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IBM 2790 Data Communication System Component Description

The IBM 2790 Data Communication System is a two-way, in-plant communication and production reporting system. This publication describes the units of the 2790 system, along with its capabilities, features, and applications. Information about the following units is included:

IBM 2715 Transmission Control Unit
IBM 2791 Area Station
IBM 2793 Area Station
IBM 2795 Data Entry Unit
IBM 2796 Data Entry Unit

The following IBM publications are recommended for use with this manual:

IBM 0357/1030/2790 Badge Specifications, Form A21-9028-1
IBM System/360 Bibliography, Form A22-6822
IBM Teleprocessing Bibliography, Form A24-3089
IBM 2740 Communications Terminal: Component Description, Form A24-3403
IBM 2740/2741 Communications Terminal–Operator's Guide, Form A27-3001
IBM System/360 OS/DOS BTAM Planning for 2790 Data Communication System Support, Form C30-1004
IBM System/360 OS/DOS Planning for Improved BTAM Support of Remote BSC Stations, Form C30-1005

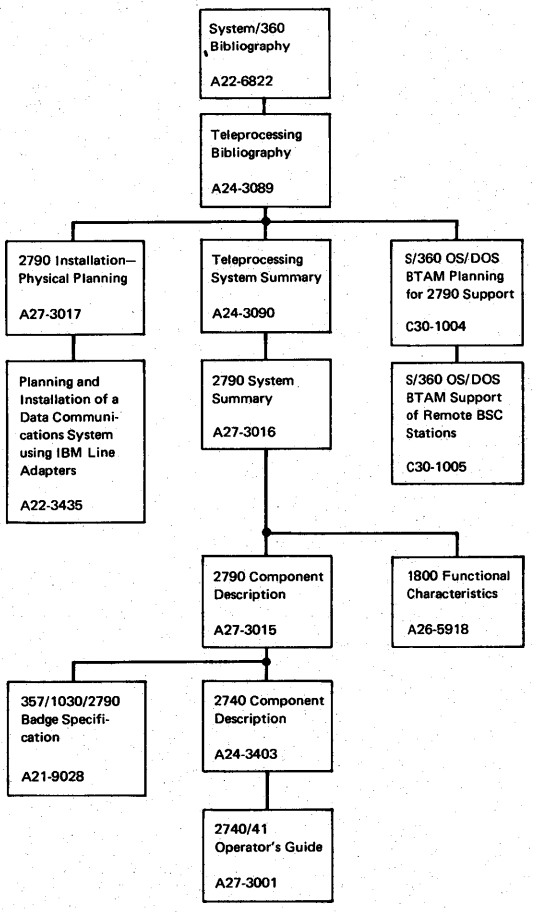
Preface

This manual is written as a comprehensive reference manual about the IBM 2715, 2791, 2793, 2795, and 2796 units of the IBM 2790 system. For information about the IBM 1800 system used as a system controller, see *IBM 1800 Data Acquisition and Control System Functional Characteristics,* Form A26-5918-7 (with TNL N26-0241), or later edition.

For information about programming the System/360 to operate with the 2790 system, see *IBM System/360 OS/DOS BTAM Planning for 2790 Data Communication System Support,* Form C30-1004, and *IBM System/360 OS/DOS for Improved BTAM Support of Remote BSC Stations,* Form C30-1005.

Manuals related to this publication are referenced in the following Publications Availability Guide:

2790 SRL Publications Availability Guide



First Edition (July 1969)

Changes are periodically made to the specifications herein; any such changes will be reported in subsequent revisions or Technical Newsletters.

This manual has been prepared by the IBM Systems Development Division, Product Publications, Department 860, P. O. Box 12275, Research Triangle Park, North Carolina 27709. A form for readers' comments is provided at the back of this manual. If the form has been removed, comments may be sent to the above address.

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Illustrations

Manufacturing facility management's need to reduce operating cost through more immediate awareness of the status of plant operations is increasing. The IBM 2790 Data Communication System (Figure 1) is a two-way, in-house data communication and production reporting system. It is a highly flexible two-way data collection system designed to meet the expanding requirements for in-plant data communications and production monitoring. The 2790 system provides for rapid transfer of information from various Area Stations (AS's) and Data Entry Units (DEU's) to a central computer for recording, processing, and analyzing.

The AS's accept alphameric data from standard 80-column punched cards; they accept numeric data from punched identification badges and manual entry units. The DEU's accept ten positions of numeric data from punched cards or identification badges; they also accept information from manual entry units. The AS and DEU information is transmitted by Area Stations to a Transmission Control Unit (system controller). The Transmission Control Unit (TCU) communicates with an IBM System/360 via a local (Multiplexor Channel) or a remote (Binary Synchronous) attachment.

Either an IBM 2715 Transmission Control Unit or an IBM 1800 Data Acquisition and Control System with an 1800/2790 Adapter may be used as the system controller for the 2790 system. For further information about the IBM 1800 performing as the system controller, see *IBM 1800 Data Acquisition and Control System Functional Characteristics,* Form A26-5918-7, with TNL N26-0241, or a later version.

The IBM 2790 system configuration consists of a central processor (IBM System/360), a Transmission Control Unit (IBM 2715), Area Stations (IBM 2791 or IBM 2793), Data Entry Units (IBM 2795 or IBM 2796), and other I/O devices. The 2790 system configuration consists of as many as 100 AS's connected in a loop configuration, starting and ending at the TCU. Adjacent units of the 2790 Data Communication System are connected by a twisted-pair cable. For example, the units may be installed at intervals of 1000 feet by using #22 AWG twisted-pair wire (Figure 2). DEU's can be attached to an AS. Connection between a DEU and an AS is established by a two-wire communications line. No locally supplied power is required at the 2795 and 2796 Data Entry Units.

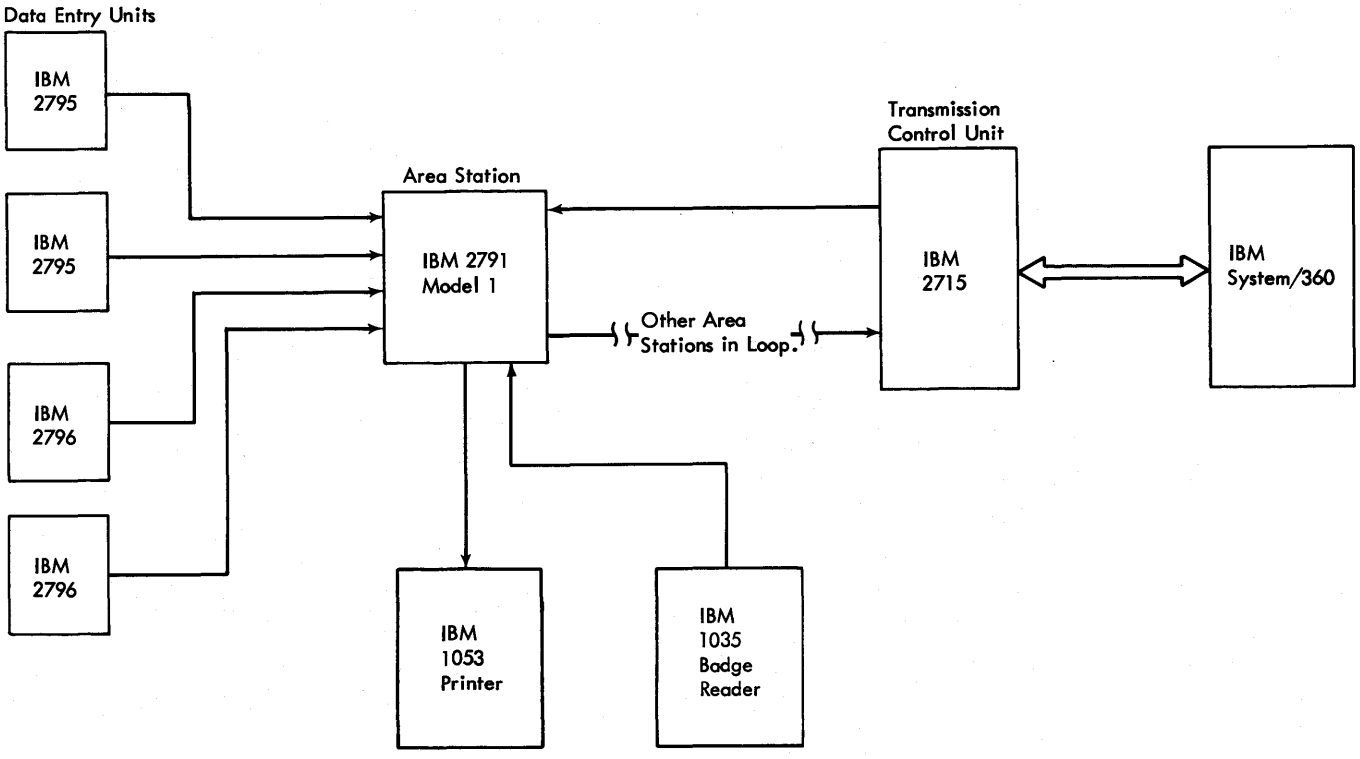


Figure 1. A Typical IBM 2790 Data Communication System

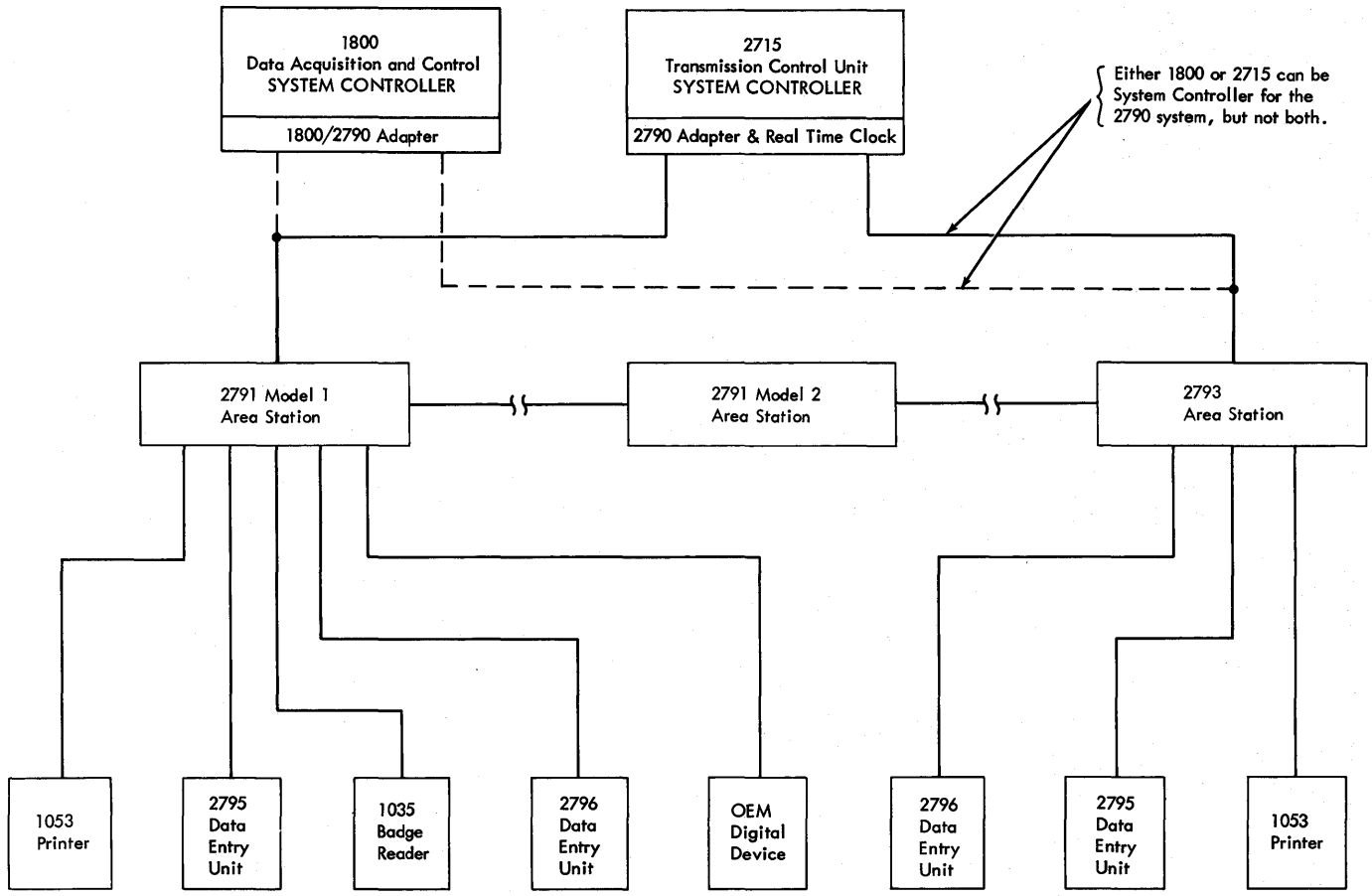


Figure 2. IBM 2790 Configuration

The IBM 2790 Data Communication System supplies the latest information to the data processing center, thus diminishing the time gap between the organization of data and its availability for use.
Some of the applications of the 2790 system are:

Product Control
Material Control
Labor Control
Tool Control
Quality Control
Attendance Recording

The advantages of the 2790 system over previous data collection systems are:

1. The 2790 system is capable of high-speed data transmission (approximately 900 characters per second partitioned among the active terminals on the loop).
2. Guidance lights on the 2791 Area Station inform the operator of the next operation the system controller expects.
3. The 2790 system has the ability to control a large number of devices (up to 100 Area Stations, 1024 Data Entry Units, 100 IBM 1053 Printers, and 300 IBM 1035 Badge Readers).
4. The DEU's are inexpensive, can be attached to the AS by a two-wire communications line, and require no locally supplied power.

TYPICAL APPLICATIONS

The following discussion illustrates a 2790 system performing typical applications in a manufacturing plant.

Attendance Recording

The IBM 2790 system may be configured in two ways for attendance recording. Where high-rate attendance recording is required, the IBM 2791 with either the resident badge reader or remote IBM 1035 may be used to provide a record of the employee's man number. (The system automatically inserts the time and location into each transaction.)

In other applications (with lower required entry rates), the IBM 2795 or 2796 may be used.

Material Control

When raw material, purchased parts, or assemblies are withdrawn from stock, the IBM 2790 system provides an up-to-date record of material on hand. A 2795 DEU or 2796 DEU is installed in each stock room. A prepunched ten-column card or badge containing a file-record identifier for such information as material, part number, quantity, and stock-room location is inserted in the DEU. Ten columns of numeric data together with variable fields are transmitted to the data processing system, updating the parts inventory.

Production Control

The control of production requires management to know the status of work flow through the various steps of the manufacturing process. Data Entry Units installed at appropriate machine locations and checkpoints can be used to record dynamically the time spent on each operation, work pile-ups, quantity of parts flow, etc. This data recorded on the system is available to management for checking the progress of an individual order through the shop, and work completed for each step of the operation. It can also be used to determine the need for additional capacity at specific steps of the operation, or the need to shift work load to new areas. Information on the status of shop loads can be used in determining standard lead times for production scheduling.

The 2795 DEU and 2796 DEU (designed for ruggedness and simplicity) are operator-oriented devices for use on the factory floor. The 2795 DEU is a small mechanical unit (approximately 7 inches by 10 inches) containing a badge-card reader, two 10-position rotary switches, a phone-jack, an error indicator/reset button, an entry flag, and a request lever, all packaged in a single compact unit for bench or wall mounting (Figure 3).

The 2796 DEU contains all the functions of the 2795 DEU plus two additional 10-position rotary switches, four rocker-thumbwheel switches, and a monitor key (Figure 4).

The DEU is connected to the AS by a customer-furnished two-wire communications line, and controlled by the AS.

2795 DATA ENTRY UNIT

The 2795 DEU includes the following features.

Badge-Card Reader

A badge-card reader located on the top of the DEU reads ten digits of numeric information punched as shown in Figure 5.

The badge-card reader can read ten columns of numeric data from either end of a punched card or ten columns of numeric data from a 357/1030 style badge.

The DEU's read 0 through 9 punches and blanks. If no 0-9 punch is in a data column, the DEU reads that column as a blank. If a data column is double punched, the DEU reads the punch closest to the 9-edge and ignores the other punches in the column.

This numeric information is provided by the following combinations of punches in a standard 80-column card, or in the equivalent positions (Figure 5) of an identification badge.

80 Column Card

Numeric Data	*Registration Punches*
Col 71-80–Card fed 80 column end first, face towards operator	Col 66–"9" and "11" punches
Col 10-1–Card fed column 1 end first, face of card away from operator	Col 15–"9" and "11" punches

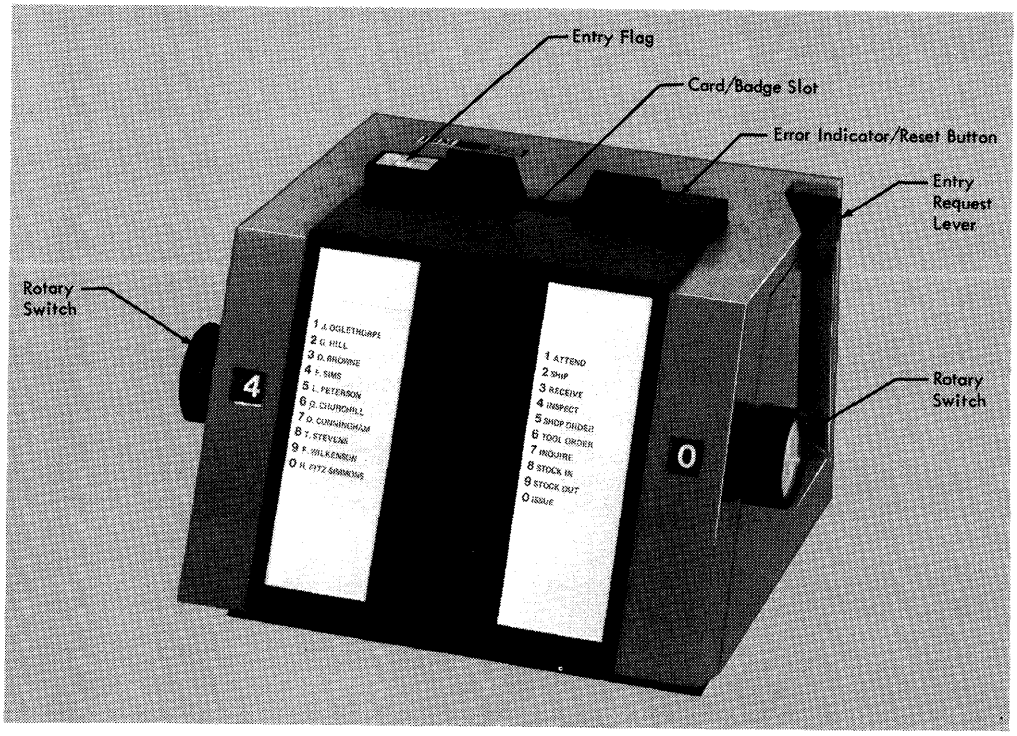


Figure 3. IBM 2795 Data Entry Unit

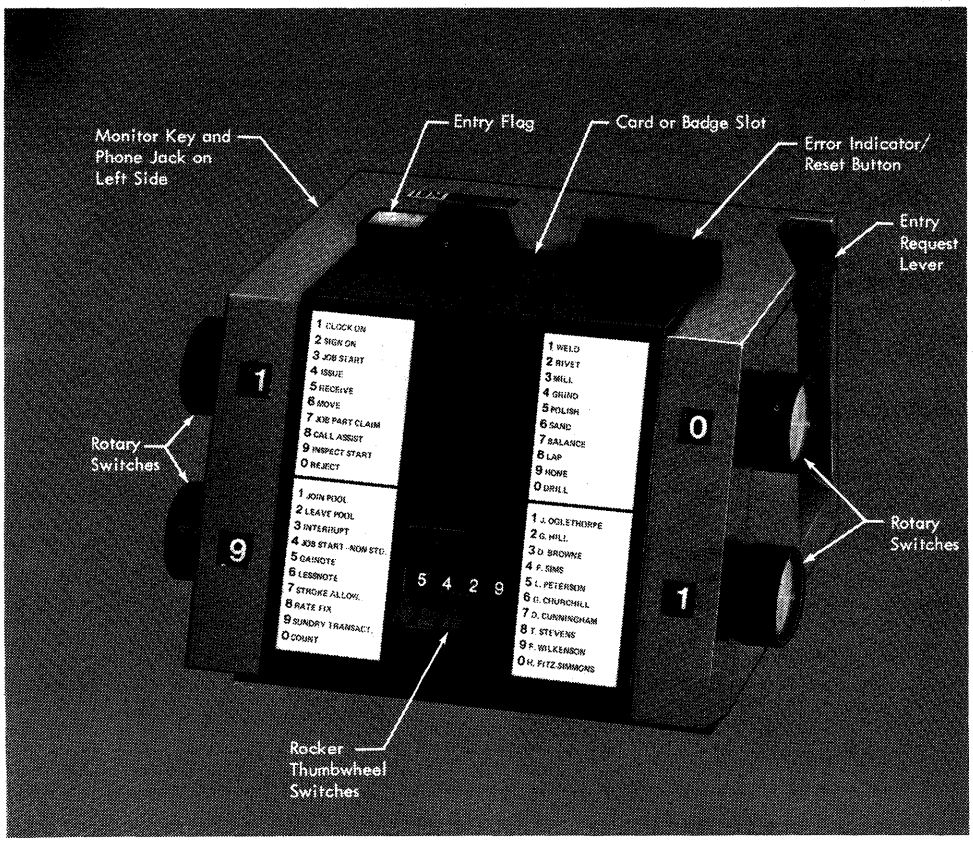


Figure 4. IBM 2796 Data Entry Unit

Identification Badge

Numeric Data	*Registration Punches*
IBM 013 Badge Punch columns 13 through 22	IBM 013 Badge Punch column 8—"9" and "11" punches

2795 Data Entry

A 2795 data entry as assembled in the 2715 TCU consist of 12 digits of data plus transaction-header information (see Figure 6):

Digit 1—Type of DEU.
Digit 2—Setting of right-hand rotary switch.
Digits 3 through 12—Contents of card or badge. Blanks are transmitted for these positions if a card or badge is not entered as part of the data entry.

Note: Such information as device address, Area Station address, and left-hand rotary switch setting are also transmitted to the system controller. The system controller constructs a transaction header from this information and prefixes it to the transaction containing the data entry.

Selection Switch

A 10-position rotary switch is located on each side of the DEU frame. These switches are capable of transmitting numeric digits 0 through 9 to indicate such things as status, names, or numbers. The transmitted digits are displayed through the indicator openings in the front panel of the DEU. The nomenclature designation of these switches is optional except for digits 0X (X is any right-hand switch setting), which are reserved for clearing and testing the operation of the unit.

A holder is provided on the front cover of the Data Entry Unit for insertion of sheets to indicate the switch nomenclature or to provide operator instructions.

Phone Jack

A telephone jack on the left cover is provided for the use of a portable telephone handset for voice communication via a customer-provided voice-communication network.

Error Indicator/Reset Button

In case of an erroneous transmission, an error indicator/reset button on the top of the Data Entry Unit snaps into view;

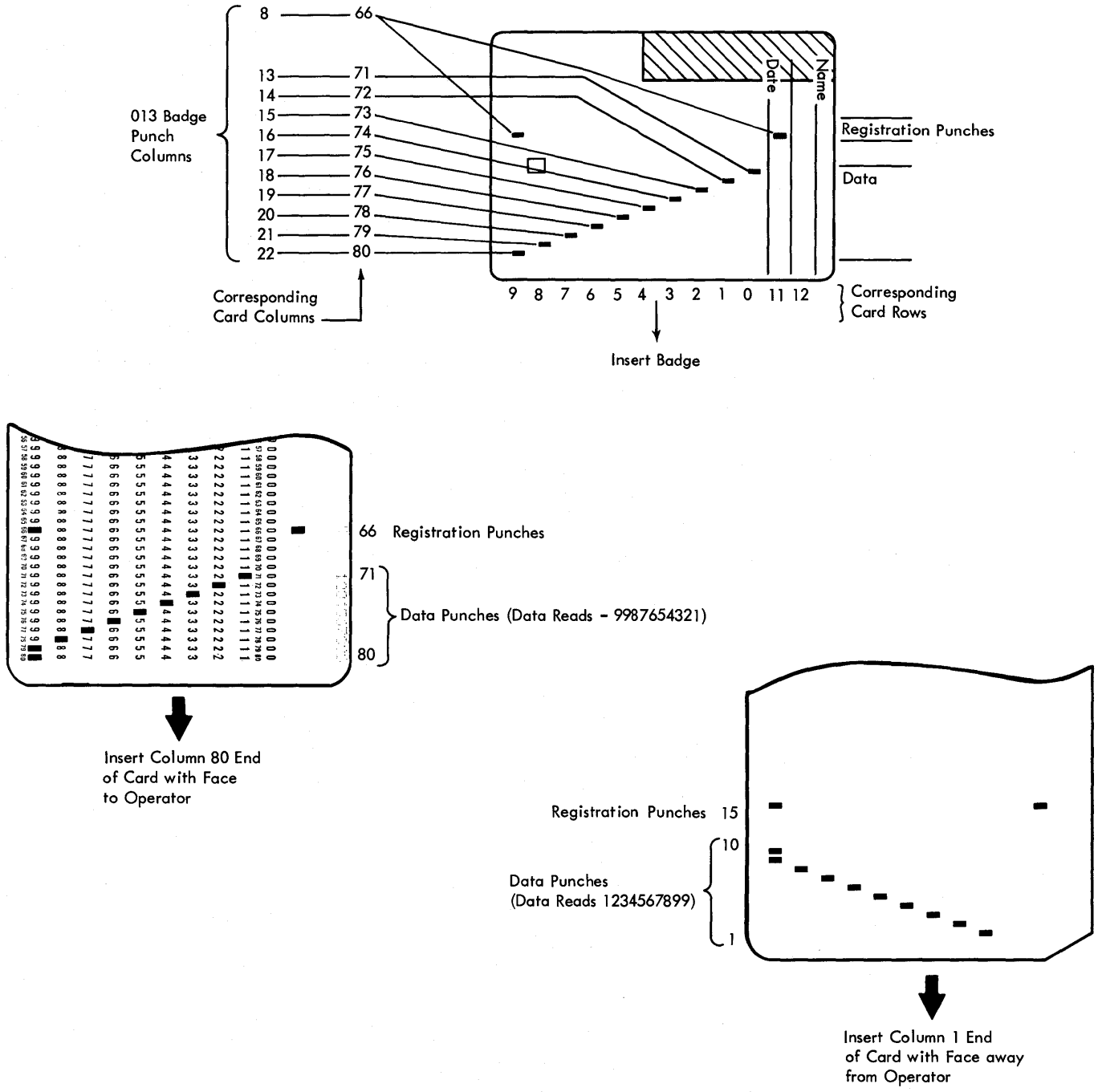


Figure 5. Badge and 80-Column Card Punch Information

the request lever remains in the latched position; and the card or badge cannot be removed from the reader. This signals the operator that retransmission of the record is required. The operator resets the terminal by pressing the error indicator/reset button. The indicator/reset button is also used to reset the terminal whenever a reset is required.

