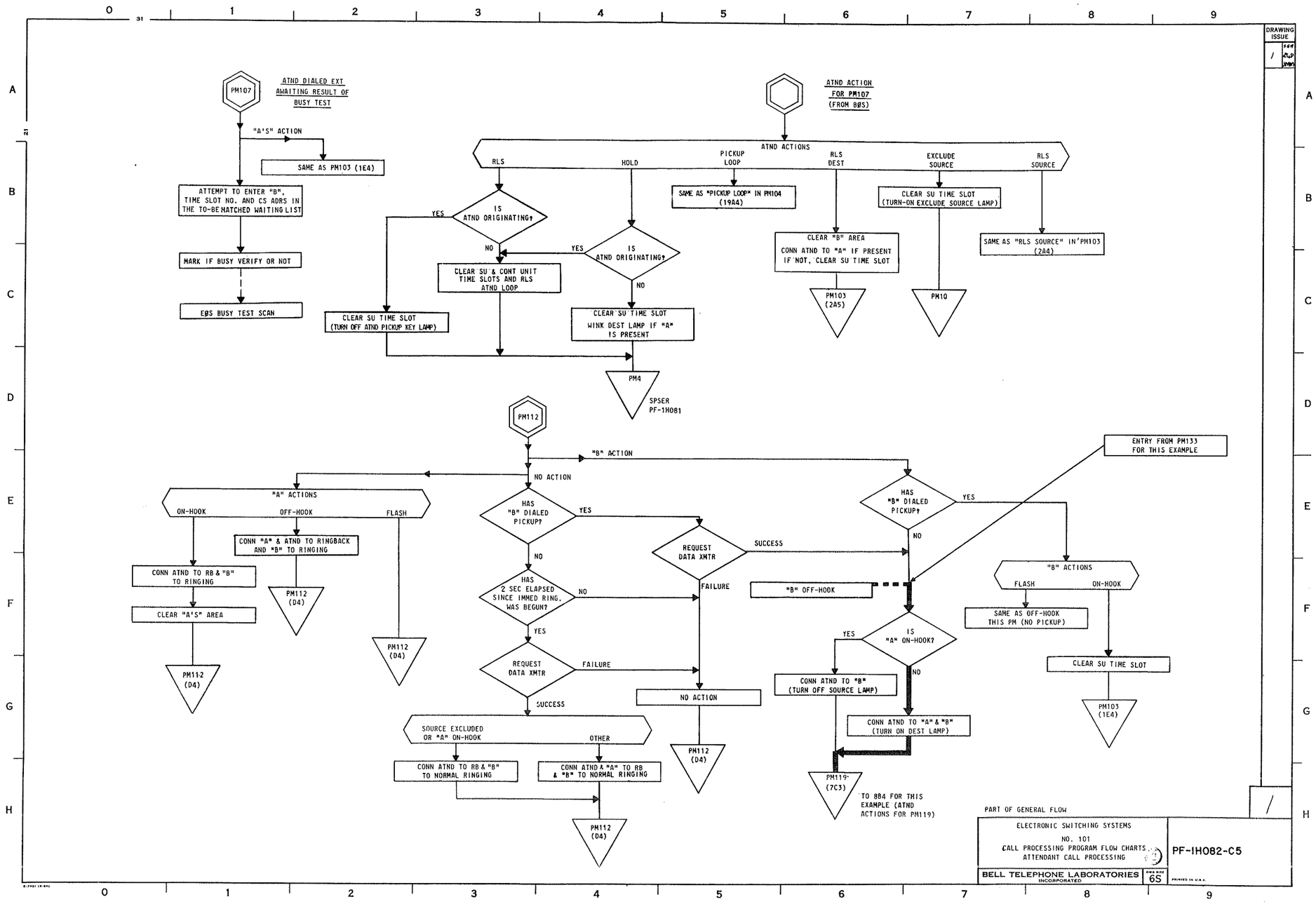


Fig. 22 – Example of an Attendant-Involved Call, Sheet C5

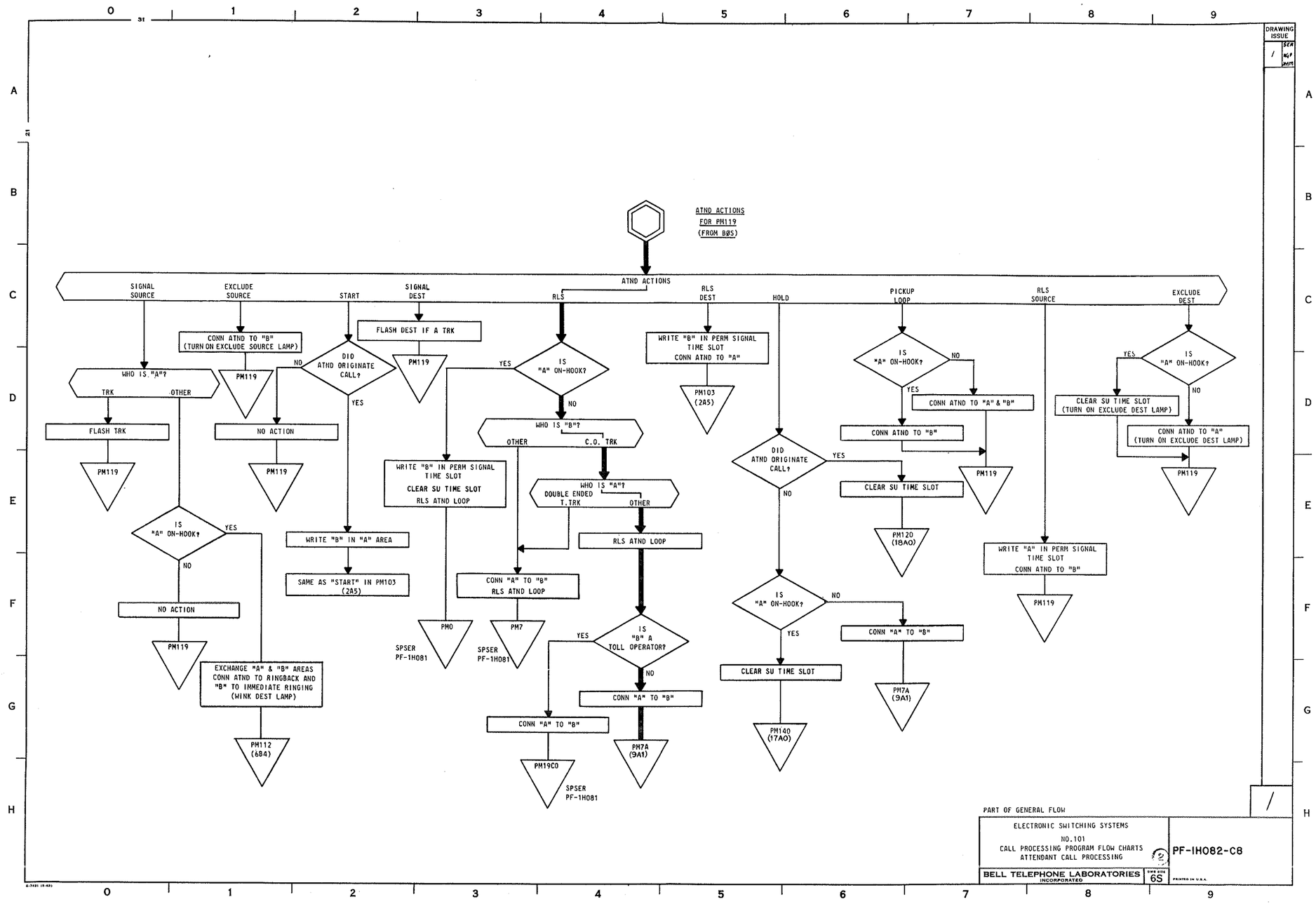


Fig. 23 – Example of an Attendant-Involved Call, Sheet C8

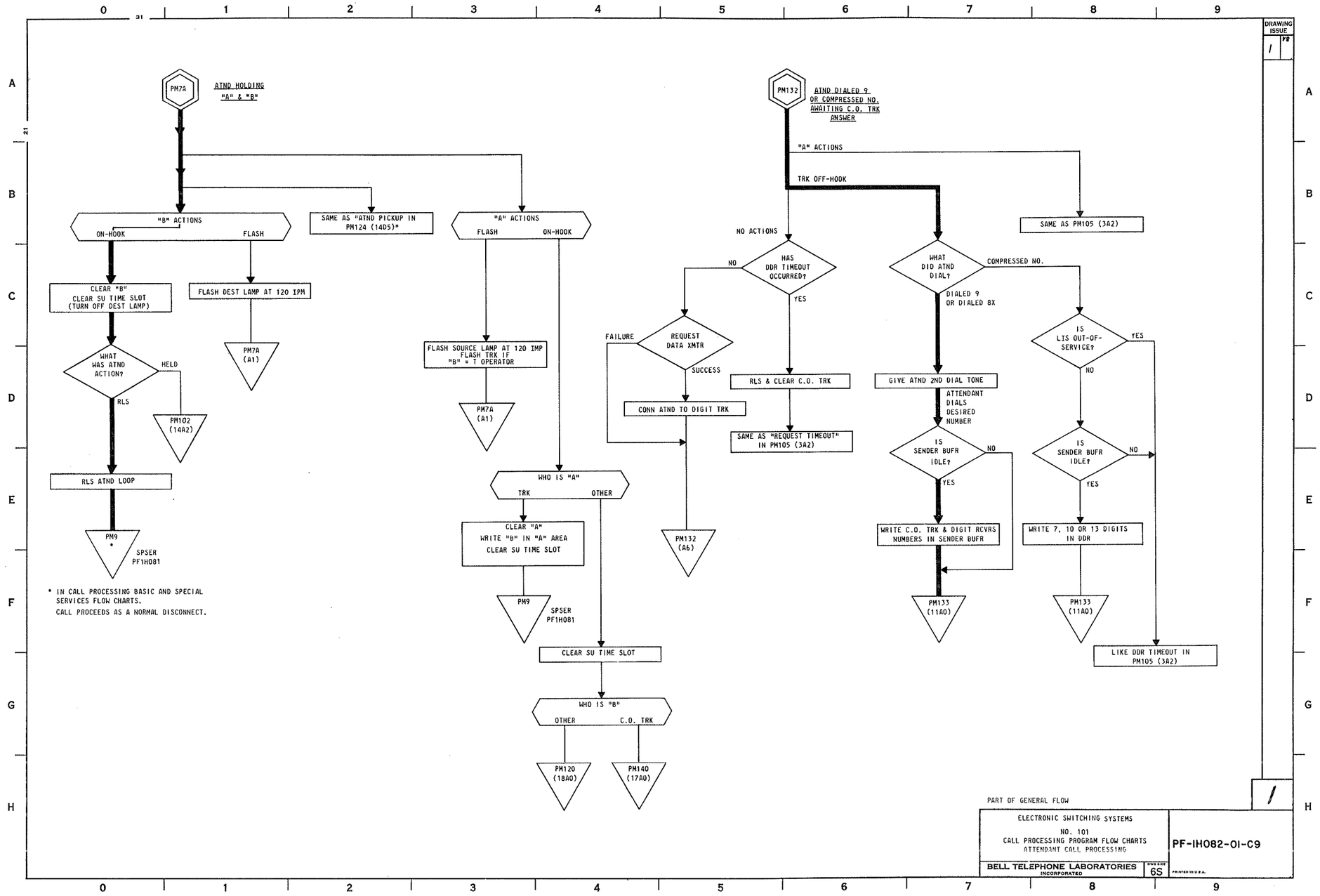


Fig. 24 – Example of an Attendant-Involved Call, Sheet C9

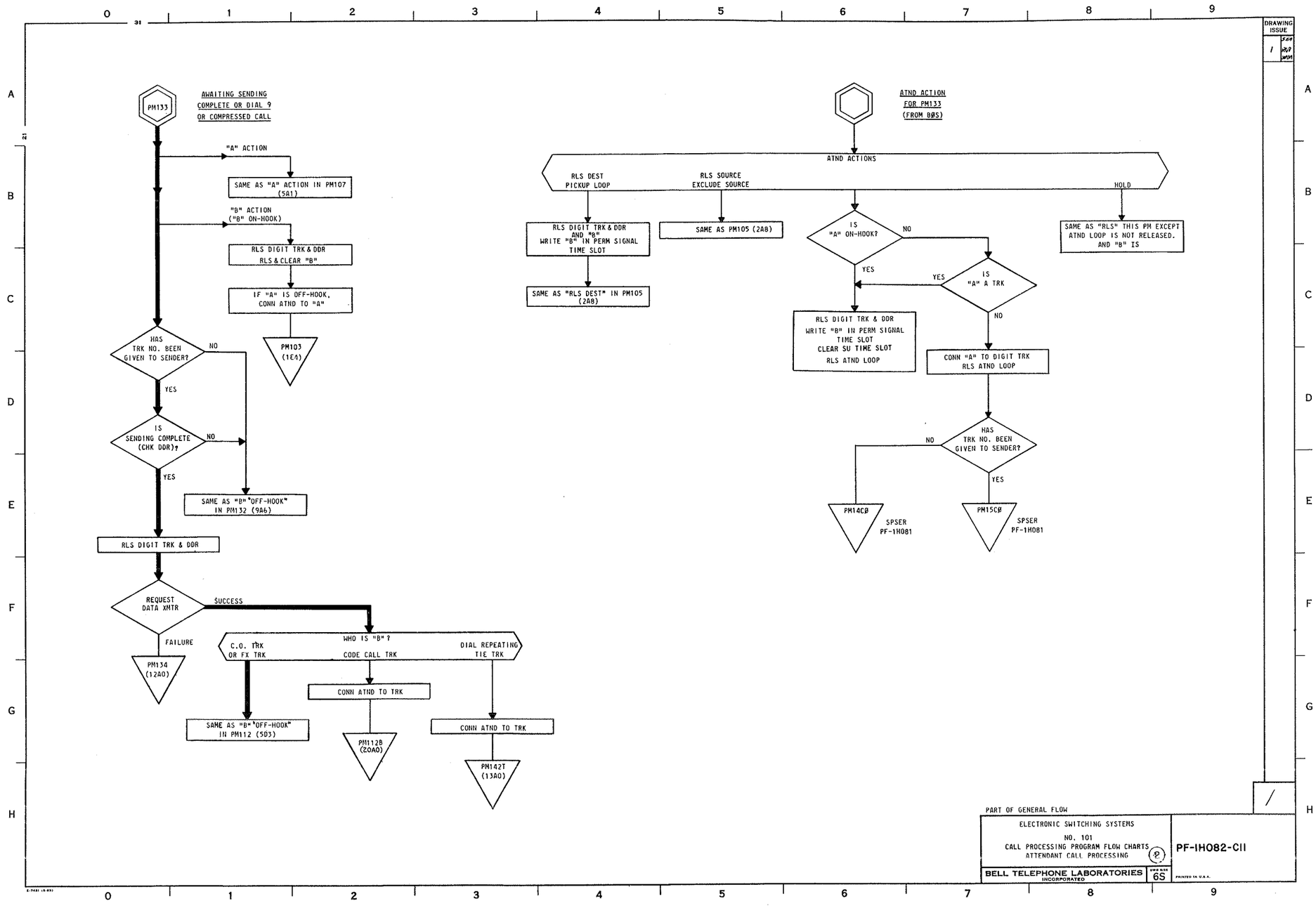
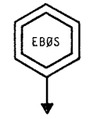


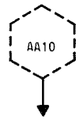
