SPERRY RAND

# UNIVAC

# BINARY SYNCHRONOUS DATA COMMUNICATIONS SUBSYSTEM (DCS-1C)

GENERAL DESCRIPTION

UP-7892

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## FIGURES



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# I. INTRODUCTION

The UNIVAC Binary Synchronous Data Communications Subsystem (DCS–1C) is a terminal device that permits the UNIVAC 9000 Series systems to communicate with IBM* equipment operating with binary synchronous communications (BSC) procedures. Manufacturers of data processing and communications equipment use different message control and data link control procedures for the transmission data, namely: message headers, addressing characters, text formats, various text delimiters, and parity checking techniques, all of which add to the complex problems existing in the state-of-the-art of communications. Because of these differences in communications conventions, many users of data processing equipment cannot interface with binary synchronous procedures.

The UNIVAC DCS–1C is an extension of the UNIVAC Data Communication Subsystem family, which is used primarily for communications-oriented data processing systems. The UNIVAC DCS–1C has been designed to resolve the previously cited technical problems by its ability to operate using binary synchronous communications (BSC) procedures. The UNIVAC DCS–1C enables synchronous data transmission at speeds from 1200 to 230,400 bits per second over standard communication circuits. It is physically small so that it can be mounted in space available in the main frame of the UNIVAC 9000 Series processors.

The UNIVAC DCS–1C can operate in both the Extended Binary Coded Decimal Interchange Code (EBCDIC) and the American Standard Code for Information Interchange (ASCII) encoded traffic and can be tailored, through use of various features, to meet the needs of the user.

A remote installation with a synchronous terminal such as a UNIVAC 9200 System can access an IBM 360/65 by way of a UNIVAC DCS–1C, thereby affording the remote user the advantages of large-scale computer equipment. Conversely, the remote synchronous terminals can be used as output terminals for the central facilities.

Use of the UNIVAC DCS–1C provides the user with the ability to:

- communicate with systems of other manufacturers, using binary synchronous communications conventions;
- exchange data files, programs, and so forth, of other systems;
- share telephone facilities;
- divide user applications; and
- time-share services such that the user can communicate with his own terminal devices.

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# 2. UNIVAC DCS-1C DESCRIPTION

## 2.1. GENERAL

The UNIVAC Binary Synchronous Data Communications Subsystem (DCS–1C) is a central-site terminal device that links one or more medium- or high-speed, synchronous data communications facilities to a multiplexer channel of a UNIVAC 9000 Series system processor. In essence, it is a communications adapter compatible with currently accepted control procedures. Hereafter, the UNIVAC Binary Synchronous Data Communications Subsystem (DCS–1C) is referred to as the UNIVAC DCS–1C.

## 2.2. CONFIGURATION

The UNIVAC DCS–1C is logically located between a processor of a UNIVAC 9000 Series system and a remote terminal device. (See Figure 2–1.) The remote terminal can be any device capable of using binary synchronous communications procedures.

The processor is connected to the UNIVAC DCS–1C by means of a multiplexer (general purpose) channel that can sustain a data transfer rate of 85,000 eight-bit bytes plus parity and interfaces with the remote terminal through point-to-point private, point-to-point switched, or multipoint private communications facilities. The UNIVAC DCS–1C communicates with a remote station in either half-duplex or full-duplex transmission.

Transmitted or received data comes from, or goes to, an area of main storage defined as a buffer. The processor, after initiating a communications operation, is free to perform any of its functions while the buffer area is being filled or emptied by the UNIVAC DCS–1C. Transmission or reception of data over a line does not interfere with the simultaneous use of any other line, I/O device, or computation.

One or two UNIVAC DCS–1C units can be mounted within a UNIVAC 9000 Series system processor; such an installation is designated Feature F1357–00. When housed in the processor cabinet, the unit(s) receives power from the existing supply in the processor; a unit has no external controls.

Also, up to four UNIVAC DCS–1C units can be mounted in a freestanding cabinet (Figure 2–2) containing a power supply, blower assemblies, and a panel with controls and indicators to control and monitor unit operations.

