CONTROL DATA
CORPORATION

CONTROL DATA®
6673-A/B/C/D, 6674-A/B/C
DATA SET CONTROLLER

REFERENCE MANUAL

REVISION RECORD

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A	Manual released. This manual supersedes the 6673-A/6674-A Data Set Controller section of the
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FIGURES

TABLES

6673-A/B/C/D, 6674-A/B/C DATA SET CONTROLLER

The CONTROL DATA® 6673-A/B/C/D, 6674-A/B/C Data Set Controller interfaces 6000 Series computers with leased telephone transmission lines. This enables data transfer between a central computer complex and a remote computer system.

The 6673/6674 consists of a Data Channel Adapter (DCA), a multiplexer, and up to four data set controllers (DSC). The 6673/6674 cabinet also provides mounting for DATA PHONE® data sets. Each installation determines how many DSC's and data sets are used. The 6673/6674 uses the AT&T 301-B Data Set which provides a transmission rate of 40.8 kilobits/second. Communication over leased line requires two AT&T data sets; one data set terminates each end of the transmission line.

Figure 1 shows a typical configuration with four DSC's. The multiplexer assigns individual DSC's to transmit or receive. Each DSC converts 12-bit parallel words from the computer (via the DCA) to serial bits for the data set. The data set transmits serial data received from the DSC over a leased transmission line. The DSC at the receiving end of the line converts this serial data into 12-bit parallel words for computer input.

Each DSC includes a cyclic code generator and Error Detection circuit that enables detection of error bursts of 12 bits or less. An error burst is any pattern of errors whose length is the number of bits between the first and last errors of a transmission.

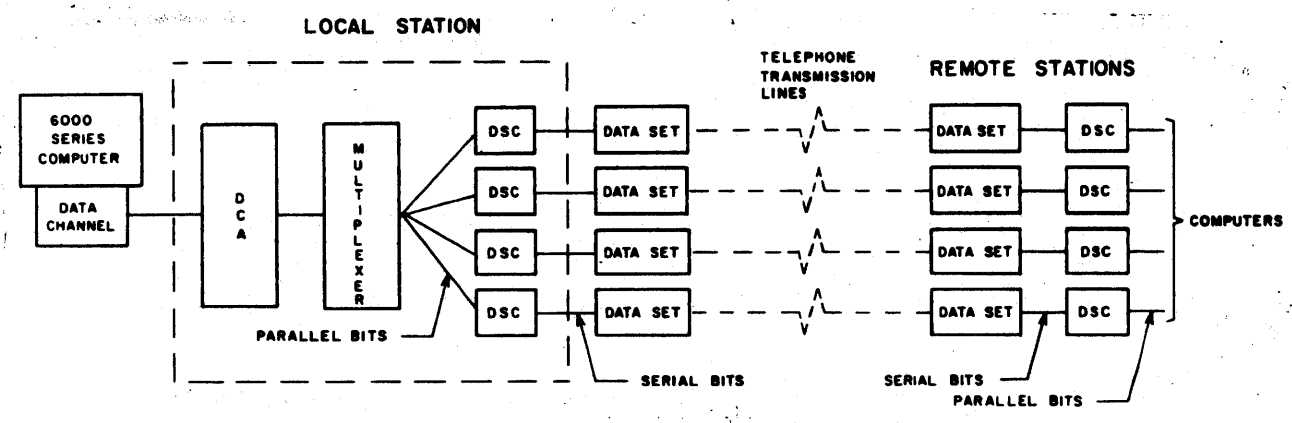


Figure 1. Typical Configuration

The transmitting DSC generates a cyclic code with each data block transmitted. A DSC may receive an interrupt word if it is not transmitting or receiving data. The interrupt word sets a status bit in the DSC. The equipment contained in the 6673/6674 is described below:

The Data Channel Adapter is a high-speed interface between the multiplexer of the 6673/6674 and a 6000 Series Peripheral Processor Data Channel. It provides the necessary logic signal conversions, resynchronization, and signal relay functions for the input/output operations. During an output operation the DCA converts the 6000 Series pulse signals to 1600 Series static signals. During an input operation the DCA converts the 1600 Series static signals to 6000 Series pulse signals, resynchronizes the pulse signals, and transfers them to the applicable Peripheral Processor via the Data Channel.

The multiplexer assigns each DSC to transmit or receive as directed by the computer and permits up to four transmit or receive operations to occur simultaneously. The exact number of high-and low-speed lines per multiplexer which can be serviced by a Peripheral Processor depends on the amount of processing required for the input and output data and on the manner in which this is handled by the operating system. The number of lines can be determined after a careful analysis of system data flow.

