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AIIM MS58-1996

STANDARD

Standard Recommended Practice

for Implementation of Small

Computer Systems Interface (SCSI-2),

(X3.131-1994) for Scanners

AIIM MS58-1996

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Standard for Information and Image Management —

Standard Recommended Practice for Implementation of Small Computer Systems Interface (SCSI-2), (X3.131-1994) for Scanners

Association for Information and Image Management International

Abstract:

The purpose of this standard recommended practice is to assist document scanner designers in devising a common implementation of the SCSI-2 interface standard, (American National Standard X3.131-1994). This standard specifies the physical and logical implementation of ANSI X3.131-1994.

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Foreword (This foreword is not part of the American National Standard for Information and Image Management ANSI/AIIM MS58-1996 — Standard Recommended Practice for Implementation of Small Computer Systems Interface (SCSI-2), (X3.131-1994) for Scanners.)

The purpose of this standard recommended practice is to assist document scanner designers in devising a common implementation of the SCSI-2 interface standard (American National Standard X3.131-1994). The consumer will benefit from a common implementation of SCSI-2 by a reduction in the number of non-compatible SCSI microcode implementations within SCSI-2 scanners, and the manufacturer will benefit by a reduction in the amount of microcode and software needed to deal with multiple applications.

Annex A, an informative annex, is included in this standard recommended practice to give guidance in regard to advanced features and possible future extensions to the SCSI-2 standard. Annex A provides implementation details on features not supported under the SCSI-2 standard.

This document is designed to be used with the TWAIN specification for scanners (Hewlett Packard Document 3129, 1992). The TWAIN specification gives details of a standard software driver for scanners. For information about the TWAIN specification, see clause 2.

This standard recommended practice is based upon the SCSI-2 interface standard (ANSI X3.131-1994), which was approved in January of 1994. ANSI/AIIM MS58 contains the text and figures from chapter 5 and chapter 15 of the SCSI-2 standard. These text and figures have been excerpted from ANSI X3.131 by permission of the X3 Secretariat, ITI, 1250 Eye Street, N.W., Washington, D.C. 20005. ANSI X3.131 was developed by Technical Committee X3T10. The only changes to the original SCSI-2 standard in this document have been the elimination of some connector and termination options in chapter 5 and the addition

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of the specification of Mandatory for several commands in chapter 15 that are listed as optional in the SCSI-2 standard.

No technical or command changes to ANSI X3.131-1994 have been made.

This document is designed to be used in conjunction with the complete text of the ANSI X3.131. ANSI X3.131 provides a complete explanation of common SCSI parameters, such as the message system. For further assistance in understanding the basic principals of SCSI, the reader is advised to contact one of the many SCSI-2 interface chip manufacturers (ex. Symbios Logic, Adaptec, Fujitsu, Q-Logic, Western Digital, etc.) or ENDL. Each of these companies offer tutorial style documents on SCSI.

Suggestions for improvement of this standard recommended practice are welcome. They should be sent to the Chair of the AIIM Standards Board, Association for Information and Image Management International, 1100 Wayne Avenue, Suite 1100, Silver Spring, MD 20910-5603.

The AIIM Standards Board had the following members at the time it approved this standard recommended practice:

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At the time it developed and approved this standard recommended practice, the C8 committee had the following members:

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American National Standard for Information and Image Management —

Standard Recommended Practice for Implementation of Small Computer Systems Interface (SCSI-2), (X3.131-1994) for Scanners, ANSI/AIIM MS58-1996

1 Audience, scope, purpose, and exclusions

1.1 Audience

This document is intended for designers of scanners and scanner controllers that will use the SCSI-2 interface (described in ANSI X3.131) to connect to systems. It is expected that these designers will create a complete scanner subsystem that will include, but not be limited to, the SCSI-2 interface.

1.2 Scope

This standard recommended practice is independent of image scan architecture, the scan methodology and technology. The intent of the document is to give guidance to the designer regarding cables, connectors, and terminators, and a minimum set of SCSI-2 commands so as to achieve a greater chance for multiple product interoperability. Annex A, an informative annex, is included to give guidance in regard to advanced features and possible future extensions to ANSI X3.131. Annex A provides implementation details on features not supported under ANSI X3.131.

1.3 Purpose

The purpose of this standard recommended practice is to assist document scanner designers in devising a common implementation of ANSI X3.131, Small Computer System Interface-2. The consumer will benefit from a common implementation of SCSI-2 by a reduction in the number of non-compatible SCSI microcode implementations within SCSI-2 scanners, and the manufacturer will benefit by a reduction in the amount of microcode and software needed to deal with multiple applications.

This document cannot address all possible needs of scanner designers, so it is expected that the individual designer may elect to implement one or more options present in ANSI X3.131, or even to make use of the Vendor Unique Features described throughout that standard. If the minimum SCSI-2 command set for scanners described herein is used as a base from which to build unique product applications, the intent and purpose of this standard recommended practice will be served.

1.4 Exclusions

This standard recommended practice does not address system software drivers for scanners. For information on how to make common system software drivers, the reader is encouraged to refer to the TWAIN specification.

2 References

All standards are subject to revision. When the following documents are superseded by an approved revision, that revision may apply.

2.1 Referenced American national standards

ANSI X3.131-1994 — Information systems — Small Computer System Interface-2 (SCSI-1).

ANSI X3.131-1986 — Information Systems — Small Computer System Interface-1 (SCSI-2).[1]

EIA RS-485-1983, Standard for electrical characteristics of generators and receivers for use in balanced digital multipoint systems.

2.2 Other referenced documents

H-P Document 3129, 1992, TWAIN specification, Release v. 1.5.

ANSI/AIIM TR2-1992, Technical Report for the Association for Information and Image Management — Glossary of imaging technology.

3 Definitions

The following definitions apply to terms that appear in this standard. Other terms are defined in *ANSI/AIIM TR2, Technical Report for Information and Image Management — Glossary of imaging technology.*

3.1 base element line: An x-axis displacement equal to zero.

3.2 base line: A y-axis displacement equal to zero.

3.3 beginning-of-medium: An x-axis and y-axis of zero displacement. Alternatively this is being positioned at the intersection of the base and scan lines.

3.4 end-of-medium: The maximum x-axis and y-axis displacement.

3.5 image: The digital result of a scan.

3.6 object: The original or item being scanned.

3.7 pixel: Picture-element, the smallest photo sight in the array.

1.This standard has been superceded and may not be available.

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3.8 platen: The surface in which the target is positioned.

3.9 scan: An operation that generates a digital image from the reflected light of an object.

3.10 scan line: A y-axis displacement from the base line.

3.11 scanning range: The total area that a scanner can generate an image from. For two dimensional objects, this may correspond to the largest object that can be scanned.

3.12 window: All or part of the scanning range of a scanner. A window defines the part of the object scanned.

4 Physical characteristics

This clause corresponds to clause 5 of ANSI X3.131 and contains the physical definition of SCSI-2 for use with scanners. The connectors, cables, signals, terminators, and bus timing values needed to implement the interface are covered.

4.1 Physical description

SCSI devices are daisy-chained together using a common 50-conductor cable for 8-bit parallel transfers. Both ends the cable are terminated. All signals are common between all SCSI devices on the cable.

Implementor's note: Committee X3T10 is documenting an alternate 16-bit single-cable solution and an alternate 32-bit solution and expects to release them in a future SCSI standard.

Two driver/receiver alternatives are specified:

1. Single-ended drivers and receivers, which allow a maximum cable length of 6 meters (primarily for connection within an enclosure).
2. Differential drivers and receivers, which allow a maximum cable length of 25 meters.

The single-ended and differential alternatives are mutually exclusive on the same physical bus.

Implementor's note: Use of single-ended drivers and receivers with the fast synchronous data transfer option is not recommended.

4.2 Cable requirements

The characteristic impedance of the cable should be no less than 90 Ω and no greater than 140 Ω The characteristic impedance of the cable used when implementing the fast synchronous data transfer option is defined in 4.2.3.

Note: There are successful single-ended implementations using cables with less than 90 Ω characteristic impedance. However, system integrity in single-ended implementations is improved when the characteristic impedance of the cable is greater than 90 Ω. Cable parameters other than characteristic impedance are critical to system integrity. The X3T10 Committee is investigating alternative ways to specify cable parameters as a part of a future version of SCSI.

A minimum conductor size of 0.08042 square mm (28 AWG) should be used to minimize noise effects and ensure proper distribution of terminator power.

Implementor's notes:
To minimize discontinuities and signal reflections, cables of different impedances should not be used in the same bus. Implementations may require trade-offs in shielding effectiveness, cable length, the number of loads, transfer rates, and cost to achieve satisfactory system operation.

To minimize discontinuities due to local impedance variation, a flat cable should be spaced at least 1.27 mm (0.050 in) from other cables, any other conductor, or the cable itself when the cable is folded.

Regulatory agencies may require use of larger wire size.

4.2.1 Single-ended cable

A 50-conductor flat cable or 25-signal twisted-pair cable shall be used for the cable. The maximum cumulative cable length shall be 6.0 meters. If twisted-pair cables are used, then twisted pairs in the cable shall be wired to physically opposing contacts in the connector.

A stub length of no more than 0.1 meters (3.9 inches) is allowed off the mainline interconnection within any connected equipment or from any connected point.

Implementor's note: Stub clustering should be avoided. Stubs should be spaced at least 0.3 meters (12 inches) apart.

SCSI bus termination shall be at each end of the cable and may be internal to the SCSI devices that are at the ends of the cable.

4.2.2 Differential cable

A 50-conductor flat cable or 25-signal twisted-pair cable shall be used for the cable. The maximum cumulative cable length shall be 25 meters. If twisted-pair cables are used, then twisted pairs in the cable shall be wired to physically opposing contacts in the connector.

A stub length of no more than 0.2 meters (8 inches) is allowed off the mainline interconnection within any connected equipment or from any connected point.

SCSI bus termination shall be at each end of the cable and may be internal to the SCSI devices that are at the ends of the cable.

Implementor's note: The use of twisted pair cable (either twisted-flat or discrete wire twisted pairs) is strongly recommended. Without twisted pairs, even at slow data rates and very short distances, crosstalk between adjacent signals causes spurious pulses with differential signals.

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4.2.3 Cable requirements for fast synchronous data transfer

In systems that use the fast synchronous data transfer option (see 4.8), the cable must meet the conductor size recommendation in 4.2. The cable should have an overall shield suitable for termination in a shielded connector.

In such systems, the cables shall have the following electrical characteristics:

Characteristic Impedance: 90 to 132 Ω

Signal Attenuation: 0.095 Db maximum per meter at 5 Mhz

Pair-to-Pair Propagation Delay Delta: 0.20 ns maximum per meter

DC Resistance: 0.230 Ω maximum per meter at 20 degrees C

4.3 Connector requirements

Two types of connectors are defined: non-shielded and shielded. The non-shielded connectors are typically used for in-cabinet applications. Shielded connectors are typically used for external applications where electromagnetic compatibility (EMC) and electrostatic discharge (ESD) protection may be required. Either type of connector may be used with the single-ended or differential drivers.

4.3.1 Nonshielded connector requirements

Two nonshielded connector alternatives are specified for the cable.

4.3.1.1 Non-shielded connector alternative 1 The alternative 1 non-shielded high-density SCSI device connector, (figure 1) shall be a 50-conductor connector consisting of two rows of 25 female contacts with adjacent contacts 1.27 mm (0.05 in) apart. The non-mating portion of the connector is shown for reference only.

The alternative 1 non-shielded high-density cable connector, (figure 2) shall be a 50-conductor connector consisting of two rows of 25 male contacts with adjacent contacts 1.27 mm (0.05 in) apart. The non-mating portion of the connector is shown for reference only.

4.3.1.2 Non-shielded connector alternative 2 The alternative 2 non-shielded low-density SCSI device connector, (figure 3) shall be a 50-conductor connector consisting of two rows of 25 male pins with adjacent pins 2.54 mm (0.1 in) apart. A shroud and header body should be used. The non-mating portion of the connector is shown for reference only.

The alternative 2 non-shielded low-density cable connector, (figure 4) shall be a 50-conductor connector consisting of two rows of 25 female contacts with adjacent contacts 2.54 mm (0.1 in) apart. It is recommended that keyed connectors be used.

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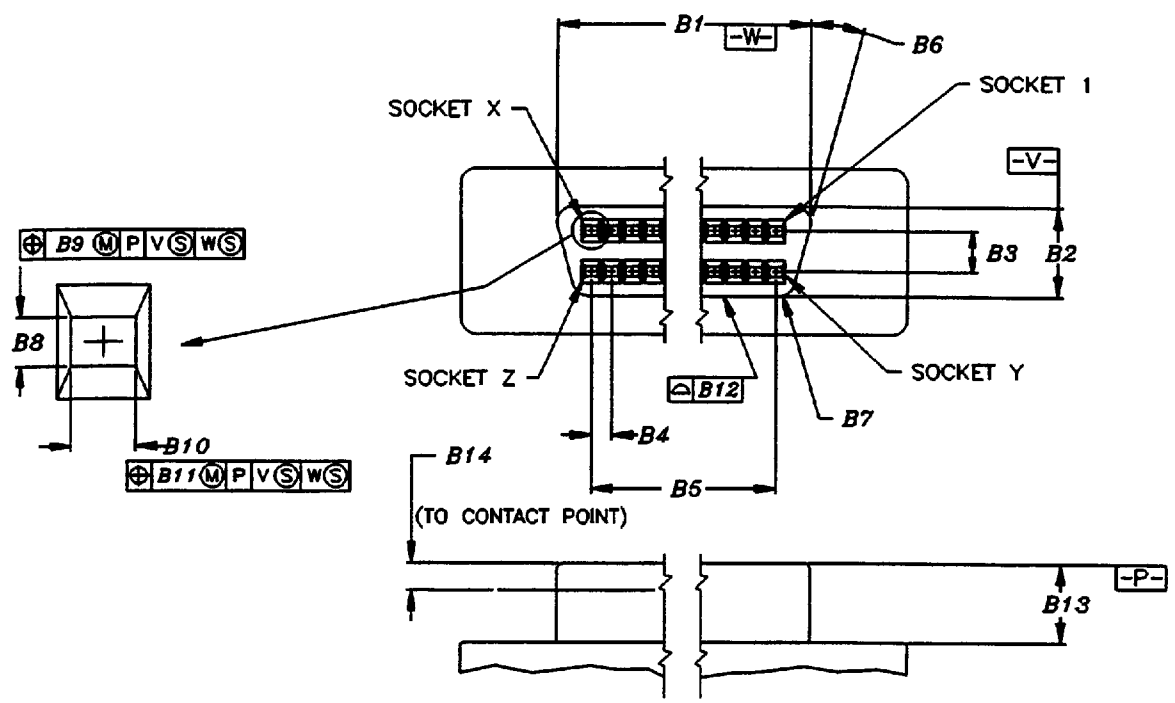

Dimensions	50 Position		68 Position	
	mm	in	mm	in
B1	34,70	1,366	46,13	1,816
B2	5,54	0,218	5,54	0,218
B3	2,54	0,100	2,54	0,100
B4	1,27	0,050	1,27	0,050
B5	30,48	1,200	41,91	1,650
B6	15°	15°	15°	15°
B7	1,00 R	0,039 R	1,00 R	0,039 R
B8	0,61±0,05	0,024±0,002	0,61±0,05	0,024±0,002
B9	0,15	0,006	0,15	0,006
B10	0,86±0,10	0,034±0,004	0,86±0,10	0,034±0,004
B11	0,15	0,006	0,15	0,006
B12	0,05	0,002	0,05	0,002
B13	5,00±0,13	0,197±0,005	5,00±0,13	0,197±0,005
B14	1,75 max.	0,069 max.	1,75 max.	0,069 max.
Socket X	25		34	
Socket Y	26		35	
Socket Z	50		68	

NOTE: Dimensions *B8* and *B10* are the opening in the dielectric. The socket contacts (not shown) fit wthin the opening.

