Greco Systems

DU-58

Operation Manual

303 E Gurley St. #522 Prescott, AZ 86301 USA 800-234-7326

OPERATOR'S MANUAL DU-58 DISK SYSTEM PART NUMBER: 5053

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SECTION 1

INTRODUCTION

1.1 General

The DU-58 is a low cost mass storage device base on 5¼ " floppy disk drives, power supply, microprocessor based controller and serial interface. The DU-58 comes with a software interface that is compatible with the DEC* TU58 Tape System, a random access, mass memory cassette system.

With the ability to be simply interfaced to any host system via the RS-422, RS-423 or RS-232C interface, the DU-58 is ideal as an inexpensive mass storage system, a software distribution medium, a diagnostics loader, and more. Due to the low cost and fast access times of floppy disks, the DU-58 is more economical and will outperform a tape system.

The DU-58 incorporates a microprocessor to perform the disk control operations, communications, formatting, error recovery, and other supervisory functions. A high level of data integrity is ensured by recording a CRC character at the end of each disk block and verifying the CRC when each block is read. If an error is encountered, the block is reread up to three times, and if the block still contains an error, transmission is terminated. Low maintenance costs and high reliability are insured by the simplicity of the DU-58's design

1.2 Highlights

- Up to 1600K bytes of mass storage per dual drive
- DEC TU58 compatible
- Block addressable
- Microprocessor based system does data logging, formatting and retries
- High data integrity ensured by the use of CRC characters
- Fast access times
- Easy to interface
- Low cast

*DEC is a registered trademark of Digital Equipment Corporation

SECTION 2

SPECIFICATIONS

SERIAL INTERFACE

Type	RS-232C RS-422, RS-423 (optional) 1 start bit, 1 stop bit, no parity
Baud Rates	9600, 19200, 38400
Connector	DB25P (RS-232C only) DEC TU58 – AMP P/N 87272-8 (optional) (RS-422, RS-423, RS-232C)

PROTOCOL

Type	DEC TU-58 compatible
Commands	NOP, INIT, READ, WRITE, POSITION, GET STATUS, SET STATUS, DIAGNOSE, BOOTSTRAP, CONTINUE, XOFF, FORMAT, XON

MEDIA

Type	5¼" floppy disk, soft sector double density, 48/96 TPI
Number of Drives	2
Capacity per Drive	400K or 800K bytes
Drive Type	Double sided, 40/80 tracks/side
Sectors/Track	10
Bytes/Sector	512

MECHANICAL

Portable	5.25"H x 10"W x 10.5"D
Rack Mount	5.25"H x 19"W panel x 8.75"D
Weight	15 lbs.

POWER

Requirements	115 VAC, 47-63 Hz, 0.5 A 230 VAC, 47-63 Hz, 0.3 A (optional)

SECTION 2

SPECIFICATIONS
(continued)

DISK SPECIFICATIONS

Type	5¼" floppy disk
MTBF	8000 POH under typical usage
PM	None
MTTR	30 minutes
Soft error rate (before recovery)	1 in 10^9 bits
Hard error rate	1 in 10^{12} bits
Seek error (before recovery)	1 in 10^6 bits
Media life	3.0 x 10^6 passes per track, 30,000+ insertions
Access time (track-to-track)	3 ms
Access time (average)	200 ms

TEMPERATURE

Operating	40°F to 109°F (5°C to 43°C)
Storage	-8°F to 117°F (-21°C to 47°C)
Relative humidity	20% to 80%

SECTION 3

DU-58 HARDWARE DESCRIPTION

3.1 Introduction

Described are the strap options, switch functions and serial I/O connectors.

3.2 Strap Options (J6)

Six straps (A-F) and a ground strap (G) are provided for selecting I/O port baud rates (A, B, C), and a user available (F) strap. The straps (J6) are illustrated in Figure 3-1 and Figure 3-2. If several pins need to be grounded, they can be daisy chained together.

3.2.1 Baud Rate Straps (A, B, C)

The Baud Rate Straps (A, B, C) are shown in Figure 3-3. These straps are used to determine the baud rate setting for the Host I/O port (J2)

Figure 3-3 refers to baud rates ranging from 9600 to 38400.

3.2.2 User Strap (F)

The User Strap (F) is used as the format strap by the DU-58 system. Each time the user strap is grounded, the disk on drive 0 is formatted. The strap should be grounded for only a short period of time.

3.3 Switch Functions

When the DU-58 System is provided with the option that supports RS-422, RS-423 and RS-232C interfaces, selection of the various interface standards is done with an 8 position DIP switch located on the rear panel of the DU-58 System, next to the Serial I/O connector. Switch setting for each interface standard are as follows:

Interface	Close (ON) These Switches
RS-422	3, 5
RS-423	1, 2, 4, 7
RS-232C	1, 2, 4

Specific switch functions are listed in Figure 3-4.

3.4 Serial I/O Connector

The Serial I/O connector is mounted on the rear panel of the DU-58 System. Depending on the type of interface provided, the DU-58 System will consist of a DB25P when only RS-232C is supported or a 10-pin DEC TU58 type connector (AMP P/N 87272) when RS-422, RS-423 and RS-232C are supported. Figure 3-4 describes the pins and signals used when the DB25P connector is used. Figure 3-5 describes the pins and signals when the 10-pin DEC TU58 type connector is used.