The DSC converts parallel data received from the computer to serial data for the data set and vice versa. A data set connects to each DSC and transmission line to receive and transmit serial data on the long distance communication facilities. The data sets provide synchronous clock pulses to bit-time the DSC and to modulate or demodulate the transmission line carrier. The data set consists of a signal controlled transceiver with an internal oscillator that produces synchronous clock pulses. The data set clocks out serial data from the DSC to phase modulate the carrier frequency during transmission. The data set demodulates incoming line signals to recover control signals and data.

*When a data set is used with a 6673/6674, the remote data set controller must be a CONTROL DATA 3275-C, or 8529-B to utilize the cyclic code error detection capability.

FUNCTIONAL DESCRIPTION

Two stations, the local and the remote, constitute a communication network (Figure 1). The local station includes the 6000 Series computer and the 6673/6674; the remote station contains the other computer and peripheral equipment. With the exception of the computer and associated equipment, each station contains compatible DSC's and identical data sets. A leased transmission line connects the stations through the terminating data sets.

Each DSC operates in half-duplex; that is, data is exchanged in only one direction at a time. When one DSC is in the Transmit mode, the other must be in the Receive mode; to exchange data in the opposite direction, both DSC's must reverse modes.

Although data is transferred in half-duplex, control signals and response indications utilize the full-duplex capability of the data set. Both the response and the control signals are automatic functions.

During transmission from the local station to the remote station, the local station is in the Transmit mode and the remote station is in the Receive mode. With both stations active, data at the local station is exchanged in the following manner (Figure 2):

1) The local computer selects a local DSC (0-3) for the Transmit mode.
2) The DSC transmits a sync word.
3) The computer selects the DSC and sends it a data word.
4) The remote station acknowledges the sync word with a Response.
5) The DSC disassembles the first parallel data word received from the computer and transmits it serially, highest order bit first.
6) By sampling the status-all bits, the computer detects when a specific DSC (0-3) requires another data word for transmission (or contains a complete data word received from the remote station).
7) When the complete data block is transmitted, the DSC transmits the cyclic code word.

With both stations active, data is received from the remote station in the following manner:

1) The local computer selects a DSC for Receive mode.
2) The DSC receives the sync word and returns a response.
3) Each data word received is assembled into a 12-bit parallel word.
4) The computer samples status-all and inputs the data word.
5) When the complete data block is received, the DSC checks the received