Figure 1 — 50/68-contact non-shielded high-density SCSI device connector
(This figure corresponds to figure 1 in ANSI X3.131.)

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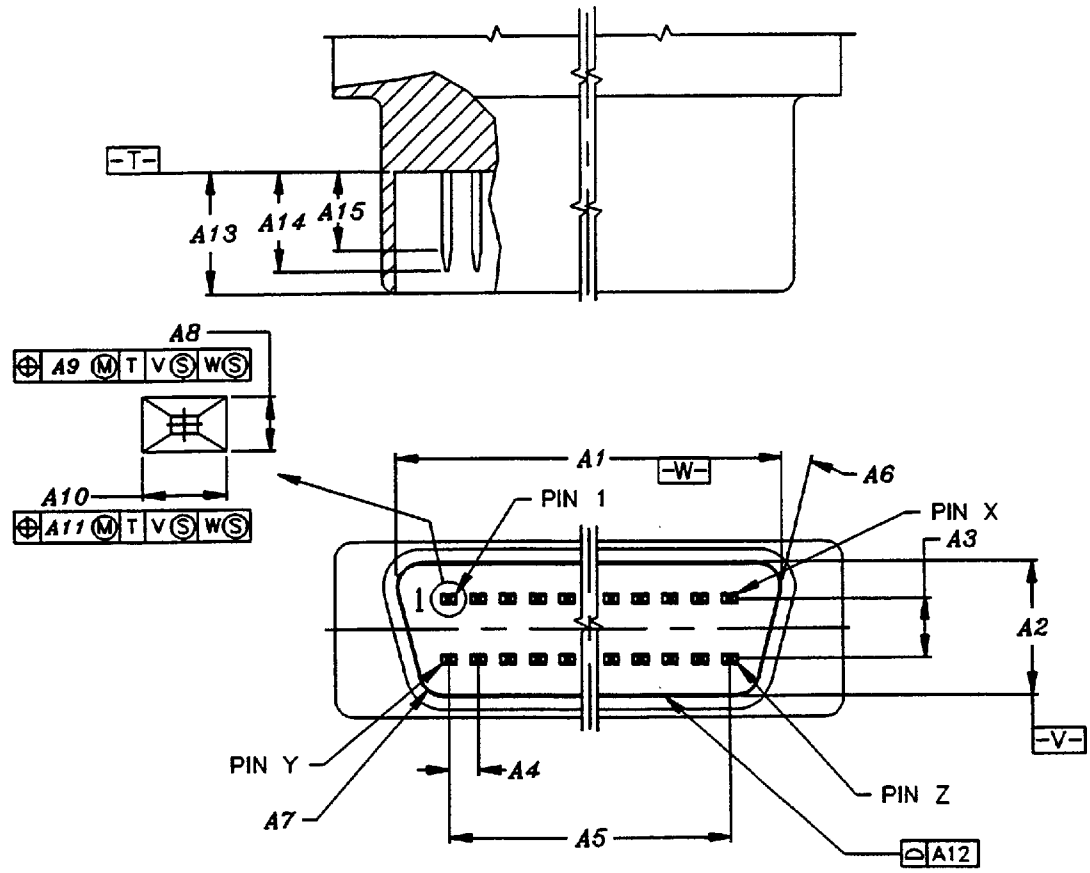

Dimensions	50 Position		68 Position	
	mm	in	mm	in
A1	34,85	1,372	46,28	1,822
A2	5,69	0,224	5,69	0,224
A3	2,54	0,100	2,54	0,100
A4	1,27	0,050	1,27	0,050
A5	30,48	1,200	41,91	1,650
A6	15°	15°	15°	15°
A7	1,04 R	0,041 R	1,04 R	0,041 R
A8	0,40± 0,010	0,0156± 0,0004	0,40± 0,010	0,0156± 0,0004
A9	0,23	0,009	0,23	0,009
A10	0,60± 0,03	0,024± 0,001	0,60± 0,03	0,024± 0,001
A11	0,23	0,009	0,23	0,009
A12	0,05	0,002	0,05	0,002
A13	5,15± 0,15	0,203± 0,006	5,15± 0,15	0,203± 0,006
A14	4,39 max.	0,173 max.	4,39 max.	0,173 max.
A15	3,02 min.	0,119 min.	3,02 min.	0,119 min.
Pin X	25		34	
Pin Y	26		35	
Pin Z	50		68	

Figure 2 — 50/68-contact non-shielded high-density cable connector
(This figure corresponds to figure 2 in ANSI X3.131.)

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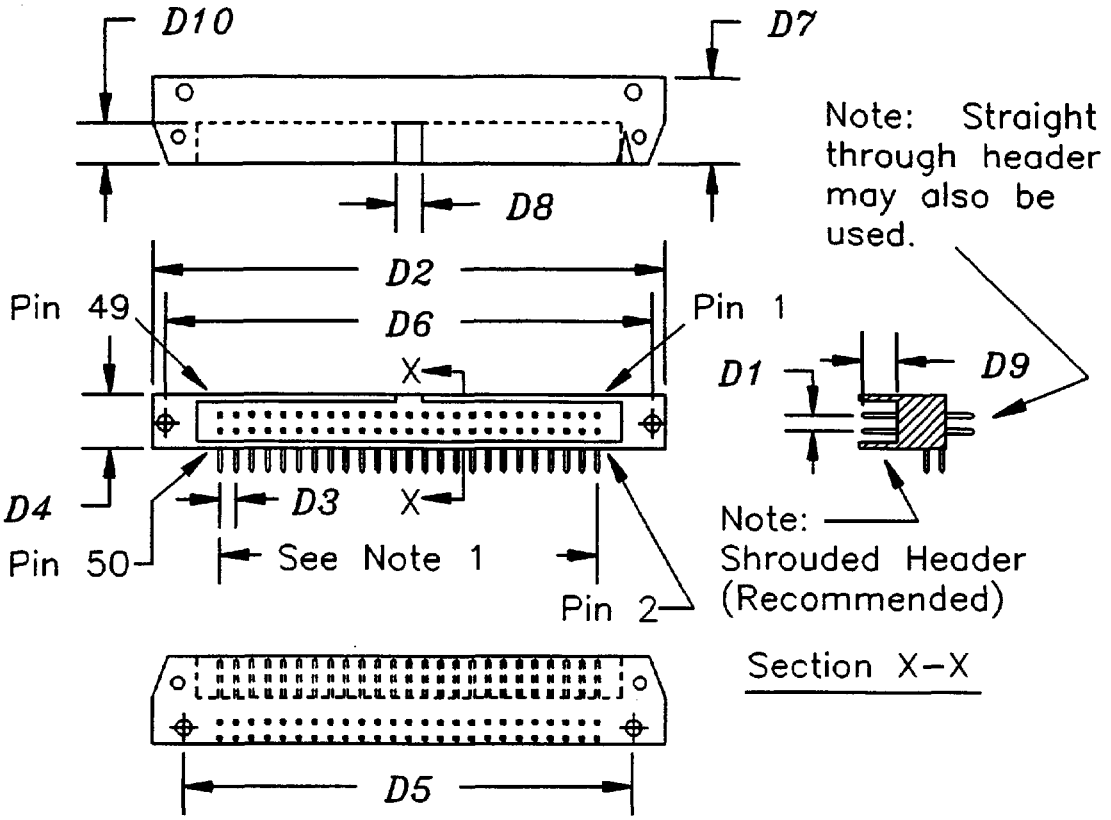

Dimension	mm	in	Comments
D1	2,54	0,100	
D2	82,80	3,260	Reference Only
D3	2,54	0,100	
D4	8,89	0,350	Reference Only
D5	72,64	2,860	Reference Only
D6	78,74	3,100	Reference Only
D7	13,94	0,549	Reference Only
D8	4,19±0,25	0,165±0,010	
D9	6,09	0,240	
D10	6,60	0,260	Reference Only

NOTES
1 Two rows of twenty five contacts on 2,540 mm (0,100 in) spacing = 60,960 mm (2,400 in).
2 Tolerances ±0,127 mm (0,005 in) non–cumulative, unless specified otherwise.

Figure 3 — 50-contact non-shielded low-density SCSI device connector (A cable)
(This figure corresponds to figure 3 in ANSI X3.131.)

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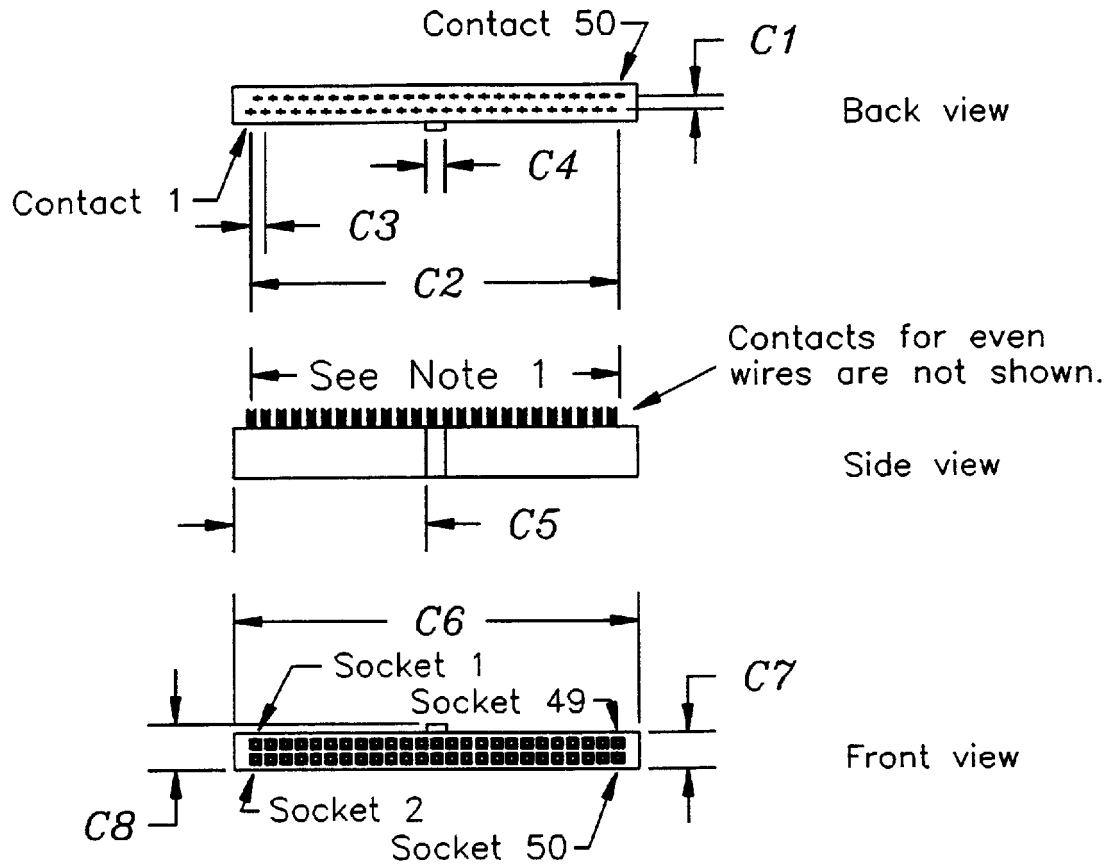

Dimensions	mm	in	Comments
C1	2,54	0,100	
C2	60,96	2,400	
C3	2,54	0,100	
C4	3,30	0,130	
C5	32,38	1,275	
C6	68,07	2,680	
C7	6,10	0,240	
C8	7,62	0,300	Maximum

NOTES

1 Fifty contacts on 1,270 mm (0,050 in) staggered spacing = 62,230 mm (2,450 in) [reference only].

2 Tolerances ±0,127 mm (0,005) non-cumulative, unless specified otherwise.

3 Connector cover and strain relief are optional.

Figure 4 — 50-contact non-shielded low-density cable connector (A cable)
(This figure corresponds to figure 4 in ANSI X3.131.)

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4.3.2 Shielded connector requirements
Two shielded connector alternatives are specified for the cable. The connector shielding system should provide a d.c. resistance of less than 10 mΩ from the cable shield at its termination point to the SCSI device enclosure.

In order to support daisy-chain connections, SCSI devices that use shielded connectors should provide two shielded device connectors on the device enclosure. These two connectors may be wired "one-to-one" with a stub to the SCSI device's drivers and receivers, provided the maximum stub length is not violated. Alternatively, two cables may be run from the two shielded connectors to the drivers and receivers so that the maximum stub length is not violated. The length of the cable within the device enclosure is included when calculating the total cable length of the SCSI bus.