FIGURE 3-1

STRAP OPTIONS (J6)

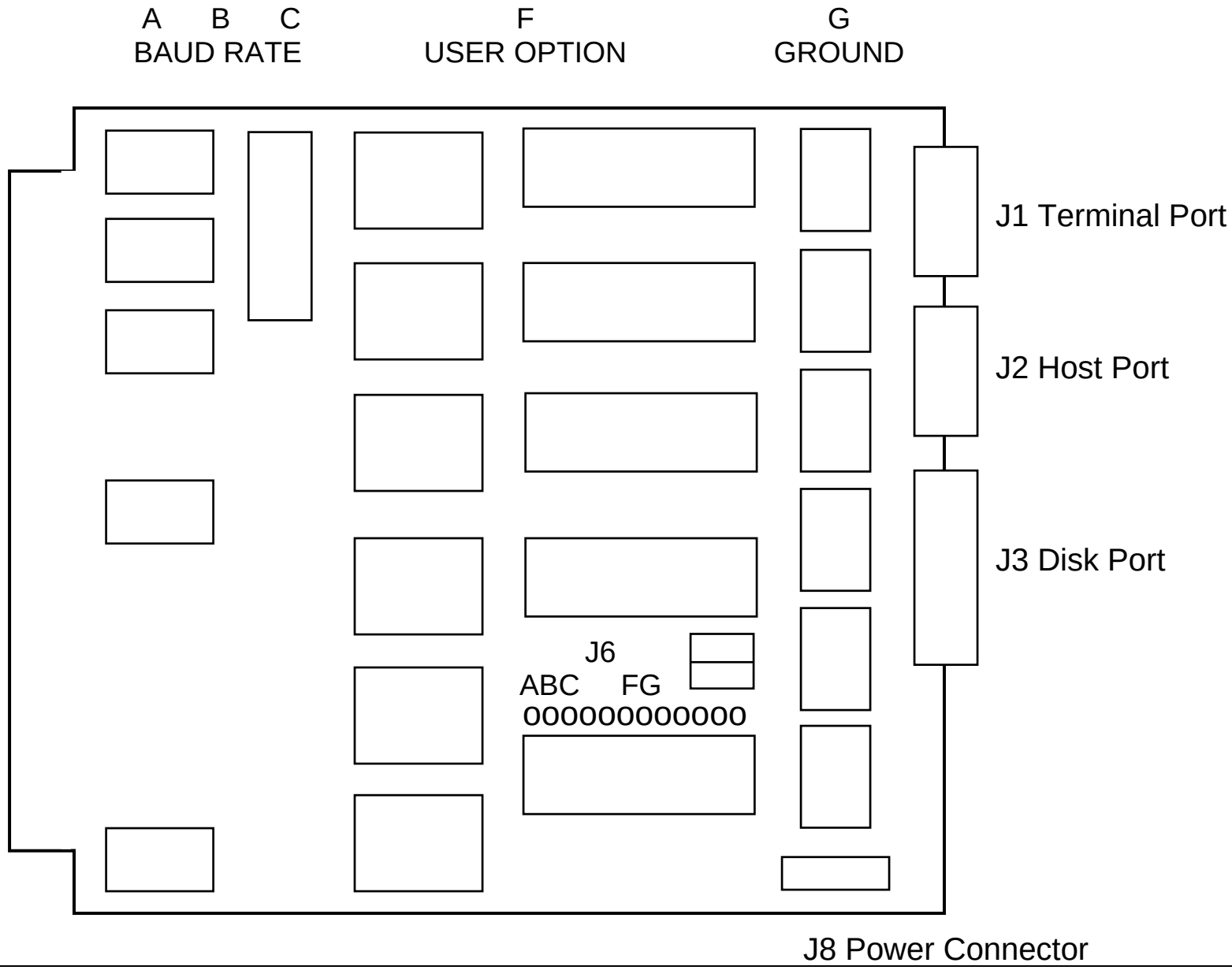


FIGURE 3-2

STRAP OPTIONS (J6)

A	B	C	D	E	F	G
o	o	o	o	o	o	o
	BAUD RATES				USER	GROUND

FIGURE 3-3

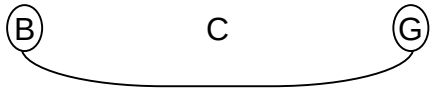
BAUD RATE STRAP

PINS			BAUD RATE
A	B	C	
NG	NG	NG	38,400
G	NG	NG	19,200
NG	G	NG	9,600

Example:

19,200 Baud

9,600 Baud



NG = Not grounded
G = Grounded

FIGURE 3-4

SWITCH SETTINGS

SWITCH	FUNCTION – CLOSED (ON)
1	CONNECTS I/O PIN 7 TO GROUND
2	CONNECTS RS-423/RS-232C DRIVER TO I/O PIN 3
3	CONNECTS RS-422 DRIVER TO I/O PIN 3
4	CONNECTS I/O PIN 4 TO GROUND
5	CONNECTS RS-422 DRIVER TO I/O PIN 4
6	CONNECTS 100 OHM LOAD RESISTOR BETWEEN I/O PINS 7 AND 8
7	CONNECTS 330 OHM LOAD RESISTOR BETWEEN GROUND AND I/O PIN 8
8	NOT USED

FIGURE 3-5

SERIAL I/O CONNECTOR – RS-232C

PIN	SIGNAL	DIRECTION	COMMENT
1	PROTECTIVE GROUND		GROUND
2	TRANSMIT DATA	OUTPUT	
3	RECEIVE DATA	INPUT	
4	REQUEST TO SEND	OUTPUT	ALWAYS TRUE
5	CLEAR TO SEND	INPUT	IGNORED
6	DATA SET READY	INPUT	IGNORED
7	SIGNAL GROUND		DC GROUND
8	DATA CARRIER DETECT	INPUT	IGNORED
20	DATA TERMINAL READY	OUTPUT	ALWAYS TRUE

