4.4 Disk Drive Interfaces

Silicon Graphics systems have continued to keep pace with the advances in disk technology. This results in support of a number of different disk drive interfaces over the history of the IRIS product line. While the SCSI bus has evolved into a bus used for more than just disk drives, an important use in SGI platforms is support of the hard disk(s). Therefore, it is covered in this section rather than in a section dedicated to general SCSI peripherals.

Table 4-32, on page 4-40 shows the disk drive interfaces supported on the various platforms as shipped. A table entry that is lightly shaded denotes where a disk interface could be added to the platform as an upgrade. Darker shading denotes the interface is not available for that chassis.

Numbers in table entries indicate maximum number of controllers and maximum number of disk drives per controller separated by a "/". For example, where two controllers each controlling 4 drives is possible, the entry would be "2/4". The total number of drives possible may exceed the number of drive bays or modules available in a chassis or the drives may not physically fit in a chassis. In cases such as these (for example, SMD drives on a Twin Tower chassis) external drive bays or racks are assumed.

4.4.1 Bus Lengths

Each type of disk interface operates over a bus with a limited maximum length. Beyond that length disk accesses are error prone and could cause significant system problems. Table 4-31 shows the maximum length allowed for the disk interfaces documented here.

Table 4-31 Maximum Bus Length for Disk Interfaces

Interface	Single Ended/ Differential	Maximum Bus Length
ESDI		3 m
SMD		15 m
IPI		15 m
SCSI-1	Single Ended	6 m
	Differential	25 m
SCSI-2	Single Ended	3 m
	Differential	10 m
Ultra SCSI	Single Ended	1.5 m
	Differential	10 m

Table 4-32 Disk Drive Interfaces on SGI Systems

Chassis	ESDI	SMD	IPI	SCSI-1	SCSI-2				Ultra-SCSI
				Single-ended	Narrow, Single-ended	Wide, Single-ended	Narrow, Differential	Wide, Differential	Wide, Single-ended
Twin Tower 12 Slot	4/2 or 4/4[1]	4/4	4/8						
Twin Tower 15 Slot	4/2 or 4/4[1]	4/4	4/8	1/7					
Diehard	4/2 or 4/4[1]	4/4	4/8	1/7			4/7[4]		
Predator	4/2 or 4/4[1]	4/4	4/8	1/7, 2/7 or 4/7[3]			4/7[4]		
Diehard2		4/4	4/8	2/7			4/7[4]		
Terminator Rack/ Eveready Deskside		4/4	4/8			8/15[2]		8/15[2]	
Personal IRIS				1/7					
Indigo (R3K)				1/7					
Indigo (R4K)					1/7				
Indigo[2]					2/7				
Indy					1/7				
Challenge S					1/7			2/15	
O2									2/{3,15}[5]
OCTANE									2/{3,15}[5]
Origin200					1/2				1/6
Origin2000									2/{6,15}[6]
Onyx2									2/{6,15}[6]

1. The 3201 controller could control 2 ESDI disks, the later 4201 controller was faster and could control up to 4 ESDI disks.
2. Drives can be configured as either single ended or differential depending on the adapter at the rear of the drive sled.
3. The Power Center Server in the Predator Rack could contain 2 IO3's resulting in 4 available SCSI buses.
4. Differential SCSI-2 drives controlled by the "Jaguar" or "Cougar" controller board.
5. The internal bus supports 3 devices while the external bus supports the full complement of 15 devices.
6. The internal bus supports 6 devices while the external bus supports the full complement of 15 devices.

Each chassis uses a certain amount of the maximum bus length for connecting disk (or other devices) inside the chassis. This amount of cabling must be taken into account when attaching disks external to the system chassis. The total length of internal and external cabling must not exceed the maximum bus length as shown in the table above. Table 4-33, "Internal Chassis Bus Lengths", on page 4-41 shows the lengths of cable used internally on the various chassis.

