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OPERATIONAL SPECIFICATIONS FOR MAGNETIC TAPE SUBSYSTEMS

CATEGORY: INTERFACE STANDARD

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Foreword

Federal Information Processing Standards Publications of the National Bureau of Standards are adopted and promulgated under the provisions of Public Law 89-306, and Part 6 of Title 15 Code of Federal Regulations. The standards are required for implementation by Federal agencies in the acquisition, development and use of automated information systems and in the interchange of data between and among agencies and with the public. The use of such standards which are adopted after extensive review by Federal agencies, industry and the public is intended to reduce Government costs and improve the effectiveness of Government services.

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Abstract

This standard defines the peripheral device dependent operational interface specifications for connecting magnetic tape equipment as a part of automatic data processing (ADP) systems. It is to be used together with FIPS PUB 60, I/O Channel Interface, and FIPS PUB 61, Channel Level Power Control Interface. This standard, together with these two referenced standards, provides for full plug-to-plug interchangeability of magnetic tape equipment as part of ADP systems.

The Government's intent in employing this standard for Operational Specifications for Magnetic Tape Subsystems is to reduce the cost of satisfying the Government's data processing requirements through increasing its available alternative sources of supply for computer system components at the time of initial system acquisition, as well as in system replacement augmentation and in system component replacement. This standard is also expected to lead to improved reutilization of system components.

When acquiring ADP systems and system components, Federal agencies shall cite this standard in specifying the interface for connecting magnetic tape peripheral equipment as a part of ADP systems.

Key words: Automatic data processing (ADP); Channel level power control interface; Computer peripherals; Computers; Federal Information Processing Standard; Input/Output; Interfaces; Operational Specifications for Magnetic Tape Subsystems.

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ANNOUNCING THE STANDARD FOR

OPERATIONAL SPECIFICATIONS FOR MAGNETIC TAPE SUBSYSTEMS

Federal Information Processing Standards Publications are issued by the National Bureau of Standards pursuant to the Federal Property and Administrative Services Act of 1949, as amended, Public Law 89-306 (79 Stat. 1127), Executive Order 11717 (38 FR 12315 dated May 11, 1973) and Part 6 of Title 15 Code of Federal Regulations (CFR).

Name of Standard. Operational Specifications for Magnetic Tape Subsystems (FIPS PUB 62).

Category of Standard. Interface.

Explanation. This standard defines the peripheral device dependent operational interface specifications for connecting magnetic tape equipment as a part of automatic data processing (ADP) systems. It is to be used together with FIPS PUB 60, I/O Channel Interface and FIPS PUB 61, Channel Level Power Control Interface. This standard, together with these two referenced standards, provides for full plug-to-plug interchangeability of magnetic tape equipment as part of ADP systems.

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When acquiring ADP systems and system components, Federal agencies shall cite this standard in specifying the interface for connecting magnetic tape peripheral equipment as a part of ADP systems.

Approving Authority. Secretary of Commerce.

Maintenance Agency. Department of Commerce, National Bureau of Standards (Institute for Computer Sciences and Technology).

Cross Index. American National Standards Institute document X3T9/780, Rev. 3, Draft Proposed American National Standard Operational Specifications for Magnetic Tape Subsystems.

Applicability. This standard is applicable to the acquisition of all magnetic tape equipment whenever the use of Federal Information Processing Standard I/O Channel Interface (NBS-FIPS-PUB-60) is required.

Verification of the correct operation of all interfaces that are required to conform to this standard shall, through demonstration or other means acceptable to the Government, be provided prior to the acceptance of all applicable ADP equipment.

Specifications. This standard incorporates by reference the technical specifications of ANSI document X3T9/780 Rev. 3. Copies of the technical specifications section of the standard will be available from the National Technical Information Service as described in the **Where to Obtain Copies** section below.

Implementation. The provisions of this standard are effective June 23, 1980. All applicable equipment ordered on or after the effective date, or procurement actions for which solicitation documents have not been issued by that date, must conform to the provisions of this standard unless a waiver has been granted in accordance with the procedure described elsewhere in this standard.

Regulations concerning the specific use of this standard in the Federal procurement will be issued by the General Services Administration to be a part of the Federal Property Management Regulations.

This standard shall be reviewed by NBS within three years after its effective date, taking into account technological trends and other factors, to determine whether the standard should be affirmed, revised or withdrawn.

Waivers. Heads of agencies desiring a waiver from the requirements stated in this standard, so as to acquire ADP equipment that does not conform to this standard, shall submit a request for such a waiver to the Secretary of Commerce for review and approval. Approval will be granted if, in the judgment of the Secretary based on all available information, including that provided in the waiver request, a major adverse economic or operational impact would occur through conformance with this standard.

A request for waiver shall include: (1) a description of the existing or planned ADP system for which the waiver is being requested, (2) a description of the system configuration, identifying those items for which the waiver is being requested, and including a description of planned expansion of the system configuration at any time during its life cycle, and (3) a justification for the waiver, including a description and discussion of the major adverse economic or operational impact that would result through conformance to this standard as compared to the alternative for which the waiver is requested.

The request for waiver shall be submitted to the Secretary of Commerce, Washington, D.C. 20230, and labeled as a Request for Waiver to a Federal Information Processing Standard. Waiver requests will normally be processed within 45 days of receipt by the Secretary. No action shall be taken to issue solicitation documents or to order equipment for which this standard is applicable and which does not conform to this standard prior to receipt of waiver approval response from the Secretary.

Where To Obtain Copies. Either paper or microfiche copies of this Federal Information Processing Standard, including the technical specifications, may be purchased from the National Technical Information Service (NTIS) by ordering Federal Information Processing Standard Publication 62 (NBS-FIPS-PUB-62), Operational Specifications for Magnetic Tape Subsystems. Ordering information, including prices and delivery alternatives, may be obtained by contacting the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, Virginia 22161, Telephone: (703) 557-4650.

TECHNICAL SPECIFICATIONS

FOR

OPERATIONAL SPECIFICATIONS FOR MAGNETIC TAPE SUBSYSTEMS

X3T9/780 Revision 3
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American National Standard

OPERATIONAL SPECIFICATIONS FOR MAGNETIC TAPE SUBSYSTEMS

PREPARED BY

Technical Committee X3T9—I/O Interface

American National Standards Committee
X3—Computers and Information Processing

Secretariat: Computer and Business
Equipment Manufacturers Association

Abstract

This standard is directed at higher performance magnetic tape subsystems that attach to the proposed ANS I/O Channel Interface, BSR X3.67. It is intended to facilitate the interconnection of magnetic tape subsystems to general purpose computer systems.

Full "plug-to-plug" interchangeability is achieved only if no changes in hardware or software components in the system are required when interchanging magnetic tape subsystems. This standard provides operational specifications that define the command codes, sense and status formats, data formats, program requirements, etc., for magnetic tape subsystems. The functional, electrical and mechanical specifications for attaching these magnetic tape subsystems to the I/O channel of a general purpose computing system are provided by the proposed ANS I/O Channel Interface, BSR X3.67.

Foreword

(This Foreword is not part of the standard for Operational Specifications for Magnetic Tape Subsystems.)

This standard provides the specifications for the operational characteristics of high performance magnetic tape subsystems that attach to the proposed ANS I/O Channel Interface, BSR X3.67, which provides the connection to an I/O channel of a general purpose computer system. Magnetic Tape subsystem refers to the combined magnetic tape control unit and magnetic tape devices.

The proposed ANS I/O Channel Interface standard provides specifications for the functional, electrical, and mechanical characteristics of the I/O Channel Interface. This includes the general specification of address, command, status and data information flow over this I/O Channel Interface.

This standard details the operational characteristics for magnetic tape subsystems utilizing the proposed ANS I/O Channel Interface. Included are the following:

(1) Addressing formats for magnetic tape control units and attached devices.
(2) Command codes for the control of magnetic tape control units and attached devices.
(3) Status and sense formats for the detection of the state of magnetic tape control units and attached devices.
(4) Data formats for transfer of data to and from magnetic tape subsystems.
(5) Error recovery procedures that provide minimum guidance for recovery actions independent of operating systems or equipment are included for reference purposes in an appendix to this standard.

Contents

SECTION

APPENDIX

OPERATIONAL SPECIFICATIONS FOR MAGNETIC TAPE SUBSYSTEMS

1. Introduction. This American National Standard is one of several standards that, as a set, specify I/O subsystem connection to, and operation on, general purpose computer systems.

1.1 Scope. This American National Standard defines the operational characteristics of high performance magnetic tape subsystems that attach to I/O channel interfaces utilizing the proposed ANS I/O Channel Interface, BSR X3.67, to facilitate plug-to-plug compatibility and ensure interchangeability of magnetic tape subsystems used on I/O channels of general purpose computer systems. It is distinct from a specification in that it delineates a minimum set of restrictions consistent with compatibility and interchange.

