# CENTREX DATA LINK FEATURES

# SOFTWARE SUBSYSTEM DESCRIPTION (SSD)

# 2-WIRE NO. 1 AND NO. 1A ELECTRONIC SWITCHING SYSTEM

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## 1. GENERAL

### INTRODUCTION

**1.01** The centrex data link software performs the control functions necessary to administer the centrex data link and provides special centrex call handling capabilities for centrex services provided by a No. 1 or No. 1A Electronic Switching System (ESS).

**1.02** When this section is reissued, the reason for reissue will be given in this paragraph.

**1.03** Part 5 of this document provides a defined list of the abbreviations and acronyms as used herein.

### PURPOSE OF THE CENTREX DATA LINK SOFTWARE

**1.04** This software provides console key and lamp administration, controls the centrex data link input/output operation, and controls calls to the attendant and call answering from any station.

### SCOPE OF SECTION

**1.05** This SSD provides an introduction to the centrex data link software operating in a No. 1 or No. 1A ESS. Information unique to No. 1A ESS is so noted. Information unique to No. 1 ESS is not provided.

**1.06** This section is based on the 1E6 (No. 1 ESS) and 1AE6 (No. 1A ESS) versions of the generic program.

## 2. PIDENTS DESCRIBED IN SECTION

**2.01** Table A provides a PIDENT to PR number cross reference listing for the programs described in this document.

**2.02** The centrex lamp and key program, PIDENTs CXIO and CXKY, provides input/output (I/O) and console key signal processing. CXIO provides all normal nonmaintenance I/O functions, ie, transmission of lamp orders and reception of key signals for the centrex data link. CXKY handles key signals from the centrex console and processes supervision reports.

## 3. CENTREX DATA LINK SOFTWARE FUNCTIONAL DESCRIPTION

**3.01** The centrex data link provides a command/control interface between the ESS central processor and the attendant console located on the customer premises (Fig. 1). Key and lamp signal processing requires an orderly interchange of control information over the centrex data link. Lamp order routines are provided to control operation of the centrex console lamps. For console key operation, the ESS receives and responds via the data link. The data link software provides a buffering effect between the ESS call control processes and the call processing and control actions performed at the attendant console. Provision is also made for night service operation, ie, for after hours service when the attendant is not on duty.

## 4. PIDENT FUNCTIONAL DESCRIPTIONS

### PIDENT CNLP

**4.01** CNLP provides a regulated interface between programs wishing to transmit console lamp orders and the input/output program, PIDENT CXIO. All lamp order traffic, whether for call processing or maintenance, which takes place while the link is in service must use the control structures provided by CNLP.

#### Lamp Order Loading

**4.02** On entry, the client requesting service is required to specify the location of a special 3-word block of call store memory called a lamp block located in the console register. The first word contains the lamp order to be transmitted. The second word contains the data link number, the type (of queue return), and a sanity check code, ie, a defensive programming device used as a sanity check on the client information. The third word contains the link word for queueing.

**4.03** Several checks are performed on the client-supplied lamp block. Both the frame number and sanity code are checked for validity. Invalid client information results in an error printout and no lamp order is transmitted. A check is also made to determine if the lamp block is on a queue.

**TABLE A**

**CENTREX DATA LINK FEATURES PIDENTS**

| PIDENT | TITLE | NO. 1 PD/PR- | NO. 1A PR- |
|---|---|---|---|
| | Centrex Lamp and Key Program | | |
| CXIO | Centrex Input/Output Scan | 1A163 | 6A163 |
| CXKY | Centrex Key Signal Director | 1A163 | 6A163 |
| CXLO | Line and Trunk Seizure—Centrex Attendant | 1A164 | 6A164 |
| CXTA | Trunk and Code Call Answer | 1A165 | 6A165 |
| CNLP | Centrex Lamp Control Program | 1A166 | 6A166 |

