CENTREX DATA LOOP AND CONSOLE CONTROL
DESCRIPTION
NO. 2 ELECTRONIC SWITCHING SYSTEM

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FIGURES

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1. GENERAL

1.01 This section describes the Centrex data loop and the console control system used in conjunction with the No. 2 Electronic Switching System (ESS) equipped to provide Centrex service. For a general description of the overall Centrex service designed for the No. 2 ESS, refer to Section 966-202-100.

1.02 This Centrex service utilizes the data handling capabilities and switching facilities of a No. 2 ESS central office. All Centrex operations are under the control of the control unit in the No. 2 ESS office to which the customer group is connected.

1.03 In order to control the states of the lamps and to receive key signals from the remote Centrex attendant telephone consoles, a data loop and a console control system is employed. Fig. 1 is a block diagram of a typical Centrex customer group. Only one console is shown although as many as four may be controlled by a single data loop and console control system.

1.04 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 No. 2 ESS central office. The data link is a peripheral unit which provides the interface between the data loop and the No. 2 ESS central office control equipment.

1.05 The remote end of a data loop terminates in a console control circuit contained in the Centrex console control cabinet at the Centrex location. The console control circuit provides the interface between the data loop and the attendant telephone consoles.

2. CENTREX DATA LOOP AND DATA LOOP SIGNAL TRANSMISSION

CENTREX DATA LOOP

2.01 Console lamp state changes and key signals are transmitted as data between the remote Centrex location and the No. 2 ESS central office by means of the data loop. Fig. 2, a block diagram of a No. 2 ESS arranged for Centrex Service, illustrates this data loop.

2.02 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 remote Centrex end by means of transmitting and receiving circuitry in such a way that the two links form a complete loop.

2.03 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 Centrex location to the No. 2 ESS 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.

2.04 Data is transmitted serially in the form of a 26-bit data word which contains 24 information bits plus two leading control bits. The two leading control bits are used to indicate to the data receiver circuit at the remote end of the data loop that transmission has started. Furthermore, these bits are used to properly synchronize the start of transmission on both links of the data loop.

A. Data Shift Registers

2.05 A 26-bit shift register is located at both the No. 2 ESS central office end and the remote Centrex 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.

2.06 The data shift register located at the central office end of a data loop accepts the data from the control unit and temporarily stores it before the data is transmitted as lamp data to the remote end of the data loop. In addition, this

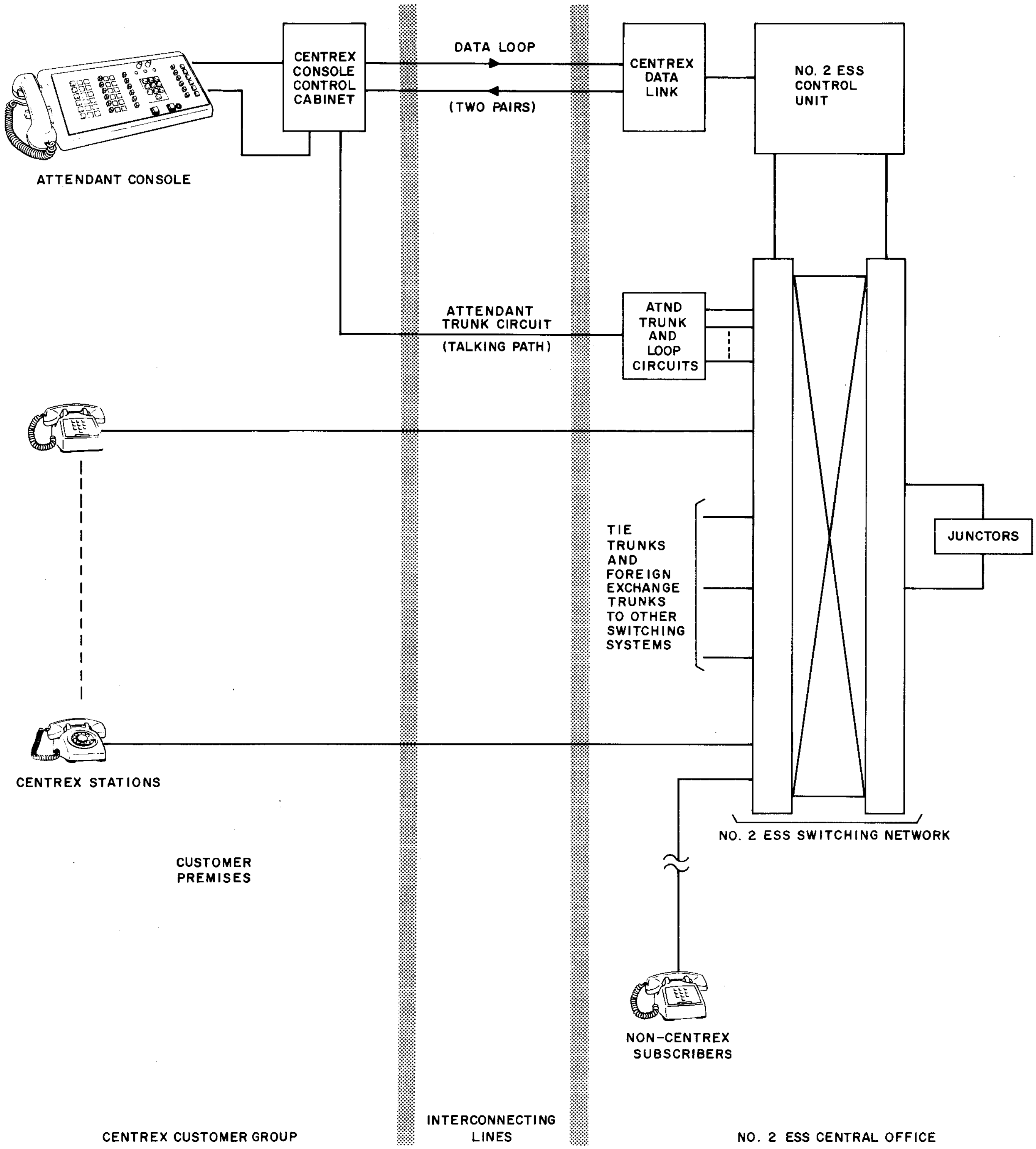


Fig. 1—No. 2 ESS Centrex System

register is also used to receive and temporarily store key signal data originating from the remote end. The control unit at the central office can read out the contents of this register via scan points when key signal data is received.