1.2 I/O Channel Interface. The proposed ANS I/O Channel Interface, BSR X3.67, specifies the functional, electrical, and mechanical characteristics of the interface which provides the connection between the general purpose computer system I/O channel and the magnetic tape subsystem.

1.3 Power Control Interface. The proposed ANS Power Control Interface, BSR X3.68, specifies the functional and mechanical characteristics which provide a sequential and interlocked means of controlling the AC input power supplied to the magnetic tape subsystem.

1.4 Subsystem Organization.

See Figures 1 and 2 and descriptions below.

1.4.1 Single Control Unit. A basic magnetic tape subsystem consists of a single tape control unit and one or more magnetic tape units (devices). Up to sixteen (16) tape units may be attached to a single tape control unit.

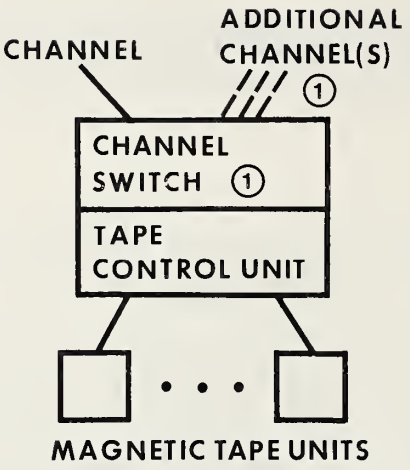
1.4.2 Multiple Control Units. A maximum magnetic tape subsystem may consist of up to four tape control units and up to sixteen (16) magnetic tape unit (devices).

1.4.3 Channel Switch. Each tape control unit may be accessed by additional channels if the channel switch option is implemented. This alternate path switching among channels allows program (software) control over the sharing of the tape control unit by the channels. The control-unit-busy sequence, in the ANS I/O Channel Interface standard, is used to inform a channel requesting use of the tape control unit that the tape control unit is busy on another channel.

Channels sharing a tape control unit via this channel switch capability may be on the same or different general purpose computer systems.

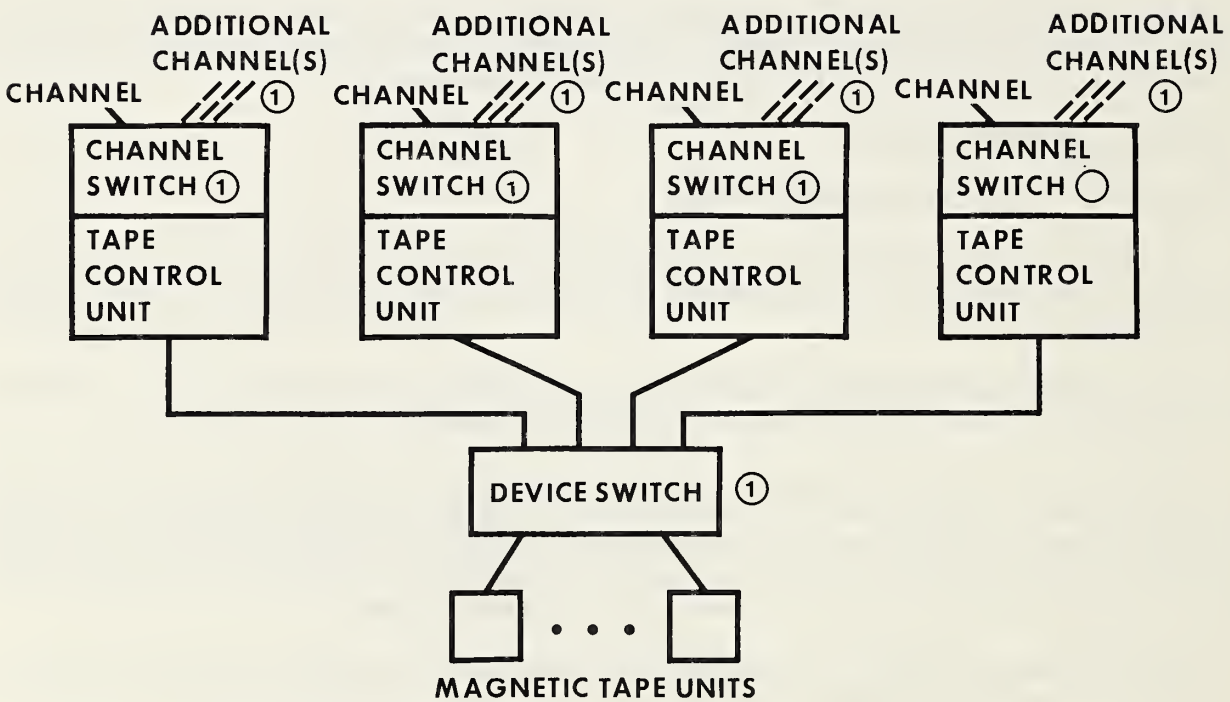
1.4.4 Device Switch. Multiple tape control unit subsystems provide for shared access of magnetic tape units (devices) by use of some type of device switch that will allow fully shared access of up to sixteen (16) devices by two, three, or four tape control units.

It is not the intention of this standard to specify the architecture of the device switch, only its externally observable (outside of the magnetic tape subsystem) characteristics. In all of the configurations, the device switch is logically invisible except for a device busy response to initial selection when the addressed magnetic tape unit is being used by another tape control unit. The device switch must contain some form of priority logic to systematically allocate a device in the event of conflicting tape control unit requests.



1 OPTIONAL FEATURES

FIGURE 1. SINGLE CONTROL UNIT SUBSYSTEM



1 OPTIONAL FEATURES

FIGURE 2. MAXIMUM SUBSYSTEM

NOTE: These drawings represent typical implementations and are provided for reference purposes only. They are not intended to specify the implementation detail for the optional features shown.

The device switch may permit simultaneous access of up to four devices (one per each tape control unit) but this standard does not require that such simultaneous access be provided.

1.5 Device Characteristics. The magnetic tape subsystem includes magnetic tape units (devices) that record and read back digital information for storage purposes on magnetic tape as defined in sections 1.5.1, 1.5.2, 1.5.3 and 1.5.4. Magnetic tape units in the subsystem may include one or more of the following recording formats.

1.5.1 6250 CPI GCR Nine-Track. The data is recorded in the Group Coded Recording (GCR) format as specified in document ANSI X3.54-1976, entitled Recorded Magnetic Tape for Information Interchange (6250 CPI, GCR), at 6250 characters per inch (246 bytes/mm).

Data is recorded in nine parallel tracks on tape in adherence to ANS Unrecorded Magnetic Tape for Information Interchange (9-Track 200 and 800 CPI, NRZI, and 1600 CPI, PE), X3.40-1973.

1.5.2 1600 CPI PE Nine-Track. The data is recorded in the Phase Encoded (PE) format as specified in document ANSI X3.39-1973, entitled Recorded Magnetic Tape for Information Interchange (1600 CPI, PE), at 1600 characters per inch (63 bytes/mm).

Data is recorded in nine parallel tracks on tape in adherence to ANS Unrecorded Magnetic Tape for Information Interchange (9-Track 200 and 800 CPI, NRZI, and 1600 CPI, PE), X3.40-1973.

1.5.3 800 CPI NRZI Nine-Track. The data is recorded in the Non-Return to Zero (NRZI) format as specified in document ANSI X3.22-1973, entitled Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI), at 800 characters per inch (31 bytes/mm).

Data is recorded in nine parallel tracks on tape in adherence to ANS Unrecorded Magnetic Tape for Information Interchange (9-Track 200 and 800 CPI, NRZI, and 1600 CPI, PE), X3.40-1973.

1.5.4 Seven-Track 200/556/800 CPI NRZI. The data is recorded in the Non-Return to Zero (NRZI) format as specified by document ANSI X3B1/556-1972, entitled Magnetic Tape for Information Interchange at 200, 556, or 800 characters per inch (8, 22, or 31 bytes/mm).

Data is recorded in seven parallel tracks on the tape.

1.6 Addressing. Every magnetic tape unit has a unique device address consisting of a tape control unit and a magnetic tape unit address. The method for manually assigning these addresses is not defined as part of this standard. The tape control unit number (address) occupies the high order (most significant) 4 bits of the 8 bit device address. The magnetic tape unit number (address) occupies the low order (least significant) 4 bits of the 8 bit device address.

1.7 Optional Magnetic Tape Subsystem Features. The following features are optional in the magnetic tape subsystems and may be intermixed in any configuration unless stated otherwise.

1.7.1 Nine-Track NRZI Feature. Permits operation in nine-track 800 CPI NRZI mode.

1.7.2 Nine-Track PE Feature. Permits operation in nine-track 1600 PE mode.

1.7.3 Nine-Track GCR Feature. Permits operation in nine-track 6250 CPI GCR mode.

1.7.4 Seven-Track Feature. Permits operation in seven-track 200/556/800 CPI NRZI mode. Data translator and/or data converter capabilities may be associated with the seven-track feature.

Single, or pairs of densities may be supported as opposed to all three tape data densities. This means that a seven-track feature may support 200, 556, 800, 200/556, 200/800, or 556/800.