Request Lever

Pushing down the request lever initiates a request to the Area Station for service and furnishes the motive power required to read the information entered by the operator. The operator initiates the request for service by positioning the lever in the latched position, which is indicated by "green" in the entry flag window.

The request lever cannot be fully positioned if the card or badge is improperly registered. When the request lever is latched in the request position, the card or badge cannot be removed from the machine. When the complete transaction has been received by the system controller, the request lever is returned automatically to its start position and the entry

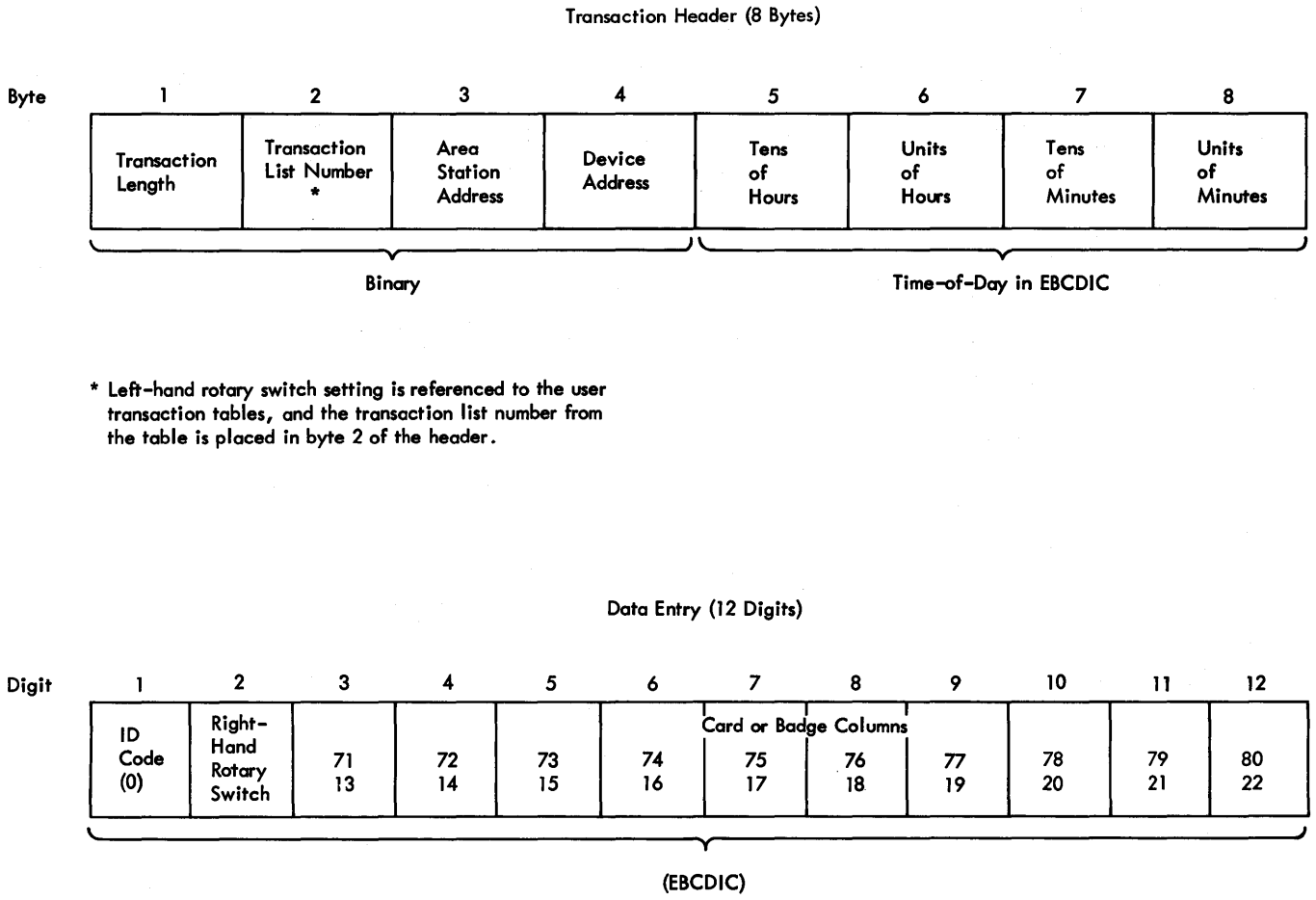


Figure 6. 2795 Data Entry as Assembled in the 2715 TCU

flag is returned to its black position (ready for the next entry).

2796 DATA ENTRY UNIT

The 2796 contains all of the features of the 2795 plus three additional features:

Rotary Switches. Two additional ten-position rotary switches are provided, for a total of four switches.

Rocker-Thumbwheel Switches. Four rocker-thumbwheel switches located on the front cover permit manual entry of four digits of numeric data.

Monitor Key. The monitor key located on the left cover allows supervisory personnel to add an approval to a given transaction. Approval is accomplished through the transmission of a unique character that is activated by using one of two keys in a three-position lock switch. One key will turn only clockwise while the other key will turn only counterclockwise. Both keys must be returned to the center position to be removed. With the lock turned clockwise, a 1 is transmitted; in the center, a 2 is transmitted; and turned counterclockwise, a 3 is transmitted.

2796 Data Entry

A 2796 data entry as assembled in the 2715 TCU consists of 18 digits of data plus transaction-header information (see Figure 7):

Digit 1—Monitor key setting and Type of DEU.
Digit 2—Setting of upper right-hand rotary switch.
Digits 3 through 12—Contents of card or badge. Blanks are transmitted for these positions if a card or badge is not entered as part of the data entry.
Digit 13—Setting of lower left-hand rotary switch.
Digit 14—Setting of lower right-hand rotary switch.
Digit 15 through 18—Setting of four rocker-thumbwheel switches.

Note: Such information as device address, Area Station address, and upper left-hand rotary switch setting are also transmitted to the system controller. The system controller constructs a transaction header from this information and prefixes it to the transaction containing the data entry.

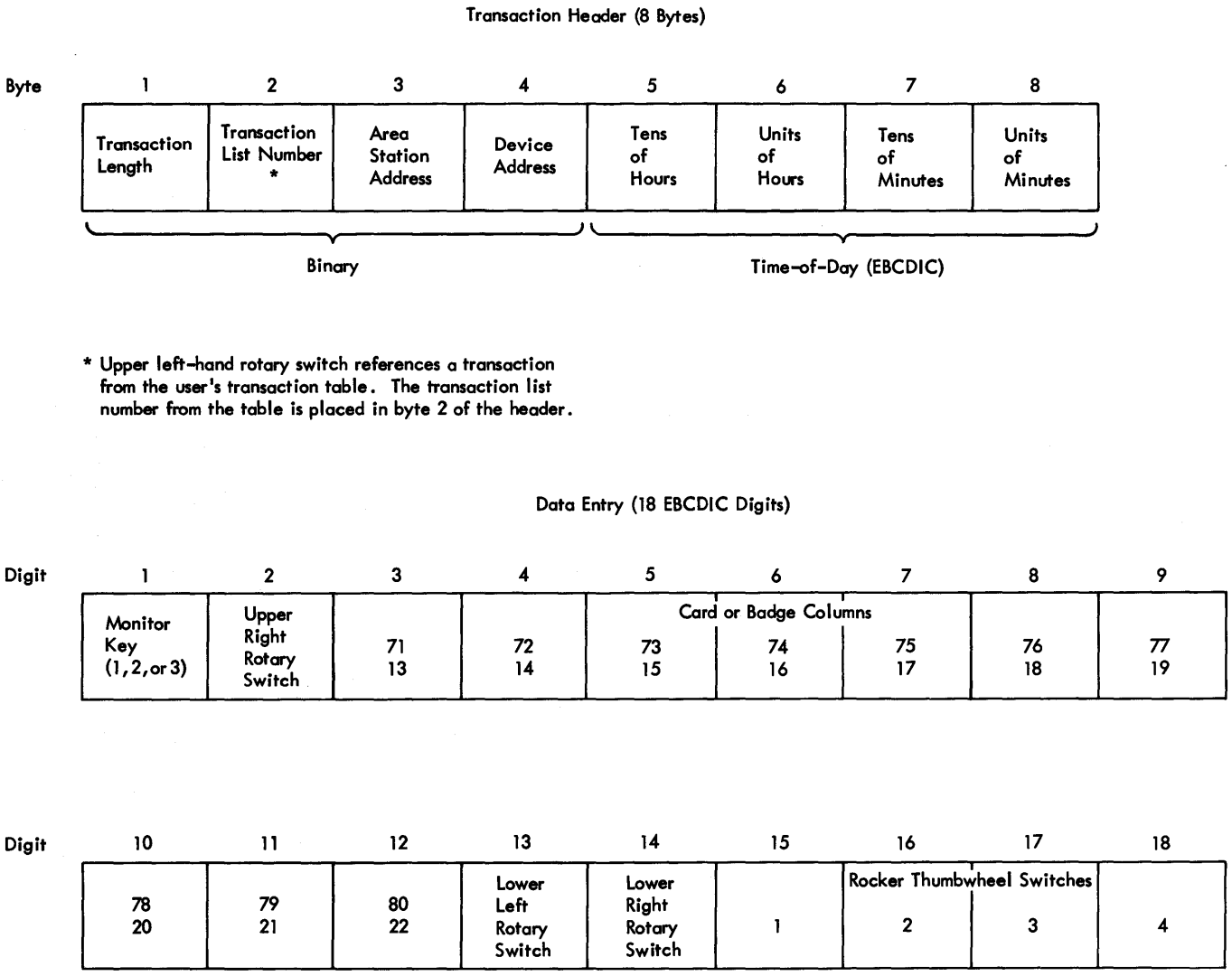


Figure 7. 2796 Data Entry as Assembled in the 2715 TCU

DATA ENTRY UNIT TRANSACTION SELECTION

The combination of the Area Station's address, the Data Entry Unit's address, and the setting of the left-hand (upper left-hand for 2796) rotary switch selects the proper transaction list from the user's transaction-list table. The transaction list provides the controls to process the data entry.

All DEU's assigned to a given AS must use the same transaction list for corresponding rotary-switch settings (transaction code). Therefore, if both 2795's and 2796's are attached to a given Area Station, the corresponding transaction number selected on either the 2795 or 2796 references the same transaction list and is subject to the same control steps and routing.

Transaction Expansion

The DEU transaction selection may be expanded beyond the nine transaction codes on the left-hand rotary switch by using "transaction expansion." Transaction expansion allows the right-hand (upper right-hand for 2796) rotary switch to supply a second digit to the transaction code, allowing a maximum selection of 81 different transactions.

DEU transactions selected by transaction expansion must be single data entry transactions.

Transaction expansion is a prerequisite for message routing.

Transaction expansion is activated when the programmer defines the transaction codes in the transaction group (TGROUP) macro. See *IBM System/360 OS,DOS BTAM Planning for IBM 2790 Data Communication System Support,* C30-1004.

The Area Station is designed to serve as a primary communication terminal for a work area or factory floor. The basic functions of the AS are to: (1) accept data from the various input devices and transmit it to the Transmission Control Unit, and (2) accept data from the TCU and forward it to output devices. Two types of Area Stations, the IBM 2791 and IBM 2793, are available:

IBM 2791 (Model 1 and Model 2)	*IBM 2793*
1000-foot cable transmission capability (#22 AWG twisted pair)*	1000-foot cable transmission capability (#22 AWG twisted pair)*
Card reader–80-column	2795/2796 Attachment basic (attachment for first 8 DEU's)
Badge reader–10-column	
9 transaction selection keys	
12-key manual entry	
6 digits of display	
Time-of-day display (when manual-entry digits are not being displayed)	
Operator guidance	
Monitor key	
Features (Model 1 only):	*Features*
IBM 1035 Badge Reader attachment	2795/2796 Attachment–additional (3 maximum)
IBM 1053 Printer attachment	IBM 1053 Printer attachment
Digital device read-in (OEM)	
2795/2796 Attachment–basic	
2795/2796 Attachment–additional (3 maximum)	

*Refer to the *IBM 2790 Data Communication System Installation Manual–Physical Planning,* Form A27-3017, for maximum length of other wire sizes.

2791 AREA STATION

The 2791 Area Station comes in two models. The 2791 Model 1 is a combination of an input station and a controller for external devices. The 2791 Model 2 is an input station only; it does not control external devices. The 2791 is either bench- or shelf-mounted. As many as 100 AS's may be connected to a Transmission Control Unit by means of a high-speed (about 500,000 bits per second) two-wire transmission line. The Area Stations are connected serially, starting and terminating at the TCU in a serial loop configuration.

Area Station Nomenclature

Commonly used words with a specific meaning for the 2790 system are:

Data Entry. A single block of data entered by an operator at the Area Station using a single data-entry device. For the card reader, a data entry consists of a card; for the badge reader, a badge; and for the numeric keyboard, one to six digits.

The maximum-length data entry is 81 characters–consisting of 80 columns from the card reader, plus one EBCDIC (Extended Binary Coded Decimal Interchange Code) character used to record the setting of the Monitor key. This information character is included with every data entry from resident card reader, badge reader, manual entry device, and Digital Device Read-In feature. It is not included with data entries from 1035 Badge Readers.

Note: Such information as device address, Area Station address, and transaction key setting are also transmitted to the system controller. The system controller constructs a transaction header from this information and prefixes it to the transaction containing the data entry.

Transaction. A user-defined series of data entries which will be collected by the system controller and may be routed to the processor and/or other output devices. A transaction is entered by the Area Station operator under guidance from the system controller.

Transaction Code Character. An 8-bit hexadecimal data byte transmitted from the Area Station to the system controller indicating which transaction key has been depressed by the operator, and other control conditions.

Transaction Expansion. The capability of selecting one of 81 possible transactions using a normal transaction code followed by an expansion digit. The expansion digit is the second digit (card column 1 or badge column 13) of the first data entry. Area Station transactions selected by transaction expansions may be multiple data entries.

Transaction expansion is a prerequisite for message routing. Transaction expansion is activated when the programmer defines the transaction codes in the transaction group (TGROUP) macro. See *IBM System/360 OS/DOS BTAM Planning for 2790 Data Communication System Support,* Form C30-1004.

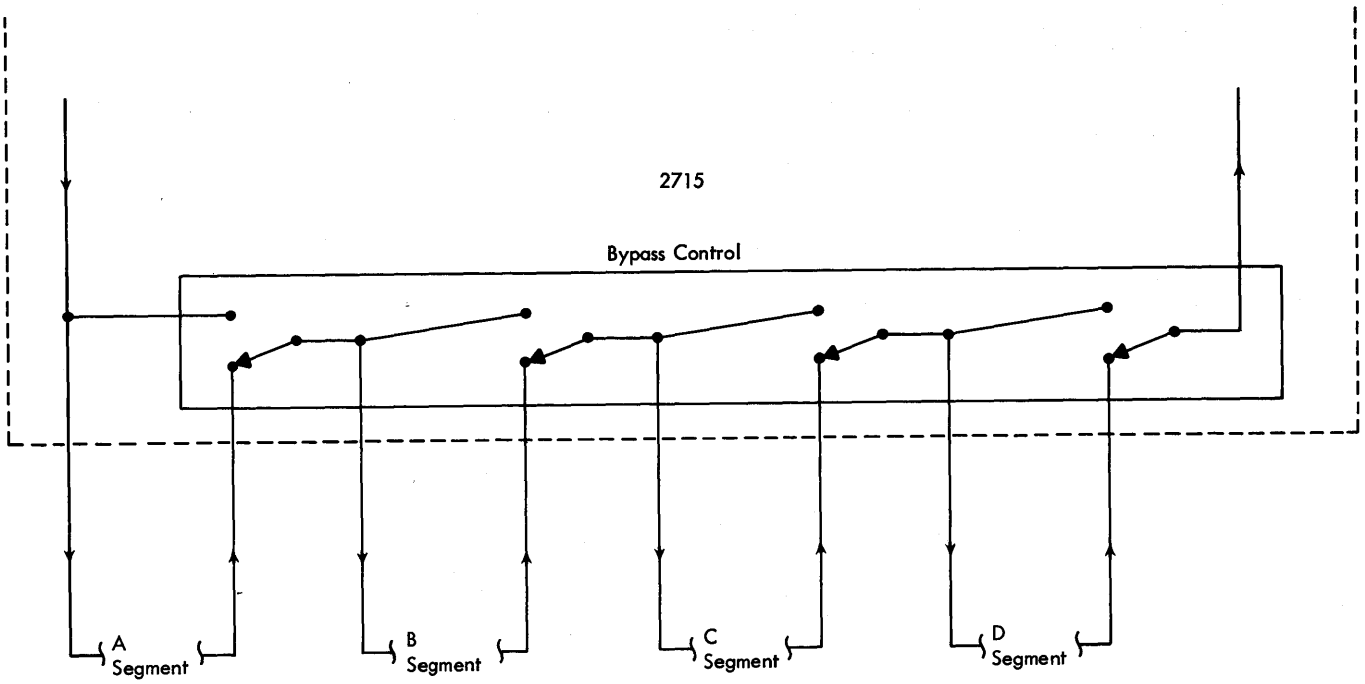


Figure 8. Segmentation

Guidance Panel. A 32-position lighted display matrix (four columns, eight rows), of which 31 positions are available to the customer to give specific instructions to the Area Station operator. The 32nd position is reserved for the Select Transaction display.

Guidance Character. An 8-bit data byte transmitted from the system controller to the Area Station to indicate the operator-guidance light to be lighted, the device to be read, and the state of the In-Process light.

Transmission Capability

The 2791 and 2793 Area Stations are connected by a twisted-pair cable. For example, these units may be installed at intervals of up to 1000 feet using #22 AWG twisted-pair wire. The transmission-line rate is about 500,000 bits per second.

The transmission line is divided into four segments. This transmission-line segmentation (Figure 8) permits access to Area Stations on other segments even though one or more segments become inoperable.

The 2790 transmission line provides 13 time-multiplexed channels of data, all operating concurrently. Eight of these channels operate at an effective data rate of approximately 100 characters per second per channel; the other five operate at approximately 20 characters per second per channel. The lower-speed channels are used to send data to IBM 1053 Printers. The higher-speed channels are used for all 2790 system input devices and for broadcasting time of day to the 2791 visual display.

Card Reader

The card reader is located on the right front (Figure 9) of the Area Station and accepts alphameric and special characters (Figure 10), translating them to Extended Binary Coded Decimal Interchange Code (EBCDIC) for transmission to the system controller. Blank columns are not transmitted to the system controller. End of card (EOC) is sensed by either reading an EOC character or by sensing the end of the card. Card-reading rate is approximately 60 characters per second.

Cards are inserted in the card receiver, face up, column-one end first. An upper left corner cut is required to ensure that the card has been entered properly.

Badge Reader

The badge reader in the Area Station is located in the upper front of the station (Figure 9). The badge reader reads ten columns of numeric information. Information from the badge moves onto the communications network from high order to low order. Blank columns in the badge are transmitted to the system controller unless the delete-blanks option is activated.

Badges are manually inserted (horizontally, face up, guide-hole first). Badges that are inserted improperly are not accepted. Properly inserted badges are retained at the badge-reading station until completion of a correct transmission. Data-transfer rate of the badge reader is approximately 100 characters per second.

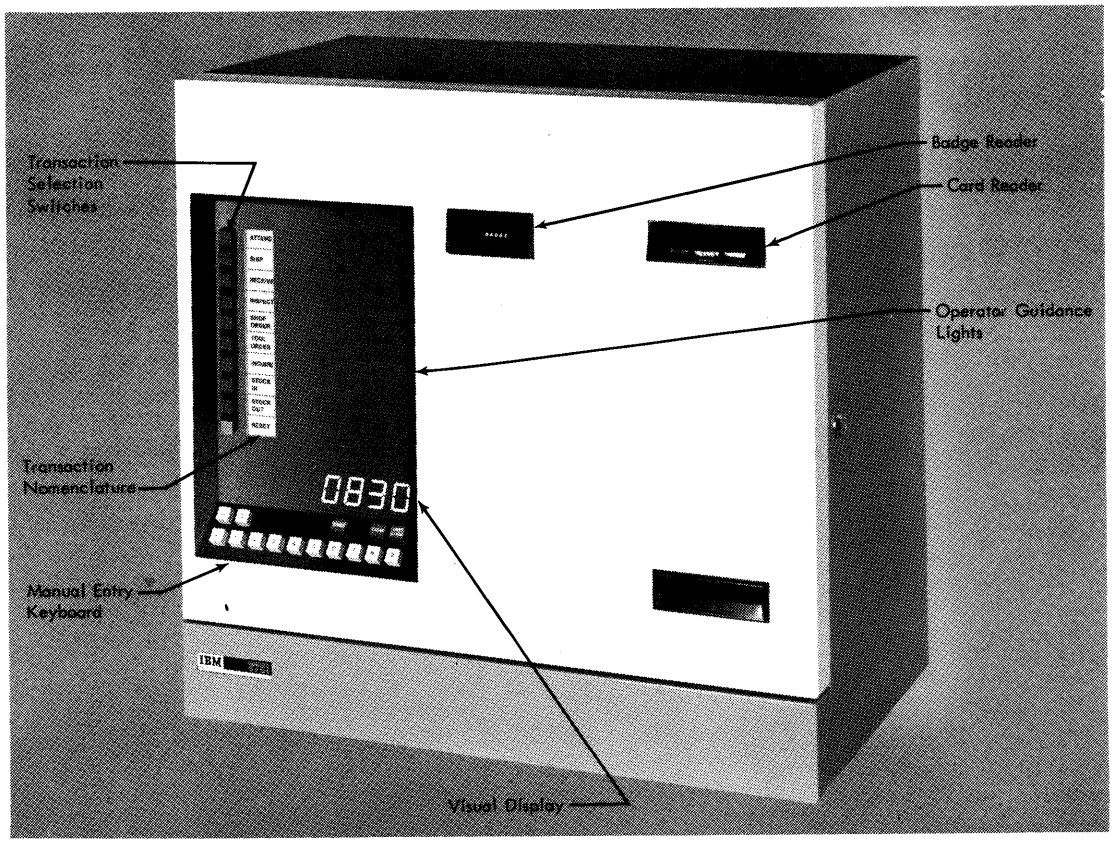


Figure 9. IBM 2791 Area Station

Transaction Selection Switch

The Transaction Selection switch is a ten-position pushbutton switch located on the left front of the Area Station (Figure 9). Selecting any of the first nine positions of the switch locks the switch until the last position is pressed. Selection of any one of the first nine switch positions by the operator generates an 8-bit character that identifies the type of transaction chosen. The system controller can (at the user's option) assign different meanings to each switch based on the Area Station address.

Manual Entry

The 12-key numeric keyboard located at the lower front provides for the entry of decimal numerics 0 through 9, -, and =. As each key is pressed, the number or special character is displayed to the operator for verification. Up to six positions are displayed for any one data entry. After verification, an Enter key is pressed to transmit the data to the 2715 TCU at approximately 100 characters per second. Additional data entries from the keyboard may be chained into one transaction under 2715 user-table control (transaction list steps).

Visual Display

A six-position visual readout is located on the lower front cover. As many as six digits of numeric data can be verified in the visual display before transmission. The time of day is displayed when manual entry is not in use. Valid characters are 0 through 9, blank, -, and =. The time-of-day display is valid if the On-Line light is ON. The time may not have been updated if the On-Line light is OFF.

Operator Guidance Panel

The operator guidance panel (Figure 11) has three sections—transaction selection area; operator guidance nomenclature; and operational indicators.

Transaction Selection Area

Adjacent to each transaction key is an area in which the customer may provide nomenclature in language appropriate to his industry or application. This area describes a particular transaction that is handled if the adjacent button is pushed. User options at the system controller can vary key assignments between 2791's.

Character	Card Punch	EBCDIC 0123 4567	Hexadecimal
A	12-1	1100 0001	C1
B	12-2	1100 0010	C2
C	12-3	1100 0011	C3
D	12-4	1100 0100	C4
E	12-5	1100 0101	C5
F	12-6	1100 0110	C6
G	12-7	1100 0111	C7
H	12-8	1100 1000	C8
I	12-9	1100 1001	C9
J	11-1	1101 0001	D1
K	11-2	1101 0010	D2
L	11-3	1101 0011	D3
M	11-4	1101 0100	D4
N	11-5	1101 0101	D5
O	11-6	1101 0110	D6
P	11-7	1101 0111	D7
Q	11-8	1101 1000	D8
R	11-9	1101 1001	D9
S	0-2	1110 0010	E2
T	0-3	1110 0011	E3
U	0-4	1110 0100	E4
V	0-5	1110 0101	E5
W	0-6	1110 0110	E6
X	0-7	1110 0111	E7
Y	0-8	1110 1000	E8
Z	0-9	1110 1001	E9
0	0	1111 0000	F0
1	1	1111 0001	F1
2	2	1111 0010	F2
3	3	1111 0011	F3
4	4	1111 0100	F4
5	5	1111 0101	F5
6	6	1111 0110	F6
7	7	1111 0111	F7
8	8	1111 1000	F8
9	9	1111 1001	F9
a	12-0-1	1000 0001	81
b	12-0-2	1000 0010	82
c	12-0-3	1000 0011	83
d	12-0-4	1000 0100	84
e	12-0-5	1000 0101	85
f	12-0-6	1000 0110	86
g	12-0-7	1000 0111	87
h	12-0-8	1000 1000	88
i	12-0-9	1000 1001	89
j	12-11-1	1001 0001	91
k	12-11-2	1001 0010	92
l	12-11-3	1001 0011	93
m	12-11-4	1001 0100	94
n	12-11-5	1001 0101	95
o	12-11-6	1001 0110	96
p	12-11-7	1001 0111	97
q	12-11-8	1001 1000	98
r	12-11-9	1001 1001	99
s	11-0-2	1010 0010	A2
t	11-0-3	1010 0011	A3
u	11-0-4	1010 0100	A4
v	11-0-5	1010 0101	A5
w	11-0-6	1010 0110	A6
x	11-0-7	1010 0111	A7
y	11-0-8	1010 1000	A8
z	11-0-9	1010 1001	A9
ç	12-2-8	0100 1010	4A
.	12-3-8	0100 1011	4B
(	12-5-8	0100 1101	4D
+	12-6-8	0100 1110	4E
¦	12-7-8	0100 1111	4F
&	12	0101 0000	50
!	11-2-8	0101 1010	5A
$	11-3-8	0101 1011	5B
*	11-4-8	0101 1100	5C
)	11-5-8	0101 1101	5D
;	11-6-8	0101 1110	5E
¬	11-7-8	0101 1111	5F
-	11	0110 0000	60
/	0-1	0110 0001	61
,	0-3-8	0110 1011	6B
%	0-4-8	0110 1100	6C
_	0-5-8	0110 1101	6D
>	0-6-8	0110 1110	6E
?	0-7-8	0110 1111	6F
:	2-8	0111 1010	7A
#	3-8	0111 1011	7B
@	4-8	0111 1100	7C
'	5-8	0111 1101	7D
=	6-8	0111 1110	7E
"	7-8	0111 1111	7F
* EOC	12-4-8	————	—
* Blank	No Punch	————	—

* Not transmitted

Figure 10. Acceptable Area Station Character Set and Card Code

Operator Guidance Nomenclature

This section of the operator guidance panel consists of a 4 by 8 light matrix in which one rectangle of the 32 is illuminated as a result of decoding the low-order five bits of the guidance character. The light panel describes in the customer's own words actions to be taken by the operator—that is, the type of badge, card, or other significant information relative to the expected data entry. Of the 32 guidance characters, 31 are available to the customer. The 32nd one is dedicated to "select transaction"; which notifies the operator that a new transaction may be selected. (The Release transaction pushbutton must be pressed before a new transaction can be selected.)