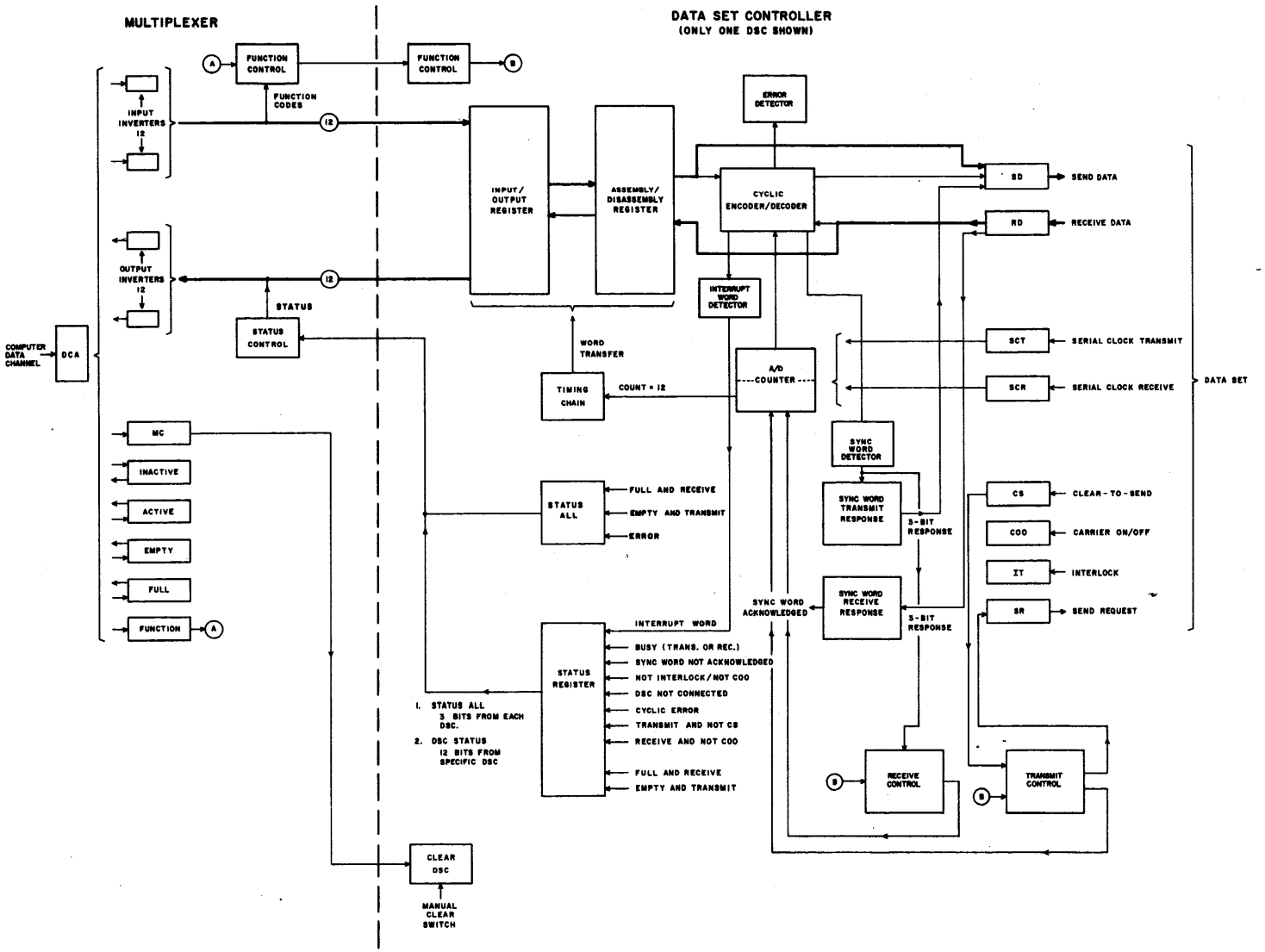


Figure 2. 6673/6674 Block Diagram

cyclic code word against one it has generated. If they do not agree, the DSC sets the cyclic code-error status bit.

The method of communication presented above is the basic sequence, and many elaborations are possible. The section on Programming, describes these variations and discusses the signals that control communication between the computer, the multiplexer, the DSC, and the data sets.

PROGRAMMING

All data transfer operations via the 6673/6674 are controlled by the local computer. Receive and Transmit operations from a specific DSC are initiated by function codes from the computer. The status-all word from the multiplexer enables the computer to determine when a DSC requires service. Operation of a DSC is monitored by requesting a status word from the respective DSC.

CODES

Control Signals

Communication signals between the 6673/6674 and the computer or between the 6673/6674 and the data set are listed in Tables 1 and 2 (Figure 2). Understanding the function of these signals clarifies the purpose of certain function or status codes. Communication signals are not transferred over data lines.

TABLE 1. COMMUNICATION SIGNALS BETWEEN CONTROLLER AND COMPUTER

Signal	Description
External Master Clear	A static "1" appears on the line whenever the 6000 Series dead start panel is used to start the system.
Function	A static "1" signal is produced on the line when an external function code is present on the data lines for examination and translation by the 6673/6674. An Inactive signal from the 6673/6674 removes the static "1" signal.
Inactive (from 6673/6674)	A static "1" signal is produced on the line as a response to an EXF request if the 6673/6674 is selected.

TABLE 1 (Cont'd)

Signal	Description
Active (from 6673/6674)	A static "1" signal is produced on the line as a response to an Active (from DCA) if the 6673/6674 is selected. This is cleared by an Inactive from the DCA.
Active (from DCA)	A static "1" signal is produced by the Data Channel while it is activated.
Inactive (from DCA)	A static "1" signal from the DCA indicates that the computer has deactivated the Data Channel.
Full (from DCA)	A static "1" signal accompanies each word of output information. Signal indicates output data present on lines. The signal is turned off by an Empty from the 6673/6674.
Full (from 6673/6674)	A static "1" signal is produced by the 6673/6674 when a data or status word is available. The signal is turned off by an Empty from the DCA.
Empty (from DCA)	A static "1" signal indicates that the DCA has accepted the input word from the 6673/6674. The signal is turned off by dropping the Full in the 6673/6674.
Empty (from 6673/6674)	A static "1" signal indicates that the 6673/6674 has accepted the output word from the DCA. This signal is turned off by dropping the Full signal in the DCA.

TABLE 2. COMMUNICATIONS SIGNALS BETWEEN CONTROLLER AND DATA SET

Signal	Description
Serial Clock Transmit (SCT)	The SCT circuit furnishes the master clock timing signals for the DSC in the Transmit mode. The data set SCT signal is a square wave (40.8 kHz - 301-B).
Send Data (SD)	The SD line carries the serial data from the DSC to the data set where the information is sampled during the negative transition of the SCT square wave.
Serial Clock Receive (SCR)	Similar to the SCT signal, the SCR signal clocks the received data to the DSC. SCR synchronization depends upon the SCT signals at the transmitting set.

TABLE 2 (Cont'd)

Signal	Description
Receive Data (RD)	RD consists of incoming serial data which is sent to the DSC and sampled during the negative transition of the SCR square wave.
Interlock (IT)	An On signal to the DSC indicates that the data set is on, that it can transmit data, and that it is not in a test condition.
Carrier On-Off (COO)	An On signal to the DSC indicates that the line carrier is present at the data set.
Send Request (SR)	The DSC delivers an On signal to the data set when it is ready to transmit data. The data set should respond with a CS signal.
Clear-to-Send (CS)	When the SR circuit is turned on by the DSC, the CS circuit should be switched on by the data set indicating that it will accept data. When the SR circuit is again turned off, the CS circuit is switched off.