2.07 The data shift register located at the remote Centrex end of the data loop accepts and temporarily stores 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.

2.08 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 the control unit at the central office or by the attendant console circuitry at the customer's premises.

2.09 When a data loop is in an idle state (that is, no data is being transmitted in either direction), spaces (binary 0's) 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.

2.10 When either the control unit 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 0's (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 0's. If the remote end of the loop requests to transmit, the register at the central office end of the loop usually transmits all 0's. In some instances, however, both registers will contain information. Data is transmitted at a rate of 1400 bits per second in both directions.

B. Lamp Data Transmission

2.11 Lamp data is sent from the control unit over the peripheral bus to the proper data link circuit in a Centrex data link frame. The selected data link controller is enabled to receive the lamp data by the central pulse distributor. When the data is loaded into the shift register, a second central pulse distributor operation enables the controller to start serial transmission to the remote end of the data loop.

C. Key Signal Transmission

2.12 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 No. 2 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 scan points which are connected to the shift register.

D. Attendant Monitor Program

2.13 The attendant monitor program scans the Centrex data units at the No. 2 ESS central office for the presence of key signals received from the remote attendant telephone consoles. When a key signal is received by the data unit, a key signal present scan point is saturated. The attendant monitor program then takes action appropriate to the key signal. After the key signals have been processed this same program sends any lamp data that has been awaiting transmission back to the console location. The Centrex attendant monitor program is entered every base level scan.

2.14 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 control unit. These scan points must be checked before lamp data is loaded into the register for transmission to the remote end of the data loop.

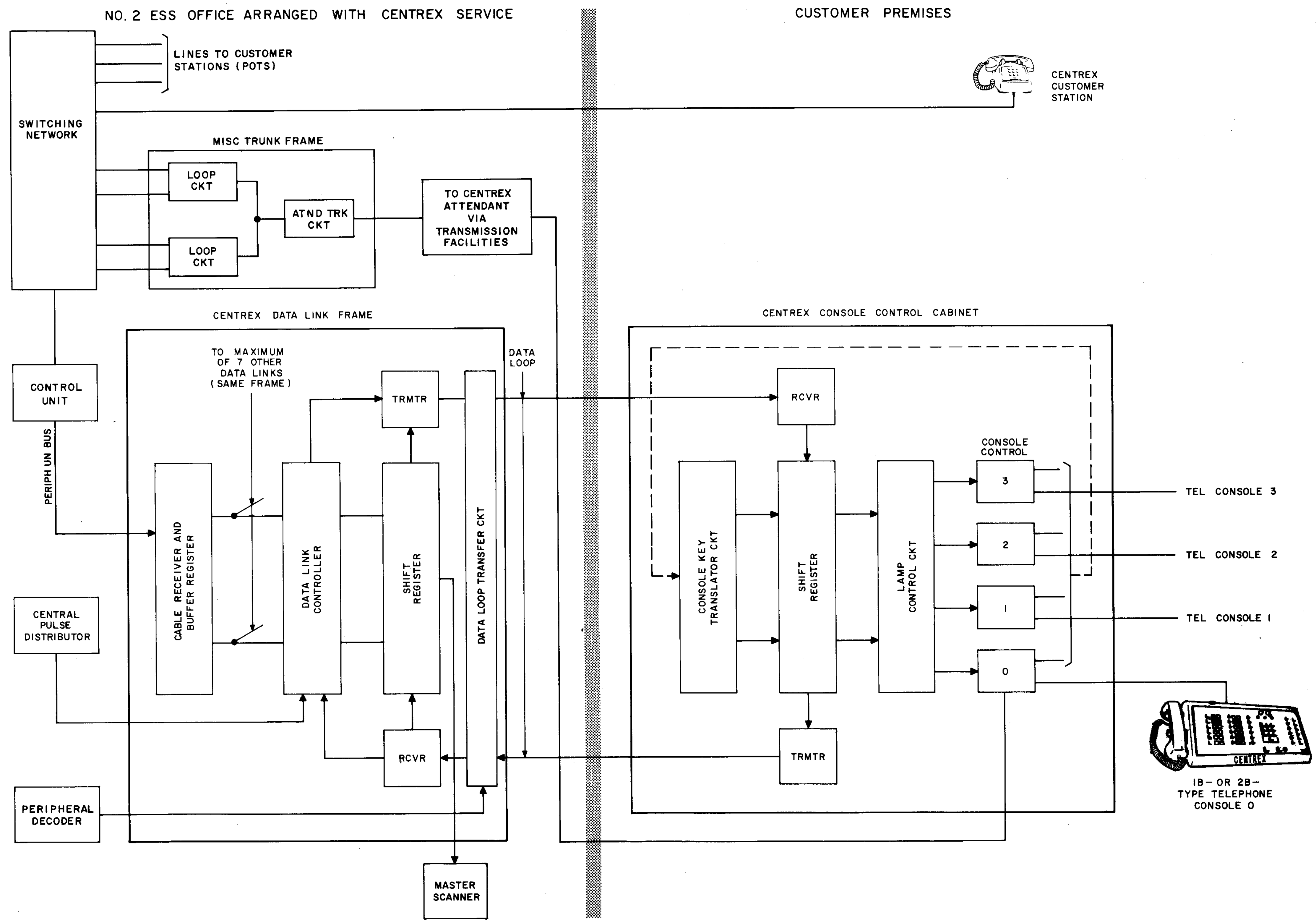


Fig. 2—Centrex Service—Block Diagram

DATA LOOP LINE SIGNAL TRANSMISSION

2.15 When a key signal 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. Data Loop Line Signal

2.16 The data loop line signal is constructed by a discontinuous frequency-shift keying method. The line signal is generated by switching between two oscillators, one operating at 700 Hz and the other operating at 2100 Hz. Fig. 3 is a block diagram of a basic data transmitter used for generating the line signal.