FIGURE 3-6

SERIAL I/O CONNECTOR – RS-422, RS-423, RS-232C

PIN	SIGNAL	DIRECTION	COMMENT
1			NOT CONNECTED
2	GROUND		GROUND
3	TRANSMIT LINE	OUTPUT	POSITIVE
4	TRANSMIT LINE	OUTPUT	NEGATIVE
5			NOT CONNECTED
6			PIN REMOVED
7	RECEIVE LINE	INPUT	NEGATIVE
8	RECEIVE LINE	INPUT	POSITIVE
9	GROUND		GROUND
10			NOT CONNECTED

SECTION 4

DU-58 PROTOCOL

4.1 Introduction

Communicating with the DU-58 is via the serial interface using a protocol compatible with the DEC TU58 Radial Serial Protocol (RSP). The RSP is a high-level command protocol that unburdens the host computer from device related operations such as positioning and read retries. Using this protocol, data can be randomly accessed on either one or two disk drives.

4.2 Message Packets

All communication with the DU-58 is in groups of bytes called message packets. There are six message packets: COMMAND, DATA, CONTINUE, XOFF, INITIALIZE, and BOOTSTRAP. A description of each follows.

4.2.1 Command Packet

The COMMAND message packet contains fourteen bytes and is used by the host to initiate a read, write, or a position operation, to perform disk formatting and verification, and to obtain status information. The COMMAND packet structure is described in Figure 4–1.

Operation Code (byte 2) is the operation being commanded. The OPCODES are described in Section 4.3.

Byte Count (bytes 8, 9) is the number of bytes to be transferred in a read or write operation.

Block Number (bytes 10, 11) is used by the read, write, and position commands. Block numbers start at zero, and the maximum block number is calculated from the number of tracks and sides being used on a disk as illustrated below.

$$MAX=[\ (tracks/side)*sides*\begin{pmatrix}1 & \text{if 512-byte addressing}\\ 4 & \text{if 128-byte addressing}\end{pmatrix}*10]-1$$

The block numbers for different disk configurations are shown in Figure 4-2.

4.2.1.1 Block Addressing

Normally, all positioning operations are addressed by 512-

byte blocks. For example, if block 2 is to be read, then the third 512-byte block on the disk is read. By setting the most significant bit (80H) of the Modifier (byte 3) in the COMMAND packet, 128-byte block addressing is selected. In this mode, all positioning operations are addressed by 128-byte blocks instead of 512-byte blocks. Zero-fill in a write operation only fills out to a 128-byte boundary in this mode as opposed to zero-filling to a 512-byte boundary.

The addressing modes are illustrated in Figure 4-3.

4.2.2 End Packet

The END message packet, essentially a type of COMMAND packet, contains fourteen bytes. This packet is sent to the host after completion or termination of an operation or on an error. The END packet structure is described in Figure 4-4.

The Success Code (byte 3) is the success indicator of the operation just completed. The error codes are described in Figure 4-5.

Actual Byte Count (bytes 8, 9) is the number of bytes actually transferred in this operation. In a successful operation, this count will be the same as the byte count in the COMMAND packet.

4.2.3 Data Packet

The DATA message packet contains up to 132 bytes with up to 128 bytes of data. This packet is used to transfer data during a read or write operation. For data transfers larger than 128 bytes, the transaction is broken up and sent 128 bytes at a time. The DATA packet structure is described in Figure 4-6.

4.2.4 Continue Packet

The CONTINUE message packet contains one byte and is used in the following ways.

1. The DU-58 during a write operation transmits a CONTINUE packet to request the next DATA packet from the host.
2. The DU-58 returns a CONTINUE packet in response to a BREAK during reinitialization.
3. The host transmits a CONTINUE packet to the DU-58 to resume data transmission previously suspended by an XOFF message packet.

The CONTINUE packet structure is described in Figure 4-7.

4.2.5 XOFF Packet

The XOFF message packet contains one byte and is transmitted to the DU-58 during a READ operation to temporarily suspend data transfers. Data transmission is resumed when the host transmits a CONTINUE or XON message packet. The XOFF message packet structure is described in figure 4-8.

4.2.6 XON Packet

The XON message packet contains one byte and is transmitted to the DU-58 to resume data transfers temporarily suspended by a XOFF packet. The XON message packet structure is described in Figure 4-8-1.

4.2.7 Initialize Packet

The INITIALIZE message packet contains one byte and is used in the following ways.

1. When transmitted to the DU-58, the DU-58 reinitializes and returns a CONTINUE PACKET.
2. When the DU-58 is powered up, the DU-58 goes through an initialization procedure and then continuously transmits INITIALIZE packets until the host responds with a BREAK.

The INITIALIZE message packet is shown in Figure 4-9.

4.2.8 Bootstrap Packet

The BOOTSTRAP message packet contains two bytes and is used to boot the host computer. When the BOOTSTRAP packet is transmitted to the DU-58, the DU-58 reads block 0 of the selected drive and transmits without radial serial packaging (RSP) the 512 bytes contained in that block. No validity checking is performed on the drive number. The BOOTSTRAP message packet is described in Figure 4-10.

4.2.9 Message Packet Checksums

The END, DATA, and COMMAND message packets contain a 16 bit checksum. The checksum is formed by treating each pair of bytes in the packet as a word and summing the words with end around carry. That means, if the sum of two words produces a carry, the carry is added into the sum.