The programmer defines which guidance lights are turned on for a transaction when he defines the transaction list (TRLIST) macro. See *IBM System/360 OS, DOS BTAM Planning for 2790 Data Communication System Support,* Form C30-1004.

Operator Guidance Panel Mask. The customer makes the guidance panel mask (overlay) to suit his own needs. The

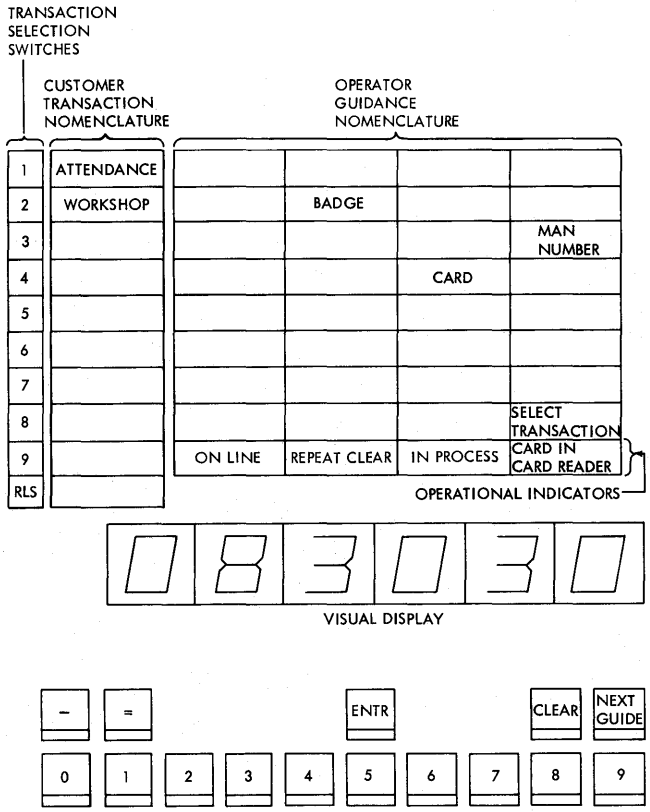


Figure 11. Operator Panel

mask can be made by photographic processes or on standard office copying equipment using heavy-duty projection transparency paper. Figure 12 shows various lettering effects that could be used in a guidance panel mask.

Full-size guidance panel templates are included at the end of this manual to aid in laying out the masks. The numbers within the boxes identify the lights as they are referenced by the transaction list macros. The nomenclature for the Release transaction switch, the Select transaction light, and the operational indicators should be included on each guidance panel mask.

Operational Indicators

The third section of the guidance panel consists of the operational indicators: On-Line, Repeat/Clear, In-Process, and Card In Card Reader.

On-Line Indicator. Indicates that the area station is operational. The Area Station is operational as a result of:

1. Power On
2. Area Station synchronized with system controller and unit not bypassed
3. System controller available to receive data
4. CE Mode switch on CE panel in operator position
5. CE Transaction switch off
6. Area station is not in diagnostic mode.

Repeat/Clear Indicator. Notifies the operator that the prior data entry was not accepted and the Clear key must be depressed. The operator then receives instructions from the operator guidance panel to correct the entry.

In-Process Indicator. Is illuminated following the 2715's acceptance of the first data entry of a multiple-entry transaction. The indicator remains on until the entire transaction is complete.

Card In Card Reader Indicator. Notifies the operator that a card has been inserted into the card reader. The card will not return until either the data has been accepted or the Clear key has been depressed.

Area Station Addresses

The Area Stations are assigned addresses when they are installed. The Area Station (AS) addresses are (80 hex) through (E3 hex). The AS sends its address with each data entry. Each device tied to an AS has a preassigned device address as follows:

Badge Reader	(80 hex)
Card Reader	(84 hex)
Keyboard	(88 hex)
Digital Device Read-In	(8C hex)
1035 Badge Reader	(81-83 hex)
1053 Printer	(40 hex)
Data Entry Units	(C0-DF hex)

2791 Data Entry

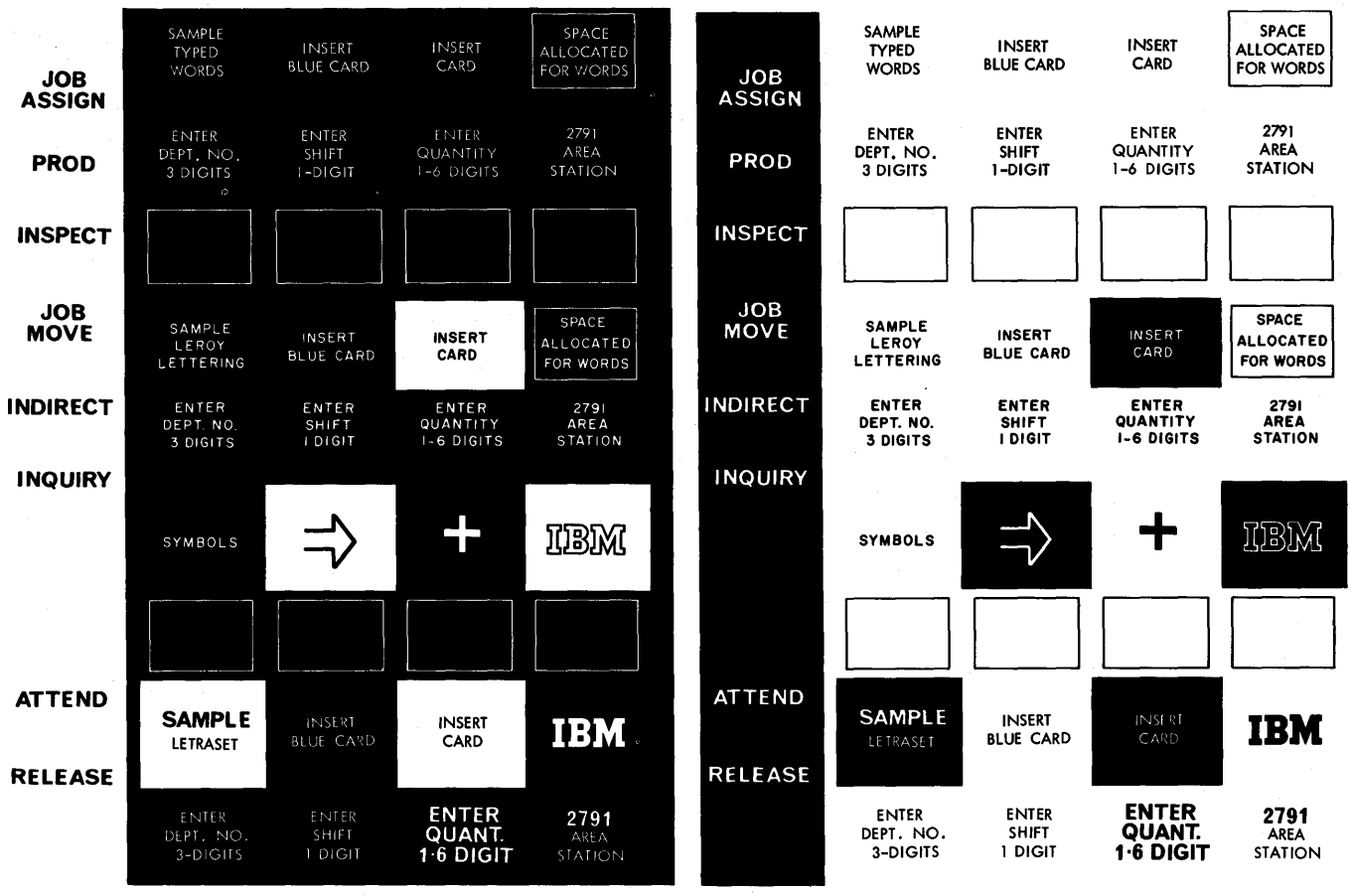
The Area Station data entry varies according to which device entered the data. Figure 13 shows the data entry for each device.

Adapters

2795/2796 Attachments

Two DEU attachment features, 2795/2796 Attachment Basic and 2795/2796 Attachment Additional, provide for attaching up to 32 Data Entry Units. The 2795/2796 Attachment Basic, which provides for attaching the first eight DEU's, is an optional feature for the 2791 Model 1 and a standard feature for the 2793. The 2795/2796 Attachment Additional, which provides for attaching additional DEU's in up to three groups of eight, is an optional feature of both the 2791 Model 1 and the 2793.

The DEU attachment (adapter) provides the scanning to select any one of the 32 possible Data Entry Units requiring service. The adapter services the devices on a blocking basis—that is, one device at a time until the message is completed. Upon completion of a message from a DEU, the scan continues until another device requires



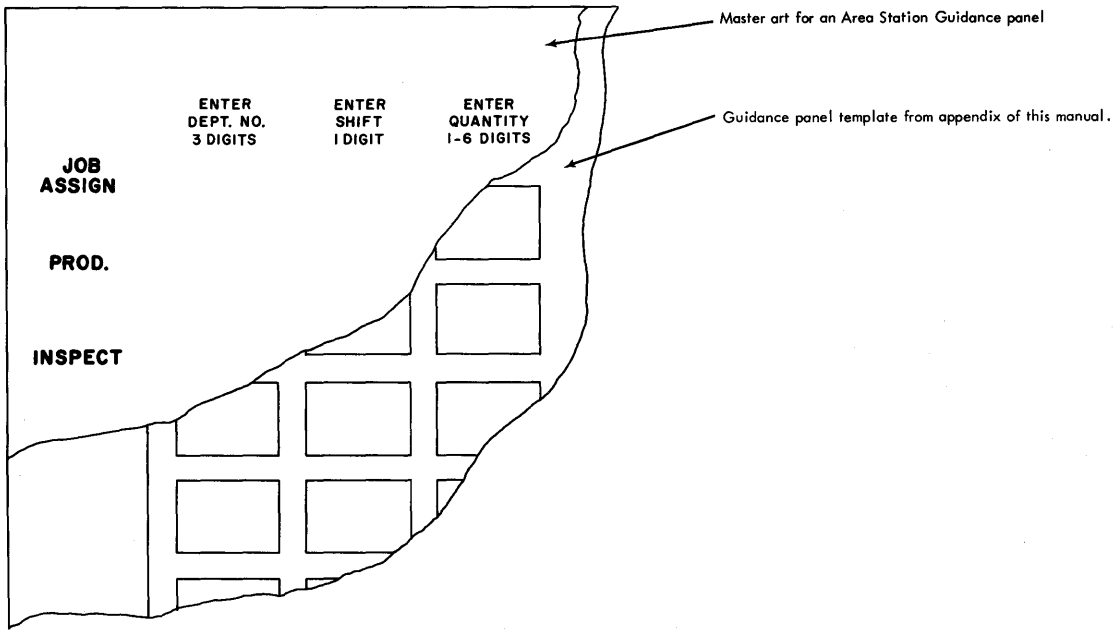


Figure 12. Sample Lettering

Transaction Header (8 Bytes)

Byte	1	2	3	4	5	6	7	8
	Transaction Length	Transaction List Number *	Area Station Address	Device Address (First Device)	Tens of Hours	Units of Hours	Tens of Minutes	Units of Minutes
	Binary				Time-of-Day in EBCDIC			

* The Transaction Selection Switch position is referenced to the user transaction table. The transaction list number from the table is placed in byte 2 of the header.

Card Data Entry (in EBCDIC)

Digit	1	2	3	4		77	78	79	80	81
	Monitor Key (0 or 1)	1	2	3	Card Columns	76	77	78	79	80

Area Station Badge Reader - Badge Data Entry (EBCDIC)

Digit	1	2	3	4	5	6	7	8	9	10	11
	Monitor Key (0 or 1)	13	14	15	16	Badge Columns 17	18	19	20	21	22

1035 Badge Reader - Badge Data Entry (EBCDIC)

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

Digital Device Read-In Data Entry (EBCDIC)

Digit	1	2	3	4	5	6	7	8	9	10	11
	Monitor Key (0 or 1)	1	2	3	4	Digital Device Read-In 5	6	7	8	9	10

Keyboard Data Entry (EBCDIC)

Digit	1	2	3	4	5	6	7
	Monitor Key (0 or 1)	1	2	Display Columns 3	4	5	6

Figure 13. 2791 Data Entry as Assembled in the 2715 TCU

service. The operation is then repeated. The adapter decodes and generates the input-device address, decodes the control code, and generates the proper control-response characters. The DEU attachment accepts data from the DEU and translates the data to the proper hexadecimal character for transmission to the 2715. The valid character set is limited to decimal numerics 0 through 9 and blank.

1053 Printer Attachment (Optional on 2791 Model 1 and 2793)

The 1053 Printer Attachment (adapter) allows the connection of one 1053 Model 1 to each Area Station. The adapter decodes and generates the device address, decodes and acts upon the control code, generates the proper response characters, and accepts EBCDIC characters from the transmission line and translates them to the tilt/rotate code for the 1053 Printer operation. This adapter will translate 44 EBCDIC uppercase characters (see Figure 14). The adapter also controls the following functions on the IBM 1053:

Tab (fill characters are not permitted)
Line Feed (fill characters are not permitted)
New Line
Backspace
Space

The Digital Device Read-In (OEM) (Optional on 2791 Model 1 Only)

The digital device read-in permits attachment of an OEM digital device (such as a scale, meter, or counter) to the Area Station. Up to ten decimal digits may be read from the OEM device under control of the operator guidance panel on the Area Station.

The 1035 Badge Reader Attachment (Optional on 2791 Model 1 Only)

The 1035 Badge Reader Attachment allows the connection of as many as three remote Badge Readers to each Area Station.

Area Station Register

Area Stations are attached to the communications line by inserting a one-byte shift register in series with the transmission line (Figure 15). This enables the station to examine and modify a full byte of information before retransmitting the byte.

2793 AREA STATION

The 2793 Area Station (Figure 16) services eight Data Entry Units. Optional features that can be attached to the 2793 are: three 2795/2796 Attachment Additional features (for a total of 32 data entry units) and an IBM 1053 printer attachment.

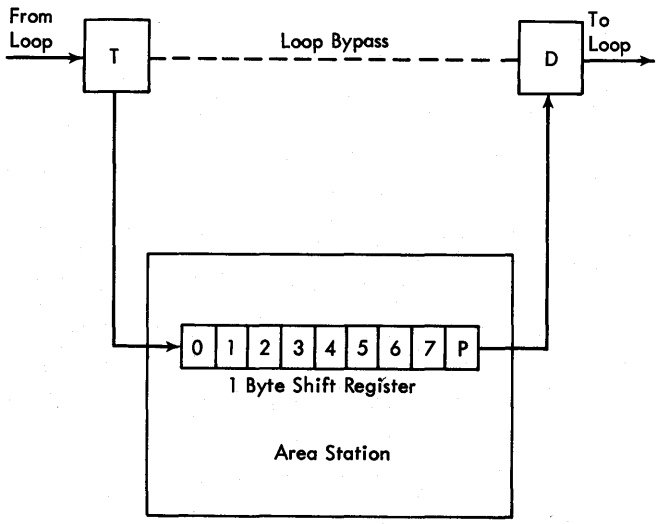
Character	EBCDIC 0 1 2 3 4 5 6 7	Hex
A	1 1 0 0 0 0 0 1	C1
B	1 1 0 0 0 0 1 0	C2
C	1 1 0 0 0 0 1 1	C3
D	1 1 0 0 0 1 0 0	C4
E	1 1 0 0 0 1 0 1	C5
F	1 1 0 0 0 1 1 0	C6
G	1 1 0 0 0 1 1 1	C7
H	1 1 0 0 1 0 0 0	C8
I	1 1 0 0 1 0 0 1	C9
J	1 1 0 1 0 0 0 1	D1
K	1 1 0 1 0 0 1 0	D2
L	1 1 0 1 0 0 1 1	D3
M	1 1 0 1 0 1 0 0	D4
N	1 1 0 1 0 1 0 1	D5
O	1 1 0 1 0 1 1 0	D6
P	1 1 0 1 0 1 1 1	D7
Q	1 1 0 1 1 0 0 0	D8
R	1 1 0 1 1 0 0 1	D9
S	1 1 1 0 0 0 1 0	E2
T	1 1 1 0 0 0 1 1	E3
U	1 1 1 0 0 1 0 0	E4
V	1 1 1 0 0 1 0 1	E5
W	1 1 1 0 0 1 1 0	E6
X	1 1 1 0 0 1 1 1	E7
Y	1 1 1 0 1 0 0 0	E8
Z	1 1 1 0 1 0 0 1	E9

Character	EBCDIC 0 1 2 3 4 5 6 7	Hex
1	1 1 1 1 0 0 0 1	F1
2	1 1 1 1 0 0 1 0	F2
3	1 1 1 1 0 0 1 1	F3
4	1 1 1 1 0 1 0 0	F4
5	1 1 1 1 0 1 0 1	F5
6	1 1 1 1 0 1 1 0	F6
7	1 1 1 1 0 1 1 1	F7
8	1 1 1 1 1 0 0 0	F8
9	1 1 1 1 1 0 0 1	F9
0	1 1 1 1 0 0 0 0	F0
.	0 1 0 0 1 0 1 1	4B
$	0 1 0 1 1 0 1 1	5B
@	0 1 1 1 1 1 0 0	7C
/	0 1 1 0 0 0 0 1	61
#	0 1 1 1 1 0 1 1	7B
&	0 1 0 1 0 0 0 0	50
-	0 1 1 0 0 0 0 0	60
,	0 1 1 0 1 0 1 1	6B
Space	0 1 0 0 0 0 0 0	40
New Line	0 0 0 1 0 1 0 1	15
Tab	0 0 0 0 0 1 0 1	05
Back Space	0 0 0 1 0 1 1 0	16
Line Feed	0 0 1 0 0 1 0 1	25
Idle **	0 0 0 1 0 1 1 1	17

Requires Typewriter Element P/N 1167998 - Feature #9592

** Idle character is not valid for 1053 printer.

Figure 14. IBM 1053 and 2740 Printer Character Set



T=Terminator
D=Driver

Figure 15. Loop Attachment and Shift Register

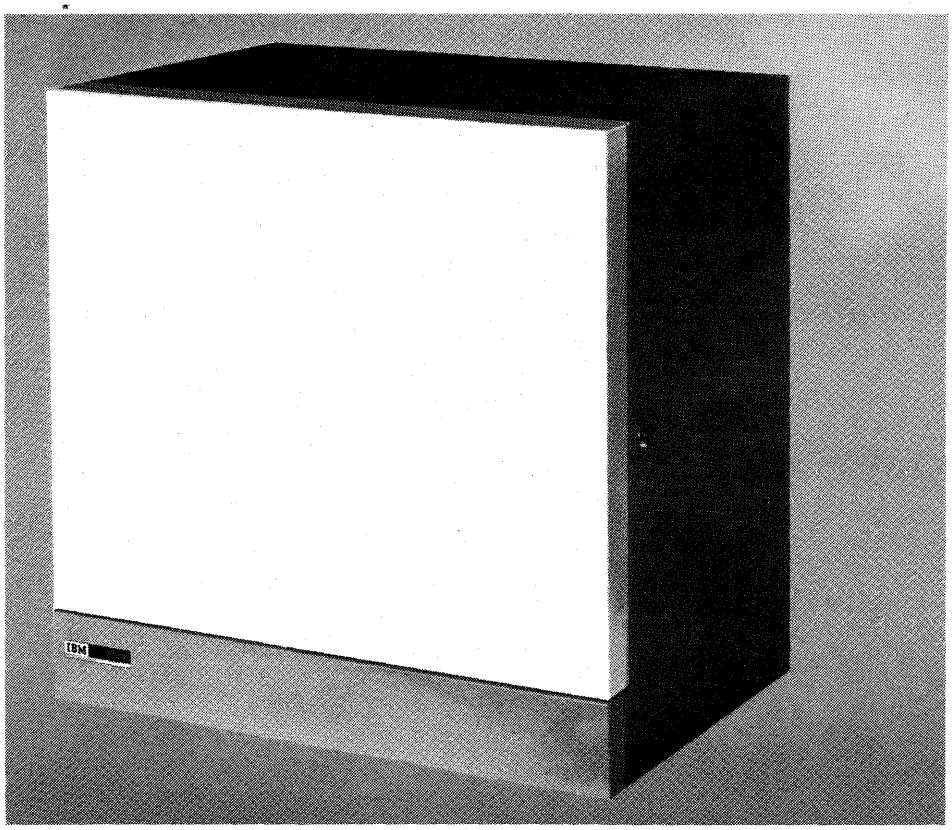


Figure 16. IBM 2793 Area Station

The 2715 TCU is a core-storage, buffered, microcoded, control unit capable of providing the user with a system-controller function to which 2790 Data Communication System terminals are attached.

2715 TCU FUNCTIONS

- Provides controls to read from and write on 2790 terminals.
- Sets 2791 Area Station guidance lights in accordance with a user-supplied transaction list.
- Checks for valid data transmissions from 2790 terminals.
- Assembles single and multiple data entries from 2790 terminals in accordance with user predefined steps located in the 2715 transaction-list table.
- Transmits transactions assembled from 2790 terminals to System/360 via a Multiplexer Channel Adapter or a Binary Synchronous Communications Adapter.
- Provides for transaction expansion, which is the ability to enter up to 81 transaction types from either a 2791 Area Station or a Data Entry Unit.
- Provides for data recovery from the disk in case of system failure.
- Performs error checking and error recording.
- Adds time-of-day (in hours and minutes) to provide a time stamp (24-hour clock only) for each transaction from 2790 terminals.
- Broadcasts time of day (12-hour clock or 24-hour clock) to all 2791 Area Stations.
- Receives messages from System/360 and routes them either to 2790 output printer, or to an attached 2740 Model 1 printer.
- Stores transactions from 2790 terminals on integral disk storage for subsequent retrieval and transmission to System/360.
- Provides for Initial Control Program Load from integral disk storage.
- Provides self-diagnostics and terminal diagnostics stored on integral disk storage.
- Provides data service and control for an IBM 2740 Communication Terminal Model 1 attachable to the 2715.
- Provides an audible alarm and contact closure. The contact closure is a switch available for operating an external customer-owned device.

The basic 2715 TCU (Figure 17) contains 16K (16,000) bytes of core storage and an integral disk storage unit having a data capacity (work area) of 450K to 870K bytes, depending on the amount of disk sorting. User tables are assembled at System/360 and transferred to the 2715 TCU via the data link. The 2715 operates with these tables to provide control and data service for attached 2790 terminals. Data assembled from 2790 terminals may be routed on a priority basis to System/360 when the 2715 is operating in the on-line mode, or it may be temporarily stored on the 2715 TCU integral disk and subsequently transferred to System/360 on a scheduled basis. The user tables assembled by System/360 for the 2715 must contain a routing designation for each type of transaction. This routing designation is defined by the user when preparing transaction-list statements for each type of transaction used at Area Stations and Data Entry Units.

A route designation of "disk" (deferred data) instructs the 2715 to place this type of a completed transaction on its integral disk storage device. Transactions are stored into blocks of 640 integral bytes of core storage and are then transferred to the disk. When the 2715 is in deferred-data mode and no priority date is queued for transmission to the processor, blocks of deferred data are transferred from the disk to the System/360 processor. If the 2715 is not in deferred-data mode, no attempt is made to transfer deferred data to the processor under normal operations. However, if the disk fails, the loop is shut down and incoming deferred data is routed to the CPU even if the 2715 is not in deferred-data mode. Approximately 600,000 bytes of disk storage are available for user data. The 2715 does not reuse the disk until System/360 has accepted all the user data stored on the 2715 disk, and a "reinitialize disk" request has been made and honored.

A route designation of "CPU" (priority data) will instruct the 2715 to transmit this type of completed transaction to System/360 on a priority basis. The 2715 will queue completed transactions of this type (in core storage) for transfer to System/360 via the data link. If System/360 is not providing adequate data service for priority data, the 2715 will store this data on its disk. When adequate data service is resumed, the 2715 will automatically fetch any priority data on disk and transfer it to System/360. Completed transactions in 2715 core storage with a routing designation of "CPU" may precede and be interspersed with priority data stored on disk. Thus, sequence of priority data cannot be assured if the System/360 does not continuously provide adequate data service.