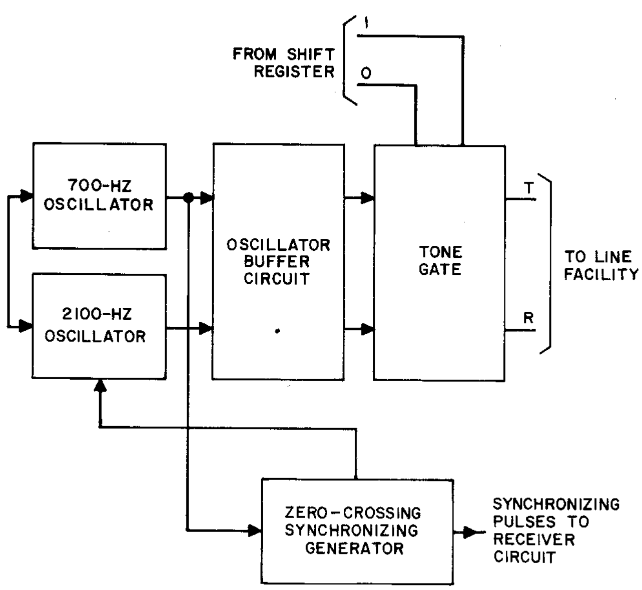


Fig. 3—Basic Data Transmitter

2.17 ***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.

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

2.19 ***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. Fig. 4 illustrates the output of the two oscillators and the points at which they are stopped and restarted in phase.

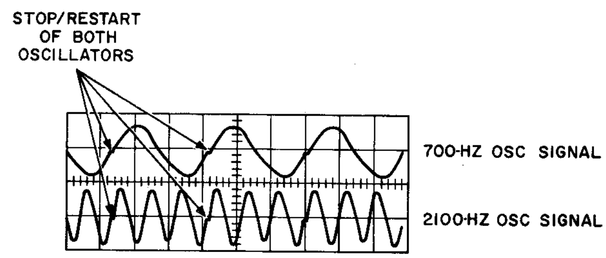


Fig. 4—Transmitter Oscillator Waveforms

2.20 Fig. 5 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.

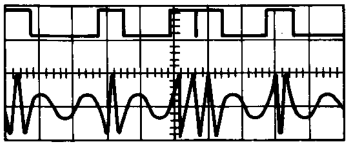


Fig. 5—DC Binary Signal and Resulting Line Signal

2.21 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. Data Recovery

2.22 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.

2.23 The data receivers 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 bit.

2.24 After switching to an active mode, the shift registers shift in synchronization with the line signal. The receivers interpret each following bit slot as data and temporarily store the received data (0 or 1) in the shift registers.

2.25 The oscillators in each data receiver are kept in synchronism and in phase with the incoming line signal by proper oscillator-to-line signal coupling. This permits synchronizing pulses and sampling pulses to be generated at the receiver. The synchronizing pulses are used to time the shifting of the receiving shift registers and to generate the sampling pulses used in sampling the center of each bit interval. Furthermore, word synchronism and bit synchronism permit the receiving circuitry to determine the end of a word. This is done by means of a bit counter which counts to 26, returns the receiver to an idle mode, and stops the shifting.

2.26 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. The data transmitter and receiver at the remote end of the data loop is basically a data repeater; the primary difference is that the remote unit transmits the contents of the local shift register back to the central office instead of the received data and it stores the received data in this same shift register.

2.27 Fig. 6 is a block diagram of a simplified data receiver at the remote end. The tone gate which ensures that data is transmitted in synchronism with the received data is included.

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

2.29 The oscillator buffer circuit amplifies the two local oscillator signals and furnishes the sampling pulses for the line signal sampler.

2.30 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 mark-space flip-flop. The flip-flop is reset by a reset pulse immediately following the sync pulse. The presence of a mark or space signal is detected, and at the end of each bit interval a mark or space pulse is present on the receiver output terminals. Each received mark and space signal is converted into a 0 or a 1 and is inserted into the lowest numbered cell of the shift register at the receiving end of the data loop.