FIGURE 4-1

COMMAND PACKET

BYTE	VALUE (HEX)	DESCRIPTION
0	02	Flag
1	0A	Message Byte Count
2		Operation Code (see Section 4-3)
	00	No Operation
	01	Initialize
	02	Read
	03	Write
	05	Position
	07	Diagnose
	08	Get Status
	09	Set Status
	0C	Format
3		Modifier
	00	No special operation
	80	128-byte block addressing
	01	Read-after-write verification during a write operation
4		Disk Drive Number
	00	Drive 0
	01	Drive 1
5	00	Switches
6	00	Always 0
7	00	Always 0
8	0000-FFFF	Byte Count – (low)
9		Byte Count – (high)
10	00-MAX	Block Number – (low)
11		Block Number (high)
12		Checksum of Bytes 0 to 11 – (low)
13		Check sum of Bytes 0 to 11 – (high) (see Section 4.2.8)

FIGURE 4-2

BLOCK NUMBERS

Number of Tracks	Number of Sides	512-Byte Block Addressing	128-Byte Block Addressing
40	2	0-799	0-3199
80	2	0-1599	0-6399

FIGURE 4-3

BLOCK ADDRESSING MODES

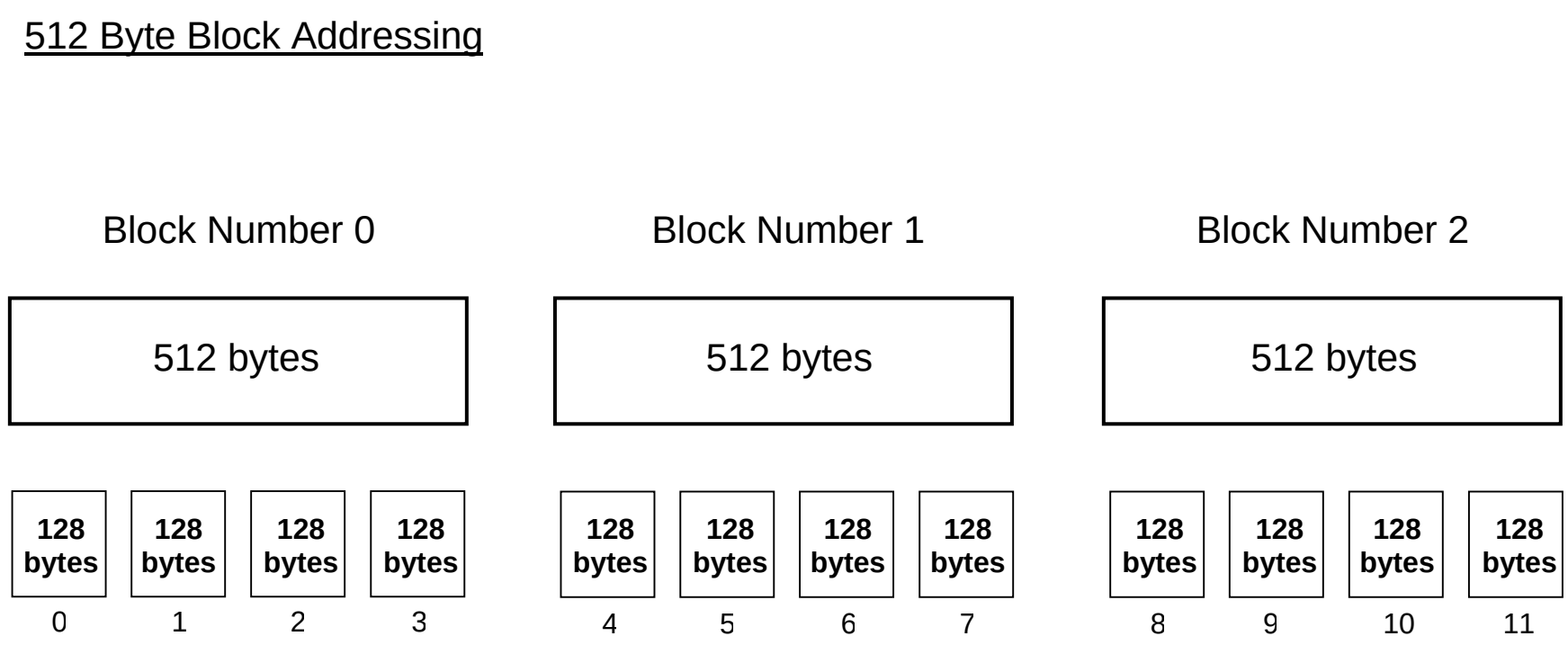


FIGURE 4-4

END PACKET

BYTE	VALUE (HEX)	DESCRIPTION
0	02	Flag
1	0A	Message Byte Count
2	40	Operation Code
3		Success Code
	00	Normal Success
	01	Success but with retries
	FE, -2_{10}	Partial Operation
	F8, -8_{10}	Invalid Drive Number
	F7, -9_{10}	No Disk
	F5, -9_{10}	Write Protected
	EF, -17_{10}	Data Error
	E0, -32_{10}	Seek Error
	D0, -48_{10}	Invalid Operation Code
	C9, -55_{10}	Invalid Block Number
4		Drive Number
	00	Drive 0
	01	Drive 1
5	00	Always 0
6	00	Always 0
7	00	Always 0
8	0000-FFFF	Actual Byte Count – (low)
9		Actual Byte Count – (high)
10	00	Summary Status – (low)
11		Summary Status (high)
12		Checksum of Bytes 0 to 11 – (low)
13		Check sum of Bytes 0 to 11 – (high) (see Section 4.2.8)