Fig. 25 – Example of an Attendant-Involved Call, Sheet C11

ENTRANCES



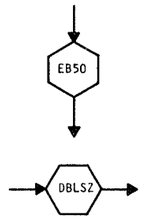
MAJOR ENTRANCE:

USED TO REPRESENT THE BEGINNING OF A MAJOR BLOCK OF PROGRAM. THE MNEMONIC FOR THIS PARTICULAR PROGRAM STORE ADDRESS IS SHOWN WITHIN THE SYMBOL.



CLOSED SUBROUTINE ENTRANCE:

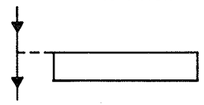
USED TO REPRESENT THE BEGINNING OF FLOW WHICH DEFINES THE SUBROUTINE. (NOT TO BE CONFUSED WITH THE SUBROUTINE SYMBOL SHOWN IN THE FLOW OF THE CALLING PROGRAM). THE SYMBOL IMPLIES THAT THE SUBROUTINE SAVES THE RETURN ADDRESS ELIMINATING A STATEMENT TO THAT EFFECT IN THE FOLLOWING FLOW.



MINOR ENTRANCE:

USED AS AN ENTRANCE WITHIN A LINE OF FLOW TO WHICH OTHER PORTIONS OF PROGRAM TRANSFER. ALSO USED AS AN ENTRANCE TO FLOW THAT IS A CONTINUATION OF FLOW TERMINATED ELSEWHERE DUE TO THE PHYSICAL LIMITATIONS OF THE DRAWING FORM.

