TTY DATA IN 1TB1-2
TTY DATA OUT 1M1820
TTY XMITT ACTIVE 1M2209

BLOWER ASSY
RIGHT RND of CAB

REMOTE GRID SINGLE STATION
GRAPHIC TERMINAL SUBSYSTEM

REVISION RECORD	
REVISION	DESCRIPTION
PD-0-0	Released -
(10-27-69)	

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FOREWORD

This manual presents an overall view of the GRID Subsystem together with detailed operating and programming information. Explanations assume a basic knowledge of data processing and display methods and address three general classifications of readers: system planner, operator, and programmer.

The text is in three sections. The first explains operational and functional characteristics of the subsystem. Section two discusses operator controls and indicators. Programming information in section three, including flow charts and sample programs, enables effective user application of the subsystem.

The following additional publications may be ordered through:

CONTROL DATA CORPORATION
Literature & Distribution Services
9200 Bloomington Freeway
Minneapolis, Minnesota 55431

DISPLAY CONTROLLER

A three-book Customer Engineering Manual documents the Display Controller.

- Book 1 (publication no. PD82134600) — contains six sections; General Description, Operation and Programming, Installation and Checkout, Theory of Operation, Maintenance, and Maintenance Aids. The first two sections act as a supplement to the Hardware Reference Manual.

Illustrated instructions for installing the equipment at the site as well as procedures for making it operational constitute the third section. The Theory of Operation is concerned with internal operations. A functional approach is used to eliminate the necessity of tracing through the logic diagrams. Maintenance consists of preventive and corrective maintenance procedures while Maintenance Aids provides useful information for customer engineers.

- Book 2 (publication no. PD82134700) — this book contains logic diagrams, timing charts, block diagrams, card placement charts, schematic diagrams and interconnection diagrams. In many instances, the back of the preceding sheet is used to explain functions shown onthe diagram. This serves as an additional "Theory of Operation," from a more analytical viewpoint.

- Book 3 (publication no. PD82134800) — this book contains replaceable parts information for the Display Controller. A provisioning parts list identifies parts called out on illustrated parts drawings. It also contains a list of vendors.

- Special Purpose Manual (publication no. PD82144400) — this book contains interface information for the basic controller Customer Engineering Manual.

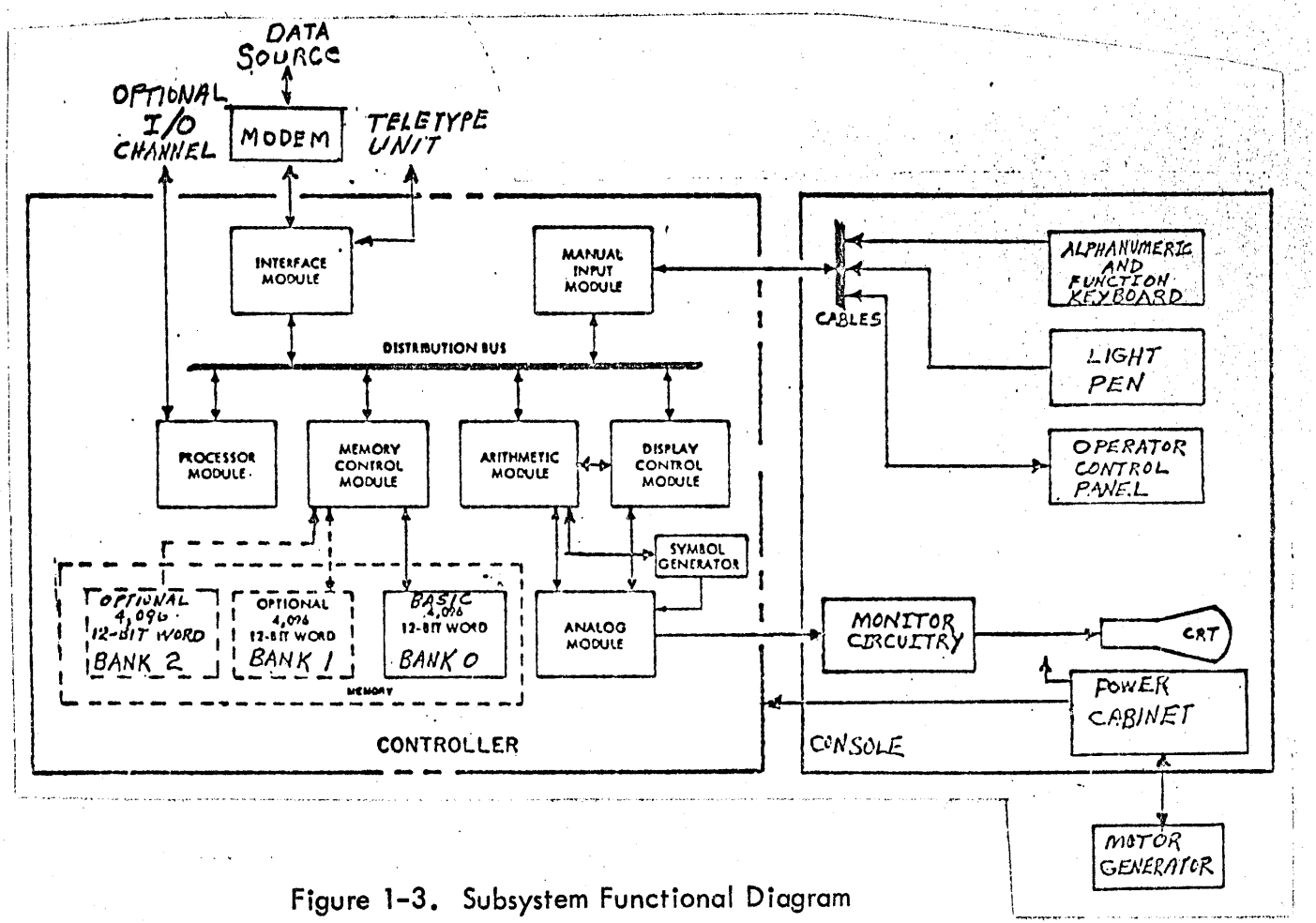

Figure 1-3. Subsystem Functional Diagram

CONTROLLER.

Seven functional modules in the controller perform all the data transfer, processing, and visual display operations.

Six of the functional modules control all logical operations. Each of the six modules connect to a distribution bus which, as the name implies, distributes data transferred from one block to the next. Specific combinations of blocks are active during execution of programs. Inactive blocks ignore distribution bus data.

The analog module interfaces to, and operates in conjunction with, the display control and arithmetic modules. Circuits in the analog module perform digital-to-analog conversions required for presentation of a crt display.

Interface Module.

The interface serves as the connecting link between the subsystem and the modem or teletypewriter unit. The modem is used for communications with the data source. The teletypewriter provides program input via paper tape and serves as an output device by functioning as a paper tape punch.

When IN processor mode, the processor module functions as the principal control element governing execution of program instructions. The processor accesses memory to obtain instructions for execution and to obtain operands and data for processing. The processor continues executing instructions until termination of

INTERFACE.

The display subsystem communicates with the data source via a modem. A teletypewriter provides data output in the form of paper tape or printed message and entry of data via paper tape or keyboard. The modem and teletypewriter share a serializing/deserializing network that converts between serial and parallel data transmission. The modem and teletypewriter can not be operated at the same time, modem and teletypewriter but data transfer does occur simultaneously with processor and display programs. Memory is utilized on a cycle stealing basis.

MODEM.

The modem receives and transmits data over commer cial wires. Data transfer rate is 2,000 bits/second for the 201A modem and 2,400 bits/second for the 201B modem. The modem may be connected for either 2-wire or 4-wire, half duplex operation. Table A3-1 lists lines used for transfer of data between display subystem and modem.

Data Transfer.

The processor sets bits in the control register to initiate each interface operations.

Prior to initiating a data transmit or receive, the A1 and A2 address registers must be loaded to specify the data buffer area.

The AI register holds the initial memory address and the A2 register holds the last memory address plus 1. When expanded memory is present, bits "0" and "1" of the control register define the memory bank to be used.