2.31 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

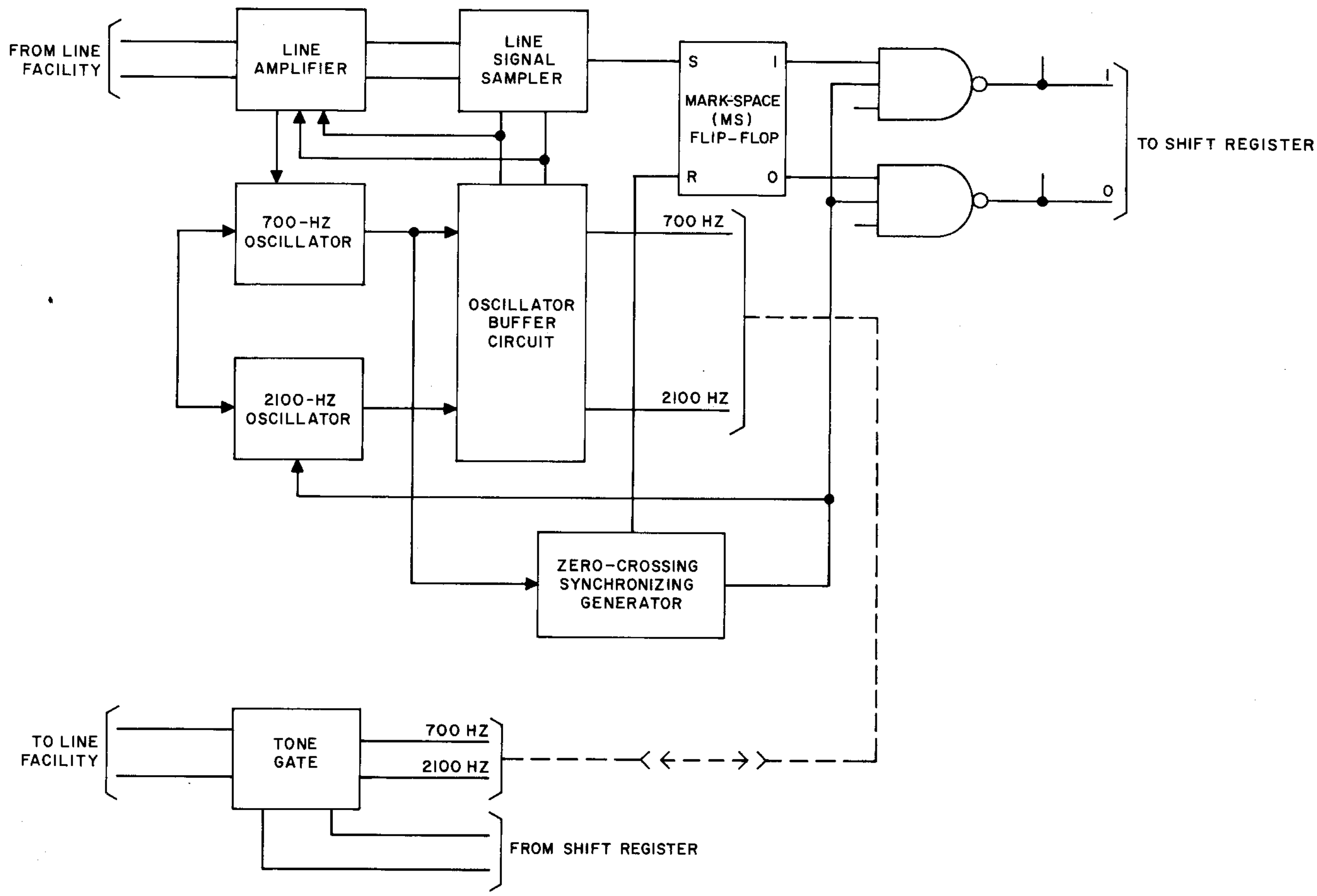


Fig. 6—Basic Data Receiver—Block Diagram

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.

3. CONSOLE LAMP CONTROL AND KEY SIGNALING

CONSOLE LAMP CONTROL

3.01 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 is 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.

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

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

(a) Bit 25 is the start (ST) bit which causes the receiver circuit to switch from an idle to an active mode.

(b) Bit 24 is primarily used in synchronizing the start of the two words that are present simultaneously on the two lines of the data loop. This bit absorbs the signal propagation time delay that exists between the central office and the remote end of the data loop. This bit is set to a 1 only when a transmission is initiated from the remote end.

CONSOLE LAMP CONTROL CODE FORMATS

3.04 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. 7. The code is composed of a 7-bit lamp control prefix and a 17-bit lamp state code format. The code shown is used to control the 1B-type consoles and is modified somewhat to control the 2B-type consoles (3.18 and 3.19).

A. Lamp Control Prefix

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

(a) Bit 22 is a signal present (SP) bit, or flag, which indicates to console control circuitry that the word being transmitted is a valid word. If bit 22 is not a 1, the word may be a maintenance order. (See 3.27.)

(b) Bits 20 and 21 form the console select code. This selects the particular one of the four possible consoles to which the lamp order is to be directed. (See CONSOLE SELECT CODE TABLE on Fig. 7.)

(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 on Fig. 7.)

(d) Bit 23 is a parity bit which is used to check odd parity over the 24-bit data word.

B. Lamp State Code Formats

3.06 The eight groups of lamps on the attendant consoles are controlled by three different lamp state code formats. These formats are shown in Fig. 7. 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 optional call indicator lamps. FORMAT B is used to control the common lamps and some of the trunk busy lamps. FORMAT C is used to control other trunk group busy lamps.

3.07 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 optional call indicator lamps, which is explained in 3.15 through 3.17.

3.08 A 0 in a particular lamp code position will cause that lamp to be extinguished when that code word is received at the remote Centrex installation.

Loop Lamp Format

3.09 If the lamp group select code (table on Fig. 7) 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 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 mark and a loop lamp group is specified, the SRC (source) lamp of the specified loop lamp group is operated to the steady (S) state.

3.10 The RLS (release) 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.

3.11 As shown in Fig. 7, some lamps may be operated to only one active state while others may be operated to one of several selected states. If no bit slots for a particular lamp contain a 1, the lamp is placed in the dark or inactive state.

LAMP CONTROL PREFIX

BIT NO.	23	22	21	20	19	18	17
	PARITY	SIGNAL PRESENT (SP)	CONSOLE SELECT CODE 1/4		LAMP GROUP SELECT CODE 1/8		

LAMP STATE CODE FORMAT

FORMAT A (LOOP LAMPS) — LAMP GROUP 0–5 LOOP LAMPS AND OPTIONAL CALL INDICATOR LAMPS

BIT NO.	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
LAMP	RLS	AUD	KEY		SOURCE				DESTINATION				CALL INDICATOR				
STATE	S	S	W	S	120	60	W	S	120	60	W	S	HOR. SELECT CODE 1/4		VERTICAL SELECT CODE 1/8		
CONFERENCE (SEE NOTE)				120	W	S											

FORMAT B (COMMON LAMPS) — LAMP GROUP 6 COMMON LAMPS

BIT NO.	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
LAMP	SPARE			TRUNK GROUP BUSY			NITE	EXCL SRC	EXCL DEST	POS BSY	CW		SPARE				
				11	10	9					W	S					

FORMAT C (TRUNK GROUP BUSY LAMPS) — LAMP GROUP 7 TRUNK GROUP BUSY LAMPS

BIT NO.	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
LAMP	SPARE			TRUNK GROUP BUSY									SPARE				
				8	7	6	5	4	3	2	1	0					

LAMP GROUP SELECT CODE TABLE

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

NOTE:

BITS 11, 12, AND 13 OF THIS FORMAT MAY BE OPTIONALLY ASSIGNED TO CONTROL CONFERENCE LAMPS.

LEGEND:

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

Fig. 7—Centrex Lamp Control Code Formats

Common Lamp Format

3.12 When the lamp group select code is binary 110 (lamp group 6), the common lamp format 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 common lamps.

Trunk Group Busy Lamp Format

3.13 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 here will also operate the selected lamp to the active state.

C. Lamp State Memory

3.14 A bipolar fereed is associated with each active lamp state. These ferreeds are mounted in 1 by 8 switches. Ten of these switches comprise a lamp state memory unit in which the active lamp states of a console are stored. Fig. 8 is a block diagram of a lamp state memory unit used to store the states of the console lamps. One lamp state memory is provided for each console. The operation of a ferreed 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.

