CENTREX DATA LOOP AND CONSOLE CONTROL DESCRIPTION/THEORY 2-WIRE NO. 1 OR NO. 1A ELECTRONIC SWITCHING SYSTEM

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1. GENERAL

1.01 This section describes the centrex data loop, the console control system, and the remote interface system used in conjunction with the 2-wire No. 1 or 1A Electronic Switching System (ESS) equipped to provide centrex-CO and PBX-CO service. For a general description of centrex-CO and PBX-CO service designed for the 2-wire No. 1 and 1A ESS, reference should be made to Section 966-102-100.

Note: Effective with what would have been CTX-8, Issue 4, of No. 1 ESS, the equivalent generic program designation is 1E4. The correspoinding generic designation for No. 1A ESS is 1AE4.

1.02 This section is reissued to include information concerning the remote data interface system and to make minor corrections. Since this reissue is a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 This section includes the following information:

- Theory of operation
- The 51A-customer premises system attendant console
- Remote data interface customer premises system
- Centrex data link circuit overall block diagrams
- Maintenance philosophy and procedures.

1.04 Centrex-CO and PBX-CO service may be provided as follows:

(a) With remote data interface equipment requiring data link hardware.

(b) With 1B-, 2B-, 27A-, or 47A-type 51A-Customer Premises Systems (CPSs) attendant consoles that require centrex data link hardware.

(c) With 121-, 131-, and 151-type 50A-CPS attendant consoles that do not require centrex data link hardware.

(d) Without attendant consoles (using call director, keyset, or simple telephone as attendant position).

1.05 This section describes the centrex data loop and console control system operation when providing centrex-CO and PBX-CO service with the 1B-, 2B-, 27A-, and 47A-type consoles or with remote data interface system equipment.

1.06 The operation of the centrex data loop and console control system for centrex-CO and PBX-CO service is basically the same. The primary difference is the modification of centrex-CO translations to simulate PBX-CO service.

> ***Note:*** For convenience of reference in this document, centrex-CO and PBX-CO customer service is referred to as centrex service.

1.07 This centrex service utilizes the data handling capabilities and switching facilities of a 2-wire No. 1 or 1A ESS central office. All centrex operations are under the control of the central control (CC) or the signal processor (SP) in the ESS office to which the customer group is connected.

1.08 In order to control the lamp states and to receive key signals from the remote centrex attendant consoles, a data loop and a console control system are employed. Figure 1 is a block diagram of a typical centrex customer group. The centrex data loop connects the attendant telephone consoles at the customer premises with the 2-wire No. 1 or 1A ESS central office. This loop is a peripheral unit which provides 2-way data communications between the central office and the attendant consoles. Lamp data is transmitted by means of this loop to the attendant consoles in order to control the states of lamps on the consoles. The console lamps indicate service requests or other supervisory signals to the attendant. Key signals from the attendant consoles are also transmitted to the central office by the data loop. These key signals are interpreted at the ESS central office as requests for specific actions at the central office. Only one console is shown although as many as four may be controlled by a single data loop and console control system.

1.09 In order to provide data for use by a management information system (MIS) or other peripheral equipment (CRT, printer, etc) at the customer premises, a remote data interface system is installed on the customer premises to provide the necessary interface functions.

1.10 The central office end of a centrex data loop terminates in a centrex data link circuit mounted on a centrex data link frame in the ESS central office. The data link is a peripheral unit which provides the interface between the data loop and the ESS central office control equipment.

1.11 The remote end of the data loop terminates in a console control circuit contained in the 51A-CPS centrex console control cabinet or in a remote data interface system at the customer location. The console control circuit provides the interface between the data loop and the attendant consoles. The remote data interface provides the interface between the data loop and a management information system or other peripheral equipment.

1.12 Listed below are the abbreviations used in this section:

ACD	Automatic call distribution
ACMOS	Automatic customer outputting system
BPS	Bits per second
CC	Central Control
CCC	Console control cabinet
CILM	Call indicator lamp memory
CPD	Central pulse distributor
CPS	Customer premises system
CXDX	Centrex data link and console demand exercise
ENST	Enable-start
ESS	Electronic switching system
KSP	Key signal present

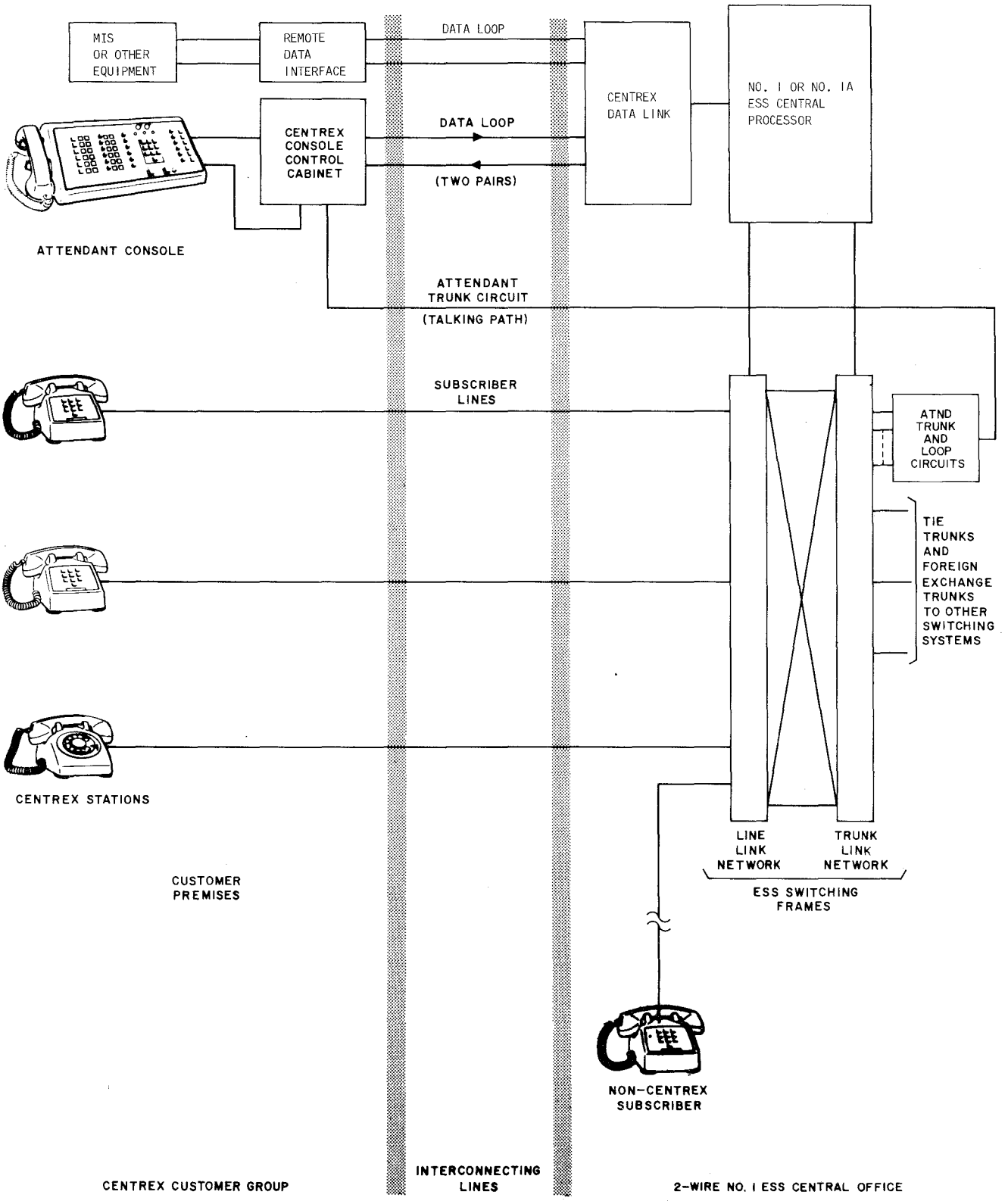


Fig. 1—Basic 2-Wire No. 1 or No. 1A ESS Centrex System

LMLM	Loop and miscellaneous lamp memory
LSP	Lamp signal present
MIS	Management information system
MS	Mark-space
OTBM	Optional trunk busy memory
RDI	Remote data interface
SP	Signal processor
TBM	Trunk busy memory
TTY	Teletypewriter.

2. CENTREX EQUIPMENT DESCRIPTION

2.01 In addition to attendant consoles and station telephones, two other specialized equipment units are required for centrex operation. These are the centrex data link frame (Fig. 2), located in the ESS central office, and a centrex console control cabinet (Fig. 3), or remote data interface system, located at the customer's premises. The centrex data link frame provides the interface between the ESS central office equipment and the data loop. The centrex console control cabinet (CCC) or remote data interface (RDI) provides the interface between the consoles or other equipment and the data loop.

CENTREX DATA LINK FRAME

2.02 A centrex data link frame (Fig. 2) is a standard 7-foot frame which can house a maximum of eight data links and the associated common equipment. The frame may be partially equipped, but link 0 must always be installed. There is a maximum of four frames per office through generic program CTX-8, Issue 3. Beginning with generic program 1E4 (1AE4), an office may have a maximum of eight data link frames.

2.03 The common equipment includes facilities for reading peripheral bus information and facilities for receiving enable signals from the central pulse distributors (CPDs). The common circuitry also includes the data link address bus and the dynamic buffer registers.

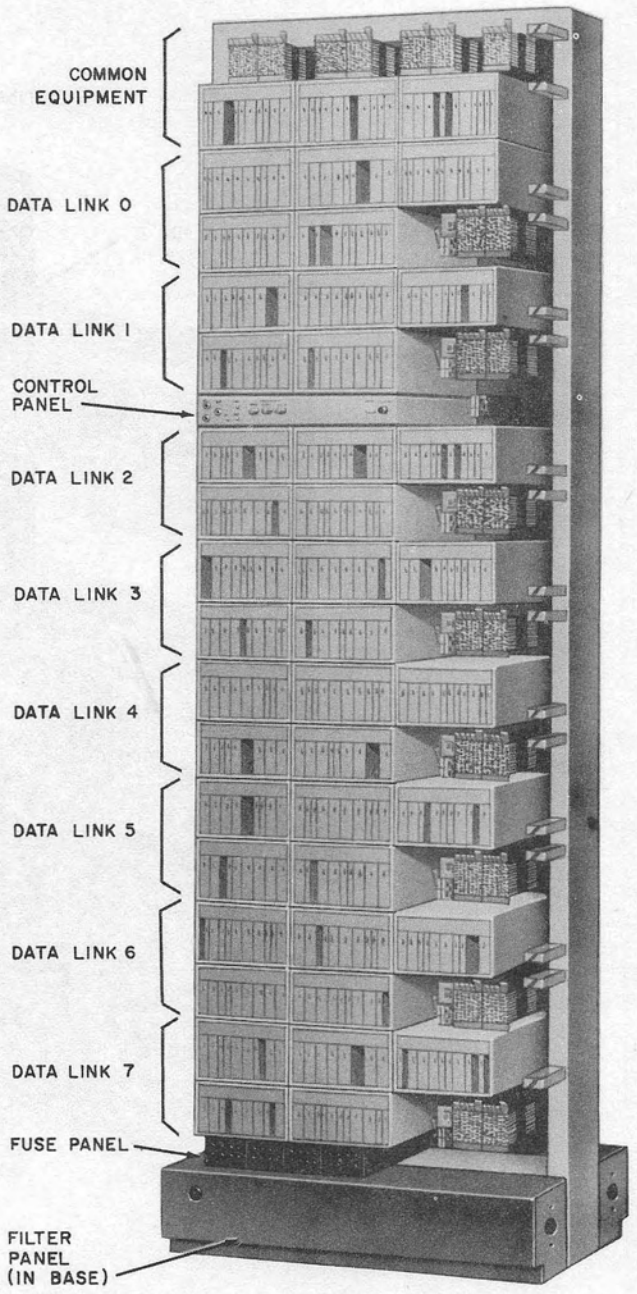


Fig. 2—ESS Centrex Data Link Frame

2.04 Each data link circuit contains a data link controller and a scanner buffer circuit in addition to the data transmitter, receiver, and shift register.