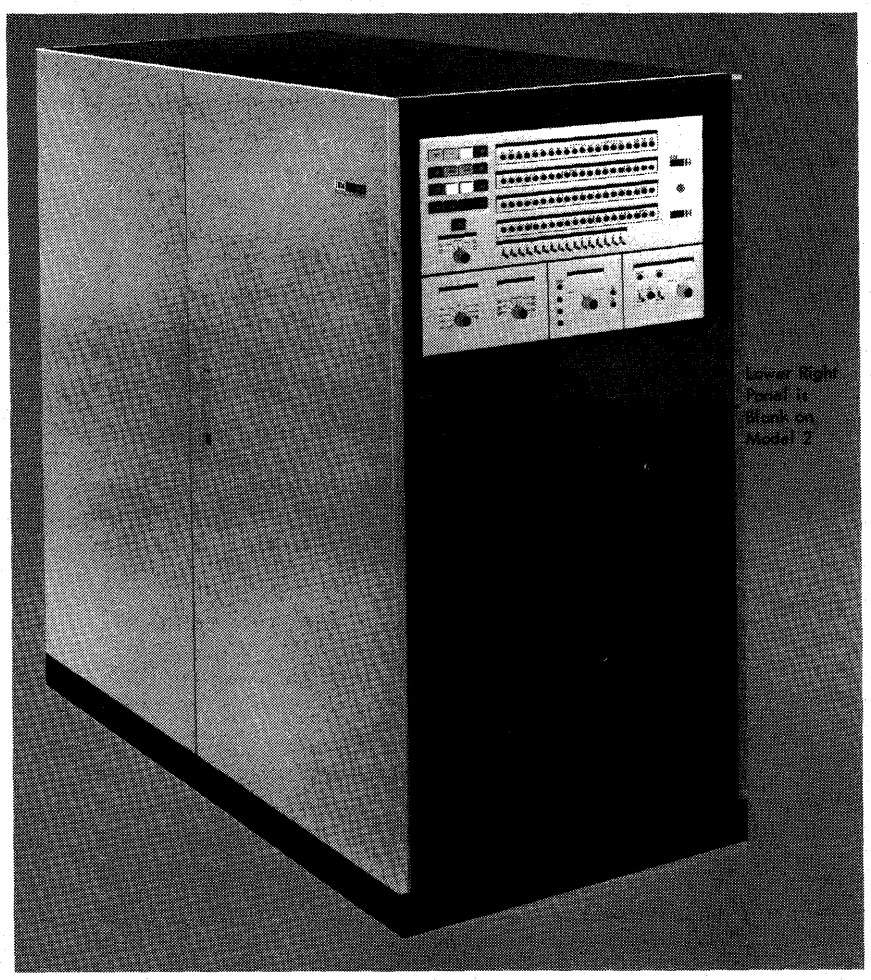


Figure 17. IBM 2715 Transmission Control Unit

Direct attachment to System/360—either via the 2715 Model 1 Multiplexer Channel adapter, or the 2715 Model 2 Binary Synchronous Communications adapter—is required to retrieve the data stored in the 2715 TCU. The 2715 disk cartridge is not data-compatible with System/360 direct-access storage devices. The disk cartridge can be replaced to update the 2715 microcoded control program to new engineering change levels, or to provide feature additions/deletions. In case malfunction of the disk occurs, an additional 2715 disk cartridge (containing information identical to the cartridge shipped with the 2715) is supplied as an initial spare part.

Modes of Operation with System/360

System/360 operations with the 2790 system may vary with user application. Some of these are:

On-Line. System/360 is programmed to operate in continuous mode with the 2715 TCU. Data from 2790 terminals is assembled into completed transactions by the 2715 and then transferred to System/360 in message blocks up to 640 bytes long.

On-Line/Off-Line. In this mode, the 2715 TCU collects data from 2790 terminals and stores the data on its integral disk. On a scheduled basis System/360 requests the stored data from the 2715 TCU. Average capacity of the 2715 disk for user data is 600K bytes.

On-Line for 2790 Inquiry and System/360 Inquiry Responses; On-Line/Off-Line for Other 2790 Data. In this mode, the 2715 routes 2790 inquiry data to System/360 on a priority basis and routes all other data from 2790 terminals to its integral disk. The inquiry data is processed by System/360 in real-time mode, while all other data is deferred and can be processed in a batch mode on a scheduled basis.

In this mode of operation, inquiry data is designated as priority data (send to CPU) and all other data is classified as deferred data (send to disk). This mode has the advantage of providing better data security at the expense of somewhat slower throughput (see "2715 Performance").

2715 MACHINE FEATURES

Standard Features for Models 1 and 2

The 2715 Models 1 and 2 contain as standard features:

2715 Model 1 (Local)	*2715 Model 2 (Remote)*
16K bytes of core storage	16K bytes of core storage
Integral disk	Integral disk
Real-time clock	Real-time clock
2790 adapter	2790 adapter
Multiplex Channel adapter	BSC adapter
	Local 2740 adapter

Selective Features for Models 1 and 2

The following selective features can be attached to the 2715 Model 1 or Model 2.

Expanded Capability

The Expanded Capability feature increases the number of Area Stations and Data Entry Units that can be attached to a 2715.

2715 Without Expanded Capability Feature. Without the Expanded Capability feature (16K bytes of core storage), the maximum configuration for a 2715 is one of the following:

- 64 IBM 2791 Area Stations with no Data Entry Units.
- 4 IBM 2791 Area Stations and 120 Data Entry Units.
- Other combinations of Area Stations and Data Entry Units that satisfy the statement "2A + D is less than 129"—where A equals the number of Area Stations and D equals the number of Data Entry Units. When using IBM 2793 Area Stations, A is equal to zero and D shows the number of Data Entry Units that may be attached.

A 2715 without the Expanded Capability feature provides the user with 1280 bytes of storage for user tables (which contain pointers, index values, and parameters for the 2715). They are assembled in object format by the System/360 assembler and sent to the 2715 by a user's BTAM problem program.

2715 With Expanded Capability Feature. With the Expanded Capability feature (32K bytes of core storage), the maximum configuration for a 2715 is one of the following:

- 100 Area Stations in any combination.
- 1024 Data Entry Units in any combination.
- Combined total of 1124 Area Stations and Data Entry Units.

A 2715 with the Expanded Capability feature provides the user with 4096 bytes of storage for transaction tables, which are loaded into the 2715 via System/360 data link.

The Expanded Capability feature is required if message routing from an attached Area Station or Data Entry Unit to another attached Area Station equipped with IBM 1053 Printer is required, independent of the System/360 operation.

A transaction entered at a 2791 Area Station or a 2795 or 2796 Data Entry Unit may have any one of the following routing designations (a through g) if the 2715 has the Expanded Capability feature. If the 2715 does not have Expanded Capability, the routing designations are limited to any one of items a, b, and c.

Routing Designations

a – To CPU (S/360) or 2715 disk
b – To 2740 printer attached to 2715
c – a and b
d – To 1053 Printer attached to an Area Station on the loop
e – a and d
f – a and b and d
g – b and d

A 2715 without Expanded Capability provides for routing (a, b, and c only) of explicit text only. (Explicit text is that data received from the originating station.)

A 2715 with Expanded Capability provides for routing of explicit text or explicit-implicit text. (Implicit text is user-predefined messages stored in 2715 core storage. One of these messages may be appended to the explicit text received from the originating terminal. The combined text is then routed in accordance with any one of the above designations. In item d above, the 1053 Printer address may be implicit or explicit. (For example, if the address is supplied with the first data entry entered at the origination station, the text is explicit.)

The Expanded Capability feature is a prerequisite for message routing.

The Expanded Capability feature is a prerequisite for BSC multipoint line control on the 2715 Model 2.

Line Transfer Switch

This feature provides the ability to manually switch the 2790 transmission lines between two adjacent 2715 TCU's acting as backup for each other (see Figure 18). All terminals must be defined identically in the user tables of both 2715's affected. Only one 2715 requires this feature.

Line Transfer Switch—Third Unit

This feature provides the ability to use a third 2715 as backup for either of two 2715's (see Figure 19). All terminals must be defined identically in the user tables of both 2715's affected. The other two 2715's must be equipped with the Line Transfer Switch feature.

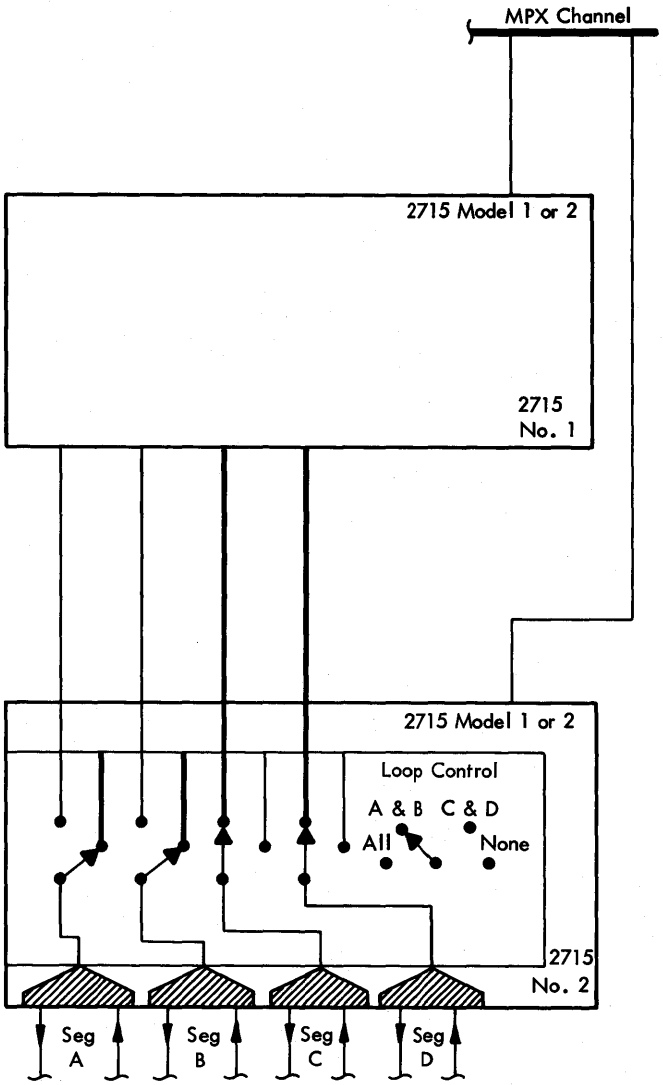


Figure 18. Line Transfer Switch

Selective Features for 2715 Model 1

The following selective features can be attached to the 2715 Model 1 only.

Local 2740-1 Adapter

The Local 2740-1 Adapter is a standard feature for the 2715 Model 2 and an optional feature for the 2715 Model 1. This feature permits attaching an IBM 2740 Communication Terminal Model 1 within 40 wire feet of the 2715. When attached, the 2740 operates as a console device for communication with both the 2715 and the host CPU. The 2740 is used in the following applications:

- Print operator awareness messages
- System/360 message printout
- Input transaction logging
- User-defined inquiry or control requests

The 2740 must be in communication mode and must have power on and paper in the carriage when the 2715 tries to send it a message; if not, an audible alarm is sounded, catalog number X'89' is posted, and the undeliverable transaction is routed to the CPU problem program with the proper error code.

2740 to System/360. The communication between the 2740 and the System/360 is defined and implemented by the user in the System/360 problem program. The procedure for entering a message to the System/360 from the 2740 is:

1. Press Line Bid (start of text)
2. Press desired control (digit 0-9)
3. Type text
4. Press EOT (end of text)

The line bid initiates the connection with the 2715 and allows the 2740 operator to enter the desired control character. The control character (digit 0-9) is placed in the transaction-control byte of the transaction being sent to the System/360. The time when the request was made is stored in the transaction header (using 24-hour clock). The text is stored in the text portion of the transaction. When EOT is pressed, the transaction is sent to the System/360 if the channel or data link is available. Neither the Bid nor the EOT are stored in the transaction. The text portion may contain up to 247 characters. If 247 characters are exceeded, the 2715 disregards the transaction and prints "ERR".

Transactions successfully entered from the 2740 that contain a transaction-control digit (0-9) are forwarded to the System/360 in the same format as any other 2715-to-System/360 message. The Area Station and device addresses are set to zero (X'00') indicating a 2740 message. The user may specify any use he wishes for the transaction-control digit (0-9); the 2715 treats all digits (0-9) in the same manner

If more than about 25 seconds elapses between entering two successive characters, the 2715 returns the 2740 to standby (ready for another bid) and disregards the partial message entered.

System/360 to 2740. System/360-to-2740 transactions must follow the same format as other output messages to the 2715. Messages for the 2740 must have a message-control character X'04' and a transaction-control character X'FB'. For output messages, the Area Station address, device address, and time of day from the transaction header are printed ahead of the text. The time field must contain a valid EBCDIC numeric character.

For System/360-to-2715/2740 messages, the user can insert special carriage-control characters (new line, tab,

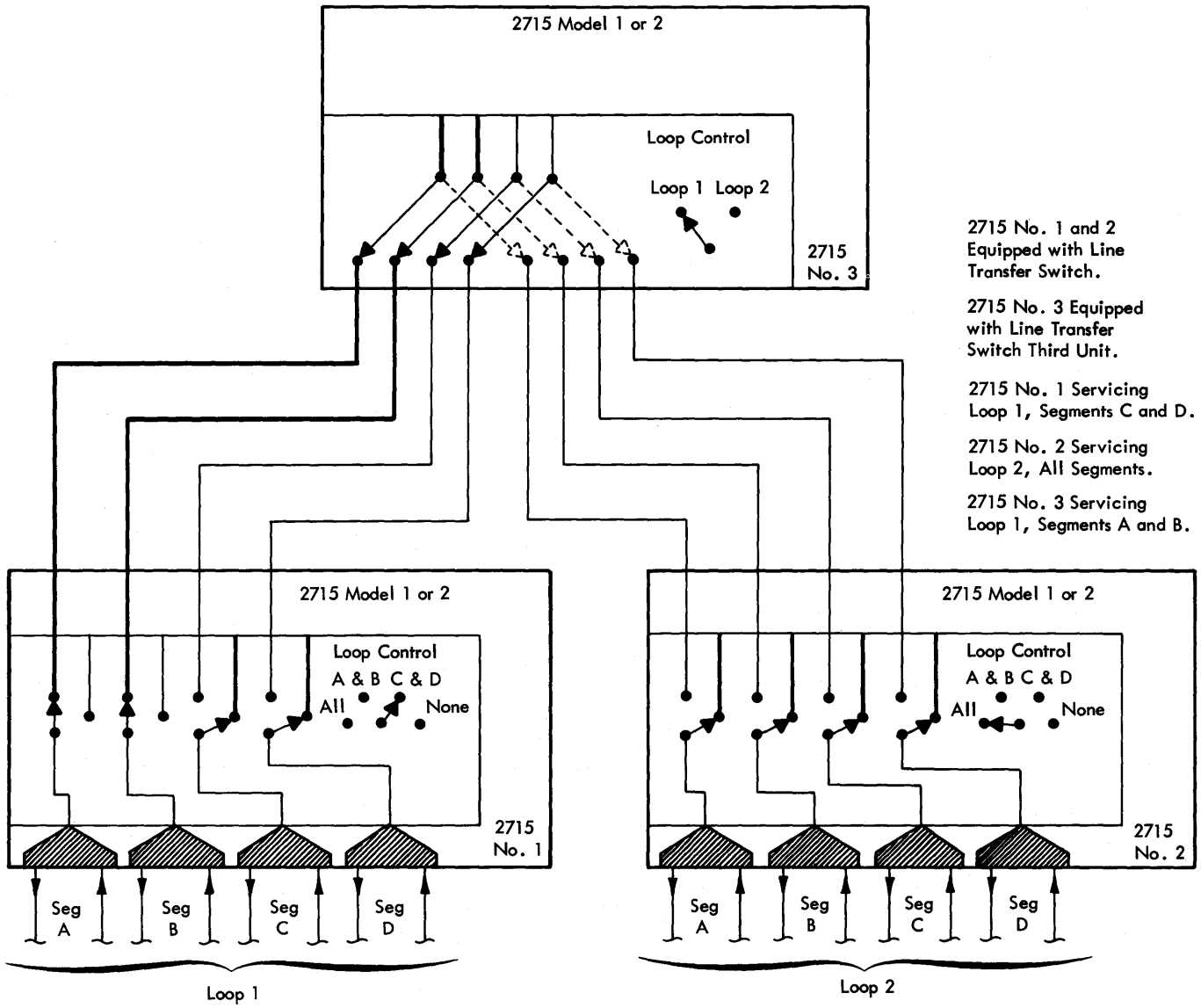


Figure 19. Line Transfer Switch–Third Unit

line feed, and backspace) within the text; however, it is the user's responsibility to include the appropriate number of "idle" characters following a tab character. The 2715 will insert the required number of idle characters following a new-line character.

The 2715 will automatically insert a new-line character at the end of text without any user-inserted control character.

2715-to-2740 Control Messages. For control between the 2715 and the 2740, the user may specify 2740 transaction routing when he assembles the user tables. Control and error messages are printed automatically. The operator initiates a control request as follows:

1. Press Line Bid (start of text)
2. Press request (alphabetic character)
3. Enter addressing data
4. Enter byte count (for "On Line Dump" only)
5. Press EOT

Allowable 2740 control requests are:

Scan Area Station Errors. The request character is an alphabetic 0 (X'D6'). The address data is the hexadecimal representation of the Area Station address.

On Line Dump. The request character is the letter R (X'D9'). The address data is the hexadecimal representation of the number of bytes to print out (X'00'–X'32'). If no byte count is entered, the 2715 will assume a X'32' count.

Two Processor Switch

This feature allows the 2715 to be attached to the Multiplexer Channel of two System/360 Processors. However, operations may occur with only one of the processors at any one time. The 2715 Two Processor Switch (TPS) has three distinct states: neutral; Channel A attached; Channel B attached. The TPS may be in only one state at a time. With the TPS in the neutral state, the 2715 is available to the first channel that selects it. The 2715 will not execute a 'system reset' from either channel when its TPS is in the neutral state.

Switching from the Neutral State. In the neutral state, the TPS will monitor the 'address out', 'select out', and 'bus out address' on both Channels 1 and 2. If a valid address is decoded on either of the channels, the 2715 will attach to that channel upon the detection of 'select out'. Any 'select out' signal coming from the unattached channel will be bypassed by the TPS, giving the program a condition-code 3 response to a Start I/O instruction. The valid address for attachment to Channel 1 may be different from that of Channel 2.

Any command, including Reserve, can be used to achieve initial attachment. After attachment, the Reserve command is treated exactly as if it were an I/O No-Op command—that is, immediate CE-DE status is given.

Switching Back to the Neutral State. Only the attached channel can cause the TPS to return to the neutral state. This is done by one of two methods:

1. If a 'system reset' is signaled by the attached channel, the TPS unconditionally returns to the neutral state.
2. If a Release command is issued by the attached channel to the 2715 and the command is honored, the TPS will return to the neutral state. To determine if the 2715 will honor the Release command, the interface controls will make an immediate check to see if the 2715 is command-free. If it is not command-free, it will signal 'busy' as status response to initial selection and the 2715 will not go to the neutral state. If the 2715 is command-free, it will signal 'channel end and device end' as a status response to initial selection and the TPS will return to the neutral state immediately following the fall of 'operational in'. The Release command should never be in or at the end of a command chain. Also, since the CE-DE status presented by the Release command and accepted by the channel indicates that the 2715 TPS will unconditionally return to neutral, command chaining should never be signaled via the Release command. Once in the neutral state, the TPS is capable of attachment to the alternate channel, or the channel just released is eligible to become partitioned.

The TPS may switch to the neutral state through a 'power on reset', which causes the TPS to return unconditionally to the neutral state.

Selective Features for 2715 Model 2

The following selective features can be attached to 2715 Model 2 only:

Dual Communications Interface

This feature allows the BSC adapter to operate with an alternate data-set interface on the common-carrier facility. The second interface provides switched-network backup of leased-line facilities.

Synchronous Clock

This feature provides the 2715 Model 2 BSC adapter with an internal clock for use with those data sets not providing clocks.

Attach World Trade Modems

This feature provides an interface from the BSC adapter to the following modem types:

UK GPO—Modem Type 1 Model 5 (see "Note")

600 bps and 1200 bps on leased and switched facilities.

GERMAN PTT (Bundespost)—Modem Type D 1200 S (GH 2100 Model 5)

600 bps and 1200 bps on leased and switched facilities.

SWEDISH PTT—Modem Type GH 2002 A, B, and C

A—600 bps and 1200 bps on switched facilities
B—600 bps and 1200 bps on leased facilities
C—600 bps and 1200 bps for in-plant multipoint

JAPANESE NTT—Modem Type DT 1203

600 bps and 1200 bps on leased point-to-point facilities.

IBM 3977 Model 1 and 2

Model 1—600 bps and 1200 bps on leased facilities
Model 2—2000 bps on leased facilities (conforming to CCITT recommendations M89)

IBM 3976 Model 3

600 bps and 1200 bps on leased and switched facilities

Note: Support for GPO Datel 1 Model 5 Modem must include the safety requirement of GPO MEMORANDUM A2524 (Issue 2), titled: "Memorandum on the Connection of Privately Owned Equipment to Post Office Private Circuits."

Configuration Parameters

The configuration parameters are specified by the customer and inserted by the IBM Customer Engineer at the time of installation. These parameters are:

- 50/60 Hz power
- Internal/external Real-Time Clock advance
- 12/24-Hour Real-Time Clock display
- System error threshold
- Half/full-duplex data set
- Internal/external BSC clock
- Switched/nonswitched/multipoint lines
- Primary/secondary stations
- BSC retry count
- Station ID
- System ID
- Poll address
- Selection address
- Originate/called station
- Intermediate/Non-intermediate block check mode
- Normal/Expanded Capability

2715 GENERAL CHARACTERISTICS

Multiplexer Channel Adapter (Standard on 2715 Model 1)

The Multiplexer Channel Adapter (MCA) establishes and maintains communication with the processor channel while performing control functions and data transfers. To the multiplexer channel, the MCA looks the same as the 2701 Data Adapter Unit.

The adapter handles all sequencing, command and instruction buffering, and data and status transfer via hardware.

Command Compatibility (2715/2701)

Compatible. Usage of the following commands is compatible between the 2715 and the 2701:

Read
Write
Prepare
Sense
No-Op
Test I/O
Enable
Disable
Set Mode
Release
Reserve

Not Compatible. The 2715 does not use the following commands used by the 2701:

Dial
Poll
Search
Address Prepare

These commands are rejected by 2715 at "initial selection."

Sense Byte

Sense Bits Used. The 2715 uses the following sense bits:

Command Reject
Bus-Out check
Equipment check
Lost Data
Timeout

The Timeout in the 2715 local configuration is immediate.

Sense Bits Not Used. The 2715 does not use the following sense bits used in the 2701:

Intervention Required
Data Check
Overrun

These conditions cannot occur in the 2715; therefore, these bits are not used.

Status Byte

Status Bits Used. The 2715 uses the following status bits:

Channel End
Device End
Unit Check
Unit Exception
Busy

Status Bits Not Used. The 2715 does not use the following status bits:

Attention
Status Modifier

Initial Selection

Initial-selection sequences are generated from execution of an I/O instruction or command chaining within the channel. The 2715 responds to initial selection with the following exceptions:

1. Power down
2. Off-line mode (inactive)

Start I/O

Execution of Start I/O causes initial selection and transfer of a command byte to the 2715. Command chaining is

treated as if it resulted from Start I/O.

Parity checking of all commands is performed by adapter hardware. Incorrect parity is indicated by a Unit Check initial status and a Bus-Out Check sense bit.

Commands

Bit configurations for valid commands on Bus Out are:

	P	0	1	2	3	4	5	6	7
Write	0	0	0	0	0	0	0	0	1
Read	0	0	0	0	0	0	0	1	0
Prepare	1	0	0	0	0	0	1	1	0
Sense	0	0	0	0	0	0	1	0	0
No-Op	1	0	0	0	0	0	0	1	1
Test I/O	1	0	0	0	0	0	0	0	0
Enable	1	0	0	1	0	0	1	1	1
Disable	0	0	0	1	0	1	1	1	1
Set Mode	0	0	0	1	0	0	0	1	1
Release	1	1	1	0	1	0	1	0	0
Reserve	0	1	1	1	1	0	1	0	0

Write

This command executes data transfer (byte mode) from the channel to the 2715.

A detected parity error during data transfer causes Unit Check (UC) to be sent with Channel End (CE) and Device End (DE); also, the Bus Out check bit is set in the Sense byte.

Read

Data stored in the data buffers is sent to the channel during a read operation. A Read command is terminated with CE-DE when the 2715 message count goes to zero. A read command is accepted but ended immediately with CE, DE, and UC status bits and a Timeout sense bit if the read-data buffers are empty.

Prepare

This command is used to indicate when data becomes available to the processor. When data is available, the Prepare command is terminated with Channel End and Device End status. No data transfer occurs during the Prepare command.

Sense

The Sense command obtains information (the sense byte) defining the error condition detected during the last operation.

No-Op

As a result of this command, the 2715 inserts Channel End and Device End in the initial status.

Test I/O

The 2715 responds to a Test I/O instruction with the following:

1. *All-zero status* indicates the 2715 is command-free and contains no pending or stacked status.
2. *Busy* indicates that the 2715 has not completed the last command.

Test I/O relieves the 2715 of any pending or stacked status.

Enable/Disable/Set Mode

For compatibility, these commands are accepted by all 2715 local configurations; however, each command is ended immediately with CE and DE. No further action is taken within the 2715 for these commands.

Reserve/Release Commands

These two commands are meaningful only when the Two-Processor Switch (TPS) feature is implemented. If these commands are issued to a 2715 without the TPS feature, they will be rejected at the 2715 channel interface. Their functions are described under the Two-Processor Switch feature.

Halt I/O

Once the 2715 has responded to initial selection by raising Operational In, the channel may signal Halt I/O. The control register is set to indicate the Halt I/O condition. The microcode initiates action to terminate any command in process. The ending status depends on the command being executed and the time of interruption as follows:

Write. Halt I/O terminates the operation normally, if the complete message was transferred. The ending status is always Channel End and Device End unless unusual conditions are detected before the Halt I/O is issued. If error conditions exist, Unit Check accompanies Channel End and Device End. If the message is terminated prematurely by a Halt I/O, the message is rejected via BSC line control. An EOT response is sent to the CPU.

Read. Halt I/O terminates data transfer to the channel. If this command issued while the data transfer is still in progress, the termination will set the Lost Data bit in the sense byte (bit 6) and end with CE-DE-UC. If the Halt I/O is issued after the last byte of data has been processed, but before generation of ending status, the Read ends normally with CE-DE unless an error condition had existed, in which case UC will also be set.

Prepare. If Halt I/O is received before receive data has been queued for processing to the channel, the operation is ter-

minated immediately with CE-DE-UE. If Halt I/O is accepted after data detection, the command proceeds to its normal ending point. The ending status will be CE-DE.

Sense. The result of Halt I/O for this command is the same as for a Read command.

No-Op. Halt I/O will not affect this command since it performs no operation and is handled as "command immediate."

Test I/O. Halt I/O will not affect this command since it performs no operation in the 2715 and is handled as a "command immediate."

Command Not in Process. If the 2715 is command-free, the Halt I/O will not affect the present state and will be disregarded. No ending status will be generated for this condition.

Binary Synchronous Communications Adapter (Standard on 2715 Model 2)

The Binary Synchronous Communications (BSC) adapter permits remote operation of the 2715 Model 2 over common-carrier or privately owned communications facilities with: (1) a System/360 equipped with a 2701 SDA-II or a 2703 Synchronous Attachment; or (2) a System/360 Model 25 equipped with ICA/SDA. Operation is in half-duplex mode for data, though the transmission facility can be two-wire or four-wire. The code is EBCDIC. The transparency feature must be specified for the 2701 SDA-II or the Model 25 SDA. Transparency is standard on the 2703 with EBCDIC code. The 2715 Model 2 does not provide USASCII code.