4.3.2.1 Shielded connector alternative 1 The shielded high-density SCSI device connector, (figure 5) is a 50-conductor connector consisting of two rows of 25 female contacts with adjacent contacts 1.27 mm (0.05 in) apart. The non-mating portion of the connector is shown for reference only.

The shielded high-density cable connector, (figure 6) is a 50-conductor connector consisting of two rows of 25 male contacts with adjacent contacts 1.27 mm (0.05 in) apart. The non-mating portion of the connector is shown for reference only.

4.3.2.2 Shielded connector alternative 2 The shielded low-density device connector, (figure 7) is a 50-conductor connector consisting of two rows of ribbon contacts spaced 2.16 mm (0.085 in) apart. The non-mating portion of the connector is shown for reference only.

The shielded low-density cable connector for the A cable (figure 8) is a 50-conductor connector consisting of two rows of ribbon contacts spaced 2.16 mm (0.085 in) apart. The non-mating portion of the connector is shown for reference only.

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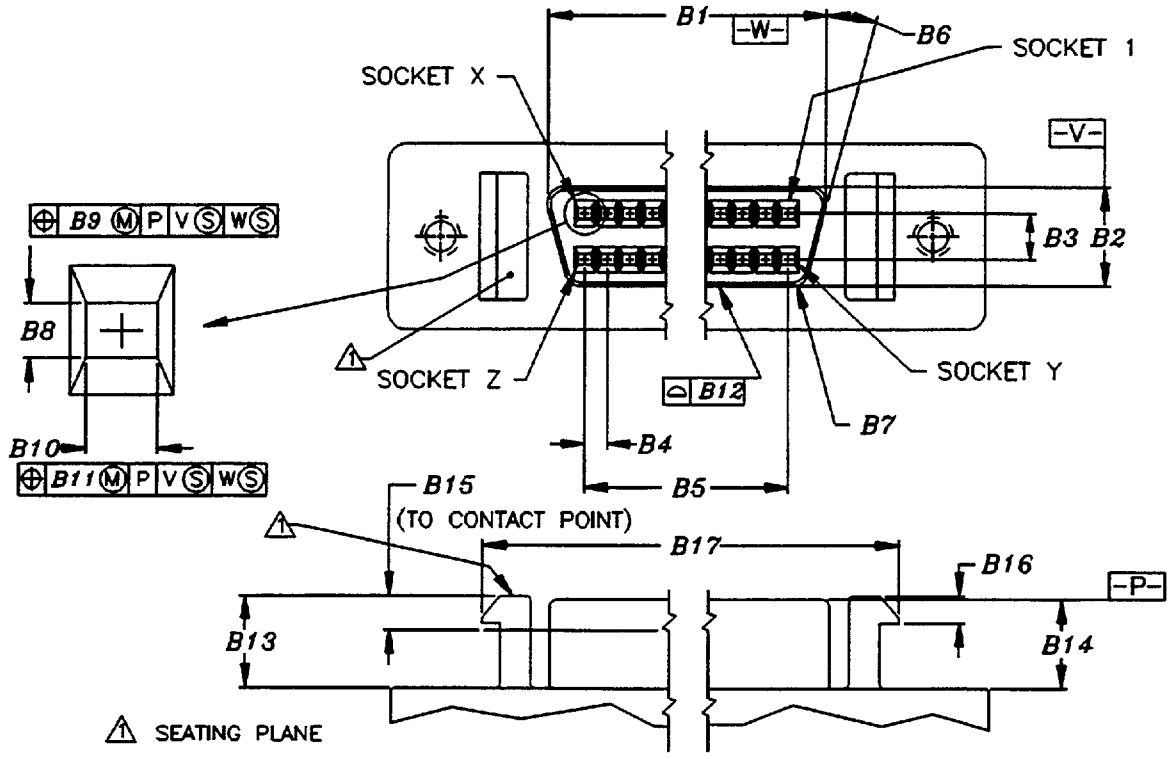

Dimensions	50 Position		68 Position	
	mm	in	mm	in
B1	34,70	1,366	46,13	1,816
B2	5,54	0,218	5,54	0,218
B3	2,54	0,100	2,54	0,100
B4	1,27	0,050	1,27	0,050
B5	30,48	1,200	41,91	1,650
B6	15°	15°	15°	15°
B7	1,00 R	0,039 R	1,00 R	0,039 R
B8	0,61±0,05	0,024±0,002	0,61±0,05	0,024±0,002
B9	0,15	0,006	0,15	0,006
B10	0,86±0,10	0,034±0,004	0,86±0,10	0,034±0,004
B11	0,15	0,006	0,15	0,006
B12	0,05	0,002	0,05	0,002
B13	5,10±0,05	0,201±0,002	5,10±0,05	0,201±0,002
B14	5,00±0,13	0,197±0,005	5,00±0,13	0,197±0,005
B15	1,85 max.	0,073 max.	1,85 max.	0,073 max.
B16	1,50±0,03	0,059±0,001	1,50±0,03	0,059±0,001
B17	42,29±0,10	1,665±0,004	53,72±0,10	2,115±0,004
Socket X	25		34	
Socket Y	26		35	
Socket Z	50		68	

NOTE – Dimensions *B8* and *B10* are the opening in the dielectric. The socket contacts (not shown) fit within the opening.

Figure 5 — 50/68-contact shielded high-density SCSI device connector
(This figure corresponds to figure 5 in ANSI X3.131.)

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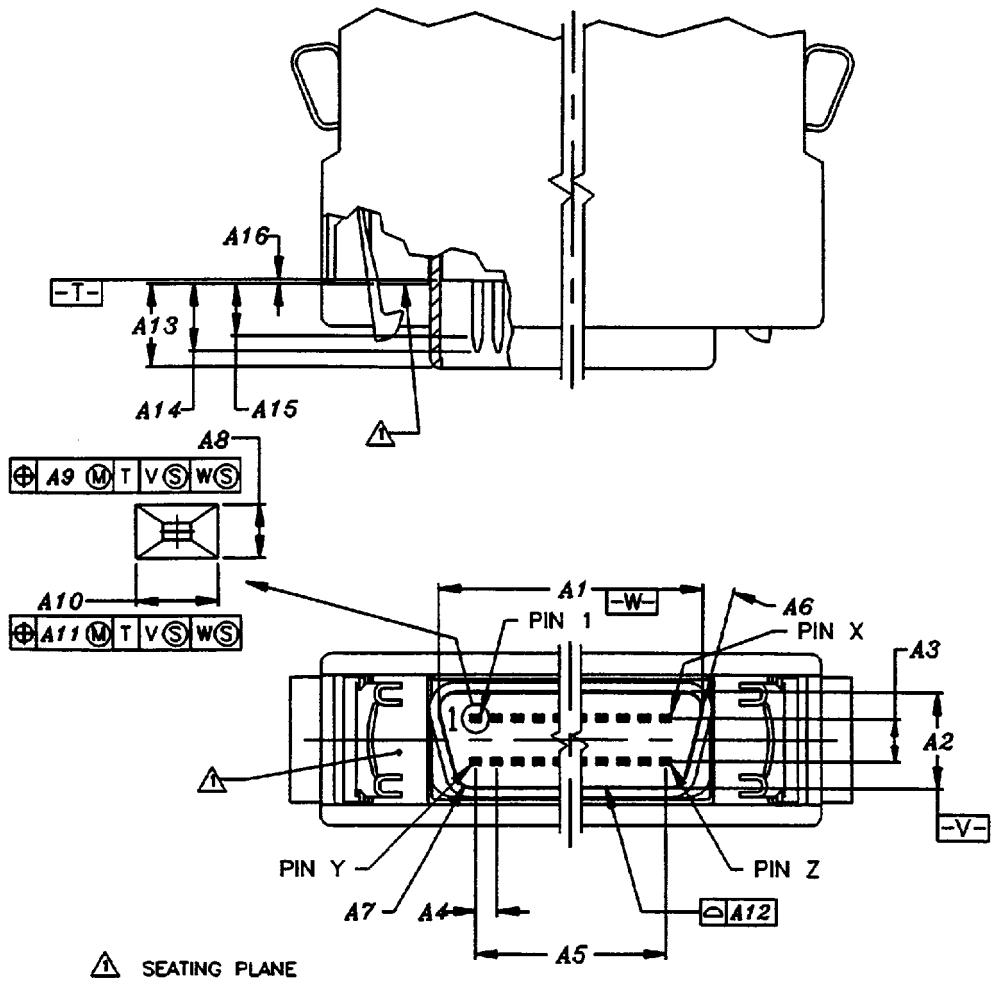

Dimensions	50 Position		68 Position	
	mm	in	mm	in
A1	34,85	1,372	46,28	1,822
A2	5,69	0,224	5,69	0,224
A3	2,54	0,100	2,54	0,100
A4	1,27	0,050	1,27	0,050
A5	30,48	1,200	41,91	1,650
A6	15°	15°	15°	15°
A7	1,04 R	0,041 R	1,04 R	0,041 R
A8	0,40±0,010	0,0156±0,0004	0,40±0,010	0,0156±0,0004
A9	0,23	0,009	0,23	0,009
A10	0,60±0,03	0,024±0,001	0,60±0,03	0,024±0,001
A11	0,23	0,009	0,23	0,009
A12	0,05	0,002	0,05	0,002
A13	4,90±0,10	0,193±0,004	4,90±0,10	0,193±0,004
A14	4,27 max.	0,168 max.	4,27 max.	0,168 max.
A15	2,64 min.	0,104 min.	2,64 min.	0,104 min.
A16	0,25±0,13	0,010±0,005	0,25±0,13	0,010±0,005
Pin X	25		34	
Pin Y	26		35	
Pin Z	50		68	

Figure 6 — 50/68-contact shielded high-density cable connector
(This figure corresponds to figure 6 in ANSI X3.131.)

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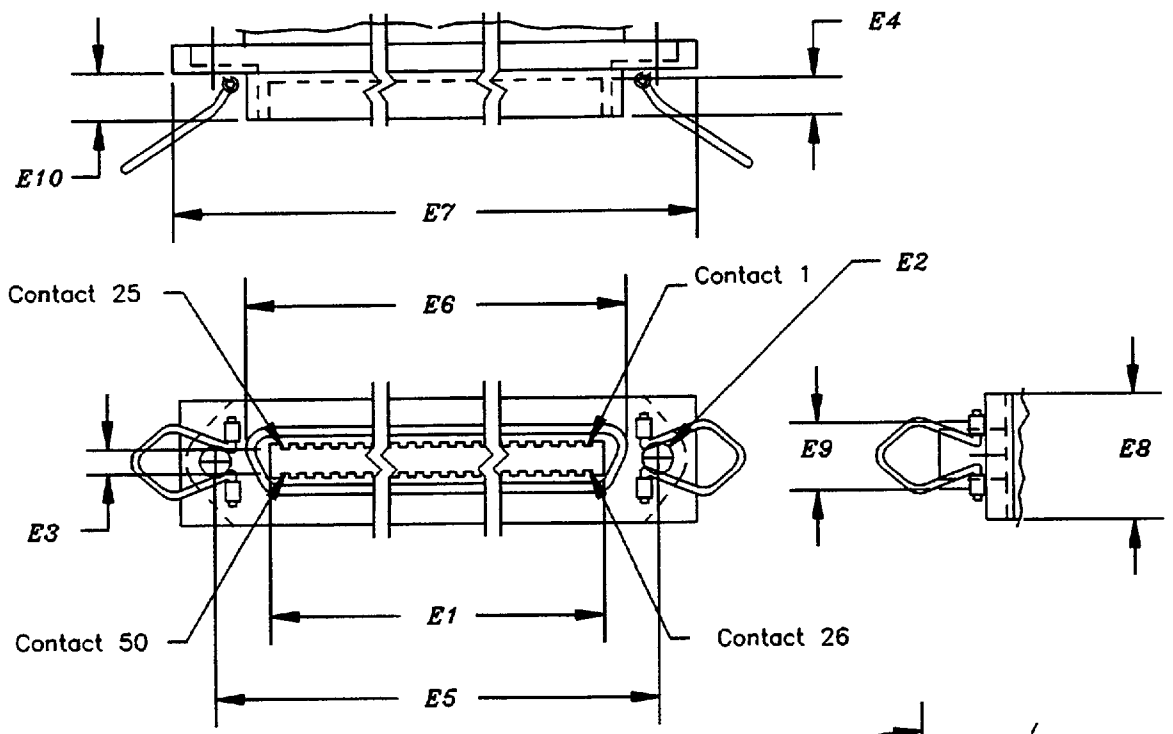

Dimensions	mm	in
E1	56,39 min.	2,220 min.
E2 1)	2,62 min.	0,103 min.
E3	3,99 min.	0,157 min.
E4	5,84 min.	0,230 min.
E5	74,85	2,947
E6	64,29 max.	2,531 max.
E7 2)	83,06	3,270
E8 2)	15,24	0,600
E9	12,04 max.	0,474 max.
E10	9,78 max.	0,385 max.
E11	2,16	0,085
E12	15° ± 2°	15° ± 2°

NOTE – Tolerances ± 0,127 mm (0,005 in) non-cumulative, unless specified otherwise.

1) This dimension is selected to accomodate 4–40 or 6–32 threaded screws.
2) These dimensions are shown for reference only.

Figure 7 — 50-contact shielded low-density SCSI device connector
(This figure corresponds to figure 7 in ANSI X3.131.)