Function Codes

The 6673/6674 translates and interprets the external function (EXF) codes listed in Table 3. The function codes represent commands or requests from the computer. The EXF code format is shown in Figure 3.

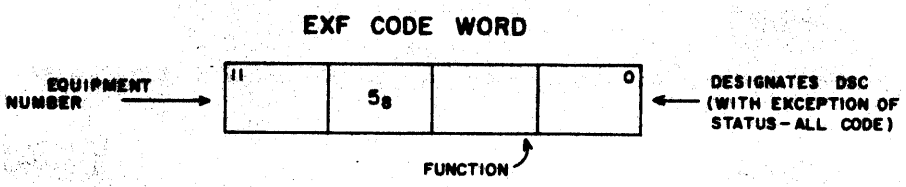


Figure 3. EXF Code Format

TABLE 3. EXTERNAL FUNCTION CODES

Definition	Code	Notes
Request Status-all	S504	Enables 3 status-all bits from each of the four DSC's.
Request Status	S51N	Enables a status word (12 bits) from DSC "N". "N" represents the number assigned to the selected DSC.

TABLE 3 (Cont'd)

Definition	Code	Notes
Select	S52N	Selects DSC "N"
Clear	S53N	Clears DSC "N"
Select Transmit	S54N	Selects DSC "N" for data transmission
Select Receive	S55N	Selects DSC "N" to receive data from the data set for transfer to the computer.
Clear Interrupt Word Received Status Bit	S56N	Clears Interrupt Word Received FF and status bit 2^0 in controller "N" (interrupt word = 7622).

S = Equipment number

Status Response Word

The status response indicates the state or condition of a specific DSC. The computer (S51N EXF code) must request the status word and designate the respective DSC (Figure 4 and Table 4). The 12 lines that carry status information also convey parallel data to the computer.

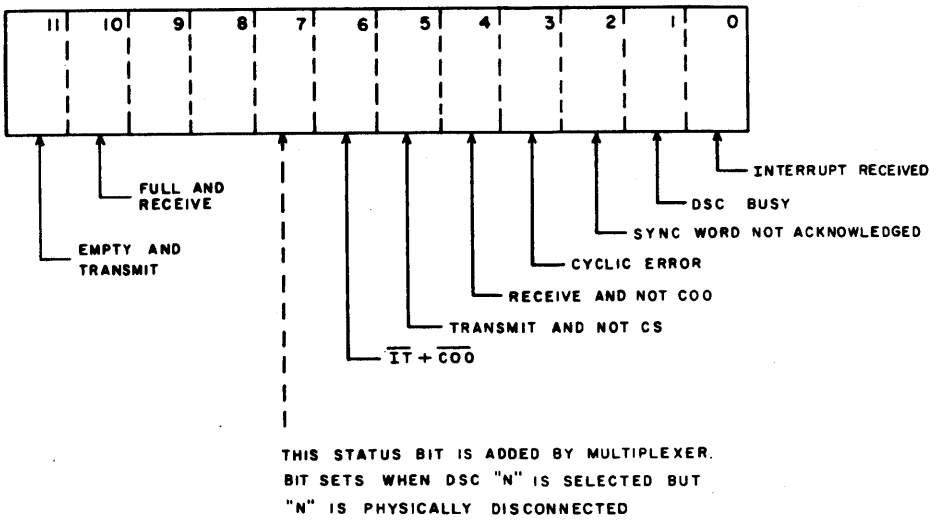


Figure 4. DSC 0 Status Word

TABLE 4. STATUS RESPONSES

Definition	Code	Notes
Interrupt Word Received	0001	Indicates that an interrupt word was received from the remote station and that this station wants attention. The interrupt word is received when the 6673/6674 is not transmitting or receiving.
Control Busy	0002	Indicates that the controller is busy. The controller may be selected and waiting for a sync word, transmitting, or receiving (data or code word).
Sync Word Sent and Not Acknowledged	0004*	Indicates that the controller has sent out a sync word but has not received a response from the remote station.
Cyclic Code	0010	Indicates that the code word received from the remote station does not compare with the code generated by the cyclic decoder in the DSC.
Select for Receive and $\overline{COO}$	0020	Indicates an equipment failure. This occurs when the DSC is selected to receive and the line carrier signal is not present at the data set ($\overline{COO}$).
Select for Transmit and $\overline{CS}$	0040	Indicates equipment failure. This occurs when the DSC is selected to transmit and the Clear-to-Send signal is not present at the data set ($\overline{CS}$).
$\overline{IT}$ or $\overline{COO}$	0100	Indicates equipment failure. $\overline{COO}$ indicates the line-carrier signal is lost; $\overline{IT}$ indicates a malfunction in the local data set.
Controller Not Connected or in Test Mode	0200	Indicates that the equipment referenced is not physically connected, or in the Test mode.
Full and Receive	2000	Indicates that the 6673/6674 is selected for receive and I/O register is full.
Empty and Transmit	4000	Indicates that the 6673/6674 is selected for transmit and the I/O register is empty.

