CHAPTER 11

CALL PROCESSING

11.1 INTRODUCTION

This chapter describes major call processing routines.

11.2 CALL PROCESSING OVERVIEW

The CBX computer controls call processing. The computer first reads or fetches an instruction from memory and then executes the instruction. Instructions perform arithmetic functions or manipulate data.

Data is stored in tables, and system parameters in memory. Tables include the following:

- First digit table
- Class of service (COS) table
- Extension number line assignment and characteristics tables

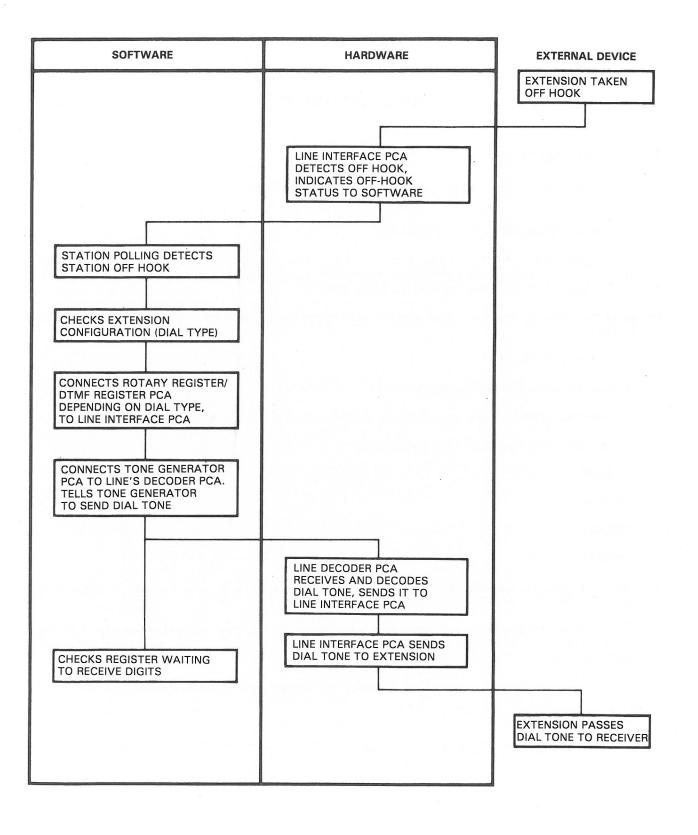
System parameters include the following:

- LFLASH
- HFLASH
- TMIDGI
- TMBUSY

Tables and system parameters are explained in Defining and Coding a ROLM CBX (stock no. 300399) and in Chapter 13 of this manual.

A system configuration printout for each system lists the contents of the tables and the values of the system parameters for that system. The printout is used for call process troubleshooting.

Figure 11-1 shows the interaction between hardware and software during a call.



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Figure 11-1. CBX Call Process

11.2.1 Transaction Blocks

Transaction blocks are located in the computer's dynamic memory. The blocks keep track of a call while it is being processed. A transaction block stores the following data for each extension:

- Connected channels
- Call state (dialing, flashing, ringing, connected)
- Dialed digits

Information about the transaction blocks can be listed with the list traffic table (LTT) or the list traffic table entry (LTE) command. These commands list information as traffic pegs (Table 11-1).

Table 11-1. Traffic Table Pegs

TRAFFIC TABLE PEG NUMBER	DEFINITION
0071	Maximum number of transaction blocks (TBs) that have ever been in idle queue.
0072	Maximum number of TBs that have ever been in ring queue.
0073	Maximum number of TBs that have ever been in connect queue.
0074	Maximum number of TBs that have ever been in dial queue.
0075	Maximum number of TBs that have ever been in outpulsing queue.
0076	Maximum number of TBs that have ever been in attendant queue.
0077	Maximum number of TBs that have ever been in station camp on and trunk queue.
0078	Maximum number of TBs that have ever been in hold queue.
0079	Maximum number of TBs that have ever been in tone queue. (Counts TBs on busy tone, error tone, or howler.)

11.2.2 Queues

Queues are lines of transactions blocks waiting for service from a particular subroutine or task. Queues are first-in-first-out buffers. The first transaction block stored is the first transaction block processed.

11.2.3 State

A transaction block is always in one of the following states or queues:

- Idle
- · Ringing
- Connected
- Station camp on
- Outpulsing
- Queued for loop select (LPS)
- Held
- · Receiving tone

Each queue of transaction blocks is in one state (idle queue, ring queue, dial queue). Transaction blocks in each queue wait for the subroutine that moves them to the next state in the call process. For example, a state handler subroutine moves a transaction block from idle state to dialing state. The status extension (STE) or status trunk (STT) command can be used to list the state of a call or to trace its transition from one state to another.

11.2.4 Status Table

The status table is part of dynamic memory. It identifies the state of each station and trunk channel (off hook, flashing). The interface channels send 16-bit words that tell the computer to update the status table; for example, to change the status from on hook to off hook.

11.2.5 Task

A task is part of the operating system and consists of a main routine and subroutines. Routines and subroutines are the computer instructions that process calls. The main routine or task determines which subroutine also will be used in that task. For example, when a trunk or an extension initiates ringing, the main routine of the ring task determines what kind of channel is initiating the call and selects the appropriate subroutine.

11.2.6 Scheduler

The scheduler is the master timing for the operating system. It calls up the appropriate tasks one at a time in the proper sequence.

11.3 INTERNAL STATION TO STATION

Figure 11-2 illustrates the process for an internal station-to-station call. The flow chart shows the specific tasks that process the call through different queues.

11.3.1 *9 Hold

Figure 11-2 shows the *9 hold call process. This flow chart continues the call process from Figure 11-3. It shows the tasks that process the call through different queues after extension 5555 places extension 213 on *9 hold.