1.7.4.1 Data Translator. Writing a tape with the data translator on causes eight-bit bytes from the I/O channel interface to be written on tape as their six-bit character equivalents.

Reading a tape with the data translator on causes six-bit characters to be translated into their eight-bit byte equivalent.

No specification is made in this standard for the conversion character set or the translation mapping between eight-bit bytes and six-bit characters. Either ASCII or a non-standardized code set, unique to the computer system utilizing this standard, may be used.

When using the data translator, data rates are not changed and there are no changes in the magnetic tape unit's operation.

1.7.4.2 Data Converter. Writing a tape with the data converter on causes four tape characters (24 bits) to be written for every three eight-bit bytes from the I/O channel interface.

Reading a tape with the data converter on causes four tape characters (24 bits) to be converted to three eight-bit bytes for transmission to the I/O channel interface.

Data conversion reduces the data transfer rate over the I/O channel interface to 75% of the normal (data converter off) rate.

Note that when no data conversion or translation is done the upper (most significant) two bits of each eight-bit byte are discarded on tape write operations and zero-filled on tape read operations.

When non-integral multiples of three eight-bit bytes are to be written on tape with the data converter on, then unfilled bits in the 24 bit (four character) converter are zero-filled for writing to tape.

In similar fashion, when reading a tape record containing non-integral multiples of four six-bit characters, with the data converter on, the unfilled bits in the 24 bit (three byte) converter are zero-filled for reading by the I/O interface.

NOTE: The above description does not completely specify all possible handling of non-integral multiples of eight-bit byte to six-bit character conversions. To ensure full interchangeability, additional vendor information must be consulted.

1.7.5 Channel Switch Feature. Permits access to the tape control unit by additional channels. See section 1.4.3.

1.7.6 Device Switch Feature. Permits access to a magnetic tape unit by additional tape control units. See section 1.4.4.

1.8 Abbreviations.

ANS	American National Standard
BCD	binary coded decimal
BOT	beginning of tape
BSB	backspace block
BSF	backspace file
CCW	channel command word
cm	centimeter
CPI	characters per inch
CRC	cyclical redundancy check

CSW	channel status word
CUE	control unit end
DCC	data converter check
DMS	diagnostic mode set
DSE	data security erase
EOT	end of tape
ERG	erase gap
FSB	forward space block
FSF	forward space file
GCR	group coded recording
hex	hexadecimal
IBG	interblock gap
ID	identification
IF	interface
I/O	input/output
ips	inches per second
Kb	kilobyte
LWR	loop write-to-read
m	meter
mm	millimeter
ms	millisecond
MS 1	Mode Set 1
MS 2	Mode Set 2
MTE	multi-track error
NOP	no operation
NRZI	non-return to zero change-on-ones recording
OS	operating system
PE	phase encoded
REW	rewind
ROR	read opposite recovery
RUN	rewind unload
R/W	read/write
sec	second
Sw	switch
TCU	tape control unit
TI	tape indicate
TIE	track in error
TM	tape mark
TU	(magnetic) tape unit

UE	unit exception
usec	microsecond
VRC	vertical redundancy check
WTM	write tape mark

2. Command Descriptions.

2.1 Commands. Commands executed by magnetic tape subsystems fall into one of the following categories:

(1) Burst Commands
(2) Motion Control Commands
(3) Non-Motion Control Commands

Figure 3 lists the command codes that must be recognized and executed by a magnetic tape subsystem to provide interchangeability. Also included in Figure 3, for reference purposes, are certain optional command codes which may be implemented in magnetic tape subsystems but which are not a requirement for interchangeability. Magnetic tape subsystems may have additional command codes implemented to aid in fault recognition, diagnosis, and logging at the discretion of individual vendors. Command codes that are not implemented in a given tape control unit shall result in a unit check status response with a command reject indicated in the sense information.

Programming note: The magnetic tape subsystem need have no interlocking to prevent the execution of improper sequences of write and read operations that may result in writing extraneous bits or leaving partial blocks on tape. Avoiding these improper sequences is a program responsibility.

The following are two examples of basic sequences that should be avoided:

(1) A write-type operation after a forward read-type operation except:

(a) When the block or Tape Mark (TM) read is known to be followed by a TM.

(b) When the block or TM read is known to have been followed by ERG when written or known to have been the last block written before a backward operation.

For example: R R W* avoid.
W B R W* avoid.

(2) A read forward-type operation following write-type operations.

For example: R B W R* avoid.
W B R R* avoid.

W indicates a write-type operation: Write, Write TM, or Erase Gap (ERG).

R indicates a forward read-type operation: Read Forward, Forward Space Block, or Forward Space File.

B indicates a backward read-type operation: Read Backward, Backspace Block, or Backspace File.

* indicates the logical record on which problems may occur.

										Command Code	
										Bit 01234567	Hex
Burst Commands											
Write										00000001	01
Read Forward										00000010	02
Read Backward										00001100	0C
Sense										00000100	04
Sense Reserve (optional)										11110100	F4
Sense Release (optional)										11010100	D4
Request Track-In-Error										00011011	1B
Loop Write-To-Read (optional)										10001011	8B
Set Diagnose (optional)										01001011	4B
Motion Control Commands											
Rewind										00000111	07
Rewind Unload										00001111	0F
Erase Gap										00010111	17
Write Tape Mark										00011111	1F
Backspace Block										00100111	27
Backspace File										00101111	2F
Forward Space Block										00110111	37
Forward Space File										00111111	3F
Data Security Erase										10010111	97
Non-Motion Control Commands											
No-Operation										00000011	03
Diagnose Mode Set (optional)										00001011	0B
Mode Set 1 (seven-track)											
Set Density			Parity		Data Converter		Translator				
200	556	800	Odd	Even	On	Off	On	Off			
X			X		X			X		00010011	13
X				X		X		X		00100011	23
X				X		X	X			00101011	2B
X			X			X		X		00110011	33
X			X			X	X			00111011	3B
	X		X		X			X		01010011	53
	X			X		X		X		01100011	63
	X			X		X	X			01101011	6B
	X		X			X		X		01110011	73
	X		X			X	X			01111011	7B
		X	X		X			X		10010011	93
		X		X		X		X		10100011	A3
		X		X		X	X			10101011	AB
		X	X			X		X		10110011	B3
		X	X			X	X			10111011	BB
Mode Set 2 (Nine-Track)											
Set Density											
800	1600	6250									
		X								11010011	D3
	X									11000011	C3
X										11001011	CB

FIGURE 3. MAGNETIC TAPE SUBSYSTEM COMMAND CODES

Because it may be difficult or impossible to ensure the above safe situations, the use of a write after read forward sequence should be used only in applications where strict control of format and command sequence exists.

Write is allowable following a backspace. Assume the following tape format:

Block 1 TM Block 2 TM Block 3 TM TM

A rewrite of the last data block (Block 3) involves the following safe and proper sequence. After reading the next to last data block (Block 2) and associated TM, read forward to verify that Block 3 is the correct one to rewrite, backspace, write the new data block (replacing Block 3), and write the associated two TMs.

If a new data set is to be added, the last data block and associated TM is read, then a read forward verifies the second consecutive TM and thus the true end of data on this tape. The safe and proper action is then to backspace, write new data block (after Block 3 and associated TM), and write the associated two TMs.

2.1.1 Command Timing Considerations. While interface sequence timing dependencies are covered in the proposed ANS I/O Channel Interface, there may be timing constraints relative to the issuance of successive command codes. These inter-command code timings are not provided in this standard and consequently, to ensure full interchangeability, individual vendor documentation must define any such constraints.

2.1.2 Command Execution Error Considerations. While many interface error conditions are covered in the proposed ANS I/O Channel Interface, there may be error conditions which are unique to individual magnetic tape subsystems. Such error conditions are not defined in this standard. Therefore, to ensure full interchangeability, vendor documentation must define all such error conditions.

2.1.3 Command Chaining. The tape control unit recognizes command chaining when a new command code is received immediately following its presentation of termination status, as defined for the proposed ANS I/O Channel Interface.

2.2 Burst Commands. Burst commands cause transfer of data across the channel/tape control unit interface. Channel End and Device End are signaled in the Status byte when the operation is complete (termination status).

The burst commands are:

Write
Read Forward
Read Backward
Sense
Sense Reserve (optional)
Sense Release (optional)
Request Track-In-Error
Loop Write-To-Read (maintenance aid—optional)
Set Diagnose (maintenance aid—optional)

2.2.1 Write. Records data on tape as it moves forward and creates an interblock gap (IBG) at the end of each block. The tape control unit checks the parity of each data byte received from the I/O interface.

2.2.2 **Read Forward.** Sets the magnetic tape unit to forward read status. As the tape moves, data is read until the read head detects the next IBG. The tape control unit checks and, if necessary and possible, corrects the bits in each byte transferred to the I/O interface. Sensing a tape mark sets Unit Exception with Channel End and Device End in the Status Byte.