TABLE A3-1. DATA TRANSFER SIGNALS

ABBREVIATION	SIGNAL	SOURCE	FUNCTION
SR	Send Request	Subsystem	Normally OFF. Switched ON to transmit and remains ON until end of transmission.
CTS	Clear to Send	Modem	Switched ON approximately 150 milliseconds after SR (in 2-wire system). Switched ON in 8.5 milliseconds in 4-wire system.
SCT	Serial Clock Transmit	Modem	Interface synchronizes data on the SD line with positive transitions of SCT.
SD	Send Data	Subsystem	Transfers serial bit stream from interface to modem. Synchronized with SCT signal.
SCR	Serial Clock Receive	modem	Interface samples data on the RD line with negative transitions of SCR.
RD	Receive Data	Modem	Transfers bit stream from modem to interface. Synchronized with SCR signal.
CO	Carrier ON	Modem	In a 2-wire system, the Carrier ON signal turns ON and OFF with each transmission turnaround. The carrier may remain ON at all times in a 4-wire system.

CONTROL REGISTER.

The control register is loaded by the processor and directs operations specified by the selected codes shown in figure A3-1.

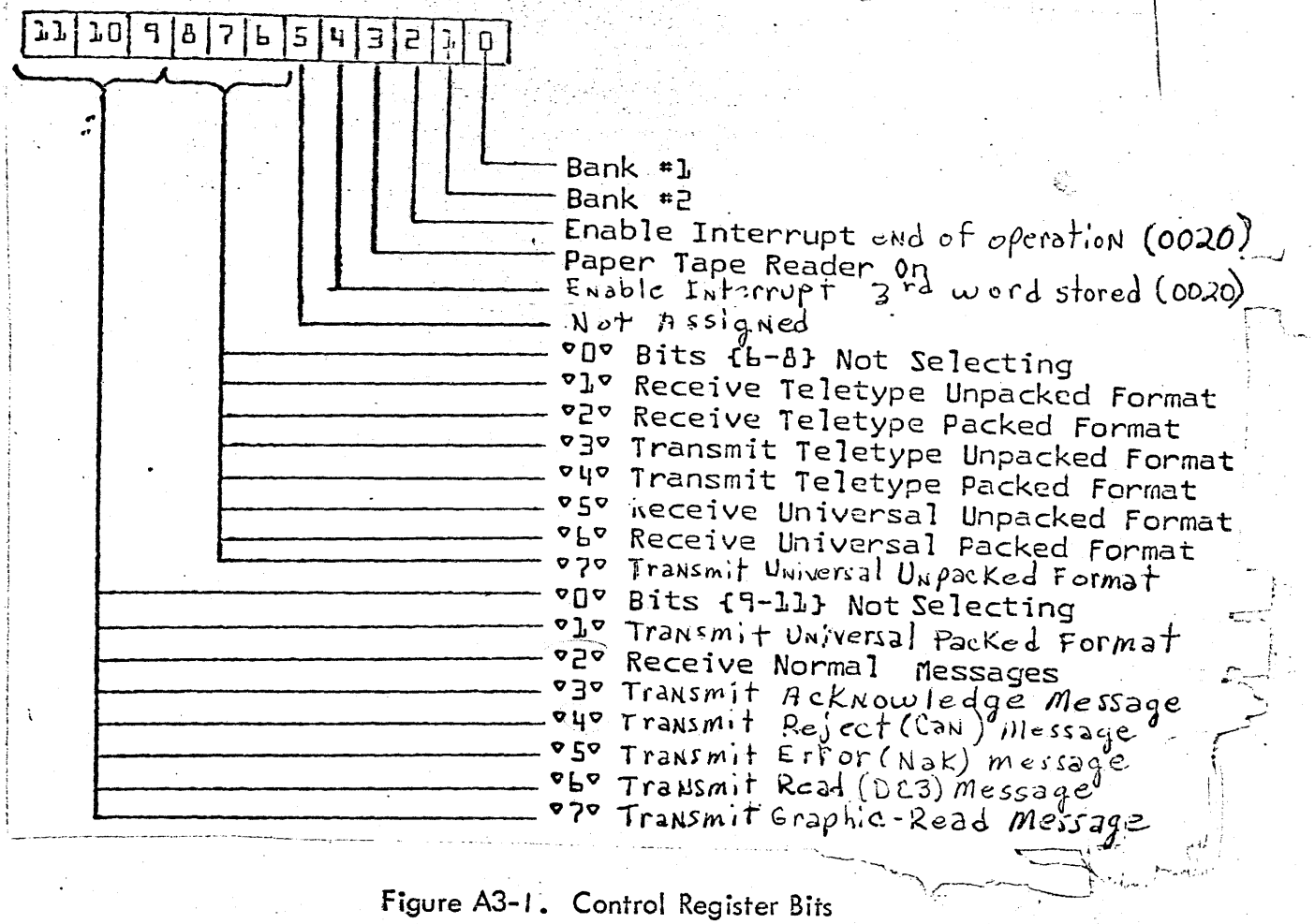

Figure A3-1. Control Register Bits

An explanation of each bit position or code selected follows:

- Bank 1, bit 0 — When this bit sets, memory bank 1 is used in interface operations.
- Bank 2, bit 1 — When this bit sets, memory bank 2 is used in interface operations.

End of Operation

- Enable Interrupt, bit 2 — When set, interrupt (0020) conditions are passed on to the processor. These interrupt conditions occur as a result of a status bit being enabled.

- Paper Tape Reader On, bit 3 — Selection of this bit and a teletype receive selection causes an X-ON code to be sent. This enables the paper tape reader to turn on (if in the ready condition). The interface then switches to receive mode. Tape motion continues until one of the following conditions occurs:

  1. X-OFF code is encountered on tape.
  2. Tight tape.
  3. Out of tape.
  4. Reader is turned off manually.

- Enable Interrupt After 3rd Word, bit 4 --- When set, interrupt 20 conditions are passed to the processor. This interrupt occurs during modem operations as the result of third word being stored in memory.

- Select Operation, bits 6, 7, and 8 — This octal code is decoded and used to specify the following operations.

  1. Code 0 indicates that this octal digit is not specifying an operation.
  2. Code 1 specifies a receive operation from the Teletypewriter. The data received is stored in memory in unpacked format.
  3. Code 2 also specifies a receive operation from the Teletypewriter. Data is to be stored in memory in packed format.
  4. Code 3 specifies a transmit operation to the Teletypewriter. Data is obtained from memory and transmitted in unpacked format.

5. Code 4 specifies a transmit operation to the Teletypewriter. Data is obtained from memory and transmitted in packed format.

6. Code 5 enables the interface for a universal receive operation. Data is received from the data source and stored in memory in unpacked format.

7. Code 6 enables the interface for a universal receive operation. Data is received from the data source and stored in memory in packed format.

8. Code 7 enables the interface to transmit a universal message to the data source in unpacked format.

- Select Operation, bits 9, 10, and 11 —

This octal code is decoded and initiates the following operations:

1. Code 0 indicates that this octal digit is not specifying an operation.
2. Code 1 enables the interface to transmit a universal message to the data source in packed format.
3. Code 2 enables the interface to receive normal mode messages from the data source. When enabled in this mode the interface will respond to all messages conforming to normal message formats.
4. Code 3 enables the interface to send a hardware generated Acknowledge Message to the data source.
5. Code 4 enables the interface to send a hardware generated Reject (CAN) Message to the data source.

6. Code 5 enables the interface to send a hardware generated Error Message (NAK) to the data source.

7. Code 6 enables the interface to send a Read Message (DC3) to the data source. The hardware formats the message, inserting text which is taken from memory. The text is transmitted in unpacked format.

8. Code 7 enables the interface to send a Graphic-Read Message to the data source. The interface formats the message, inserting text which is obtained from memory. The text is transmitted in packed format.

STATUS REGISTER.

The Status Register indicates the present operational status of the interface and may be interrogated by the processor. The register is cleared with each control register selection.

Figure A3-2 shows the status register bits.