D. Lamp State Changes

3.15 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 ferreeds 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 in the selected lamp group is operated. An all-0 code in a particular lamp code position causes that lamp to be extinguished when that particular code word is received at the remote Centrex location.

E. Call Indicator Lamp Control

3.16 The optional call indicator lamp field is also controlled by the loop lamp format (FORMAT A on Fig. 7). Bits 0 through 4 are assigned to their control. A maximum of 24 call indicator lamps per console can be controlled by these bits.

3.17 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 as long as the attendant is connected to the loop.

3.18 A separate memory unit (Fig. 9), consisting of three 1 by 8 ferreed switches, is provided for call indicator lamps. This memory unit has the capacity to store the states of up to 24 call indicator lamps. Ferreeds in the call indicator memory are controlled in four groups of six lamps each. Bits 0 through 2 of the loop lamp code format are arranged in a 1-out-of-8 vertical select code; bits 3 and 4, in a 1-out-of-4 horizontal select code in order to select the desired lamp. Binary codes 001 through 110 are used for the 1-out-of-8 vertical selection, and binary codes 00 through 11 are used for the 1-out-of-4 horizontal selection. For example, to select call indicator lamp 5, the vertical select code would be 010 and the horizonal select code would be 01. Each instruction to the call indicator memory requires a 2-step updating sequence. First, all six ferreeds in the selected call indicator group are released; then all ferreeds specified in the incoming code are operated. Binary code 111 (bits 0, 1, and 2) in the vertical select code is used to reset all ferreeds and therefore turn off all lamps in the group selected by bits 3 and 4. Binary code 000 in the vertical select code is used if the ferreeds in the call indicator memory are to be left unchanged.

F. Trunk Busy Memory

3.19 The control of 2B-type consoles requires additional trunk busy memory beyond that available in the basic lamp state memory units. This is provided by a special trunk busy memory (Fig. 10) which replaces one of the basic lamp state memory units in a console lamp control circuit.

3.20 The special trunk busy memory consists of three additional 1 by 8 ferreed switches equipped in memory unit position 1 of the first

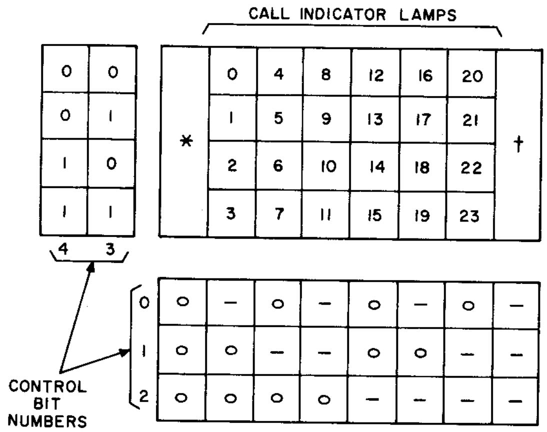
CONTROL BIT NUMBER	0	1	2	3	4	5	6	7
16	RELEASE S							
15	AUDIBLE S							
14	KEY 0 W	KEY 1 W	KEY 2 W	KEY 3 W	KEY 4 W	KEY 5 W		
13	KEY 0 S	KEY 1 S	KEY 2 S	KEY 3 S	KEY 4 S	KEY 5 S	TB* 11 S	TB 8 S
12	SRC 0 120	SRC 1 120	SRC 2 120	SRC 3 120	SRC 4 120	SRC 5 120	TB* 10 S	TB 7 S
11	SRC 0 60	SRC 1 60	SRC 2 60	SRC 3 60	SRC 4 60	SRC 5 60	TB* 9 S	TB 6 S
10	SRC 0 W	SRC 1 W	SRC 2 W	SRC 3 W	SRC 4 W	SRC 5 W	NITE S	TB 5 S
9	SRC 0 S	SRC 1 S	SRC 2 S	SRC 3 S	SRC 4 S	SRC 5 S	EXCL SRC S	TB 4 S
8	DEST 0 120	DEST 1 120	DEST 2 120	DEST 3 120	DEST 4 120	DEST 5 120	EXCL DEST S	TB 3 S
7	DEST 0 60	DEST 1 60	DEST 2 60	DEST 3 60	DEST 4 60	DEST 5 60	POS BSY S	TB 2 S
6	DEST 0 W	DEST 1 W	DEST 2 W	DEST 3 W	DEST 4 W	DEST 5 W	CW W	TB 1 S
5	DEST 0 S	DEST 1 S	DEST 2 S	DEST 3 S	DEST 4 S	DEST 5 S	CW S	TB 0 S
17	o	–	o	–	o	–	o	–
18	o	o	–	–	o	o	–	–
19	o	o	o	o	–	–	–	–
LAMP GROUP NUMBER	0	1	2	3	4	5	6	7
	LOOP LAMP MEMORY						COMMON LAMP MEMORY	TRUNK BUSY MEMORY

LEGEND:

- S – STEADY
- W – WINK
- D – DARK
- 60 – ONE FLASH PER SECOND
- 120 – TWO FLASHES PER SECOND
- CW – CALLS WAITING
- DEST – DESTINATION
- EXCL DEST – EXCLUDE DESTINATION
- EXCL SRC – EXCLUDE SOURCE
- POS BSY – POSITION BUSY
- SRC – SOURCE
- TB – TRUNK BUSY

* THESE THREE FERREEDS MAY BE OPTIONALLY ASSIGNED TO CONTROL CONFERENCE LAMPS.

Fig. 8—Lamp State Memory—Block Diagram



* 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 FERREEDS IN THE ROW SELECTED BY BITS 3 AND 4 WILL BE RESET AND THE ASSOCIATED CALL INDICATOR LAMPS WILL BE EXTINGUISHED.