2.2.3 **Read Backward.** Sets the magnetic tape unit to backward read status. Read backward operation is similar to read forward, except that the seven-track NRZI data converter mode cannot be used. Data flow and controls are the same as in Read Forward. A read backward given at load point or into load point sets Unit Check in the Status byte. The magnetic tape unit remains in backward status at the end of a read backward command.

2.2.4 **Sense.** The sense bytes are transferred to the channel. There may be a maximum of 24 bytes of sense data available. All sense bytes do not need to be transferred. The information transferred includes unusual conditions associated with the last operation and provides details about the current conditions present in the tape control unit and the magnetic tape unit. A sense command directed to a magnetic tape unit will be executed independent of the condition of the magnetic tape unit as long as the address is valid for the tape control unit.

2.2.5 **Sense Reserve.** This optional command is identical to the sense operation except the addressed tape control unit is reserved to the channel issuing this command. The tape control unit will remain reserved to the issuing channel until either:

(1) A Sense Release command is issued by the reserving channel, or
(2) A system reset occurs through the reserving channel.

Attempting to select a tape control unit that is reserved by another channel results in a tape control unit busy indication in the Status byte.

2.2.6 **Sense Release.** This optional command is identical to the Sense operation except that the reserved tape control unit will be released.

NOTE: Sense data transmitted as a result of Sense Reserve and Sense Release commands will reflect the successful completion of these operations. Sense Reserve and Sense Release commands can only be used on magnetic tape subsystems having the optional channel switch feature. If these commands are issued to a tape control unit without this feature, Command Reject results. When using these commands, they must be the first command in a chain or Command Reject will result.

2.2.7 **Request Track-In-Error (Request TIE).** The Request TIE command is used to aid the NRZI error recovery. If no NRZI features are present, then this command is treated as a no operation with the normal reset of Sense data occurring (see section 3.2). When NRZI features are present, this command transfers one byte of data from the channel to the tape control unit and pre-conditions the tape control unit for NRZI read error recovery.

When issued for a nine-track NRZI magnetic tape unit, a Request TIE conditions the tape control unit for a single corrective read operation.

When issued for a seven-track NRZI magnetic tape unit, the Request TIE byte controls the read clipping level for the next read operation.

2.2.8. **Loop Write-to-Read (LWR).** This is an optional write command that checks the data and control paths but does not move tape.

On nine-track magnetic tape units, an LWR command issued at BOT is executed in 1600 CPI mode. Otherwise, LWR is executed in the current operating mode of the magnetic tape unit.

LWR does not require the magnetic tape unit to be in write status, but the magnetic tape unit must be in the ready condition. Execution of an LWR does not change the status of the magnetic tape unit. An LWR command uses the same data paths as a Write command.

2.2.9 Set Diagnose. The Set Diagnose command is an optional command intended for diagnostic operations. Its execution may result in data being transferred to the tape control unit. This data may cause modified magnetic tape subsystem operation even extending to commands issued subsequently.

2.3 Motion Control Commands. Motion control commands cause movement of tape but do not transfer any data across the channel/tape control unit interface.

All motion control commands result in the presentation of status as follows:

(1) Channel End is presented when the command is accepted (initial status).

(2) Device End is presented when the operation, except for Rewind Unload (see below), is successfully completed (termination status).

(3) When a magnetic tape unit performing one of these operations is addressed, either busy, or control unit busy status may be presented, depending upon tape control unit involvement in that operation.

Motion control commands are:

Rewind
Rewind Unload
Erase Gap
Write Tape Mark
Backspace Block
Backspace File
Forward Space Block
Forward Space File
Data Security Erase

2.3.1 Rewind (REW). The selected magnetic tape unit rewinds to load point.

2.3.2 Rewind Unload (RUN). The selected magnetic tape unit rewinds tape to load point and then automatically unloads the tape to whatever extent possible.

NOTE: For Rewind Unload, Device End, Control Unit End, and Unit Check are presented as termination status after the command initiates at the magnetic tape unit. Device End is presented again when the operator reloads tape, presses START, and the magnetic tape unit goes from the not ready to the ready condition.

2.3.3 Erase Gap (ERG). The selected magnetic tape unit moves tape forward and erases tape for the nominal distance shown below:

	Single ERG	*Successive ERGs*
(6250 CPI)	3.75 inch (95, 3mm)	3.45 inch (87, 6mm)
(1600 CPI and 800 CPI nine-track)	4.2 inch (106, 7mm)	3.6 inch (91, 4mm)
(seven-track)	4.5 inch (114, 3mm)	3.75 inch (95, 3mm)

2.3.4 Write Tape Mark (WTM). The selected magnetic tape unit moves tape forward and writes a tape mark block which is a special block used to separate files.

For magnetic tape units operating at 6250 and 1600 CPI, a WTM command causes the subsystem to write a tape mark preceded by an Erase Gap.

2.3.5 Backspace Block (BSB). The selected magnetic tape unit moves tape backward to the next interblock gap or to load point, whichever comes first. Sensing a tape mark sets Unit Exception with Device End in the termination status byte. The magnetic tape unit remains in backward status.

2.3.6 Backspace File (BSF). The selected magnetic tape unit moves tape backward to the interblock gap on the load point side of a tape mark, or to load point, whichever comes first.

2.3.7 Forward Space Block (FSB). The selected magnetic tape unit moves tape forward to the next interblock gap. Sensing a tape mark sets Unit Exception with Device End in the termination status byte.

2.3.8 Forward Space File (FSF). The selected magnetic tape unit moves tape forward to the interblock gap beyond the next tape mark.

2.3.9 Data Security Erase (DSE). The selected magnetic tape unit erases tape from the point at which the operation is initiated until the end-of-tape marker is sensed.

The DSE command is accepted by the tape control unit only when chained immediately following an Erase Gap command. Receipt of this command under any other conditions results in Command Reject. Attempting DSE at or beyond the EOT marker results in immediate presentation of termination status.

During DSE execution, the magnetic tape unit may monitor erase head current to ensure that the tape is erased. If any failure is detected, the operation is terminated by setting the magnetic tape unit to the not ready condition and unit check termination status is presented.

2.4 Non-Motion Control Commands. Non-motion control commands do not cause tape to move and do not transfer data across the channel/tape control unit interface.

Channel End and Device End are presented when non-motion control commands are accepted (initial status). Non-motion control commands are:

No-Operation
Mode Set 1
Mode Set 2
Diagnostic Mode Set (maintenance aid—optional)

2.4.1 No-Operation (NOP). NOP performs no function in the tape control unit or magnetic tape unit and does not reset the tape control unit sense data.

NOTE: Placing a NOP command at the end of a series of chained commands may delay channel disconnect from the tape control unit.

2.4.2 Mode Set 1 (MS 1). Mode Set 1 commands sent to a tape control unit with the seven-track NRZI feature establishes the magnetic tape unit in an operating mode for succeeding seven-track NRZI operations. Bits 0 and 1 of the command code control density. Bits 2, 3, and 4 control parity and the data converter and translator features of the magnetic tape subsystem. See Figure 3.

If the seven-track feature is not present, or a particular seven-track recording density is not supported, the Mode Set 1 command causes no operation to be performed other than the normal reset of sense data (see Section 3.2).

A Mode Set 1 command establishes the operating mode of all seven-track magnetic tape units attached to the tape control unit. Unless reset, the tape control unit retains an operating mode until another Mode Set 1 command is received.

2.4.3 **Mode Set 2 (MS 2).** Mode Set 2 commands sent to a tape control unit with nine-track features present set the operating mode (6250 CPI GCR, 1600 CPI PE, or 800 CPI NRZI) for succeeding write-type operations on the selected magnetic tape unit. If the selected magnetic tape unit is not at load point or does not have the appropriate nine-track features present, MS 2 causes no action other than the normal reset of sense data (see Section 3.2). If nine-track features are not present in the tape control unit, then Command Reject results.

Unless reset, the tape control unit retains its mode setting until it receives another Mode Set 2 command.

2.4.4 **Diagnostic Mode Set (DMS).** DMS is an optional command which may be used to modify the execution of burst mode commands which follow in the same chain. These modifications may include the generation of controlled error conditions and may change units current levels, parity generation and detection, data error correction and similar functions to aid in maintenance activities.

2.5 **Test I/O (TI/O).** The Test I/O function is indicated by a special command code (hex code 00) which has unique restrictions imposed upon its issuance including the fact that it cannot be part of a command code chain. The TI/O command causes no operation except for the presentation of a status byte indicating the condition of the addressed magnetic tape unit. Under certain error conditions a contingent connection (see Section 2.7) may be established.

2.6 **Interface Disconnect.** Interface Disconnect is a channel interface signalling procedure, as specified in the proposed ANS I/O Channel Interface Standard, that abnormally terminates channel to tape control unit sequences that are in progress. Though the Interface Disconnect procedure may be invoked by a higher level computer system command to halt I/O, the resulting action in the magnetic tape subsystem is all that is specified here.