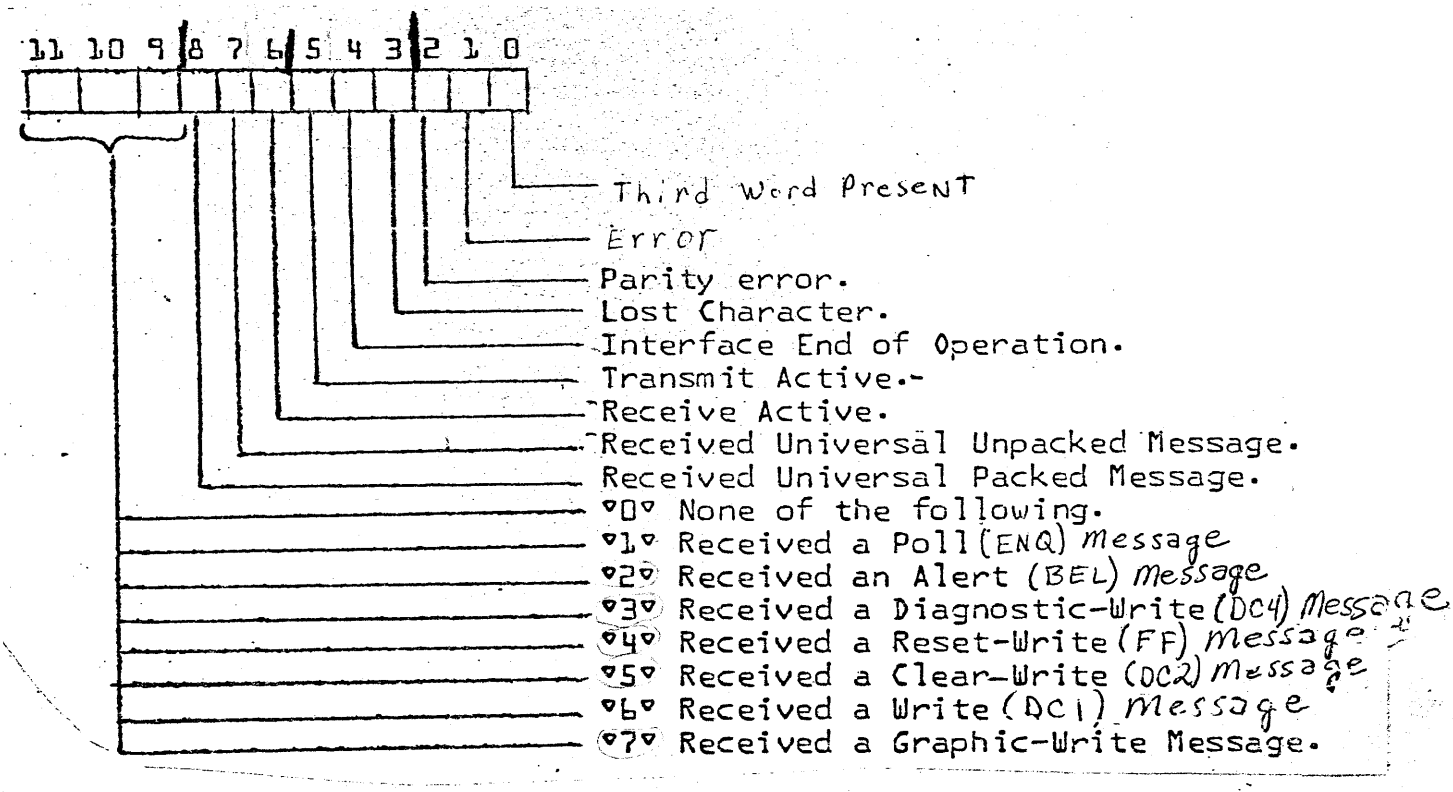

Figure A3-2. Status Register Bits

An explanation of each bit and code selected follows.

- Third Word Present, bit 0 --- The third word present interrupt allows the data source to specify the addresses where data is to be stored. If the message is received in packed format, A1, A2, and (A2-A1) are stored in memory and an interrupt occurs. The status bit will be present between third and fourth words so the processor may check (A2-A1, calculated) = (A2-A1, received). A1 and A2 are then changed and the status bit is checked again to make sure the fourth word has not been stored yet.

- Error, bit 1 --- sets if illegal message code is detected, control register is illegally selected, or if an illegal station address is received. While in the receive mode, the interface checks for the correct station address following the site address. Correct station addresses are 140_8 or 160_8 for a poll message and 141_8 or 161_8 for all other messages.

NOTE

When transmitting, the interface inserts a 14X or 16X code, whichever was contained in the last correctly received message. Station address is checked in the normal receive mode only.

- Parity Error, bit 2 —

Two types of parity checks are performed on messages. Character parity is odd and applies to all characters. Message parity is accumulated starting with the start of heading code and ends with the end of text code. Message parity is odd and does not include syn codes. The parity error light located in the monitor directly below the screen lights when this bit is set.

During normal mode of operation, the parity status bit sets as a result of one of the following conditions.

1. Character parity error on any character starting with the site address.
2. Message parity error on receipt of a message parity character.

NOTE

If a character parity error occurs on a message control character, the message will not be stored in memory. If a character parity error is detected on the data portion of a normal write message (unpacked format), a parity error code (133) is inserted into memory for that word. If a character parity error is detected on a normal graphic-write message, the data will be stored as received.

During universal mode of operation, the parity status bit sets as a result of one of the following conditions.

1. If a character parity error is detected between the time character synchronization is established and the time the buffer is terminated by register A_1 being equal to register A_2.
2. The message check character is expected immediately following the character on which register A_1 is equal to register A_2. If the message check character does not cause the parity checker to end in an zero condition, the parity error status will be set.

Parity is not checked on teletype messages .

- Lost Character, bit 3 —

This status bit sets under the following conditions in normal mode.

1. If an ETX code is not received directly after register A1 equals register A2.
2. If Carrier ON signal drops before a message parity character is received.

Bit 3 sets if the following condition occurs while equipment is in universal mode.

1. If Carrier ON drops before register A_1 is equal to register A_2.

- Interface End of Operation, bit 4 — This bit sets after termination of any interface receive or transmit operation.
- Transmit Active, bit 5 — This bit sets when the following condition occurs during modem operations.

1. During an interface transmit operation after a Clear to Send signal is received.

During teletype operations:

1. Immediately upon selection of a teletype transmit operation.

This bit clears after transmission is completed. The connect light located IN the monitor at the base of the crt screen lights when this bit sets.

• Receive Active, bit 6 –

Bit 6 toggles when the following condition occurs during normal or universal mode of operation.

1. Immediately after character synchronization has been established.

During teletype operation

1. Immediately upon selection of a teletype receive operation in the control register.

Bit 6 clears if any of the following occurs.

In normal mode:

1. Receipt of a message parity character.
2. Receipt of a word following the one on which register A_1 equals register A_2.
3. Carrier ON switched to OFF before one of the previous two conditions occured.

In universal mode:

1. Receipt of a word following the one on which register A_1 equals register A_2.
2. Carrier ON switches to OFF before register A_1 equals to register A_2.

In teletype mode:

1. Receipt of an X-OFF code.
2. When register A_1 equals register A_2. Setting this bit also lights the connect light located in the monitor below the crt screen.

- Receive Universal Unpacked Message, bit 7 — This bit sets after a receive operation terminates and the interface is enabled to receive a universal unpacked message. The bit clears when the control register is loaded to specify a new operation.
- Receive Universal Packed Message, bit 8 — This bit sets after a receive operation terminates and the interface is enabled to receive a universal packed message. The bit clears when the control register is loaded to specify a new operation.
- Normal Mode Messages Received, bits 9, 10, and 11 —

A combination of these bits set upon termination of a normal read from the modem. Bits 9, 10, and 11 indicate the type of message received. These bits are cleared when a new operation is specified by loading the control register. The type of message received is identified by the following codes.

1. Code 0 indicates that none of the following message types have been received.
2. Code 1 indicates the receipt of a Poll (ENQ) Message.
3. Code 2 indicates the receipt of an Alert (BEL) Message.
4. Code 3 indicates the receipt of a Diagnostic-Write (DC4) Message.
5. Code 4 indicates the receipt of a Reset-Write (FF) Message.
6. Code 5 indicates the receipt of a Clear-Write (DC3) Message.
7. Code 6 indicates the receipt of a Write (DC1) Message.
8. Code 7 indicates the receipt of a Graphic-Write Message.

NORMAL MODE OPERATION.

Table A3-2 lists the message formats for normal mode receive messages.