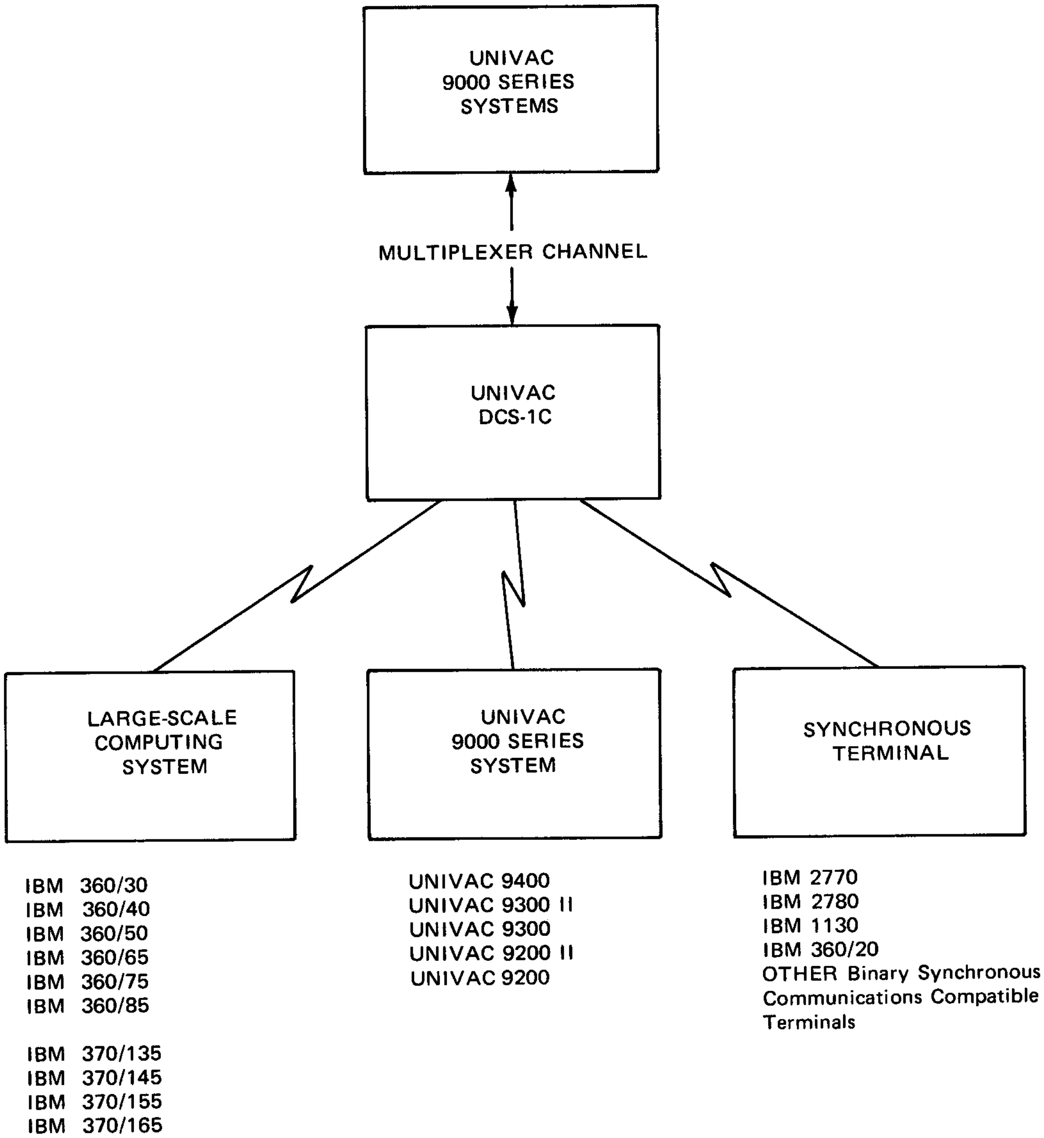
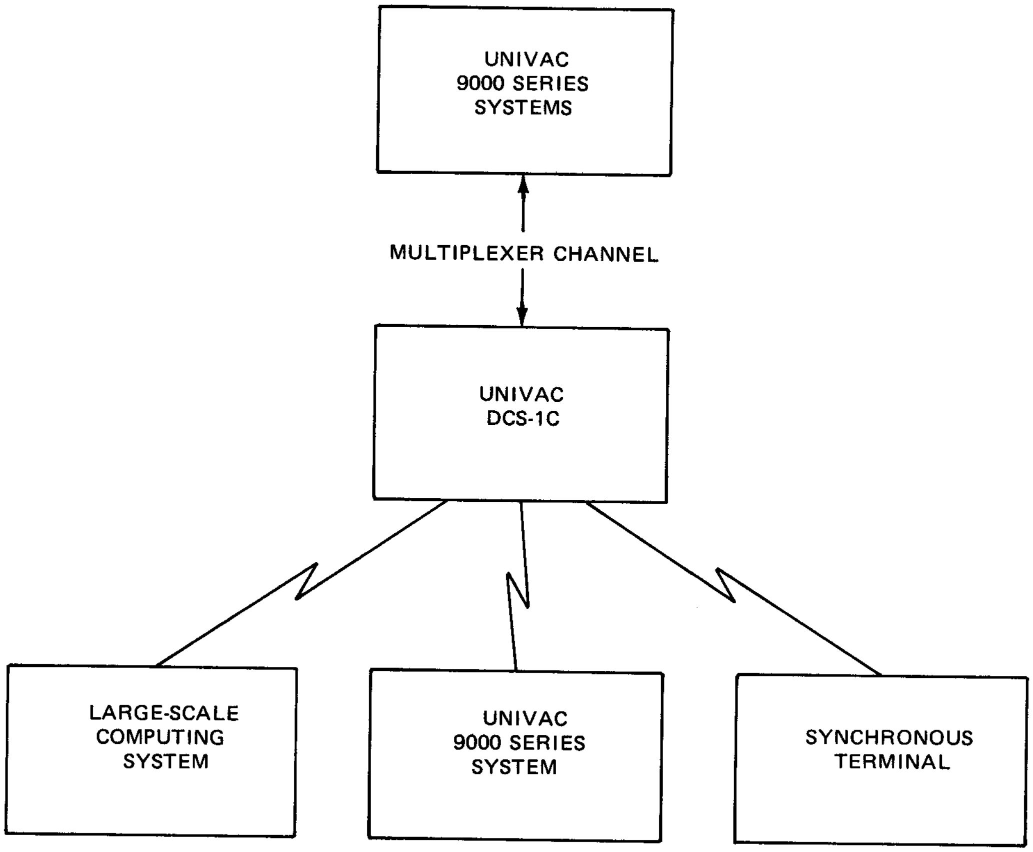