The Interface Disconnect causes data transfer to stop. The tape control unit disconnects from the channel and proceeds independently to the completion of the operation. If addressed while completing the operation, the tape control unit presents busy status. When the tape control unit reaches the normal ending point, it attempts to obtain selection on the interface to present termination status to the channel.

The tape control unit does not generate any status solely as a result of an Interface Disconnect. If Interface Disconnect is received when the addressed magnetic tape unit is not busy, no status is generated nor is the magnetic tape unit made busy.

If an Interface Disconnect occurs before tape motion has actually started, the operation may be cancelled with Channel End, Device End, and Unit Check presented in the termination status. An Interface Disconnect will suppress command chaining.

2.7 **Contingent Connection.** Under certain conditions, a temporary connection is maintained between the tape control unit and a magnetic tape unit on behalf of the channel until the computer system can provide certain required actions. This connection is called a contingent connection and is initiated when the most recent status byte has the Unit Check bit set. The purpose of the contingent

connection is to maintain the integrity of the sense data that supplies further information as to the cause of the Unit Check status.

The contingent connection is maintained until a command code other than Test I/O is received from the channel to which the Unit Check status was presented.

If a command is received for a device other than the contingently connected one, the tape control unit responds with control unit busy status. This also applies to any command received on another channel for tape control units with the Channel Switch feature.

3. Status and Sense Information.

3.1 Status Byte. The status byte contains a parity bit and 8 other bits which indicate the current status of the tape control unit and the addressed magnetic tape unit. The tape control unit sends this byte to the channel interface during initial selection and again at the end of each operation. Designations of the 8 bits and the conditions that they represent are:

Bit	*Designation*	*Interpretation*
0	Attention	Not used.
1	Status Modifier	Used along with status bit 3 to indicate tape control unit busy.
2	Control Unit End	Control Unit End indicates that the tape control unit has become available for use in another operation. Control Unit End is set: (1) Upon completion (at the tape control unit level) of every operation during which a Control Unit Busy was signaled. (2) Upon completion of a control operation which had Channel End in the initial status and during which a Unit Check or Unit Exception was detected.
3	Busy	Busy indicates that the magnetic tape unit or tape control cannot execute a command for one of the following reasons: (1) If any command (including Test I/O) is recognized, no status is stacked and the addressed magnetic tape unit is rewinding or is currently in use by another tape control unit or alternate channel. (2) If any command, other than Test I/O, is recognized and status is stacked. (3) If any command, other than Test I/O, is recognized and the tape control unit has a Control Unit End, or the addressed magnetic tape unit has a Device End or Unit Check status condition outstanding (not yet accepted by the channel).
4	Channel End	Channel End indicates that the channel interface is no longer required for the operation. It is set when a read, read backward, write, or sense command has been completed, or a control command has been accepted.

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Bit	*Designation*	*Interpretation*
5	Device End	Device End is set: (1) When the tape reaches load point during a rewind or the EOT marker during Data Security Erase. (2) When a Rewind Unload operation is completed at the tape control unit level. (3) When a control command is completed at the magnetic tape unit level. (4) With Channel End, at the completion of other commands. (5) If a magnetic tape unit performing an operation becomes not ready (for example, power off, manual reset). (6) When a magnetic tape unit becomes not busy after selection was attempted while it was busy. (7) On the first initial selection after the magnetic tape unit becomes ready. This may be inhibited if that magnetic tape unit was addressed while in the non-ready state.
6	Unit Check	Unit Check indicates the magnetic tape unit or tape control unit has encountered an unusual condition. The cause of a Unit Check is stored as sense data which is available to the program in response to a Sense Command. Unit Check is set when any of the following occur: (1) Any sense byte 0 error indicator is set. (2) A Read Backward, Backspace Block, or Backspace File is initiated into or at load point. (3) A Rewind Unload is completed at the tape control unit level. (4) Bit 7 of sense byte 1 (Not Capable) is set. (5) The addressed magnetic tape unit is not ready. (6) Bit 3 of sense byte 5 (ID Burst Check) is set. (7) Bit 4 of sense byte 8 (Control Burst Check) is set.
7	Unit Exception	Unit Exception is set when the tape control unit detects a condition that usually does not occur and which does not necessarily indicate an error. Unit Exception is set: (1) If the tape is positioned anywhere beyond the trailing edge of the EOT marker (as indicated by bit 2 of sense byte 4) and a Write, Write Tape Mark, or Erase Gap operation is attempted. (2) If a tape mark is sensed during a Read, Read Backward, Forward Space Block, or Backward Space Block.

3.2 Sense Bytes. Sense data supplements the information contained in the status byte. There are up to 24 bytes of sense data, stored in the magnetic tape subsystem, containing information on error conditions, magnetic tape unit status, tape control unit status, and maintenance aids. The first 6 sense bytes are a requirement for interchangeability. Sense bytes 7 through 24 may be optionally supplied but are not a requirement for interchangeability. A sense command causes the bytes to be transferred to the channel.

All sense information is reset upon acceptance of any command other than NOP, a sense command or a Test I/O. All sense information is reset by a reset of the tape control unit.

Sense bits should be set to zero where their definitions are incompatible or inconsistent with choice of design. Unused sense bits should be set to zero.

3.2.1 Sense Byte 0 (Unit Check).

Bit	*Designation*	*Interpretation*
0	Command Reject	Command reject is set: (1) When a Write type operation is issued to a file-protected magnetic tape unit. (2) When an undefined command code is received by the tape control unit. (3) If a DSE command is issued that is not command chained to an Erase Gap command. (4) If Sense Reserve or Release command is issued: (a) to a tape control unit that does not have a Channel Switch Feature, or (b) other than as the first command in a chain sequence. (5) If an MS 2 command is received and no nine-track features are installed.
1	Intervention Required	Intervention Required is set whenever the addressed magnetic tape unit is not ready or non-existent. NOTE: Going not-ready while performing a command causes Unit Check along with any other termination status.
2	Bus Out Check	Bus Out Check is set: Whenever Bus Out has incorrect (even) parity during command or data byte transfer.
3	Equipment Check	Equipment Check is set on a tape control unit operation when: (1) Bit 1 of sense byte 4 is set. (2) Bit 3 or 4 of sense byte 8 is set. (3) Bit 0, 2, 3, 4, 5, or 7 of sense byte 10 is set.
4	Data Check	Data Check is set when: (1) End-of-block is sensed before any data bytes are detected during a GCR or PE read or read backward operation. Bit 0 of sense byte 1 is also set. (2) Bit 0, 1, 2, 3, 4, or 7 of sense byte 3 is set. (3) Bit 3 in sense byte 4 is set. (4) Bit 2, 4, 5, or 6 in sense byte 5 is set. (5) Bits 0, 3, 5, or 6 in sense byte 8 is set. (6) Bit 1 of sense byte 9 is set.

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Bit	*Designation*	*Interpretation*
5	Overrun	Overrun is set when the channel cannot supply data to the tape control unit fast enough on a write operation or take data fast enough from the tape control unit on a read operation. If data check is on, overrun is suppressed.
6	Word Count Zero	Word Count Zero is set: (1) When the channel stops the data transfer on a write operation before the first byte is received by the tape control unit. (2) When Interface Disconnect Sequence is received after receipt of a Write or Read command but before tape motion is initiated.
7	Data Converter Check	When operating in data converter mode for a read operation, Data Converter Check (DCC) is set to indicate that the last byte (or only byte) sent to the channel was padded with zeros. The following conditions will cause a DCC error to occur on records which are not an even multiple of four characters: (1) If one character is read from tape, and the byte sent to the channel had bits 6 and 7 padded with zeros. (2) If two characters are read from tape, and two bytes are sent to the channel with the second byte padded with zeros in bits 4, 5, 6, and 7. (3) If three characters are read from tape, and three bytes are sent to the channel with the third byte padded with zeros in bits 2, 3, 4, 5, 6, and 7. NOTE: Data Converter Check cannot occur in a read backward operation.

3.2.2 Sense Byte 1.

Bit	*Designation*	*Interpretation*
0	Noise	Noise is set when: (1) A Data Check occurs during a 6250 CPI or 1600 CPI read or read backward operation. (2) No data is transferred on a read or read backward operation. (3) Data is detected on an erase operation. (4) Data is detected during the erase portion of a write tape mark operation.
1	TU Status A	TU status A is set when an addressed magnetic tape unit is selected, ready, and not busy.
2	TU Status B	TU status B is set when an addressed magnetic tape unit is rewinding, is under the control of another tape control unit, or is not ready. Assuming no outstanding device end status, bits 1 and 2 determine response to initial selection as follows:

TU Status A	TU Status B	TU Status	Response to Initial Selection*
Off	Off	Non-existent	Unit Check**
Off	On	Not ready, arm For Device End	Unit Check**
On	Off	Ready and not rewinding	Status with no error
On	On	Ready and Rewinding or in use by another tape control unit or alternate channel	Busy

* If the stack status flag is off and no Device End is outstanding.
** Unit Check is not signaled for a sense operation. Following a Unit Check (due to Non-existent or Not ready) or Busy indication, Device End is signaled when the magnetic tape unit becomes ready and is not rewinding or not in use by another tape control unit or alternate channel.