TABLE A3-2. NORMAL MODE RECEIVE MESSAGE FORMATS

MESSAGE	CODE	DESCRIPTION
POLL	026	Syn
(Enquiry)	026	Syn
	026	Syn
	026	Syn
	001	SOH (Start of Heading)
	16X-17X	Site Address
	140/160	Station Address
	005	Poll
	003	ETX (End of Text)
	XXX	MPC (Message Parity Character)
ALERT	026	Syn
(Bell)	026	Syn
	026	Syn
	026	Syn
	001	SOH (Start of Heading)
	16X-17X	Site Address
	141/161	Station Address
	021	Alert
	003	ETX (End of Text)
	XXX	MPC (Message Parity Character)

TABLE A3-2 NORMAL MODE RECEIVE MESSAGE FORMATS (CONT)

MESSAGE	CODE	DESCRIPTION
DIAGNOSTIC-WRITE (Device Control 4)		
	026	Syn
	026	Syn
	026	Syn
	026	Syn
	001	SOH (Start of Heading)
	16X-17X	Site Address
	141/161	Station Address
	020	Diagnostic-Write
	XXX	DATA — Received in unpacked format.
	XXX	
	XXX	
	003	ETX (End of Text)
	XXX	MPC (Message Parity Character)
RESET-WRITE (Form Feed)		
	026	SyN
	026	SyN
	026	SyN
	026	SyN
	001	SOH (Start of Heading)
	16X-17X	Site Address
	141/161	Station Address
	014	Reset-Write
	XXX	DATA — Received in unpacked format.
	XXX	
	XXX	
	003	ETX (End of Text)
	XXX	MPC (Message Parity Character)

TABLE A3-2. NORMAL MODE RECEIVE MESSAGE FORMATS (CONT)

MESSAGE	CODE	DESCRIPTION
CLEAR-WRITE (Device Control 2)		
	026	Syn
	026	Syn
	026	Syn
	026	Syn
	001	SOH (Start of Heading)
	16X-17X	Site Address
	141/161	Station Address
	022	Clear-Write
	XXX XXX XXX	DATA } Received in unpacked format.
	003	ETX (End of Text)
	XXX	MPC (Message Parity Character)
WRITE (Device Control 1)		
	026	Syn
	026	Syn
	026	Syn
	026	Syn
	001	SOH (Start of Heading)
	16X-17X	Site Address
	141/161	Station Address
	021	Write
	XXX XXX XXX	DATA } Received in unpacked format.
	003	ETX (End of Text)
	XXX	MPC (Message Parity Character)

TABLE A3-2. NORMAL MODE RECEIVE MESSAGE FORMATS (CONT)

MESSAGE	CODE	DESCRIPTION
GRAPHIC-WRITE		
	026	SYN
	026	SYN
	026	SYN
	026	SYN
	001	SOH (Start of Heading)
	16X-17X	Site Address
	141/161	Station Address
	016	Graphic-Write
	XXX XXX XXX	DATA } Received in packed format.
	003	ETX (End of text)
	XXX	MPC (Message Parity Character)

Normal Mode Receive Operation.

Figure A3-3 is a flow diagram for the normal mode receive operation.

A normal mode receive operation is initiated as follows:

1. Processor loads register A_1 with the first word address (fwa) and register A_2 with the last word address plus one (lwa+1) of the input buffer area.

2. Processor loads the upper octal digit of the control register with a code of 2.

NOTE

If a Poll Message or Alert Message is pending, loading register A_1 and register A_2 is not required since data is not to be stored in memory.

The following sequence, along with figure A3-3, shows operation of the interface while enabled for a normal mode receive operation.

1. Character Synchronization is established by the receipt of two consecutive syn codes. Bit 6 of the status register is toggled once synchronization has been achieved.

2. A Start of Heading code follows character synchronization. Failure to detect a Start of Heading code following synchronization results in the interface searching for 2 consecutive syn codes again.

3. A Site Address Code follows a Start of Heading code. Failure to detect a site address code that matches the setting of the equipment switches (any of 20 octal addresses ranging from 160_8 to 177_8) results in the interface searching for SYNC codes again.

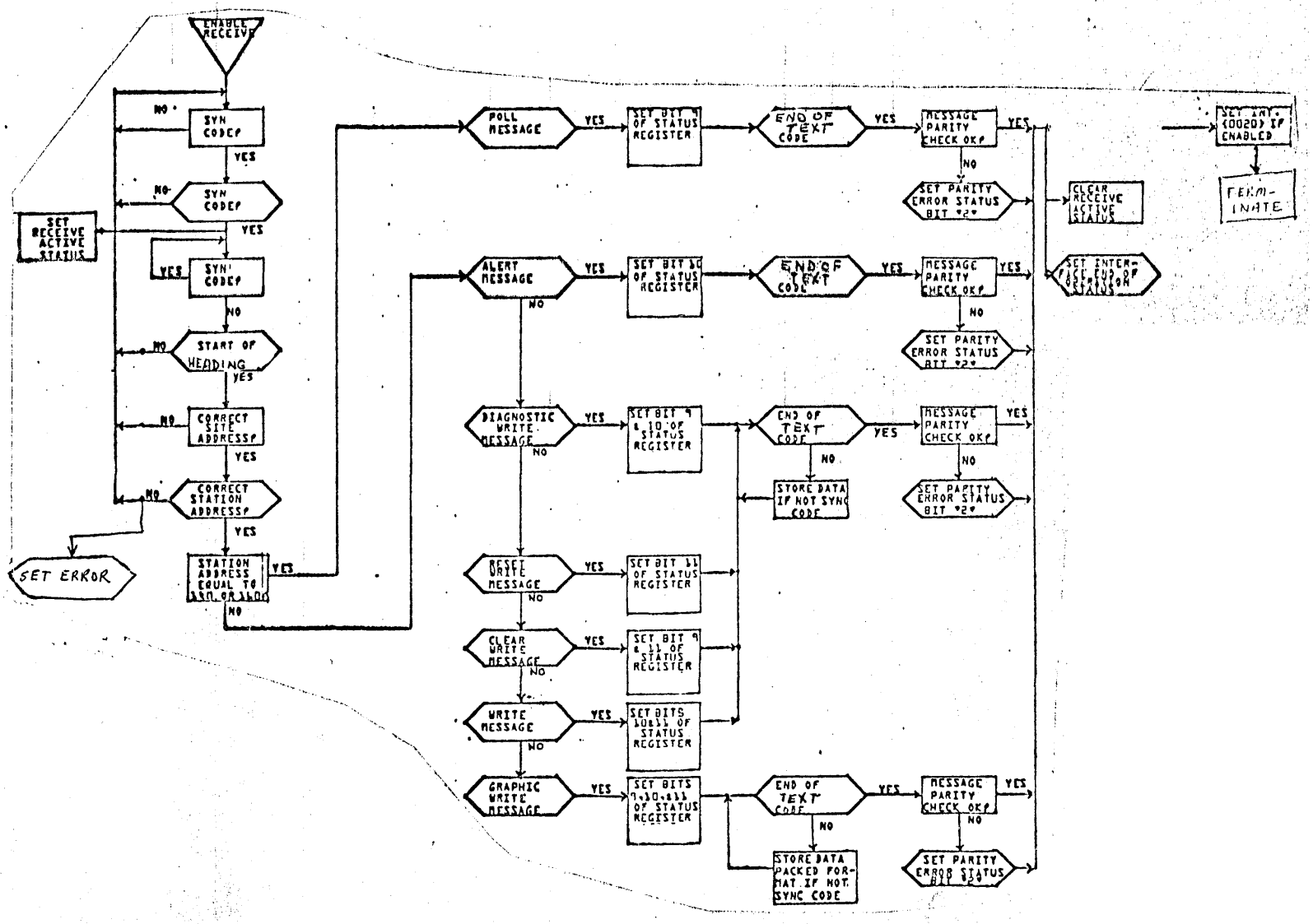

Figure A3-3. Normal Mode Receive Operation

4. A Station Address code follows a correct site address. The station address is 140_8 or 160_8 for a Poll Message and 141_8 or 161_8 for all other messages. Failure to detect the correct station address results in the interface setting the error status bit.

5. A Message Control Code follows a correct station address. The message control character may be one of six types; Poll, Alert, Diagnostic-Write, Reset-Write, Clear-Write, Write or Graphic-Write. The operation upon receipt of these codes follows.

- Poll — If the Station Address is 140_8 or 160_8, a poll code is expected. If it is not received, the error status bit sets.

  If the station address is correct, the upper octal digit of the status register is set to a code of 1 octal. The interface then looks for an End of Text code.