11.3.2 Can't Ring and Busy

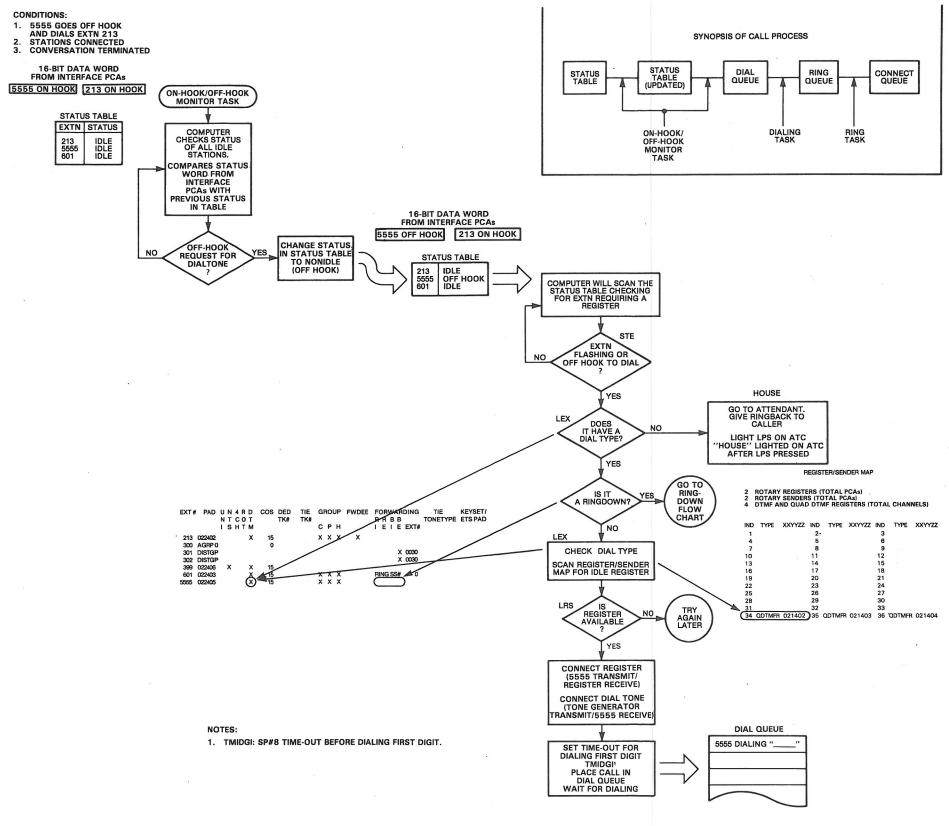
Figure 11-4 shows the tasks the scheduler calls up if a called station does not answer and is not system forwarded.

11.3.3 COM Group

Figure 11-5 illustrates the COM group call process. The dialing task reads the first digit and checks the first digit table. It recognizes the call as a COM group call. The task expects only two digits, and it ignores called-station do not disturb (DND) and forwarding.

11.3.4 Ringdown

Figure 11-6 illustrates the ringdown call process. When a ringdown extension goes off hook, the computer checks the extension number line assignment and characteristics table. It finds a system speed call index number that represents the ringdown target extension. The computer cross-references the index number in the system speed call table to obtain the associated extension or trunk number. The call process then continues as shown in Figure 11-2.

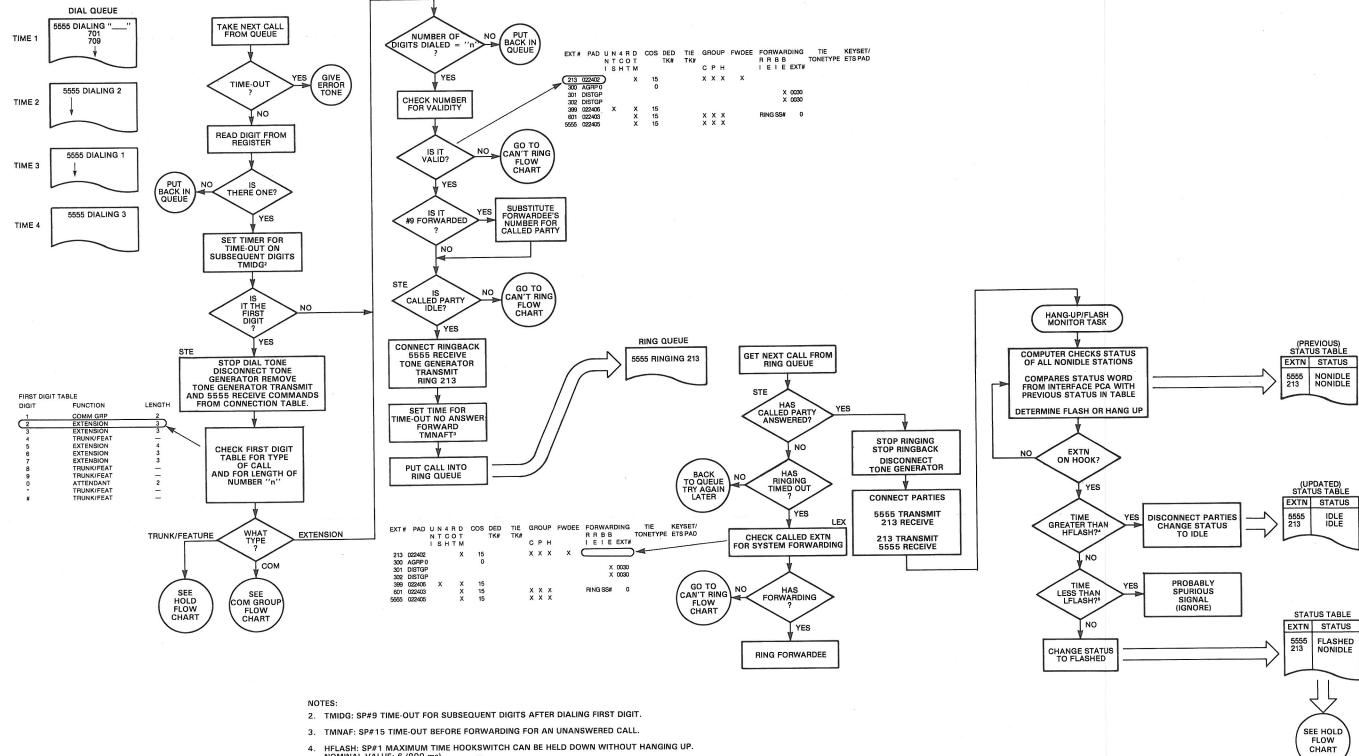


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cation-To-Station

Call Process (Sheet 1 of 2)