Table 4-33 Internal Chassis Bus Lengths

Chassis	ESDI	SMD	IPI	SCSI-1	SCSI-2	Ultra SCSI
Twin Tower 12 Slot	6 ft. (1.82 m) + 2 ft. (0.6 m) for each drive module	1.5 ft. (0.45 m)	1.5 ft. (0.45 m)	3.28 ft. (1 m) + 1.64 ft. (0.5 m) for each drive module		
Twin Tower 15 Slot	6 ft. (1.82 m) + 2 ft. (0.6 m) for each drive module	1.5 ft. (0.45 m)	1.5 ft. (0.45 m)	3.28 ft. (1 m) + 1.64 ft. (0.5 m) for each drive module		
Diehard		1.5 ft. (0.45 m)	1.5 ft. (0.45 m)	7 ft. (2.13 m)		
Predator		1.5 ft. (0.45 m)	1.5 ft. (0.45 m)			
Diehard2		1.5 ft. (0.45 m)	1.5 ft. (0.45 m)	Ch 0: 8 ft. (2.43 m) Ch 1: 6 ft. (1.82 m)		
Eveready Deskside					3 ft. (0.91 m)	
Terminator Rack					3 ft. (0.91 m)	
Personal IRIS				3.9 ft. (1.2 m)		
Indigo (R3K)				1.3 ft. (0.4 m)		
Indigo (R4K)					1.3 ft. (0.4 m)	
Indigo^2					1.3 ft. (0.4 m)	
Indy					1.3 ft. (0.4 m)	
O2						0.83 ft. (0.25 m)
OCTANE						4 ft. (1.2 m)
Origin200						
Origin2000						1 ft. (0.3 m)
Onyx2						1 ft. (0.3 m)

4.4.2 Terminations

For proper operation, the disk interfaces must have the appropriate termination at the end of the bus. For ESDI, SMD and IPI these terminations are made at the last drive of the chain, usually by plugging in a termination pack into a connector on the disk drive itself.

For SCSI, termination is typically done via a separate terminator assembly. Systems shipped with SCSI-1 capability were equipped with a passive terminator for attaching to the end of the SCSI bus (the SCSI bus connector as shipped from the factory). Starting with the systems that shipped with SCSI-2 buses, the systems were equipped with active terminators. Given the higher speed of the SCSI-2 bus, the active termination is required. Using passive termination on SCSI-2 systems may cause disk problems.

It cannot be overemphasized how important termination is for proper system operation. Many customer problems result from missing or improper termination.

4.4.3 ESDI Disk Interface

4.4.3.1 General Information

ESDI drives were used primarily on the early Twin Tower chassis. The drive modules that stacked on top of the power supply tower had connectors on the back of the module that connected the drive to the controller. The controller connected to the drives via I/O panel assemblies and external cables.

A drive module would have three connectors on the back. One would be the DB-25 for data to that specific drive, the other two would be DB-37's which connected to the drive and allowed for connection of a "daisy chain" cable to the next drive module. The drawing below shows such a panel.

Although it is possible to support ESDI drives and controllers on platforms in later products, it was replaced rapidly by SCSI as the default disk interface.

The ESDI interface consists of two separate connectors. One is a 37 pin Sub-D (DB-37) that carries control signals to all the drives connected to one controller. The other is a 25 pin Sub-D (DB-25) that carries data to one specific drive. The actual ESDI interface is via a 34 and 20 pin flat cable, but for ease of external connection, the DB-37 and DB-25 connectors were used.