Fig. 9—Call Indicator Lamp Memory

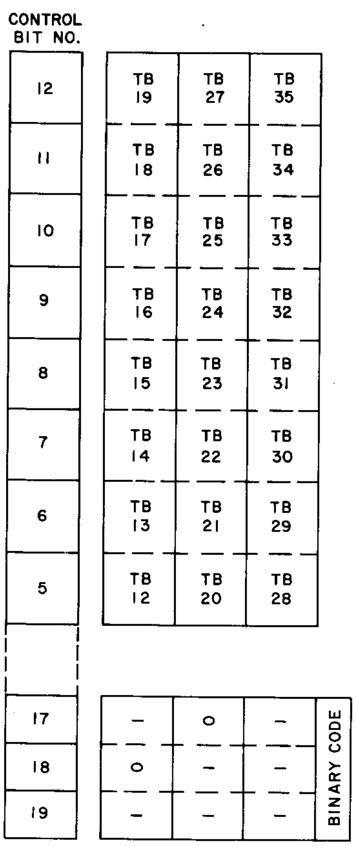


Fig. 10—Optional Trunk Busy Memory

lamp control circuit associated with a 2B-type console customer.

3.21 Fig. 11 is a block diagram of the acceptable combinations of basic lamp state memory units and trunk busy memory units which may be controlled by a single data loop circuit.

CONSOLE KEY FORMAT

3.22 Key information from the remote Centrex attendant consoles are transmitted to the No. 2 ESS 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 5-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.

3.23 Fig. 12 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 signal present bit to indicate to the central control 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 parity check bit.

3.24 The 31 possible codes which may be derived from a group of five bits are shown in Table A; 20 codes are presently used and 11 are 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.

3.25 ***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.

3.26 ***Console State Keys:*** Decimal codes 8 through 15 are used to encode those keys which affect the overall state of the console or which have other certain specialized functions. Some

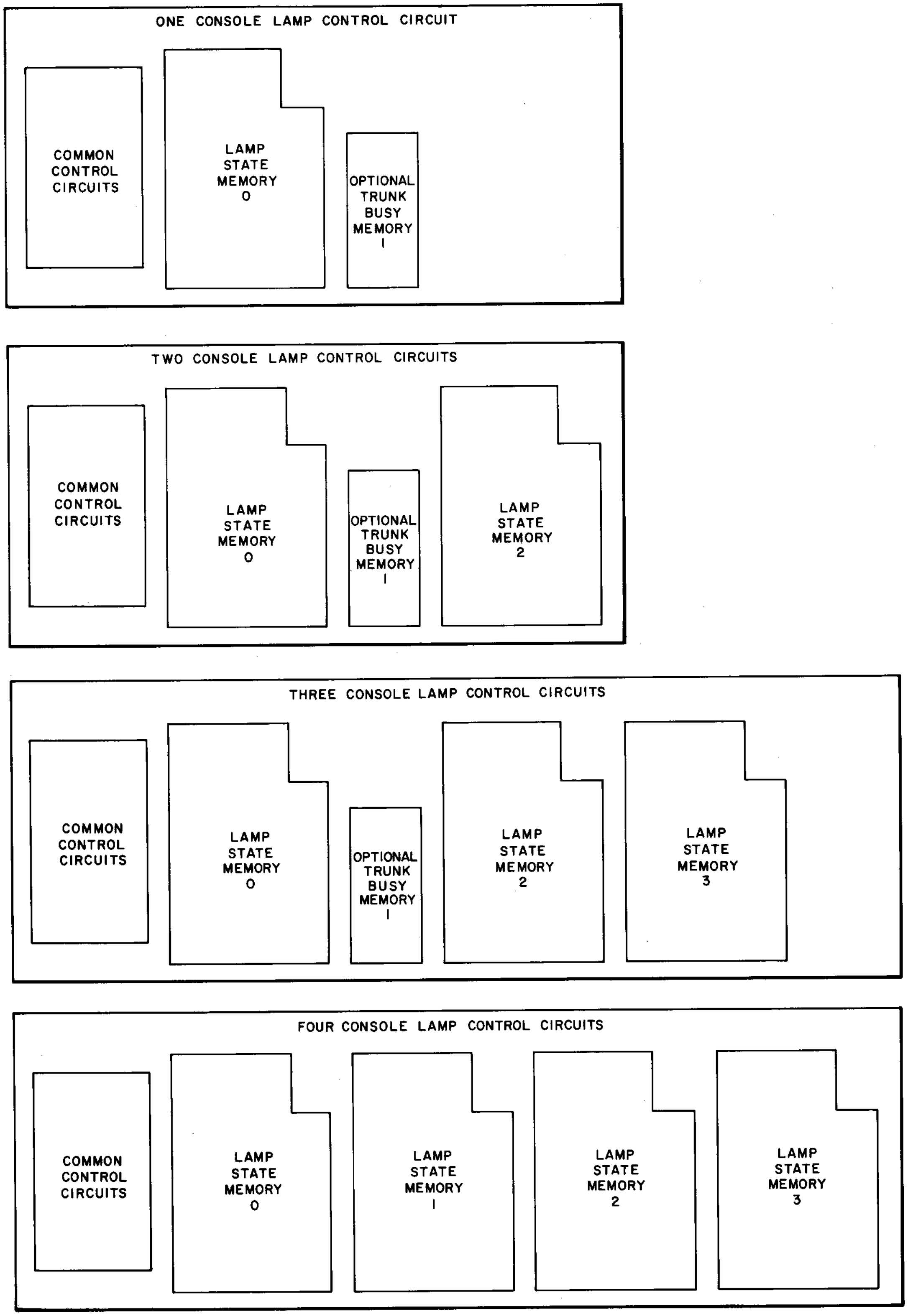


Fig. 11—Use of Optional Trunk Busy Memory

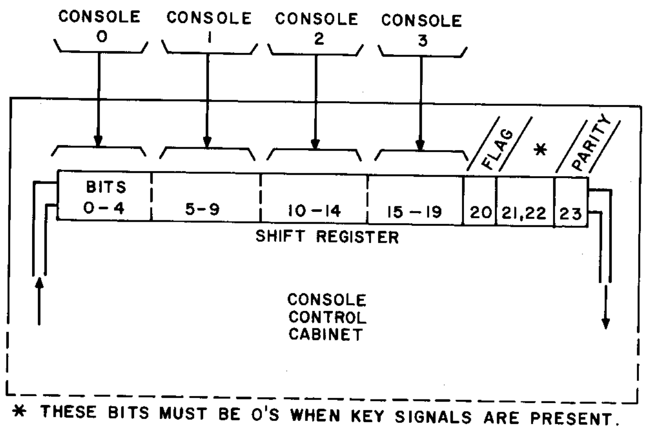


Fig. 12—Console Key Signal Bit Assignments

of these keys are provided on an optional basis. There are two spare codes available in this group.