*Data set controller at remote station must include sync word acknowledge circuit to enable status bit 4.

Status-all Response Word

The status-all word (3 bits from each DSC) is requested before each multiplexer cycle

(S504 EXF code). The status-all word is transferred over the 12 lines that transfer data to the computer. Figure 5 shows the status-all word.

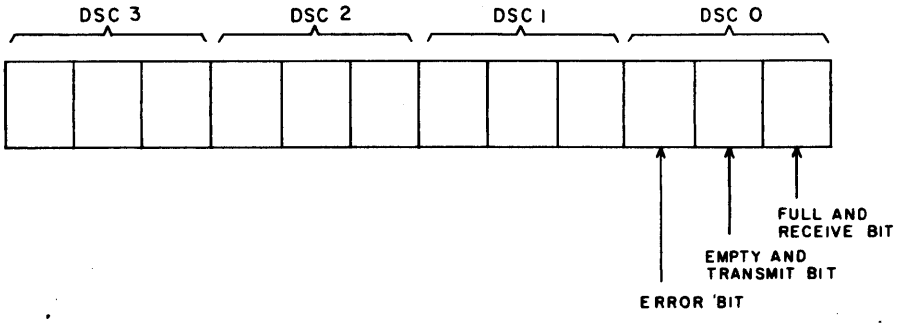


Figure 5. Status-all Word

TABLE 5. STATUS-ALL RESPONSES

Description	Code	Notes
Full and Receive	XXX1	Selected for receive and I/O register full
Empty and Transmit	XXX2	Selected for transmit and I/O register empty
Error	XXX4	Any of the following error conditions a) Selected for receive and not COO b) Selected for transmit and not CS c) Cyclic code error

The above status-all responses are for DSC 0.

MODES OF OPERATION

Transmit Mode

The following 6673/6674 signal interchanges occur when the local computer is transmitting to a remote station. Figure 6 illustrates signal paths.

Transmit Mode Programming Example

Initial Conditions: The 6673/6674 is operational but no transmit or receive operation is in process. Although the multiplexer may service up to four DSC's, the operation of only one DSC is described (page 11). Additional DSC's would operate in an identical

manner. The following sequence assumes that the COO and IT data set signals are present and all units are cleared.

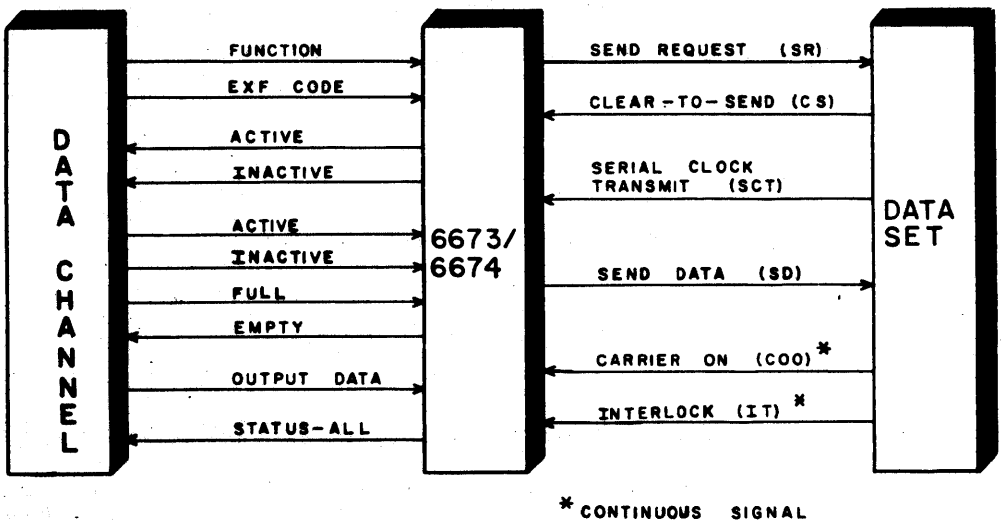


Figure 6. Transmit Mode

Multiplexer:

1) Function and EXF codes select transmit DSC 0.
2) Multiplexer selects DSC 0 for transmit.
   a) This enables the Empty and Transmit status bit in DSC 0 portion of status-all word (Figure 7).
   b) DSC 0 sends out sync word to data set (approximately 300 μsec to send out complete word).
3) Multiplexer may select the remaining three DSC's to transmit or receive if requested by EXF code.
4) The computer requests status-all. Since the Input/Output (I/O) register of DSC 0 is cleared, the Empty and Transmit status-all bit for DSC 0 is a "1".
5) Status-all word is sent to the computer.
6) The computer recognizes Empty and Transmit status of DSC 0.
7) On next multiplexer cycle, computer selects DSC 0 (select code S520).
8) Computer outputs 12-bit data word to DSC 0. DSC 0 accepts word and stores it in the I/O register. Word is transferred to Assembly/Disassembly (A/D)

register and transmitted upon completion of sync word transmission.