4.4.3.2 Connector Drawings

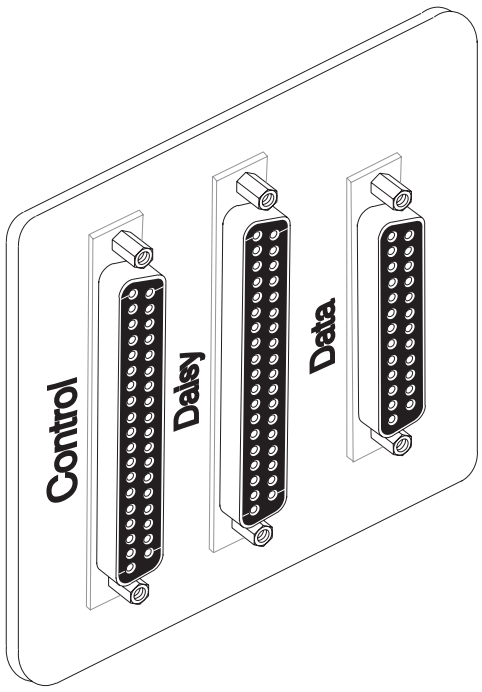

Figure 4-24 ESDI Drive Module Plate

4.4.3.3 Pinout

Table 4-34 ESDI Control Cable Pinout (J1/P1)

Pin Number	Signal Name	Pin Number	Signal Name
1	-Host Reset	21	Reserved
2	Ground	22	Ground
3	+Host Data 7	23	-Host IOW
4	+Host Data 8	24	Ground
5	+Host Data 6	25	-Host IOR
6	+Host Data 9	26	Ground
7	+Host Data 5	27	Reserved
8	+Host Data 10	28	+Host ALE
9	+Host Data 4	29	Reserved
10	+Host Data 11	30	Ground
11	+Host Data 3	31	+Host IRQ 14
12	+Host Data 12	32	+Host IO16
13	+Host Data 2	33	+Host ADDR1
14	+Host Data 13	34	-Host PDIAG
15	+Host Data 1	35	+Host ADDR0
16	+Host Data 14	36	+Host ADDR2
17	+Host Data 0	37	-Host CS0
18	+Host Data 15	38	-Host CS1
19	Ground	39	-Host SLV/ACT
20	Key	40	Ground

Table 4-35 ESDI Data Cable Pinout (J2/P2)

Pin Number	Signal Name	Pin Number	Signal Name
1	-Drive Selected	11	-Read Reference Clock
2	-Sector Address Mark Found	12	Ground
3	-Seek Complete	13	+NRZ Write Data
4	-Address Mark Enabled	14	-NRZ Write Data
5	-REserved for Step Mode	15	Ground
6	Ground	16	Ground
7	+Write Clock	17	+NRZ Read Data
8	-Write Clock	18	-NRZ Read Data
9	-Cartridge Changed	19	Ground
10	+Read Reference Clock	20	-Index

4.4.4 SMD Disk Interface

Like ESDI, SMD disks require two cables - one control cable that connects to all the drives and one data cable for each drive. Both the control and data connectors are 62 pin “D” connectors (DB62). The I/O plate with the control connector is marked “Control” while the data connector I/O panel will be marked “Disk 0”, “Disk 1”, “Disk 2” or “Disk 3”.