*Figure 2–1. Compatible Communications Equipment*




IBM 360/30
IBM 360/40
IBM 360/50
IBM 360/65
IBM 360/75
IBM 360/85

IBM 370/135
IBM 370/145
IBM 370/155
IBM 370/165

UNIVAC 9400
UNIVAC 9300 II
UNIVAC 9300
UNIVAC 9200 II
UNIVAC 9200

IBM 2770
IBM 2780
IBM 1130
IBM 360/20
OTHER Binary Synchronous Communications Compatible Terminals

*Figure 2–1. Compatible Communications Equipment*

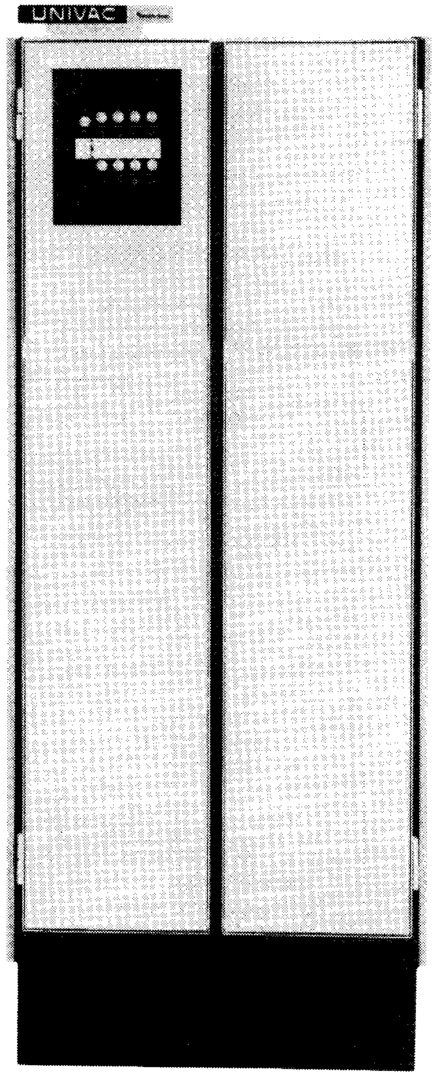



*Figure 2–2. UNIVAC DCS–1C Cabinet*

## 2.3. COMPONENTS

The basic UNIVAC DCS–1C consists of a line terminal controller (LTC), a line terminal (LT), and a communications interface (CI). Figures 2–3 and 2–4 illustrate the interrelationship of these components when two UNIVAC DCS–1C units are mounted within a processor and when four are mounted in a freestanding cabinet.

The LTC receives I/O requests from the multiplexer channel, validates I/O commands, and passes bit-parallel data between the line terminal and the processor. The LT makes the electrical connection between the line terminal controller and the CI, and converts the received bit-serial characters from the CI to bit-parallel characters for conveyance to the processor by the LTC. The CI (either RS 232 or wideband) provides the physical, electrical, and logical connection with a synchronous data set.