9) Computer now services remaining DSC's if they are used and require service.

10) The computer continues to sample the status-all word until it detects another "1" (indicating that one of the DSC's requires service).

Controller DSC 0:

1) When the 12-bit sync word is transmitted, the 12th serial bit enables an I/O register →A/D register transfer. This transfers the first data word to the A/D register.

2) Step 1 (Figure 7) transfers the first data word to the A/D register. This enables the following:

   a. With the I/O register empty, the Empty and Transmit status-all bit again becomes a "1" and DSC 0 can accept another word.

   b. The data word in the A/D register is sent to the cyclic encoder and transmitted bit by bit. It requires approximately 300 μsec to transmit each 12-bit word.

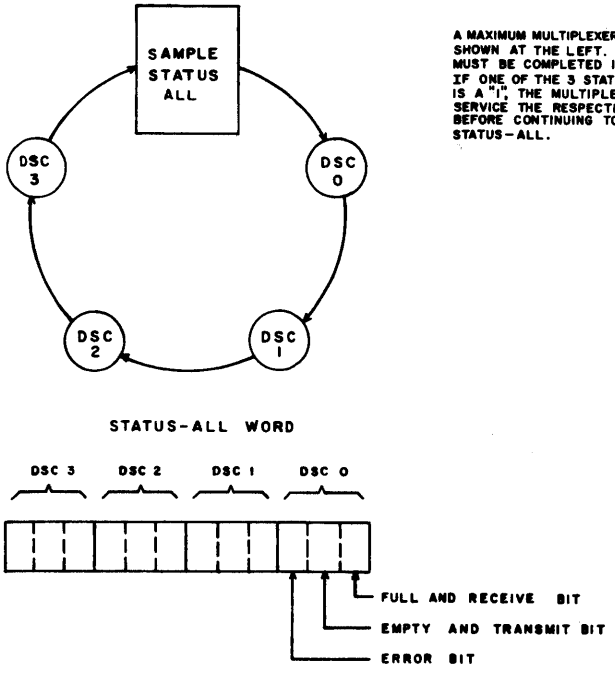


Figure 7. Multiplexer Cycle

3) When the 12th data bit is transmitted, an I/O→A/D transfer brings the next data word to the A/D register. The transmit operation continues in this manner for the entire data block.

4) During the serial transfer of the last word in the data block the last word is in the A/D register, but the I/O register does not contain a new data word. Transferring the 12th bit of the last data word from A/D, enables the DSC to gate out the cyclic code. Upon completion of the code transmission, the transmit function terminates.

5) After transmission of the cyclic code word, a sync word is not transmitted for 300 μ sec. This delay allows the receiving DSC to recognize the end of the data block and check the code word.

Receive Mode

The following control signals are interchanged between the Data Channel, the 6673/6674, and a data set during a receive operation. Data is transferred from a remote station to the local computer. Refer to Figure 8 for a signal flow diagram.

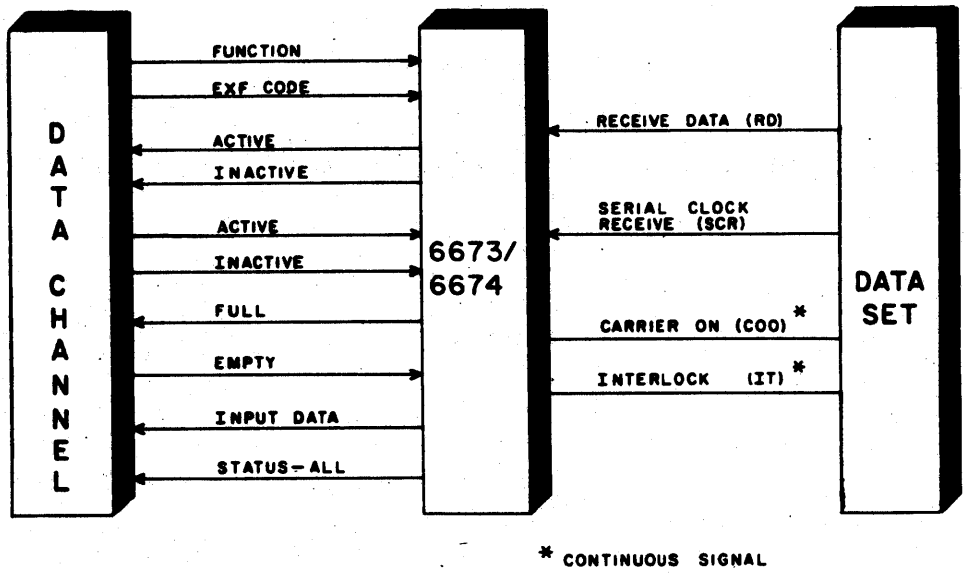


Figure 8. Receive Mode

Receive Mode Programming Example

Initial Conditions: The 6673/6674 is operational but no transmit or receive operation is in process. The operation of only one DSC is described; the operation of the other three DSC's is identical. The following sequence assumes that the COO and SCR data set signals are present and all units are cleared.