CALL PROCESSING 11-7/11-8



- HFLASH: SP#1 MAXIMUM TIME HOOKSWITCH CAN BE HELD DOWN WITHOUT HANGING UP. NOMINAL VALUE: 6 (900 ms)
- LFLASH: SP#0 MINIMUM TIME HOOKSWITCH MUST BE HELD DOWN TO FLASH. NOMINAL VALUE: 2 (300 ms)

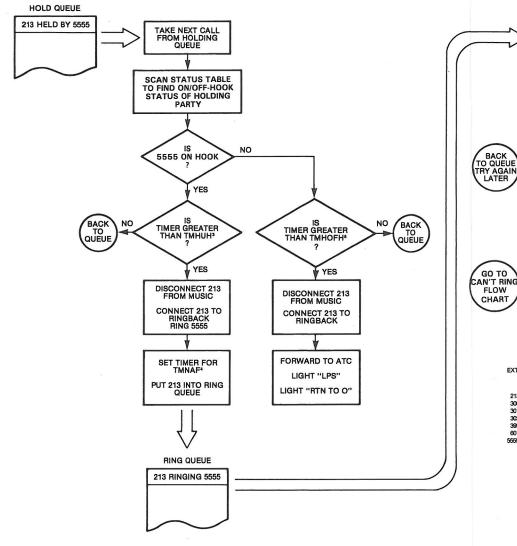
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IDLE

FLASHED NONIDLE

Figure 11-2. Station-To-Station Call Process (Sheet 2 of 2) CALL PROCESSING 11-9/11-10

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- 3. TMHUH: SP#13. TIME-OUT FOR HELD CALL TO RING BACK TO EXTENSION THAT INITIATED HOLD.
- 4. TMNAF: SP#15. TIME-OUT BEFORE FORWARDING FOR AN UNANSWERED CALL.
- 5. TMHOFH: SP#14. TIME-OUT FOR CALL TO REMAIN ON HOLD BEFORE INTERCEPTED BY ATTENDANT (IF EXTENSION THAT INITIATED HOLD IS BUSY).

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Figure 11-3. *9 Hold Call Process

GET NEXT CALL FROM RING QUEUE

HAS CALLED PARTY ANSWERED?

HAS RINGING TIMED OUT?

HAS FORWARDING ?

YES RING FORWARDEE

 $x \times x$

NO

YES

STOP RINGING STOP RINGBACK

DISCONNECT TONE GENERATOR

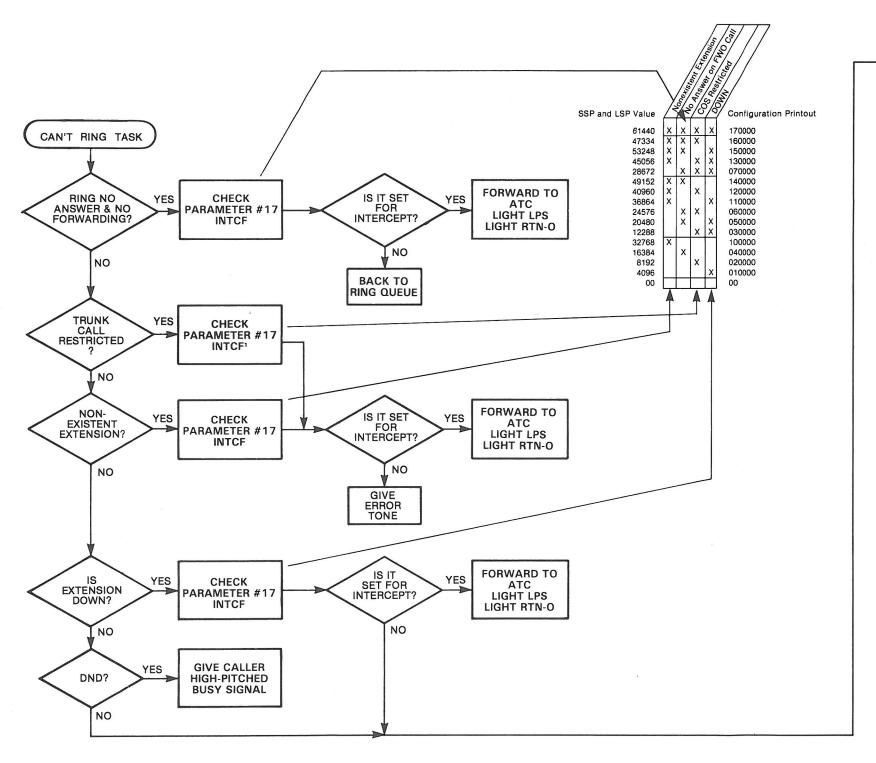
CONNECT PARTIES 5555 TRANSMIT 213 RECEIVE