2.05 The data link controller accepts the enable signals from the common equipment and

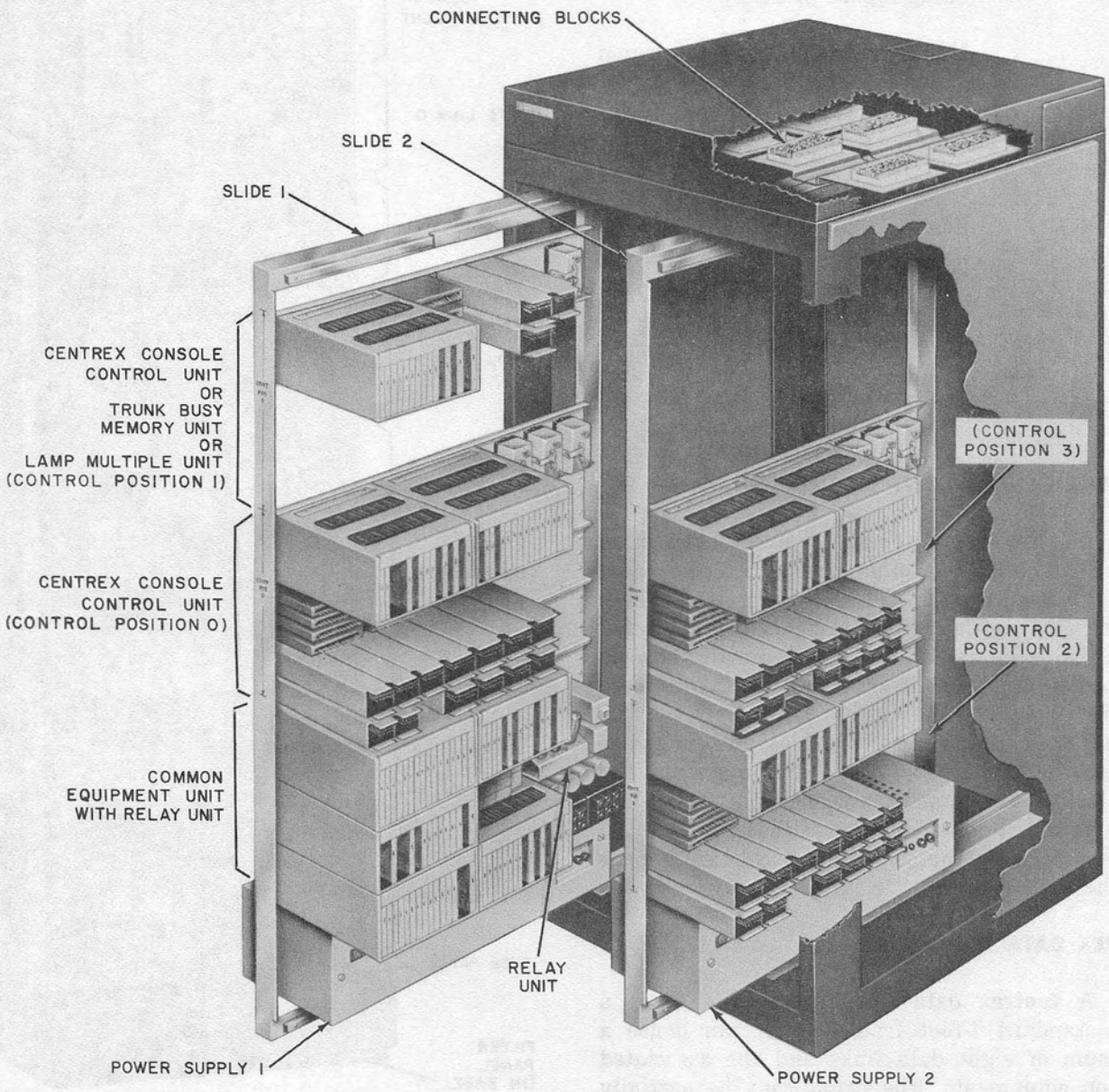


Fig. 3—ESS Centrex Console Control Cabinet

selects the peripheral bus containing the desired data. The controller also provides timing functions and sequencing of events necessary to initiate the reading of the peripheral bus data and to transmit the received data word.

2.06 The scanner buffer circuit contains buffer circuits necessary to supply the current to drive scan points.

2.07 Each data link also contains a bit counter used to determine the end of transmission by counting the number of bits transmitted.

2.08 A centrex data link circuit performs the following functions:

(a) Accepts and temporarily stores a 24-bit word from either of the two peripheral buses

(b) Converts this stored word into a sequence of mark and space signals and transmits them to the line in serial form

(c) Generates the line-signal intelligence by a frequency-shift method of signaling

(d) Simultaneously transmits and receives data at a rate of 1400 bits per second (BPS) and temporarily stores the received information in the same location (data shift register) that previously contained the transmitted word

(e) Initiates data transmission when requested by either the central office or the remotely located centrex equipment.

DATA LINK INTERCONNECTIONS

2.09 Each centrex data link frame is equipped with scan points, signal distributor points, duplicated CPD points, and connections to the duplicated peripheral unit bus.

Central Pulse Distributor Points

2.10 Each centrex data link frame is provided with two duplicated CPD points per data link. A CPD point is assigned to gate data into the shift register from each peripheral unit bus. This permits a choice of either bus and either CPD; therefore, four different routes are available to load the shift register. The other CPD point causes the data link to go into the transmit mode. A special reverse sequence of these points is also used to place the link in a test mode in which the shift register can be shifted one step at a time on command.

Signal Distributor Point

2.11 One signal distributor point is assigned per data link to provide a maintenance function. This point is a part of the data loop transfer circuit (Fig. 4). It is used to switch the data loop from a normal loop to a local loop condition to aid in isolating troubles in the data loop circuitry.

Supervisory Scan Points

2.12 One supervisory scan point is assigned per data link frame as a common fuse alarm. This is a supervisory scan point scanned at a 100-millisecond rate. If a data link or the common equipment on a data link frame should develop a power failure due to a blown fuse, this supervisory scan point is energized, and an indication is displayed on the ESS master control center alarm, display, and control panel.

2.13 The data link frame is also equipped with an alarm retire key which has an associated supervisory scan point.

2.14 A set of scan points (one per data link) is employed to indicate that a valid data loop is present (that is, a 700-cycle tone is present in both directions).

Directed Scan Points

2.15 Two 16-point information scan rows are assigned per data link to provide access to the centrex data unit shift register. These scan points are assigned in adjacent rows. Twenty-six of the scan points are delegated to read the contents of the shift register; four are assigned to indicate the state of the console for maintenance and checking purposes; and two are spares. These scan points are scanned whenever the key signal present (KSP) fast scan point indicates the presence of data. The information row scan point assignment has been arranged so that the data link can grow smoothly from a 1-console to a 4-console installation.

Fast Supervisory Scan Points

2.16 Each centrex data link is equipped with a KSP scan point. This is a supervisory scan point which is saturated when a key signal is received from an attendant console at a remote customer location. Before any lamp data is transmitted from the central office to the remote location, this scan point is examined to determine whether or not there is a key signal or interrogate word stored in the data register. If one is present, lamp data transmission is delayed until the key signal has been read out. Entire scanner rows of 16 scan points are assigned for the exclusive use of the KSP function. Unused scan points in these rows will not be used for other purposes. If there are more than eight data links in a central office, the additional scanner rows need not be on adjacent rows in the scanner.

CENTREX CONSOLE CONTROL CABINET

2.17 Each centrex customer with 1B, 2B-, 27A-, or 47A-type attendant consoles is provided with a centrex console control cabinet (Fig. 3). This cabinet provides the interface between the data loop and the attendant consoles. One console control cabinet is capable of controlling a maximum of four of the small (1B- or 27A-type) attendant telephone consoles. For large (2B- or 47A-type) attendant console installations, the first such cabinet can be equipped to handle three large consoles and one trunk busy memory (TBM) unit. Additional cabinets belonging to the same customer group can be equipped to handle four large consoles.

2.18 A centrex console control cabinet may be shared by different centrex customer groups under the restrictions covered in Section 966-102-100.

2.19 This centrex console control cabinet contains equipment common to all consoles controlled by the cabinet and equipment added on a per console basis.

COMMON EQUIPMENT

Common control equipment

Power supply (one per slide)

Trunk busy memory unit (for 2B- or 47A-type consoles and position no. 1, first cabinet only)

Lamp multiplying circuit (in position no. 1, ninth cabinet only)

ADDED EQUIPMENT PER CONSOLE

Console control unit

2.20 The console control cabinet provides the following functions:

(a) Encodes attendant console key signals

(b) Transmits key signals as data to the central office

(c) Receives lamp data from the central office

(d) Decodes lamp data received from the central office

(e) Provides timing

(f) Furnishes local power

(g) Provides the lamp interrupter circuitry

(h) Contains the lamp memories

(i) Contains a pulser circuit for controlling ferreeds in the lamp memories

(j) Receives and decodes special non-lamp-order words for interrogate and diagnostic purposes.

REMOTE DATA INTERFACE SYSTEM

2.21 Each centrex customer with an MIS, ACD phase 2, ACMOS, or similar customer premises terminal equipment requires an interface with the ESS and is provided with a remote data interface (RDI) system designed for the specific terminal equipment (Fig. 5). The RDI is available beginning with generic program 1E4 (1AE4).

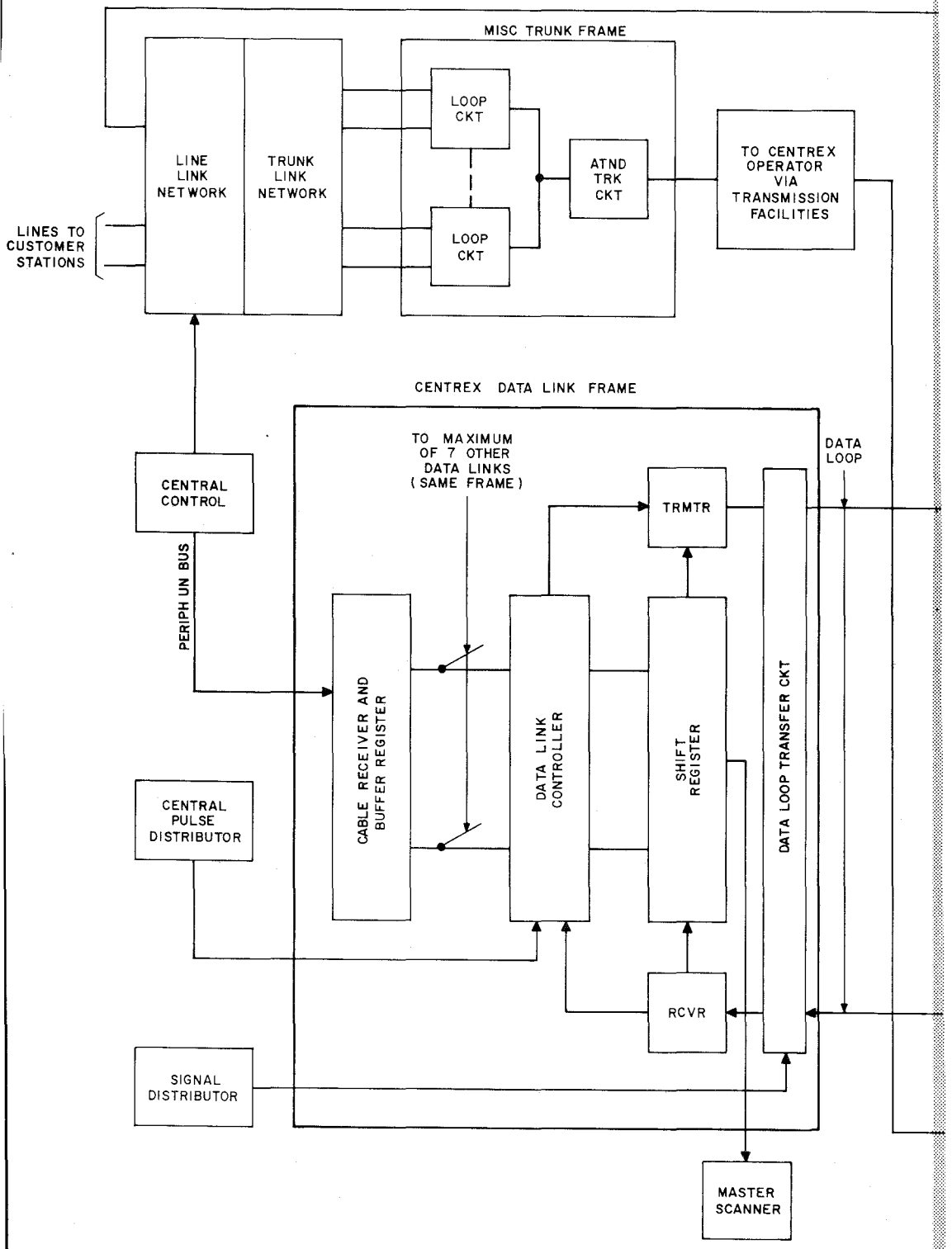
2.22 The RDI system is composed of a combination of the following types of equipment:

Modulator-demodulator

Interface equipment

Programmable controller

2-WIRE NO. 1 OR 1A ESS OFFICE ARRANGED WITH CENTREX SERVICE



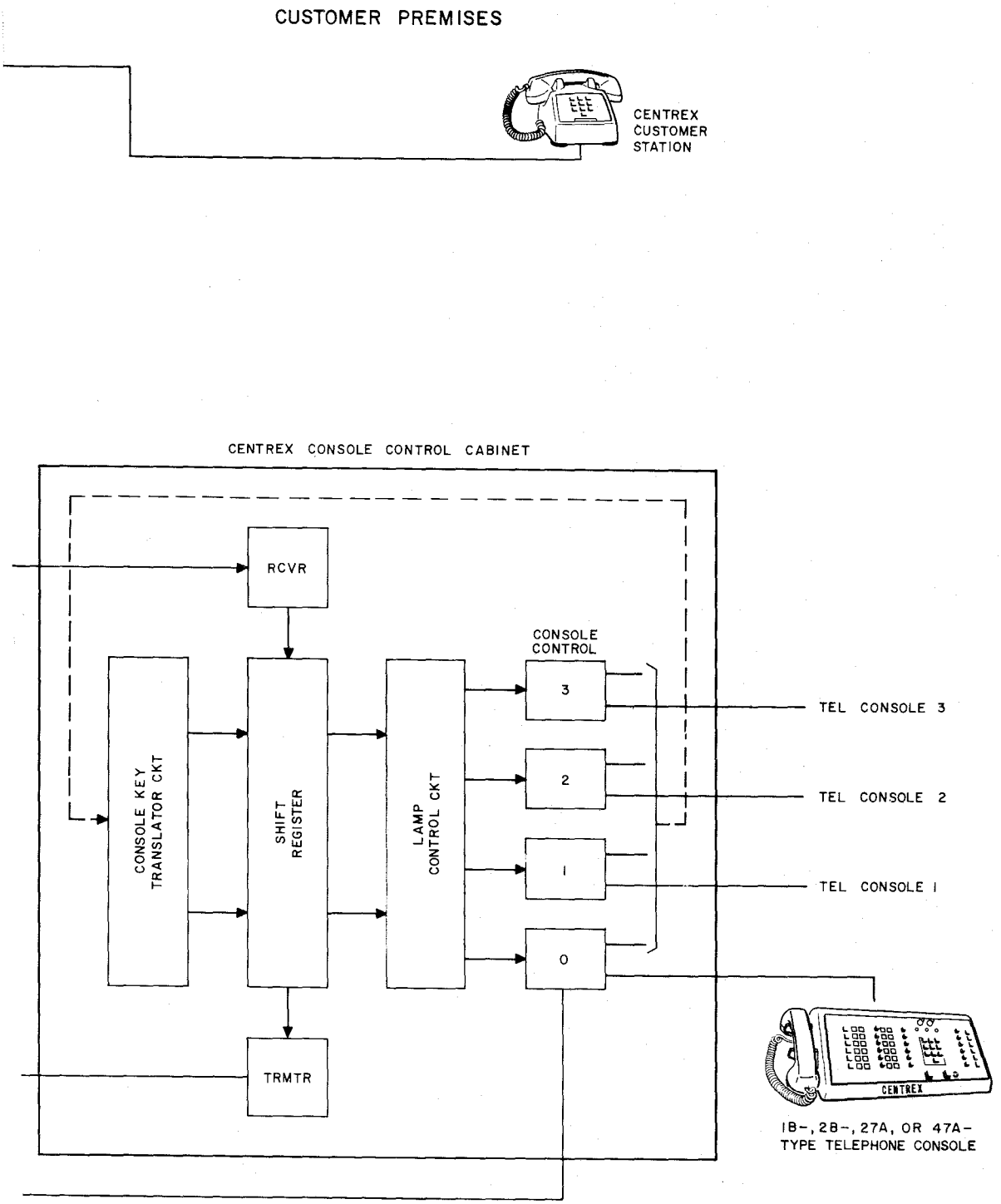


Fig. 4—Centrex-CO or PBX-CO Services Using Console Control Cabinet—Block Diagram

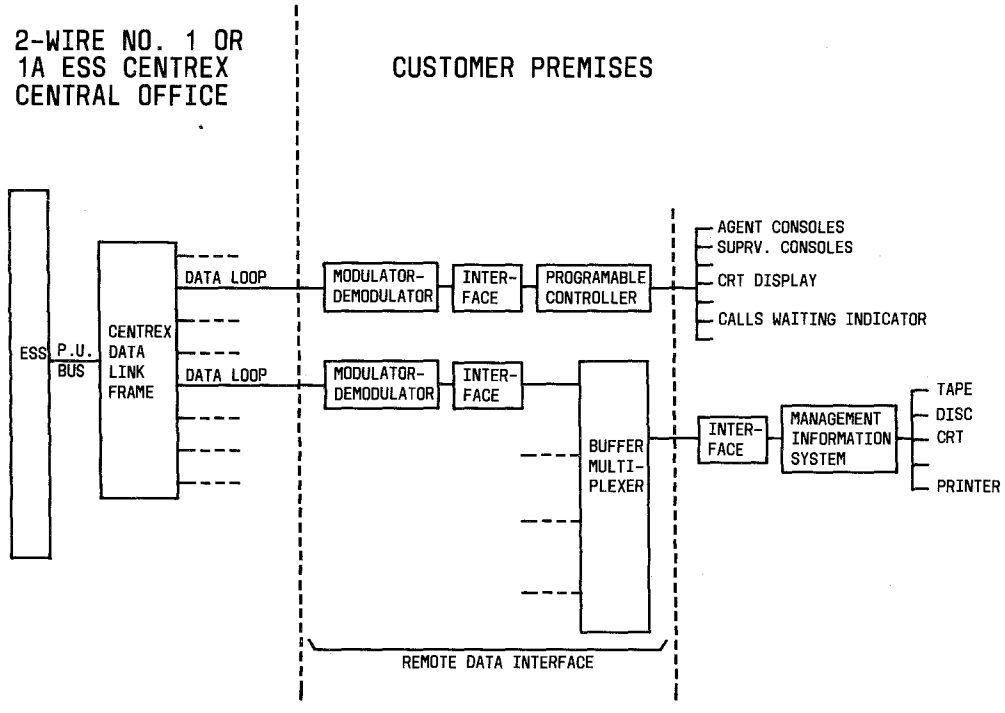


Fig. 5—Centrex Service Using Remote Data Interface System—Block Diagram

Buffer-multiplexer.

3. CENTREX DATA LOOP AND DATA LOOP SIGNAL TRANSMISSION

CENTREX DATA LOOP

3.01 Console lamp state changes and key signals are transmitted as data between the customer location and the central office by means of the data loop. Figure 4, a block diagram of centrex service, illustrates this data loop.

3.02 The centrex data loop consists of two separate 2-wire unidirectional data links. These data links are interconnected at the central office end and at the customer end by means of transmitting and receiving circuitry in such a way that the two links form a complete loop.

3.03 Lamp data used to control the states of the lamps on the consoles is transmitted from the central office to the attendant consoles, and key signal data is transmitted from the customer location to the central office by means of this data loop. Voice frequencies are used for transmission. A synchronous form of transmission is employed; therefore, the receiving end of a data loop is always in synchronism with the transmitting end.

3.04 Data is transmitted serially in the form of a 26-bit data word which contains 24 information bits plus a leading 1 and a control bit. The leading 1 is used to indicate to the data receiver circuit at the remote end of the data loop that transmission has started.

A. Data Shift Registers

3.05 A 26-bit shift register is located at both the central office end and the customer end of the data loop. These shift registers provide the means for parallel-to-serial and serial-to-parallel

conversion of the transmitted and the received data.

3.06 The data shift register located at the central office end of a data loop accepts the 24 bits of data from the peripheral unit bus and temporarily stores it before the data is transmitted as lamp data to the remote end of the data loop. In addition, this register is also used to receive and temporarily store key signal data originating from the remote end. The CC (or SP) at the central office can read out the contents of this register via scan points when key signal data is received.

3.07 The data shift register located at the customer end of the data loop accepts and temporarily stores 24 bits of data originating from keys being depressed on the console. (This data is transmitted as key signal data to the central office end of the data loop.) In addition, this register receives and temporarily stores the lamp data which is used for controlling the console lamps transmitted from the central office end.

3.08 Transmission on the data loop is controlled by the circuitry located in the central office. However, a request to transmit the contents of a register may be initiated by either the CC (or the SP) at the central office or by the attendant console circuitry at the customer's premises.

3.09 When a data loop is in an idle state (that is, no data is being transmitted in either direction), spaces (binary 0s) are, in effect, being transmitted continuously in both directions. Upon receiving a request to transmit, the transmitting circuitry at the central office applies the contents of the shift register to the line in serial form. The first pulse transmitted is always a mark (a binary 1). The receipt of an initial mark changes the state of the receiver at the remote end from idle to active and causes the receiving shift register to shift in synchronism with the received line signal.

3.10 When either the CC or the console circuitry requests transmission of a data word, the two registers interchange their contents. Since normally only one of these registers contains any information when a data transmission occurs, a blank word containing all 0s (spaces) is usually transmitted in one direction. If the central office end of the loop requests to transmit, the register at the remote end usually transmits all 0s. If the remote end of the loop requests to transmit, the register at the central office end of the loop usually transmits all 0s. In some instances, however, both registers will contain information. Data is transmitted at a rate of 1400 BPS in either direction.

B. Lamp Data Transmission

3.11 Service requests and other supervisory signals are sent as lamp data from the ESS central office to the customer location by means of the data loop. Lamp data is sent from the CC (SP) over the peripheral bus to the common control equipment in a centrex data link frame. The common control equipment selects the proper lamp data transmitter, which is enabled by the CPD. From here, the data is loaded into a register and transmitted serially as binary coded signals by means of a data link to a data receiver at the centrex customer location. The lamp control circuit decodes the message and stores it in a lamp state memory unit. The lamp state memory then operates the selected console lamps to the desired state.

C. Key Signal Transmission

3.12 Key signals are generated when an attendant operates a console key. These signals are encoded by an associated key signal translator in the console control cabinet at the customer's premises. The encoded data is inserted into the local shift register as a binary number when the register is found to be empty. From there this data is transmitted in serial form to the ESS central office where it is received by a receiver. The receiver stores the data in the data shift register. The contents of the register are read out by means of the key scan program which is entered from the CC executive control program at regular interrupt intervals.

D. Key Scan Program

3.13 A key scan program scans the centrex data units at the central office for the presence of key signals received from the remote attendant consoles. When a key signal is received by the data unit, a KSP scan point is saturated. The key scan program then generates a hopper entry containing the key signal. After the key signals have been read, this same program sends any lamp data that has been awaiting transmission back to the console location. The centrex key scan program is entered from the executive control program on an interrupt basis.

3.14 Several scan points are provided to inform the system about the state of the data link circuit—that is, whether or not the data link circuit is in the process of transmitting or receiving data and/or whether or not there is any information present in its register waiting to be read by the CC. These scan points must be checked before lamp data is loaded into the register for transmission to the remote end of the data loop.