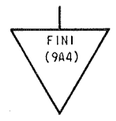
ANNOTATION



ANNOTATION:

NOT AN OPERATION. USED TO FURNISH EXPLANATORY INFORMATION THAT MAY BE HELPFUL IN FOLLOWING THIS LINE OF FLOW.

TERMINATIONS



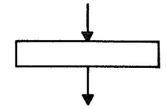
EXIT - NORMAL:

USED TO INDICATE THAT FLOW IS BROKEN HERE AND CONTINUED ELSEWHERE. THE MNEMONIC FOR THE LOCATION AT WHICH THE FLOW IS CONTINUED IS SHOWN WITHIN THE SYMBOL TOGETHER WITH THE SHEET NUMBER ON WHICH THE ENTRANCE APPEARS AND THE COORDINATES OF SAME ON THAT SHEET.

EXIT - CLOSED SUBROUTINE:

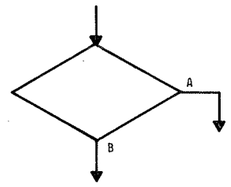
USED TO INDICATE RETURN TO THE CALLING PROGRAM. IF SUBROUTINE HAS MORE THAN ONE RETURN (FIG. TO LEFT IS FOR ONE RETURN), THE NOTATION "RET ADRS +1" (FOR SECOND), "RET ADRS +2" (FOR THIRD), ETC., IS USED. THE QUOTES ARE INCLUDED AS PART OF THIS NOTATION TO DISTINGUISH IT FROM THE MNEMONICS USED IN THE NORMAL EXIT SYMBOL.

OPERATIONS



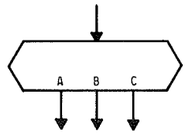
OPERATION - NO DECISION:

USED TO STATE ACTIONS TAKEN AT THIS POINT. STATEMENT WITHIN SYMBOL IS A BRIEF DESCRIPTION ON THE ACTION (INCLUDES ANY BIT-MARKING INFORMATION, IF APPLICABLE).



OPERATION - BINARY DECISION:

USED TO INDICATE BINARY DECISION REQUIRED AT THIS POINT. THE STATEMENT WITHIN THE SYMBOL IS A BRIEF DESCRIPTION OF THE DECISION REQUIRED (INCLUDES MEMORY AND BITS TO BE INTERROGATED, IF APPLICABLE). THE "STRAIGHT-THROUGH" DECISION IS THE ONE NORMALLY EXPECTED. THE POSSIBLE RESULTS OF THE DECISION ARE LABELED ON THE APPROPRIATE LINES OF FLOW LEAVING THE SYMBOL.

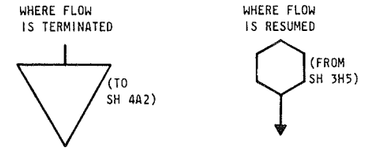


OPERATION - MULTIPLE DECISION:

SAME AS BINARY DECISION EXCEPT MULTIPLE DECISION IS REQUIRED. POSSIBLE RESULTS OF THE DECISION ARE SHOWN WITHIN THE SYMBOL ABOVE THE APPROPRIATE LINES OF FLOW.

EXIT-ENTRANCE USE, UNNAMED

IF A LINE OF FLOW HAS TO BE BROKEN AND CONTINUED ELSEWHERE, AND NO MNEMONIC IS AVAILABLE TO LABEL THE MATING SYMBOLS, THE FOLLOWING TECHNIQUE IS USED:



NOTES:

1. THE TERM "CLOSED SUBROUTINE" AS USED HEREIN, IS DEFINED AS A BLOCK OF PROGRAM WHICH, WHEN CALLED, SAVES THE RETURN ADDRESS AND AFTER EXECUTION, RETURNS TO THE CALLING PROGRAM AT THE SAVED ADDRESS.
2. IF THE OPERATION INDICATED IS PERFORMED BY A CLOSED SUBROUTINE, THE SYMBOL IS SHOWN IN A BROKEN LINE CONFIGURATION IN THE FLOW OF THE CALLING PROGRAM. ALSO, THE INCLUDED STATEMENT BEGINS, "TRFR (ABCD)---", WHERE "ABCD" IS THE NAME OF THE SUBROUTINE.
3. IN GENERAL, THE DIRECTION OF FLOW ON A DRAWING IS TOP-TO-BOTTOM; LEFT TO RIGHT. THE HORIZONTAL LINE OF FLOW FROM THE BINARY DECISION SYMBOL MAY BE RUN FROM THE LEFT "POINT" OF THE SYMBOL IF THIS RESULTS IN A MORE DIRECT PATH FOR THIS LINE.