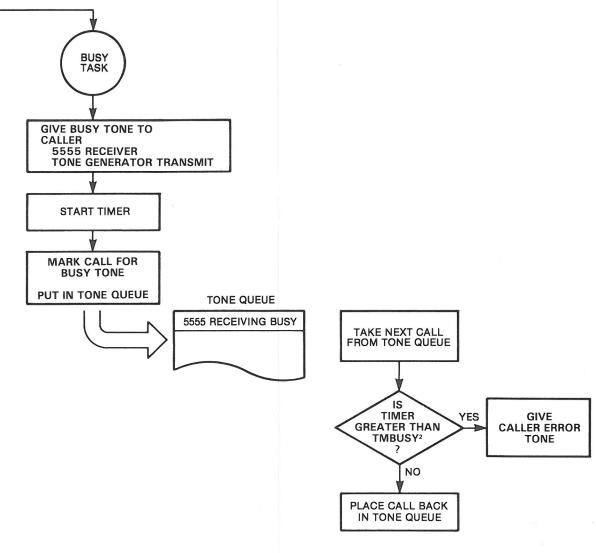
LATER 213 TRANSMIT 5555 RECEIVE

HANG-UP/FLASH MONITOR TASK (AS IN STATION FLOW CHART)

X 0030 RING SS# 0

CALL PROCESSING 11-11/11-12





NOTES:

- 1. 32768- INTERCEPT CALLS TO NONEXISTENT EXTENSION
 - 16384- INTERCEPT FORWARDED OR HELD CALLS THAT ARE NOT ANSWERED
 - 8192- INTERCEPT CALLS THAT VIOLATE COS RESTRICTIONS
 - $4096\mbox{-}$ Intercept calls to extns downed by self-test for fault condition or, the sum of various combinations
- 2. TMBSY: SP#12. TIME-OUT FOR CALL TO SWITCH FROM BUSY TONE TO ERROR TONE

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Figure 11-4. Can't Ring and Busy Call Process

CALL PROCESSING 11-13/11-14

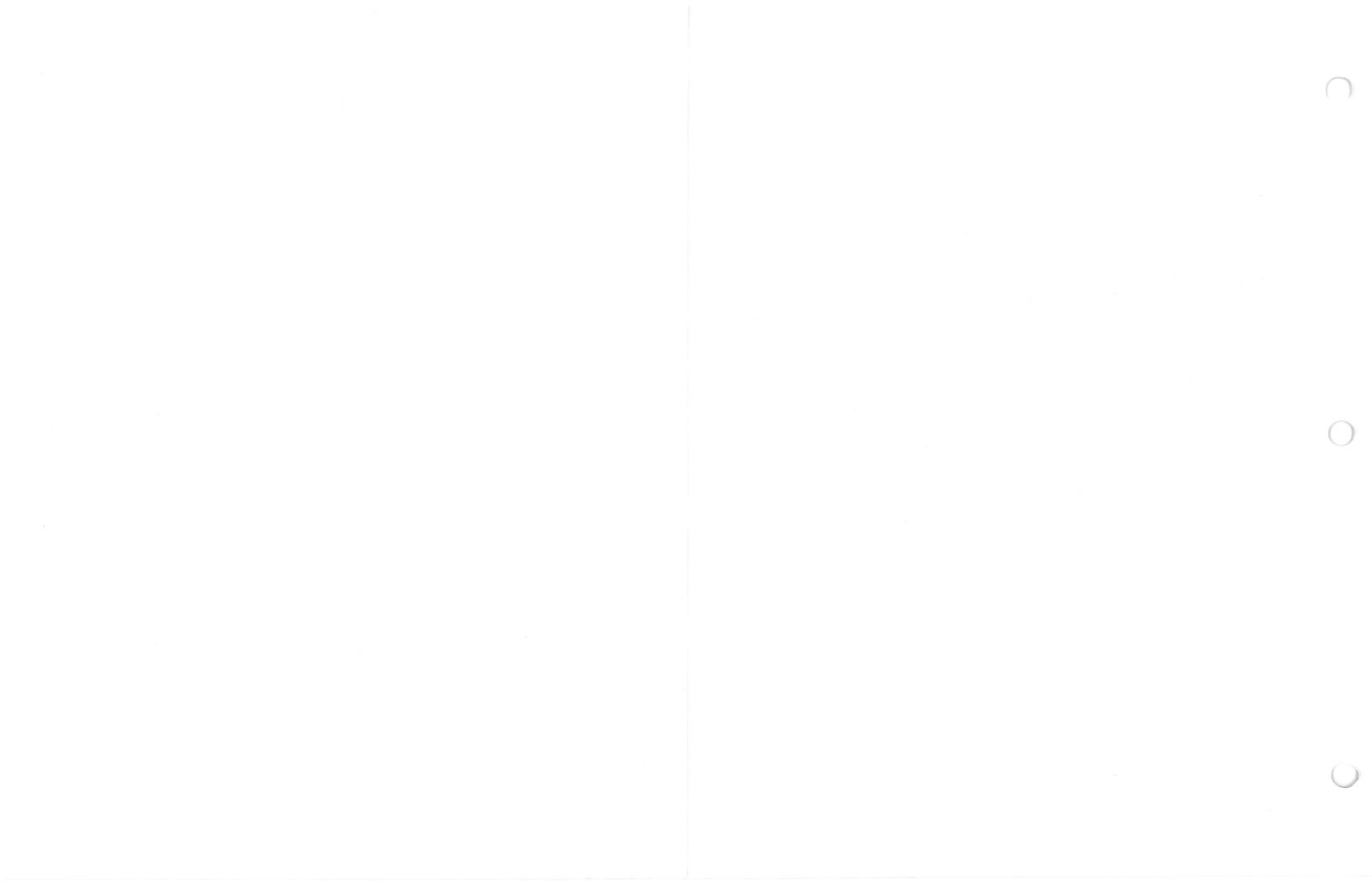
DIAL QUEUE RING QUEUE CONNECT QUEUE CONDITIONS: EXTN 5555 GOES OFF HOOK AND DIALS COM #11 (EXTN 213) DIALING TASK RING TASK 16-BIT DATA WORD FROM INTERFACE PCAs ON-HOOK/OFF-HOOK MONITOR TASK 5555 OFF HOOK 213 ON HOOK DIAL QUEUE STATUS TABLE STATUS TABLE COMPUTER CHECKS
STATUS OF ALL IDLE
STATIONS
COMPARES STATUS
WORD FROM INTERFACE
PCAS WITH PREVIOUS
STATUS IN TABLE EXTN # STATUS 5555 DIALING "___" 701 709 EXTN # STATUS GO BACK TO DIAL QUEUE TRY LATER COMPUTER WILL SCAN STATUS TABLE CHECKING FOR EXTN REQUIRING A REGISTER TAKE NEXT CALL FROM QUEUE 709 IDLE 701 IDLE 213 IDLE 55555 OFF HOOK IDLE 709 701 213 5555 601 IDLE IDLE IDLE IDLE IDLE YES DETERMINE EXTENSION NUMBER OF CALLED PARTY 1. FIND COM GROUP #(3) 2. FIND EXTN #(11) TIME-OUT EXTN FLASHING OR OFF HOOK TO DIAL? 5555 DIALING "1" OFF-HOOK REQUEST FOR DIAL TONE? FREE REGISTER IGNORE DND & FORWARDING YES READ DIGIT FROM REGISTER YES LEX GO TO HOUSE (STATION FLOW CHART) CHANGE STATUS IN STATUS TABLE TO NONIDLE (OFF HOOK) 5555 DIALING "1" CONNECT RINGBACK 5555 RECEIVE TONE GENERATOR TRANSMIT IS THERE ONE? YES **RING 213** GO TO RING-DOWN FLOW CHART IS IT A RINGDOWN SET TIMER FOR TIME-OUT NO ANSWER FORWARD "TMNAF" SET TIMER FOR TIME-OUT ON SUBSEQUENT DIGITS TMIDG EXT # PAD U N 4 R D COS DED TIE GROUP FWDEE N T C O T TK# TK# C P H FORWARDING TIE KEYSET/ R R B B TONETYPE ETS PAD I E I E EXT# NO 34 QDTMFR 021402 35 QDTMFR 021403 36 QDTMFR 021404 213 022402 300 AGRP 0 301 DISTGP 302 DISTGP 399 022406 601 022403 5555 022405 CHECK DIAL TYPE PUT CALL INTO RING QUEUE SCAN REGISTER/SENDER MAP FOR IDLE REGISTER RING QUEUE GET NEXT CALL FROM RING QUEUE YES IS REGISTER AVAILABLE ? STOP DIAL TONE DISCONNECT TONE GENERATOR (REMOVE TONE GENERATOR TRANSMIT AND 5555 RECEIVE COMMANDS FROM CONNECTION TABLE) FIRST DIGIT TABLE
DIGIT FU HAS CALLED PARTY ANSWERED? YES COMM GRP CONNECT REGISTER 5555 TRANSMIT REGISTER RECEIVE CONNECT DIAL TONE TONE GENERATOR TRANSMIT 5555 RECEIVE CHECK FIRST DIGIT TABLE FOR TYPE OF CALL AND FOR LENGTH OF NUMBER "n" STOP RINGING STOP RINGBACK DISCONNECT TONE GENERATOR DIAL QUEUE SET TIME-OUT FOR DIALING FIRST DIGIT (TMIDGI) 5555 DIALING " CONNECT PARTIES 5555 TRANSMIT 213 RECEIVE HANG-UP/FLASH MONITOR TASK WHAT 213 TRANSMIT 5555 RECEIVE EXTENSION