3.15 The centrex key scan function can be performed either by a CC or by an SP program (whichever is used for input-output functions).

4. THEORY — INTRODUCTION

4.01 The purpose of the centrex data link circuit is to:

(a) Accept and record 24 bits from either of the two peripheral buses

(b) Provide the means for converting this parallel word into a sequence of mark and space signals transmitted to the line in serial form

(c) Generate and construct the proper line signal intelligence in accordance with a predetermined frequency—shift method of signaling

(d) Provide means for simultaneously transmitting and receiving data at a rate of 1400 BPS and recording the received information in the same location that previously contained the transmitted word

(e) Provide the means for initiating transmission placed as a request by either the ESS or remotely located data receiving circuitry

(f) Provide means for detecting the absence of signals on the incoming line

(g) Provide means, for diagnostic purposes, to advance the shift register and counter in single steps.

4.02 The centrex data link sub-unit blocks shown in Fig. 6 indicate both common circuitry and circuitry needed for each data link which is mounted in the same bay. The common circuitry provides facilities for reading peripheral bus information and includes pulse stretching or dynamic buffer register circuitry. This circuitry will serve as a temporary memory for all bits received over the peripheral bus circuit. The circuit is duplicated in that each peripheral bus is connected to two identical halves containing receivers and register circuits. The common circuitry also contains facilities for receiving and amplifying enable signals. Provisions are made for accepting two enable signals for each data link and an additional enable-start (ENST) signal.

5. THEORY — DATA LOOP LINE SIGNAL TRANSMISSION

5.01 When key signals or lamp data is to be transmitted via a data loop, it must be converted into audio-frequency signals and must be applied to the transmission facility. Basically, the method of generating and receiving the line signal is the same for both directions. The data to be transmitted is temporarily stored in the shift register at the transmitting end of the data loop prior to transmission. The contents of the shift register are then read out serially and are converted into audio frequencies for transmission to the opposite end of the data loop. A synchronous form of transmission is employed whereby the receiving circuitry operates in synchronism with the transmitting circuitry.

A. Line Signal Data Transmission

5.02 The data loop line signal is constructed by a discontinuous frequency-shift keying method (Fig. 7). The line signal is generated by switching between two oscillators, one operating at 700 Hz and the other operating at 2100 Hz.

5.03 ***Tone Gate:*** Switching between the two oscillators is accomplished by the use of a tone gate. The tone gate applies the output of either of the two oscillators to the line, depending on the contents of the shift register. When the first bit in the shift register is a 1 (mark), the tone gate applies the output of the 2100-Hz oscillator to the line. When the first bit is a 0 (space), the tone gate applies the output of the 700-Hz oscillator to the line. Each of the succeeding bits causes the output of either the 700-Hz or 2100-Hz oscillator to be applied to the line in a similar manner.

5.04 ***Oscillator Buffer Circuit:*** The oscillator buffer circuit isolates the oscillator from the tone gate.

5.05 ***Zero-Crossing Synchronizing Generator:*** This circuit is used to ensure that the shifting of the register is synchronized with the phase of the audio signal oscillators. Each zero crossing of the 700-Hz signal occurs at the same time and has the same polarity slope as the 2100-Hz signal. This is accomplished by stopping both oscillators momentarily and restarting them again in proper phase relation. This phase-correcting function is performed by the zero-crossing synchronizing generator. Figure 8 illustrates the output of the two oscillators and the points at which they are stopped and restarted in phase.

5.06 ***Oscillator:*** The basic source of the line signal is a pair of oscillators which are fundamentally identical. Mutual coupling insures that a reasonable degree of frequency tracking exists. Signal amplification and synchronizing pulses are generated by circuit packs SYNC-0 and OBC-0. These two circuit packs provide for the necessary signal gain as well as timing and synchronizing pulses.

5.07 Figure 9 illustrates a dc binary signal applied to a tone gate and the resulting line signal which is transmitted. (Only a few of the bits are shown in this illustration.) A binary 0, or space signal, is represented by a half cycle of the 700-Hz signal. A binary 1, or mark signal, is represented by three half cycles of the 2100-Hz signal. The presence of a mark will, therefore, cause a phase reversal during the center of a bit interval as opposed to the presence of a space.

5.08 When key data or lamp data is not being transmitted, the data loop idles with a steady 700-Hz tone applied to the line. This tone is equivalent to a continuous stream of spaces. The steady idling tone keeps the receiver circuit at the receiving end of a data loop in synchronism with the transmitter. This continuous idling tone also serves as a guard against impulse noise on the line causing false starts of the shift registers at the receiving end of the data loop.

B. Line Signal Data Recovery

5.09 Data recovery from the line signal is accomplished by sampling the received signal at the center of each bit interval. A phase reversal during the center of a bit interval caused by the presence of the 2100-Hz signal is interpreted by the receiving equipment as a mark.

5.10 The data receivers (Fig. 4) at both ends of the data loop are in either an idle or an active mode similar to the transmitters. The receivers must be switched to the active state prior to the reception of the data. The data receiver circuit at the central office end of the data loop is switched from an idle to an active mode as the associated transmitter changes from idle to active. The data receiver at the remote end is switched from an idle to an active mode by the receipt of the initial mark.

5.11 After switching to an active mode, the shift registers shift in synchronization with the transmit signal. This is because the last cell of the shift register is the bit being transmitted at any instant. The receivers interpret each bit slot as data and temporarily store the received data in an MS flip-flop, from which it is gated into the shift register in proper phase relationship to the shift pulses.

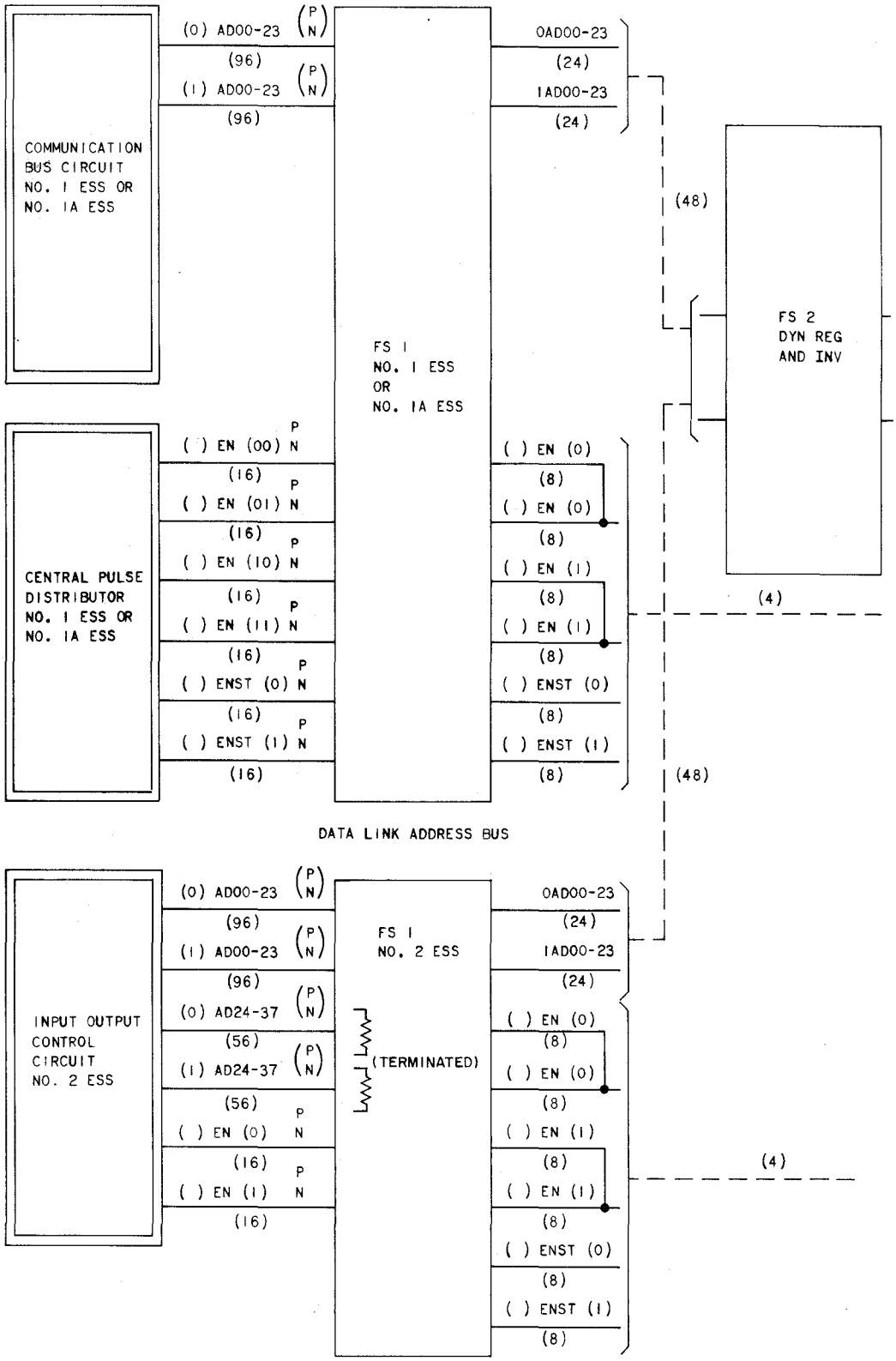
5.12 The oscillators in each data receiver are kept in synchronism and in phase with the incoming line signal by line-to-oscillator signal coupling. This permits synchronizing pulses and sampling pulses to be generated at the receiver. The synchronizing pulses are used to accurately adjust the phase of the receive oscillators. At the remote end these pulses also provide the shift function. These closely locked oscillator pairs also generate the sampling pulses used in sampling the center of each bit interval.

5.13 The central office end of a centrex data loop is equipped with one pair of oscillators for transmission and another pair for data recovery, whereas the remote end of a data loop is equipped with only one set of oscillators which performs both transmitting and receiving functions.

5.14 Figure 10 is a block diagram of a simplified data receiver. The tone gate which ensures that data is transmitted in synchronism with the received data is included.

5.15 The line amplifier in the data receiver amplifies the received line signal and provides the coupling to synchronize the 700-Hz oscillator signal with the line signal.