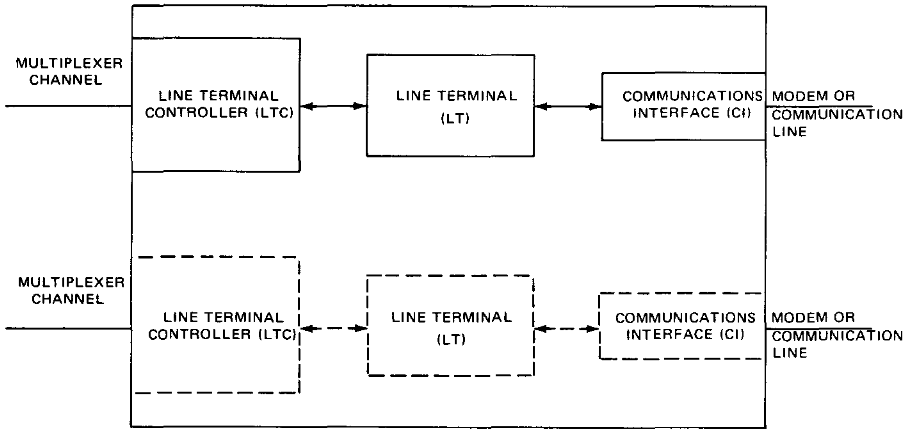



*Figure 2–3. Interrelationship of UNIVAC DCS–1C Components When Mounted in a Processor*

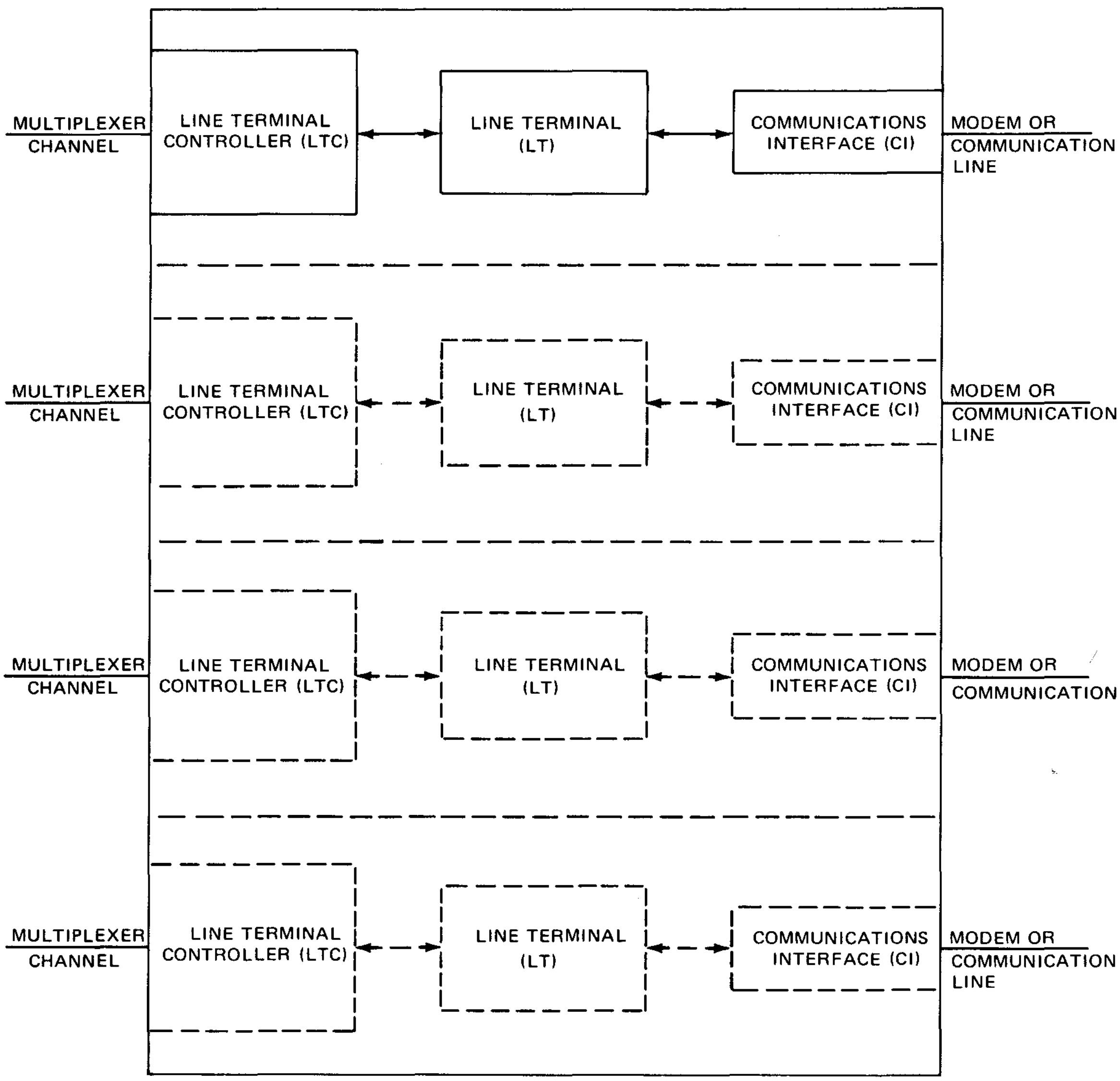



*Figure 2–4. Interrelationship of UNIVAC DCS-1C Components When Mounted in a Freestanding Cabinet*

## 2.3.1. LINE TERMINAL CONTROLLER

The line terminal controller (LTC) coordinates, through the multiplexer channel, the activities of the processor and any communications feature in the subsystem.