Communication between the System/360 and the 2715 Model 2 will be via one of the following three configurations:

1. Point-to-point, non-switched—at 600*, 1200, 2000, 2400, or 4800 bps.
2. Point-to-point, switched—at 600*, 1200 or 2000 bps.
3. Multipoint**, non-switched—at 600*, 1200, 2000, or 2400 bps.

*600 bps is for World Trade modems only.
**Multipoint operation requires Expanded Capability feature.

BSC functions provided by the 2715 are: identification, polling, contention, selection, headers (nonuser 2715 to System/360 data only), transparent text, terminate, and disconnect.

If the data set does not provide clocking, a Synchronous Clock feature is required. Refer to *TP Systems Summary*, Form A24-3090-3 or later edition, for information on data-set attachments.

Data transmission to and from the System/360 is in transparent mode only; the 2715 does not support USASCII.

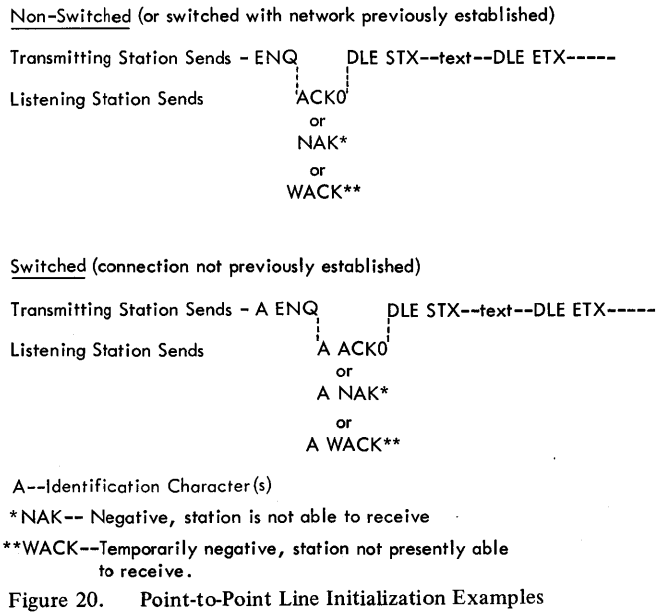


Figure 20. Point-to-Point Line Initialization Examples

Initialization—Point-to-Point

When a station (System/360 or 2715) determines that a transmit queue contains a message to be transmitted, it enters the initialization stage of transmission. This station then contends for the line by sending ENQ—or A ENQ [identification character(s) followed by ENQ character] on a switched network—to the other station. The listening station then responds with a positive acknowledgment ACK0 (or A ACK0 on a switched network), thereby completing the initialization stage. Figure 20 shows examples.

Initialization—Multipoint

In the multipoint operation, the System/360 (control station) controls all initialization. If the System/360 desires to transmit a message to the 2715, it will go into selection mode. If it desires to service the 2715—that is, check to see if the 2715 has a message(s) to transmit—it will go into polling mode. The positive response to selection is ACK0, whereby the System/360 then transmits its data. The positive response to polling is the text message itself. Figure 21 shows examples.

Text Replies

At the completion of the initialization stage, the data link is established between the System/360 and the 2715, and the master starts the transmission of the text message. The text message is always preceded by the control characters DLE, STX, and is always followed by the control characters DLE, ETX (ETB). The slave responds to the ETX (ETB) character with a positive acknowledgment ACK-0 or ACK-1 to the master, in case of correct transmission, or with the negative acknowledgment NAK, in case of incorrect transmission. Upon receiving a NAK indication, the master will repeat transmission of the same message until successful

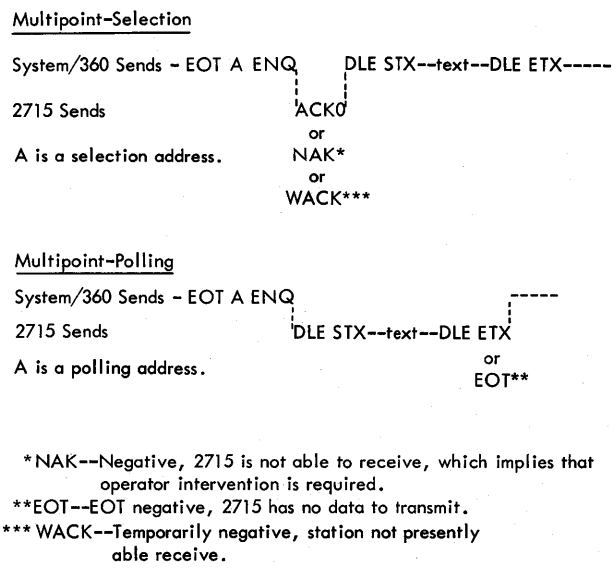


Figure 21. Multipoint Line Initialization Examples

transmission is achieved or until the number of retries has been exhausted, at which time errors will be logged (that is, when the 2715 is the master). After receiving a positive acknowledgment, the master continues to transmit its text messages, with the same format just described, until the transmit queue has been exhausted. If the master receives an improper ACK (that is, ACK-0 when ACK-1 is expected or ACK-1 when ACK-0 is expected, after a text message but before having sent ENQ), the master will transmit ENQ a specified number of times until a negative acknowledgment or the proper response has been received. If the proper acknowledgment is received, the next message is transmitted; if a negative acknowledgment (NAK) is received, the message is retransmitted.

If no response (or an invalid response) is received to the message transmitted, the master will transmit ENQ until either a response is received or the specified number of retries has been exhausted. If the proper response is received, the next message is transmitted. If an improper acknowledgment is received, the last message is retransmitted. (If the 2715 is the master station and the error-retry count is exhausted, the error is logged, an operator-awareness message "data link not operational" is sent to the 2740, and the 2715 rebids for the line.)

Switched Network Operation

During the initial configuration of the system, the 2715 can be assigned to be either an originating or an answering station.

If assigned as an originating station, the 2715 continuously monitors 'data set ready'. When it detects that the data set is ready, the 2715 sends an identification sequence followed by ENQ. When it receives a positive acknowledgment from the CPU, the 2715 sends data, if available, or EOT if no data is available.

If assigned as an answering station, the 2715 can operate in either manual or auto-answer mode, depending on the data-set hookup. When the 2715 is an answering station and its data set receives a signal, the 2715 monitors for an identification sequence. If no identification sequence is received within 20 seconds, the 2715 disables the line (timeout condition). If the identification sequence is received, data transmission is maintained as in a point-to-point configuration.

The 2715 disables the data set ("go-on-hook") when DLE EOT is detected or when no activity is present on the line for 20 seconds.

Special BSC Considerations for the 2715

Reverse Interrupt (RVI). Reverse interrupt allows a slave station to request control of the line from the master station. When the slave station desires to interrupt the master station to gain line control, the slave station sends RVI instead of a normal positive acknowledgment. If the 2715 receives the RVI, the 2715 responds with EOT providing it has more than 64 empty buffers available. If the 2715 is the slave station, it transmits RVI when it has a queued, priority message.

Wait Before Transmit–Positive Acknowledge (WACK). The WACK character is a positive response from the slave station that requests the master station to wait before it transmits further text messages.

When the 2715 is the slave station, it responds with WACK when it has more than 36 buffers (for 16K storage) for 81 buffers (for 32K storage) filled with data from the CPU that is waiting to be transferred to the 2740, a 1053, or maintenance module.

When the 2715 is the master station, a response of WACK causes the 2715 to continue to send ENQ's until either the CPU responds with ACK or a user-specified number of ENQ's has been transmitted. If the CPU responds with ACK, the 2715 sends the text message. If the specified number of ENQ's occurs before an ACK is received from the CPU, the 2715 sends EOT in response to WACK.

Termination (EOT). When the master station terminates message transfer and the appropriate positive acknowledgment is received in response to its last message, the master will transmit EOT to the slave. The EOT will put the link in control mode, ready for new transmissions. Thus, the transfer state is terminated.

The 2715 transmits EOT to indicate some unusual conditions as follows:

- EOT is transmitted when the sum of message-transaction lengths plus two does not equal the total message length.
- EOT is transmitted if the 2715 detects an incorrect message control byte.

- EOT is transmitted if the message received exceeds 126 bytes.
- EOT is transmitted to reinitialize control if the error recovery procedure does not succeed in correctly receiving a transmission.

Disconnect (DISC). The 2715 switched-network configuration provides for a 20-second timeout to prevent prolonged periods of data link inactivity. Upon receipt of DISC (DLE EOT) or after 20-second timeout, the 2715 will automatically go "on-hook."

The 2715 transmits an EOT when it is either a master station ending a message transfer or a slave station responding to a master station transmission of EOT. After transmitting the EOT, the 2715 initializes a 20-second timeout and relinquishes the right to bid for the line. If the 2715 does not receive a response (ENQ, EOT, or DLE EOT) before the end of the 20-second timeout, it disconnects the data link by dropping the data-set connection. If the CPU responds with EOT before the end of the 20-second timeout, the 2715 responds with EOT (assuming it has no need to bid for the line) and restarts the 20-second timeout. This control sequence allows the System/360 to override the 20-second timeout if it desires.

Operator-Awareness Message. The 2715 provides two operator-awareness messages to inform the user of communication problems. These two messages are:

- Data link not operational.
- Data link established.

"Data link not operational" is printed on the 2740 when the retry count is exhausted. No other messages are printed until one good message is transmitted over the BSC line; when a good message is transmitted, "data link established" is printed on the 2740.

Leading Graphics. The 2715 will not transmit leading graphics. However, it will accept up to seven graphics preceding a slave-station response (ACK/NAK). The 2715 monitors the graphics for control characters only, and otherwise will not act upon them.

Real-Time Clock (RTC)

This feature is standard on the 2715 Models 1 and 2. Functions provided by this feature are:

1. Maintains a 24-hour clock that time-stamps all user data at the transaction level (that is, transaction header will contain time stamp). The time stamp consists of four EBCDIC characters that specify hours and minutes. For 2715 to System/360 messages, the time stamp contains the value of the clock when the first data entry of the transaction was received. For System/360 to 2715 messages, the time stamp must contain valid numeric EBCDIC characters. Messages to the 2740 or 1053 print the time stamp preceding the text.
2. Broadcasts time of day about every four seconds to all 2791 Area Stations' visual display. At the user's option, this time will be maintained as either 24-hour or 12-hour clock.

Time Advance

A standard option allows the 2715 to synchronize the advance of the RTC from the user's master-clock system. If this option is not used, the RTC advance is synchronized from the 2715 power source. The master-clock systems used may be one of three types: three-wire self-regulating, two-wire polarity-reversing, or two-wire single-impulse. The duration of the 'minute advance' pulse must be at least 275 milliseconds. For the three-wire self-regulating and the two-wire polarity-reversing master clocks, the duration of the correction pulse must be at least 275 milliseconds. The two-wire single-impulse master clock does not provide correction pulses.

Interface information is provided in the *IBM 2790 Installation Manual–Physical Planning,* Form A27-3017.

Time Set

The 2715 CE/operator panel allows the operator to set and display the RTC. Time must be set by the operator whenever the 2715 is powered on.

Day Number

The 2715 provides a three-byte EBCDIC field for storing day number. The day number can be entered by the operator at the CE/operator panel whenever the 2715 is powered on. The day can also be entered or changed from the System/360.

When the 2715 transfers data to the System/360 or to disk, it prefixes a message header to the data. The day is included in the message header.

CE/OPERATOR PANEL

The CE/operator panel (Figure 22) is accessible to the operator and can be used for limited functions. Many of the switches and lights are designed for Customer Engineering Maintenance, and cannot be used by the operator.

Pushbutton Switches

Power On. Turns the 2715 power on.

ICPL. Loads the Initial Control Program.

Power Off. Turns the 2715 power off.

Alarm Reset. Resets the audible alarm.

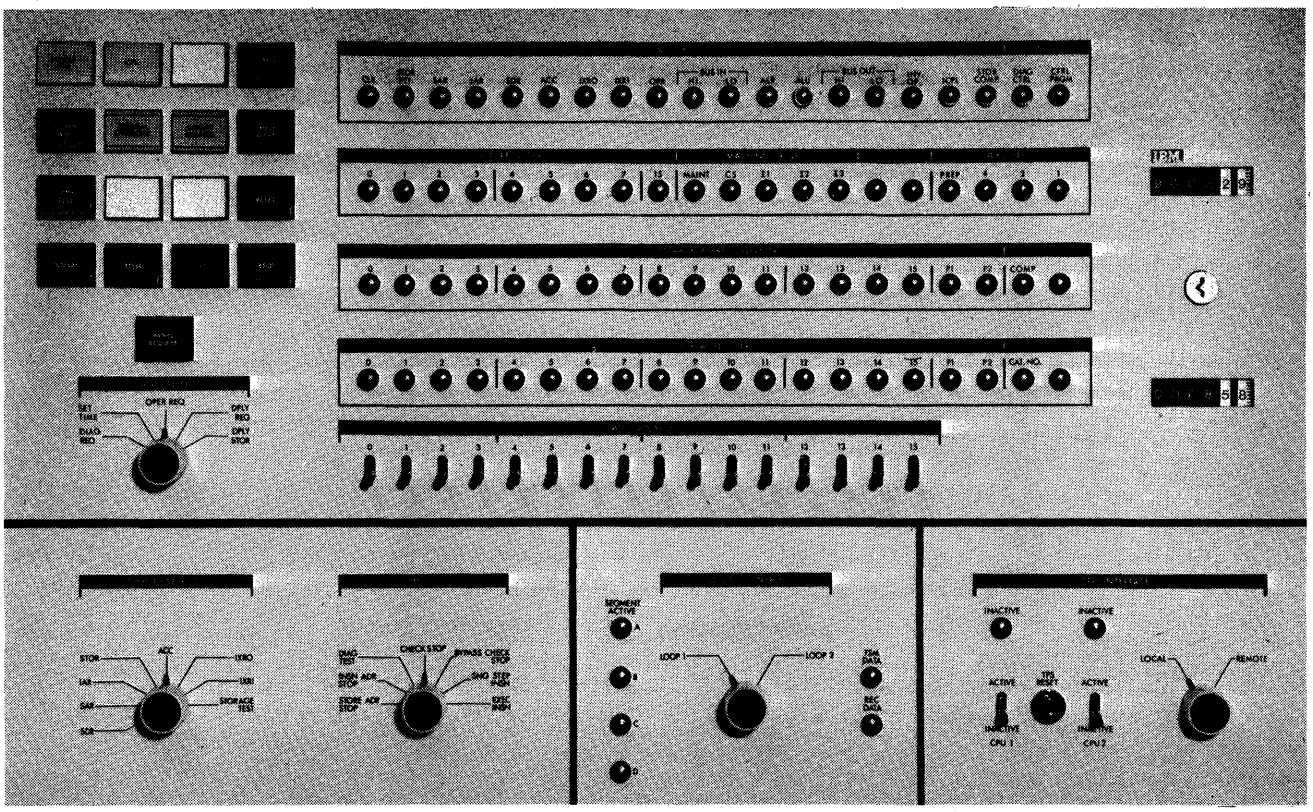


Figure 22. CE/Operator Panel

Check Reset. Resets CE check lights.

Lamp Test. Tests indicator lamps.

Reset. CE pushbutton.

Display. CE pushbutton.

Stor. CE pushbutton.

Start. CE pushbutton.

Stop. CE pushbutton.

Panel Request. Starts the routine selected by the Panel Select switch.

Panel Select

The Panel Select switch selects the following operator or CE routines.

Diagnostic Request. Requests BSC on-line test or 2791/2793 on-line diagnostic.

Set Time/Day. Enters time or day from the Data/Address switches when the Panel Request button is pushed.

Operator Request. Allows the operator to request the following routines by using the Data/Address switches and Panel Request (see "2715 Control Requests" for details).

1. Monitor Time
2. Monitor Day
3. Bypass Area Stations
4. Restore Area Stations
5. Bypass Segment
6. Restore Segment
7. Stop Loop Input
8. Start Loop Input
9. Set Dual Communication
10. Reset Dual Communications
11. 2715 Restart
12. Scan Area Station Errors
13. Send Partial Error Log

Diag Continue. Supplements "Diagnostic Request" to:

1. Enter input configuration data prior to initialing a diagnostic.
2. Continue AS diagnostic to detect additional errors.

Display Storage. Allows the operator to display the storage address selected in the Data/Address switches without interfering with normal operation.

Display Select

The Display Select switch is a CE routine switch.

Mode

The Mode switch is a CE routine switch.

Loop Control

The Loop Control panel comes in three configurations.

Basic Configuration. On the basic 2715, this panel shows the status of the 2790 loop in indicator lights.

Line Transfer Switch Configuration. If the 2715 has a Line Transfer switch feature, the Loop Control panel has a four-position Loop Selection switch in addition to the status indicators.

Line Transfer Switch–Third Unit Configuration. If the 2715 has a Line Transfer Switch–Third Unit feature, the Loop Control panel has a two-position Loop Selection switch in addition to the status indicators.

CPU Interface

The CPU Interface panel provides a 2715 Model 1 with Local/Remote power, Two-Processor Switch control, and Active/Inactive control for a 2715 without TPS. This panel is blank for a 2715 Model 2.

Data/Address

The Data/Address switches are used to enter data or address parameters into the 2715.

Catalog Number Light

The Catalog Number light indicates that the Display Register lights contain a catalog number. The catalog number indicates a machine condition as follows:

X'01' – Invalid panel request.
X'02' – No buffers available to honor request.
X'03' – Invalid time digits entered from panel.
X'04' – Invalid day digits entered from panel.
X'05' – Area Station failed to bypass.
X'06' – Area Station failed to restore.
X'07' – Request invalid for local configuration.
X'08' – Request failed to bypass/restore segment.
X'09' – Start loop timeout.
X'0A'– Bad label during disk-label check.
X'0B'– Successful completion of label-correction program.
X'0C'– Access mechanism failure.
X'0D'– Status error during label correction.
X'0E'– AS diagnostic can't execute because loop is down.
X'0F'– AS diagnostic aborted on loop failure.
X'10' – Invalid diagnostic request.
X'41' – Invalid time/day digits entered from panel.
X'42' – Invalid 2715 restart request–loop is up.

Note: The alarm rings with the following conditions.

X'81' – Write failure during error-message assembly.
X'82' – Double write failure on logout sector (alternate used).
X'83' – Write failure during error-counter update.
X'84' – Invalid request for canned message.
X'85' – No buffers available for threshold-sort message.
X'89' – 2740 intervention required (power off, out of paper, or wrong mode).
X'8A'– Disk hard status error.
X'8B'– Disk seek failure.
X'8C'– Disk timeout
X'8D'– Disk overflow.
X'8E'– Disk double write.
X'91' – No source for maintenance request.
X'95' – Loop-adapter hardware error.
X'98' – MPX code checkpoint error.
X'99' – MPX hardware check.
X'9A'– Loop down due to buffer pool problem.
X'9B'– 2740 malfunction.
X'A1'– BSC error on data-set interface.
X'A2'– BSC hard error.

2790 ADAPTER

The 2790 adapter controls the high-speed (approximately 500,000 bits per second) transmission loop. The loop is divided into four segments at the 2790 adapter; each segment has its own connections to the adapter. Data from each segment is normally fed to the next segment in the loop. However, any combination of segments may be bypassed under user or diagnostic control. When a segment is bypassed, the Area Stations on that segment receive data from the adapter, but the adapter will not accept data from the segment.

Data-Handling Capacity

The 2790 adapter can concurrently receive input data from eight different Area Stations, and send output data to five different Area Stations.

The number of data entries per second that the 2790 system can handle depends on the type of data entry and if the "delete blanks" feature is activated on the Area Station. The following set of formulas provides a method of computing the peak use of the 2790 transmission line for a given data traffic. Figure 23 shows some of the formulas in chart form. The chart and formulas will aid the user in determining whether his peak traffic exceeds the transmission-line capacity. If peak traffic exceeds the line capacity, the user may want to place limitations on nonpreferred traffic during periods of peak preferred traffic or he may locate preferred-traffic terminals first on the transmission-line loop.

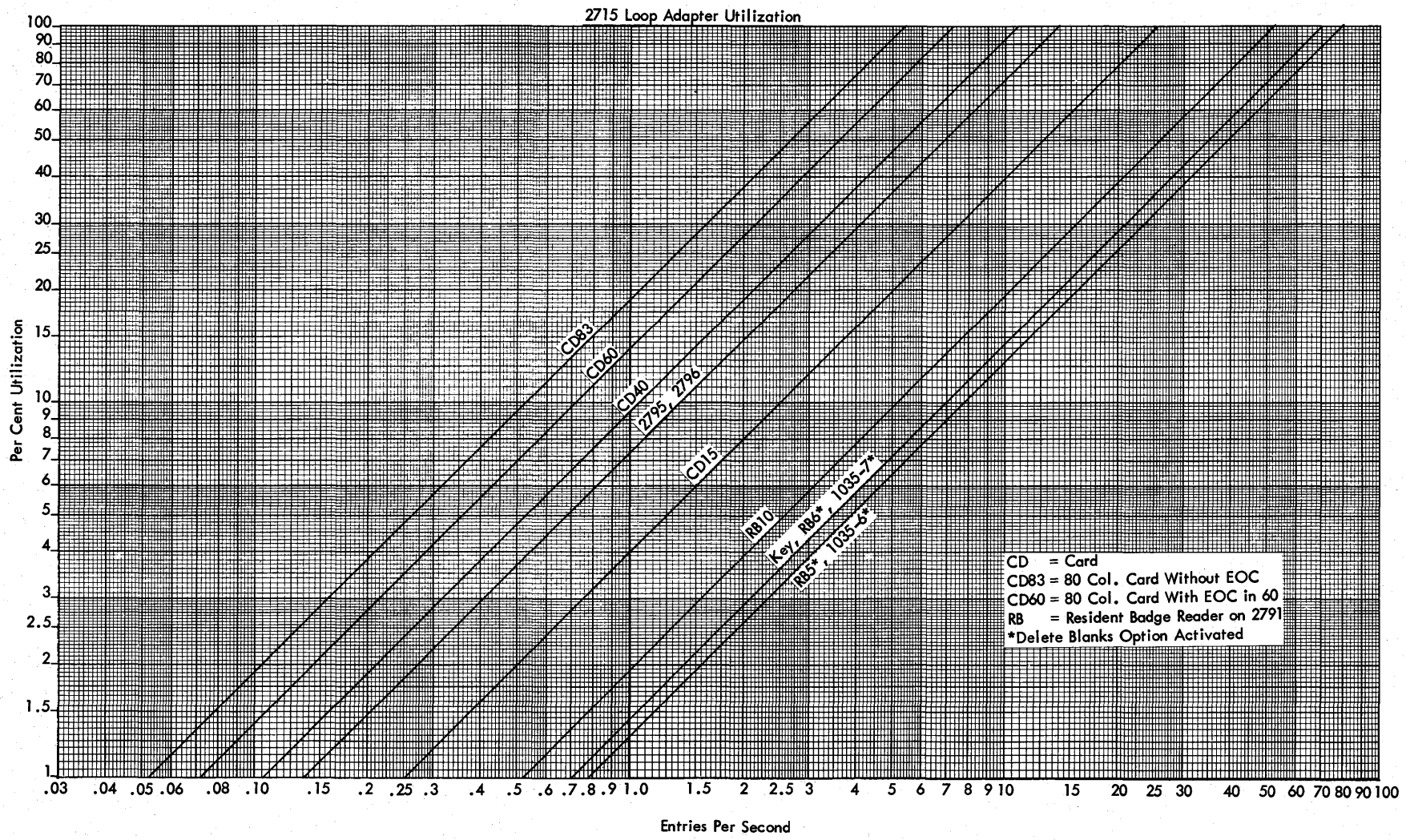


Figure 23. Transmission Line Utilization Chart

Note: Utilization of the 2790 transmission line loop may be degraded if the 2715 to System/360 data link is not adequate to service priority data. Deferred data is automatically stored on 2715 disk and does not affect utilization-degradation considerations. If the 2715 to System/360 data link is permanently down, all priority data is stored on the 2715 disk without degrading the loop utilization. When the 2715 disk is filled, the 2790 system is brought to a soft stop.

The user can bypass and restore segments of the 2790 adapter loop or individual Area Stations under control of messages received at the 2715. These messages can be sent from System/360 or from the 2715 CE/operator panel. Thus the System/360 can dynamically bypass and restore 2790 terminals to provide priority for preferred traffic.

For example, a user with a time-attendance application may have a requirement that all employees clock out during a specified time interval. Possibly other data traffic combined with attendance-recording traffic may exceed full-load traffic for a short period of time, thus increasing the time required to clock out the employees. If the graph and formulas show that this is likely, the user may request that other employees not enter nonattendance data during the attendance-recording period, or the System/360 can temporarily bypass those Area Stations not used for attendance and restore them after completion of the attendance period.

Badge Reading on 1035–Delete Blanks Activated on 2791

% Utilization (1035) = (N + 4) 0.128 x entries/second
where N=number of punched badge positions

Badge Reading on 1035–Delete Blanks Not Activated on 2791

% Utilization (1035) = 1.79 x entries/second

Badge Reading on 2791 Resident Badge Reader–Delete Blanks Not Activated

% Utilization (2791 RB) = (N + 5) 0.128 x entries/second
where N=number of punched badge positions

Badge Reading on 2791 Resident Badge Reader–Delete Blanks Activated

% Utilization (2791 RB) = 1.92 x entries/second

Keyboard Entries from 2791 Keyboard

% Utilization (2791 K) = 1.41 x entries/second

Card Entries from 2791 Card Reader

Utilization (2791 CD) = (0.219N + 0.64) x entries/second
where N=number of columns scanned from card up to and including EOC character. N=83 if EOC is not present.

Entries from Data Entry Units

% Utilization (2795/2796) = 7.27 x entries/second

Total Utilization

Total utilization equals the sum of the individual utilizations. If total utilization reaches 100%, requests for data entries in excess of 100% will be serviced when prior read operations are completed. When data entry requests exceed 100% utilization, the Area Stations at the beginning of the tra transmission-line loop will be serviced before stations at the end of the loop.

Utilization Examples

Example 1. Assume the user wants to clock out 5400 employees in three minutes (30 employees per second) using sixty 1035 Badge Readers (Delete Blanks off).

% Utilization = 1.79 x 30 = 53.7%

Thus, allowing two seconds per badge entry, the 30 clock-outs per second can be obtained at a walk-by rate of 30 per badge station per minute if other system requirements do not exceed 46.3% of the system utilization. The 46.3% would allow three 56-column cards and one 2796 data entry to be read during the same second without affecting the badge-reading rate. Should more than 46.3% of read time occur, and depending on physical placement of the terminals on the transmission line, degradation of the clock-out rate to less than 30 per second may occur.

Example 2. Assume the customer wants to clock out 9000 employees in a three-minute period (50 employees per second) using one hundred 1035 Badge Readers (Delete Blanks off).