Fig. 26 – Bell System No. 101 ESS Standard Program Flow Chart Symbols

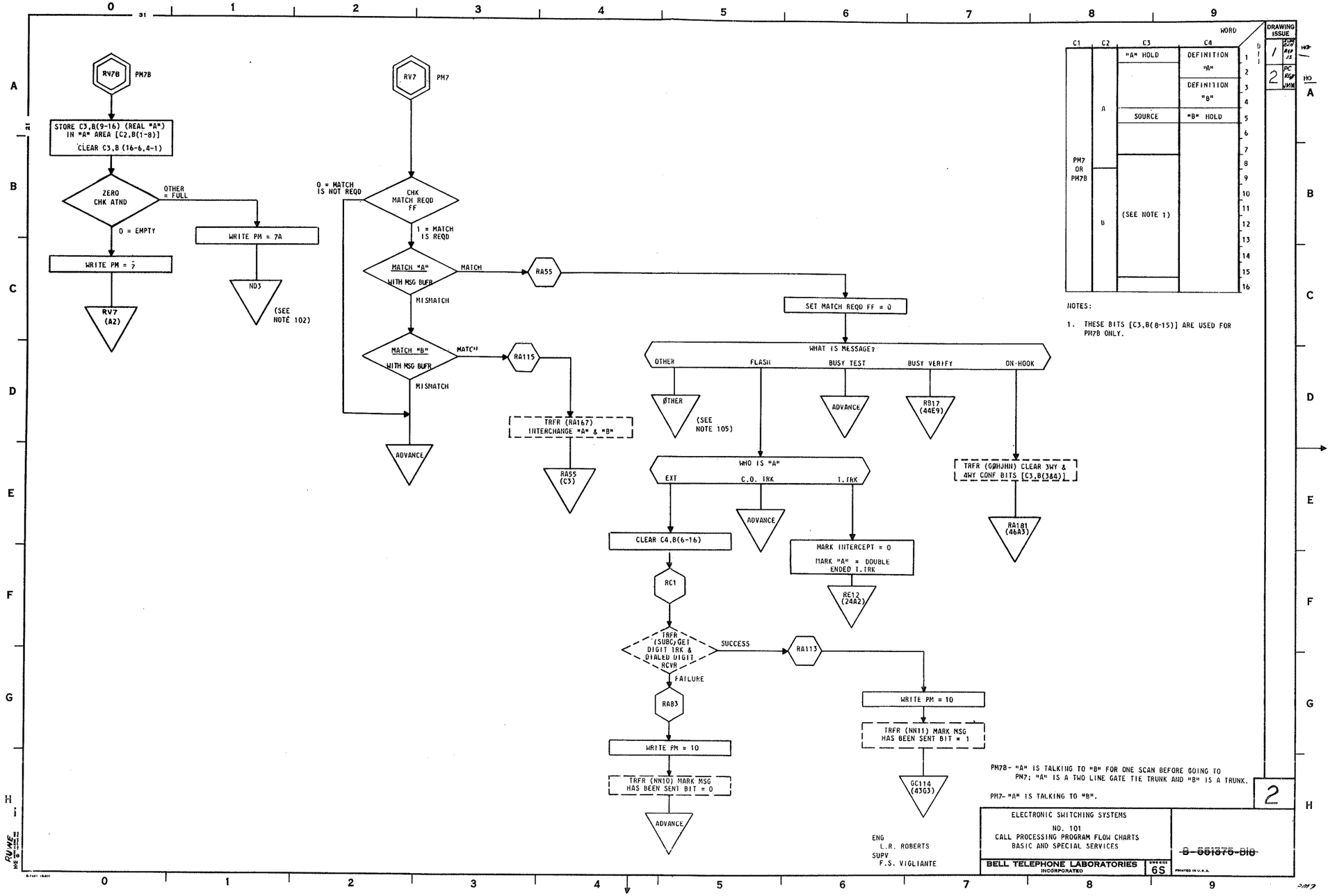


Fig. 27A – Detailed Flow Chart Example

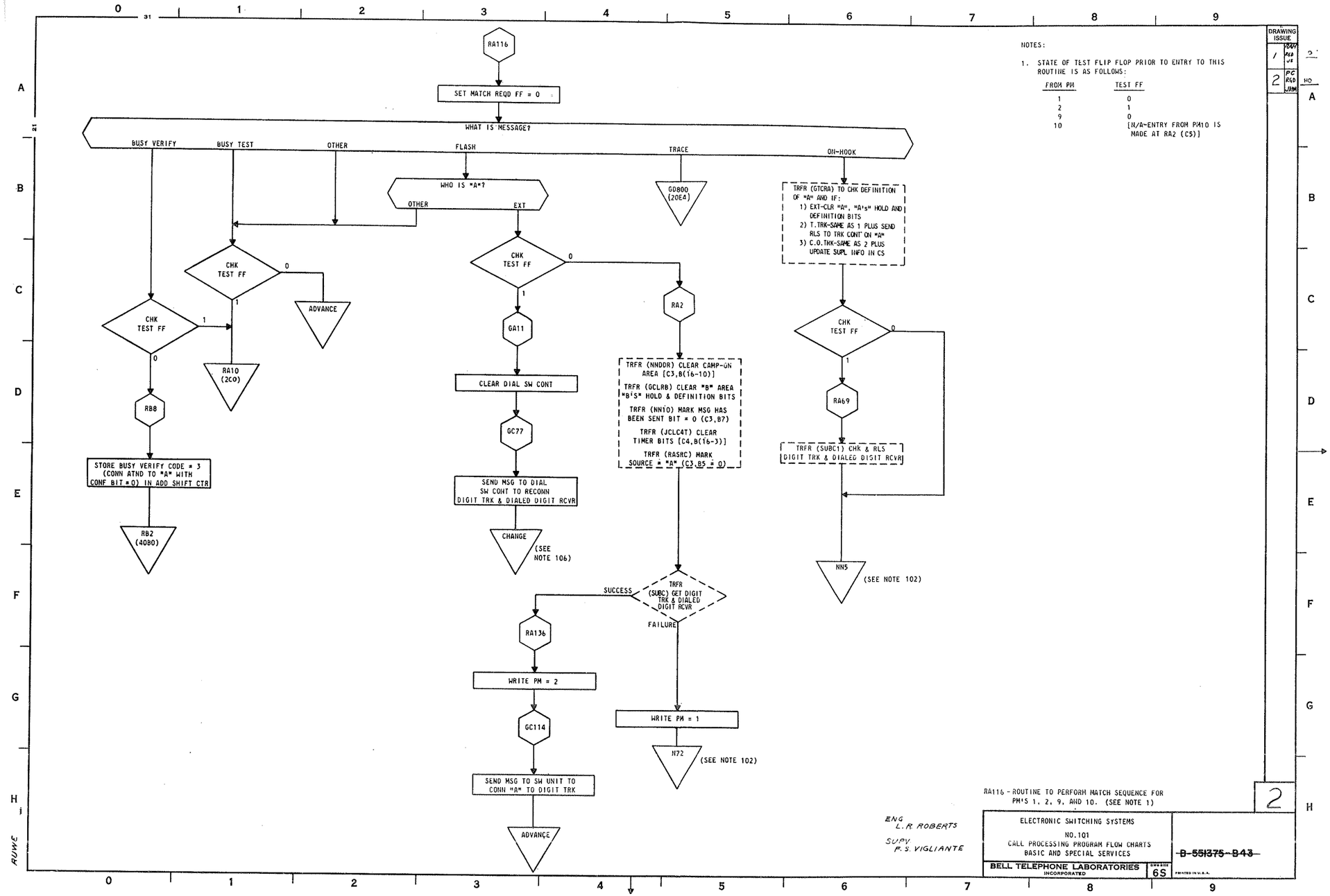


Fig. 27B – Detailed Flow Chart Example

TTY	ADDRESS OCTAL	DEC
-R--	7400	3840
-R-1	7401	3841
-R-2	7402	3842
-R-3	7403	3843
-R-4	7404	3844
-R-5	7405	3845
-R-6	7406	3846
-R-7	7407	3847
-R-8	7410	3848
-R-9	7411	3849
-R-0	7412	3850
-R-M	7413	3851
-R-S	7414	3852
-R-C	7415	3853
-R-T	7416	3854
-R-R	7417	3855
-R1-	7420	3856
-R11	7421	3857
-R12	7422	3858
-R13	7423	3859
-R14	7424	3860
-R15	7425	3861
-R16	7426	3862
-R17	7427	3863
-R18	7430	3864
-R19	7431	3865
-R10	7432	3866
-R1M	7433	3867
-R1S	7434	3868
-R1C	7435	3869
-R1T	7436	3870
-R1R	7437	3871