4.4.4.1 Connector Drawings

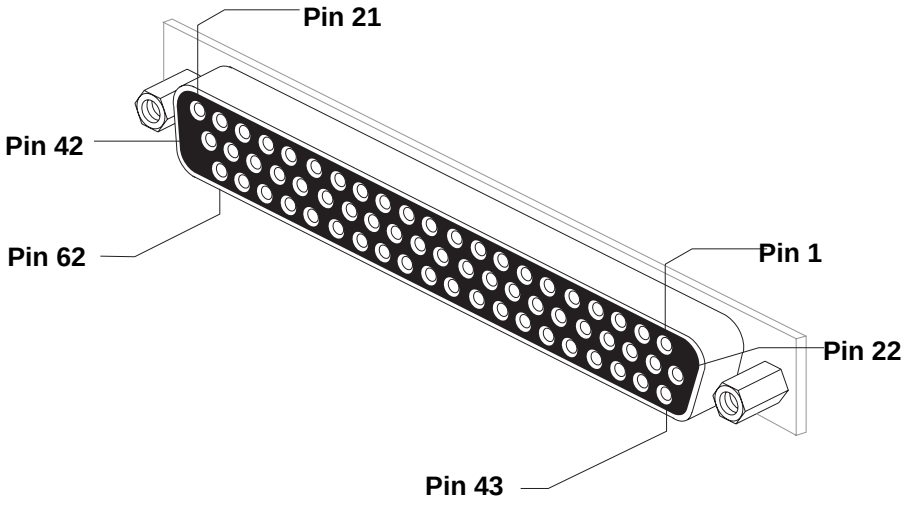

Figure 4-25 SMD Connector

4.4.4.2 Pinout

Table 4-36 SMD Data Connector Pinout

Signal Name	Description	Signal Pin (Low)	Signal Pin (High)
svock		22	46
rddata	read data	43	27
rdck	read clock	2	6
wtck	write clock	3	28
wtdata	write data	44	48
unsel	unit select	29	45
skend		25	8
gnd	ground	1, 4, 7, 23, 24, 30, 47, 49	
N/C	No connection	5, 9, 26, 50	

Table 4-37 SMD Control Connector Pinout

Signal Name	Description	Signal Pin (Low)	Signal Pin (High)
tag1		1	32
tag2		22	52
tag3		43	53
bit0	data bit 0	23	33
bit1	data bit 1	2	12
bit2	data bit 2	3	13
bit3	data bit 3	24	34
bit4	data bit 4	44	54
bit5	data bit 5	45	55
bit6	data bit 6	25	35
bit7	data bit 7	4	14
bit8	data bit 8	5	15
bit9	data bit 9	26	36
bit10	data bit 10	11	21
ocdl		46	56
fltl		47	57
skerr		27	37
oncyl	on cylinder	6	16
index		7	17
ready		28	38
addm		58	48
dpbusy		49	59
unseltag		29	39
unsel1		8	18
unsel2		9	19
sp		30	40
unsel4		50	60
unsel8		51	61
wtpot		31	41
gnd	ground	10, 20	

4.4.5 IPI Disk Interface

The IPI controller has two ports. Each port can control four drives. The single, 50 conductor cable carries the signals to all the drives. A daisy chain cable connects the drive signals from one drive to the next. This is typically done internal to the drive chassis or drive tray. Pinout for this connection is in Table 4-38.

4.4.5.1 Connector Drawings

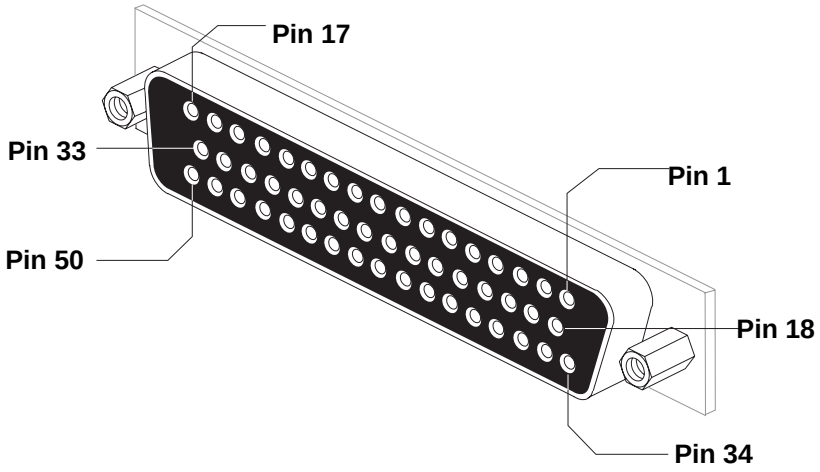

Figure 4-26 IPI Connector

4.4.5.2 Pinout

Table 4-38 IPI Disk Interface Pinout (3 Row DB-50)