% Utilization = 50 x 1.79 = 89.5%

This leaves 11.5% for other read operations. Thus, one 52-column card or two 2795 entries could also be read during this second without degrading attendance-clockout rate.

Example 3. Assume user wants to clock out 30 employees per second as in example 1, and also assume that:

1. 1035's are down-line;
2. Other concurrent operations during clockout place a demand for six 56-column cards/second.

Further assuming that card reading takes priority because of channel position, only 22.6% utilization remains for attendance clockout.

Entries/sec = % Utilization/1.79=22.6/1.79=12.6 badges/sec

Hence, clock-out rate has been reduced from 30 badges per second to 12.6 badges per second. Total clock-out time for 5400 employees increases to 7.1 minutes if the card rate of six cards per second is sustained for the full 7.1 minutes of attendance clockout.

It is suggested that the customer place limitations on non-attendance transactions furing clockout if this is a sensitive item on his system.

Example 3 demonstrates an artificial peaking condition of 2556 card transactions occurring during the clock-out

period lasting 7.1 minutes, and is used solely to demonstrate that traffic conditions can impose wait-time irregularities. Where this appears sensitive, the user should assess his peak traffic conditions to determine if limitations on nonpreferred traffic should be made during periods of peak preferred traffic.

2715 OPERATIONAL CHARACTERISTICS

Data Management

The data-management scheme of the 2715 is devised to handle data from the loop and pass it to the processor while performing the transaction-assembly function enroute. Provision is made to defer data transmission by storing it on the integral disk unit for subsequent transmission to the processor.

The 2715 integral disk is also used during the transaction-assembly function when the traffic load reaches such proportions that it is impractical to handle it in core storage. Data transactions from System/360 to the 2715 are transferred to the 2740 terminal or the 1053 printer for printout, or to the 2715 maintenance section for internal control. This System/360 output data is never stored on the 2715 disk. All undeliverable data transactions will be returned to System/360 problem program as priority data with an error code inserted into the second byte of the transaction-header time field. The error condition will be encoded into the zone bits of this byte so as to preserve the original time stamp. Note that the zone bits of the first time byte may also be changed.

The following error codes are assigned:

X'E' 2740 not attached—The 2740 is not attached to the system, and the 2740 was specified in a user-table entry. The transaction-list number in the header identified the incorrect user-table entry.

X'D' 2740 intervention required—The 2740 requires intervention because it has power off, is out of paper, or is in improper mode.

X'C' Incomplete transaction—This transaction is incomplete due to one of several causes:

- Operator aborted the transaction.
- Byte count was exceeded on a repeat transaction.
- Stop loop was executed and transaction was not completed in the time allowed.

X'B' 1053 not attached—The transaction was addressed to an Area Station that did not have a 1053 attached. This can be due to CPU program problems if the CPU originated the transaction, due to user-table problems in the case of message routing with implicit addressing, or due to operator errors in message routing with explicit addressing.

X'A' 1053 not operational—The addressed station has a 1053 attached, but for some reason it is not operational.

X'9' 2740 overload—The 2740 was specified in so many transactions that a significant part of the 2715 buffering was queued for the 2740 and system operation was affected. In this case the 2715 will flag transactions with this error code, bypass the 2740, and send them to the processor as priority data. Transactions already on the 2740 queue are not effected and print out at the 2740. When the 2740 queue clears, the system will revert to its normal operation.

X'8' Message-routing overload—The output queue contained so much of the 2715 buffering that system operation was affected. The 2715 will flag transactions with this code and route them to the processor as priority data. Transactions already on the output queue are handled normally. When the output queue clears, the system will return to normal operation.

Note that in the last two cases the user program still has access to the 2740 or 1053 output within the normal output limitations. Thus he may reroute this traffic under control of the user program is he wishes.

It is the user's responsibility to restore the zone bits in the first and second bytes of the time-stamp field whenever he detects an error if he wishes to restore the time field to true EBCDIC representation (for example, if he were to re-route the transaction).

The idle character must not be sent to the 1053 Printer (it is an invalid character for the printer). The idle character should be sent to the 2740 printer if the tab carriage control character is embedded in the text. If a new-line character is embedded in the text, the 2715 inserts the required trailing idle characters.

Deferred-Data Mode

Deferred-data mode is set or reset by a control transaction from the System/360. When deferred-data mode is set and the 2715 has no priority data, deferred data is sent to the System/360 as soon as a full block of data is on the disk.

If the 2715 receives a 'stop loop' control transaction just prior to receiving 'set deferred data mode', the response to 'set deferred data mode' is held up until all data is sent to the CPU. When all data has been sent, the 2715 sets deferred-data mode and sends a positive response to the CPU. The 'reinitialize disk' transaction control will not be accepted by the 2715 until both 'stop loop' and 'set deferred data mode' have been executed and the positive response to 'set deferred data mode' has been sent.

2715 to System/360		System/360 to 2715	
Type	Hex Code	Type	Hex Code
Transaction ID	00-7F	Bypass Area Station	C1
Positive Response CPU Request	CA	Restore Area Station	C2
Negative Response CPU Request	CB	Bypass Segment	C3
Response Invalid CPU Request	CC	Restore Segment	C4
Positive Response 2715 Request	DA	Set Deferred Data Mode	C5
Negative Response 2715 Request	DB	Stop 2790 Input	C6
Response Invalid 2715 Request	DC	Restore 2790 Input	C7
User Defined	F0-F9	User Table Load Start	D1
Unsolicited 2715 Response	FD	User Table Load Data	D2
		User Table Load End	D3
		CPU Restart	D4
		2715 Restart	D5
		Scan Area Station Errors	D6
		Send Partial Error Log	D7
		Reinitialize Disk	D8
		Set Day Number	E2
		Monitor Day Number	E3
		Monitor Time	E4
		Reset Deferred Data Mode	E6
		1053 Printer Data	FA
		2740 Terminal Data	FB

Figure 24. Transaction Control Byte

Data Format

Data Entry

A data entry consists of a single block of data entered by an operator at an Area Station, Data Entry Unit, remote Badge Reader, or other input device. See "Area Stations" and "Data Entry Units" for definition by device type.

The Transaction

A transaction may consist of one to thirteen data entries from a 2796, or from one to sixteen data entries from a 2791 or 2795, for a maximum of 247 data bytes per transaction.

An assembled transaction consisting of single or multiple data entries has an eight-byte header prefixed to the first data entry. Thus, the maximum transaction length is 255 bytes. A System/360 to 2715 transaction may contain up to 126 bytes, including an eight-byte header that must be provided by the System/360 problem program. The transaction header contains the following information:

1st byte	Length (binary)
2nd byte	Control (binary)
3rd byte	Area Station address (binary)
4th byte	Device address (binary)
5th-8th byte	Time stamp (EBCDIC)

Length. A binary count of the number of bytes in the transaction including the eight-byte header. The maximum-length transaction is 255 bytes from 2715 to System/360 or 126 bytes from System/360 to 2715. Output transactions will normally be formatted as a line of print.

Control. A binary code that specifies the type of transaction. Figure 24 shows a list of assigned transaction controls.

Area Station Address. A binary address byte specifying which one of 100 Area Stations in the system is either the data source or data recipient. Valid addresses are hexadecimal 80 through E3 for Area Station transactions, or 00 for non-Area Station transactions.

Device Address. A binary address byte which specifies one of 32 Data Entry Units; a 1053 Printer; a 1035 Badge Reader; a digital device input (OEM); or a 2791 resident card reader, badge reader, or manual entry unit. The device addresses (hexadecimal) are:

Badge Reader	X'80' (80 hex)
Card Reader	X'84'
Keyboard (manual entry)	X'88'
Digital Device Read-In	X'8C'
1035 Badge Reader	X'81'–'83'
1053 Printer	X'40'
Data Entry Units	X'C0'–'DF'

Time Stamp. A four-byte field which contains the value of the clock when the transaction was received. It is carried in 24-hour form, in hours and minutes, as EBCDIC characters. For System/360 to 2715 messages, this field is optional; if not used for time, it must contain valid EBCDIC numeric characters.

The Message

All messages are composed of one message header, one or more transaction headers with the corresponding text, and the BSC framing control characters. Message formatting is completely flexible within the limits of message and transaction definitions.

2715 to System/360 Message. The 2715 to System/360 message length is limited to 640 bytes–message header, 5 bytes; transaction header(s), 8 bytes; and text. The message-header format is defined as follows:

First, Second, and Third Byte–Day Number (EBCDIC)
Fourth and Fifth Byte–Restart Number (bit-significant and binary)

Day Number. A three-byte EBCDIC field which contains a customer-specified day number.

Restart Number. A two-byte field which defines type of data and associated restart information. Bit 9 indicates this message is deferred data; bit 10 indicates this message is priority data; the remaining bits indicate a disk address.

System/360 to 2715 Message. The System/360 to 2715 message length is limited to 128 bytes–message header, 2 bytes; transaction header(s), 8 bytes; and text. The message header format is defined as follows:

First Byte–Length (binary)
Second byte–Control (bit-significant)

Length. A binary count of the number of bytes in the message, including the message header. The BSC framing control characters are not included in the count.

Control. A bit-significant byte which indicates one of three destinations for output data. The following hexadecimal notation indicates output destination:

X'01' – 1053 Printers
X'02' – 2715 Control Message
X'04' – 2740 Terminal

Messages originating at the System/360 to be printed on the 2740 attached to the 2715 TCU or to be printed on the 1053 attached to an Area Station must have the format shown in Figure 25.

The 2715 will accept multiple messages within the limitations of the 2715 core-storage sizes:

2715–16K Bytes. The 2715 will accept consecutive messages for a total of 630 internally allocated bytes before forcing System/360 to "wait before transmitting" (WACK). As the byte count decreases to 504 bytes or less, the 2715 will accept one or more subsequent messages.

2715–32K Bytes. The 2715 will accept consecutive messages for a total of 1260 internally allocated bytes before forcing System/360 to "wait before transmitting" (WACK). As the byte count decreases to 1134 bytes or less, the 2715 will accept one or more subsequent messages.

Internally Allocated Bytes. Due to internal control requirements, the following table should be used to determine the number of bytes required by the 2715 to buffer a System/360 output message. Total core-storage requirements must be figured on a transaction basis, with the message header not affecting this total.

Transaction Length (Bytes)	Internally Allocated Core (Bytes)
1 - 14	14
15 - 28	28
29 - 42	42
43 - 56	56
57 - 70	70
71 - 84	84
85 - 98	98
99 - 112	112
113 - 126	126

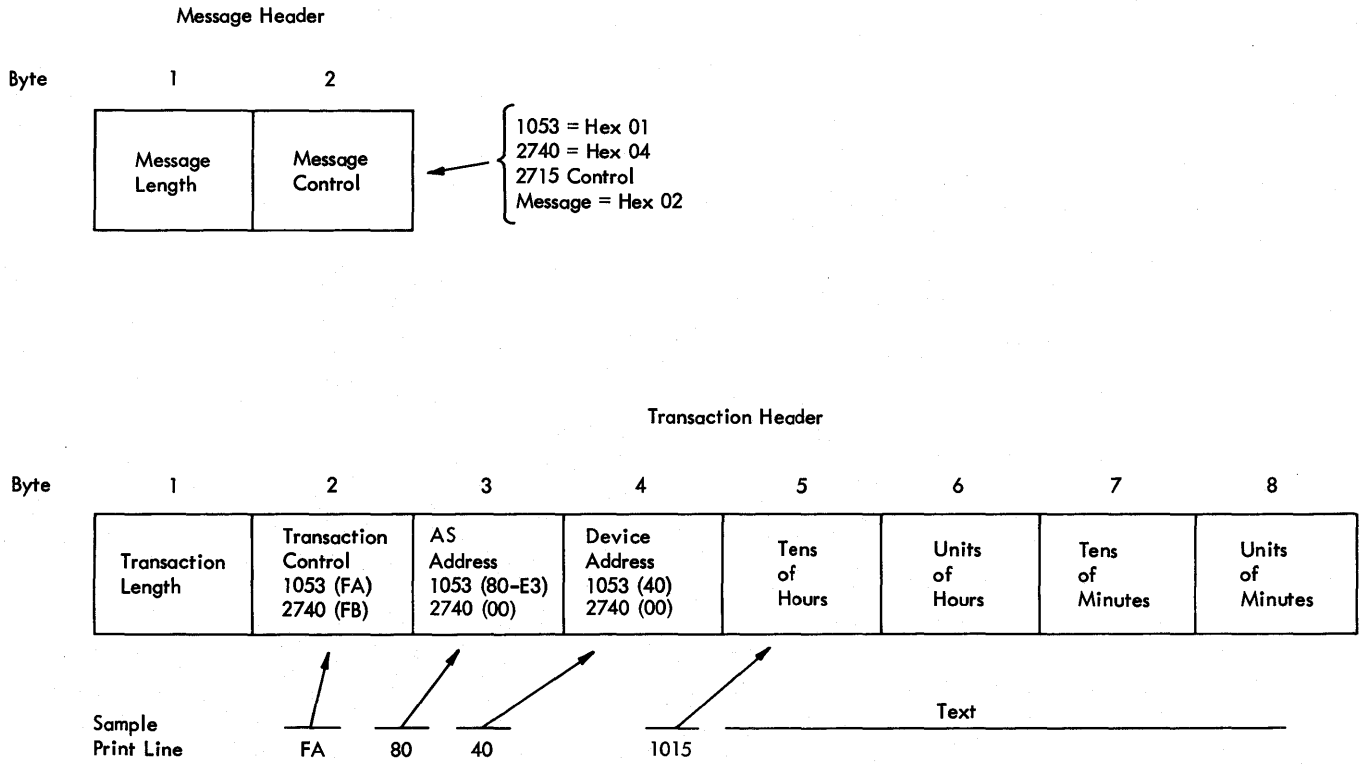


Figure 25. Message Format–System/360 to 2740/1053

AS or DEU to 1053 Printer Message (Message Routing). Messages routed from a Data Entry Unit to an Area Station to a 1053 Printer are formatted as shown in Figure 26. In addition to being routed to a 1053, the message may be logged on the 2740 and/or sent to the CPU as deferred or priority data.

Message routing provides for the handling of implicit and explicit address and/or text as follows:

- Implicit addressing; explicit text* followed by implicit text.
- Implicit addressing; explicit text.*
- Explicit addressing; explicit text* followed by implicit text.
- Explicit addressing; explicit text.*

2715 Control Requests

Figure 27 tabulates information about valid sources for control requests, routing for responses, and data formats for System/360 and CE panel requests. This table will be referred to extensively in this section.

**Explicit text* is one or more data entries.

Request Formats (Standard)

System/360 Originated. The message-header control byte is set to X'02' indicating a 2715 control message. The transaction control byte is shown in Figure 27 for the desired function. The data assignment varies per request. In the following text, data bytes will be referred to as $d_1, d_2, \ldots, d_n$, Note that not all 2715 control requests are valid from the System/360 (e.g., 'set time').

CE Panel Originated. With the exception of 'set time' and 'set work day' requests, all valid CE-panel control requests are made by:

1. Placing the Panel Select rotary switch in the Oper Req position.
2. Entering the desired transaction control byte into the Data/Address switches 0-7.
3. Entering any other required data (varying with request) into Data/Address switches 8-15.
4. Pressing the Panel Request pushbutton.

Note that not all control requests are valid from the CE panel.

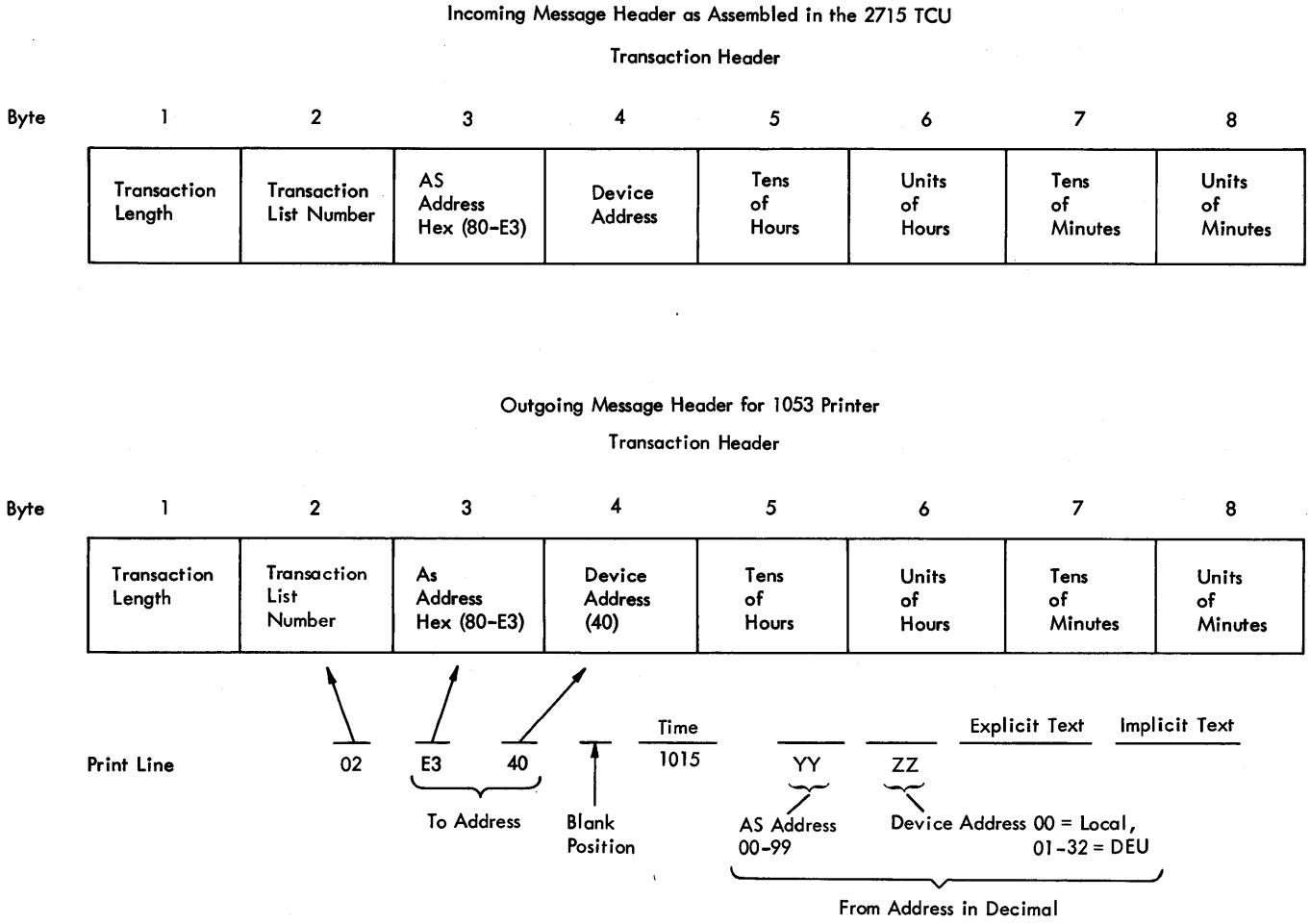


Figure 26. Message Format–AS or DEU to 1053

Response Formats

In Figure 27, the column labeled "Responses" defines where responses are sent as a function of where the request originated. Note that the 2715 sends a response message to the System/360 whenever a panel operator request causes the 2790 system to be reconfigured (e.g., 'bypass AS' initiated by panel request).

To System/360. The transaction bytes for control response messages are shown in Figure 24. The first hexadecimal is 'C' for System/360 initiated requests, 'D' for 2715 (CE panel or 2740) initiated requests. The second hexadecimal digit defines the type response:

'A' = Positive response
'B' = Negative response
'C' = Invalid response

Response data bytes will be referred to as $r_1, r_2, ..., r_n$. Assignments vary per requests. Response messages are transmitted to System/360 at the same priority level as priority data.

To CE Panel. Successful completion of a valid panel operator request is indicated by displaying the transaction control byte in positions 0-7 and X'FO' in positions 8-15 of the display register. An invalid panel response is flagged by displaying X'0001' (unless otherwise stated) in the display register and setting the red Cat. No. lamp. Invalid panel requests never generate System/360 response messages. Negative responses are indicated by setting of appropriate Cat. Nos.

X'C1'–Bypass Area Station

- Function–Causes a 2790 Bypass command to be issued to the designated Area Station, causing it to go off-line. If the Area Station is already bypassed or not defined, a negative response is sent to the source.

- Request Format–

  S/360–Standard format with d_1 = Area Station address.

  CE Panel–Standard format with Area Station address entered in positions 8-15 of the Data/Address switches.

- Response Format–

  S/360 request:

  a. Positive–Standard response, with r_2 containing the Area Station address.

Operator Request	Valid Source(s)			Response Sent To:		CPU Request Format			Panel							
									Request				Positive Response			
						Control Byte		Data	Data Switches (d1-d4)				Display Register (r1-r4)			
	CPU	2740	Panel	CPU	Source	Hex	Kybd	d1-d4	0-3	4-7	8-11	12-15	0-3	4-7	8-11	11-15
Bypass Area Station	X	-	X	X	X	C1	A	A1A2	C	1	A1	A2	C	1	F	0
Restore Area Station	X	-	X	X	X	C2	B	A1A2	C	2	A1	A2	C	2	F	0
Bypass Segment	X	-	X	X	X	C3	C	s	C	3	s		C	3	F	0
Restore Segment	X	-	X	X	X	C4	D	s	C	4	s		C	4	F	0
Set Deferred Data Mode	X	-	-	X	-	C5	E	-	-	-	-	-	-	-	-	-
Stop 2790 Input	X	-	X	X	X	C6	F	-	C	6	-	-	C	6	F	0
Restore 2790 Input	X	-	X	X	X	C7	G	-	C	7	-	-	C	7	F	0
Set Dual Comm.	-	-	X	-	X	C8	H	-	C	8	-	-	C	8	F	0
Reset Dual Comm.	-	-	X	-	X	C9	I	-	C	9	-	-	C	9	F	0
User Table Load Start	X	-	-	X	-	D1	J	-	-	-	-	-	-	-	-	-
User Table Load Data	X	-	-	X	-	D2	K	-	-	-	-	-	-	-	-	-
User Table Load End	X	-	-	X	-	D3	L	-	-	-	-	-	-	-	-	-
CPU Restart	X	-	-	X	-	D4	M	C	-	-	-	-	-	-	-	-
2715 Restart	X	-	X	X	X	D5	N	C1C2	D	5	-	-	D	5	F	0
Scan AS Error	X	X	X	-	X*	D6	O	-	D	6	-	-	D	6	F	0
Send Partial Error Log	X	-	X	X	-	D7	P	-	D	7	-	-	D	7	F	0
Reinitialize Disk	X	-	-	X	-	D8	Q	-	-	-	-	-	-	-	-	-
On-Line Core Dump	-	X	-	-	X	D9	R	a1-a4	-	-	-	-	-	-	-	-
Set Day	X	-	X	-	X	E2	S	0,n1-n3	F	N1	N2	N3	E	2	F	0
Monitor Day	X	-	X	-	X	E3	T	-	E	3	-	-	0	N1	N2	N3
Monitor Time	X	-	X	-	X	E4	U	-	E	4	-	-	T1	T2	T3	T4
Set Time	-	-	X	-	X	E5	V	-	T1	T2	T3	T4	E	5	F	0
Reset Deferred Data Mode	X	-	-	-	-	E6	W	-	-	-	-	-	-	-	-	-
Bypass/Restore 2740 Alarm	-	-	X	-	X	-	-	-	E	7	-	-	E	7	F	0

Note: Uppercase letters represent hexadecimal characters
Lowercase letters represent EBCDIC characters
A1A2 = Area station address
a1-a4 = Core address
C = Restart Constant
d1-d4 = Data positions
N = Any number
s = Segment address
T = Time

* Sent to 2740 if available; otherwise, sent to CPU.

Figure 27. Control Requests

b. Negative–Standard response is sent (r_2 = Area Station address) when the designated Area Station fails to bypass, or if the Area Station is not defined.

CE panel request:

a. Positive–Standard response.
b. Negative–Cat. No. X'0005' is contained in the Display Reg.

X'C2'–Restore Area Station

- Function–Causes a 2790 Restore command to be issued to designated Area Station, causing it to go on-line.

- Request Format

S/360–Standard format with d_1 containing the Area Station address.

CE Panel–Standard format with Area Station address entered in positions 8-15 of the Data/Address switches.

- Response Format

S/360 request:

a. Positive–Standard response with r_2 containing the Area Station address.
b. Negative–Standard response is sent (r_2 = AS address) when the designated AS fails to restore.

CE panel request:

a. Positive–Standard response.
b. Negative–Cat. No. X'0006' is contained in the display register.

X'C3'–Bypass Segment

- Function–Causes the designated segment to be bypassed. The steps in accomplishing this are:
  a. If the 2790 input is active, the actions of the 'stop 2790 input' (X'C6') are performed (record stop, timeout, and aborting of transactions). No X'C6' response is generated.
  b. The designated segment is bypassed.
  c. A X'C3' response is sent to S/360 unconditionally (unless an invalid panel request)

- Request Format

S/360 and Panel–Standard format with r_2 = designated segment in EBCDIC.

- Response Format

See "General Responses."

X'C4'–Restore Segment

- Function–Causes the loop to stop momentarily and the designated segment to be restored to operation. The steps are:
  a. If the 2790 input is active, the loop is brought to a record stop and an eight-second timeout is performed.
  b. The designated segment is restored.
  c. The loop is returned to its original state and a response message sent to the S/360.

- Request Format

S/360 and CE Panel–Standard format with r_2 = designated segment (EBCDIC) to be restored.

- Response Format

See "General Responses."

X'C5'–Set 'Read Deferred Data Mode'

- Function–Causes the 2715 to read deferred data from 2715 disk storage and to send it to S/360. The sending of the deferred data has lower priority than priority data residing in core storage and on 2715 disk. The resetting of this mode may be done in two ways:
  a. 'Reset read deferred data mode' control request.
  b. The mode will be *automatically* reset when the 2790 input has been stopped, and there is no priority or deferred data in the 2715, either on disk or in core.

- Request Format

S/360–Standard format.

- Response Format

a. Positive–No response is generated as a direct result of executing this control request. However, when the 'read deferred data mode' is reset automatically, a standard positive response to the X'C5' control request is generated, with:

r_2 = Binary buffer element count of data remaining on the 2740 Output queues.

r_3 = Buffer element count of data remaining on the 2790 output queues.

X'C6'–Stop 2790 Input

- Function–Stops the 2790 input. The steps in bringing the 2790 input to an orderly stop are:
  a. A 2790 transactions stop (that is, no new transactions started) is performed and a timeout is done to allow

chained transactions in progress to complete. The duration of this timeout can be specified as a configuration constant.
b. All incomplete transactions are flagged and all transactions are assembled ready for transfer to the S/360.
c. All deferred data in core is written on the 2715 disk.
d. An X'C6' response is sent to S/360 unconditionally (unless it was a panel request and the 2790 input was already stopped).