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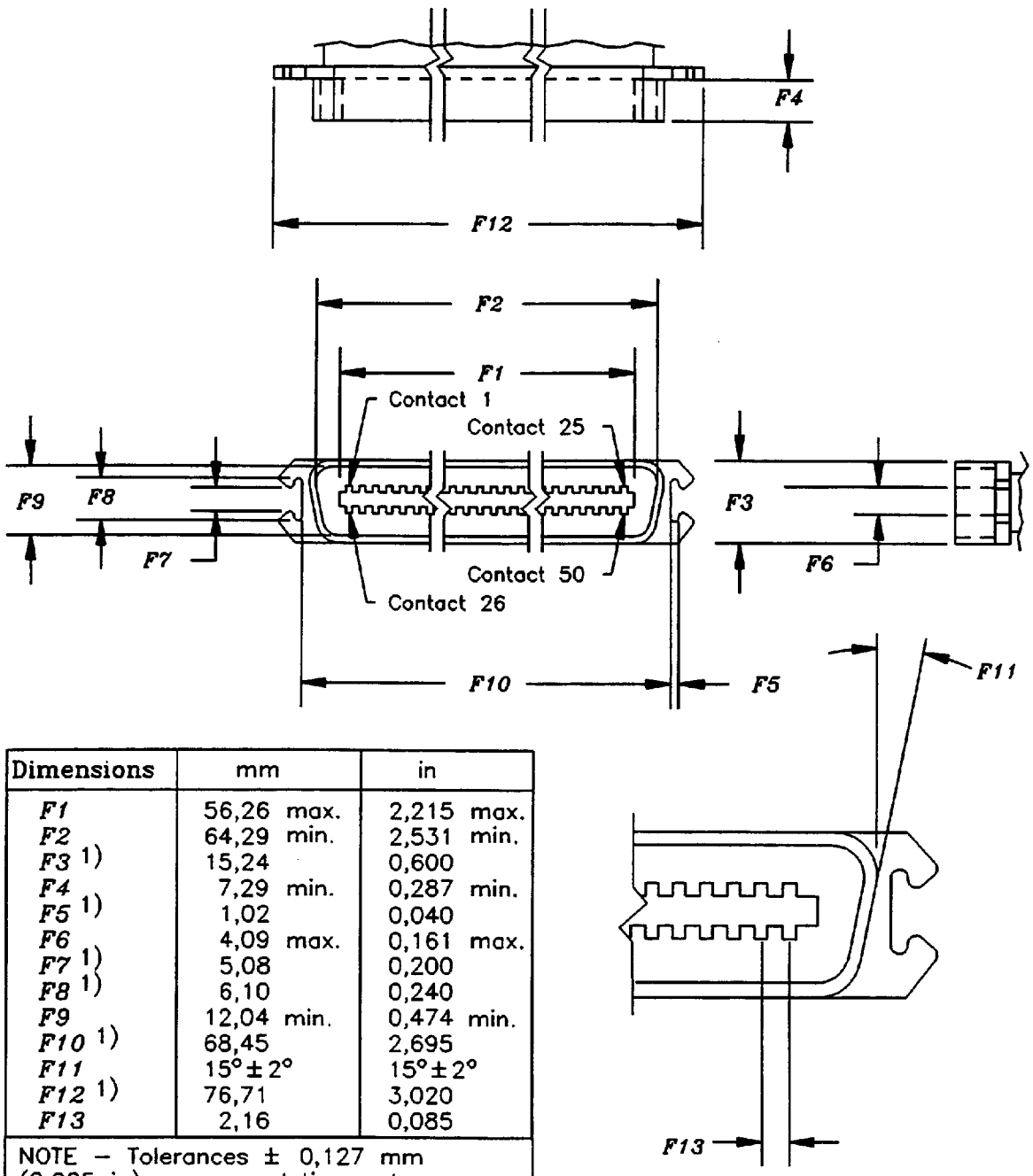

Dimensions	mm	in
F1	56,26 max.	2,215 max.
F2	64,29 min.	2,531 min.
F3 1)	15,24	0,600
F4	7,29 min.	0,287 min.
F5 1)	1,02	0,040
F6	4,09 max.	0,161 max.
F7 1)	5,08	0,200
F8 1)	6,10	0,240
F9	12,04 min.	0,474 min.
F10 1)	68,45	2,695
F11	15° ± 2°	15° ± 2°
F12 1)	76,71	3,020
F13	2,16	0,085

NOTE – Tolerances ± 0,127 mm (0,005 in) non-cumulative, unless specified otherwise.

1) These dimensions are shown for reference only.

Figure 8 — 50-contact shielded low-density cable connector
(This figure corresponds to figure 8 in ANSI X3.131.)

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4.3.3 Connector contact assignments

The connector contact assignments are defined in Tables 1 through 3. Table 1 defines which of the other two tables to use and which set of contact assignments to use.

Connector type	Driver/receiver type	Connector figure	Contact assignment table	Contact set
Non-shielded Alternative 1	Single-Ended	1 & 2	2	2
Non-shielded Alternative 1	Differential	1 & 2	3	2
Non-shielded Alternative 2	Single-Ended	3 & 4	2	1
Non-shielded Alternative 2	Differential	3 & 4	3	1
Shielded Alternative 1	Single-Ended	5 & 6	2	2
Shielded Alternative 1	Differential	5 & 6	3	2
Shielded Alternative 2	Single-Ended	7 & 8	2	2
Shielded Alternative 2	Differential	7 & 8	3	2

Table 1 — Cross-reference to connector contact assignments
(This table corresponds to table 1 in ANSI X3.131.)

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Signal name	Connector contact number		Cable conductor number		Connector contact number		Signal name
	Set 2	Set 1			Set 1	Set 2	
GROUND	1	1	1	2	2	26	-DB(0)
GROUND	2	3	3	4	4	27	-DB(1)
GROUND	3	5	5	6	6	28	-DB(2)
GROUND	4	7	7	8	8	29	-DB(3)
GROUND	5	9	9	10	10	30	-DB(4)
GROUND	6	11	11	12	12	31	-DB(5)
GROUND	7	13	13	14	14	32	-DB(6)
GROUND	8	15	15	16	16	33	-DB(7)
GROUND	9	17	17	18	18	34	-DB(P)
GROUND	10	19	19	20	20	35	GROUND
GROUND	11	21	21	22	22	36	GROUND
RESERVED	12	23	23	24	24	37	RESERVED
OPEN	13	25	25	26	26	38	TERMPWR
RESERVED	14	27	27	28	28	39	RESERVED
GROUND	15	29	29	30	30	40	GROUND
GROUND	16	31	31	32	32	41	-ATN
GROUND	17	33	33	34	34	42	GROUND
GROUND	18	35	35	36	36	43	-BSY
GROUND	19	37	37	38	38	44	-ACK
GROUND	20	39	39	40	40	45	-RST
GROUND	21	41	41	42	42	46	-MSG
GROUND	22	43	43	44	44	47	-SEL
GROUND	23	45	45	46	46	48	-C/D
GROUND	24	47	47	48	48	49	-REQ
GROUND	25	49	49	50	50	50	-I/O

NOTES:

(1) The minus sign next to a signal indicates active low.

(2) The conductor number refers to the conductor position when using 0.050-inch centerline flat ribbon cable with a low-density connector or when using 0.025-inch centerline flat ribbon cable with a high-density connector. Other cable types may be used to implement equivalent contact assignments.

(3) Two sets of contact assignments are shown. Refer to table 1 to determine which set of contacts applies to each connector.

(4) See 4.4.4 for a definition of the RESERVED lines.

Table 2 — Single-ended contact assignments
(This table corresponds to table 2 in ANSI X3.131.)

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Signal name	Connector contact number		Cable conductor number		Connector contact number		Signal name
	Set 2	Set 1			Set 2	Set 1	
GROUND	1	1	1	2	2	26	GROUND
+DB(0)	2	3	3	4	4	27	-DB(0)
+DB(1)	3	5	5	6	6	28	-DB(1)
+DB(2)	4	7	7	8	8	29	-DB(2)
+DB(3)	5	9	9	10	10	30	-DB(3)
+DB(4)	6	11	11	12	12	31	-DB(4)
+DB(5)	7	13	13	14	14	32	-DB(5)
+DB(6)	8	15	15	16	16	33	-DB(6)
+DB(7)	9	17	17	18	18	34	-DB(7)
+DB(P)	10	19	19	20	20	35	-DB(P)
DIFFSENS	11	21	21	22	22	36	GROUND
RESERVED	12	23	23	24	24	37	RESERVED
TERMPWR	13	25	25	26	26	38	TERMPWR
RESERVED	14	27	27	28	28	39	RESERVED
+ATN	15	29	29	30	30	40	-ATN
GROUND	16	31	31	32	32	41	GROUND
+BSY	17	33	33	34	34	42	-BSY
+ACK	18	35	35	36	36	43	-ACK
+RST	19	37	37	38	38	44	-RST
+MSG	20	39	39	40	40	45	-MSG
+SEL	21	41	41	42	42	46	-SEL
+C/D	22	43	43	44	44	47	-C/D
+REQ	23	45	45	46	46	48	-REQ
+I/O	24	47	47	48	48	49	-I/O
GROUND	25	49	49	50	50	50	GROUND

NOTES:

1) The conductor number refers to the conductor position when using 0.050-inch centerline flat ribbon cable with a low-density connector or when using 0.025-inch centerline flat ribbon cable with a high-density connector. Other cable types may be used to implement equivalent contact assignments.

2) Two sets of contact assignments are shown. Refer to table 1 to determine which set of contacts applies to each connector.

3) See 4.4.4 for a definition of the RESERVED lines.

Table 3 — Differential contact assignments
(This table corresponds to table 4 in ANSI X3.131.)

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4.4 Electrical description

For the measurements in this section, SCSI bus termination is assumed to be external to the SCSI device. See 4.4.4 for the terminating requirements for the RESERVED lines. SCSI devices may have the provision for allowing optional internal termination.

4.4.1 Single-ended alternative

All signals not defined as RESERVED, GROUND, or TERMPWR shall be terminated at both ends of the cable. The implementor shall use the following method to terminate each end (see figure 9):

The termination of each signal shall meet these requirements:

— The terminators shall each supply a characteristic impedance between 100 and 132 Ω.

— The terminators shall be powered by the TERMPWR line and may receive additional power from other sources but shall not require such additional power for proper operation (see 4.4.3).

— The current available to any signal line driver shall not exceed 48 mA when the driver asserts the line and pulls it to 0.5 volts d.c. Only 44.8 mA of this current shall be available from the two terminators.

— The voltage on all released signal lines shall be at least 2.5 volts d.c. when the TERMPWR line is within specified values (see 4.4.3).

— These conditions shall be met with any legal configuration of targets and initiators as long as at least one device is supplying TERMPWR.

4.4.1.1 Output characteristics All signals shall use open-collector or three-state drivers. Each signal driven by an SCSI device shall have the following output characteristics when measured at the SCSI device's connector:

V_{OL} (low-level output voltage) = 0.0 to 0.5 volts d.c. at 48 mA sinking (signal assertion)

V_{OH} (high-level output voltage) = 2.5 to 5.25 volts d.c. (signal negation)

4.4.1.2 Input characteristics SCSI devices with power on shall meet the following electrical characteristics on each signal (including both receivers and passive drivers):

V_{IL} (low-level input voltage = 0.0 to 0.8 volts d.c. (signal true)

V_{IH} (high-level input voltage) = 2.0 to 5.25 volts d.c. (signal false)

I_{IL} (low-level input current)= -0.4 to 0.0 mA at V_I = 0.5 volts d.c.

I_{IH} (high-level input current) = 0.0 to 0.1 mA at V_I = 2.7 volts d.c.

Minimum input hysteresis = 0.2 volts d.c.

Maximum input capacitance = 25 pF
(measured at the device connector closest to the stub, if any, within the device)

It is recommended that SCSI devices with power off also meet the above I_{IL} and I_{IH} electrical characteristics on each signal.

To achieve maximum noise immunity and to assure proper operation with complex cable configurations, it is recommended that the nominal switching threshold be approximately 1.4 volts.

4.4.2 Differential alternative

All signals consist of two lines denoted +SIGNAL and -SIGNAL. A signal is true when +SIGNAL is more positive than -SIGNAL, and a signal is false when -SIGNAL is more positive than +SIGNAL. All assigned signals of the A cable described in 4.6 shall be terminated at each end of the cable with a terminator network as shown in figure 10. Resistor tolerances in the terminator network shall be ±5% or less.

The DIFFSENS signal of the connector is used as an active high enable for the differential drivers. If a single-ended device or terminator is inadvertently connected, this signal is grounded, disabling the differential drivers (see figure 11).

The characteristic impedance of differential terminators is 122 Ω.

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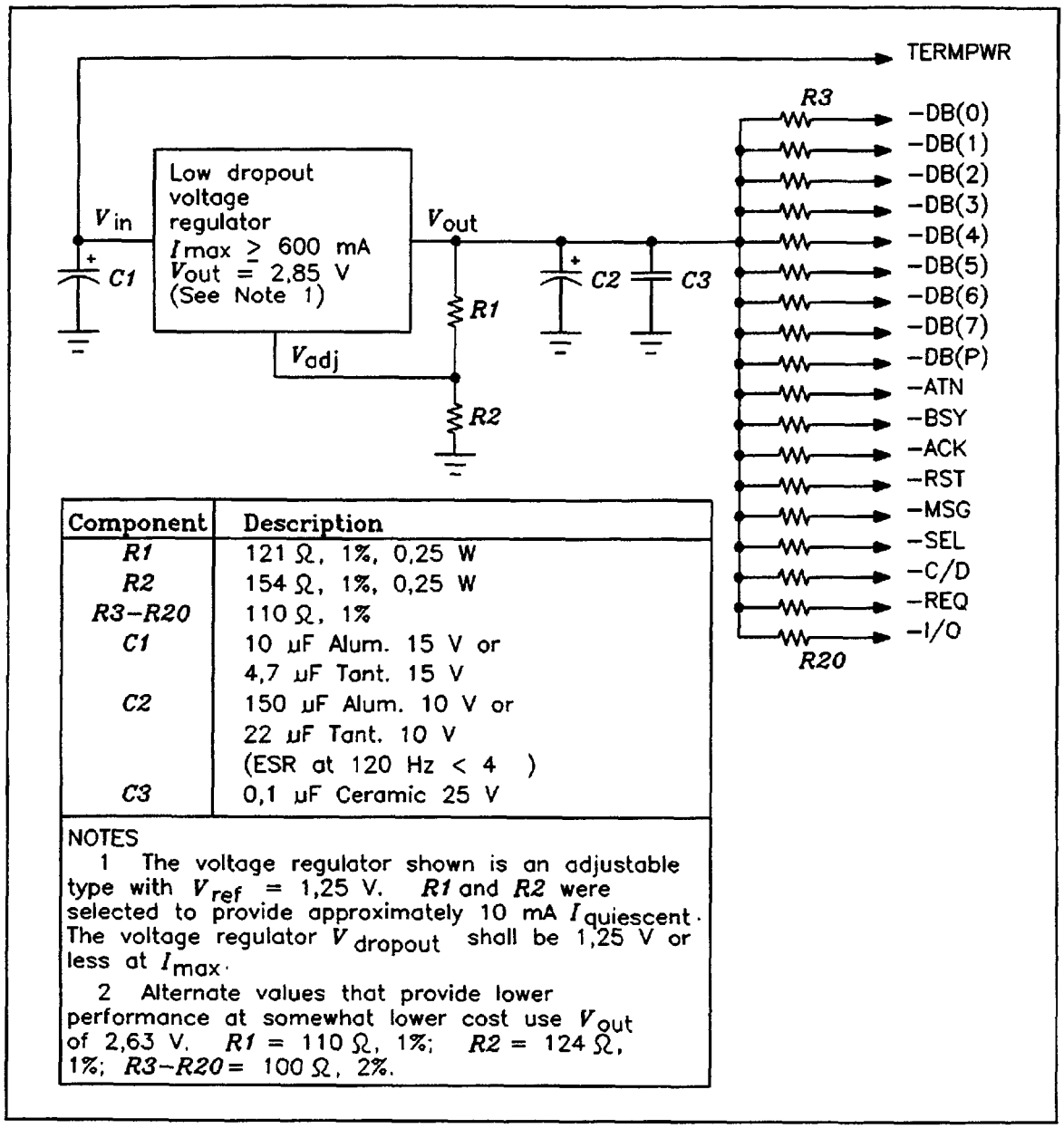

Component	Description
R1	121 Ω, 1%, 0,25 W
R2	154 Ω, 1%, 0,25 W
R3–R20	110 Ω, 1%
C1	10 µF Alum. 15 V or 4,7 µF Tant. 15 V
C2	150 µF Alum. 10 V or 22 µF Tant. 10 V (ESR at 120 Hz < 4)
C3	0,1 µF Ceramic 25 V

NOTES

1 The voltage regulator shown is an adjustable type with V_{ref} = 1,25 V. *R1* and *R2* were selected to provide approximately 10 mA $I_{quiescent}$. The voltage regulator $V_{dropout}$ shall be 1,25 V or less at I_{max}.