FIGURE 4-5

SUCCESS CODES

VALUE (HEX, OCTAL, DECIMAL)	DESCRIPTION
00, 000, 0	**Normal Success** The operation was successfully completed.
01, 001, 1	**Success but with retries** The operation was successfully completed but required re-reading of blocks on the disk. Continual retries indicates that the disk is marginal and data on the disk should be saved on another disk. (see Section 4.5)
FE, 376, -2	**Partial Operation (end of medium)** The number of bytes to be transferred in a read or write operation caused the DU-58 to read or write beyond the end of the disk.
F8, 370, -8	**Invalid Drive Number** The COMMAND message packet contains an invalid drive number (byte 4).
F7, 367, -9	**No Disk** A disk has not been inserted in the disk drive.
F5, 365, -11	**Write Protected** The disk is write protected.
EF, 357, -17	**Data Error** The DU-58 was unable to read a block form the disk or write a block on the disk. This is caused by corrupted data on the disk or the disk not being formatted.
E0, 340, -32	**Seek Error** The DU-58 was not able to find (seek) a block on the disk. This is caused by corrupted data on the disk or the disk not being formatted.
D0, 320, -48	**Invalid Operation Code** The COMMAND message packet contained an invalid block number (bytes 10, 11).
C9, 311, -55	**Invalid Block Number** The COMMAND message packet contained an invalid block number (bytes 10, 11).

FIGURE 4-6

DATA PACKET

BYTE	VALUE (HEX)	DESCRIPTION
0	01	Flag
1	n	Byte Count (1 – 128_{10})
2		Data
•		•
•		•
•		•
•		•
n		Data
n + 1		Last Data Byte
n + 2		Checksum of bytes 0 to (n+1)-(low)
n + 3		Checksum of bytes 0 to (n+1)-(high) (see Section 4.2.8)

FIGURE 4-7

CONTINUE PACKET

BYTE	VALUE (HEX)	DESCRIPTION
0	10	Flag

FIGURE 4-8

XOFF PACKET

BYTE	VALUE (HEX)	DESCRIPTION
0	13	Flag

FIGURE 4-8-1

XON PACKET

BYTE	VALUE (HEX)	DESCRIPTION
0	11	Flag

FIGURE 4-9

INITIALIZE PACKET

BYTE	VALUE (HEX)	DESCRIPTION
0	04	Flag

FIGURE 4-10

BOOTSTRAP PACKET

BYTE	VALUE (HEX)	DESCRIPTION
0	08	Flag
1		Drive Number
	00	Drive 0
	01	Drive 1

4.3 Command Operation Codes

Following is a description of the COMMAND message packet operation codes.

4.3.1 OPCODE 0 - NOP (No operation)

This command causes the DU-58 to return an END packet. There are no modifiers (byte 3) to the NOP command packet. Upon completion of this operation, an END message packet is returned to the host.

4.3.2 OPCODE 1 - Initialize

The command causes the DU-58 to reset itself to a ready state. No positioning results from this operation. There are no modifiers (byte 3) to the INITIALIZE command packet. Upon completion of this operation, an END message packet is returned to the host.

4.3.3 OPCODE 2 - Read

Before a read operation can begin, a COMMAND message packet is transmitted to the DU-58. The COMMAND packet selects which of the disk drives (0 or 1) is to perform the read operation, specifies the starting address of the block to be read, and specifies the number of bytes to be read. The DU-58 then positions to the block and starts reading data from the block. The first 128 bytes of data are transmitted to the host using a DATA message packet. Then the next 128 bytes of data are transmitted in a DATA packet. This continues until all the data in the block has been transmitted. The next block is then read and transmitted in 128 byte DATA packets. This continues until the byte count specified in the COMMAND packet has been reached. After the specified byte count has been reached, the DU-58 transmits an END packet. The END packet contains the actual number of bytes transferred and lists any error messages. In the event of a failure, the END packet is sent at the time of failure without filling up the data count.

All positioning is in 512-byte blocks unless a modifier (byte 3) of 80H is received in the COMMAND packet; then addressing is in terms of 128-byte blocks.

The read transaction between the DU-58 and the host is shown in Figure 4-11.

4.3.4. OPCODE 3 - Write

Before a write operation can begin, a COMMAND message packet is transmitted to the DU-58. The COMMAND packet selects which of the disk drives (0 or 1) is to perform the write operation, specifies the address of the block to be written, and specifies the number of bytes to be written.

The DU-58 responds with a CONTINUE message packet. The first 128 bytes of data using a DATA packet are transmitted to the DU-58. If the specified byte count has not been reached, a CONTINUE packet is sent to the host. The CONTINUE packet tells the host to send the next 128 bytes to the DU-58. This continues until the specified byte count has been reached; then the DU-58 sends an END packet. The END packet contains the actual number of bytes written and lists any error messages. In the event of failure, the END packet is sent at the time of failure without filling up the data count.

All positioning is in 512-byte blocks unless a modifier (byte 3) of 80H is received in the COMMAND packet, then addressing is in terms of 128-byte blocks.

The DU-58 automatically zero-fills any remaining bytes in a 512-byte block or in a 128-byte block if 128-byte block addressing is specified.

A modifier (byte 3) of 01H causes the DU-58 to read each block that has just been written (read-after-write verification). This ensures that the data was written correctly to the disk. If the read fails, an END packet is immediately transmitted to the host.

The write transaction is shown in Figure 4-12.

4.3.5 OPCODE 5 - Position

This command causes the DU-58 to position to the selected block of the selected drive. After positioning to the selected block, an END message packet is transmitted to the host. All positioning is in 512-byte blocks unless a modifier (byte 3) of 80H is received in the COMMAND message packet, then addressing is in terms of 128-byte blocks.