- Request Format

  S/360 and Panel–Standard format with no additional data required.

- Response Format

  See "General Response."

X'C7'–Restore 2790 Input

- Function–Restores the read channels to the 2790 system allowing 2790 data input and output of time to the Area Stations.

  NOTE–After an ICPL:

  a. A 'set time' control request must be executed before an X'C7' request will be accepted as valid.
  b. A response message is sent to S/360 (unless an invalid panel request).

- Request Format

  S/360 and Panel–Standard with no additional data required.

- Response Format

  See "General Responses."

General Responses

S/360 Responses. The X'C3', X'C4', X'C6', and X'C7' control requests (which alter the 2790 system) share a common S/360 response-message format, which is defined here.

In general the response message will have as data:

r_1 = transaction control byte (Standard)
r_2 = condition code

The response message formats and corresponding condition codes are:

a. Positive–

   r_2 = requested segment for X'C3', X'C4' requests, unused for others–see error codes 'F5' and 'F6' for definitions of data bytes r_3 - r_n

b. Negative–

   1. r_2 = X'F1': 2790 loop remains open with all segments bypassed.
   2. r_2 = X'F2': 'Receive service' latch in 2715 hardware (2790 Adapter) not coming on.
   3. r_2 = X'F3': all segments bad.
   4. r_2 = X'F4': 2790 system already in requested configuration.

   The following codes are additional data:

   r_3 = A (EBCDIC) if segment A restored; or X'40' if segment A bypassed
   r_4, r_5, r_6, = same as r_3 above for segments B, C, D
   r_8,...,r_n = Addresses of Area Stations bypassed

   5. r_2 = X'F5': A timeout occurred in attempting to re-sync the 2790 system.
   6. r_2 = X'F6': Requested segment configuration would would not restore.

c. Invalid Response–Standard response used for checking bypass/restore requests for valid segments.

   r_1 = transaction control byte
   r_2 = Requested segment (if used in request)
   Also used when attempting to 'restore 2790 input' (X'C7') before setting time.

Panel Response. Any panel request that affects the status of the 2790 system (i.e., C1, C2, C3, C4, C6, and C7) automatically causes a response message to be sent to S/360, with the following exceptions:

- When an invalid segment is specified on Bypass/Restore Segment commands.
- When the 2790 system is already in the requested configuration (except for X'C1')

a. Positive–Standard format.
b. Negative–The following catalog numbers correspond to the S/360 response condition codes:

Condition Codes	*Cat. No.*
F1	'0011'
F2	'0012'
F3	'0013'
F4	'0014'
F5	'0015'

c. Invalid Response–Standard format (Cat. No. X'0001')

X'C8'–Set Dual Communications Switch
X'C9'–Reset Dual Communications Switch

- Functions–These control requests are valid only on 2715 Model 2 with Dual Communication Interface feature (see "Selective Features for 2715 Model 2").

  The X'C8' control request switches the 2715 BSC adapter from operation with the primary interface to operate with the alternate interface.

The X'C9' control request switches back to operation with the primary interface.

- Request Format

  CE Panel–Standard format.

- Response Format

  CE panel request:

  a. Positive–Standard format
  b. Negative–Not used
  c. Invalid–The following Cat. Nos. are displayed in the display register:

     Cat. No. 0003–Requested configuration already present.
     Cat. No. 0004–Dual Communications Interface feature not present.
     Cat. No. 0007–Request made on 2715 Model 1.

X'D1', X'D2', and X'D3'–User Table Load

- Function–These control requests allow the user to define his 2790 system and operation to the 2715. The user sends the user tables generated by a System/360 assembly to the 2715, where they are loaded in core and written on disk. These tables are used by the 2715 until the user reconfigures his system with another 'user table load.'

  The 2715 must be preconditioned with a 'stop 2790 input' control request or an ICPL. No other control request may be interspersed within the 'user table load' sequence. A 'restore 2790 input' must follow a 'user table load' sequence if normal operation is to continue.

- Request Format

  S/360 Only–Standard format with:

  X'D1'–Defines the start of 'user table load'; no data is transmitted.
  X'D2'–This control request byte is used as the transaction control byte for sending the output of the S/360 assembler. Each card from the object deck is sent to the 2715 as a one-transaction message.
  X'D3'–Defines the end of the user table. No data is transmitted.

- Response Format

  S/360 only:

  a. Positive–Standard format (r_1 = X'D1').
  b. Negative–Standard format with one of the following (in EBCDIC) for r_2 (r_1 = X'D1'):

     0–Additional user-table cards following END card
     1–Name or sequence count error (col. 73-80 in card)
     2–2790 input not stopped
     3–First card not ESD card
     4–No END card
     5–Table too large
     6–Invalid card type (columns 2-4)
     7–X'D3' control request missing
     8–Wrong-length byte in user-table data
     9–Wrong core-size assembly being loaded

X'D4'–CPU Restart

- Function–Attempts to recover all deferred data that was received after the restart number contained in the request. This request must be preceded by 'reset read deferred data mode'. The 'CPU restart' control request is designed to operate in conjunction with a checkpoint/restart capability to recover deferred data (see "Restart Number Logging").

- Request Format

  S/360 only–Standard response with:

  d_1 and d_2–contain the deferred restart number log which was checkpointed.

- Response

  S/360 only–Standard format with the following values for d_2:

  a. Positive–

     F0–Recovery normal

  b. Negative–

     F1–No recovery was necessary. No deferred data had been sent since the previous checkpoint.
     F2 (see Note 1)–A conflict in the status of a message on the disk was noted but recovery continued to a normal ending.
     F3–User-program restart-number-logging error. No recovery attempted.
     F4 (see Note 1)–Recovery aborted when non-deferred data was found in deferred-data queue.
     F5 (see Note 1)–End of disk was reached before completing recovery. Restart was aborted.

     Note 1: These are "should not occur" responses; situations that cause these responses to be generated will normally be detected as errors during normal 2715 operations which instigate a service call.

X'D5–2715 Restart

- Function–Attempts to recover data that has been buffered on disk and not yet transmitted to the S/360 after a 2790 system or 2715 hard failure, or stop, has occurred.

  Note: This request *assumes* an ICPL has occurred since the failure, and checks to ensure that the 2790 input is stopped. *For the proper recovery of data, the 2790 input must not be started after the ICPL.*

- Request Format

  S/360–Standard format with:

  d_1 and d_2–contain the deferred-restart-number log.
  d_3 and d_4-contain the priority restart-number log. (See 'Restart Number Logging')

  CE Panel–Standard format with no additional data used.

- Response Format

  S/360 requests–Standard format with:

  a. Positive–r_2 and r_3 each contain X'F0' for no unusual conditions detected (normal completion code).
  b. Negative–r_2 = completion code for deferred data queues; r_3 = completion code for priority data queues. The completion codes are:

     F0–Completion normal
     F1–Some data was located but the queue may be incomplete.
     F2–No data was located.
     F5–Some data was located but the queue may be incomplete and a disk error occurred.
     F6–No data was located and a disk error occurred.

  c. Invalid–Standard format with: r_2 = F8, and no data recovery attempted.

  CE panel request:

  a. Positive–Standard format (X'D5F0').
  b. Invalid–Cat. No. X'0042' is contained in the display register.

X'D6'–Scan Area Station Errors (Maintenance Function)

- Function–Causes the 2715 error-logout file to be scanned. Error statistics are extracted per the AS address specified. Two output messages are formatted, each summarizing four errors.

- Request Format

  S/360–Standard format.

- Response Format

  Note: These messages are routed to the S/360 for console printout only if no 2740 is available for output on the 2715.

  Response:

  SOH % C XSTX [Text] ETX

  Text consists of a routing byte (user specified) followed by error information extracted for the specified Area Station.

X'D7'–Send Partial Error Log (Maintenance Function)

- Function–Causes error data in the 2715 error-logout message assembly area to be transmitted to the S/360.

  Error data is transferred *automatically* whenever this message assembly area becomes full. The 'D7' request is provided to enable the CE to purge this area, thereby ensuring that all 2715 error recording accumulated to a certain point in time has been transferred to the S/360 error file prior to running EREP.

- Request Format

  S/360–Standard format: no additional data required.

  CE Panel–Standard format: no additional data required.

- Response Format

  Response:

  SOH % XSTX [Text] ETX

  Text consists of a format byte (X'08'), two blanks, two identification bytes (user specified), and from one to five blocks of error data. Each block contains day and time stamp (7 bytes) and statistics for seven errors (28 bytes). Message length depends on the number of error blocks included: L = 5 + 35N, where N = the number of blocks.

X'D8'–Re-Initialize 2715 Disk

The 2715 does not re-use disk for data storage. Therefore, to reduce the seek time between data read and writes, and to prevent completely filling up the disk, the 2715 disk must be periodically re-initialized.

To prevent overrunning the disk, the 2715 checks for a threshold of 64 available sectors. When this threshold is exceeded, the 2715 will:

a. Generate an X'FD' message (Unsolicited 2715 Response) informing S/360.
b. Initiate a "Stop 2790 Input" Control Request.

- Function–Checks for the proper preconditioning of the 2715, and, if correct, will re-initialize the disk.

  Required re-initialization sequence:

  a. 2790 input must be stopped (X'C6' executed).
  b. 2715 must be empty of all input data; i.e., S/360 must have set 2715 in "read deferred data" mode (X'C5' executed) *and* received the X'C5' response indicating the 2715 is empty of input data.
  c. S/360 sends X'D8' request.

- Request Format

  S/360 only–Standard format

- Response Format

  Standard format:

  a. Positive–disk re-initialized.
  b. Negative–proper re-initialization sequence not followed.

X'E2'–Set Work Day Number

- Function–Provides for setting the work day number. This number is included in the message header of all data transferred to the S/360 or disk.

- Request Format

  S/360–

  d_1–not used
  d_2, d_3, d_4 = 3-digit work number (EBCDIC)

  CE Panel–

  a. Set the Panel Request selector switch to Set Time position.
  b. Enter X'F' and the three-hex-digit work day numbers. No data checking is performed.
  c. Press the Panel Request pushbutton.

- Response Format

  S/360–No response generated.

  CE Panel–Standard response (X'E2F0' to Display Reg).

X'E3'–Monitor Work Day

- Function–Monitors the work day number previously entered. This number is included in the message header of all data transferred to S/360 or to disk.

- Request Format

  S/360 and CE Panel–Standard format with no additional data required.

- Response Format

  S/360–Standard format, with the work day number available in the message header.

  CE Panel–the display register contains the three work-day-number digits. Positions 0-3 are X'0', and positions 4-15 contain the hundreds, tens, and units digits.

X'E4'–Monitor Time

- Function–Monitors the Real-Time Clock that time-stamps all user data at the transaction level.

- Request Format

  S/360 and CE Panel–Standard format with no additional data required.

- Response Format

  S/360–Standard format, with the time available in the transaction header.

  CE Panel–The display register contains the four time digits. The high byte displays (in hex) the tens and units hour digits, and the low byte displays the tens and units minute digits.

X'E5'–Set Time

- Function–Sets the Real-Time Clock that time-stamps all user data at the transaction level.

- Request Format

  CE Panel:

  a. Set the Panel Request selector switch to Set Time position.
  b. Enter the time digits into the Data/Address switches. Positions 0-7 contain in hex the tens and units hour digits, and positions 8-15 the tens and units minute digits.
  c. Press the Panel Request pushbutton.

- Response Format

  CE Panel:

  a. Positive–The time digits are contained in the corresponding display register positions.
  b. Negative–Not used.
  c. Invalid–Cat. No. X'0041' is set into the display register for invalid digits. Invalid digit combinations are any that do not form a valid 24-hour clock time.

X'E6'–Reset 'Read Deferred Data Mode'

- Function–Causes the 2715 to stop requesting deferred data from disk for transmitting to S/360. The 2715 will continue to send any deferred data already queued in core for transmission.

- Request Format

  S/360–Standard format.

- Response Format

  No response is generated to this control request. Refer to description of "X'C5'–Set 'Read Deferred Data' Mode"

for discussion of automatically resetting 'read deferred data mode'.

Restart-Number Logging

A restart number is included in the message header of every message sent to the CPU. These numbers are intended to allow data recovery when either the 2790 system hard stops or the user program has checkpoint/restart capability.

Priority-message restart numbers have the hexadecimal formats "XX2X" and "0020" (the latter is called a "zero restart number"). Zero restart numbers should not be logged; the other format should. Priority-data restart numbers need not be checkpointed, if this facility is available, since priority data is not recoverable in a checkpoint/restart operation. When the disk is successfully re-initialized, the restart-number log should be set to zero.

All deferred-message restart numbers have the hexadecimal format "XX4X"; and all should be logged. If checkpoint/restart capability exists, the deferred-restart number log should be checkpointed. After successful disk re-initialization, the deferred restart-number log should also be set to zero.

Logging is defined here as saving the last restart number received, not storing every number as it is received. Both priority and deferred restart-number logs should be set to zero when the 2715 is ICPL'ed.

Core Storage

The basic 2715 uses a 16K-byte ferrite core storage unit for storing control programs and for message buffering. The core storage unit has a word width of 18 bits and a cycle time of 1.2 microseconds. The basic 16K-byte core storage provides up to 1280 bytes for transaction tables; the Expanded Capability feature increases the transaction-table storage to 4096 bytes.

System/360 Reset

System/360 reset will terminate all 2715 Model 1 multiplexer channel adapter operations. All other operations will continue normally.

2715 PERFORMANCE

The performance of the 2715 can be specified from several points of view. It is discussed here in terms of sorting speeds, and in terms of channel throughput.

Sorting

Sorting speed is a function of a number of factors. The most important of these are:

1. Input rate in characters per second.
2. Time it takes an operator to enter the transaction.
3. Frequency and duration of traffic peaks.
4. Percentage of message-routing transactions.

The sorting algorithm has a speed of 150 to 200 characters per second. If the entry rate is below this value, the algorithm will sort as fast as transactions are completed. When the entry rate exceeds this value, the sort file begins to build up and sorting proceeds more slowly. When there are long delays between entries of a transaction, as with an inexperienced operator, the sort will also proceed more slowly, as this causes the sort file to become larger and more data entries must be examined to assemble the transaction. These delays are only temporary, however, since the sort can catch up rapidly when this peak traffic subsides. The operator at the Area Station is not aware that sorting is being delayed. Another factor that affects the sorting speed is the volume of message-routing transactions, especially those with implicit text. This effect would be significant only in a system with very large volumes of message routing.

Channel Throughput

In discussing channel throughput, consider three modes of operating the system with respect to the S/360 processor.

On-Line. In this mode, the multiplexer channel is available at all times and, except for deferred data, little data buffering is required in the 2715. With the Model 1, the multiplexer channel adapter has a maximum data-transfer rate of about 3000 characters per second. This means that the channel can handle all data from the 2790 adapter, assuming adequate data service is provided by System/360. In addition, deferred data can be recovered from the disk at the same time. Factors that affect the actual data rate include: rate of data reception from terminals, the amount of data that consists of sorted transactions, and interference from other devices on the multiplexer channel.

If the 2715 Model 2 is used, data transfer rates are effected by the line speed. The maximum data-transfer rate at 4800 bits per second is 600 characters per second; however, the actual rate is likely to be much less because of line turnarounds, responses, etc. The channel speed will be limited primarily by the rate of data reception from the terminals. Of course, if the input rate from the 2790 adapter exceeds the rate of the channel, data must be stored on disk for later recovery when channel time is available.

On-Line/Off-Line. There are two critical factors that affect channel speed. One is the frequency of the request for data; the other is the amount of terminal activity at the time of the request.

The 2715 disk priorities are so structured that writes have priority over reads. If there is a large volume of data on the disk (infrequent requests), the disk will have more seek activity to service both reads and writes, thus reducing channel speed.

If the request is made during a high-traffic period, nearly all disk time can be spent putting data on the disk and the

read operation will proceed very slowly. Therefore, for best results, the on-line operation for data recovering should be scheduled at a low-traffic period.

In this mode of operation, the sort speed could also be reduced, since the writes to store data have priority over disk operations for sorting.

On-Line for Inquiry, On-Line/Off-Line for Other Traffic. In this mode of operation, all data is classified as deferred, except for inquiry type transactions. Since all deferred data is placed on the 2715 integral disk, this mode has the advantage that data can be recovered from the disk in case of system failure. However, data is blocked prior to being placed onto the disk, with the partial blocks being accumulated in core storage. When deferred-data mode is set, data is recovered from the disk when no priority data is queued for the channel. If large blocks of data are accumulated before deferred-data mode is set, the channel throughput will be slowed because of the added disk activity. Normally, with deferred-data mode set, there would be little data on the disk, but throughput will still be somewhat slower. If there are large volumes of sorted data, the channel speed could be slowed as sort-disk operations have priority over read-disk operations. This mode also implies that the disk must be re-initialized more frequently, since nearly all data is placed on disk and the limit is reached more quickly.

The 2790 Data Communication System involves a large number of operators. Therefore, operator errors as well as transmission errors must be considered.

ERROR AT THE 2795/2796 DATA ENTRY UNIT

The 2715 performs the following error checks on data from the Data Entry Units:

1. Digit 1 of a data entry contains a code (EBCDIC 0-3) to designate the type of DEU. The 2795 transmits a digit 0; the 2796 transmits a digit 1, 2, or 3 depending on the Monitor key position. The 2715 checks for a 12-character data entry from a 2795 and for an 18-character data entry from a 2796.
2. At the user's option, the 2715 checks that a user-provided check digit (0-9) compares with a digit read in one of the first 15 positions of data. The user exercises this option when preparing transaction-list statements for the DEU.

The 2715 causes a Read-End command to be sent when an error is recognized. The 2795/2796 operator is notified by the Error Indicator Reset button snapping into view. The request lever cannot be pressed for another operation until the Reset button is pressed. The 2715 discards the data received in error from the Data Entry Unit.

ERROR AT THE 2791 AREA STATION

At the user's option, the 2715 will check for two types of errors at the 2791 Area Station. The user exercises this option when preparing transaction list statements for the 2791 Area Stations. They are as follows:

1. Length Check

This check permits the user to instruct the 2715 to check that the length of a data entry from a 2791 device be checked against a user-provided quantity. The lengths that may be specified are as follows:

Card Reader–2 through 81, or null (blank)
Manual Entry–7 or null
Digital Device Read-In–
  Delete Blanks ON–11 or null
  Delete Blanks OFF–2 through 11 or null
Badge Readers–
  1035 Badge Reader–1 through 10 or null
  Resident Badge Reader–2 through 11 or null

The null parameter is invoked when the user leaves the length parameter check field blank. The 2715 does not perform a length check under this condition.

When a length check is specified, the user should also specify the Error Guidance lamp to be lit if the actual data-entry length is not equal to the length supplied in the transaction-list statement.

2. Digit Check

This check permits the user to instruct the 2715 to make one digit check per data entry. The digit to be checked may have the value 0 through 9 and must be located in one of the high-order positions (1 through 15) of the data entry. If the user omits this check (null) the 2715 does not make a digit check. When specifying the digit check, the user should also specify the Error Guidance lamp to be lit if the digit to be checked from the data entry is not equal to the digit value supplied.

If an error is detected when making the length or digit check, the 2715 will discard the data received from the erroneous data entry and return the user-specified error-guidance code. The 2791 operator is notified via the Error Guidance light and may examine the media in question and restart the data entry. If the entry is accepted this time, the 2715 will advance the 2791 to the next step.

The operator may request "next guidance" if he is uncertain which step was in error. The 2715 will return the original guidance light for the step that was in error.

Other 2790 Transmission Line Error Checks

In addition to the preceding, the 2715 performs the following error checks on data received from the 2790 transmission line:

AS address changed
Device address changed
Abnormal status for end request
Data request overrun
Null acknowledgment overrun
Data character comparison
Status character comparison

If the 2715 detects one of these error conditions, it will discard the data in question and cause the following indications to the 2791, 1035, or 2795/2796 operator.

2791 Area Station Indications

1. Repeat/Clear lamp will be lit.
2. Card or badge will be held.

The operator clears this condition by pressing the Clear key. This extinguishes the error lamp and releases the media (card or badge). Guidance reverts to that designated for the step in error. The operator may retry the step by inserting the proper media.

1035 Badge Reader Indications

1. Repeat lamp will be lit.
2. Badge is held.

The operator presses the Clear Button, which extinguishes the Repeat lamp and releases the badge. The operator may then re-enter the badge.

2795/2796 Data Entry Unit Indications

1. Error indicator/Reset button will snap into view.
2. Request lever remains in latched position; the card or badge cannot be removed.

The operator resets by pressing the Reset button, which releases the interlock on the request lever.

ERROR AT THE TRANSMISSION CONTROL UNIT

2715 Error Recording

The following description applies to all 2715-detected errors with the exception of status-register checks, which result in a hard stop.

Error recording in the 2715 consists of a 28-byte error buffer, resident control program to load errors into the error buffer, a nonresident program to move error information from from error buffer to disk storage, and a nonresident program to format the error transaction before placing it on-line to the processor.

Each single error is placed in the error buffer as a four-byte error record. This error record consists of a one- or two-byte address followed by status information detailing the error.

When the error buffer becomes filled or once an hour, whichever occurs first, day and time-stamp data is attached and the error data is transferred to the error log maintained on the disk. The error log consists of eight fixed sectors; each sector can accumulate a total of 42 errors.

When an error-log sector becomes filled, an error message containing the data is automatically formatted and transferred to System/360 for data-set logging and later retrieval. The contents of a partial error-log sector can be transferred on a demand basis at any time.

The data contained in a 2715 error message consist of a single transaction of 215 bytes, and represents one sector's worth of error recording.

2715 to System/360 error messages are not received by the user but are routed by BTAM for data-set logging. Upon CE initiation of the Error Recovery Executive Program (EREP), the proper formatting of these error records is executed and a meaningful System/360 error printout is made available. The formatting consists of a translation from binary to EBCDIC English language.

2715 Diagnostics

The 2715 diagnostic programming consists of one System/360 coded program and numerous 2715 microcoded test routines.

The System/360 program is a 2715 System Exerciser Program. It functionally tests a 2715 system in a multiplexing environment similar to that encounted in a customer operation. It reports all detectable system errors and failures and logs statistics on system usage at all levels. It may be used for 2715 system installation, verification, or testing.

The 2715 microcoded diagnostic test routines perform the primary 2715 system maintenance facility. They reside on the 2715 disk and are executed within the 2715 automatically or upon CE request. There are two general classes of test routines:

1. 2715 Hardware
2. 2715 Device

Hardware Tests

The 2715 hardware test routines isolate hardware failures in each of the following areas of the 2715:

Data Flow and Storage
Channel Adapter
BSC Adapter
Disk Adapter
2790 Adapter
2740 Adapter

Device Tests

The 2715 device test routines isolate functional and hardware failures in the devices attached to the 2715. The degree of failure isolation provided by these tests is a function of the isolation facility provided by the device. The following devices are supported:

Integral Disk
2740 Communication Terminal
2790 Loop
Area Station, with:
- Key Entry
- Card Readers
- 1053 Printers
- Data Entry Units
- Badge Readers

Multiplexer Channel Error Recovery Procedures

An I/O error causes an interrupt condition. The condition causing the interrupt is indicated in the Channel Status Word (CSW) if the Unit Check bit (bit 38) is present in the CSW. A Sense command must be performed to obtain further information about the error interrupt.

Hardware-Detected Errors

System/360 Interface I/O Bus-Out Check. All information transferred on 'I/O bus out' requires proper parity. An improper *address* byte (bad parity) during Start I/O is detected as an invalid address, thus preventing selection and attachment of the 2715.

The processor is notified of *command* parity errors by 'sense bus out check'. In this situation the processor should initiate a retry procedure.

The use of Binary Synchronous data-link control enables the adapter to retry if data errors are detected during output transactions.

System/360 Interface I/O Bus-In Check. All data input to the channel is checked for correct parity. Parity is generated from the eight information bits to ensure correct communication on the interface. This generated parity is compared with the associated parity position of the data register transferred to the bus.

During data transfer the message is aborted by use of 'Bi-Sync Block Cancel', upon which a retry is initiated.

Data Flow Adapter Bus-In Check. Input errors detected on adapter to data flow bus-in transfers are retried three times. If the failure persists after three retries, the audible alarm is sounded.

Microcode-Detected Errors

Checking is implemented at critical points within the adapter microcode. The purpose of this checking is to prevent loss of control due to hardware/program interface malfunction. Error recovery in such a situation may simply return control to the 2715 supervisor. All errors within the adapter are recorded.

Multiplexer Channel Adapter Microdiagnostics

All adapter hardware—with the exception of System/360 interface drivers and terminators and the gating circuits to and from these—may be tested by 2715 diagnostic routines resident on disk. The microdiagnostics are intended as a method of fault location and are used successfully only when the adapter is isolated from the System/360 interface. Therefore, the inactive state is a prerequisite for diagnostic capability in the channel adapter—that is, the 2715 must be off-line with respect to System/360.

The 2715 is a buffered core storage, microcoded control unit, providing the user with a flexible central controller to which Area Stations, Data Entry Units and other I/O devices are attached. For purposes of this section, the user is assumed to be controlling the system at the System/360 and the operator is operating and monitoring the system at the Area Stations and Data Entry Unit locations.

The 2790 provides the user with a flexible communication and information system. To achieve this, the user provides a set of statements describing the processing that his input must undergo. Since the 2715 is a hardware and microcode type controller, it does not allow for complete user coding control. Instead, the microcode interprets control requirements by means of a set of user-specified tables. These tables contain pointers and index values as well as parameters for the microcode.

The data link between the System/360 and the 2715 is through the Binary Synchronous Communications (BSC) interface, whether attachment is local or remote. Remote attachment line speed permits a maximum data rate of 600 characters per second; local attachment permits approximately 3000 characters per second. The maximum-size message that can be transmitted from the 2715 to System/360 is 640 bytes, excluding BSC framing control characters. All messages are transmitted in EBCDIC transparent code.

SYSTEM OPERATION

Data transactions, which originate on one of the devices attached to the 2715, are formatted into messages and either transmitted to the integral disk unit in the 2715 for later retrieval by the user's BTAM program or are sent directly to the System/360 without any intervening delays. Messages from System/360 are sent to the 2715, which acts on them immediately. These messages may be directed to output devices attached to the 2715, or they may be control-type messages that call upon the 2715 to modify its operaton in some way. If either the 2715 or the System/360 is incapable of receiving data for a temporary period, normal BSC control sequences indicate this, and the sender must wait. Should the data link be disabled for some reason, the 2715 will enqueue all messages received for later transmittal.

Transactions may be blocked together to make one longer message, or be sent singly. This function is performed automatically by the 2715 microcode on 2715 to System/360 messages, and performed by the user's problem program on System/360 to 2715 messages.