5.16 The oscillator buffer circuit amplifies the two local oscillator signals and furnishes the sampling pulses for the line signal sampler.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(96)
(1) AD00-23 (P N)
(96)
FS 1 NO. 1 ESS OR NO. 1A ESS
0AD00-23
(24)
1AD00-23
(24)
(48)
FS 2 DYN REG AND INV
CENTRAL PULSE DISTRIBUTOR NO. 1 ESS OR NO. 1A ESS
( ) EN (00) P N
(16)
( ) EN (01) P N
(16)
( ) EN (10) P N
(16)
( ) EN (11) P N
(16)
( ) ENST (0) P N
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(4)
(48)
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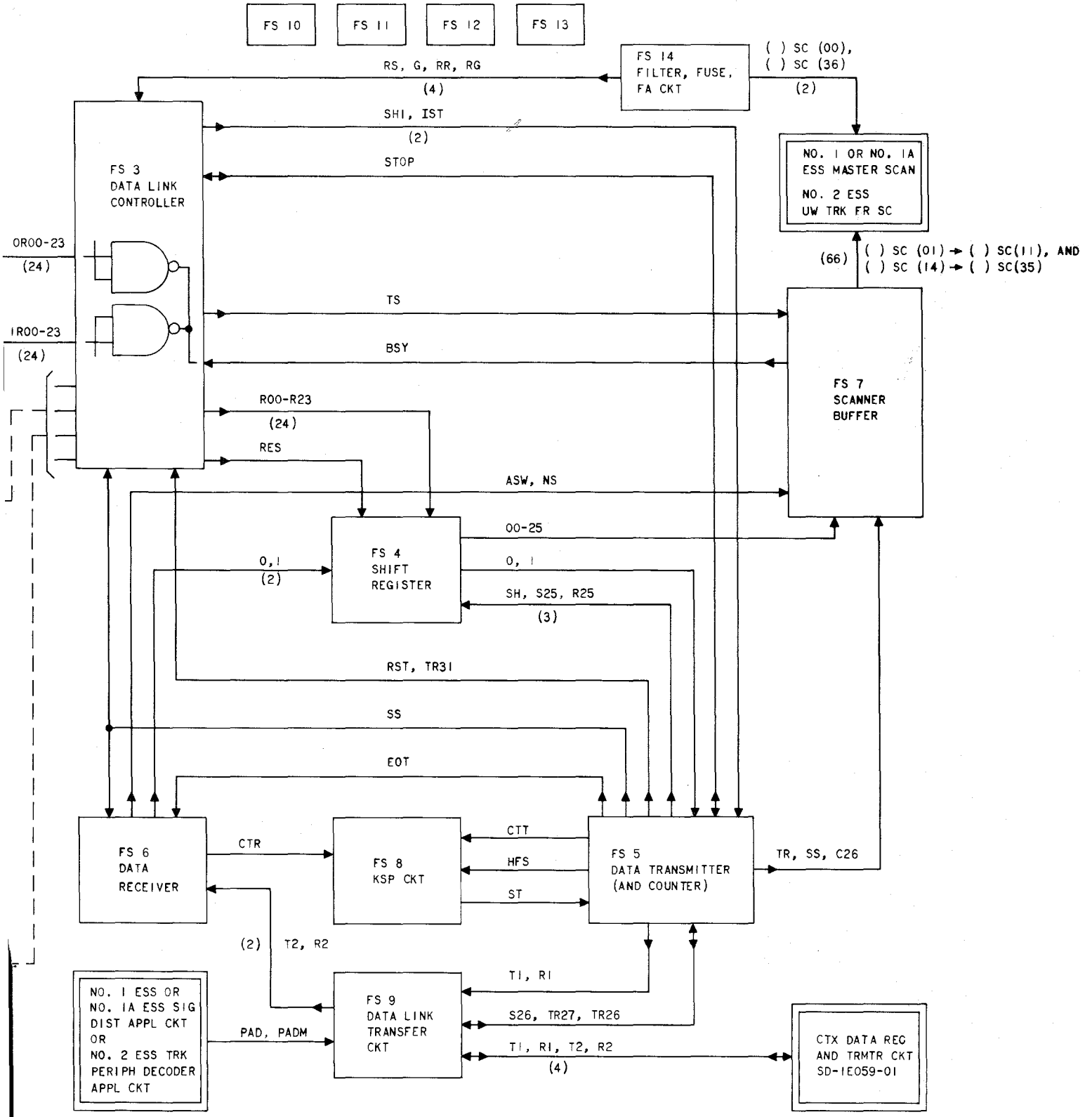


Fig. 6—Centrex Data Link Circuit—Overall Block Diagram

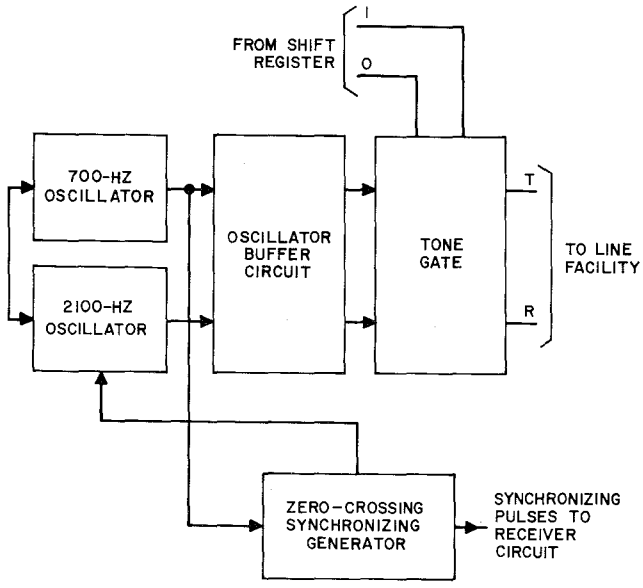


Fig. 7—Basic Data Transmitter—Block Diagram

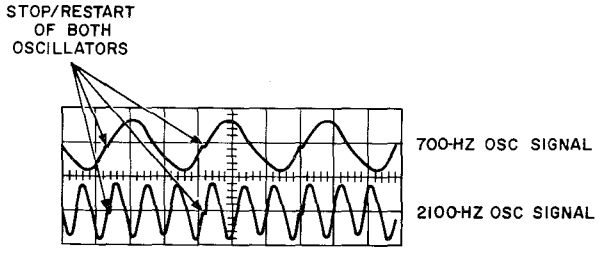


Fig. 8—Transmitter Oscillator Waveforms

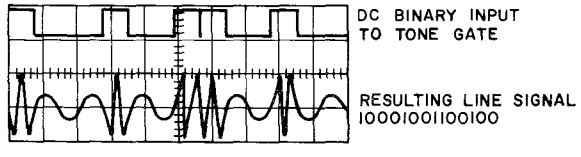


Fig. 9—DC Binary Signal and Resulting Line Signal

5.17 When a mark signal is received from the line amplifier, the line signal sampler sets the mark-space (MS) flip-flop. At the end of each bit interval, a synchronizing pulse from the zero-crossing sync generator interrogates the state of the MS flip-flop. Each received mark and space signal is converted into a 1 or a 0, respectively, and is inserted into the lowest numbered cell of the shift register.

5.18 The end of a received data word is determined by the bit counter which counts the number of bits received. When the bit count indicates that a complete word has been received, the receiver and the transmitter return to an idle mode. Similar bit counters are located at both the central office end and the remote end of the data loop.

6. THEORY — CONSOLE LAMP CONTROL AND KEY SIGNALING

CONSOLE LAMP CONTROL

6.01 The states of the attendant telephone console lamps are controlled by a centrex console lamp control circuit located in the centrex console control cabinet. The controlling lamp data is received from the data loop by means of the lamp data receiver circuit and is temporarily stored in the data shift register. The received data is decoded and applied to operate bipolar ferreed switches in lamp state memory units. The ferreed switches connect the selected lamp to ground for steady or to a lamp interrupter for the various flashing rates.

6.02 Console lamps are arranged into eight groups for control purposes. When a lamp data word is transmitted to a customer location, it is addressed to one of these lamp groups and to a particular console control position.

6.03 The lamp data word received consists of a leading 1 and a control bit plus a 24-bit data word. The two leading bits only perform administrative functions and are not considered part of the data portion of the word.

- Bit 24 (cell C) is used to provide an initial 1 for the word being transmitted back to the central office. It is set as soon as the incoming initial 1 is detected and shifted to the output cell (ST, bit 25) at the next zero-crossing.

- Bit 25 is the initial 1 transmitted from the central office. It is set only at the

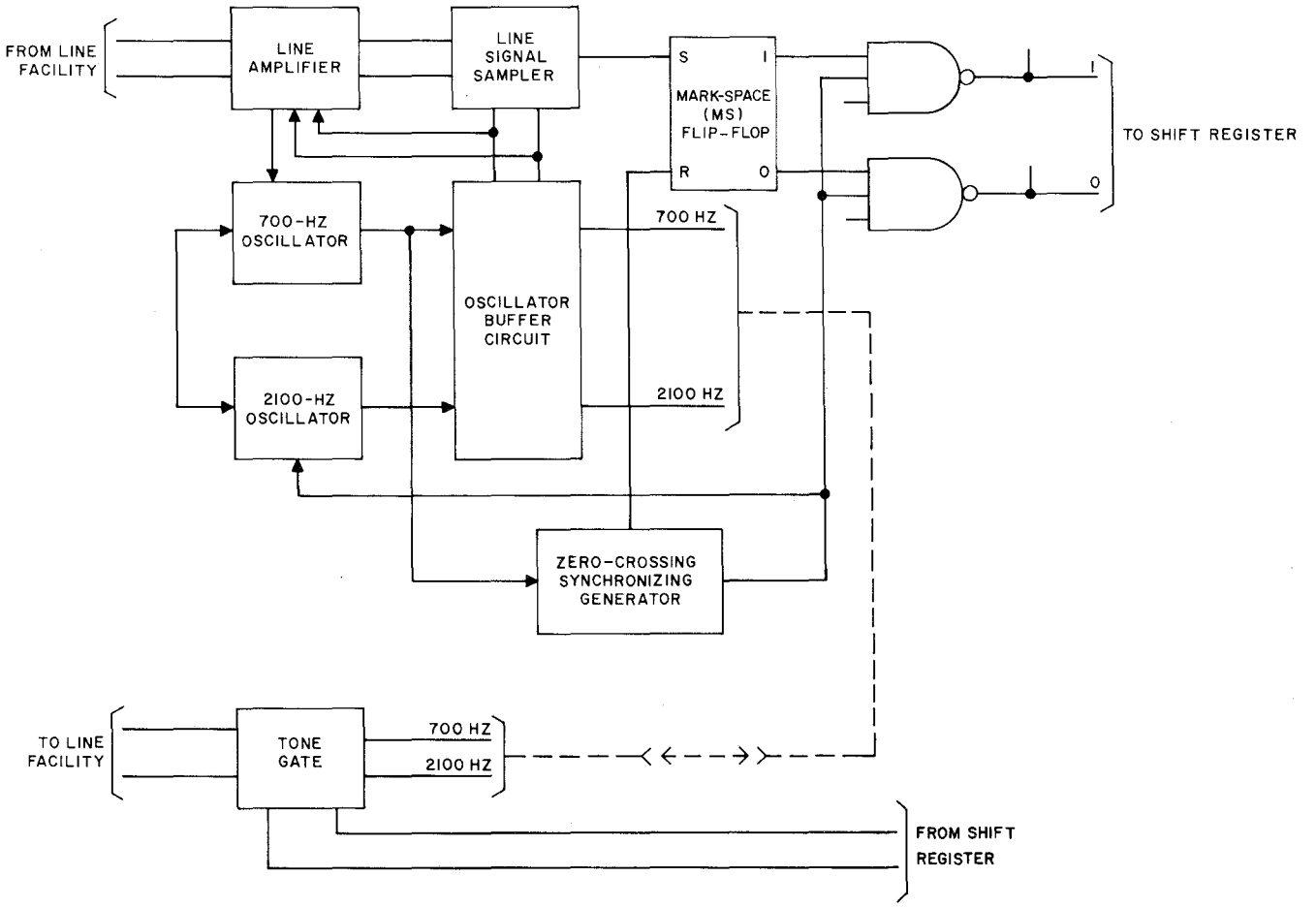


Fig. 10—Basic Data Receiver (Remote End)—Block Diagram

zero-crossing at the beginning of transmission and should not be confused with ***cell*** 25 which represents what is being transmitted out at any given instant.