The functions of the LTC are:

- To validate the processor commands; that is, to verify that the device address in the processor command is the address of a line terminal (LT), that the operation specified is within the repertoire of the addressed LT, and that the parity of the command is correct.
- To respond to processor commands and LT requests for service.
- To validate the character parity of data coming from and going to the processor.
- To control the LTs and permit concurrent operation of LTs.
- To select LTs requesting service according to priority.
- To release each LT after it has performed its operation.

Table 2—1 lists the characteristics of the LTC.

| CHARACTERISTICS | |
|---|---|
| Number of line terminal controllers (LTCs) required | 1 |
| Number of synchronous timing assemblies | One for each LT interfacing with an AT & T 202C or 202D data set, or each data set having no clock. |
| Number of communications interface circuits required | 1 |
| Number of line terminals (LTs) | 1 |
| Type of transmission | Synchronous |
| Mode of operation | Single byte: bit parallel to and from processor and LT or dialing adapter. |
| Byte size | 8 bits per byte plus parity (to and from multiplexer channel) |
| Number of commands | 16 |
| Number of status bytes | 6 |
| Number of sense bytes | 3 |
| Type of byte parity (to and from multiplexer channel) | Odd parity for all data transfers |
| Number of multiplexer subchannels required | 1 for each unit |

*Table 2—1. Line Terminal Controller Characteristics*

### 2.3.2. LINE TERMINAL

The line terminal (LT) receives data in bit-serial form from the communications interface (CI) and converts it to bit-parallel form for conveyance to the processor by the line terminal controller (LTC). Conversely, the LT converts bit-parallel data from the processor to bit-serial form for the communications interface.

Two types of line terminals are available, transparent and nontransparent:

- Transparent Line Terminal (F1395–01)

  The transparent line terminal accommodates both transparent (uncoded characters) messages and nontransparent (encoded in either EBCDIC or ASCII characters) messages.

- Nontransparent Line Terminal (F1395–00)

  The nontransparent line terminal accommodates messages encoded in either EBCDIC or ASCII but cannot accommodate transparent (uncoded) messages.

Both line terminals perform error checks automatically during message transmission. (See 2.3.2.8.)

Table 2–2 lists the characteristics of the line terminals.

| CHARACTERISTICS | |
|---|---|
| Transmission method | Synchronous |
| Transmission mode | Bit serial |
| Character compatibility | 7-level-plus-parity ASCII, 8-level EBCDIC, and 8-level transparent |
| Error checking methods | ■ Character parity<br>■ Longitudinal redundancy check<br>■ Cyclic redundancy check |
| Character recognition | The following ASCII and EBCDIC control characters are recognized:<br>■ Synchronization (SYN)<br>■ Start of header (SOH)<br>■ Start of text (STX)<br>■ End of transmission block (ETB)<br>■ End of transmission (EOT)<br>■ End of text (ETX)<br>■ Data link escape (DLE)<br>■ Positive acknowledge (ACK)<br>■ Negative acknowledge NAK)<br>■ Enquiry (ENQ)<br>■ Wait before transmitting (WABT) |
| Maximum transfer rates | UNIVAC 9200 System, UNIVAC 9200 II System: 50,000 bps<br>UNIVAC 9300 System, UNIVAC 9300 II System, UNIVAC 9400 System: 230,400 bps |

*Table 2–2. Line Terminal Characteristics*

### 2.3.2.1. DATA TRANSFERS

Data transfers between a line terminal and the processor are exchanged in bit-parallel form, using eight-bit bytes. Between the line terminal and the data set (modem), characters are exchanged bit-serially. The least significant bit (bit position $2^0$) is transmitted and received first.

### 2.3.2.2. TIMERS

Three types of hardware timers can be made operational as desired at a particular installation:

- Transmit Timer (1 second)

  The transmit timer controls the insertion, in the message, of the synchronizing character (SYN in nontransparent mode, DLE-SYN in transparent mode) at 1-second intervals (nominal).

- Receive Timer (3 seconds)

  The receiver timer monitors the receipt of the synchronizing characters and indicates an error condition if the characters are not received within a 3-second period (nominal). (SYN patterns are deleted from input messages whether or not this timer is used.) The timer should not be activated in a dialed-access system, because the time required for establishment of a connection on the switched network probably exceeds 3 seconds.

- Text Timer (0.5, 1, or 5 seconds)

  The time from the occurrence of a starting character (SOH or STX) to the next ending character (ETB, ETX, or ENQ) is monitored by the text timer to limit message length on a data link. The time can be set to 0.5, 1, or 5 seconds as desired at a particular installation.