3.27 ***Call Processing Keys:*** Decimal codes 16 through 31 are used to encode those keys which are used in the processing of a particular call. Some of these keys are also provided on an optional basis. There are seven spare codes available in this group. Decimal code 0 in any console key signal slot is used to indicate that no key signal was transmitted from that particular console.

MAINTENANCE ORDERS

3.28 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.

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

3.30 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.

3.31 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

(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.

3.32 When bits 22, 21, and 20 are either 0, 0, and 0 or 0, 0, and 1 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 the key signals of a new order.

4. CENTREX EQUIPMENT DESCRIPTION

4.01 In addition to attendant consoles and station telephones, two other specialized equipment units are required for Centrex operation. These are the No. 2 ESS Centrex data link frame (Fig. 13) located in the No. 2 ESS central office and a

TABLE A

CENTREX CONSOLE KEY CODES

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

* OPTIONAL

No. 2 Centrex console control cabinet (Fig. 14) 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 provides the interface between the consoles and the data loop.

NO. 2 ESS CENTREX DATA LINK FRAME

4.02 A Centrex data link frame (Fig. 13) is a standard 7-foot frame which can house up to eight data links and the associated common equipment. The frame may be partially equipped but link 0 must always be installed.

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

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

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

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

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

4.08 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

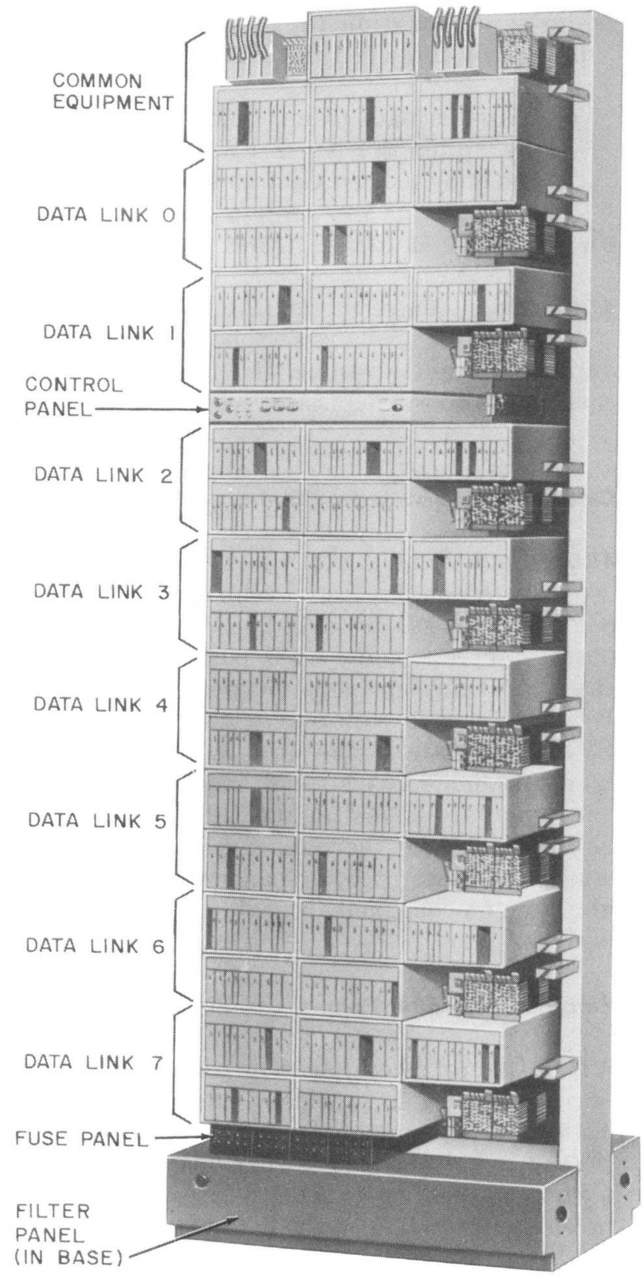


Fig. 13—No. 2 ESS Centrex Data Link Frame

(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 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 No. 2 ESS central office or the remotely located Centrex equipment.

DATA LINK INTERCONNECTIONS

4.09 Each Centrex data link frame is equipped with scan points, peripheral decoder points, duplicated central pulse distributor points, and connections to the duplicated peripheral unit bus.

Central Pulse Distributor Point

4.10 Each Centrex data link frame is provided with one duplicated central pulse distributor (CPD) point per data link. When pulsed in a positive direction, the CPD point gates data into the shift register from the peripheral unit bus. When pulsed in a negative direction this same CPD point causes the data link to go into the transmit mode. A special sequence of positive and negative pulses on the CPD point may also be used to place the data link in a test mode in which the shift register can be shifted one step at a time on command.

Peripheral Decoder Point

4.11 One peripheral decoder point is assigned per data link to provide a maintenance function. This point is a part of the data loop transfer circuit (Fig. 2). It is used to switch the data loop from a normal condition to a local loop condition to aid in isolating troubles in the data loop circuitry.

Fuse Alarm Scan Point

4.12 The data link frames share a common fuse alarm scan point with several other types of peripheral units. These scan points are interrogated at two second intervals. If a data link or the common equipment on a data link frame should develop a power failure due to a blown fuse, this scan point changes state, an alarm is sounded, and a TTY message is printed out.

4.13 The data link frame is also equipped with an alarm retire key.

Directed Scan Points

4.14 Two adjacent rows of directed scan points are provided. These scan points permit the ESS to read the entire 26-bit shift register as well as the unit busy and transmit scan points and a special scan point for diagnostic purposes. (The latter scan point is saturated when the bit counter reaches state 26.)

4.15 Each Centrex data link is equipped with four additional scan points, the key-signal present (KSP), all-seems-well (ASW), power (PWR), and no-signal (NS) scan points. These four points, for each of the eight data links on one frame, are located in two adjacent rows of the scanner. They are interrogated once every base level scan by the attendant monitor program.