CONSOLE LAMP CONTROL CODE FORMATS

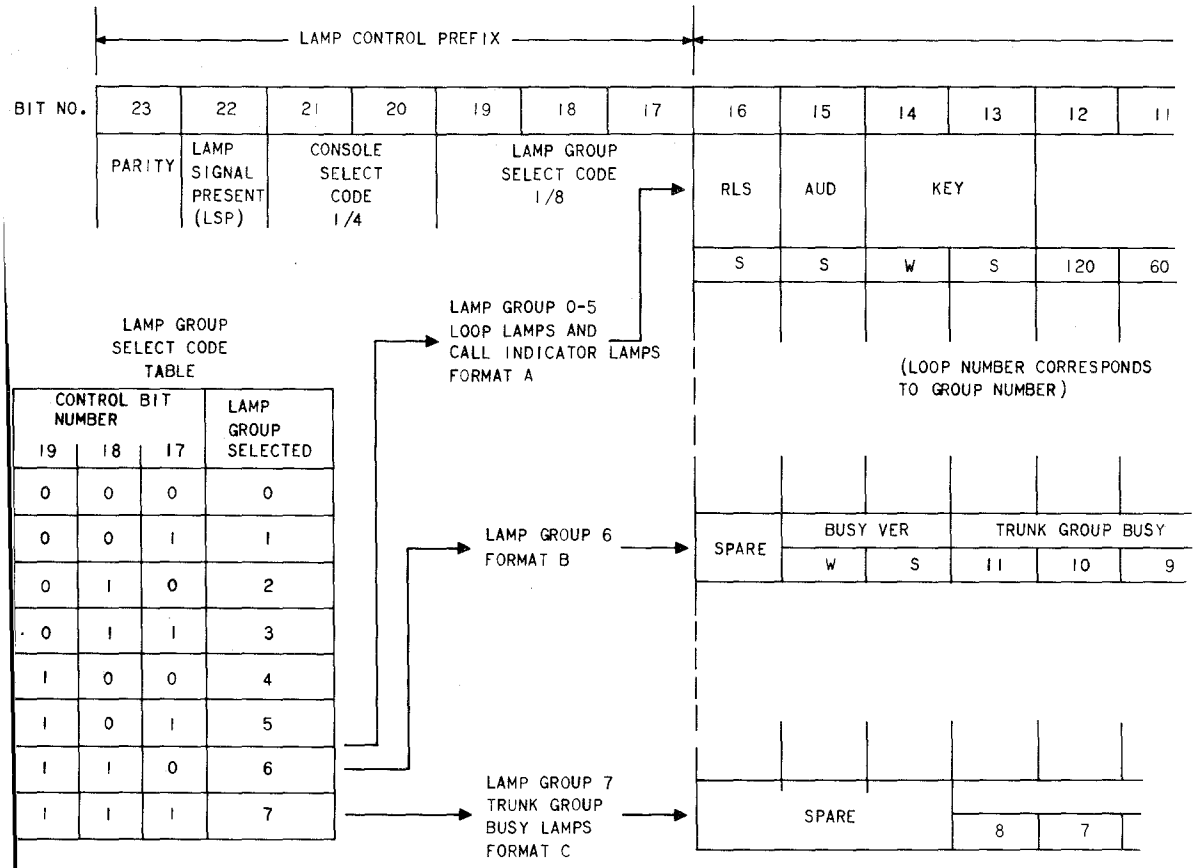
6.04 The code formats for the 24-bit data portion of the word used to control the states of lamps on the centrex attendant consoles are shown in Fig. 11. The code is composed of a 7-bit lamp control prefix and a 17-bit variable-format lamp state code. The code shown is used to control the 1B- or 27A-type consoles and is modified somewhat to control the 2B- or 47A-type consoles (6.18 and 6.19).

A. Lamp Control Prefix

6.05 The seven most significant bits of the code make up the lamp control prefix, which performs the following functions.

(a) Bit 22 is a lamp signal present (LSP) bit, or flag, which indicates to the console control circuitry that the word being received is a valid lamp order. If bit 22 is not a 1, the word may be a maintenance order (6.28).

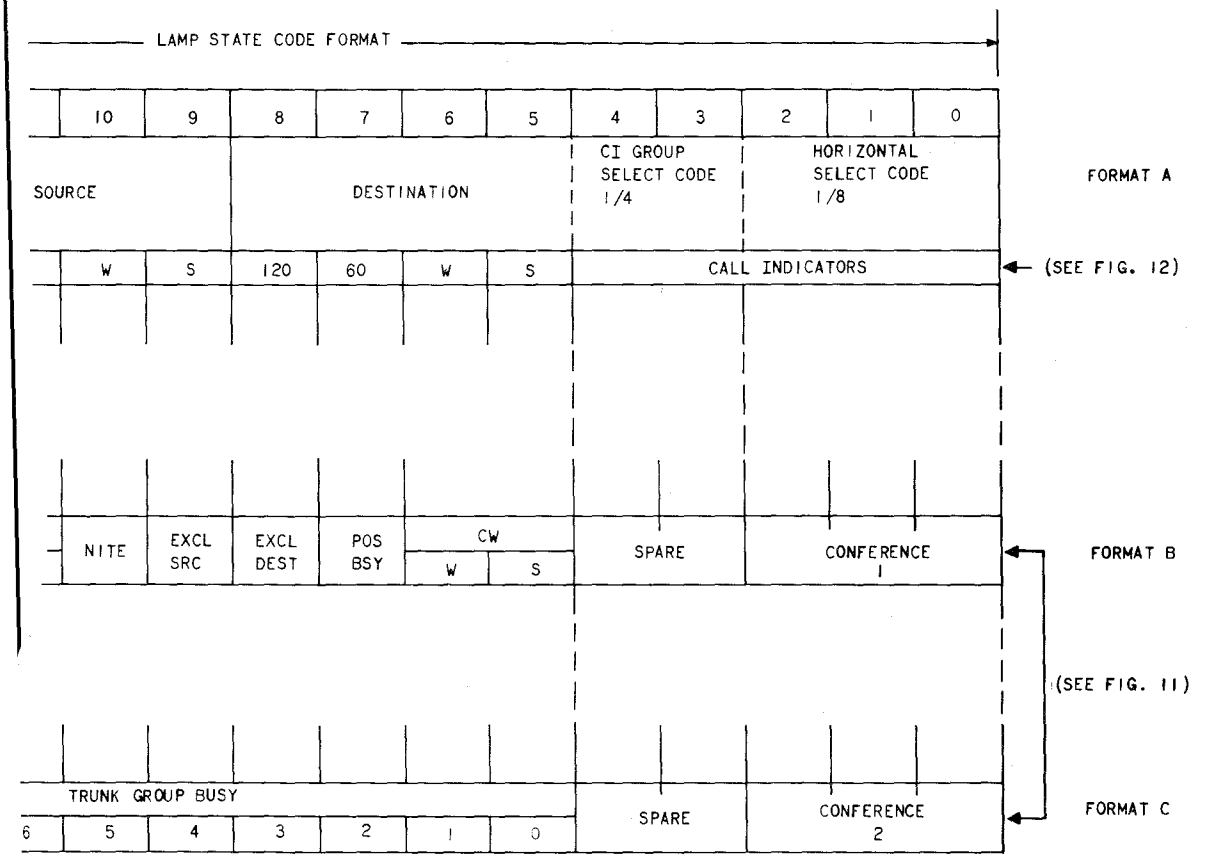
(b) For lamp orders, bits 20 and 21 form the console select code. This selects the particular one of four possible console control units to which the lamp order is to be directed. (See console select code table in Fig. 11.)



CONTROL BIT NUMBER 19	18	17	LAMP GROUP SELECTED
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

CONSOLE SELECT CODE TABLE

CONTROL BIT NUMBER 21	20	CONSOLE SELECTED
0	0	0
0	1	1
1	0	2
1	1	3



LEGEND:

S - STEADY
W - WINK
60 - ONE FLASH PER SECOND
120 - TWO FLASHES PER SECOND

Fig. 11—Centrex Lamp Control Code Formats

(c) Bits 17, 18, and 19 form the lamp group select code. These bits determine which group of lamps on the selected console is to be controlled. (See lamp group select code table in Fig. 11.)

6.06 The lamps on the attendant consoles are controlled by three different lamp state code formats associated with console control units. These formats are shown in Fig. 11. ***Format A*** is used to control the six groups of loop lamps (KEY, SRC, and DEST lamps), the RLS lamp, the audible signal, and the call indicator lamps. ***Format B*** is used to control the common lamps and some of the trunk group busy lamps. ***Format C*** is used to control other trunk group busy lamps and is associated with the optional trunk busy memory [OTBM (6.18 and 6.19)].

B. Lamp State Code Formats

6.07 A single bit in the lamp state code format is provided for each allowable active lamp state. The selected lamp is operated to the chosen active state by the presence of a 1 in the proper bit slot. An exception to this is the operation of the call indicator lamps, which is explained in 6.16 through 6.18.

6.08 A 0 in a particular lamp code position will cause that lamp to be extinguished whenever that lamp group is selected.

Loop Lamp Format (Format A)

6.09 If the lamp group select code (table in Fig. 11) is between 000 and 101 (binary code), a corresponding loop lamp group (decimal 0 through 5) is selected and the loop lamp format (FORMAT A) is transmitted to control the lamps in this group. Any bit position (5 through 16) which contains a 1 in a word transmitted to the consoles will operate the selected console lamp to the chosen state. For example, if bit 9 is a 1 and a loop lamp group is specified, the SRC lamp of the specified loop lamp group is operated to the steady (S) state.

6.10 The RLS lamp, the audible signal, and the optional call indicator lamps may be operated by data addressed to either of the six groups of loop lamps.

6.11 As shown in Fig. 11, some lamps may be operated to only one active state while others may be operated to one of several selected states. If none of the bit slots for a particular lamp contain a 1, the lamp is placed in the inactive state.

Format B

6.12 When the lamp group select code is binary 110 (lamp group 6), lamp format B is specified. A selected lamp here is also operated to the chosen active state by the presence of a 1 in the proper bit slot. This format controls three of the trunk busy lamps in addition to the other lamps. Format B also includes control of the five states of the conference 1 lamp. This is a function of lamp group 6 and bits 0, 1, and 2 as translated into a 1-out-of-8 selection.

Trunk Group Busy Lamp Format (Format C)

6.13 When the group select code is binary 111 (lamp group 7), the trunk group busy lamp format is specified. This format controls a field of nine additional trunk group busy lamps. A 1 in the proper bit slot will also operate the selected lamp to the active state. Format C also controls the conference 2 lamps in a similar manner to Format B (6.12).

C. Lamp State Memory

6.14 A lamp state memory associated with a centrex cabinet can be defined in two parts. They are the loop and miscellaneous lamp memory (LMLM) and the call indicator lamp memory (CILM). In addition, there is an OTBM which is a separate unit mounted in position No. 1 of the first cabinet associated with the large (2B- or 47A-type) consoles. The OTBM is discussed further in 6.19. In a lamp memory, a bipolar ferreed crosspoint is associated with each active lamp state. These ferreed crosspoints are mounted in 241C 1 by 8 switches. Twelve of these switches comprise an LMLM unit, in which most of the lamp states of an attendant telephone console are stored. Figure 12 is a block diagram of an LMLM unit. Three 241C 1 by 8 switches are used for the CILM. Figure 13 is a block diagram of a CILM. The LMLM and CILM, as well as associated lamp driving and miscellaneous circuitry, share a console control unit position. One lamp state memory is provided for each console. The operation of a ferreed crosspoint in a lamp state memory actuates the corresponding active state by connecting the selected lamp either to ground for steady or to the appropriate lamp

interrupter for wink, 60 interruptions per minute, or 120 interruptions per minute, respectively.

D. Lamp State Changes in the LMLM

6.15 Each change of state of a lamp on a console requires the complete updating of the whole lamp group of which the lamp is a part. Updating is accomplished when another data word is received. The updating operation requires two steps. First, all ferreed crosspoints in the selected lamp group are released, thus erasing the previous lamp states; then, for each 1 in the lamp state code of the new data word received, the corresponding ferreed crosspoint in the selected lamp group is operated. An all-zero code in a particular lamp code position causes that lamp to be extinguished and remain extinguished when that particular code word is received at the customer location.

6.16 The call indicator lamp field is also controlled by Format A (Fig. 11). Bits 0 through 4 are assigned to their control. A maximum of 24 call indicator lamps per console can be controlled by these bits.

6.17 Call indicator lamps indicate to the console attendant information concerning the origin of the call currently being processed; therefore, only one lamp in the call indicator group is illuminated at one time. The indication remains on the console long enough for the attendant to be aware of the call's origin.

6.18 A separate memory unit (Fig. 13), consisting of three 1 by 8 ferreed switches, is provided for call indicator lamps. Ferreed crosspoints in the call indicator memory are controlled in four groups of six lamps each. Bits 0, 1, and 2 of Format A are arranged in a 1 out of 8 horizontal select code and bits 3 and 4 in a 1 out of 4 vertical select code in order to select the desired lamp. Binary codes 001 through 110 provide an actual 1 out of 8 horizontal selection from bits 0, 1, and 2, and binary codes 00 through 11 are used for the 1 out of 4 vertical (call indicator group) selection from bits 3 and 4. For example, to select call indicator lamp 5, the horizontal select code would be 010 and the vertical (CI group) select code would be 01. Each instruction to the call indicator memory requires a 2-step updating sequence. First, if one of the six ferreed crosspoints in the selected call indicator group was operated, the call indicator group is released. Then, a ferreed crosspoint specified in the incoming code is operated. Binary code 111 (bits 0, 1, and 2) in the horizontal select code is used to reset all ferreed crosspoints and, therefore, turn off all lamps in the group selected by bits 3 and 4. Binary code 000 in the horizontal select code is used if the ferreed crosspoints in the call indicator memory are to be left unchanged.