OS and DOS Support

Telecommunications support under both OS/360 BTAM and DOS/360 BTAM is being expanded to include support for the 2715 Transmission Control Unit.

This support consists of modifications to BTAM and new Assembler Macro definitions to support generation of user table-defining statements to object format. For detailed programming information, see *IBM System/360 OS/DOS BTAM Planning for IBM 2790 Data Communication System Support,* Form C30-1004.

BTAM Modifications

Two main modifications will be made to BTAM. One provides for centralized logging of errors collected by the 2715 relating to devices attached to it. This facility is useful for Customer Engineering maintenance of the 2715 complex. The second provides for 2715-originated messages to be printed on the System/360 console. This means that the System/360 operator can receive operator-awareness type messages if the 2715 has no 2740 attached or if the 2740 requires intervention.

2715 User Table Assembly

Seven DOS/360 and OS/360 Assembler Language macros define user tables for the 2715. The user tables define the hardware configuration, the step-by-step terminal functions, and the related 2715 functions.

CONFIGUR. The CONFIGUR macro is used to generate the table definition block, which contains pointers to the 2715 tables.

AS. The AS macro is used to build an entry in the Area Station table and the Data Entry Unit table, and a corresponding entry in the Data Entry Unit index table.

TGROUP. The TGROUP (transaction group) macro is used to define entries in a TGROUP table. Each keyword operand associates a transaction list with a transaction code. A maximum of 63 TGROUP macros are allowed.

TRLIST. The TRLIST (transaction list) macro is used with the Area Station list (ASLIST) macro and the Data Entry Unit list (DEULIST) macro to define a transaction. When the transaction is initiated by an Area Station, the TRLIST macro is followed by one or more ASLIST macros. When the transaction is initiated by a Data Entry Unit, the TRLIST macro is followed by one or more DEULIST macros. The first transaction list must be for all of the IBM 1035 Badge

Readers. This consists of a TRLIST macro instruction followed by one DEULIST macro instruction.

The transaction list tables created by the TRLIST, ASLIST, and DEULIST macro instructions are composed of: a header, and an internal message, and/or from one to sixteen data entry steps. The header information is provided in the TRLIST macro instruction. The TRLIST macro must follow the last TGROUP macro.

ASLIST. The ASLIST (Area Station list) macro instruction is used to define one step of a transaction list for a 2791 Area Station. One to sixteen ASLIST macros may follow a TRLIST macro; the last ASLIST macro may define an internal message.

DEULIST. The DEULIST (Data Entry Unit list) macro is used to define one step of a transaction list for a Data Entry Unit. For a 2796 DEU one to thirteen DEULIST macros and for a 2795 DEU one to sixteen DEULIST macros may follow a TRLIST macro; the last DEULIST macro may define an internal message.

STEND: The STEND macro is used to indicate the end of all user macros and must be the last card processed before the assembler END card.

The STEND macro compares the total number of bytes generated for the 2715 user tables with the maximum allowable size for the user's particular 2715 configuration. If the table size exceeds the allowable maximum, MNOTE is issued indicating that the assembly is invalid.

After the macros have been translated to object format, the user's problem program can transmit them to the 2715 by reading the object module (without using LINK-EDIT), formatting each card into a 2715 message, and using normal BTAM BSC WRITE facilities.

User Table

Figure 28 shows a simplified version of a user table that is designed to show the relationship of the various macro-generated tables.

Area Station Data Entry. The Area Station address (AS ID) is used to find the correct transaction group (TG) from the Area Station table (AS table).

The transaction code (TC) is used to find the correct transaction list from the transaction group table (TG table).

The transaction list plus the step number from the Area Station Sequence table is used to find the correct step from the transaction list table (TR List table). The transaction list step contains the information necessary for the microcode to process the data entry.

DEU Data Entry. The area station address (AS ID) is used to find the correct transaction group (TG) from the DEU table.

The transaction code (TC) is used to find the correct transaction list from the transaction group table.

The Area Station address is used to find an address from the DEU index table. The index table address plus the DEU address is used to find the correct step from the DEU sequence table.

The transaction list plus the step number from the sequence table is used to find the correct step from the transaction list table (TR List table). The transaction list step contains the information necessary to process the data entry.

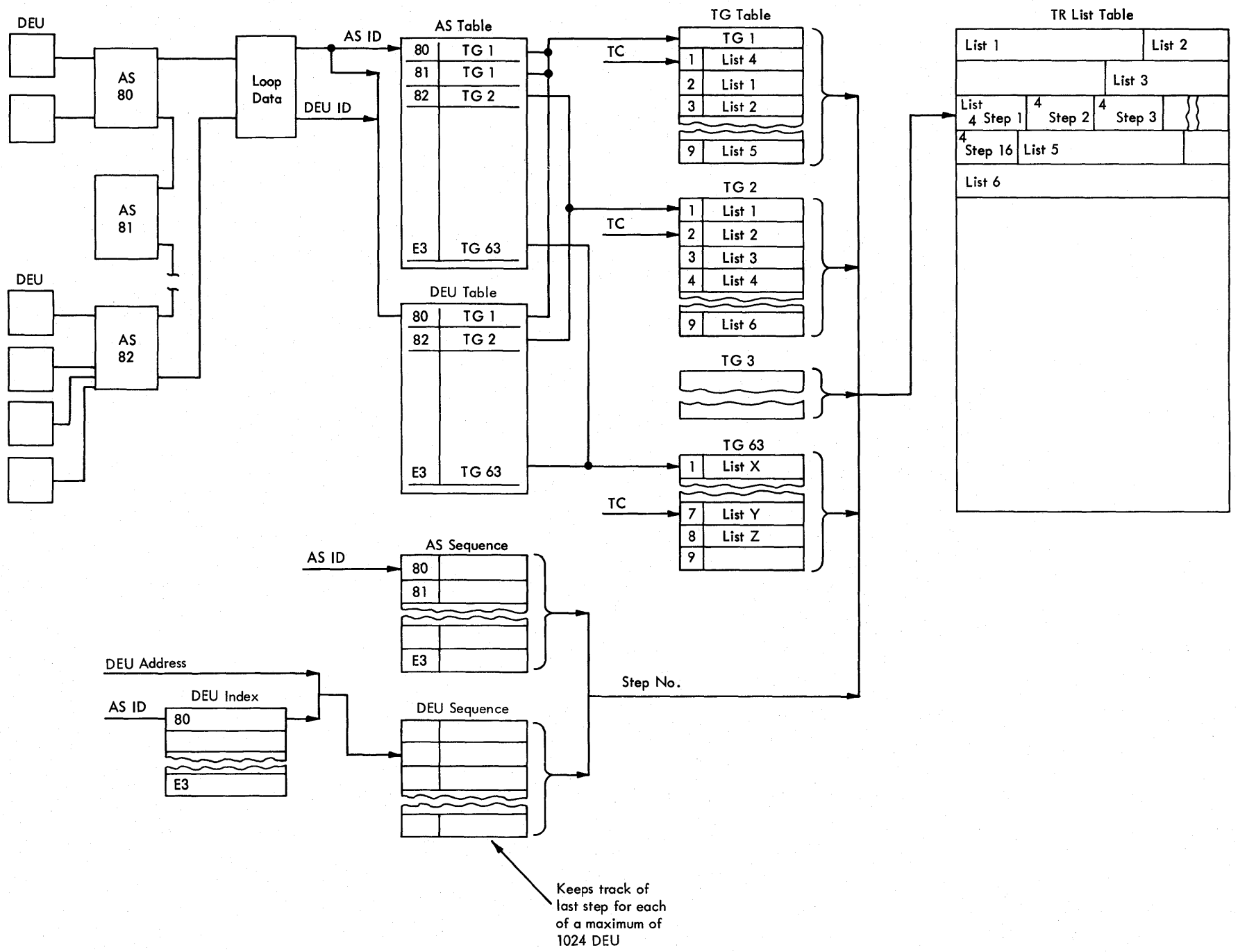


Figure 28. Simplified Example of User Table

ACK: Line control character for positive acknowledgment.

AS: Area Station; AS is also the mnemonic for the macro that defines the Area Station for the System/360 assembler program.

ASLIST: Mnemonic for the Area Station list macro instruction.

bps: Bits per second.

Broadcast: To send data to all stations on the loop.

BSC: Binary Synchronous Communications.

BTAM: Basic Telecommunications Access Method.

Bundespost: The German government-operated common carrier.

Byte: Eight data bits plus one parity bit.

CE: Channel End status bit. CE is also used as an abbreviation for Customer Engineer when used in connection with the CE/Operator Panel.

CONFIGUR: Mnemonic for a System/360 assembler macro instruction.

CPU: Central processing unit.

CSW: System/360 channel status word.

Data Entry: A single block of data entered at the Area Station or Data Entry Unit using a single data-entry device.

For the 2796, a data entry contains the Monitor key identification, four rotary-switch settings, thumbwheel-switch settings, and card or badge reading.

For the 2795, a data entry contains the two rotary-switch settings and the badge or card reading.

For the 2791, a data entry contains the Monitor key identification; Transaction Selection switch setting; and data from the card reader, badge reader, or numeric keyboard.

DE: Device End status bit.

DEU: Data Entry Unit.

DEULIST: Mnemonic for a System/360 assembler macro instruction.

DLE: Binary-synchronous line-control character, Data Link Escape.

DOS: Disk Operating System/360.

EBCDIC: Extended Binary Coded Decimal Interchange Code.

ENQ: Line-control character, "enquiry."

EOC: End of card.

ETB: Line-control character, "end of transmission block."

ETX: Line-control character, "end of text."

Explicit Text: Text from a source external to the 2715.

GPO: General Post Office, the government-operated common carrier in Great Britain.

Guidance Character: An eight-bit data byte transmitted from the system controller to the Area Station to indicate the Operator Guidance light to be lighted, the device to be read, and the state of the In-Process light.

Hexadecimal: A base 16 notation used in the System/360.

Hz: hertz (same as the former expression, *cycles per second*).

ICPL: Initial Control Program Load.

Implicit Text: User-defined message stored in 2715 core storage.

I/O: Input/Output.

Loop: Transmission lines connecting the Area Stations and the system controller.

Macro: A statement used to define a number of program steps.

MCA: Multiplexer Channel Adapter.

Message: One or more transactions sent as one "transmission" between the system control unit and the CPU, Area Station, or 2740.

Microcode: The internal coding that controls the 2715 hardware.

MPX: Multiplexer.

NAK: Line-control character, "negative acknowledgment."

NL: New-line character.

NTT: Nippon Telephone and Telegraph, the name of the government-operated common carrier in Japan.

OS: Operating System/360.

PTT: Post Telephone and Telegraph, a generic term for the government-operated common carrier in each of many countries.

RTC: Real-Time Clock.

STX: Line-control character, "start of text."

STEND: Mnemonic for a System/360 assembler macro instruction.

System Controller: The unit, either 2715 or 1800, that controls the 2790 loop.

TC: Transaction code.

TCU: Transmission Control Unit.

TGROUP: Mnemonic for a System/360 assembler macro instruction.

Time Stamp: A four-byte field that contains the value of the Real-Time Clock when the transaction was received. The time is recorded in 24-hour form as EBCDIC characters.

TPS: Two-Processor Switch.

Transaction: A sequence of interrelated data entries entered by the operator at an Area Station or Data Entry Unit and assembled by the system controller.

Transaction Tables: See "User Transaction Tables."

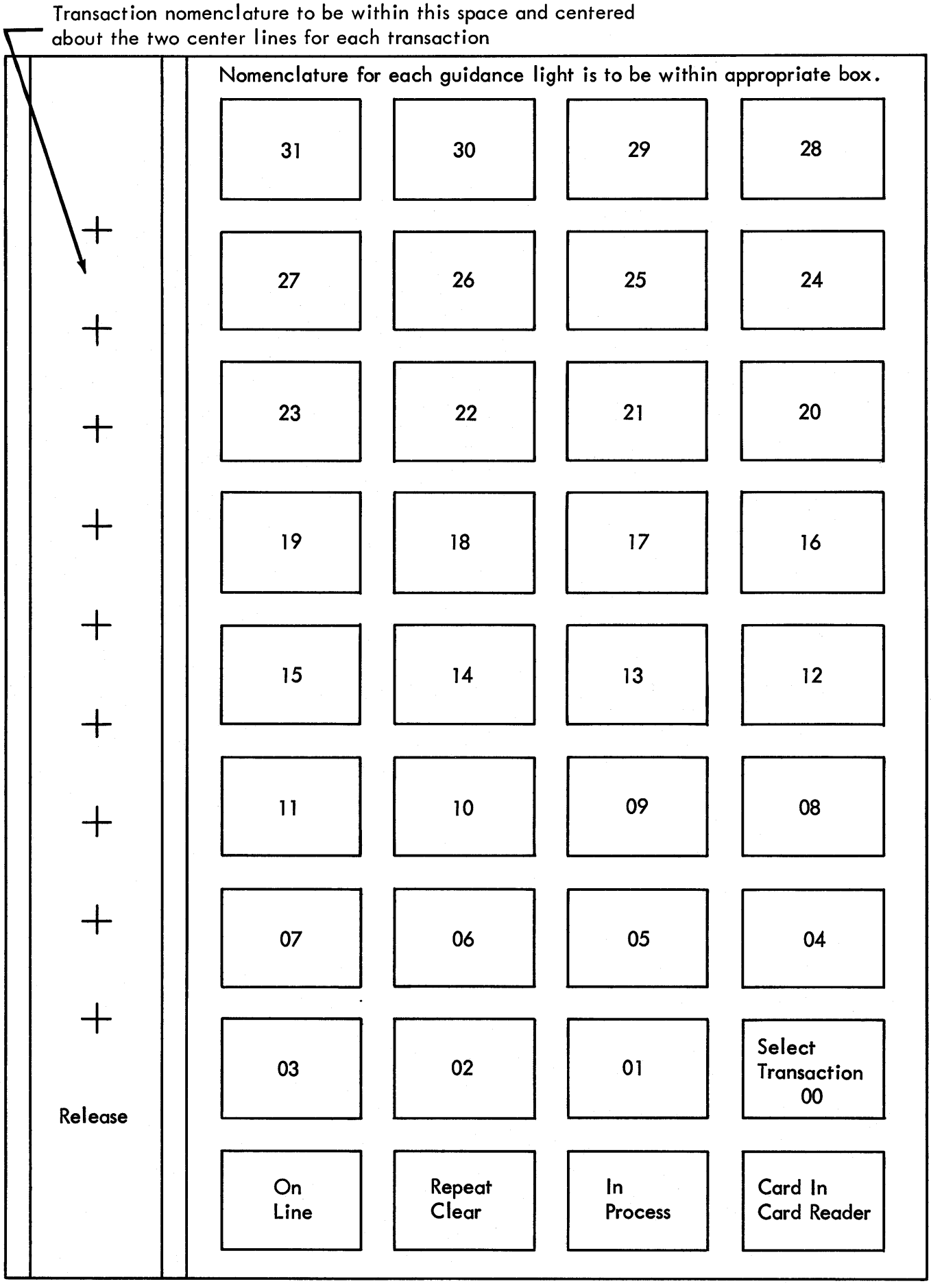
TRLIST: Mnemonic for a System/360 assembler macro instruction.

UC: Unit Check status bit.

USASCII: United States of America Standard Code for Information Interchange.

User Table: See "User Transaction Tables."

User Transaction Tables: Program tables that define the parameters and controls for the 2790 system. DOS and OS/360 Assembler Language macros are provided to define user tables for the 2715.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Nomenclature for each guidance light is to be within appropriate box.
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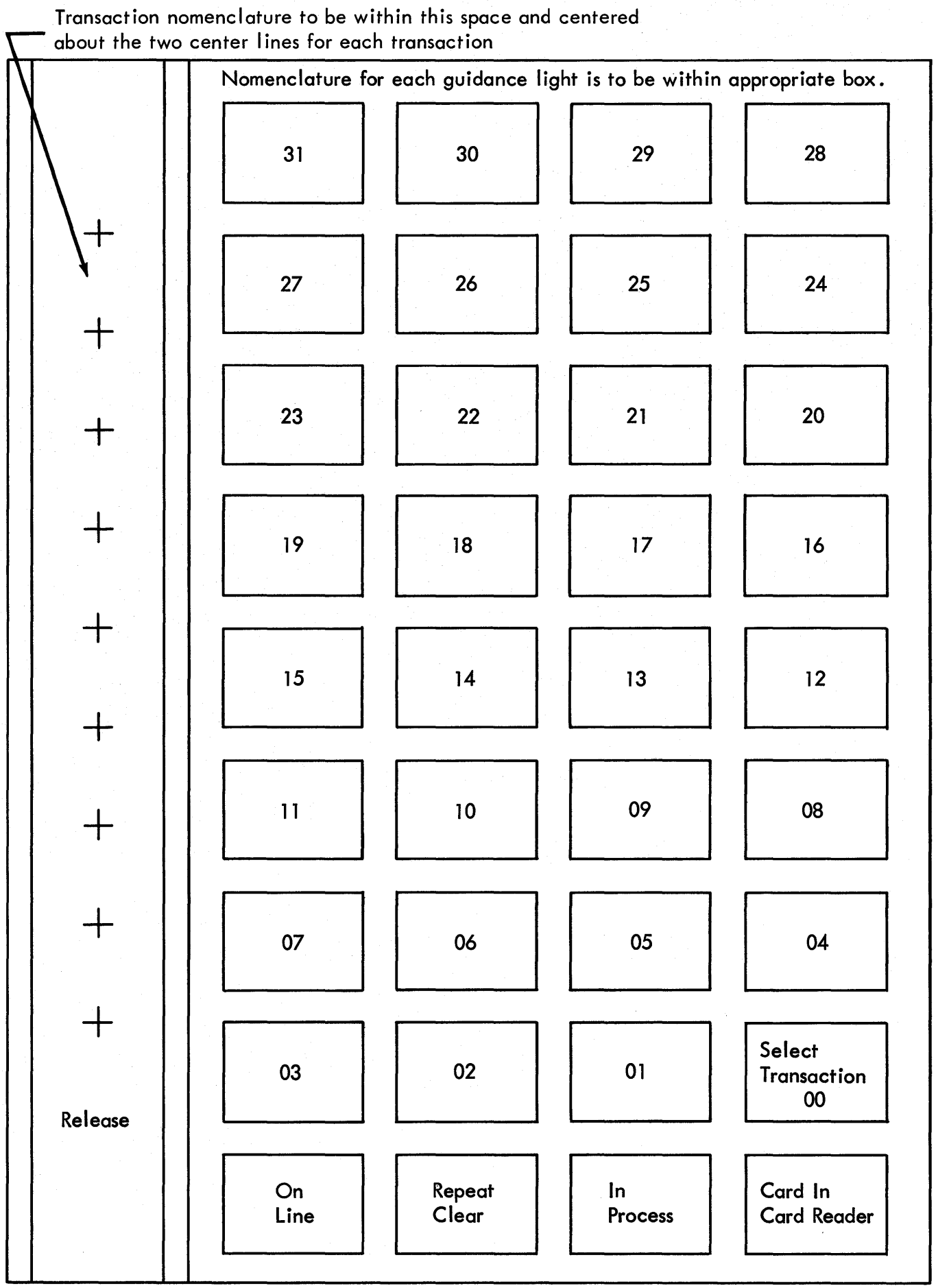
Card In Card Reader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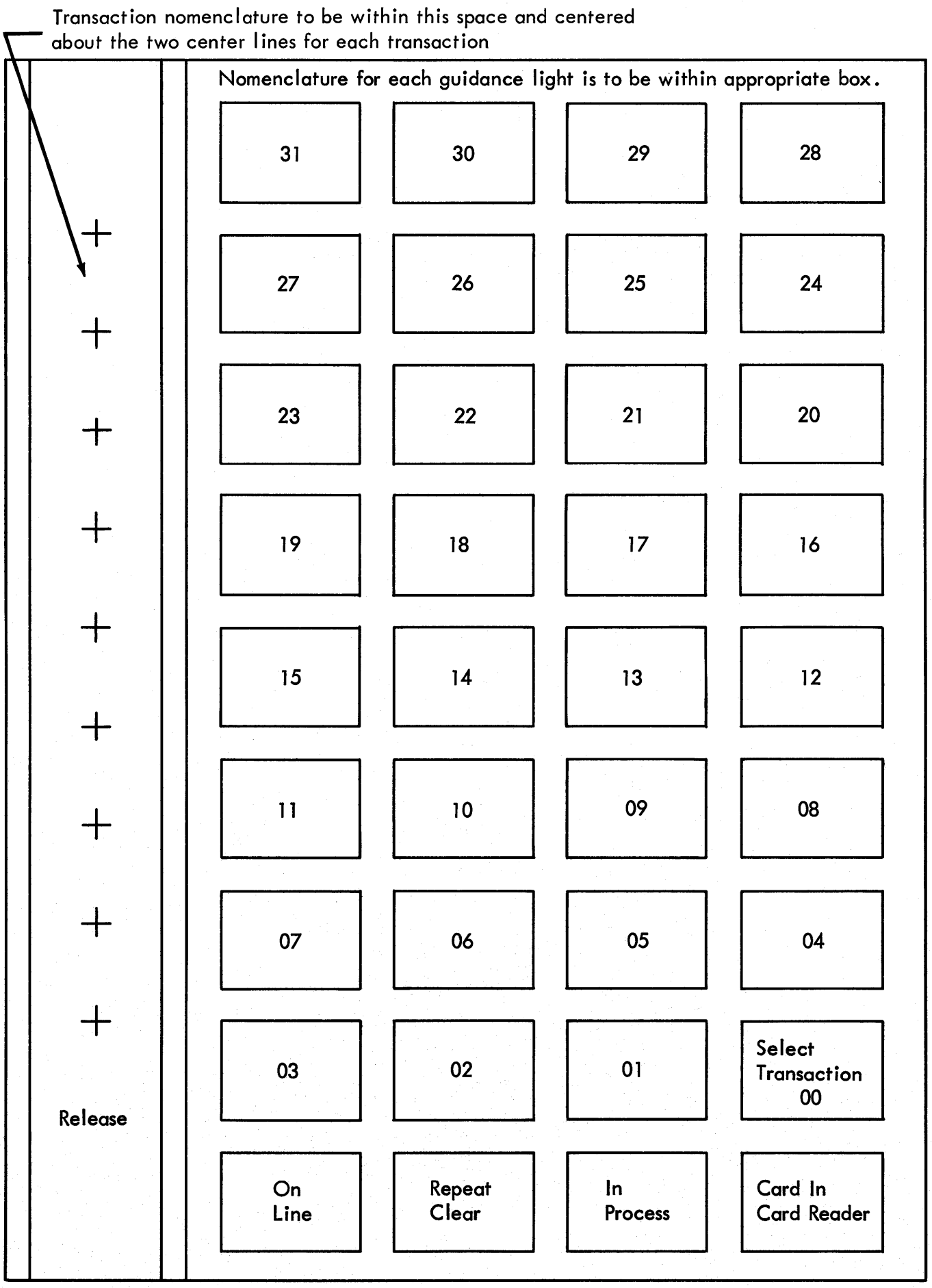
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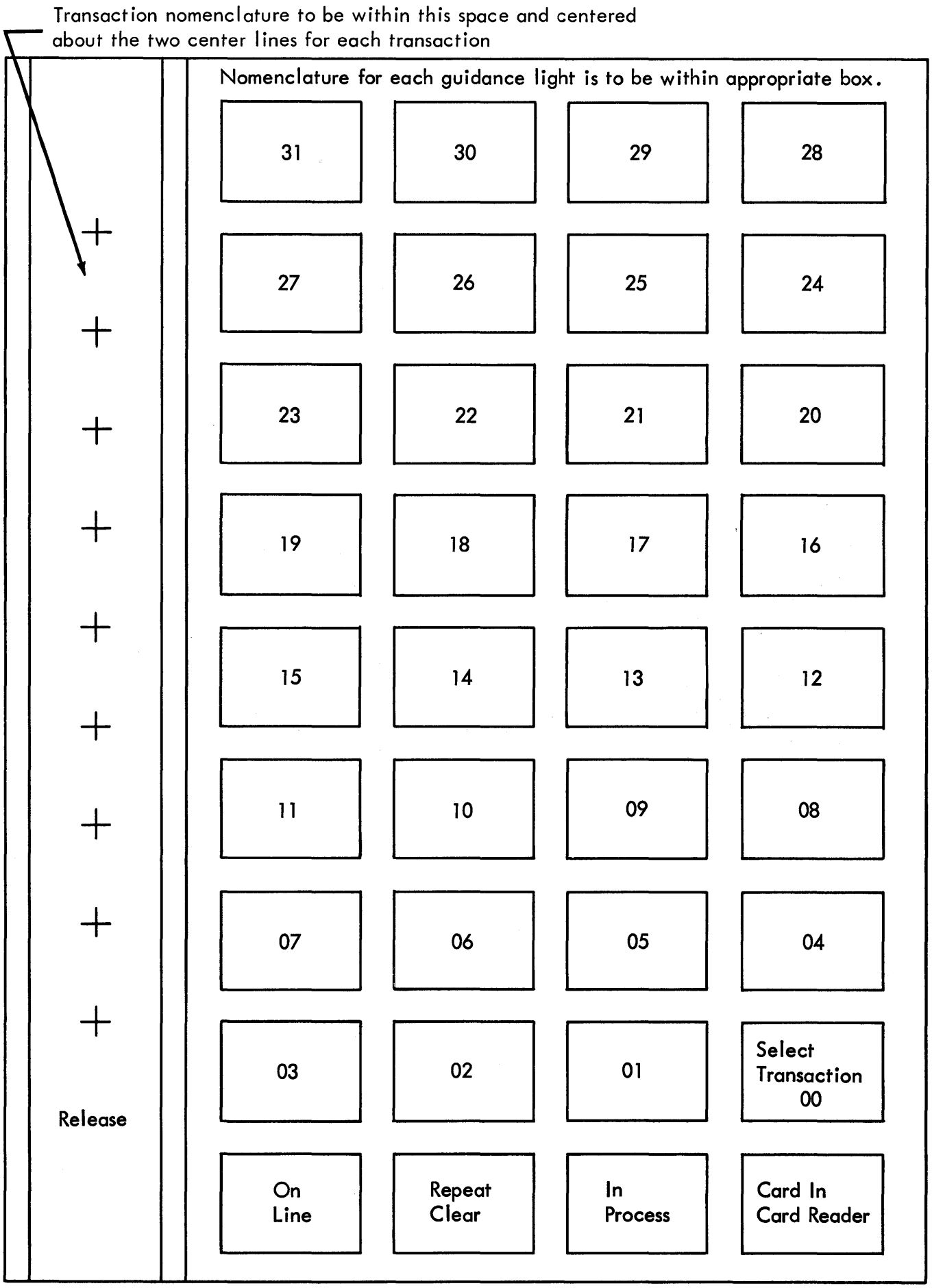
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