3	Seven Track	Seven Track is set when the selected magnetic tape unit has the seven-track feature.
4	Load Point	Load Point is set when the selected magnetic tape unit is at the beginning of a tape.
5	Write Status	Write Status is set when the selected magnetic tape unit is in write status.
6	File Protect	File Protect is set when the selected magnetic tape unit is in file protect status.
7	Not Capable	Not Capable is set when: (1) Leaving load point on a Read or Forward Space command and the magnetic tape unit feature, tape control unit feature, and tape format do not agree. Tape motion is halted. Channel End, Device End, and Unit Check are presented in the termination status byte for Read operations, and Control Unit End, Device End, and Unit Check are presented for Forward Space operations. (2) On a write or read operation if the density of the magnetic tape unit does not match the capability of the tape control unit.

3.2.3 Sense Byte 2 (Track In Error). This sense byte contains the track-in-error (TIE) indicator bits that are set at the end of a Read, Read Backward, Write, or Loop-Write-To-Read (LWR) command.

Nine-track NRZI operation.

(1) For Write or LWR operations bits 6 and 7 are set.
(2) For read or read backward operations.
  (a) A single bit and Data Check indicate the track in error.
  (b) Bits 6 and 7 with Data Check indicate an uncorrectable error pattern.
  (c) Bits 6 and 7 without Data Check indicate normal operation.

Seven-track operation.

During seven-track read or read backward operations, the track-in-error byte is used for magnetic tape unit sense level control. The values are:

Interpretation	*TIE*
Normal—no read VRC error	00
1st read VRC error	80
2nd read VRC error	40
3rd error will return to normal and continue to cycle as shown above.	

3.2.4 Sense Byte 3 (Data and Equipment Checks).

Bit	*Designation*	*Interpretation*
0	Read/Write Vertical Redundancy Check	R/W VRC is set: 6250 When in error correction mode and the track(s) in error cannot be found. 1600 When there is a VRC error without a dead track or phase error. NRZI When a VRC occurred during a read or read backward operation or a missing byte is detected. Also set on a seven-track write operation if a missing byte is detected.
1	Multiple Track Error/ Longitudinal Redundancy Check	Set as follows: 6250/1600 When multiple tracks in error are detected. NRZI When a Longitudinal Redundancy Check occurred during a read, read backward, write, or write tape mark operation.
2	Skew Error	Set when excessive skew was detected on a 6250 CPI or 1600 CPI write, read, or read backward operation or an NRZI write operation. Set in 6250/1600 CPI mode if a track fails to start.
3	End Data Check/Cycle Redundancy Check	Set for the following: 1600 CPI read operations if the ending marker is not detected, or if the postamble has less than six or more than 50 bytes. All write operations when a CRC error occurs. 6250 or 800 CPI nine-track read operations when a CRC error occurs.

4	Envelope/Error Correction Check	ENV/ECC is set for the following: 6250 When any track signal falls below the threshold on a read or write operation. This does not set Data Check. 1600 When there is a phase error or any track falls below the threshold on a read or write operation. This sets Data Check on write only. NRZI When a byte with incorrect parity is detected during a write or write tape mark operation.
5	1600 CPI set in TU	Set when the selected magnetic tape unit is in phase-encoded mode.
6	Backward	Set when the selected magnetic tape unit is in backward status.
7	C/P Compare	Set when hardware logic detects an internal parity error. Also set in seven-track NRZI if correct parity (odd or even) is not maintained by the tape control unit as follows: (a) With translator and data converter both off if parity within a byte changes within the tape control unit during read or write. (b) With data converter on and translator off on read operations if the parity of a group of four BCD characters changes within the tape control unit. (c) With data converter on and translator off during write operations if the parity of a group of three 8-bit character bytes changes within the tape control unit. NOTES: (1) Bus Out Parity Error or MTE can cause a C/P Compare error. (2) Data Converter Check blocks C/P Compare if DCC occurs first.

3.2.5 Sense Byte 4.

Bit	*Designation*	*Interpretation*
0	Spare	
1	Reject Tape Unit	Reject Tape Unit is set if the selected magnetic tape unit becomes not-ready during execution of a tape motion command.
2	Tape Indicate	Tape Indicate is set whenever the end-of-tape marker is sensed during a forward tape operation.
3	Write Driver Error	Write Driver Error is set if an error in the data being written by the write drivers is detected.
4	Spare	
5	Loop-Write-To-Read	Set when the last command was a Loop-Write-To-Read.
6	Tape Unit Check	Set to indicate certain magnetic tape unit errors (e.g., loss of column vacuum, write or erase head failure, etc.).
7	Spare	

3.2.6 Sense Byte 5.

Bit	*Designation*	*Interpretation*
0	Spare	
1	Spare	
2	Write Tape Mark Check	Set when a tape mark is not written properly.
3	ID Burst Check	Set if the 6250 CPI or PE identification burst is not written correctly following load point. May be set if sense byte 8, bit 4, is set.
4	Start Read Check	Set when beginning of data is not recognized.
5	Partial Record	Set when IBG appears before end of data is recognized.
6	Postamble Error	Set when a postamble error is detected.
7	Spare	

3.2.7 Sense Byte 6 (Magnetic Tape Unit).

Bit	*Designation*	*Interpretation*
0	Seven-Track Tape Unit	Set when the selected tape unit is a seven-track unit.
1	Write Current Failure	Indicates that one or more write drivers have been turned on or write bias current is flowing while the magnetic tape unit is in read status.
2	Dual Density	Set when the selected magnetic tape unit is capable of 1600 and 800 CPI operation or the selected magnetic tape unit is capable of 6250 and 1600 CPI operation.
3	Not Set to 1600 CPI	This bit indicates the mode of the magnetic tape unit in the following manner: Bit 3 on: 7-track or 9-track NRZI or 6250 CPI GCR Bit 3 off: 1600 CPI
4-7	Tape Unit Model Identification	Present to indicate unique model identification information in the following manner: Bit 4 on: 6250/1600 CPI Bit 4 off: 1600/800 CPI Bits 5, 6, 7 off, on, on: 75 ips on, off, off: 125 ips on, off, on: 200 ips

3.2.8 Sense Byte 7 (Magnetic Tape Unit READY-Drop Source).

Bit	*Designation*	*Interpretation*
0	Lamp Failure	When set indicates that one of the sensor lamps has failed.
1	Tape Bottom Left	When set indicates that the tape bottomed in the left column.
2	Tape Bottom Right	When set indicates that the tape bottomed in the right column.
3	Reset Key	When set indicates that the magnetic tape unit is not ready because RESET was pressed, or the door interlock was opened, after the unit had been in a start condition.
4	Data Security Erase	Indicates that a DSE is in process or was being performed. This bit will not be on at normal completion of DSE (magnetic tape unit reached the EOT marker).
5	Erase Head Failure	No erase head current or write head bias current is flowing in write status or erase head current is flowing while in read status.
6	Air Bearing Pressure	The air bearing and/or the machine reel hub pressure has dropped below a critical level.
7	Load Failure	The magnetic tape unit failed to load properly.

3.2.9 Sense Byte 8 (Tape Control Unit Detected Errors).

Bit	*Designation*	*Interpretation*
0	IBG Detected	Set if, when writing 6250 or 1600 CPI, IBG is detected while writing the data portion, or the beginning of the record is not detected within a specified time after one track in each zone is detected.
1	Spare	
2	Spare	
3	Early Begin Read Back Check	Set if the beginning of the block comes too soon on a write tape mark operation. This bit sets Data Check (1600 CPI) or Equipment Check (6250 CPI).
4	Control Burst Check	Set if the control burst cannot adjust the gain of the individual tracks. May or may not cause an equipment check.
5	Spare	
6	Slow End Read Back Check	Set on write operations if end of data is not detected.

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Bit	*Designation*	*Interpretation*
7	Velocity Retry/ Restart	Set when: (1) Another attempt was necessary on initial Velocity Check on write operation. (2) When a single byte of noise occurred during an NRZI read delay. NOTE: This bit is not an error.

3.2.10 Sense Byte 9.

Bit	*Designation*	*Interpretation*
0	6250 CPI Correction	Set for information only when 1- or 2-track correction was necessary and does not indicate an error.
1	Velocity Change During Write	Set when an excessive velocity change is detected during a write operation.
2	Channel Buffer Check	Set when data into the channel buffer does not match data out of the channel buffer.
3	CRC Error	Set when a CRC error is detected.
4	6250 CPI Tape Control	Set when the tape control unit has capability to read and write 6250 CPI code.
5	Spare	
6	Spare	
7	Tape Control Unit Reserved	Set when the tape control is in reserved status.