E. Optional Trunk Busy Memory

6.19 The control of a 2B- or 47A-type console requires additional trunk busy memory beyond that available in the basic lamp state memory units. This is provided by a special trunk group busy memory unit (Fig. 14) which replaces one of the basic lamp state memories (specifically a console control unit).

6.20 The OTBM consists of three 1 by 8 ferreed switches equipped in memory unit position 1 of the first lamp control circuit associated with a 2B- or 47A-type console customer.

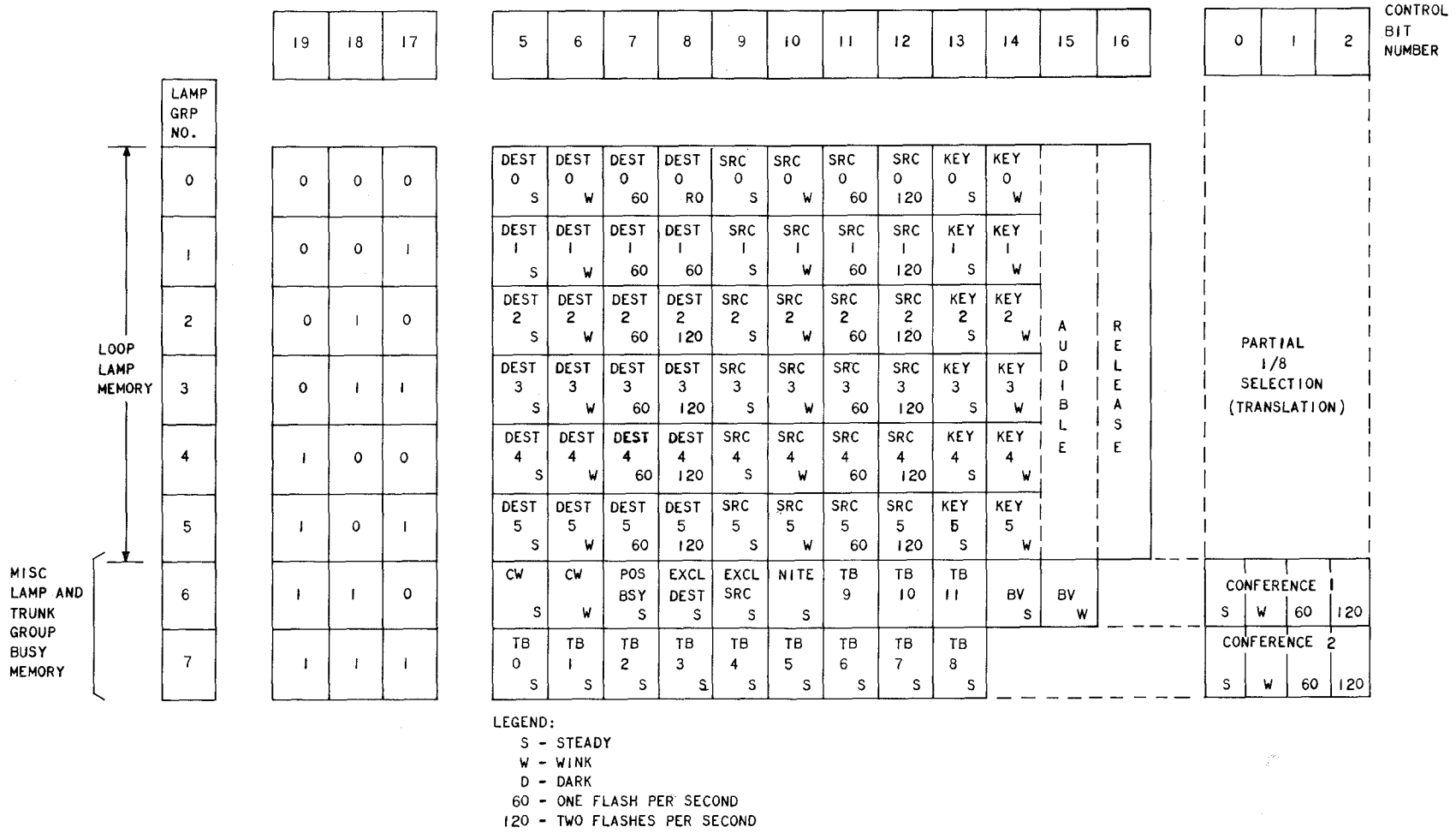
6.21 Figure 15 is a block diagram of the acceptable combinations of basic lamp state memory units and trunk busy memory (TBM) units which may be controlled by a single data loop circuit.

CONSOLE KEY FORMAT

6.22 Information from the centrex attendant consoles is transmitted to the central office as binary coded signals. These key signals are interpreted as requests for specific actions concerning calls that are associated with the consoles. Key signals from a single console require five bit spaces for encoding; therefore, the data register located in the console control cabinet has sufficient capacity to encode as many as four consoles. The contents of the register are read out serially as a 24-bit word during data transmission.

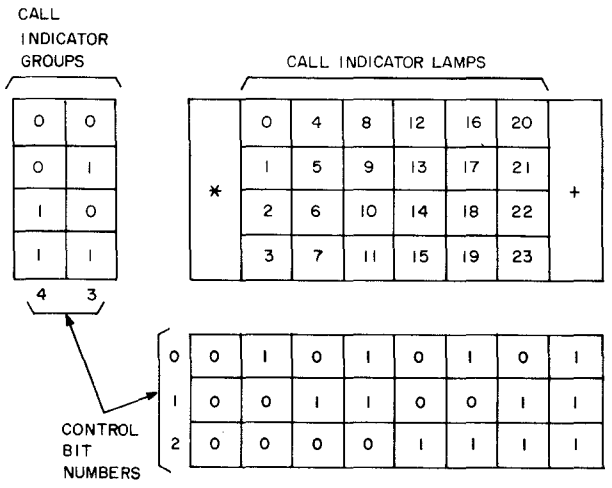
6.23 Figure 16 shows the key signal bit assignments for each of the four possible consoles. Four groups of five bits (0 through 19) are assigned for the key signals from each console; one bit (20) is a flag or KSP bit to indicate to the CC the presence of a valid key signal word; two bits (21 and 22) must be 0 when a key signal is to be transmitted; and bit 23 is a 0 (don't-care) bit.

6.24 The 31 possible codes which may be derived from a group of five bits are shown in Table A; 21 codes are presently used and 10 are



LEGEND:
- S - STEADY
- W - WINK
- D - DARK
- 60 - ONE FLASH PER SECOND
- 120 - TWO FLASHES PER SECOND

Fig. 12—Loop and Miscellaneous Lamp Memory (LMLM)



* WHEN CONTROL BITS 0, 1, AND 2 ARE 000, CALL INDICATOR LAMPS SELECTED BY BITS 3 AND 4 REMAIN UNCHANGED.

+ WHEN CONTROL BITS 0, 1, AND 2 ARE 111, ALL OF THE FERREED CROSSPOINTS IN THE ROW SELECTED BY BITS 3 AND 4 WILL BE RESET AND THE ASSOCIATED CALL INDICATOR LAMPS WILL BE EXTINGUISHED.

Fig. 13—Call Indicator Lamp Memory (CILM)

spares. The code is divided into three logical groups. This logical grouping facilitates the decoding of these key signals by the control program. The three groups are:

- Loop keys
- Console state keys
- Call processing keys.

6.25 ***Loop Keys:*** Decimal codes 1 through 7 are used to encode the loop keys on the consoles. There is one spare code available in this group.

6.26 ***Console State Keys:*** Decimal codes 8 through 10 are used to encode those keys which affect the overall state of the console or which have other certain specialized functions.

6.27 ***Call Processing Keys:*** Decimal codes 11 through 31 are used to encode those keys which are used in the processing of a particular call. There are seven spare codes available in this group. Decimal code 0 in any console key signal

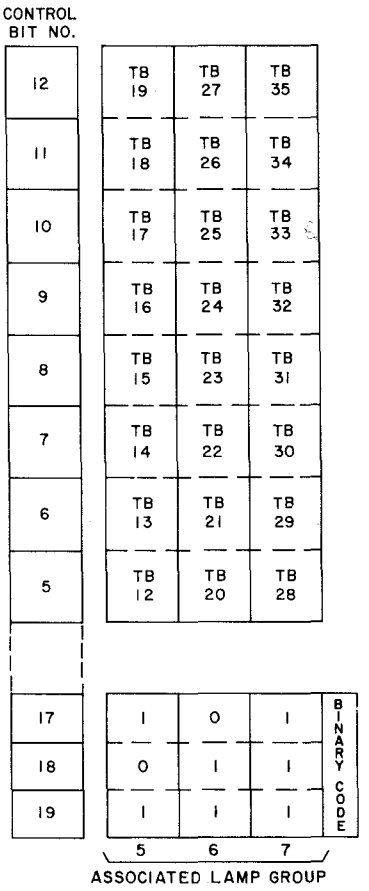


Fig. 14—Optional Trunk Busy Memory (OTBM)

slot indicates that no key signal was transmitted from that particular console.

MAINTENANCE ORDERS

6.28 Data can be encoded and transmitted to the shift registers in console control cabinets to perform maintenance functions. When data is transmitted to the control cabinet shift registers and bit 22 is a 0, the order is interpreted as a maintenance order. Bits 20 and 21 are then used to specify the maintenance function to be performed.

6.29 When bit 22 is a 0 and bits 21 and 20 are both 1s, the order is used to perform a loop-around test. This test checks the overall ability of the data loop to properly transmit and receive data. This order contains data which is transmitted to the shift register in the console control cabinet. A second transmission initiated

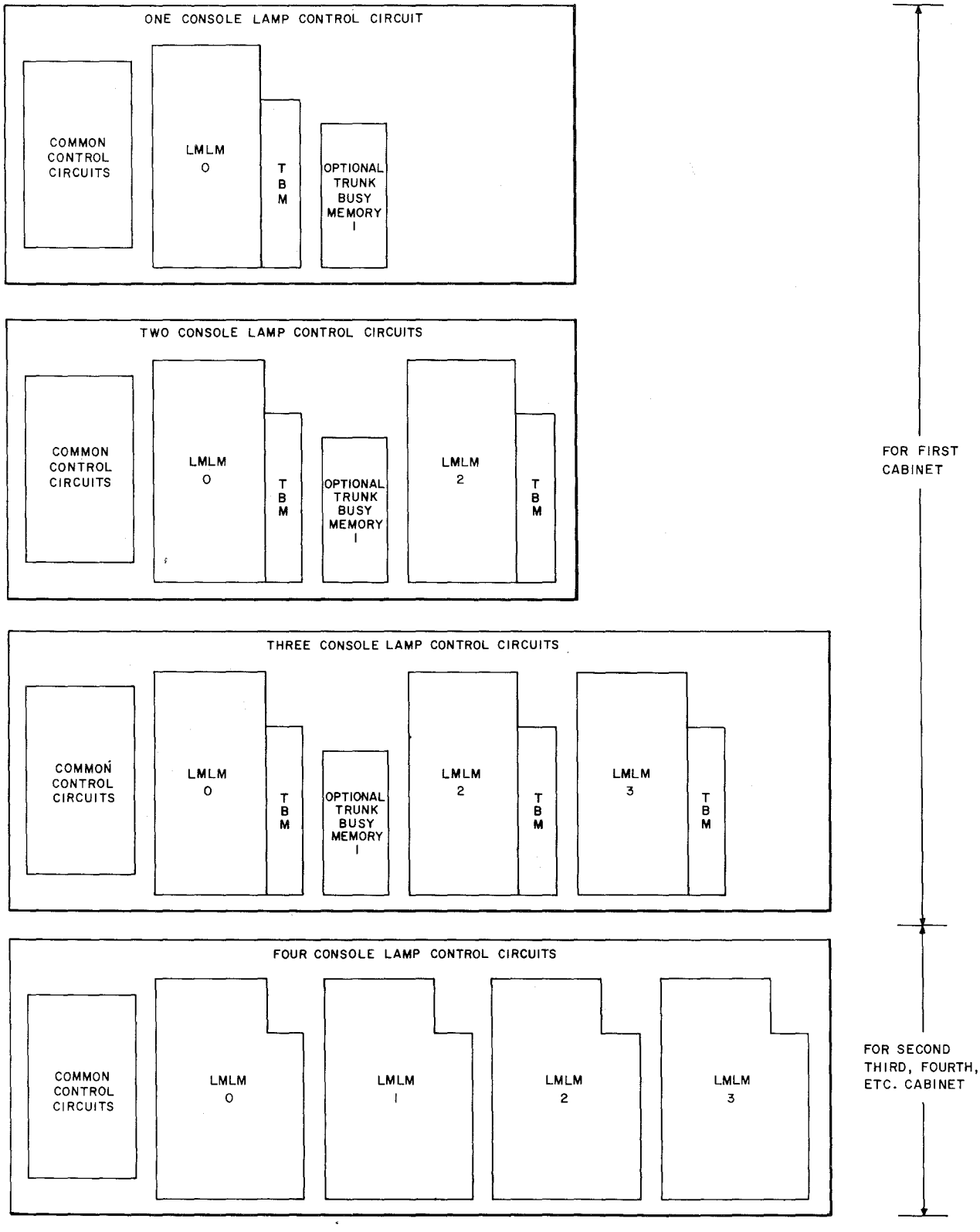


Fig. 15—Use of Optional Trunk Busy Memory in a 2B-Type or 47A-Type Console Installation