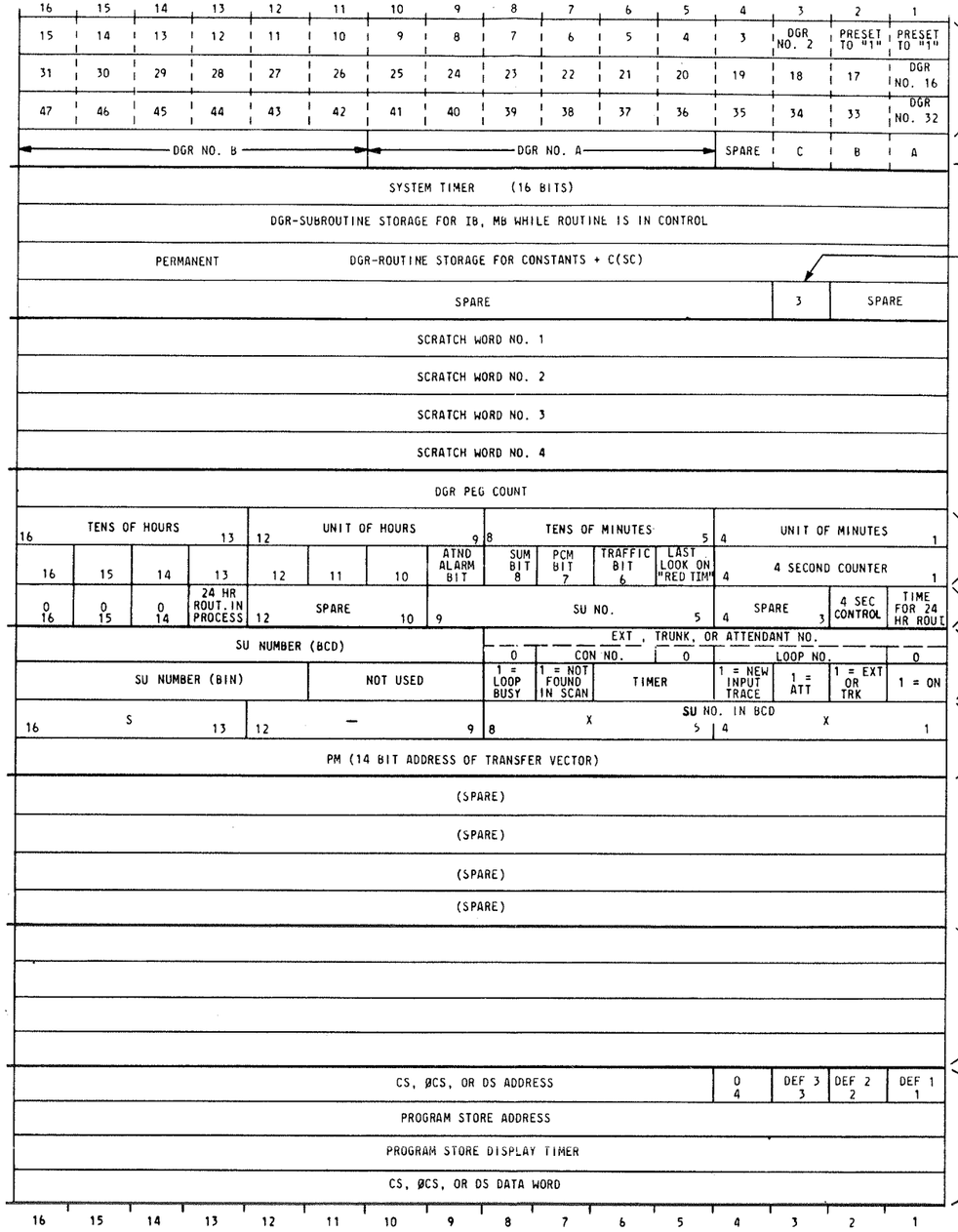


Fig. 28 – Call Store Per Control Unit Information

```
                                                ALTER
                                                NUMBER      INSTRUCTION                    COMMENTS

PAGE 24                                  NO. 101 ESS EQUIPMENT SELECTIØN AND DIAL TRANSLATIØN

FLAGS LØC      ØP   ADDR  TA
                                          1027 *
                                          1028 *
                                 11000    1029          ØRG     11000          IDLE TS SELECTIØN
                                          1030 *
                                          1031 *
     11000     27     35 1               1032  SUBE    CGT CAXCB              SAVE REQ. ADDR.
     11000 B   27     33                 1033          CGT TSXCB
     11001     27     32 0               1034          CGT SUXCA              LØCATE SUPP.
     11001 B   33     01                 1035          WRT C1                 STØRE RETURN ADDR.
     11002     27     03 0               1036          CGT CBXCØ
     11002 B   33     04                 1037          WRT C4                 STØRE REQ. ADDR.
     11003     20     011005             1038          STA AT129              RETURN HERE
     11004     37     11036 0            1039          TRA AA10               SUX16 +1 TØ PSAR

     11005     27     17 1               1041  AT129   CGT CØXTS              SET UP FØR CSS-
     11005 B   27     16                 1042          CGT CØXCA              SECTØR SCAN
     11006     34     25 0               1043          ADI HCA
     11006 B   34     03   $                           NØP                                  MACHINE INSERTED
     11007     34     25 1               1044  AT130   ADI HCA
     11007 B   35     01                 1045          RED C1
     11010     12     16 0               1046          NØT AT133              IS T. S. IDLE
     11010 B   34     03   $                           NØP                                  MACHINE INSERTED
     11011     13     07 1               1047  AT131   TIX AT130              NØ--IS T.S. EQUAL ØR LESS THAN 2
     11011 B   34     03   $                           NØP                                  MACHINE INSERTED
     11012     27     32 1               1048  AT132   CGT SUXCA              ALL BUSY
     11012 B   35     04                 1049          RED C4
     11013     27     12 0               1050          CGT CØXCB              SET UP REQ. ADDR.
     11013 B   34     03   $                           NØP                                  MACHINE INSERTED
     11014     35     01 1               1051  AT146   RED C1
     11014 B   27     34                 1052          CGT CBXTS              FAILURE
     11015     32     32 0               1053          CGT CBXCA
     11015 B   34     00                 1054          GPA                    RETURN

     11016     27     35 1               1056  AT133   CGT CAXCB              IDLE