Multiplexer:

1) Function and EXF codes select DSC 0 to receive.

2) Multiplexer selects DSC 0 to receive.

3) When DSC 0 detects a sync word, the word is recognized by the Cyclic Encoder/Decoder circuit. The 12th bit of the sync word enables a gate which allows DSC 0 to receive data and enables a 3-bit response to the transmitting data set. The 3-bit response clears the Sync Word Not Acknowledged bit at the transmitting DSC. The 12-bit sync word is not loaded into the A/D register.

4) The first word of the data block follows the sync word. The A/D register assembles this data word; the 12th bit of this word enables an A/D→I/O register transfer. Data words are received and assembled at a rate of 300 usec per word.

5) When the I/O register is loaded, the Full and Receive status bit in the DSC 0 portion of the status-all word sets.

6) The next time the computer requests status-all, it detects the "1" (Full and Receive) in the DSC 0 status-all word.

7) The computer recognizes this "1" and selects DSC 0 (select code S520).

8) The computer inputs the 12-bit data word from DSC 0.

9) Thereupon, the computer services the remaining DSC's if they require service.

10) The computer continues to sample status-all until it detects another "1" in the status-all word.

11) When the 12th bit of the second data word is loaded into the A/D register, the A/D register transfers this word to the I/O register. This sets the Full and Receive status-all bit and the process is repeated.

Controller DSC 0: Controller 0 continues to receive and assemble data words at 300 μsec/word until the computer has accepted the entire data block. Words in the I/O register must be transferred to the computer or the next A/D→I/O transfer will terminate the receive operation.

The computer must know the length of the data block transferred from the remote station. For example, assume that the data block consists of 100 words; the computer will then input exactly 100 words. If the computer does more inputs, the last word (the code word) and the "idle pattern" that follow are accepted as data.

The code word always follows the last word in the data block. When the 12th bit of the code word is loaded into the A/D register, the last data word has been transferred to the computer. The 12th bit of the next word ("idle pattern" transmission) sets the cyclic-error status bit if the code word in the I/O register does not compare with the output of the cyclic encoder/decoder. Setting the cyclic-error status bit also sets the status-all error bit.

To terminate the receive operation after the last word is accepted by the computer, the Data Channel must be deactivated or the DSC deselected. The DSC is deselected by one of the following:

1) Selecting another DSC
2) Requesting status-all
3) Requesting status of the DSC

PROGRAMMING CONSIDERATIONS

Interrupt

An interrupt word from a remote computer indicates that the remote station requires attention. The local computer checks the 6673/6674 interrupt status bit and selects the associated DSC to receive (if so programmed).

Error Detection

The DSC automatically checks for errors when receiving data blocks. A circuit in the DSC, the Cyclic Encoder/Decoder circuit, signals the computer if an error is detected. Both the transmitting and the receiving DSC have a Cyclic Encoder/Decoder circuit. This circuit generates a code word which is transmitted after the last word of a data block. The receiving DSC compares the code word received from the remote station with the code word generated at the receiving DSC; if they are not identical, the data block is in error.

A scheme for encoding and decoding blocks of data by generating a 12-bit cyclic code is used. This provides the following error detection capabilities:

1) Any odd number of errors
2) All error bursts of 12 bits or less
3) 99.5 percent of all error bursts of 13 bits

4) 99.98 percent of all error bursts of 14 bits or greater.

An error burst is any pattern of errors whose length is the number of bits between the first and last errors of a transmission. The cyclic code is one of the most effective and economical error detection techniques for serial transmission presently known.

A maximum line efficiency of 99.4 percent can be achieved when the length of the data block is 341 12-bit words.

Testing

Data transmission and reception may be checked without computer control through a control panel on the DSC. The control panel generates a data block consisting of a sync word, a 12-bit word, and a cyclic word. Checking data through the DSC saves valuable computer time.