4.3.6 OPCODE 7 - Diagnose

This command causes the DU-58 to verify a disk on the selected drive. When a disk is verified, every block on the disk is read and the CRC character for that block is verified (see Section 4.5). This ensures that the data in the block has not been corrupted. Upon completion, an END message packet is transmitted to the host. There are no modifiers (byte 3) to the DIAGNOSE command packet.

4.3.7 OPCODE 8- Get Status

This command returns an END message packet. The success code returned in the END packet is the success code of the previous operation. There are no modifiers (byte 3) to the GET STATUS command packet.

4.3.8 OPCODE 9 - Set Status

This command is treated as a NOP operation because the DU-58 status cannot be set from the host. There are no modifiers (byte 3) to the SET STATUS command packet. The DU-58 returns an END message packet.

4.3.9 OPCODE 12 - Format

This command causes the DU-58 to format the disk on drive 0. Only drive 0 may be used for formatting. A disk must be formatted before being used for storage of data. When a disk is formatted, all data previously recorded on the disk is destroyed. After the disk is formatted, the disk is verified (see OPCODE 7). Upon completion of the verification, an END message packet is transmitted to the host. There are no modifiers (byte 3) to the FORMAT command packet.

FIGURE 4-11

READ OPERATION PACKET EXCHANGE

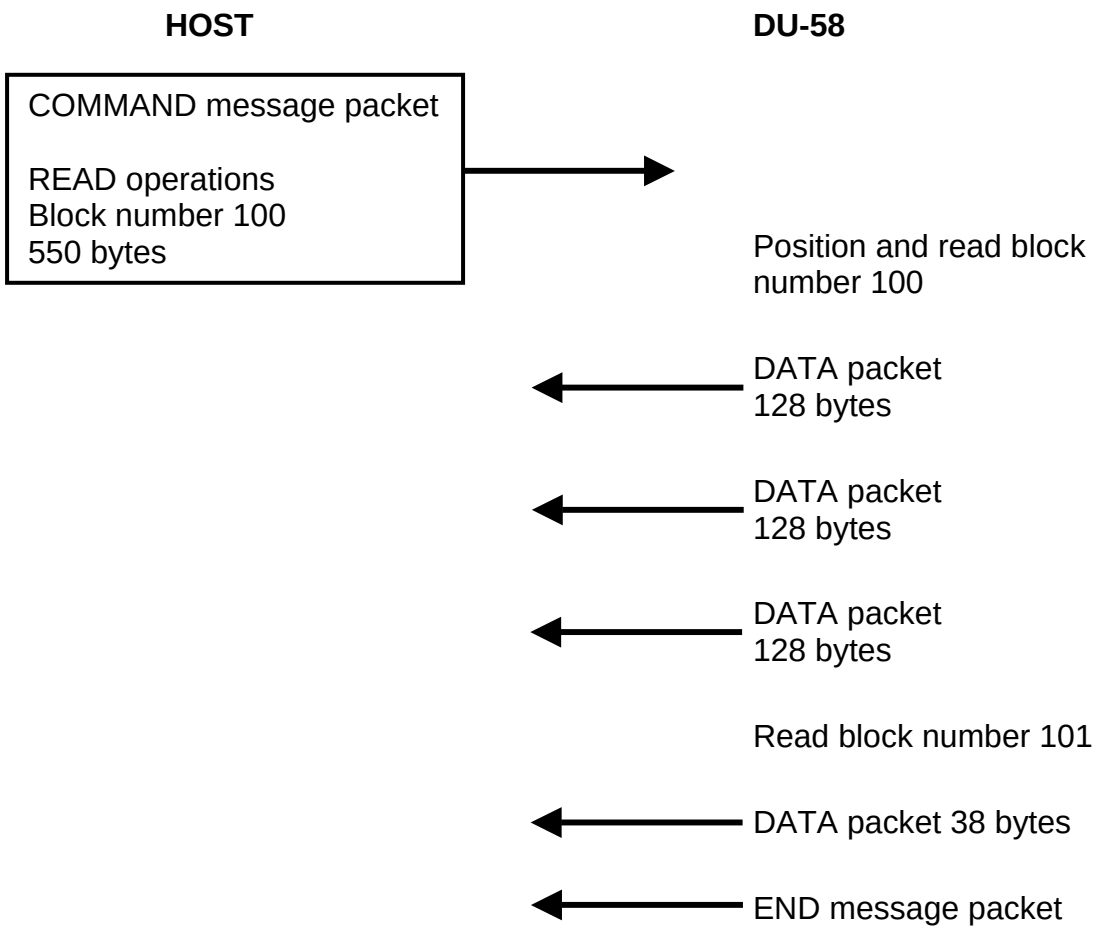
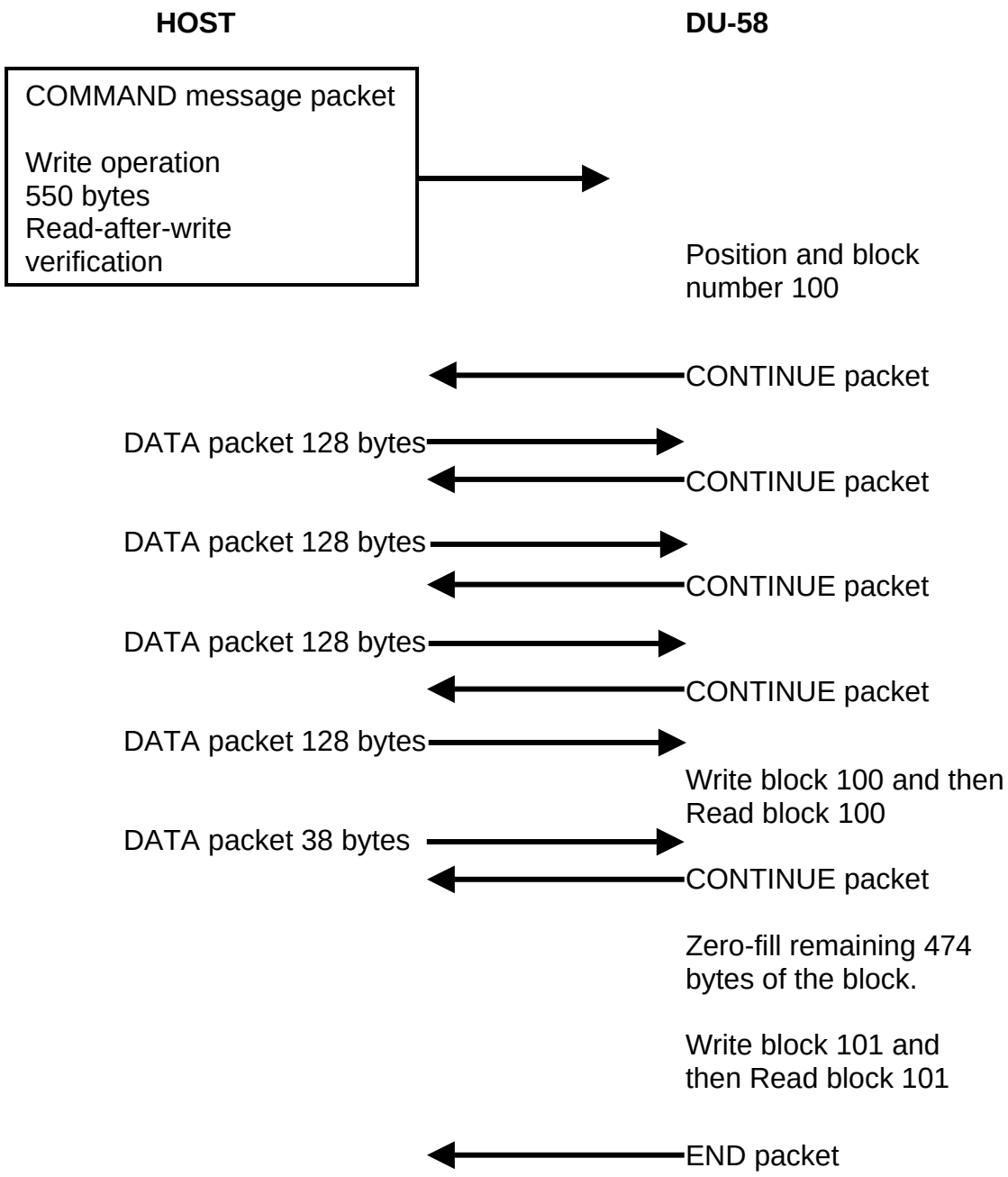