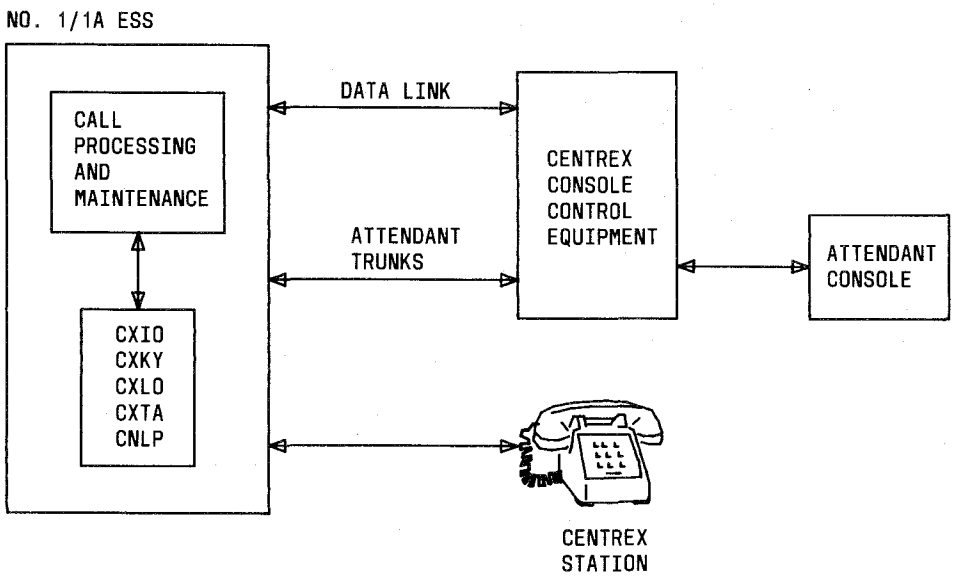


**Fig. 1—System Interface**

Queueing is handled as required to ensure proper transmission sequencing.

**4.04** The normal case is that the client is valid and not on a queue. If this is the case, a check is made to see if there is a queue for the data link over which the order is to be transmitted. Queue bits are maintained for this purpose. If queueing is required, the lamp block is placed at the bottom of the queue and notification is returned with the client return. The queueing logic retains a first-in, first-out sequence. For the no-queueing required case, control is given to a routine (CNBUFL) to send the lamp order to the output buffer. An attempt is made to load BUF0 (ie, the first buffer) for the particular link. If BUF0 is unavailable, an attempt is made for BUF1. If the load into BUF1 succeeds, a final check of BUF0 is made since J-level could have unloaded BUF0 in the meantime. If BUF0 is free, then the order is moved into it. In either case, if the order is successfully loaded, then the lamp bit is set. If the load fails, ie, both

buffers were unavailable, then the order is queued. Control is then given back to the client. Refer to the program listing for more detailed information.

### Queue Unloading

**4.05** Queue unloading is accomplished by a flagged J-level entry (CNLPQE) from PIDENT ECIO to make an interject request. Then the interject level entry (CNLPSQ) attempts to remove lamp orders from the queue and load them into the output buffers. Refer to the program listing for detailed information on the controlling sequences.

### PIDENT CXIO

**4.06** PIDENT CXIO is structured into five margin sections:

(a) Main entry

(b) All seems well (ASW) processing

(c) Key report processing

(d) Lamp order output

(e) Data link fault recognition and trouble reporting.

These sections are briefly described in the following paragraphs. For more detailed information on the individual control routines, refer to the CXIO program listing.

### Main Entry

**4.07** CXCCIO is the primary J-level entry to initiate centrex data link I/O processing. There are a maximum of eight data link frames in a No. 1A ESS; a different data link frame is processed on each entry. Upon entry, CXIO determines which frame is to be processed during this cycle. A frame index is examined to select the correct frame. Following a phase four emergency action recovery, the index found will equal zero. In this case the program will initialize (INIT) the index before proceeding.

**4.08** Once the current frame has been found, the index is used to locate the address of the frame's I/O block. The control section of the I/O block is then used to scan the key signal present and ASW scan points. The scan results are stored for use by other sections of the program. If required (eg, all frames processed), the frame index is updated to restart the process during the next cycle.

### ASW Processing

**4.09** The ASW expected bits, set by the lamp portion of this program on the previous cycle, are checked. If none are found set, control is given to the key report portion of the program (KEY). When an ASW expected bit is found, a test is made on the scan data just received to see whether or not the ESS end of the data link has received the required ASW. The ASW scan point is driven by a binary cell which changes state each time a correct reply is received from the far-end data terminal. The program tests the current state of the ASW scan point against the last look state. If these states are the same, there has been an ASW failure and control is passed to the fault recognition portion of the program (ASWER). Once ASW processing has completed successfully, control is given to the key report (KEY) section of the program.

### Key Report Processing

**4.10** Key signals present are detected by passing the data link supervisory scan data (saved previously) through a key signal accept mask. Key flags, when found, prompt a hopper report for each data link requiring one. The following actions are taken for each reporting data link:

(a) Information row scan—obtains the data link shift register contents.