3.2.11 Sense Byte 10.

Bit	*Designation*	*Interpretation*
0	Command Status Reject	Set when magnetic tape unit fails to return the proper command status.
1	Spare	
2	Control Status Reject	Set when magnetic tape unit fails to return the proper control status.
3	Write TM or Record Not Detected Block Read Back Check	Set when the record or tape mark written cannot be spaced over.

4	Dynamic Reversal Check	Set when the tape control unit loses control of tape position during dynamic reversal on write.
5	Tach Start Failure	Set when no change is detected in the tachometer status within a specified length of time during start delay.
6	Spare	
7	Velocity Check	Set when the magnetic tape unit does not attain and/or maintain proper velocity during write delay.

3.2.12 Sense Byte 11.

Bit	*Designation*	*Interpretation*
0	Spare	
1	Spare	
2	Spare	
3	Spare	
4	Spare	
5	Spare	
6	Spare	
7	Spare	

3.2.13 Sense Byte 12.

Bit	*Designation*	*Interpretation*
0	Spare	
1	Spare	
2	Spare	
3	Spare	
4	Spare	
5	Spare	
6	Spare	
7	Spare	

3.2.14 Sense Byte 13.

Bit	*Designation*	*Interpretation*
0-1	Tape Control Features	Used to indicate tape control unit features as follows:

Bit	0,	1	
	off,	off:	None of the following
	off,	on:	7-Track NRZI
	on,	off:	9-Track NRZI
	on,	on:	Spare

2-7	Tape Control Unit ID	High order bits of the tape control unit serial number.

3.2.15 Sense Byte 14.

Bit	*Designation*	*Interpretation*
0-7	Tape Control Unit ID	Low order bits of the tape control unit serial number.

3.2.16 Sense Byte 15.

Bit	*Designation*	*Interpretation*
0-7	Magnetic Tape Unit ID	High order bits of the magnetic tape unit serial number.

3.2.17 Sense Byte 16.

Bit	*Designation*	*Interpretation*
0-7	Magnetic Tape Unit ID	Low order bits of the magnetic tape unit serial number.

3.2.18 Sense Byte 17 (Tape Control Features).

Bit	*Designation*	*Interpretation*
0	Tape Control Unit Feature	Set when the tape control unit contains the Channel Switch feature.
1-3	Tape Control Unit Feature	Used to indicate tape control unit features as follows:

Bits	1,	2,	3	
	off,	off,	off:	Spare

off,	off,	on:	2x8 Device Switch Low (Addresses 0-7)*
off,	on,	off:	3x8 Device Switch Low (Addresses 0-7)*
off,	on,	on:	4x8 Device Switch Low (Addresses 0-7)*
on,	off,	off:	Communicator only
on,	off,	on:	2x8 Device Switch High (Addresses 8-F)*
on,	on,	off:	3x8 Device Switch High (Addresses 8-F)*
on,	on,	on:	4x8 Device Switch High (Addresses 8-F)*

4-7	Tape Control Unit Level	Used to indicate the engineering change of the tape control unit.

*The device addresses of magnetic tape units physically attached to this tape control unit.

3.2.19 Sense Byte 18.

Bit	*Designation*	*Interpretation*
0	Power/Check Airflow	Set to indicate when voltage is out of range or cooling air has failed.
1-3	Magnetic Tape Unit Coded	Used for coded form of the magnetic tape unit serial number.
4-7	Magnetic Tape Unit Level	Used to indicate the engineering change level of the magnetic tape unit.

3.2.20 Sense Byte 19.

Bit	*Designation*
0	Primed for Device End Magnetic Tape Unit 7
1	Primed for Device End Magnetic Tape Unit 6
2	Primed for Device End Magnetic Tape Unit 5
3	Primed for Device End Magnetic Tape Unit 4
4	Primed for Device End Magnetic Tape Unit 3
5	Primed for Device End Magnetic Tape Unit 2

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Bit	*Designation*
6	Primed for Device End Magnetic Tape Unit 1
7	Primed for Device End Magnetic Tape Unit 0

3.2.21 Sense Byte 20.

Bit	*Designation*
0	Primed for Device End Magnetic Tape Unit F
1	Primed for Device End Magnetic Tape Unit E
2	Primed for Device End Magnetic Tape Unit D
3	Primed for Device End Magnetic Tape Unit C
4	Primed for Device End Magnetic Tape Unit B
5	Primed for Device End Magnetic Tape Unit A
6	Primed for Device End Magnetic Tape Unit 9
7	Primed for Device End Magnetic Tape Unit 8

3.2.22 Sense Byte 21 (Thread and Load Diagnostics).

Bit	*Designation*
0	LOAD Button Depressed
1	Left Reel Turning
2	Right Reel Turning
3	Tape Present
4	Reels Loaded
5	Load Rewind
6	Load Complete
7	Load Check

3.2.23 Sense Byte 22 (Field Replaceable Unit Identification).

3.2.24 Sense Byte 23 (Field Replaceable Unit Identification).

Appendix A—Error Recovery Procedures

(This Appendix is not a part of the standard, Operational Specifications for Magnetic Tape Subsystems, but are included for information purposes only.)

A.1 General. These error recovery procedures provide guidance for uniform minimum recovery actions independent of operating systems or equipment and describe additional recovery options.

Figure A1 shows checking sequence ("priority") for status and sense bits, and indicates the actions required.

A.1.1 Tape Cleaner Sequence. A tape cleaner sequence moves tape back and forth past the tape cleaner blade to dislodge any contaminants that may be causing read errors. The tape cleaner sequence for a forward read operation is five backspaces, then four forward spaces. For a backward read operation, the sequence is four backspaces, then five forward spaces.

Beginning of Tape: If the beginning of tape (load point) is reached in "n" backspaces during a tape cleaner sequence, reposition tape for a Forward Read with "n minus 2" Forward Spaces. Reposition tape for a Backward Read with "n" Forward Spaces.

Figure A1. Status and Sense Indicator (Bits) Checking Sequence

	Sense Byte			Applicable To:			
Priority	Byte	Bit	Bit Condition	Read	Write	Control	Action
01			Unit Check	X	X	X	II
02	0	3	Equipment Check	X	X	X	X
03	0	2	Bus Out Check	X	X	X	IV
04	0	1	Intervention Required	X	X	X	III
05	0	0	Command Reject	X	X	X	XIII
06	0	5	Overrun	X	X		VII
07	1	4	Load Point	X		X	XII
08	0	4	Data Check	X			V
08	0	4	Data Check		X		VI
08	0	4	Data Check			X	VIII
09	7	4	Data Security Erase			X	XI
11	0	7	Data Converter Check	X			XIII
12	1	7	Not Capable	X	X	X	IX
13	5	3	ID Burst Check		X		XIV

Tape Mark Block: If a tape mark is read during a tape cleaner sequence, ignore the unit exception indication and process the tape mark as a normal block.

A.1.2 Error Documentation. In the event that an operating system provides a means for documentary Magnetic Tape Subsystem errors, the following information should be included:

(1) Message code.

(2) Channel, tape control unit, and magnetic tape unit addresses.

(3) Command in progress when error occurred.

(4) Error condition causing the message.

(5) All status and sense bits.

A.2 Action Requirements.

A.2.1 Terminal Action Ia (With Operator Option). An operating system may provide operator-control options and/or additional programmed error recovery.

If both are defined:

(1) Again attempt the recovery procedure.

(2) Continue to the additional programmed error recovery.

A.2.2 Terminal Action Ib (Without Operator Option). If the additional programmed error recovery is defined, exit to it.

A.2.3 Action II (Unit Check). Issue a sense command (unless already performed), and continue checking as in Figure A1.

A.2.4 Action III (Intervention Required). No Device End in Unit Status: Test for TU Status B (sense byte 1, bit 2). If TU Status B is off, device is "nonexistent." Provide operator message, post completion with error condition, and exit to operating system. See "Terminal Action Ia."

If TU Status B is on, the device is 'not ready.' Provide "operator intervention required" message, and reissue the command when the tape unit has been made ready.

Device End in Unit Status: If the command was Rewind Unload, continue processing. Otherwise, ignore an intervention required condition, and continue checking as indicated in Figure A1.

A.2.5 Action IV (Bus Out Check). No Device End in Unit Status: Reissue the command.

Device End in Unit Status: If error occurs while writing, reposition tape and reissue command. For all other commands, reissue the command. If error persists after six attempts, provide operator message, post completion with error condition, and exit to operating system. See "Terminal Action Ia" and "Supplementary Information."

A.2.6 Action V (Data Check on Read or Read Backward).

(1) Determine if the block should be classified as a noise block (noise block is less than the minimum block length of 12 bytes). If the block is valid data (noise bit on [sense byte 1, bit 0] or block length meets

or exceeds minimum length requirements), attempt another read operation. If the block is a noise record, go to step 4.

(2) Set the correct mode (if seven-track), and reposition tape.