2 Alternate values that provide lower performance at somewhat lower cost use V_{out} of 2,63 V. *R1* = 110 Ω, 1%; *R2* = 124 Ω, 1%; *R3–R20* = 100 Ω, 2%.

Figure 9 — Termination for single-ended devices
(This figure corresponds to figure 10 in ANSI X3.131.)

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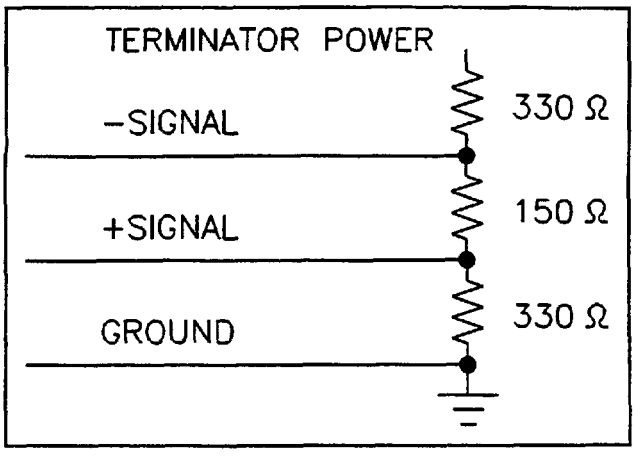

Figure 10 — Termination for differential devices
(This figure corresponds to figure 11 in ANSI X3.131.)

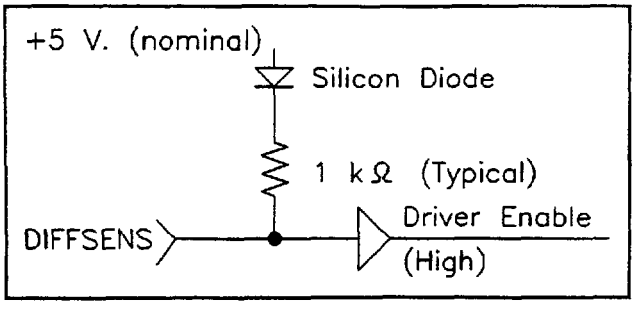

Figure 11 — Differential driver protection circuit
(This figure corresponds to figure 12 in ANSI X3.131.)

4.4.2.1 Output characteristics Each signal driven by an SCSI device shall have the following output characteristics when measured at the SCSI device's connector:

V_{OL} (low-level output voltage) = 1.7 V maximum at I_{OL} (low-level output current) = 55 mA.

V_{OH} (high-level output voltage = 2.7 V minimum at I_{OH} (high-level output current) = -55 mA.

V_{OD} (differential output voltage) = 1.0 V minimum with common-mode voltage ranges from -7 to +12 volts d.c.

V_{OL} and V_{OH} shall be as measured between the output terminal and the SCSI device's logic ground reference.

The output characteristics shall additionally conform to Electrical Characteristics of Generators and Receivers for use in Balanced Digital Multipoint Systems, EIA RS-485.

4.4.2.2 Input characteristics SCSI devices shall meet the following electrical characteristics on each signal (including both receivers and passive drivers):

I_I (Input current on either input) = ±2.0 mA maximum.

Maximum input capacitance = 25 pF.

The I_I requirement shall be met with the input voltage varying between -7 and +12 volts d.c., with power on or off, and with the hysteresis equaling 35 millivolts, minimum.

The input characteristics shall additionally conform to EIA RS-485.

4.4.3 Terminator power SCSI initiators shall supply terminator power to the TERMPWR contact(s) and, if it implements the wide SCSI option, to the TERMPWRB contacts. This power shall be supplied through a diode or similar semiconductor that prevents backflow of power to the SCSI device. Targets and SCSI devices that become temporary initiators (e.g., targets which implement the COPY command or asynchronous event notification) are not required to supply terminator power.

Any SCSI device may supply terminator power. Interface error rates are lower if the termination voltage is maintained at the extreme ends of the cable.

All terminators independent of location shall be powered from the TERMPWR and TERMPWRB contact(s). The use of keyed connectors is recommended in SCSI devices that provide terminator power to prevent accidental grounding or the incorrect connection of terminator power.

Implementor's note: Regulatory agencies may require limiting maximum (short circuit) current to the terminator power lines. Recommended current limiting is 1.5 amperes for TERMPWR and 2 amperes for TERMPWRB. For systems utilizing multiple initiators, the initiators may be configured with option straps or current limiting devices. Maximum available current should not exceed 5 amperes.

SCSI devices shall sink no more than 1.0 mA from TERMPWR and no more than 1.0 mA from TERMPWRB except to power an optional internal terminator.

Single-ended SCSI devices providing terminator power shall have the following characteristics:

V_{Term} = 4.25 to 5.25 volts d.c., 900 mA minimum source drive capability

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Differential SCSI devices providing terminator power shall have the following characteristics:

V_{Term} = 4.0 to 5.25 volts d.c., 600 mA minimum source drive capability

Implementor's note: It is recommended that the terminator power lines be decoupled at each terminator with at least a 2.2 µfarad high-frequency capacitor to improve signal quality.

4.4.4 RESERVED lines The lines labeled RESERVED in the cable contact assignment tables (table 2 and table 3) shall be connected to ground in the bus terminator assemblies or in the end devices on the SCSI cable. The RESERVED lines should be open in the other SCSI devices, but may be connected to ground.

4.5 SCSI bus

Communication on the SCSI bus is allowed between only two SCSI devices at any given time. There is a maximum of eight SCSI devices. Each SCSI device has an SCSI ID bit assigned as shown in figure 12. Three sample system configurations are shown in figure 13. There can be any combination of initiators and targets provided there is at least one of each.

When two SCSI devices communicate on the SCSI bus, one acts as an initiator and the other acts as a target. The initiator originates an operation and the target performs the operation. An SCSI device usually has a fixed role as an initiator or target, but some devices may be able to assume either role.

An initiator may address up to eight peripheral devices that are connected to a target. The target may be physically housed within the peripheral device in which case the peripheral device is referred to as an embedded SCSI device.

Certain SCSI bus functions are assigned to the initiator and certain SCSI bus functions are assigned to the target. The initiator may arbitrate for the SCSI bus and select a particular target. The target may request the transfer of COMMAND, DATA, STATUS, or other information on the DATA BUS, and in some cases it may arbitrate for the SCSI bus and reselect an initiator for the purpose of continuing an operation.

Information transfers on the DATA BUS are asynchronous and follow a defined REQ/ACK handshake protocol. One byte of information may be transferred with each handshake. An option is defined for synchronous data transfer in ANSI X3.131, clause 6.6.21.

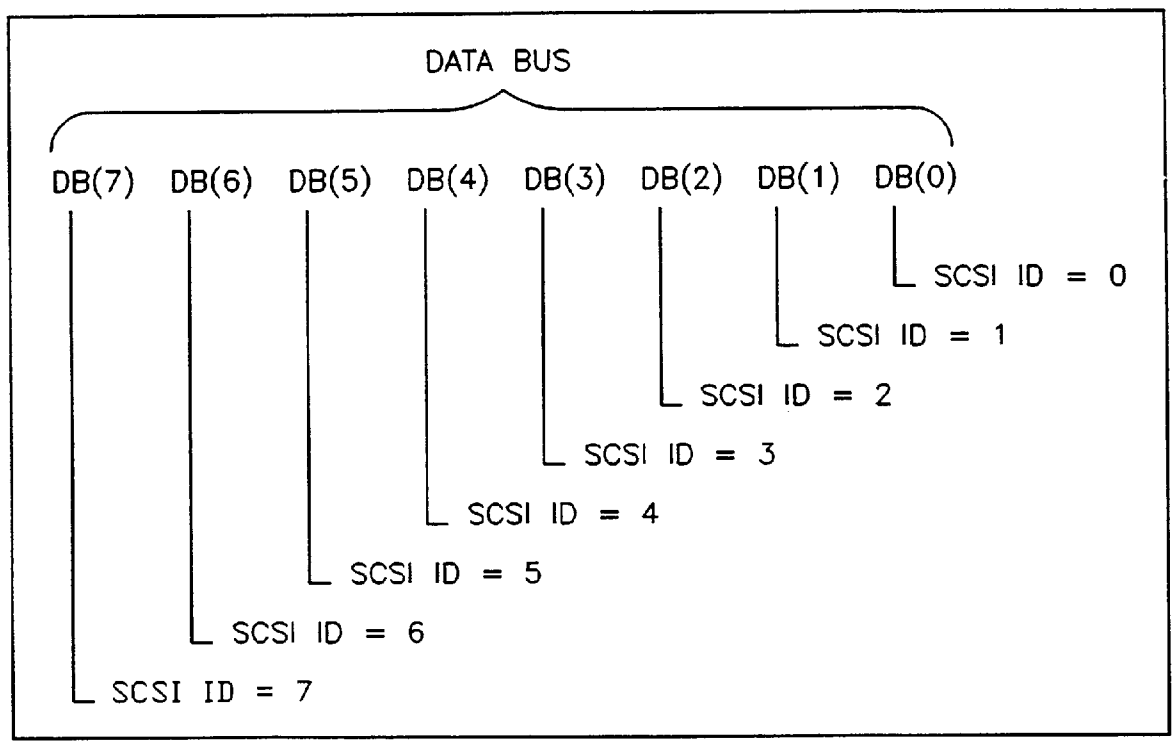

Figure 12 — SCSI ID bits
(This figure corresponds to figure 13 in ANSI X3.131.)

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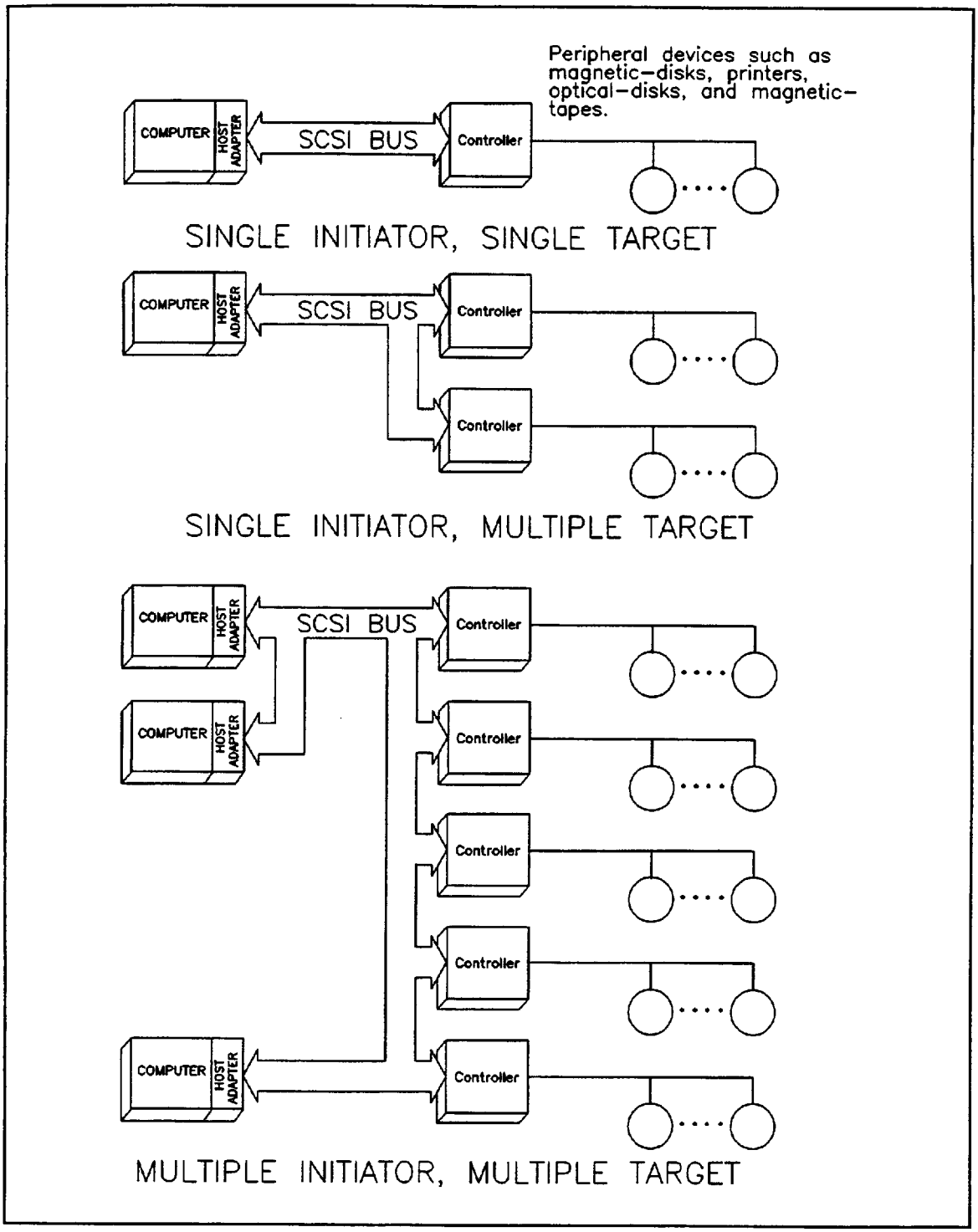

Figure 13 — Sample SCSI configurations
(This figure corresponds to figure 14 in ANSI X3.131.)