- Alert — Upon receipt of an alert message control code, the interface sets status register bit 10 and looks for an End of Text code. Receipt of a station address code other than 141_8 or 161_8 sets the error status bit.
- Diagnostic-Write — Upon receipt of this message contol code the interface sets bits 9 and 10 of the status register and prepares to store data into memory. The data is stored in unpacked format. Receipt of a station address code other than 141_8 or 161_8 sets the error status bit.
- Reset-Write — Same as Diagnostic-Write except bit 11 of the status register is set. Receipt of a station address code other than 141_8 or 161_8 sets the error status bit.

- Clear-Write — Same as Diagnostic Write except bits 9 and 11 of the status register are set. Receipt of a station address code other than 14_8 or 16_8 sets the error status bit.
- Write Message — Same as Diagnostic Write except bits 10 and 11 of the status register are set. Receipt of a station address code other than 14_8 or 16_8 sets the error status bit.
- Graphic-Write — The interface sets bits 9, 10, and 11 of the status register and prepares to store data in memory in packed format. Receipt of a station address code other than 14_8 or 16_8 sets the error status bit.

6. End of Text Code. This code is a signal to the intertace that the message is completed and the message parity character follows.

7. Message Parity Character. Upon receipt of this character, the interface sets interface end of operation (bit 4 of the status register). If a message parity error occurs, bit 2 of the status register sets. It also sets interrupt 20 (if enabled) to indicate that a receive operation is complete and clears the Receive Active status bit.

Table A3-3 lists the message formats for normal mode transmit messages.

TABLE A3-3. NORMAL MODE TRANSMIT MESSAGE FORMATS

MESSAGE	CODE	DESCRIPTION
ACKNOWLEDGE		
	026	Syn
	026	Syn
	026	Syn
	026	Syn
	001	SOH (Start of Heading)
	16X-17X	Site Address
	141/161	Station Address
	006	Acknowledge
	003	ETX (END OF Text)
	XXX	MPC (Message Parity Character)
REJECT (Cancel)		
	026	Syn
	026	Syn
	026	Syn
	026	Syn
	001	SOH (Start of Heading)
	16X-17X	Site Address
	(140/160) (141/161)	Station Address
	030	Reject
	003	ETX (End of Text)
	XXX	MPC (Message Parity Character)

TABLE A3-3. NORMAL MODE TRANSMIT MESSAGE FORMATS (CONT)

MESSAGE	CODE	DESCRIPTION
ERROR (Negative Acknowledge)	026	Syn
	026	Syn
	026	Syn
	026	Syn
	001	SOH (Start of Heading)
	16X-17X	Site Address
	141/161	Station Address
	025	Error
	003	ETX (End of Text)
	XXX	MPC (Message Parity Character)
READ (Device Control 3)	026	Syn
	026	Syn
	026	Syn
	026	Syn
	001	SOH (Start of Heading)
	16X-17X	Site Address
	141/161	Station Address
	023	Read
	XXX	DATA (Transmitted in Unpacked Format)
	XXX	
	XXX	
	003	ETX (End of Text)
	XXX	MPC (Message Parity Character)

TABLE A3-3. NORMAL MODE TRANSMIT MESSAGE FORMATS (CONT)

MESSAGE	CODE	DESCRIPTION
GRAPHIC-READ		
	026	Syn
	026	Syn
	026	Syn
	026	Syn
	001	SOH (Start of Heading)
	16X-17X	Site Address
	141/161	Station Address
	017	Graphic Read
	XXX XXX XXX	DATA — Transmitted in packed format.
	003	ETX (End of Text)
	XXX	MPC (Message Parity Character)

Normal Mode Transmit Operation.

Initiate a normal mode message transmission by loading the upper octal digit of the control register with any of codes 3 through 7. The interface formats a message as shown in table A3-3, inserting data from memory if required. Transmit active status bit 5 sets when the operation is initiated.

Termination of the operation causes the following to happen:

1. Clear transmit active status bit 5 .
2. Set interface end of operation status bit 4.

3. Generate an interrupt 0020 (if enabled).

Selecting a specific message for transmission is accomplished as follows:

- Transmit Acknowledge Message is initiated by loading the upper octal digit of the control register with a code of 3 octal. The interface sends a complete hardware generated message to the data source.
- Transmit Reject Message is initiated by loading the upper octal digit of the control register with a code of 4 octal. The interface sends a complete hardware generated message to the data source.
- Transmit Error Message is initiated by loading the upper octal digit of the control register with a code of 5 octal. The interface sends a complete hardware generated message to the data source.
- Transmit Read Message is initiated as follows:

    1. Processor loads register A_1 with first word address and register A_2 with the last word address plus one of the output block.
    2. Processor loads the upper octal digit of the control register with a code of 6 octal.

The interface formats the message inserting the data block specified by registers A_1 and A_2 in unpacked format.

- Transmit Graphic Read Message is initiated as follows:

  1. Processor loads register A_1 with first word address and register A_2 with the last word address plus one of the output block.
  2. Processor loads the upper octal digit of the control register with a code of 7 octal.

The interface formats the message inserting the data block specified by registers A_1 and A_2 in packed format.

UNIVERSAL MODE OPERATION.

Under this mode of operation the interface . generates messages in the general formats shown in table A3-4.

TABLE A3-4. UNIVERSAL MODE TRANSMIT MESSAGE FORMAT

MESSAGE	CODE	DESCRIPTION
UNIVERSAL UNPACKED		
	026	Syn
	026	Syn
	026	Syn
	026	Syn
	XXX	↑
	XXX	MESSAGE } Transmitted in unpacked format
	XXX	↓
	XXX	MPC (Message Parity Character)
UNIVERSAL PACKED		
	026	Syn

TABLE A3-4. UNIVERSAL MODE TRANSMIT MESSAGE FORMAT (CONT)

MESSAGE	CODE	DESCRIPTION
UNIVERSAL PACKED (CONT)	026	Syn
	026	Syn
	026	Syn
	XXX XXX XXX	MESSAGE } Transmitted in packed format
	XXX	MPC (Message Parity Character)

In Universal mode, a memory block is specified for each transmit and receive operation.

Transmit

Universal Mode Unpacked Format.

This operation is selected as follows:

1. Processor loads register A_1 with the first word address and register A_2 with the last word address plus one of the output block.
2. Processor loads the octal digit in the control register (bits 6, 7, 8,) with a code of 7.

The interface sets transmit active status bit 5 after loading the control register. Then it generates four syn codes. Data is taken from memory and the lower seven bits of each memory word is transmitted to the data source along with a parity bit. This continues until register A_1 equals register A_2. At this time a message parity character is sent and transmission terminates.

Termination of the operation causes the following to happen:

1. Clears transmit active status bit 5.
2. Sets interface end of operation status bit 4.
3. Generates interrupt 0020 (if enabled).

Universal Mode Transmit Packed Format.

This operation is selected as follows:

1. Processor loads register A_1 with the first word address and register A_2 with the last word address plus one of the output block.
2. Processor loads the octal digit in the control register (bits 9, 10, 11,) with a code of 1.

This sets transmit active status bit 5 after loading the control register. Then it generates four syn codes. Data is then taken from memory and disassembled into two six bit bytes. The upper six bits are taken first and bit seven is added as a 1. This, along with a parity bit, is sent as a data link character. The lower six bits are handled in the same manner. This continues until register A_1 equals register A_2. At this time a message parity character is sent and transmission terminates.

Termination of the operation causes the following to happen:

1. Clears transmit active status bit 5.
2. Sets interface end of operation status bit 4.
3. Generates interrupt 0020 (if enabled).

IN universal mode, the interface responds to messages in the formats shown in table A3-5

TABLE A3-5. UNIVERSAL MODE RECEIVE MESSAGE FORMAT

MESSAGE	CODE	DESCRIPTION
UNIVERSAL UNPACKED		
	026	Syn
	026	Syn
	026	Syn
	026	Syn
	XXX XXX XXX	MESSAGE } Received in unpacked format.
	XXX	MPC (Message Parity Character)
UNIVERSAL PACKED		
	026	SyN
	026	SyN
	026	SyN
	026	SyN
	XXX XXX XXX	MESSAGE } Received in packed format.
	XXX	MPC (MESSAGE PARITY CHARACTER)

Universal Mode Receive Unpacked Format.