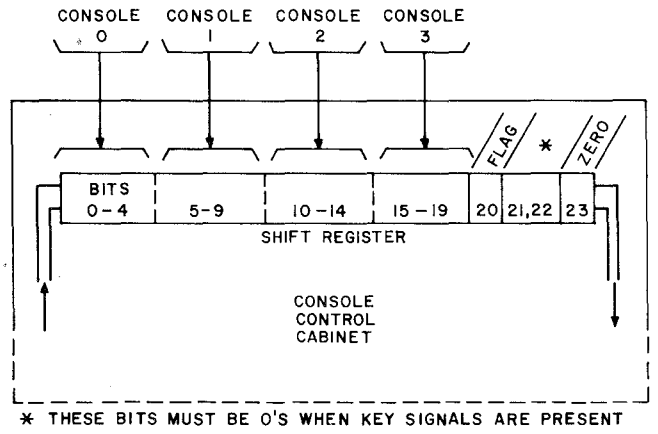


Fig. 16—Console Key Signal Bit Assignments

from the central office causes the data to be transmitted back to the central office.

6.30 When bit 22 is a 0, bit 21 is a 1, and bit 20 is a 0, the order is an interrogate order. This order is transmitted to a console control cabinet to determine the status of the POS BSY and the NITE lamps on each of the consoles controlled by the console control cabinet. This order also determines whether or not the customer's equipment is on emergency power or has fuses open.

6.31 As a response to the interrogate order, data is entered into the shift register in the console control cabinet and is transmitted back to the central office. This data contains bits which may be set to indicate the states of the NITE and POS BSY lamps of the consoles and the emergency power status of the console control cabinet. The bits which may be set and their indications are as follows:

(a) Bit number 0—Console 0 NITE lamp lighted.

(b) Bit number 1—Console control cabinet is on emergency power, ie, either a fuse is blown or battery voltage is low if so equipped.

(c) Bit number 4—Console 0 POS BSY lamp lighted.

(d) Bit number 5—Console 1 NITE lamp lighted.

(e) Bit number 9—Console 1 POS BSY lamp lighted.

(f) Bit number 10—Console 2 NITE lamp lighted.

(g) Bit number 14—Console 2 POS BSY lamp lighted.

(h) Bit number 15—Console 3 NITE lamp lighted.

(i) Bit number 19—Console 3 POS BSY lamp lighted.

6.32 When bits 22, 21, and 20 as transmitted to the remote end are either 000 or 001, respectively, the order is a no-operation order. Bits 0 through 19 will be set to 0. These orders are used to clear the shift register in the console control cabinet of data and to prepare the register for the reception of key signals from the consoles.

6.33 When bits 22, 21, and 20 are 001, bit 20 will be changed to a 0 by the centrex data receiver and transmitter circuit.

7. THEORY—REMOTE DATA INTERFACE

7.01 Beginning with generic program 1E4, (1AE4), a centrex data link is available with the customer premises equipment and the controlling software designed to transmit translation-type data to a programmable terminal and to load data link orders in an output buffer. The customer premise equipment required for this data link is referred to as the remote data interface.

AUTOMATIC CALL DISTRIBUTION, PHASE 2

7.02 ACD phase 2 requires an RDI for the agent consoles and the other CU equipment to pass data for city of origin, call waiting, agent lamp information, key depressions, and CRT control. This RDI (Fig. 5) consists of:

Modulator—Demodulator

Interface

Programmable Controller

The management information system (MIS) associated with ACD phase 2 requires another RDI (Fig. 5) which consists of:

Modulator—Demodulator

Interface

TABLE A

CENTREX CONSOLE KEY CODES

CONSOLE KEY OPERATED	BINARY CODE TRANSMITTED	EQUIVALENT DECIMAL NUMBER	KEY GROUPS
NONE	00000	0	LOOP KEYS
LOOP 0	00001	1	
LOOP 1	00010	2	
LOOP 2	00011	3	
LOOP 3	00100	4	
LOOP 4	00101	5	
LOOP 5	00110	6	
SPARE	00111	7	
POS BUSY	01000	8	CONSOLE STATE KEYS
NITE	01001	9	
SPARE	01010	10	
BUSY VER	01011	11	CALL PROCESSING KEYS
CONF. 1	01100	12	
CONF. 2	01101	13	
CAMP-ON	01110	14	
RLS TTRK	01111	15	
RLS	10000	16	
RLS SRC	10001	17	
RLS DEST	10010	18	
START	10011	19	
SIG SRC	10100	20	
SIG DEST	10101	21	
HOLD	10110	22	
EXCL SRC	10111	23	
EXCL DEST	11000	24	
SPARE	11001	25	
SPARE	11010	26	
SPARE	11011	27	
SPARE	11100	28	
SPARE	11101	29	
SPARE	11110	30	
SPARE	11111	31	

Buffer-Multiplexer

This RDI is able to multiplex up to 4 data links. In addition, an MIS interfaced unit must be used. These data links pass informtion which is primarily traffic oriented, such as the state of agent consoles, queues, trunk groups, simulated facilities, and reconfiguration information from the customer.

AUTOMATIC CUSTOMER MESSAGE OUTPUTTING SYSTEM

7.03 The ACMOS provides call data to customer owned and maintained hotel/motel property management system through an RDI. ACMOS will report all completed local message unit calls for each TN to the customer for immediate billing purposes and identify the calling and called lines on selected intercom calls. The RDI (Fig. 5) consists of:

Modulator-Demodulator

Interface

Buffer—Multiplexer

The customer must furnish an MIS interface unit.

CUSTOMER OWNED AND MAINTAINED MIS EQUIPMENT

7.04 Customer owned equipment which is capable of requesting and/or receiving data from the ESS requires an RDI. This RDI (Fig. 5) consists of:

Modulator-Demodulator

Interface

Buffer-Multiplexer

The customer must furnish an MIS interface unit.

8. THEORY — POWER, FUSES, AND FUSE ALARM

8.01 ***Centrex Console Control Cabinet Power Requirements:*** The centrex console control cabinet, located at the customer premises, is designed to normally operate from a standard 117-volt ac outlet provided by the customer. An optional battery supply, 105E power plant or equivalent, is available for the centrex cabinet. The power drawn varies according to the number of consoles provided and the amount of attendant traffic. A centrex console control cabinet fully equipped with four attendant telephone consoles requires a maximum of 400 watts (approximately 3.4 amperes) at periods of peak traffic.

8.02 In the centrex office each data link is protected by a separate fuse that has its designation related to the link number. Power is applied by pressing a dual-state single pushbutton which, when operated, removes power from that link. Power is removed and restored on an individual data link basis. When power is removed, the associated red key-lamp lights. The restoration of power is sequenced so that power is applied to the circuit prior to the removal of clamping grounds. This sequence of events during power restoration ensures that the link circuit is left in a reset state. This applies to both transmitting and receiving circuitry.

8.03 The fuse alarm consists of a common alarm indication for the bay. The fuse alarm relay operates if any fuse in the bay is opened. The state of this relay is further indicated by a scan point connection which is assigned on a bay basis. Power-off or a fuse alarm condition is indicated by the red PWR OFF lamp.

9. MAINTENANCE

GENERAL

9.01 The maintenance philosophy of the centrex data loop is based on the hardware design as well as software and manual fault detection and diagnosis. The maintenance aids used are the centrex data link and console demand exercise (CXDX) program for the software and the maintenance teletypewriter (TTY) for manual diagnosis.

9.02 Improper console lamp operations and key signals may be caused by faults occurring in an attendant console, a control cabinet, interconnecting data link circuitry, or the 2-wire No. 1 or 1A ESS central office equipment. When a fault becomes apparent at the attendant consoles, attempts may be made at the ESS central office to determine and to correct the faults. Data link diagnostic programs may be requested automatically (through parity checks) or manually (from the maintenance TTY) to determine if the fault is occurring in the data link circuitry. If the trouble cannot be located and corrected from the central office, it may be necessary for maintenance personnel

to go to the centrex customer's location to aid in determining the trouble. When a fault causing a trouble occurs at a centrex customer location, its cause may not be readily apparent to maintenance personnel on the customer's premises. By requesting that the ESS central office perform the CXDX program, routine exercises may be directed to the desired console (and associated equipment) to aid in locating and identifying the fault. These routines may be performed ***only*** on consoles and console controls (TBM units) which previously have been removed from service by the proper TTY input message.

SOFTWARE TEST PROCEDURES

9.03 The CXDX program is capable of encoding and transmitting data which attempts to operate the lamps on the consoles to all of the states to which they may be normally operated. The CXDX program can also receive and analyze key signal data originating from consoles. When key signals are analyzed by the CXDX program, a signal is encoded and is then transmitted back to the console to indicate to personnel at the console whether or not the proper key signal was received. Lamps or keys may be exercised either individually or in special sequences.

9.04 The CXDX program may also be requested to verify the overall operations of newly installed consoles. This should be done prior to permitting the release of consoles for customer use.

9.05 When a major trouble (loss of console power) occurs at the console or when troubles occur in the data link serving the console control cabinet, the use of the CXDX program may not be practical.

MANUAL TEST PROCEDURES

9.06 The maintenance TTY is utilized to control the data links and associated attendant consoles. Maintenance personnel can use several maintenance features which are provided by the centrex maintenance supervisory program. These are as follows:

(a) To unconditionally restore to or remove from service a data link

(b) To force the data link to use a specified bus and/or CPD choice

(c) To initiate the diagnosis of a specified link or all data links

(d) To determine the status of all data links

(e) To remove from or restore to service a single attendant console

(f) To initiate the CXDX program to aid in console maintenance.

Reference should be made to Section 231-160-302 for explanations of the use of related TTY messages for diagnostic and demand exercises. Also, reference should be made to the input and output message manuals for exact details on the formats and use of all TTY messages.

10. REFERENCES

10.01 The following listing provides further information concerning the centrex data loop and console control.

SECTION	TITLE
231-160-301	Centrex Data Link and Console Demand Exercise Program Procedures
231-160-302	Centrex Data Link and Attendant Telephone Console Maintenance Procedures
966-100-100	2-Wire No. 1 and No. 1A Electronic Switching System General Description
966-102-100	2-Wire No. 1 Electronic Switching System Centrex CO Service
966-120-100	2-Wire No. 1A Electronic Switching System General Description
SD-1E059-01	Centrex Data Receiver and Transmitter Circuit
SD-1E063-01	Centrex Attendant's Console Lamp Control Circuit
SD-1A265-01	Centrex Data Link Circuit.