     11016 B   27     33                 1057          CGT TSXCB              SAVE ADDR. IN CB
     11017     27     32 0               1058          CGT SUXCA
     11017 B   34     25                 1059          ADI HCA
     11020     34     25 0               1060          ADI HCA
     11020 B   35     01                 1061          RED C1                 ARE BØTH S. U. HALVES-
     11021     34     03 0 $             1062          NØP                    WØRKING ØKAY
     11021 B   26     22                 1063          SHL 2
     11022     00     26 0               1064          IBT AT135              1 = NØ, 0 = YES
     11022 B   34     03   $                           NØP                                  MACHINE INSERTED
     11023     27     32 1               1065  AT134   CGT SUXCA              RETURN TØ IDLE T. S. ADDR
     11023 B   35     01                 1066          RED C1                 SUCCESS
     11024     27     34 0               1067          CGT CBXTS
     11024 B   32     32                 1068          CGT CBXCA
     11025     34     21 0               1069          ADI CØ                 RETURN + 1
     11025 B   34     00                 1070          GPA
     11026     01     34 1               1071  AT135   2BT AT137              WHICH HALF IS ØUT, 1 = ØDD
     11026 B   27     03                 1072          CGT CBXCØ              EVEN HALF ØUT
     11027     00     2. 0               1073          IBT AT134              IS THIS T. S. EVEN
     11027 B   34     03   $                           NØP                                  MACHINE INSERTED
```

Fig. 29A – Coded Program Listing Subroutine SUBE, Idle Time Slot Selection

```
                                        ALTER
                                        NUMBER      INSTRUCTION                COMMENTS

PAGE 25          NO. 101 ESS EQUIPMENT SELECTIØN AND DIAL TRANSLATIØN

FLAGS LØC     ØP   ADDR TA
      11030   27     16 1        1074   AT136 CGT CØXCA
      11030 B 34     03    $             NØP                          MACHINE INSERTED
      11031   20 055133          1075         STA APM16               STØRE SPECIAL PM
      11032   33     01 0        1076         WRT C1
      11032 B 34     03    $             NØP                          MACHINE INSERTED
      11033   37  11011 0        1077         TRA AT131               CØNT. SCAN

      11034   27     03 1        1079   AT137 CGT CBXCØ               ØDD HALF ØUT
      11034 B 00     30          1080         1BT AT136               IS THIS T. S. ØDD
      11035   37  11023 0        1081         TRA AT134

                                  1083 *                               RØUT. TØ GET FIRST CSS TS ADDR.
                                  1084 *
      11036   27     12 1        1085   AA10  CGT     CØXCB
      11036 B 27     04          1086         CGT SUXCØ
      11037   34     21 0        1087         AD1 CØ
      11037 B 34     00          1088         GPA
```