FIGURE 4-12

WRITE OPERATION PACKET EXCHANGE



4.4 Break and Initialization

Break is a unique logic entity that can be interpreted by the DU-58 and the host regardless of the state of the protocol. Break is transmitted when the serial line, which normally switches between two logic states called mark and space, is kept in the "space" condition for more than one character time. This causes the DU-58 UART to set its framing error bit. The DU-58 will interpret the framing error as break.

Break has two applications in the DU-58. When the DU-58 is powered up, it performs its internal checkout and initialization and then transmits INITIALIZE message packet continuously to the host to inform the host that it is present. The host acknowledges the DU-58 by sending BREAK for a minimum of one character time and then sending two INITIALIZE message packets. The DU-58 responds with a CONTINUE message packet and enters and idle state in which it will wait for further instructions.

If communications break down due to any transient problem, the host may restore order by sending BREAK and two INITIALIZE message packets as outlined above: Whatever faulty operations were underway will be cancelled and the DU-58 will reinitialize itself, return a CONTINUE packet and wait for instructions.

Figures 4-13 and 4-14 illustrate the power-up packet exchange and the reinitialization packet exchange.

FIGURE 4-13

POWER-UP PACKET EXCHANGE

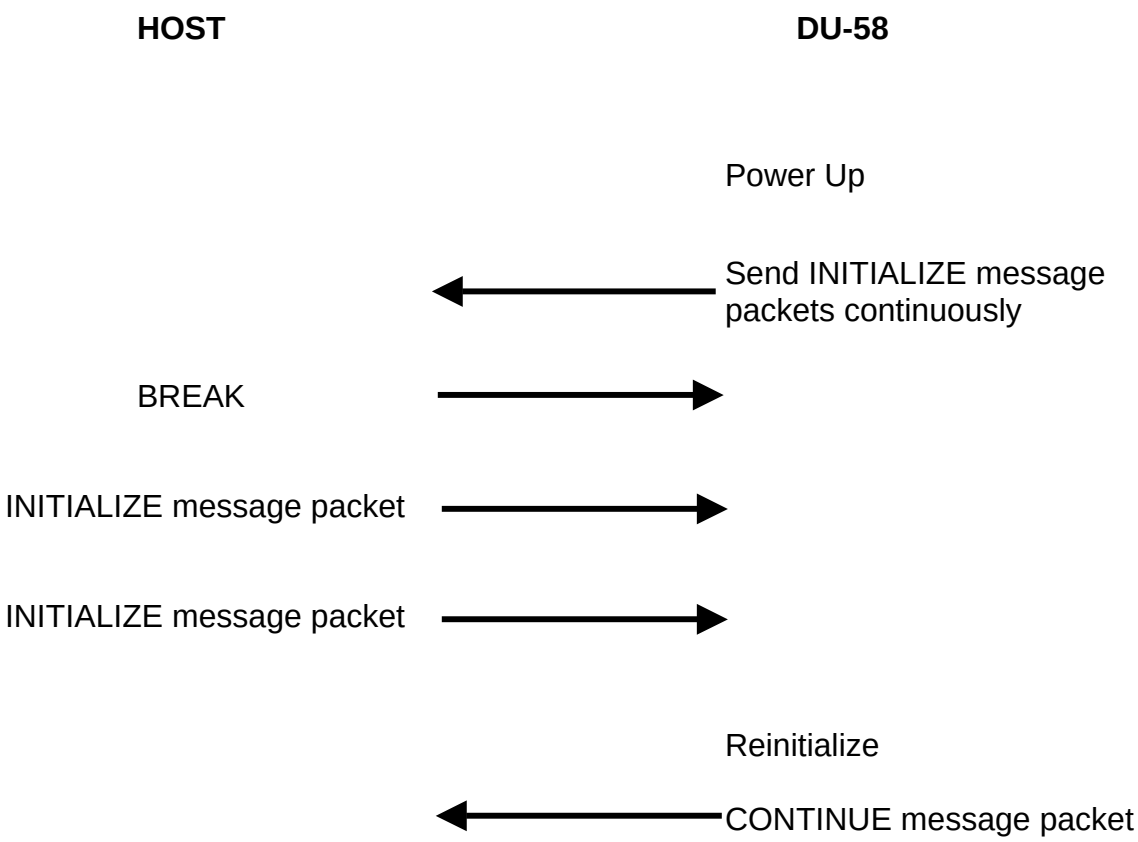
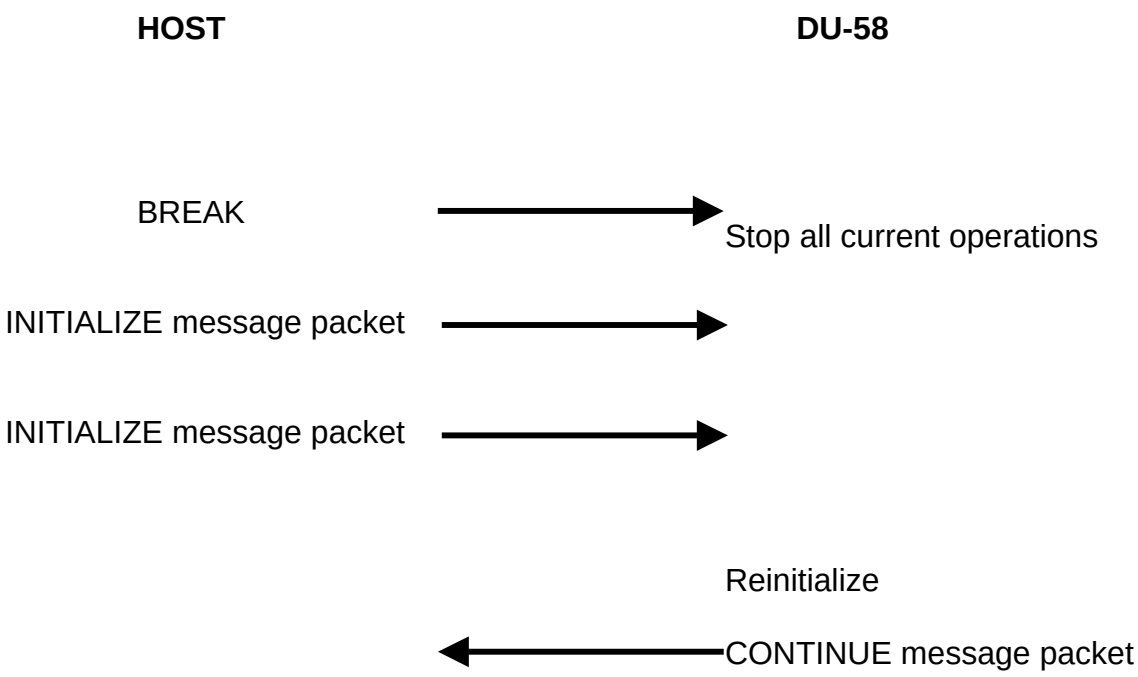


FIGURE 4-14

REINITIALIZATION PACKET EXCHANGE



4.5 Data Integrity

The DU-58 uses a CRC character (16 bit error checking word) to ensure accurate data recording and retrieval. During a WRITE operation, the CRC character is generated and written on the disk at the end of each block. During a READ operation, the data read is used to generate a second CRC character which is then compared to the CRC at the end of the block. If they are not the same, the DU-58 automatically tries to re-read the block. If it is unsuccessful after three retries, an END packet is immediately sent to the host. Upon the successful completion of a read operation, and if a retry occurred during the operation, a success code of 01H is transmitted in the END packet.

If retries are continually occurring on a disk, then the disk is marginal, should be backed up, and reformatted.

The DIAGNOSE operation (OPCODE 7) reads each block on the disk. Therefore, the CRC check is performed on each block.

4.6 Format

A disk must be formatted before being used for storage of data. When formatted, all data previously recorded on the disk is destroyed. Only drive 0 may be used for formatting. The DU-58 can be commanded to format a disk in two ways. The first method is by transmitting a COMMAND message packet with the format operation code (OPCODE 12).

The second method is by depressing a red colored push button switch located on the rear panel of the DU-58. Each time the push button is depressed, the disk on drive 0 is formatted. The disk is only formatted, no disk verification as with the Format OPCODE occurs. Also, an END message packet is not transmitted to the host.