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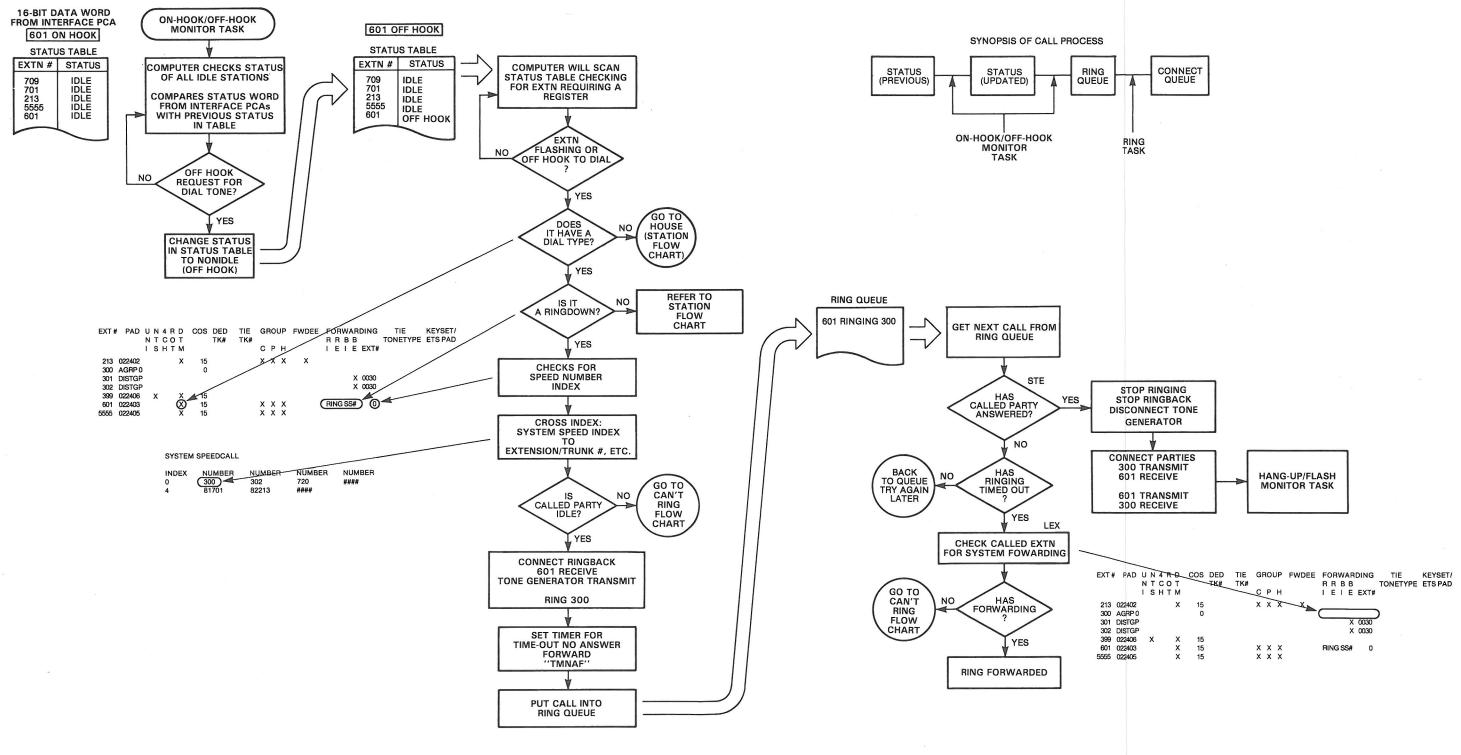
Figure 11-5. COM Group Call Process