Fig. 29B – Coded Program Listing Subroutine SUBE, Idle Time Slot Selection

"SNAPSHOTS" OF CALL PROCESSOR ACTIONS DURING A PERIOD OF NO TRAFFIC
STARTING WITH BEGINNING OF SECTOR, EBOS TO EB1

COMMAND	CLOCK PHASES P	Φ	PROG. CONTROL SD-1H049	DATA CONTROL SD-1H035	REMARKS
STT CMD	0	0	GARN-GATE C(AR) TO PSOR [STT]		
	1	1	TRANSLATION OF STT CMD	CLEAR DCR	
	2	2	SET STT F/F		
	3	3	SET CST 5 F/F (CMD ST TO D. CNTL)		
			STTR-CLR MB, RESETS BP, STC INRDT & RES FF & SET BI FF		
	0	4		GATE C(AC) TO TEMP. AR	
	1	5	SET LS FF (CNTLS CMD TIMING)	AC4-CLR AC	
	2	6	TCA-SETS RPS FF	CST6-JAM SET 2 HOB OF AC = 11	PREPARING TO READ DATA INF.
				NCS-GATE C(SU) TO AC 3-7 AND SET BIT 2 OF AC=1	PREPARATION TO READ W3
	3	7		8Φ CLOCK GATES C(AC) TO AR	
				SET CIPI FF (CMD IN PROG.)	
	0	0	RESET CST 5 FF, RESET APA, RPSI-(READ PROG. STORE, NEXT WORD) [TSA]	NRO-READ DDS	TO FIND STATE OF OUT. DATA TRK
	1	1	RESET RPS FF	ADD 1 TO ADDRESS CTR	PREPARING TO READ W4
	2	2	TCB-SETS RSC FF		
	3	3	IDLD-RESET BI FF		DATA TRK IDLE
	0	4	RESET LS FF,		STT CMD COMPLETE IN PROG. CONTROL AREA
			GSCN-GATES RIGHT HALF OF PSOR [CLR] TO LEFT HALF		
CLR IB	1	5	TRANSLATE CLR IB IN PSOR-RESET RSC FF		
			APA-ADVANCE PROG. ADDRESS REGISTER		
	2	6	TCA-SET RPS FF, CLEAR IB		
	3	7		GATE C(AC) TO AR	
	0	0	GARN - TSA CMD	NRO-READS DDS	READS W4 INTO MEMORY REGISTER
TSA CMD	1	1	TRANSLATES TSA CMD IN PSOR-RESET RPS FF		TSA TRANSFER TO AA10 SUBROUTINE GETS NO. OF FIRST TIME SLOT & FIRST CS ADDRESS IN THIS SECTOR.
	2	2		SET COV1 (CMD OVER) FF	
	3	3	TSAEH-GATE C(PA) TO CO		
	0	4		CLR AC	
	1	5		GATE C(TEMP. AR) TO AC	
	2	6	CLR PA		
	3	7	GATE PSOR TO PA	COVB-RESETS CIPI & STT FF	
	0	0			
	1	1			
	2	2	TCC-SETS RPS FF		
	3	3			
	0	4	RPSI - [CGT COXCB + SUXCO]		
			RESET APA		
	1	5	RESET RPS FF		
	2	6	TCD - SET RNC FF		
	3	7			
	0	0	GARN [CGT COXCB + SUXCO]		
CGT COXCB	1	1	TRANSLATE CGT COXCB		
			APA + RESET RNC FF		
	2	2	CLEAR CB, SET RPS + RSC FFS		
	3	3	GATE C(CO) X CB		

Fig. 30A – Fine Grain Detail of Execution of Commands by Clock Phases

COMMAND	TIME P	TIME Φ	PROG. CONTROL SD-1H049	DATA CONTROL SD-1H035	REMARKS
	0	4	RPSI [AD1-CO + GPA]		
			GSCN [CGT SUXCO]		
CGT SUXCO	1	5	RESET RPS + RSC		
	2	6	CLR CO, SET RNC FF		
	3	7	GATE C(SU) TO CO		
	0	0	GARN [AD1-CO + GPA]		
AD1 CO	1	1	RESET RNC FF, SET INA FF		INA IS SET TO ANTICIPATE THE GPA COMMAND IN THE RIGHT HALF, THUS ALLOWING GPA TO TAKE PLACE IN 12 USEC. RATHER THAN THE USUAL 16 FOR A TRANSFER IN THE RIGHT HALF
			TRANSLATE AD1-CO		
	2	2	SET RSC FF, AD1-CO		
	3	3			
	0	4	GSCN [GPA]		
GPA	1	1	RESET RSC FF, TRANSL GPA		
	2	2	CLEAR PA		
	3	3	GATE C(CO) TO PA		
	0	4			
	1	5			
	2	6	TCB - SET RPS FF		
	3	7			
	4	0	RPSI [STO]		LOCATION OF STO COMMAND = SU NO. X 16, + 1 EG FOR SU NO. 1 $00,000,000,010,001_2 = 00021_8$
	1	1	RESET RPS FF		
	2	2	TCC SET RNC FF		
	3	3			
	0	4	GARN [STO]		
STO	1	5	APA + RESET RNC FF		
			TRANSLATE STO CMD		
	2	6	CLEAR PA + CO		
	3	7	GATE C(PSOR) TO CO		
			GATE C(CB) TO PA		
	0	0			
	1	1			
	2	2	TCB - SET RPS FF		
	3	3			
	0	4	RPSI [AD1 CO + CGT SUXCA]		
	1	5	RESET RPS FF		
	2	6	TCC-SET RNC FF		
	3	7			
	0	0	GARN [AD1 CO]		
AD1 CO	1	1	APA & TRANSLATE AD1 CO		
			RESET RNC FF		
	2	2	SET RSC; AD1 TO CO		
			SET RPS FF		
	3	3			
	0	4	RPSI [WRT C4 & CGT COXCA]		
			GSCN [CGT SUXCA]		
ETC					

Fig. 30B – Fine Grain Detail of Execution of Commands by Clock Phases