### 2.3.2.3. SYNCHRONIZATION

The line terminal precedes each output message with four synchronization (SYN) characters according to the specified code (EBCDIC or ASCII). During transmission, the terminal inserts a SYN character (DLE-SYN in transparent messages) once each second. All synchronization characters are deleted from incoming messages so that no program involvement is required.

### 2.3.2.4. CONTROL CHARACTER RECOGNITION

The line terminal recognizes the control characters, in either EBCDIC or ASCII, listed in Table 2–2.

All special messages used in binary synchronous communications (BSC) transmission are acceptable to the UNIVAC DCS–1C. Special messages include those characters which indicate:

- Acknowledge (ACK)

- Negative Acknowledge (NAK)

- Enquiry (ENQ)

- Wait Before Transmitting (WABT)

On output, the programmed command determines whether the control character code is to be EBCDIC or ASCII. On input, the terminal makes this determination by examining the SYN characters.

The terminal's reaction to a given control character is conditioned by its adherence to certain procedural conventions. These conventions are:

- A nontransparent text message begins with either SOH or STX.
- A transparent text message begins with STX.
- Both nontransparent and transparent text messages end with ETB, ETX, or ENQ. The ETB or ETX is treated as a normal ending. The ENQ indicates that the message should be ignored.
- Any input or output message not preceded by SOH or STX is a control sequence.
- Control sequences are nontransparent.

The terminal implements these procedural conventions by logically establishing one of two data transfer modes: text or control. The terminal's operating mode is determined by the control characters being transferred from the data link to storage, or from storage to the data link, not by the current I/O command.

Text mode is established when the first non-SYN character from the data line or storage is SOH or STX. Text mode is terminated upon detection of ETB, ETX, or ENQ.

### 2.3.2.5. TRANSPARENT TEXT MODE

Both line terminals accommodate EBCDIC or ASCII encoded characters. The F1395–01 line terminal also handles transparent text blocks. Only text messages may be transmitted under the send-transparent command. Control sequences such as EOT, NAK, or ENQ must be issued with the send-normal command.

The program establishes an output buffer containing the transparent message. The first character in that buffer must be STX. The last character must be ETX or ETB (Table 3–4) to avoid a block parity error at the remote terminal.

Once the send-transparent command is accepted, the terminal requests the first output character. If this character is STX, the terminal transmits the STX character after hardware generates a character sequence of SYN SYN SYN SYN DLE. Each byte forwarded from the processor is checked for correspondence with DLE, ETB, ETX, or ENQ. If the character is DLE, a second DLE character is inserted and an additional output request is made to determine whether this is transparent data or a valid ending character. If an additional character is received from storage, the previous character is assumed to be data and is transmitted. If the buffer is empty, a valid ending character is assumed. DLE is inserted ahead of this character, and the 16-bit cyclic redundancy check (CRC) summation is inserted behind the ending character. All 32 bits are then transmitted and the command is terminated.

### 2.3.2.6. NONTRANSPARENT TEXT MODE

On output operations, parity accumulation begins with the first character after SOH or STX and continues through the first ending character (ETB, ETX, or ENQ) encountered.

The SYN character inserted by the hardware at 1-second intervals is not included in the parity count. Control characters appearing between starting and ending characters are ignored, but are included in the parity count and are transmitted. When one of the three ending characters is detected, it is counted and transmitted. The parity count is then forwarded and the output command is terminated. The terminal can be arranged to transmit a pad character after the parity pattern. A pad character (all zeros) is deleted when received.

On input operations, transfers begin with the starting character (SOH or STX), and parity accumulation starts with the next character. SYN characters are deleted and are not counted. Transfers continue until ETB, ETX, or ENQ is detected. The ending character is transferred, followed by the parity bytes, and the input command is terminated. Normal completion is reported by the UNIVAC DCS–1C generating and transferring the device end status byte to the multiplexer channel if the message ended in ENQ. If the received parity count does not match the accumulated count, a block check error character is returned.

### 2.3.2.7. CONTROL MODE

On output operations, all control sequences must be nontransparent and must not be preceded by SOH or STX. Odd vertical (character) parity is added to ASCII character coding. The command is terminated by the terminal upon detection of ENQ and the ENQ character is transmitted. If the sequence does not contain ENQ, output continues until the program buffer is emptied.

On input operations, all characters of the control sequence are transferred. Vertical (character) parity is not checked. The terminal terminates the input command upon detection of ENQ, NAK, EOT, or DLE. If the detected character is DLE, both DLE and the following character are transferred to storage.