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4.6 SCSI bus signals

There are a total of 18 signals on the cable. A total of 9 signals are used for control and 9 are used for data (messages, commands, status, and data), including parity. These signals are described as follows:

— **BSY (BUSY):** An "OR-tied" signal that indicates that the bus is being used.

— **SEL (SELECT):** An "OR-tied" signal used by an initiator to select a target or by a target to reselect an initiator.

Implementor's notes: The SEL signal was not defined as "OR-tied" in SCSI-1. It has been defined as "OR-tied" in SCSI-2 in anticipation of needing another "OR-tied" signal for future standardization. This does not cause an operational problem in mixing SCSI-1 and SCSI-2 devices.

— **C/D (CONTROL/DATA):** A signal driven by a target that indicates whether CONTROL or DATA information is on the DATA BUS. True indicates CONTROL.

— **I/O (INPUT/OUTPUT):** A signal driven by a target that controls the direction of data movement on the DATA BUS with respect to an initiator. True indicates input to the initiator. This signal is also used to distinguish between SELECTION and RESELECTION phases.

— **MSG (MESSAGE):** A signal driven by a target during the MESSAGE phase.

— **REQ (REQUEST):** A signal driven by a target on the A cable to indicate a request for an ACK information transfer handshake.

— **ACK (ACKNOWLEDGE):** A signal driven by an initiator on the A cable to indicate an acknowledgment for a REQ information transfer handshake.

— **ATN (ATTENTION):** A signal driven by an initiator to indicate the ATTENTION condition.

— **RST (RESET):** An "OR-tied" signal that indicates the RESET condition.

— **DB(7-0,P) (DATA BUS):** Eight data-bit signals, plus a parity-bit signal that form a DATA BUS. DB(7) is the most significant bit and has the highest priority during the ARBITRATION phase. Bit number, significance, and priority decrease downward to DB(0). A data bit is defined as one when the signal value is true and is defined as zero when the signal value is false. Data parity DB(P) shall be odd. Parity is undefined during the ARBITRATION phase.

4.6.1 Signal values Signals may assume true or false values. There are two methods of driving these signals. In both cases, the signal shall be actively driven true, or asserted. In the case of OR-tied drivers, the driver does not drive the signal to the false state, rather the bias circuitry of the bus terminators pulls the signal false whenever it is released by the drivers at every SCSI device. If any driver is asserted, then the signal is true. In the case of non-OR-tied drivers, the signal may be actively driven false. In this standard recommended practice, wherever the term "negated" is used, it means that the signal may be actively driven false, or may be simply released (in which case the bias circuitry pulls it false), at the option of the implementor. The advantage to actively driving signals false during information transfer is that the transition from true to false occurs more quickly and the noise margin is much higher than if the signal is simply released. This facilitates reliable data transfer at high rates, especially at the longer cable lengths used with differential drivers.

4.6.2 OR-tied signals The BSY, SEL, and RST signals shall be OR-tied only. In the ordinary operation of the bus, the BSY and RST signals may be simultaneously driven true by several drivers. No signals other than BSY, RST, and DB(P) are simultaneously driven by two or more drivers, and any signal other than BSY, SEL, and RST may employ OR-tied or non-OR-tied drivers. DB(P) shall not be driven false during the ARBITRATION phase but may be driven false in other phases. There is no operational problem in mixing OR-tied and non-OR-tied drivers on signals other than BSY and RST.

4.6.3 Signal sources Table 4 indicates which type of SCSI device is allowed to source each signal. No attempt is made to show if the source is driving asserted, driving negated, or is passive. All SCSI device drivers that are not active sources shall be in the passive state. The RST signal may be asserted by any SCSI device at any time.

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Bus phase	Cable signals				
	BSY	SEL	C/D,I/O,MSG,REQ	ACK,ATN	DB(7-0) DB(P)
BUS FREE	None	None	None	None	None
ARBITRATION	All	Win	None	None	S ID
SELECTION	I&T	Init	None	Init	Init
RESELECTION	I&T	Targ	Targ	Init	Targ
COMMAND	Targ	None	Targ	Init	Init
DATA IN	Targ	None	Targ	Init	Targ
DATA OUT	Targ	None	Targ	Init	Init
STATUS	Targ	None	Targ	Init	Targ
MESSAGE IN	Targ	None	Targ	Init	Targ
MESSAGE OUT	Targ	None	Targ	Init	Init

All: The signal shall be driven by all SCSI devices that are actively arbitrating.

S ID: A unique data bit (the SCSI ID) shall be driven by each SCSI device that is actively arbitrating; the other seven data bits shall be released (i.e., not driven) by this SCSI device. The parity bit (DB(P)) may be released or driven to the true state, but shall never be driven to the false state during this phase.

I&T: The signal shall be driven by the initiator, target, or both, as specified in the SELECTION phase and RESELECTION phase.

Init: If driven, this signal shall be driven only by the active initiator.

None: The signal shall be released; that is, not be driven by any SCSI device. The bias circuitry of the bus terminators pulls the signal to the false state.

Win: The signal shall be driven by the one SCSI device that wins arbitration.

Targ: If the signal is driven, it shall be driven only by the active target.

Table 4 — Signal sources
(This table corresponds to table 6 in ANSI X3.131.)

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4.7 SCSI bus timing

Unless otherwise indicated, the delay-time measurements for each SCSI device, shown in table 5, shall be calculated from signal conditions existing at that SCSI device's own SCSI bus connection. Thus, these measurements (except cable skew delay) can be made without considering delays in the cable. The timing characteristics of each signal are described in the following paragraphs.

Timing description	Timing value
Arbitration delay	2.4 µs
Assertion period	90 ns
Bus clear delay	800 ns
Bus free delay	800 ns
Bus set delay	1.8 µs
Bus settle delay	400 ns
Cable skew delay	10 ns
Data release delay	400 ns
Deskew delay	45 ns
Disconnection delay	200 µs
Hold time	45 ns
Negation period	90 ns
Power-on to selection time	10 seconds recommended
Reset to selection time	250 ms recommended
Reset hold time	25 µs
Selection abort time	200 µs
Selection time-out delay	250 ms recommended
Transfer period	set during an SDTR message
Fast assertion period	30 ns
Fast cable skew delay	5 ns
Fast deskew delay	20 ns
Fast hold time	10 ns
Fast negation period	30 ns

Table 5 — SCSI bus timing values
(This table corresponds to table 7 in ANSI X3.131.)

4.7.1 Arbitration delay The minimum time an SCSI device shall wait from asserting BSY for arbitration until the DATA BUS can be examined to see if arbitration has been won. There is no maximum time.

4.7.2 Assertion period The minimum time that a target shall assert REQ while using synchronous data transfers. Also, the minimum time that an initiator shall assert ACK while using synchronous data transfers.

4.7.3 Bus clear delay The maximum time for an SCSI device to stop driving all bus signals after:

1. The BUS FREE phase is detected (see ANSI X3.131 6.1.1),
2. SEL is received from another SCSI device during the ARBITRATION phase,
3. The transition of RST to true.

For the first condition above, the maximum time for an SCSI device to clear the bus is 1200 nanoseconds from BSY and SEL first becoming both false. If an SCSI device requires more than a bus settle delay to detect BUS FREE phase, it shall clear the bus within a bus clear delay minus the excess time.

4.7.4 Bus free delay The minimum time that an SCSI device shall wait from its detection of the BUS FREE phase (see ANSI X3.131 6.1.1) until its assertion of BSY when going to the ARBITRATION phase.

4.7.5 Bus set delay The maximum time for an SCSI device to assert BSY and its SCSI ID bit on the DATA BUS after it detects BUS FREE phase (see ANSI X3.131 6.1.1) for the purpose of entering the ARBITRATION phase.

4.7.6 Bus settle delay The minimum time to wait for the bus to settle after changing certain control signals as called out in the protocol definitions, which are explained in clause 6 of X3.131.

4.7.7 Cable skew delay The maximum difference in propagation time allowed between any two SCSI bus signals measured between any two SCSI devices.

4.7.8 Data release delay The maximum time for an initiator to release the DATA BUS signals following the transition of the I/O signal from false to true.

4.7.9 Deskew delay The minimum time required for deskew of certain signals.

4.7.10 Disconnection delay The minimum time that a target shall wait after releasing BSY before participating in an ARBITRATION phase when honoring a DISCONNECT message from the initiator.

4.7.11 Hold time The minimum time added between the assertion of REQ or ACK and the changing of the data lines to provide hold time in the initiator or target while using synchronous data transfers.

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4.7.12 Negation period The minimum time that a target shall negate REQ while using synchronous data transfers. Also, the minimum time that an initiator shall negate ACK while using synchronous data transfers.

4.7.13 Power-on to selection time The recommended maximum time from power application until an SCSI target is able to respond with appropriate status and sense data to the TEST UNIT READY, INQUIRY, and REQUEST SENSE commands.

4.7.14 Reset to selection time The recommended maximum time after a hard RESET condition until an SCSI target is able to respond with appropriate status and sense data to the TEST UNIT READY, INQUIRY, and REQUEST SENSE commands.

4.7.15 Reset hold time The minimum time for which RST is asserted. There is no maximum time.

4.7.16 Selection abort time The maximum time that a target (or initiator) shall take from its most recent detection of being selected (or reselected) until asserting a BSY response. This time-out is required to ensure that a target (or initiator) does not assert BSY after a SELECTION (or RESELECTION) phase has been aborted. This is not the selection time-out period; see ANSI X3.131 6.1.3.1 and 6.1.4.2 for a complete description.

4.7.17 Selection time-out delay The minimum time that a SCSI device should wait for a BSY response during the SELECTION or RESELECTION phase before starting the time-out procedure. Note that this is only a recommended time period.

4.7.18 Transfer period The minimum time allowed between the leading edges of successive REQ pulses and of successive ACK pulses while using synchronous data transfers. (See ANSI X3.131, clause 6.1.5.2 and 6.6.21.)

4.8 Fast synchronous transfer option

When devices negotiate a synchronous data transfer period of less than 200 ns they are said to be using "fast synchronous data transfers." (Devices which negotiate a synchronous data transfer period greater than or equal to 200 ns use timing parameters specified in 4.7.) When a fast synchronous data transfer period is negotiated, those specific times redefined in this section are used; those not redefined remain the same. The minimum synchronous data transfer period is 100 ns.

4.8.1 Fast assertion period This value is the minimum time that a target shall assert REQ while using fast synchronous data transfers. Also, the minimum time that an initiator shall assert ACK while using fast synchronous data transfers.

4.8.2 Fast cable skew delay This value is the maximum difference in propagation time allowed between any two SCSI bus signals measured between any two SCSI devices while using fast synchronous data transfers.

4.8.3 Fast deskew delay This value is the minimum time required for deskew of certain signals while using fast synchronous data transfers.

4.8.4 Fast hold time This value is the minimum time added between the assertion of REQ or ACK and the changing of the data lines to provide hold time in the initiator or target, respectively, while using fast synchronous data transfers.

4.8.5 Fast negation period This value is the minimum time that a target shall negate REQ while using fast synchronous data transfers. Also, the minimum time that an initiator shall negate ACK while using fast synchronous data transfers.

5 Scanner devices

This clause corresponds to clause 15 of ANSI X3.131.

5.1 Model for scanner devices

Scanner devices generate a digital representation of two or three dimensional objects (e.g., a page of text, a photograph, or a piece of art). This is accomplished by sensing the amount of light transmitted from the object and generating the digital data. The digital data can then be sent across the SCSI bus to an initiator for further processing.

There are two types of scanners in use; in one type, the operations and functions of the scanner are fixed; in the other type, the operations and functions are programmable and need to be set up prior to being used for scanning objects.

The scanner device generates the data and transfers it in accordance with the commands received from the initiator. The contents of the data is vendor specific, therefore the initiator and the scanner must know how to use the contents of the data.

Scanners generate a digital image of an object in a two dimensional plane. The x-axis dimension is along the cross-scan direction which is perpendicular to the

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direction in which a scan occurs. The y-axis dimension is along the scan direction and is parallel to the direction in which a scan occurs. The coordinates are measured from the upper left hand corner of the two dimensional plane. The x-axis measurement increases in a positive manner going from left to right. The left side of the two dimensional plane (i.e., where x equals zero) is called the base element line. The y-axis measurement increases in a positive manner going from top to bottom. The top side of the two dimensional plane (i.e., where y equals zero) is called the base line. The scanning range encompasses the area in which the scanner can operate. It is the area from the scan line and base line to the maximum x and y position. These conventions are adopted to aid in understanding the fields within the command descriptor blocks and parameters used for scanner devices. As such this is a conceptual model and may not accurately reflect the physical device.

The displacements used for positioning windows is independent of the resolution with which a window is scanned. The measurement of displacements is controlled by the scan measurement mode parameters.

In the event of a scanner automatic creation of subwindows within a defined window (i.e., the auto bit in the DEFINE WINDOW parameters is one), one of the following responses is appropriate:

a. the initiator may issue a GET WINDOW PARAMETERS command prior to any READ commands,

b. if the initiator issues a READ command before issuing a GET WINDOW PARAMETERS command, the target shall return CHECK CONDITION status. The ILI and valid bits in the sense data shall be set to one. The initiator should then issue a GET WINDOW PARAMETERS command. This feature is useful when the scanner has the ability to distinguish between image and text data and to define windows accordingly.