This operation is selected as follows:

1. Processor loads register A_1 with the first word address and register A_2 with the last word address plus one of the input buffer.
2. Processor loads the octal digit in the control register (bits 6, 7, 8,) with a code of 5.

The interface establishes character synchronization, sets receive active status bit 6, and stores incoming data (unpacked format) into the buffer area specified by registers A_1 and A_2. This operation continues until one of the following occurs:

1. Register A_1 equals A_2.
2. Carrier ON switches OFF.

NOTE

Syn codes received throughout message are not stored in memory.

Termination of the operation causes the following to happen:

1. Clear receive active status bit 6.
2. Set received universal unpacked message status bit 7.
3. Set interface end of operation status bit 4.

4. Generate interrupt 0020 (if enabled).

Universal Mode Receive Packed Format.

This operation is selected as follows:

1. Processor loads register A_1 with the first word address and register A_2 with the last word address plus one of the input buffer.
2. Processor loads the octal digit in the control register (bits 6, 7, 8,) with a code of 6.

The interface establishes character synchronization, sets receive active status bit 6, and stores incoming data (packed format) into buffer area specified by registers A_1 and A_2. This operation continues until one of the following occurs:

1. Register A_1 equals A_2.
2. Carrier ON switches OFF.

Termination of the operation causes the following to happen:

1. Clear receive active status bit 6.
2. Set received universal packed message status bit 8.
3. Set interface end of operation status bit 4.
4. Generate interrupt 0020 (if enabled).

Figures A3-4 and A3-5 show word formats for data link messages.

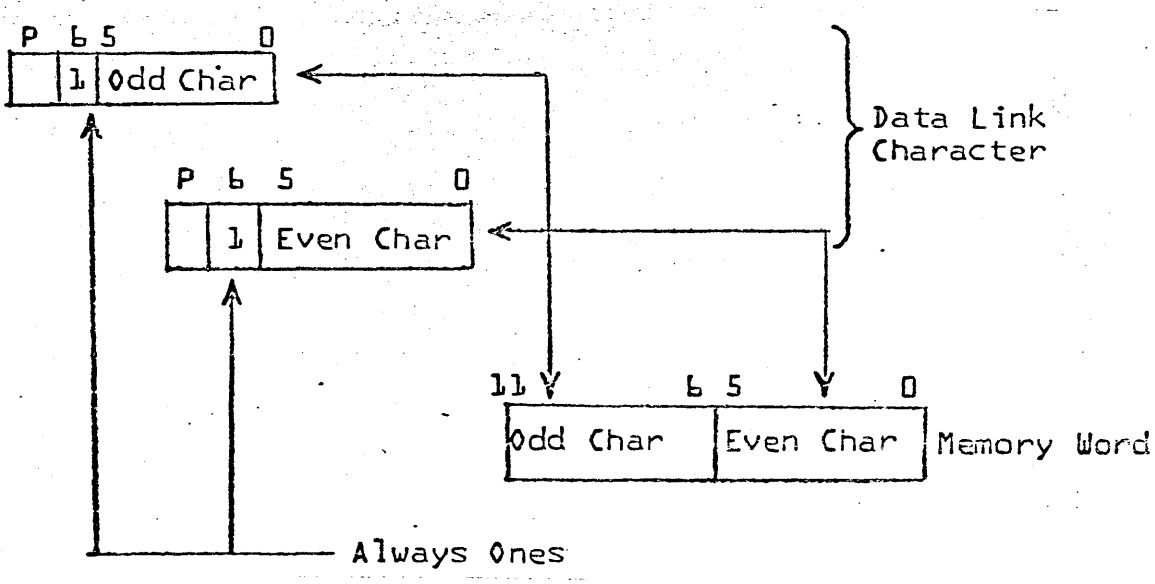

Figure A3-4. Data Link (Packed Format)

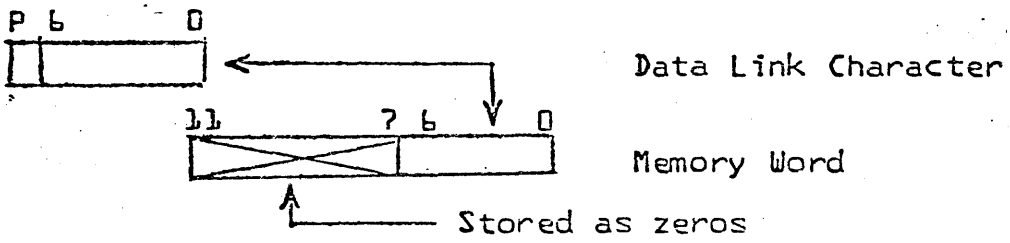

Figure A3-5. Data Link (Unpacked Format)

TELETYPE MODE

Teletype Model ASR-33 or ASR-35 is offered as a means of hardcopy output in the form of printed page or punched tape. It also serves as a means of keyboard or paper tape input.

Communications with the teletype unit take place in either packed or unpacked format. The unit operates with a 7 bit ASCII Code

Operation of the paper tape reader is controlled from the interface by use of the X-ON and X-OFF signals, respectively. The punch is turned on and off manually.

Output to Printer and Punch.

Output to the printer and punch is initiated as follows:

1. Processor loads registers A_1 and A_2 with the first word address and last word address plus one of the output block.
2. Processor loads the control register with a code of 030X for output in unpacked format or 040X for output in packed format.

Transmit active status bit 5 sets and the output starts at the address specified by register A_1. If the unpacked format is used, the lower seven bits of the memory word are sent. The printer will respond to the lower seven bit as an ASCII code specifying a character or function. If the punch is turned on, holes will be punched to reflect the bit configuration of the 7 bit word being sent.

NOTE

If an X-ON code is sent while in unpacked format and the reader is ready, it will start the reader.

When data is being sent in packed format, a six-bit byte of the memory word is transmitted along with a seventh bit which is always a 1. This forces the data to fall in the character subset, and prevents the recognition of an X-ON, X-OFF, paper advance, etc. This format is normally used when making a binary tape.

NOTE

If X-OFF codes are desired at intervals throughout the tape, they must be sent in unpacked format.

Termination of the operation causes the following to happen:

1. Clear transmit active status bit 5.
2. Set interface end of operation status bit 4.
3. Generate interrupt 0020 (if enabled).

Keyboard or Tape Reader Input.

An input operation from the teletype unit is initiated as follows:

1. Processor loads registers A_1 and A_2 with the first word address and last word address plus one of the input block.
2. Processor loads the control register with a code of 05XX for input in unpacked format or 06XX for input in packed format.

NOTE
of the control register)

If the paper tape reader on bit (bit 3 ^ is selected, an X-ON code is generated and sent. The interface then goes into receive mode and accepts data as it's presented.

After selecting bit 3, receive active status bit 6 is set and data is accepted and stored in either unpacked or packed format until register A_1 equals A_2. When in packed mode, the lower 6 bits of two teletype characters are assembled into one word and stored into memory. The tape reader will be stopped by the following conditions:

1. Turn off manually.
2. Out of tape.
3. Tight tape.

4. Encountering an X-OFF code on tape.

Termination of a teletype input operation will occur on the following conditions:

1. Register A_1 equals register A_2.
2. Detection of an X-Off code.

Termination of the operation causes the following to happen:

1. Clears transmit active status bit 5.
2. Sets interface end of operation status bit 4.
3. Generates interrupt 0020 (if enabled).

Figures A3-6 A3-7 illustrate the formats for teletype messages.