### 2.3.2.8. ERROR CHECKING

Three error checking methods are available to the UNIVAC DCS–1C hardware to ensure that transmissions are effected without loss of information. They are:

- Vertical Redundancy Check (VRC)

  The VRC method is a character parity check in which a VRC bit is appended to each 7-bit ASCII character. Character parity is calculated and checked only on ASCII characters, and only in nontransparent mode. This extra bit is a 0 or 1, depending on the number of 0 and 1 bits in the 7-bit character. The LT appends the proper bit to each character upon transmission and removes it upon reception after first verifying that it has been correctly assigned a 0 or 1. If the parity bit is incorrect, an error signal notifies the computer program so that corrective action can be taken.

- Longitudinal Redundancy Check (LRC)

  The LRC method is used only for nontransparent ASCII text and consists of a modulo-2 noncarry addition of the seven data bits in all characters after the starting character up to and including the termination character. The LT appends an LRC character to each message immediately following the end-of-text (ETX) character. This check character is computed by the LT on the basis of all 0 and 1 bits in the entire message and verified upon reception of all text messages using ASCII language; discrepancies are handled in the same manner as for the VRC text.

- Cyclic Redundancy Check (CRC–16)

  The CRC–16 method appends a 16-bit cyclic redundancy check (CRC) character to all EBCDIC and transparent messages immediately following the end-of-message character. The CRC–16 character is the result of a binary division operation performed on the entire message as if the message were one binary number. The CRC–16 character is an alternative to the VRC/LRC method performed on all ASCII nontransparent messages. The LT verifies the correctness of CRC characters received and, upon detection of an error, notifies the computer program of its occurrence.

### 2.3.3. COMMUNICATIONS INTERFACE

The communications interface (CI) provides the physical, electrical, and logical connections to the communications line data set or modem. Because there are differences in carrier equipment, the CI must provide the correct match.

Two types of communications interface packages are available for use with the UNIVAC DCS–1C:

- Communications Interface – EIA RS232–C (F1395–00)

  An Electronic Industires Association standard modem interface, designed to specification RS232 Revision C, for use with any modem designed to the same specification.

- Communications Interface – Wideband (F1395–01)

  For use with Western Electric Wideband Data Set 301 and 303 series equipment.

## 2.4. OPTIONAL FEATURES

The basic UNIVAC DCS–1C can be augmented by optional features, to complement the carrier and remote terminal equipment or to accomplish a total systems design goal such as automatic dialing, polling, and station selection.

### 2.4.1. DIALING ADAPTER

The Dialing Adapter (F1363–00) permits program-controlled establishment of connections on a switched network. The adapter operates in conjunction with an appropriate (pulse or tone) Bell System Automatic Calling Unit (ACU). It accepts dial digits from the UNIVAC 9000 Series system processor and presents them to the dialing unit. A UNIVAC DCS–1C can accommodate one dialing adapter.

### 2.4.2. POLLING

Polling (F1360–00) facilitates use of a UNIVAC 9000 Series system processor as a multipoint master station. With this feature, the program is relieved of many of the I/O functions associated with traffic solicitation from the tributary stations.

### 2.4.3. STATION SELECT

Station Select (F1361–00) enables the detection of a single, user-specified character by the line terminal. This character would, presumably, be the first address character of a multipoint tributary station.

### 2.4.4. APPLICATION OPTIONS

Three additional UNIVAC DCS–1C features, none of which have any direct effect upon programming, also are available; they are:

- Wideband Interface (F1395–01)

- I/O Buffer (F1359–00) for temporary storage of four input or four output characters.

- Synchronous Timing Assembly (F1011–00). For use in any system having a data set without the requisite clock.

# 3. UNIVAC DCS-IC REPERTOIRE

## 3.1. I/O COMMANDS

The UNIVAC DCS–1C is an I/O device with respect to the UNIVAC 9000 Series systems. As such, it responds to 16 I/O commands given in the form of execute-I/O and test-I/O commands. These commands are described briefly in Table 3–1. Full details of the commands are given in the *UNIVAC 9000 Series Compatible Data Communications Subsystem Programmer Reference, UP–7846* (current version).

| COMMAND | FUNCTION |
|---|---|
| Adprep | Enables receipt of addressed control or text messages. |
| DCS-test | Disables connection between communications interface and data set and directs output to input logic of line terminal; line terminal generates channel end/device end status. |
| Dial | Initiates program-controlled establishment of dialed connections. |
| Disconnect | Terminates dial-connected call, at UNIVAC DCS–1C end of line, by dropping the DATA TERMINAL READY signal between the communications interface and the data set. |
| End-test | Terminates DCS-test or local-test command; line terminal generates channel end/device end status. |
| Local-test | Enables loop-back test from output logic, through data set, and back to input, line terminal generates channel end/device end status. |
| Look-for-SYN | Causes the communications interface to turn on the DATA TERMINAL READY signal, after which the data link is monitored for two successive SYN characters. |
| New-SYN | Overrides and recycles a current look-for-SYN command. The new SYN command causes the station to drop character phase and begin looking for two successive SYN characters, after which the command performs the same functions as the look-for-SYN command. |
| Poll | Turns on input and polls multipoint tributary stations. |
| Search | Line terminal receives all traffic addressed to it and all control (nontext) traffic occurring on a multipoint circuit; command is terminated upon detection of EOT. |
| Send-Normal | Used to send nontransparent text and all control sequences. |
| Send-transparent | Used to send transparent text only. |