(b) Hopper loading—forms a 2-word hopper entry.

(c) Hopper test—a full hopper prompts a request for interject unloading.

(d) Data register reset—reset the shift register and process more key reports from other data links.

If interject unloading is requested, then (d) is not done. Once all links have been processed, control is given to the lamp order portion of the program (LAMP).

### Lamp Order Output

**4.11** If one or more of the data links have lamp data to be transmitted, then the appropriate data link shift register is loaded via the peripheral bus. Before the shift register is loaded, the program checks the data link busy scan point to see if the data link is in the correct state for receiving the transmit order. If busy, the DELAY subroutine is entered. Once lamp order processing has been completed for all links, control is returned to PIDENT ECIO.

### Fault Recognition and Trouble Reporting

**4.12** The ASW failure portion of this program (ASWER) is entered when ASW did not occur as expected. This routine uses a failure index to select a program response based on the number of times ASW has failed for the link in question. Indexing through the failure table (FATBL) yields the following sequence:

(a) ASWF1—attempt retransmit, use same bus and central pulse distributor (CPD).

(b) ASWF2—test enable-sanity, regenerate if possible. May turn link off for excessive error count. If enable is OK, then switch CPD and bus.

(c) ASWF3—switch bus again.

(d) ASWF4—switch bus and CPD.

(e) ASWF5—generate a hopper trouble report and turn the link off.

(f) ASWF6—same as ASWF2, for now.

(g) ASWF7—same as ASWF5.

(h) ASWF8—same as ASWF5.

**4.13** TBL is the general trouble routine to load a hopper maintenance report. This report causes the data link to be marked maintenance busy, the diagnostic program to be flagged, and a teletypewriter (TTY) report to be made.

### PIDENT CXKY

**4.14** CXKY interrogates a key signal received from a centrex console to determine what effect it will have on the state of the console and on any call on the console. Supervision reports associated with the loop keys are also investigated by this program. Other routines provided by CXKY include those provided to turn the trunk busy and call waiting lamps on or off, to respond to headset in or out reports, and to provide the necessary checks on a centrex group before setting up a call to the group.

### Centrex Console Keys and Lamps

**4.15** The centrex console provides three sets of keys: loop keys, state keys, and call processing keys. The loop keys are used to switch the attendant talking connection to a selected loop circuit. The state keys are used to control the overall state of the console. The call processing keys are used by the attendant in the processing of a call.

**4.16** A 5-bit code is used for key reports. The 32 possible codes have the following values:

(a) 00—no key report present

(b) 01—07—loop key report

(c) 08—15—state and call processing keys report to common key routines

(d) 16—31—call processing key report.

Inspection of the initial key report processing table (IKEY) will show that some of the possible codes are legal or illegal depending upon the call state.

### Supervision Reports

**4.17** CXGSRE is the setup for processing a supervisory change on a loop. This routine will update key-state information, the lamp state, and if required, transmit the loop lamp order. Supervision reports are fielded through a table of supervision reports and lamp/circuit actions required for each defined state. SUPTB is the start of this table, ie, the lamp and state supervision matrix. CXKY provides numerous entries and control routines which respond to both normal and abnormal actions taken at the centrex console. For more information, refer to the CXKY program listing.

**PIDENT CXLO**

**4.18** CXLO handles the call processing actions required to control a callup to the point of establishing a talking connection between the calling party and the attendant. Calls terminating to the attendant may originate from within the centrex, from within the central office providing the centrex service, or from another central office. Call handling for these types of calls is briefly described in the following paragraphs. For more detailed information, refer to the CXLO program description.

**Intraoffice Calls to Attendant**

**4.19** Intraoffice calls are directed to the attendant when:

(a) A line within the central office (and possibly within the centrex group) dials a temporarily disconnected number in the centrex group and has been routed to attendant intercept.

(b) A centrex line dials a conference attendant access code.

(c) A centrex line dials 0.

(d) A centrex manual line originates.

(e) A line within the central office dials the centrex group listed directory number (LDN).

**4.20** For a normal line to attendant call, CXLO assumes control of the call after digit collection has indicated the attendant as the terminating party. The program first attempts to seize a loop register via a call to the YASZLP routine in PIDENT CXYH. If an idle loop register cannot be found, busy tone is given to the calling line. If a loop register is obtained, it is initialized by the CXINLP subroutine. A check of the console group status is then made via a call to the CXCGST routine in PIDENT CXKY. Three returns are possible:

(a) Night service in effect

(b) Console group busy, ie, the queue is full, so busy tone is given to the calling party

(c) Console group not busy and not in night service state; the call will progress.