SYNOPSIS OF CALL PROCESS

SEE STATION FLOW CHART



CONDITIONS: 601 (RINGDOWN) GOES OFF HOOK-RINGS DOWN TO TARGET (ATTENDANT 300)



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Figure 11-6. Ring-Down Call Process



11.4 STATION TO TRUNK

This paragraph describes call processing routines that connect the station user to an outgoing trunk. The flow charts show basic and route-optimized call process routes.

11.4.1 Basic Trunk-Accessing Call Process

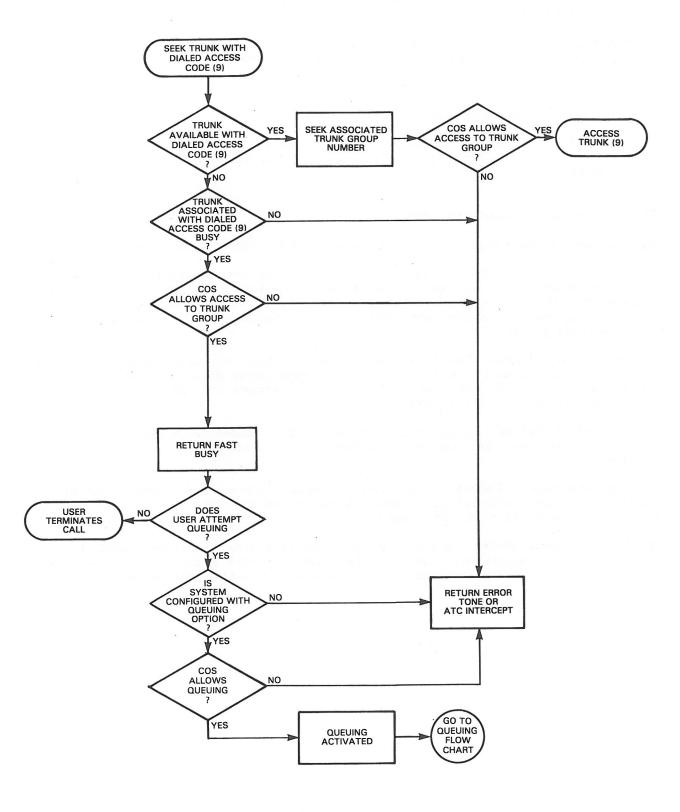
Figure 11-7 illustrates the basic call process required to access an outside trunk. This flow chart represents a CBX system without toll restriction or route optimization.

11.4.2 Release 4 Route Optimization

This paragraph describes the call process using Release 4 route optimization.

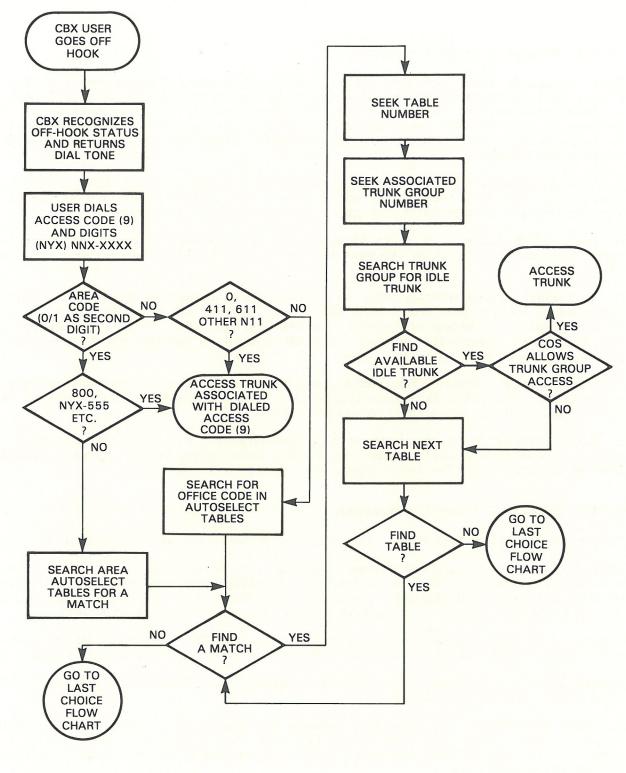
Figure 11-8 illustrates the process of accessing an outside trunk with Release 4 route optimization. Release 4 route optimization uses autoselect and area autoselect tables to select the most economical route available. This simplifies dialing and eliminates the need for separate access codes for each special service trunk group.

- a. Last Choice Trunk. The last choice trunk is the last trunk group over which route optimization will send a call. This trunk group does not have a table associated with it. The CBX identifies it by the access code dialed. Last choice trunks are usually direct trunks.
- b. Autoselect Tables. These tables contain office codes (prefixes or 1+ office codes). These codes are for an area that is called on a specific trunk or group of trunks.
- c. Area Autoselect Tables. These tables contain area codes, area plus office codes, or +1 area plus office codes. These codes also are for an area that is called on a specific trunk or group of trunks.
- d. Trunk Access Code. The trunk access code is a specific number used to seize a trunk. In route optimization, the last choice trunk group is assigned an access code. This access code must be the same as the autoselect access code.