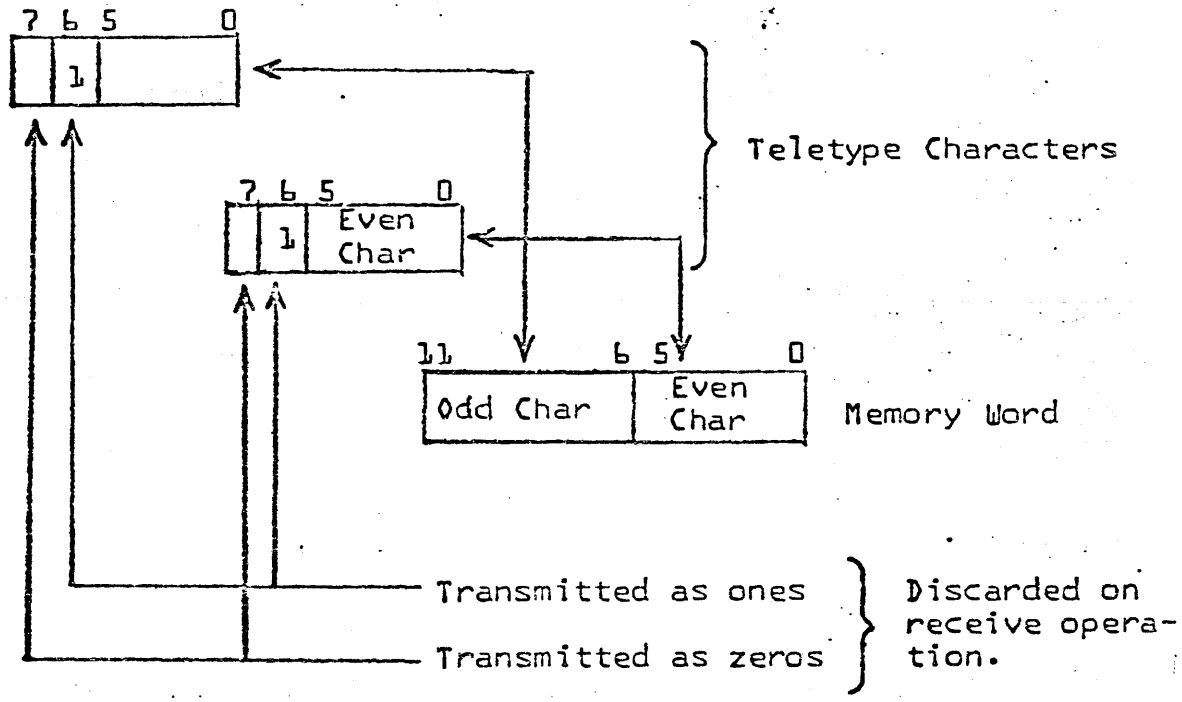

Figure A3-6. Teletype (Packed Format)

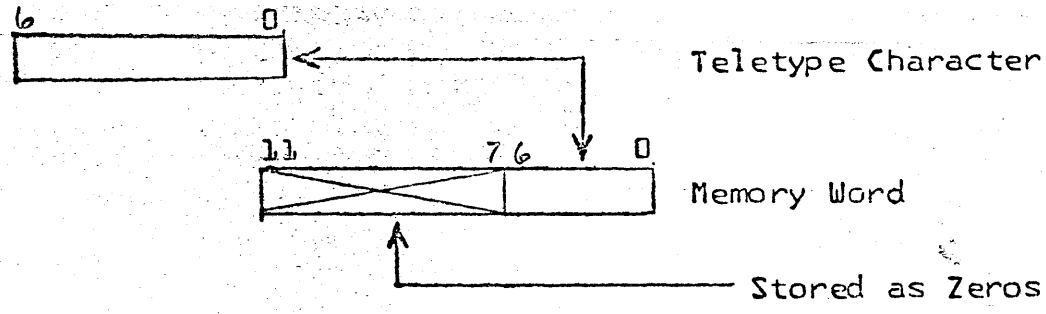

Figure A3-7. Teletype (Unpacked Format)

TELETYPEWRITER CODES.

Table A3-6 lists the codes used for transmit and receive operations for the teletypewriter.

TABLE A3-6. TELETYPEWRITER CODES

CHARACTER	ASCII CODE	CHARACTER	ASCII CODE	CHARACTER	ASCII CODE
NULL	000	"	042	D	104
SOM	001	#	043	E	105
EOA	002	$	044	F	106
EOM	003	%	045	G	107
EOT	004	&	046	H	110
WRU	005	'	047	I	111
RU	006	(	050	J	112
BELL	007	)	051	K	113
FE_0	010	*	052	L	114
H. TAB	011	+	053	M	115
LINE FEED	012	,	054	N	116
V. TAB	013	-	055	O	117
FORM	014	.	056	P	120
RETURN	015	/	057	Q	121
SO	016	0	060	R	122
SI	017	1	061	S	123
DC_0	020	2	062	T	124
X-ON	021	3	063	U	125
TAPE AUX. ON	022	4	064	V	126
X-OFF	023	5	065	W	127
TAPE AUX. OFF	024	6	066	X	130
ERROR	025	7	067	Y	131
SYNC	026	8	070	Z	132
LEM	027	9	071	[	133
S_0	030	:	072	\	134
S_1	031	;	073	]	135
S_2	032	<	074	↑	136
S_3	033	=	075	←	137
S_4	034	>	076	ACK	174
S_5	035	?	077	ALT MODE	175
S_6	036	@	100	ESC	176
S_7	037	A	101	RUB OUT	177
SP	040	B	102		
!	041	C	103		

BIT 4 RESPONSE.

Normally, the remote Graphics Terminal responds to each write message with an acknowledge, reject, or error message. The type of response issued tells the data source that the message was correctly or incorrectly received.

Telephone errors normally occur in bursts which result in unintelligible communications. Situations such as this leave the data source in doubt as to the status of the write message. With proper programming, the terminal is capable of providing this status and alleviating consequences of telephone channel error bursts.

A restriction is placed on the use of station addresses. The station address is 140_8 or 160_8 for poll messages and 141_8 or 161_8 for all other messages. Alternate use of the two different addresses in successive messages to the remote Graphic Terminal is imperative. If the message is correctively received, the terminal returns the same address in the response message. Incorrect receipt results in a response with the alternate address. The following list shows the station address condition for both correct and incorrect receipt of write messages. Normally, the data source retransmits a write message if it is incorrectly received. Message 5 indicates this procedure.

	Transmitted Message	Station Address	Response Message	Station Address
Message 1	Write	161	Acknowledge	161
Message 2	Write	141	Acknowledge	141
Message 3	Write	161	Acknowledge	161
Message 4	Write	141	Error	161
Message 5	Write	141	Acknowledge	141

If the data source failed to receive a correct response, another message (poll) may be transmitted in an effort to determine the status of the previous write message, Another write message may also be used. If the original write message had been received correctly, the response to this second transmission contains the original station address.

In the following list, the acknowledge message marked with an asterisk is assumed to have been destroyed by an error burst. By transmitting a poll message, the data source receives a reject message(assuming read message not pending) containing the station address used by the preceding write message. This station address tells the data source that the preceding message was received and processed correctly.

	Transmitted Message	Station Address	Response Message	Station Address
Message 1	Write	161	Acknowledge	161
Message 2	Write	141	Acknowledge	141
Message 3	Write	161	Acknowledge *	161
Message 4	Poll	140 or 160	Reject	161
Message 5	Write	141	Acknowledge	141

If the write message had been incorrectly received, the error message response (assuming the response is enabled) contains the alternate station address as shown by the following list. Assuming an error burst destroys the error response, the data source transmits a poll message to determine status. The alternate address in the reject message informs the data source of the error condition in the previous write message. Retransmission of the write message is the normal procedure.

	Transmitted Message	Station Address	Response Message	Station Address
Message 1	Write	161	Acknowledge	161
Message 2	Write	141	Acknowledge	141
Message 3	Write	161	Error	141
Message 4	Poll	140 or 160	Reject	141
Message 5	Write	161	Acknowledge	161

INTERFACE COMMUNICATIONS EXAMPLE.

The flow chart shown in figure A3-8 details an example program for loading a master program into the remote terminal subsystem memory. Table A3-7 shows a bootstrap routine for transfering a loader program from the teletypewriter paper tape reader to the subsystem memory. With the bootstrap routine in memory, depress ON LINE before depressing RUN. Although the teletypewriter operates off line, the on line facility is necessary to secure the master program from the data source.