It may occur that a scanner device temporarily does not have resources available to manage a data transfer from the initiator or does not have data available to transfer to the initiator. One of the following responses is appropriate in such a case:

a. a CHECK CONDITION status is returned and the sense key is set to NOT READY with the appropriate additional sense code (This response is applicable to a TEST UNIT READY command);

b. the target disconnects until the resource or data is available, and then re-connects to resume the operation;

c. a BUSY status is returned.

If the scanner device determines that an error or exception condition has occurred while executing the SCSI command from the initiator, a CHECK CONDITION status is returned. A REQUEST SENSE command can then be used to determine additional information regarding the error or exception condition.

5.2 Commands for scanner devices

The commands for scanner devices shall be as shown in table 6.

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Command name	Operation code	Type	Subclause
CHANGE DEFINITION	40h	O	8.2.1 (ANSI X3.131)
COMPARE	39h	O	8.2.2 (ANSI X3.131)
COPY	18h	O	8.2.3 (ANSI X3.131)
COPY AND VERIFY	3Ah	O	8.2.4 (ANSI X3.131)
GET DATA BUFFER STATUS	34h	O	5.2.1 (this document)
GET WINDOW	25h	M	5.2.2 (this document)
INQUIRY	12h	M	8.2.5 (ANSI X3.131)
LOG SELECT	4Ch	O	8.2.6 (ANSI X3.131)
LOG SENSE	4Dh	O	8.2.7 (ANSI X3.131)
MODE SELECT(6)	15h	O	8.2.8 (ANSI X3.131)
MODE SELECT(10)	55h	M	8.2.9 (ANSI X3.131)
MODE SENSE(6)	1Ah	O	8.2.10 (ANSI X3.131)
MODE SENSE(10)	5Ah	M	8.2.11 (ANSI X3.131)
OBJECT POSITION	31h	M	5.2.3 (this document)
READ	28h	M	5.2.4 (this document)
READ BUFFER	3Ch	O	8.2.12 (ANSI X3.131)
RECEIVE DIAGNOSTIC RESULTS	1Ch	O	8.2.13 (ANSI X3.131)
RELEASE UNIT	17h	M	10.2.9 (ANSI X3.131)
REQUEST SENSE	03h	M	8.2.14 (ANSI X3.131)
RESERVE UNIT	16h	M	10.2.10 (ANSI X3.131)
SCAN	1Bh	M	5.2.5 (this document)
SET WINDOW	24h	M	5.2.7 (this document)
SEND	2Ah	O	5.2.6 (this document)
SEND DIAGNOSTIC	1Dh	O	8.2.15 (ANSI X3.131)
TEST UNIT READY	00h	M	8.2.16 (ANSI X3.131)
WRITE BUFFER	3Bh	O	8.2.17 (ANSI X3.131)

Key: M = Command implementation is mandatory.
O = Command implementation is optional.

Table 6 — Commands for scanner devices
(This table corresponds to table 277 in ANSI X3.131.)

All other operation codes for scanner devices are reserved for future standardization.

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5.2.1 GET DATA BUFFER STATUS command The GET DATA BUFFER STATUS command (table 7) provides a means for the initiator to get information about the data buffer. Information is returned only for window identifiers for which a SCAN command has been received (see 5.2.5).

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (34h)							
1	Logical unit number			Reserved				Wait
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation length							
8								(LSB)
9	Control							

Table 7 — GET DATA BUFFER STATUS command
(This table corresponds to table 278 in ANSI X3.131.)

A wait bit of zero indicates that the target shall respond immediately. A wait bit of one indicates that the target shall wait for image data to be available before returning scan status data.

The data buffer status data format is defined in table 8.

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Data buffer status length							
1								
2								(LSB)
3	Reserved							Block
Data buffer status descriptor(s)								
0	Window identifier							
1	Reserved							
2	(MSB) Available data buffer							
3								
4								(LSB)
5	(MSB) Filled data buffer							
6								
7								(LSB)

Table 8 — Data buffer status format
(This table corresponds to table 279 in ANSI X3.131.)

The data buffer status length indicates the length in bytes of the following scan status data that is available to be transferred during the DATA IN phase. The data buffer status length does not include itself. The data buffer status data transferred to the initiator includes zero or more data buffer status descriptors. Each descriptor returns information for the window specified by the window identifier.

The block bit specifies the buffering capabilities of the scanner. A block bit of one indicates that the data buffer is full and all image data must be transferred to the initiator before the scan operation resumes. A block bit of zero indicates that data buffer is not full and scan operations can continue with the available data buffer space.

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The available data buffer field indicates, in bytes, the amount of buffer available for transfers from the initiator. This field is valid only in scanners with the ability to accept data from an initiator for processing.

The filled data buffer field indicates the amount of image data in bytes available for transfer to the initiator.

5.2.2 GET WINDOW Command The GET WINDOW command (table 9) provides a means for the initiator to get information about previously defined windows.

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (25h)							
1	Logical unit number			Reserved				Single
2	Reserved							
3	Reserved							
4	Reserved							
5	Window identifier							
6	(MSB) Transfer length							
7								
8								(LSB)
9	Control							

Table 9 — GET WINDOW command

(This table corresponds to table 280 in ANSI X3.131.)

A single bit of one specifies that a single window descriptor be returned for the specified window identifier. A single bit of zero specifies that window descriptors be returned for all window identifiers that were defined by a SET WINDOW command or by the target if the automatic bit (in table 11) was set to one.

The get window data shall consist of a header (see table 10) followed by one or more window descriptors. Each window descriptor specifies the location, size, and scanning method used for a window.

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Window data length							
1								(LSB)
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	(MSB) Window descriptor length							
7								(LSB)

Table 10 — Get window data header

(This table corresponds to table 281 in ANSI X3.131.)

The window data length specifies the length, in bytes, of the following data that is available to be transferred. The window data length does not include itself. If the allocation length is not sufficient to return all the get window data, the window data length shall not be adjusted to reflect the truncation data.

The window descriptor length specifies the length, in bytes, of a single window descriptor. Each descriptor shall be of equal length. The first forty bytes are defined in this standard recommended practice, and the remaining bytes in each descriptor are vendor specific.

The window descriptors are defined in table 11.

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Bit / Byte	7	6	5	4	3	2	1	0
0	Window identifier							
1	Reserved							Auto
2	(MSB) X-Axis resolution							
3								(LSB)
4	(MSB) Y-Axis resolution							
5								(LSB)
6	(MSB) X-Axis upper left							
9								(LSB)
10	(MSB) Y-Axis upper left							
13								(LSB)
14	(MSB) Window width							
17								(LSB)
18	(MSB) Window length							
21								(LSB)
22	Brightness							
23	Threshold							
24	Contrast							
25	Image composition							
26	Bits per pixel							
27	(MSB) Halftone pattern							
28								(LSB)
29	RIF	Reserved					Padding type	
30	(MSB) Bit ordering							
31								(LSB)
32	Compression type							
33	Compression argument							
34	Reserved							
39								
40	Vendor specific parameter byte(s)							
n								

Table 11 — Window descriptor bytes
(This table corresponds to table 282 in ANSI X3.131.)

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The window identifier specifies the window defined by the window descriptor. A window is referenced by the window identifier during data transfers and parameter updates.

When used with the SET WINDOW command, an automatic (auto) bit of one indicates that the target is allowed to create sub-windows within the window specified. An auto bit of zero indicates that target is not allowed to create sub-windows.

When used with the GET WINDOW command, an auto bit of zero indicates that the window was defined directly by the SET WINDOW command. A value of one indicates that the window was defined by the target. This is a sub-window within a window defined by a SET WINDOW command.

The window identifiers assigned by the target shall be unique and not currently in use. The parameters for the sub-windows may be retrieved using the GET WINDOW command.

The x-axis resolution field specifies the resolution in the scan line direction. The unit of measure is picture elements (pixels) per inch. A value of zero specifies the default resolution.

The y-axis resolution field specifies the resolution in the base line direction. The unit of measure is scan lines per inch. A value of zero specifies the default resolution.

The x-axis upper left field specifies the x-axis coordinate of the upper left corner of the window. This coordinate is measured from the scan line using the target's current measurement unit divisor (see 5.3.3.1).

The y-axis upper left field specifies the y-axis coordinate of the upper left corner of the window. This coordinate is measured from the base line using the target's current measurement unit divisor (see 5.3.3.1).

The window width field specifies the width of window in the scan line direction. The window width is measured using the target's current measurement unit divisor (see 5.3.3.1).

The window length field specifies the length of the window in the base line direction. The window length is measured using the target's current measurement unit divisor (see 5.3.3.1).

The brightness field specifies the level of brightness used to scan the object. A value of zero specifies the default brightness or automatic brightness control if it is supported. Any other value indicates a relative brightness setting with 255 being the highest setting, 1 being the lowest setting, and 128 being the nominal setting.

The threshold field specifies the threshold at which scan data is converted to binary data. A value of zero specifies the default threshold or automatic threshold control if it is supported. Any other value indicates relative threshold setting with 255 being the highest setting, 1 being the lowest setting, and 128 being the nominal setting.

The contrast field specifies the level of contrast used to scan the object. A value of zero specifies the default contrast or automatic contrast control if it is supported. Any other value indicates a relative contrast setting with 255 being the highest setting, 1 being the lowest setting, and 128 being the nominal setting.

The image composition field specifies the type of scan operation requested. The image composition is defined as shown in table 12.

Code	Description
00h	Bi-level black & white
01h	Dithered/halftone black & white
02h	Multi-level black & white (gray scale)
03h	Bi-level RGB color
04h	Dithered/halftone RGB color
05h	Multi-level RGB color
06h - FFh	Reserved

Table 12 — Image composition codes
(This table corresponds to table 283 in ANSI X3.131.)

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The bits per pixel field specifies the number of bits used to represent the intensity of a single color.

The halftone field specifies the level of halftone at which the scan data is converted to binary data. The values in this field are vendor specific. The halftone field is used in conjunction with the image composition field.

A reverse image format (RIF) bit of zero indicates that white pixels are to be indicated by zeros and black pixels are to be indicated by ones. A RIF bit of one indicates that white pixels are to be indicated by ones and black pixels are to be indicated by zeros. The RIF bit is applicable only for images represented by one bit per pixel.

The padding type field specifies how the target shall pad the image data transmitted to the initiator if it is not an integral number of bytes. The padding type is defined in table 13.

Code	Description
00h	No padding
01h	Pad with 0's to byte boundary
02h	Pad with 1's to byte boundary
03h	Truncate to byte boundary
04h - FFh	Reserved

Table 13 — Padding types
(This table corresponds to table 284 in ANSI X3.131.)

The bit ordering field specifies the order in which data is transferred to the host from the window. The bit ordering specifies the direction of pixels in a scan line, the direction of scan lines within a window and the image data packing within a byte. The values in this field are vendor specific.

The compression type and compression argument fields specify the compression technique to be applied to the image data (see table 14).

Compression code	Description	Compression argument
00h	No compression	Reserved
01h	CCITT T.4 as used in Group 3 Facsimile	Reserved
02h	CCITT T.6 as used in Group 3 Facsimile	K factor
03h	CCITT T.6 as used in Group 4 Facsimile	Reserved
04h - 0Fh	Reserved	Reserved
10h	Optical Character Recognition (OCR)	Vendor specific
11h - 7Fh	Reserved	Reserved
80h - FFh	Vendor specific	Vendor specific

Table 14 — Compression types and arguments
(This table corresponds to table 285 in ANSI X3.131.)

5.2.3 OBJECT POSITION command The OBJECT POSITION command (table 15) provides positioning functions. Absolute as well as relative positioning is provided. A target shall return CHECK CONDITION status and set the sense key to ILLEGAL REQUEST if a positioning function is requested that is not supported.

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (31h)							
1	Logical unit number			Reserved		Position function		
2	(MSB)							
3	Count							
4								(LSB)
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control							

Table 15 — OBJECT POSITION command
(This table corresponds to table 286 in ANSI X3.131.)

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The position function field specifies the requested function (see table 16).

Position function	Description
000b	Unload object
001b	Load object
010b	Absolute positioning
011b	Relative positioning
100b	Rotate object
101b	Reserved
110b	Reserved
111b	Reserved

Table 16 — Position function
(This table corresponds to table 287 in ANSI X3.131.)

5.2.3.1 Unload object This position function specifies that the object shall be positioned for removal. If upon receipt of this command there is no object loaded, the target shall return a GOOD status. This condition shall not be considered as an error. If the target is unable to unload the object (i.e., paper jam or misfeed condition), the target shall return CHECK CONDITION status and set the sense key sense to MEDIUM ERROR.

5.2.3.2 Load object This position function specifies that the object is to be loaded and positioned to the base line. If upon receipt of this command there is a object already loaded, the target shall return GOOD status. This condition shall not be considered as an error. If an object is not loaded and the target is unable to load an object, the target shall return CHECK CONDITION status and set the EOM bit to one and the sense key to MEDIUM ERROR.

5.2.3.3 Absolute positioning This position function specifies that the object is to be positioned at a y-axis displacement from the base line. The y-axis displacement is determined using the count field and the target's current measurement unit divisor (see 5.3.3.1). A count field of zero positions the object at the base line.

Any other value in the count field shall cause the target to position the object that number of units in the scan line direction. If there is no object loaded or if the specified y-axis displacement is not achieved the target shall return CHECK CONDITION status and set the EOM bit to one and the sense key to MEDIUM ERROR.

5.2.3.4 Relative positioning This position function specifies that the object is to be positioned at a y-axis displacement relative to the current position. The y-axis displacement is determined using the count field and the target's current measurement unit divisor (see 5.3.3.1). A count field of zero causes no change in position of the object.

A positive value in the count field shall cause the target to position the object that number of units in the scan line direction. If the scan range is exceeded the target shall return CHECK CONDITION status. The EOM bit is set to one, the ILI bit is set to one, and sense key is set to MEDIUM ERROR. The valid bit is set to one, and the information bytes are set to the difference (residue) between the requested count and the actual number of units moved.

A negative value (e.g., twos complement notation) in the count field shall cause the target to position the object that number of units toward the base line. If there is no object loaded or if the specified y-axis displacement is not achieved, the target shall return CHECK CONDITION status and set the EOM bit to one and the sense key to MEDIUM ERROR. If the base line is encountered, the target shall position the object at the base line and return CHECK CONDITION status. The ILI bit is set to one, and the sense key is set to MEDIUM ERROR. The valid bit is set to one, and the information bytes are set to the difference (residue) between the requested count and the actual number of units moved.