(3) Set the correct mode (if seven-track), and send the track-in-error information (sense byte 2) to the tape control unit with a Request TIE command.

NOTE: For program simplicity, the mode set and Request TIE commands may be issued whether required or not.

(4) Reissue the read or read backward command.

NOTE: No command may be executed between steps 3 and 4, as commands to the tape control unit may destroy the track-in-error and mode set information. When attempting to correct a nine-track block, use only the track-in-error information from that block.

(5) Repeat steps 1 through 4 until the block is read successfully or at least 41 attempts are made. Perform a tape cleaner sequence after every fourth attempt.

(6) If the error persists, determine whether Read Opposite Recovery (ROR) is possible. Read Opposite Recovery is not possible if:

(a) Data chaining is being performed.

(b) Operating in seven-track, data-convert mode (sense byte 1, bit 3 on).

(c) A suppress data transfer option is active for failing read command.

If ROR is not possible, provide error documentation and post completion with an error condition. If ROR is possible, proceed to step 9 (tape is correctly positioned for first ROR attempt). See "Terminal Action Ia" and "Supplementary Information."

(7) Determine if the block should be classified as a noise block. See Action V, step 1.

(8) Set the correct mode (if seven-track), and reposition tape.

(9) Set the correct mode (if seven-track), and send the track-in-error information (sense byte 2) to the tape control unit with a Request TIE command.

(10) Issue a Read command in the opposite direction, ignoring (suppressing) the data transfer.

(11) Repeat steps 7 through 10 until the block is read successfully or at least 41 attempts have been made. If the block is read successfully, determine the number of attempts left and go to step 12. If, after 41 attempts, the Read in the opposite direction is still unsuccessful, go to step 19.

NOTE: After every fourth try, perform a tape cleaner sequence.

(12) If the actual block count is greater than the failing original Read count, go to step 19.

If the actual block count is equal to or less than the failing Read count, compute the correct data address and count for the Read in the opposite direction. Proceed to step 13.

(13) Determine if the block should be classified as a noise block. See Action V, step 1.

(14) Set the correct mode (if seven-track), and reposition tape.

(15) Set the correct mode (if seven-track), and send the track-in-error information (sense byte 2) to the tape control unit with a Request TIE command (if nine-track).

(16) Issue the Read in the opposite direction with the computed address, the count, and ignore the data transfer.

(17) Repeat steps 13 through 16 until the block is read successfully or the remainder of the 41 attempts have been performed. If the block is read successfully, go to step 18. If after attempting 41 tries, the Read in the opposite direction is still unsuccessful, go to step 19.

NOTE: After every fourth try, perform a tape cleaner sequence.

(18) Set the correct mode (if seven-track). Space over the error block, post completion without error condition, and continue with normal processing.

(19) Set the correct mode (if seven-track), and reissue the read or read backward command.

If the error persists, provide an operator message, post completion with error condition, and exit to the operating system. See "Terminal Action Ia" and "Supplementary Information."

A.2.7 Action VI (Data Check On Write and Write Tape Mark). Reposition the tape, issue an Erase Gap (ERG), issue a Mode Set (if seven-track), and reissue the command. For a Write, repeat this procedure until successful or until 15 attempts have been made. If the error persists through 14 retries, go to Step 1.

For a Write Tape Mark, repeat this procedure until successful or until 16 attempts have been made. If the error persists through 16 tries, go to Step 2.

Step 1. Change the failing Write command to a Loop-Write-To-Read command to obtain data for error recording.

The Loop-Write-To-Read command must not be chained from or to any of the commands in the original failing command chain. (Such a chain could cause tape movement and destruction of previously written tape records.)

After the Loop-Write-To-Read has been completed, the error data will be stored in the tape control unit sense data. The failing Write command will be issued to complete the 16th attempt and, if an error occurs, the resulting error data will be recorded.

Step 2. Provide an operator message, post completion with error condition, and exit to the operating system. See "Terminal Action Ia."

NOTE: This action is designed for the maximum length of 32,768 bytes at 800 CPI.

A.2.8 Action VII (Overrun). For a Read Forward, Read Backward, or Write command, reposition tape and reissue the command. If the error persists after six attempts, provide operator message, post completion with error condition, and exit to the operating system. See "Terminal Action Ia" and "Supplementary Information."

A.2.9 Action VIII (Data Check On Control). For a Write Tape Mark, execute Action VI. For an Erase Gap, reissue the command.

If the error persists after four attempts, provide operator message, post completion, and exit to the operating system. See "Terminal Action Ia."

A.2.10 Action IX (Not Capable). Provide operator message, post completion with error condition, and exit to operating system. See "Terminal Action Ia."

A.2.11 Action X (Equipment Check). Equipment Check is valid only if associated with Device End. If tape position is indeterminate, provide error documentation and post completion with the error condition. See "Terminal Action Ia."

A.2.12 Action XI (Data Security Erase). Provide error documentation and post completion with error condition. See "Terminal Action Ia."

A.2.13 Action XII (Load Point). Post completion with check condition. See "Terminal Action Ib" and "Supplementary Information."

A.2.14 Action XIII (Command Reject, Data Converter Check). Provide error documentation and post completion with error condition. See "Terminal Action Ib" and "Supplementary Information."

A.2.15 Action XIV (ID Burst Check on Write, Write Tape Mark, and Erase Gap). Use a Rewind command to reposition the tape and reissue the command.

For a Write, repeat this procedure until successful or until 15 attempts have been made. If error persists through 15 tries, go to step 1.

For a Write Tape Mark or Erase Gap, repeat this procedure until successful, or until 16 attempts have been made. If the error persists through 16 tries, go to step 2.

Step 1. Change the failing Write command to a Loop-Write-To-Read command to obtain data for error recording.

The Loop-Write-To-Read command must not be chained from or to any of the commands in the original failing command chain. (Such a chain could cause tape movement and destruction of previously written tape records.)

After the Loop-Write-To-Read has been completed, the error data will be recorded. The failing Write command will be issued to complete the 16 attempts and, if an error occurs, the resulting error data will be recorded.

Step 2. Provide an error documentation and post completion with error condition. The error documentation should indicate that the probable cause of the permanent error is a bad spot on the tape media in the area where the ID Burst must be written.

A.3 Supplementary Information. Bus Out, Overrun, Data Check on Read or Write: Additional programmed recovery might include alternate path retry.

Load Point: Normally, load point is used as a data set delimiter and, thus, is provided for in the additional programmed recovery. If load point is an unexpected condition and causes abnormal termination, provide suitable comment regarding the source of the termination.

Data Converter Check: This check occurs on binary tapes not generated by the data converter feature and is used to adjust the final bytes of the block. Normally, the additional programmed recovery provides for this condition.

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[Docket No. 900101-0219]

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Approval of Revisions to Federal Information Processing Standards (FIPS) Family of Input/Output Interface Standards

AGENCY: National Institute of Standards and Technology (NIST), Commerce.

ACTION: The purpose of this notice is to announce that the Secretary of Commerce has approved revisions to the Federal Information Processing Standards (FIPS) family of input/output interface standards, and has approved discontinuation of the exclusion and verification lists for these standards.

SUMMARY: On March 20, 1990, notice was published in the Federal Register (55 FR 10272) proposing revision of Federal Information Processing Standards (FIPS) 60-2, 61-1, 62, 63-1, 97, 111, 130, and 131 to make them non-mandatory, and discontinue the exclusion and verification lists for these standards. This proposal superseded the proposal for revision of these standards announced in the Federal Register (52 FR 44462) of November 19, 1987. Procedures for the Exclusion List for FIPS 60, 61, 62, 63, and 97 were published in the Federal Register on

connected to small and medium sized computer systems, when it is determined that interchange of equipment between different systems is likely.

Implementation. This standard became effective May 18, 1985. This revision becomes effective December 18, 1990.

Waivers. This standard is non-mandatory. No waivers are required.

FIPS 130, Intelligent Peripheral Interface (IPI), is revised as follows:

Section 8, Applicability. This standard applies to the connection of computers to storage peripheral device controllers. This standard is recommended for use in the acquisition of magnetic disk drives, optical disk drives, and tape drives to be connected to minicomputer systems, when it is determined that interchange of equipment between different systems is likely.

Section 10, Implementation. This standard became effective December 16, 1987. This revision becomes effective December 18, 1990.

Section 11, Waivers. This standard is non-mandatory. No waivers are required.

FIPS 131, Small Computer System Interface (SCSI) is revised as follows:

Section 8, Applicability. This standard addresses the connection of small computers to peripheral devices with integral controllers. This standard is recommended for use in the acquisition of storage peripherals and small computer systems for office or laboratory use, when it is determined that interchange of equipment between different systems is likely.

Section 10, Implementation. This standard became effective December 16, 1987. This revision becomes effective December 18, 1990.

Section 11, Waivers. This standard is non-mandatory. No waivers are required.

Dated: December 12, 1990.

John W. Lyons,

Director.

[FR Doc. 90-29563 Filed 12-17-90; 8:45 am]

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