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Figure 11-7. Basic CBX Station-to-Trunk Call Process



NOTE:

N = ANY DIGIT 2 THROUGH 9

Y = 0 OR 1

X = ANY DIGIT

Figure 11-8. Release 4 Route Optimization Call Process

CALL PROCESSING 11-21

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11.4.3 Release 5 Route Optimization

This paragraph describes the call process for Release 5 route optimization. Figure 11-9 illustrates the process for accessing an outside trunk with Release 5 route optimization. Release 5 route optimization differs from Release 4; in Release 5, after the CPU finds the dialed area or office code on a table, it never returns to the autoselect table. Instead, trunk selection is handled by route group tables.

- a. Area Routeselect Table. The area routeselect table contains area codes, 1+ area codes, area code plus office codes, and 1+ plus office codes that may be dialed on the most economical trunk group associated with the table.
- b. Routeselect Table. The route select table contains office codes or 1+ office codes that may be dialed on the most economical trunk group associated with that table.
- c. Autoselect Group Number. The autoselect group number is a number (1 to 63) assigned to each trunk group that the CBX can select to economically route an outgoing call. In Releases 5 and 6, the CBX searches for a trunk by identifying the autoselect group (ASG) number. The ASG number is independent of the trunk group number and display group number.
- d. Route Group Number. The route group number represents a particular route group table. The table is a prioritized list of all available routes that can be used to place an outgoing route-optimized call.
- e. Route Descriptor. A route descriptor consists of a route and the methods required to complete a call on that route. The route group table is a prioritized list of descriptors. The least expensive route is listed first.

11.4.4 Release 6 Route Optimization

This paragraph describes the call process for Release 6 route optimization.

Figure 11-10 illustrates the process for accessing an outside trunk with Release 6 route optimization. Release 6 route optimization includes the best features of both Release 4 and Release 5 route optimization. It includes the route group search of Release 5 and the return to search autoselect entries of Release 4.

Figure 11-11 illustrates the call process after the CBX has exhausted all route optimization possibilities. The last choice trunk is usually a direct trunk.

Figure 11-12 illustrates trunk queuing. Queuing lets users wait in line for a busy trunk to become available.

- a. Home Area Code. The home area code is designated by an asterisk following the area code. This indicates to the CPU that it is a home area code. Calls to that area are placed over the same route, whether or not the area code is dialed before the office code.
- b. Selectroute Table. Selectroute tables contain office codes and may list a specific area or code that serves with the office codes only or to office codes and area codes.

c. Areacodeonly Table. Areacodeonly tables contain only area codes associated with a given calling area.

NOTE

Release 6 route optimization also uses autoselect group numbers, route numbers, and route descriptors (paragraph c above).