**4.21** For normal progression, the next step is to make the loop register master and release the originating register. Actions are then taken to obtain network paths and resources to provide audible to the calling party and, via the data link, alert the attendant that a call is present. Refer to the CXLO program listing for detailed control information on the geneal sequence described above.

**Interoffice (ie, Incoming) Call to Attendant**

**4.22** Incoming calls which may be directed to the centrex attendant are as follows:

(a) Calls originating from a foreign exchange (FX) trunk

(b) Calls from an incoming trunk (ICT) which dialed a temporarily disconnected LDN in the centrex and was routed to attendant intercept

(c) Calls over a tie trunk to a conference attendant via a dialed conference access code

(d) A dial 0 call over a tie trunk

(e) Regular ICT calls to the centrex LDN.

**4.23** As in the intraoffice case, CXLO assumes control of the call after digit collection has determined that the terminating party is the centrex attendant. For an FX call, (global CXFXAT) CXLO first attempts to obtain an idle loop register via a call to YASZLP (PIDENT CXYH). If an idle loop register cannot be found, the YFBUSY routine in PIDENT YFTO is used to put the FX ICT on the high and wet list. If a loop register is obtained, it is initialized (CXINLP). Console group status is then determined via a call to CXCGST (PIDENT CXKY). The return from CXCGST may indicate that (1) night service is in effect or that (2) the console group is not on night service. The return does not handle the queue full condition (as described for the intraoffice case) since the FX call will be queued anyway. The loop register is now linked to the right of the incoming step-by-step register, the master register on the call. The loop register is made master and the incoming step-by-step register is released. The attendant call is completed in a manner similar to that for the intraoffice type.

**4.24** Other entries in CXLO control the actions taken for the remaining types of incoming attendant calls and for night service actions. Special

actions are also taken if incoming trunk service observing is in effect. For more information, refer to the CXLO program listing.

**PIDENT CXTA**

**4.25** With centrex service, when a call is made to the attendant and night service is in effect, a night station is rung and audible devices on the customer premises may be activated. Trunk answering makes it possible to answer this call by picking up at the night station or by dialing an answer code from any other noninward restricted phone in the centrex group. CXTA controls the call once a station has dialed an answer code.

**4.26** Centrex code calling allows a centrex station (or other station via a tie trunk or via the attendant) to dial an access code to a code caller circuit. Upon receiving second dial tone, the calling party dials a code assigned to the individual with whom the calling party wishes to speak. This code is then gonged out over sound devices (or by some other signaling method, ie, lights, horns, etc) on the customer premises. The call is answered by the called party dialing an answer code from the most convenient phone. CXTA handles the answering activities associated with code calling.

**Trunk Answer**

**4.27** When CXTA receives control of the call, the line attempting to answer has already dialed the answer code. When the originating party is a line, ring trip scans for the night station are turned off. But, a check is made to see if the night station has gone off-hook since the answer code was dialed before the scans were discontinued. If the night station has answered, then it gets the call and the line which dialed the answer code gets overflow. Also, should the originating line go on-hook before the answering station is connected, then overflow is given to the answering station. If network blocking prevents connection from the answering line (ie, the line which dialed the answer code), then the answering line is given overflow. Trip scans for the night station are turned back on and the originating line is scanned for abandon. At this time another attempt may be made to answer by tripping the night station or by redialing the answer code as before. If the answer code is dialed but there is no call to be answered or night service is not in effect, then the station which dialed the answer code is given overflow.

**4.28** If the incoming call is a trunk, similar actions are taken as described above. For an FX trunk, audible to the calling line is provided by the originating office.

**Code Call Answer**

**4.29** For code calling, digit analysis recognizes the code call access code and connects the originating party to the code calling circuit. CXTA is entered when digit analysis recognizes a code call answer code from some station within the centrex. CXTA performs the actions necessary to connect the originating party to the answering station. For more information, refer to the program listing.

## 5. ABBREVIATIONS AND ACRONYMS

| SECTION | TITLE |
|---|---|
| ASW | All Seems Well |
| CPD | Central Pulse Distributor |
| ESS | Electronic Switching System |
| FX | Foreign Exchange |
| ICT | Incoming Trunk |
| I/O | Input/Output |
| LDN | Listed Directory Number |
| SSD | Software Subsystem Description |
| TTY | Teletypewriter |