Key Signal Present Scan Point

4.16 The KSP scan point is a scan point which is saturated when a key signal is received from an attendant console at the remote Centrex location. Before any lamp data is transmitted from the No. 2 ESS central office to the remote location, this scan point is examined to determine whether or not there is a key signal stored in the data register. If a key signal is present, lamp data transmission is delayed until the key signal has been read out. Key signal present scan points are scanned once per base level loop.

All-Seems-Well Scan Point

4.17 The ASW scan point is used to detect errors in transmission. Whenever a valid parity order is detected by the equipment on the customer's premises, an all-seems-well signal is returned to the central office. This signal is used to change the state of saturation of the all-seems-well scan point which is interrogated by the program after lamp data transmission.

4.18 The PWR scan point is used to detect a power-off condition on the data link circuit in the central office. With power on, the scan point is saturated. Any interruption in power due to a blown fuse or operation of the power-off key causes the scan point to be unsaturated.

4.19 The NS scan point is used to detect interruption of the tone on the data link from the remote end. Normally this scan point is saturated when either the 700 or 2100 Hz tone is present on the link. If the tone is absent due to power off at the remote end or a broken cable, the scan point becomes unsaturated.

NO. 2 ESS CENTREX CONSOLE CONTROL CABINET

4.20 Each Centrex customer is provied access to a Centrex console control cabinet (Fig. 14). This cabinet provides the interface between the data loop and the attendant consoles. One console control cabinet is capable of controlling up to four of the 1B- or 2B-type attendant telephone consoles. For 2B-type attendant telephone console installations, the first such cabinet may optionally be equipped to handle three 2B-type consoles and one trunk busy memory unit. Additional cabinets belonging to the same customer group can be equipped to handle four 2B-type consoles.

4.21 A Centrex console control cabinet may be shared by different Centrex customer groups under the restrictions covered in Section 966-202-100.

4.22 A 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 Equipment Unit

Power Supply (One Per Slide)

Trunk Busy Memory Unit (For 2B-Type Consoles Only)

ADDED EQUIPMENT PER CONSOLE

Console Control Unit

4.23 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 state memory

(i) Contains a pulser circuit for controlling ferreeds in the lamp state memory.

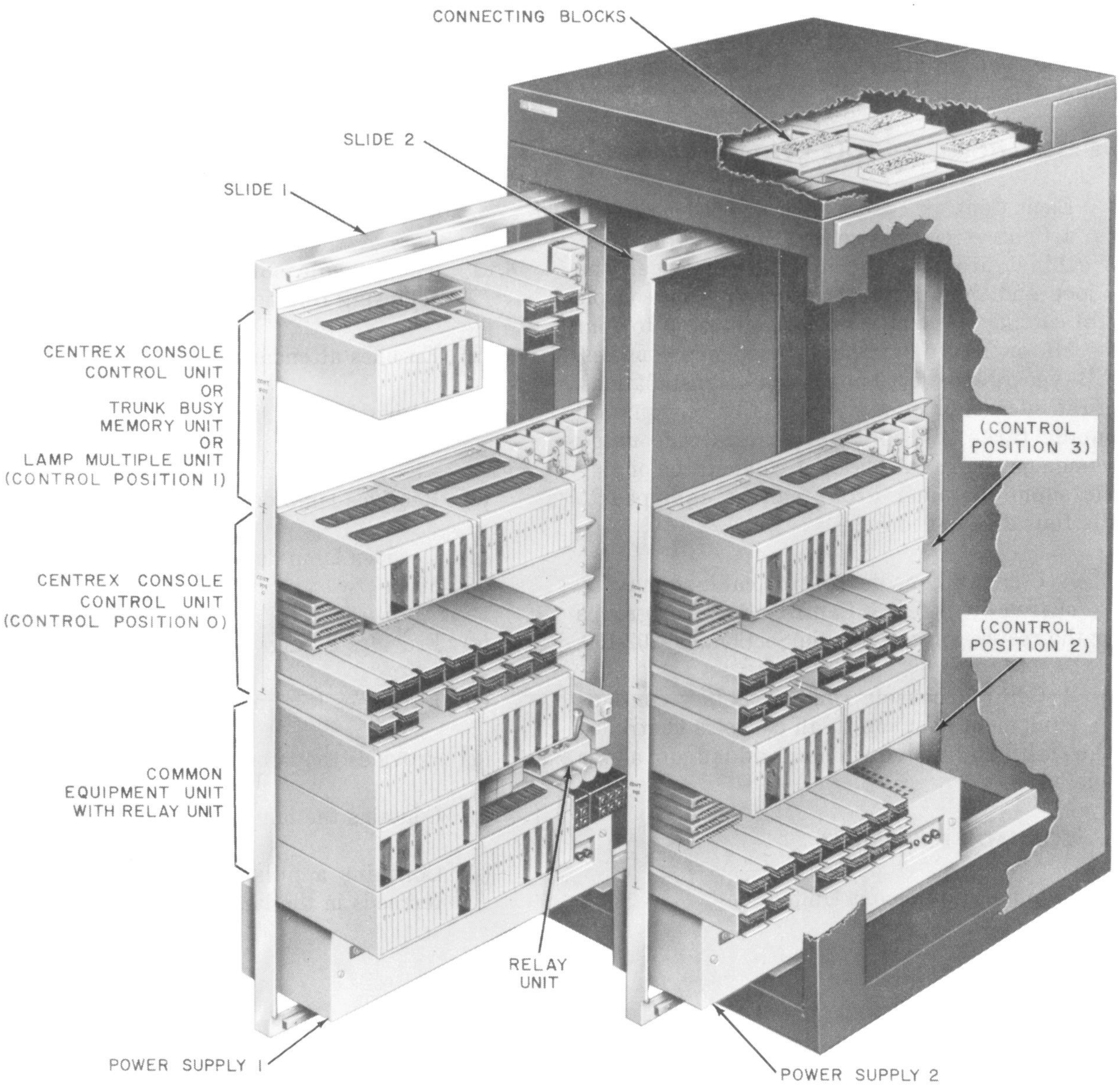


Fig. 14—No. 2 ESS Centrex Console Control Cabinet