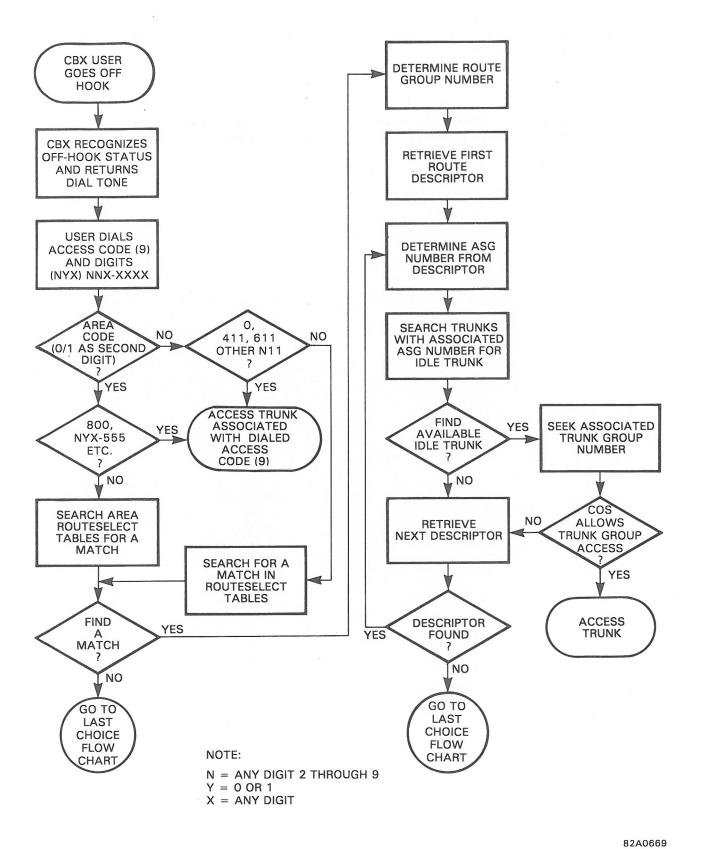


Figure 11-9. Release 5 Route Optimization Call Process

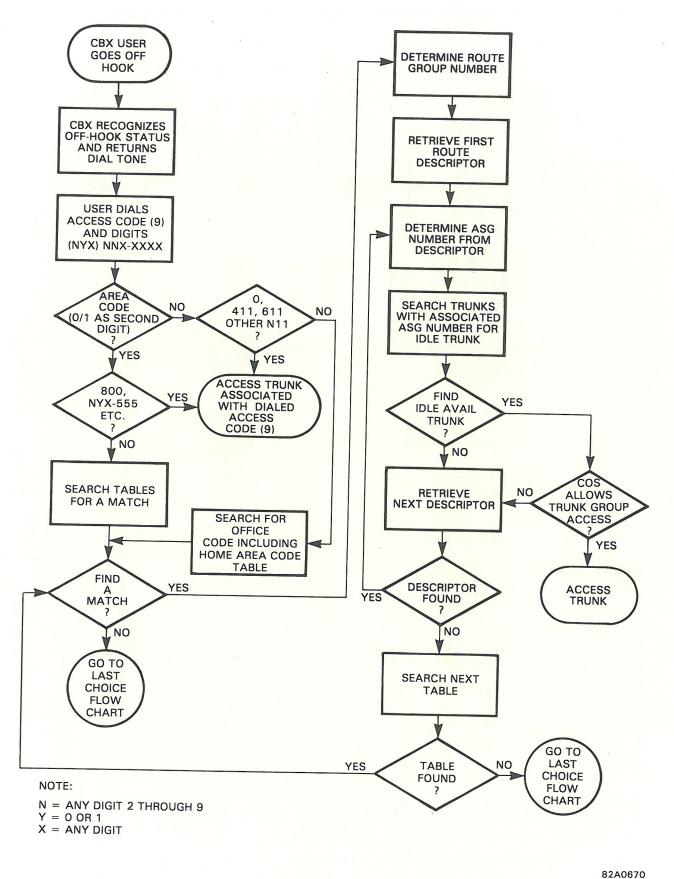
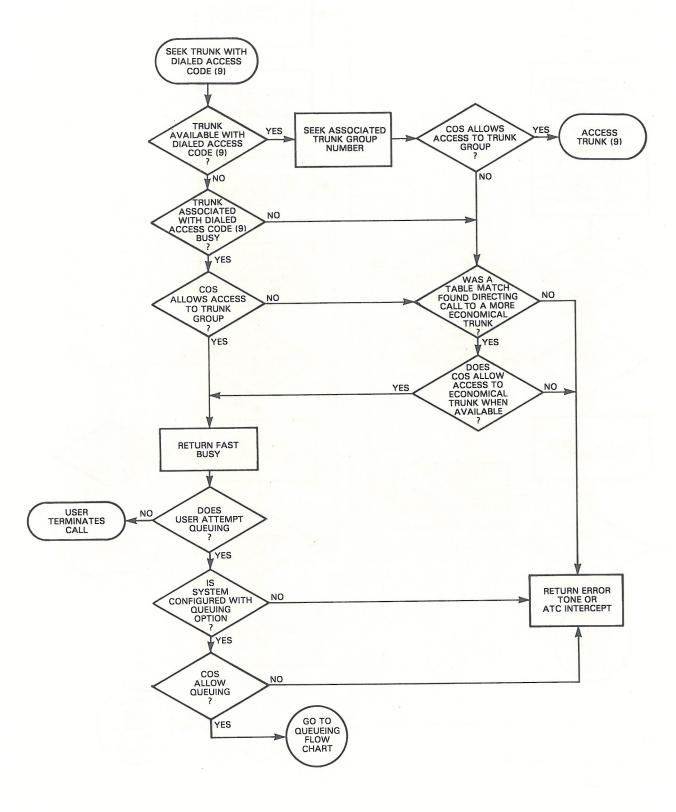
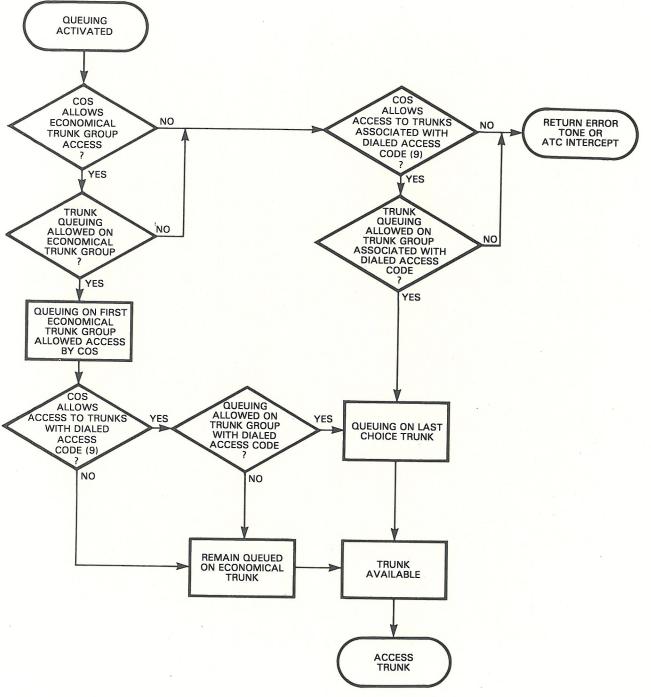


Figure 11-10. Release 6 Route Optimization Call Process



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Figure 11-11. Last Choice Trunk Call Process



QUEUING ACTIVATED	
COS ALLOWS ECONOMICAL TRUNK GROUP ACCESS ODIALED ACCESS CODE (9) COS ALLOWS ALLOWS ACCESS TO TRUNKS ACCESS TO TRUNKS ASSOCIATED WITH DIALED ACCESS CODE (9)	
YES YES	
TRUNK QUEUING ALLOWED ON ECONOMICAL TRUNK GROUP ? OND TRUNK GROUP ASSOCIATED WITH DIALED ACCESS CODE 2	
YES	
QUEUING ON FIRST ECONOMICAL TRUNK GROUP ALLOWED ACCESS BY COS	
COS ALLOWS QUEUING	
ALLOWS ACCESS TO TRUNKS WITH DIALED ACCESS CODE (9) ALLOWED ON TRUNK GROUP ACCESS CODE (9) QUEUING ALLOWED ON TRUNK GROUP TRUNK GROUP ACCESS CODE CHOICE TRUNK CHOICE TRUNK	
NO NO	
REMAIN QUEUED ON ECONOMICAL TRUNK AVAILABLE	
ON ECONOMICAL TRUNK AVAILABLE	
ACCESS TRUNK	
Figure 11-12. Queuing Call Process	
CALL DECORROTANG 11 05	