5.2.3.5 Rotate object This position function specifies that the object is to be rotated in a counter-clockwise direction in units of one one-thousandth of a degree. The count field specifies the number of units that the object is to be moved.

The count field is used with the position function to specify the displacement of the object.

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5.2.4 READ command The READ command (table 17) requests that the target transfer data to the initiator.

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (28h)							
1	Logical unit number			Reserved				
2	Data type code							
3	Reserved							
4	(MSB) Data type qualifier							
5								(LSB)
6	(MSB) Transfer length							
7								
8								(LSB)
9	Control							

Table 17 — READ command
(This table corresponds to table 288 in ANSI X3.131.)

The transfer data type distinguishes between the different types of data that may be transferred between the initiator and the target. The types of transfers are specified in table18.

Code	Description
00h	Image
01h	Vendor specific
02h	Halftone mask
03h	Gamma function
04h - 7Fh	Reserved
80h - FFh	Vendor specific

Table 18 — Data type codes
(This table corresponds to table 289 in ANSI X3.131.)

The data type qualifier field provides a means to differentiate data transfers of the same data type code. The values used in this field are vendor specific.

The transfer length specifies the number of blocks, the target shall transfer to the initiator during the DATA IN phase. The block size is the current block size in the mode parameters block descriptor (see 8.3.3 in ANSI X3.131). A transfer length of zero is not considered an error, and no data shall be transferred.

If the target transfers less than transfer length blocks a CHECK CONDITION status shall be returned. The ILI bit is set to one, the valid bit is set to one, and the information bytes are set to the difference (residue) between the requested transfer length and the actual number of blocks transferred.

This command shall be terminated with a status of RESERVATION CONFLICT if any reservation access conflict (see 10.2.10 of ANSI X3.131) exists, and no data shall be transferred.

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5.2.5 SCAN Command The SCAN command (table 19) requests the target begin a scan operation.

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (1Bh)							
1	Logical unit number			Reserved				
2	Reserved							
3	Reserved							
4	Transfer length							
5	Control							

Table 19 — SCAN command
(This table corresponds to table 290 in ANSI X3.131.)

The transfer length specifies the length, in bytes, of the window identifier list that shall be sent during the DATA OUT phase. A transfer length of zero indicates that no data shall be transferred. This condition shall not be considered as an error.

The window identifier list consists of zero or more window identifiers, each of which specifies a window to be scanned.

5.2.6 SEND command The SEND command (table 20) transfers data from the initiator to the target.

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (2Ah)							
1	Logical unit number			Reserved				
2	Data type code							
3	Reserved							
4	(MSB) Data type qualifier							
5	(LSB)							
6	(MSB) Transfer length							
7								
8	(LSB)							
9	Control							

Table 20 — SEND command
(This table corresponds to table 291 in ANSI X3.131.)

The data type code and data type qualifier are defined in the READ command (see 5.2.4).

The transfer length specifies the number of blocks the target shall transfer from the initiator during the DATA OUT phase. The block size is the current block size in the mode parameters block descriptor (see 8.3.3 of ANSI X3.131). A transfer length of zero, is not considered an error, and no data shall be transferred.

This command shall be terminated with a status of RESERVATION CONFLICT if any reservation access conflict (see 10.2.10 of ANSI X3.131) exists, and no data shall be transferred.

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5.2.7 SET WINDOW command The SET WINDOW command (table 21) provides a means for the initiator to specify one or more windows within the scanning range of the device.

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (24h)							
1	Logical unit number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	(MSB)							
7								
8	Transfer length							(LSB)
9	Control							

Table 21 — SET WINDOW command
(This table corresponds to table 292 in ANSI X3.131.)

The transfer length specifies the length, in bytes, of the data that shall be sent during the DATA OUT phase. A transfer length of zero indicates that no window parameters data shall be transferred. This condition shall not be considered as an error.

The window parameters data shall consist of a header followed by one or more window descriptors. Each window descriptor specifies the location, size, and scanning method used for a window.

The set window data header is defined in table 22.

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	(MSB)							
7	Window Descriptor Length							(LSB)

Table 22 — Set Window data header
(This table corresponds to table 293 in ANSI X3.131.)

The window descriptor length specifies the length in bytes of a single window descriptor. Each descriptor shall be of equal length. The first forty bytes are defined in this standard and the remaining bytes in each descriptor are vendor specific.

See table 11 for the definition of a window descriptor.

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5.3 Parameters for scanner devices

5.3.1 Diagnostic parameters This section defines the descriptors and pages for diagnostic parameters used with scanner devices.

The diagnostic page codes for scanner devices are defined in table 23.

Page code	Description	X3.131 Subclause
00h	Supported diagnostic pages	8.3.1.1
01h-7Fh	Reserved	
80h - FFh	Vendor-specific pages	

Table 23 — Diagnostic page codes
(This table corresponds to table 294 in ANSI X3.131.)

5.3.2 Log parameters This section defines the descriptors and pages for log parameters used with scanner devices.

The log page codes for scanner devices are defined in table 24.

Page code	Description	X3.131 Subclause
01h	Buffer over-run/ Under-run page	8.3.2.1
03h	Error counter page (read) page	8.3.2.2
07h	Last *n* error events page	8.3.2.3
06h	Non-medium error page	8.3.2.4
00h	Supported log pages	8.3.2.5
08h - 2Fh	Reserved	
3Fh	Reserved	
30h - 3Eh	Vendor-specific pages	

Table 24 — Log page codes
(This table corresponds to table 295 in ANSI X3.131.)

5.3.3 Mode parameters This section defines the descriptors and pages for mode parameters used with scanner devices.

The mode parameter list, including the mode parameter header and mode block descriptor is defined in 8.3.3 in ANSI X3.131.

The medium-type code field is contained in the mode parameter header 8.3.3 in ANSI X3.131. This field is reserved for scanner devices.

The device specific parameter field is contained in the mode parameter header 8.3.3 in ANSI X3.131. This field is reserved for scanner devices.

The density code field is contained in the mode parameter block descriptor 8.3.3 in ANSI X3.131. This field is reserved for scanner devices.

The mode page codes for scanner devices are defined in table 25.

Page code	Description	X3.131 Subclause
0Ah	Control mode page	8.3.3.1
02h	Disconnect-reconnect page	8.3.3.2
03h	Measurement units page	15.3.3.1[a]
09h	Peripheral device page	8.3.3.3.
01h	Reserved	
03h - 08h	Reserved	
0Bh - 1Fh	Reserved	
00h	Vendor specific (does not require page format)	
20h - 3Eh	Vendor specific (page format required)	
3Fh	Return all pages (valid only for the MODE SENSE command)	

a. Also described in 5.3.3.1 of this document.

Table 25 — Mode page codes
(This table corresponds to table 296 in ANSI X3.131.)

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5.3.3.1 Measurement units page The measurement units page (table 26) specifies the units of measurement used for calculating the displacement of window and for positioning an object. The measurement units are independent of the horizontal and vertical scan resolutions.

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page code (03h)					
1	Parameter length (06h)							
2	Basic measurement unit							
3	Reserved							
4	(MSB) Measurement unit divisor							
5	(LSB)							
6	Reserved							
7	Reserved							

Table 26 — Measurement units page
(This table corresponds to table 297 in ANSI X3.131.)

The parameters savable (PS) bit is only used with the MODE SENSE command. This bit is reserved for the MODE SELECT command (explained in 8.2.9 of X3.131). A PS bit of one indicates that the target is capable of saving the page in a non-volatile vendor-specific location.

The basic measurement unit field is defined in table 27. Targets shall use inches as the default basic measurement unit.

Code	Description
00h	Inch
01h	Millimeter
02h	Point
03h - FFh	Reserved

Table 27 — Basic measurement units
(This table corresponds to table 298 in ANSI X3.131.)

The measurement unit divisor specifies the number of units needed to equal one basic measurement unit. Targets shall use 1200 as the default measurement unit divisor. If a value of zero is specified the target shall return CHECK CONDITION status and set the sense key to ILLEGAL REQUEST.

Implementor's Note: A target that does not implement this page or only supports default values uses one twelve-hundredths (1/1200) of an inch as the unit of measure.

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Annex A
(Informative)
Additional features not compliant with ANSI X3.131

(This Annex is not part of the American National Standard for Information and Image Management, MS58-1996 Standard Recommended Practice for Implementation of Small Computer Systems Interface (SCSI-2), (X3.131-1994) for Scanners)

A1 In order to take advantage of some advanced scanner features, it may be desired to modify the scanner Window Descriptor bytes as described in tables 11 and 12. What follows is a recommendation for such modifications with the warning that these modifications are not part of ANSI X3.131, nor sanctioned by the SCSI-2 Committee, (ASC X3T10). Most of the tables and text from the Window Descriptor byte description is repeated below with modifications where indicated. All modifications from the standard text are marked with arrows and change bars at the left side of the applicable paragraph. All tables use the same reference number as the standard but are preceded with 'A.'

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Bit / Byte	7	6	5	4	3	2	1	0
0	Window identifier							
1	Reserved							Auto
2	(MSB) X-Axis resolution							
3								(LSB)
4	(MSB) Y-Axis resolution							
5								(LSB)
6	(MSB) X-Axis upper left							
9								(LSB)
10	(MSB) Y-Axis upper left							
13								(LSB)
14	(MSB) Window width							
17								(LSB)
18	(MSB) Window length							
21								(LSB)
22	Brightness							
23	Threshold							
24	Contrast							
25	Image composition							
26	Bits per pixel							
27	(MSB) Halftone pattern							
28								(LSB)
29	RIF	RGB format			Reserved	Padding type		
30	(MSB) Bit ordering							
31								(LSB)
32	Compression type							
33	Compression argument							
34	Reserved							
39								
40	Vendor specific parameter byte(s)							
n								

Table A-11 — Window descriptor bytes

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A2 Byte Descriptions The window identifier specifies the window defined by the window descriptor. A window is referenced by the window identifier during data transfers and parameter updates.

When used with the SET WINDOW command, an automatic (auto) bit of one indicates that the target is allowed to create sub-windows within the window specified. An auto bit of zero indicates that target is not allowed to create sub-windows.

When used with the GET WINDOW command, an auto bit of zero indicates that the window was defined directly by the SET WINDOW command. A value of one indicates that the window was defined by the target. This is a sub-window within a window defined by a SET WINDOW command.

The window identifiers assigned by the target shall be unique and not currently in use. The parameters for the sub-windows may be retrieved using the GET WINDOW command.

The x-axis resolution field specifies the resolution in the scan line direction. The unit of measure is picture elements (pixels) per inch. A value of zero specifies the default resolution.

The y-axis resolution field specifies the resolution in the base line direction. The unit of measure is scan lines per inch. A value of zero specifies the default resolution.

The x-axis upper left field specifies the x-axis coordinate of the upper left corner of the window. This coordinate is measured from the scan line using the target's current measurement unit divisor (see 5.3.3.1).

The y-axis upper left field specifies the y-axis coordinate of the upper left corner of the window. This coordinate is measured from the base line using target's current measurement unit divisor (see 5.3.3.1).

The window width field specifies the width of window in the scan line direction. The window width is measured using the target's current measurement unit divisor (see 5.3.3.1).

The window length field specifies the length of the window in the base line direction. The window length is measured using the target's current measurement unit divisor (see 5.3.3.1).

The brightness field specifies the level of brightness used to scan the object. A value of zero specifies the default brightness or automatic brightness control if it is supported. Any other value indicates a relative brightness setting with 255 being the highest setting, 1 being the lowest setting, and 128 being the nominal setting.

The threshold field specifies the threshold at which scan data is converted to binary data. A value of zero specifies the default threshold or automatic threshold control if it is supported. Any other value indicates relative threshold setting with 255 being the highest setting, 1 being the lowest setting, and 128 being the nominal setting.

The contrast field specifies the level of contrast used to scan the object. A value of zero specifies the default contrast or automatic contrast control if it is supported. Any other value indicates a relative contrast setting with 255 being the highest setting, 1 being the lowest setting, and 128 being the nominal setting.

The halftone field specifies the level of halftone at which the scan data is converted to binary data. The values in this field are vendor specific. The halftone field is used in conjunction with the image composition field.

The image composition field specifies the type of scan operation requested. The image composition is defined as shown in table A-12.

Code	Description
00h	Bi-level black & white
01h	Dithered/halftone black & white
02h	Multi-level black & white (gray scale)
03h	Bi-level RGB color
04h	Dithered/halftone RGB color
05h	Multi-level RGB color
06h - FFh	Reserved

Table A-12 — Image Composition Codes

The bits per pixel field specifies the number of bits used to represent the intensity of a single color.

A reverse image format (RIF) bit of zero indicates that white pixels are to be indicated by zeros and black pixels are to be indicated by ones. A RIF bit of one indicates the minimum grey scale value for white pixels are to be indicated by ones and black pixels are to be indicated by zeros. The RIF bit is applicable for all images regardless of the number of bits per pixel.

The RGB Format field, byte 29, bits 6-4, (see table A-12.1) defines the format of the RGB information specified in byte 25. These bits shall be ignored if RGB data is not specified by the Image Composition Code.

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Bits 6-4	Description
000	RGB data interleave by plane
001	RGB data interleave by line
010	RGB data interleave by pixel
011-111	Reserved

Table A-12.1 — RGB format

The padding type field specifies how the target shall pad the image data transmitted to the initiator if it is not an integral number of bytes, words or doublewords. The padding type is defined in table A-13.

Bits 2-0	Description
000	No padding
001	Pad with 0's to byte boundary
010	Pad with 1's to byte boundary
011	Truncate to byte boundary
100	Pad with 0's to word boundary
101	Pad with 1's to word boundary
110	Pad with 0's to doubleword
111	Pad with 1's to doubleword

Note: Word boundaries are evenly divisible by 16 and doubleword boundaries are evenly divisible by 32.

Table A-13 — Padding types

The bit ordering field specifies the order in which data is transferred to the host from the window. The bit ordering specifies the direction of pixels in a scan line, the direction of scan lines within a window and the image data packing within a byte. The values in this field are vendor specific, but some standardization of low order bit meanings is expected in SCSI-3.

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