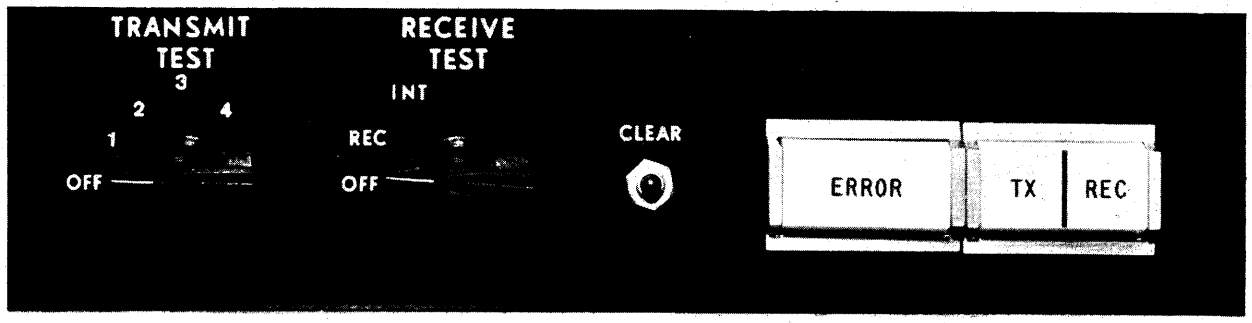
Response Circuit

The DSC Response circuit enables the computer to check whether the remote station recognizes the sync word. The receiving DSC automatically returns a response code to the transmitting DSC when the receiving DSC detects a sync word. This allows the transmitting computer to determine if communication has been established. Response code transmission is simultaneous with data reception.

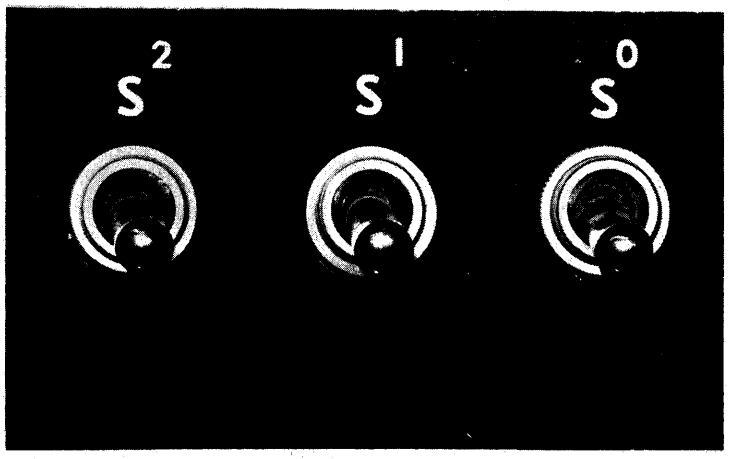
MANUAL OPERATION

The 6673/6674 operates entirely under computer control in normal operation. Before operation, however, the operator must set the initial conditions (described on page 18).

Figure 9 shows the control panel on the multiplexer and the DSC's; Table 6 lists the controls or indicators on the control panels.



DSC CONTROL PANEL



MULTIPLEXER CONTROL PANEL

Figure 9. 6673/6674 Control Panel

TABLE 6. DSC AND MULTIPLEXER CONTROL PANELS

DSC		
Controls	Description	Function
TX/REC	Indicator	The TX indicator lights when the DSC is transmitting; the REC indicator lights when the DSC receives information.
ERROR	Indicator	Momentarily lights to indicate that the cyclic decoder has detected an error.
TRANSMIT TEST OFF, 1, 2, 3, 4	Rotary Switch	Simulates the Transmit mode on positions 1-4. Each word is as follows: Position 1 000 000 000 000 Position 2 111 111 111 111

TABLE 6 (Cont'd)

Controls	Description	Function
		Position 000 001 101 101 Position 111 110 010 010 (Highest order bit transmitted first)
RECEIVE TEST OFF REC INT	Rotary Switch	REC position simulates the Receive mode for maintenance purposes when another DSC transmits one-word data blocks. DSC searches for the sync word and checks for errors. INT position simulates interrupt for maintenance; the Interrupt FF sets if the proper code word is received from a remote DSC.
CLEAR	Momentary Switch	Clears the DSC as a preface to new commands for maintenance purposes.
Multiplexer		
S^2, S^1, S^0,	Toggle Switches	The three toggle switches on the multiplexer labeled S^2, S^1, and S^0, assign the 6673/6674 an equipment number on the Data Channel. This allows the octal digit represented by "S" in the function code (SXXX) to be assigned any value (0-7).

INITIAL CONDITIONS FOR OPERATION

The operator establishes the operating conditions by adjusting switches (Table 6).

1) Check cabinet circuit breaker to determine if power is on.
2) Check Transmit and Receive Test switches. For normal operation they must be in OFF position. In the Test mode, position RECEIVE TEST switch on the DSC at one station to REC or INT and position the TRANSMIT TEST switch on the DSC at the other station to position 1, 2, 3, or 4.
3) Always clear the DSC after power is applied.

COMMENT SHEET

MANUAL TITLE CDC 6673-A/B/C/D, 6674-A/B/C Data Set Controller Reference Manual

PUBLICATION NO. 60334500 REVISION B

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