*Table 3–1. I/O Commands (Part 1 of 2)*

| COMMAND | FUNCTION |
|---|---|
| Sense | Causes the line terminal to send up to three sense bytes to the processor. |
| Set-DTR | Causes the communications interface to send the DATA TERMINAL READY signal to the data set, in order to receive dialed calls without also having the input logic of the line terminal turn on. |
| Test-I/O | Causes the addressed line terminal to send status information. |
| Turn-off | Causes termination of any active command and generates a channel end/device end status. |

*Table 3–1. I/O Commands (Part 2 of 2)*

## 3.2. STATUS BYTES

The UNIVAC DCS–1C responds to each processor command with a status byte. A status byte contains information about the acceptance of a command, the status of a unit, or the performance of a command. Status bytes may be sent to the processor, by way of the line terminal controller, following acceptance of a command, upon termination of an operation, or when requested by the central processor. The status byte repertoire is listed in Table 3–2.

| STATUS | FUNCTION |
|---|---|
| EBCDIC | Indicates that received message is in EBCDIC mode. |
| Busy | Indicates that previously issued command is in progress. |
| Channel end | Indicates that previously issued command has been terminated; this byte is generated only once per operation and is not generated unless an operation has been initiated. |
| Device end | Indicates completion of an operation by an I/O device. |
| Unit check | Indicates an error condition and commands the line terminal to get sense bytes. |
| Unit exception | Indicates that the received text block is transparent. |

*Table 3–2. Status Byte Repertoire*

## 3.3. SENSE BYTES

Three sense bytes are generated by the line terminal and sent to the processor in response to a sense (9400 System) or test-I/O (9200, 9200 II, 9300, or 9300 II System) command from the processor. Two or three sense bytes are sent to the processor upon command.

Sense byte 1 and byte 2 repertoires are listed in Tables 3–3 and 3–4.

Sense byte 3 is sent to the processor when a timeout occurs in connection with a poll command. In this case, the sense byte contains the index character of the last station called.

| SENSE DATA | FUNCTION |
|---|---|
| Command reject | Indicates an invalid command or that equipment feature is not installed. |
| Bus out check | Indicates parity error in command byte. |
| Data check | Indicates parity error in output data. |
| Overrun | Indicates that the hardware is unable to transfer input data as a result of late acknowledgment, or the occurrence of a buffer termination prior to receipt of a termination character. |
| Ring indicator | Indicates a ringing signal is being received from a remote station. |

*Table 3—3. Sense Byte 1 Repertoire*

| SENSE DATA | FUNCTION |
|---|---|
| Block check | Indicates block parity error or that ENQ follows STX or SOH. |
| Character check | Indicates ASCII character parity error. |
| Carrier check | Indicates loss of data set carrier signal. |
| Dial check | Indicates incomplete dial operation. |
| Format error | Indicates no STX character at the start of a transparent message. |
| Text timeout | Indicates selectable (0.5-, 1-, 5-second) text time has expired. |
| Receive timeout | Indicates input LT 3-second time has expired. |
| Control mode timeout | Indicates input LT 1-second time has expired. |

*Table 3—4. Sense Byte 2 Repertoire*

# 4. SOFTWARE SUPPORT

Software support of the UNIVAC DCS–1C consists of the binary synchronous communications control routine (BSCCR), which serves as an interface between the user's program and the UNIVAC DCS–1C. It is generated in assembly language, and is produced as a relocatable deck for subsequent linking with the user's program.

The routine is a generalized binary synchronous communications handler. This means that it is the skelton of a routine designed to issue commands only to a UNIVAC DCS–1C for communications with any device conforming to binary synchronous conventions. To transform the handler from a generalized form to a specific form, the user must provide the BSCCR generator with a series of values that customize the handler to permit communication with a particular remote device. This remote device may be affected by hardware or software, or both.

The user is responsible for providing information for the BSCCR in two forms:

- declarative macros, such as maximum message length, number of recovery attempts, and so on; and
- imperative macros, such as OPEN, GET, PUT, and CLOSE.

When the BSCCR has been provided with the foregoing information, the user may then link it with other handlers, such as a reader, punch, printer, or remote UNIVAC DCT 2000 Input/Output Control System (IOCS), with a worker program, thus forming the routine for the UNIVAC 9000 Series system.

The BSCCR can also be used as a multiline handler to control any mixture of UNIVAC DCS–1C configurations, in half- or full-duplex mode, provided the total data transmission rate does not exceed the system capacity. The BSCCR functions in a single-program environment only.