TABLE A3-7. BOOTSTRAP ROUTINE

Bank 0 Address	Instructions	Comments
7760	0120	Clear Interrupt Lockout
7761	2100	Load Memory
7762	7774	Location of FWA
7763	0175	FWA→A1
7764	2100	Load Memory
7765	7775	Location of LWA + 1
7766	0176	LWA + 1→A2
7767	2100	Load Memory
7770	7776	Location of RCW
7771	0177	RCW→RC
7772	0400	0000→X
7773	6401	ZJB
7774	XXXX	FWA
7775	XXXX	LWA + 1
7776	0204	Remote Control Word

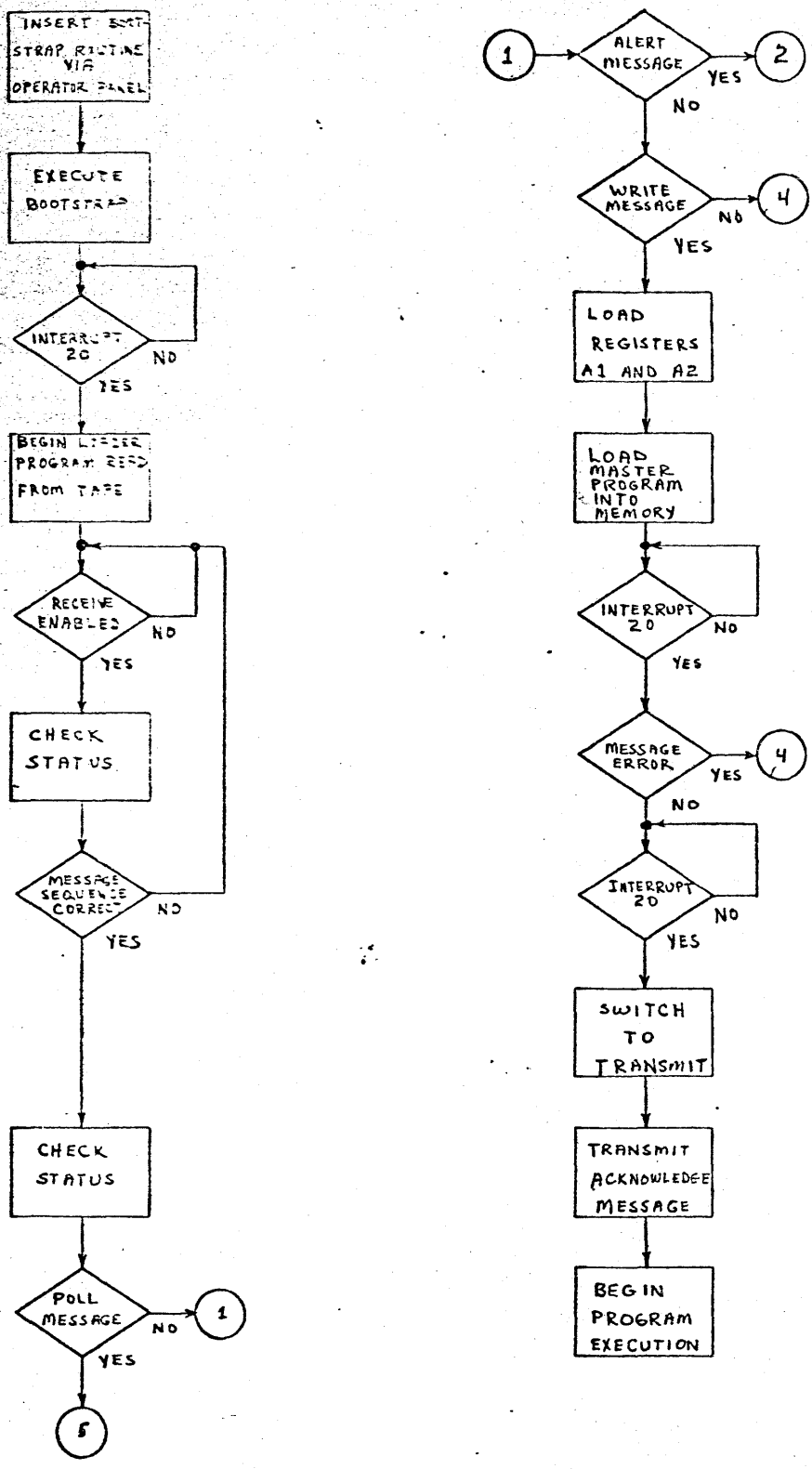

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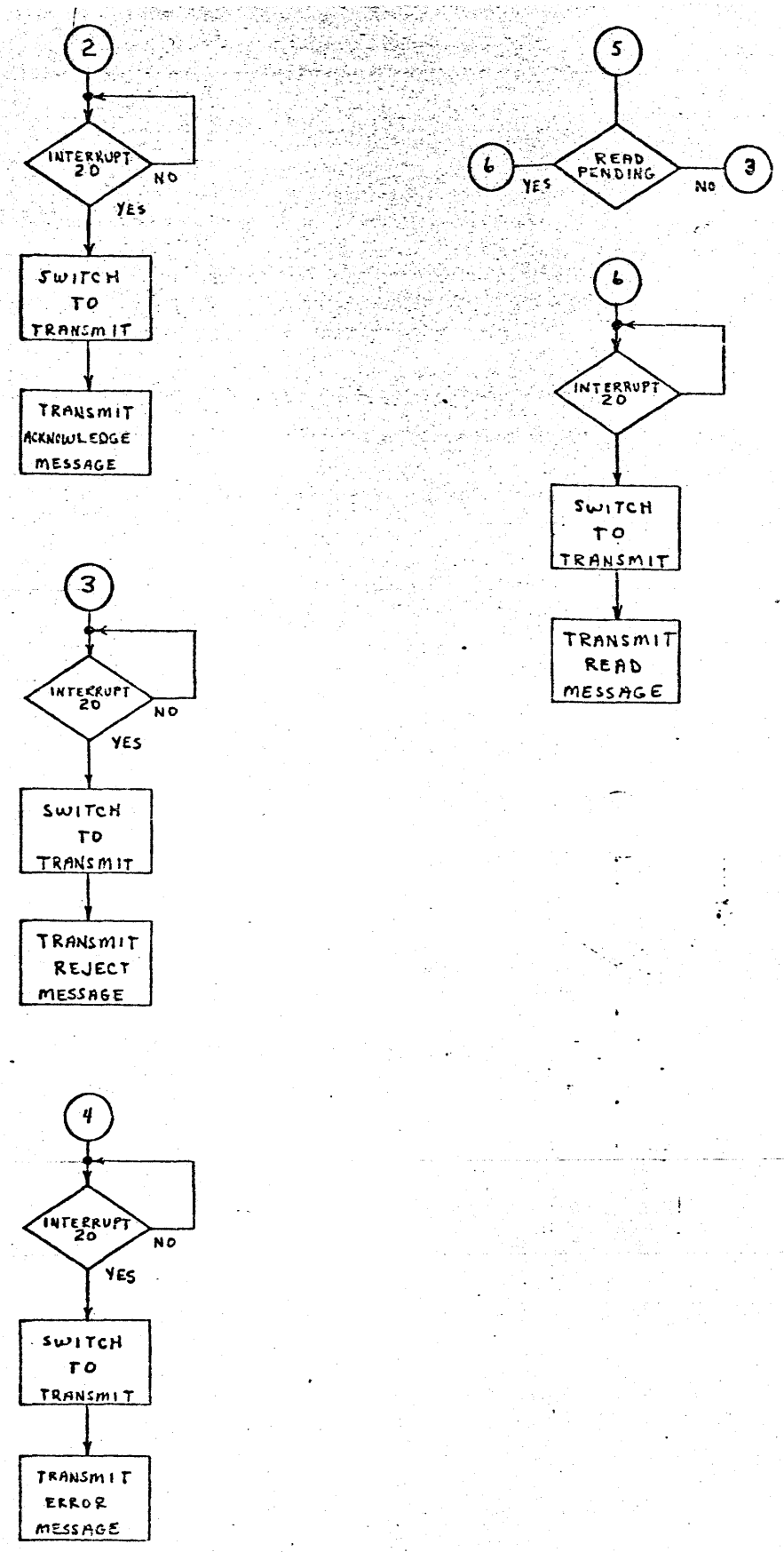
FIGURE A3-8. MASTER


2
INTERRUPT 20
NO
YES
SWITCH TO TRANSMIT
TRANSMIT ACKNOWLEDGE MESSAGE
3
INTERRUPT 20
NO
YES
SWITCH TO TRANSMIT
TRANSMIT REJECT MESSAGE
4
INTERRUPT 20
NO
YES
SWITCH TO TRANSMIT
TRANSMIT ERROR MESSAGE
5
6
YES
READ PENDING
NO
3
6
INTERRUPT 20
SWITCH TO TRANSMIT
TRANSMIT READ MESSAGE