Signal Name	Signal Pin (Low)	Signal Pin (High)
ATTN	4	20
SYO	25	41
SLI	23	39
SYI	48	15
MO	29	45
SEL0	27	43
BB0	16	32
BB1	33	49
BB2	36	3
BB3	40	7
BB4	8	24
BB5	42	9
BB6	2	18
BB7	19	36
BBP	50	17
BA0	46	13
BA1	14	30
BA2	6	22
BA3	10	26
BA4	44	11
BA5	12	28
BA6	21	37
BA7	38	5
BAP	31	47
GND	1,34	

4.4.6 SCSI-1 Interface (Centronics)

4.4.6.1 Connector Drawing

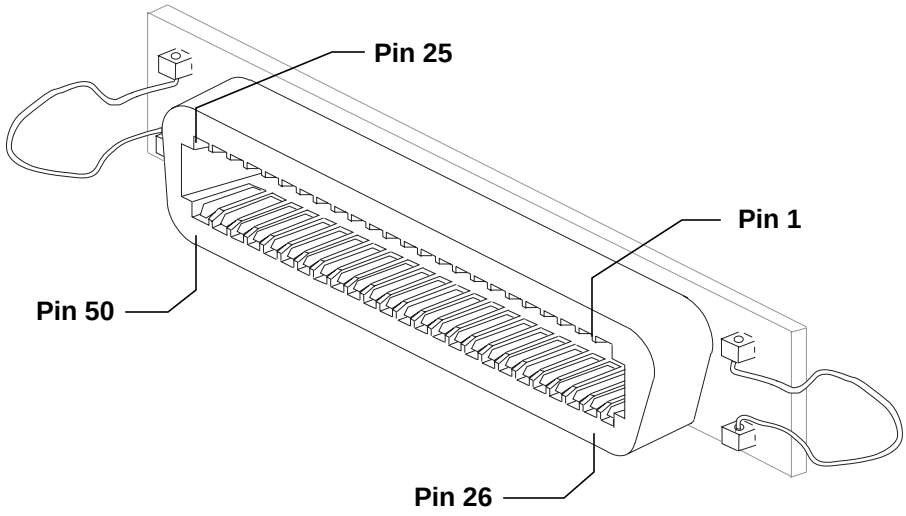

Figure 4-27 SCSI-I (Centronics) Connector

4.4.6.2 Termination

Termination is typically done via a separate terminator assembly. This assembly usually is placed on the external SCSI connector.

Systems shipped with SCSI-1 capability were equipped with a passive terminator for attaching to the end of the SCSI bus (the SCSI bus connector as shipped from the factory).

Starting with the systems that shipped with SCSI-2 buses, the systems were equipped with active terminators. Given the higher speed of the SCSI-2 bus, the active termination is required. Using passive termination on SCSI-2 systems may cause disk problems.

It cannot be overemphasized how important termination is for proper system operation. Many customer problems result from missing or improper termination.

4.4.6.3 Pinout

Table 4-39 SCSI-1 (Centronics) Connector Pinout

Signal Name	Description	Signal Pin	Ground Pin
DB0	Data Bit 0	2	1
DB1	Data Bit 1	4	3
DB2	Data Bit 2	6	5
DB3	Data Bit 3	8	7
DB4	Data Bit 4	10	9
DB5	Data Bit 5	12	11
DB6	Data Bit 6	14	13
DB7	Data Bit 7	16	15
DBP	Data Parity Bit	18	17
GND	Ground	20	19
GND	Ground	22	21
GND	Ground	24	23
TRMPWR	Terminator Power (4V SCSI-1, 4.25V SCSI-2)	26	
GND	Ground	28	27
GND	Ground	30	29
ATN	Attention	32	31
GND	Ground	34	33
BSY	Busy	36	35
ACK	Acknowledge	38	37
RST	Reset	40	39
MSG	Message	42	41
SEL	Select	44	43
C/D	Control/Data	46	45
REQ	Request	48	47
I/O	Input/Output	50	49

4.4.7 SCSI-2 (Narrow) High Density Interface

4.4.7.1 Connector Drawing

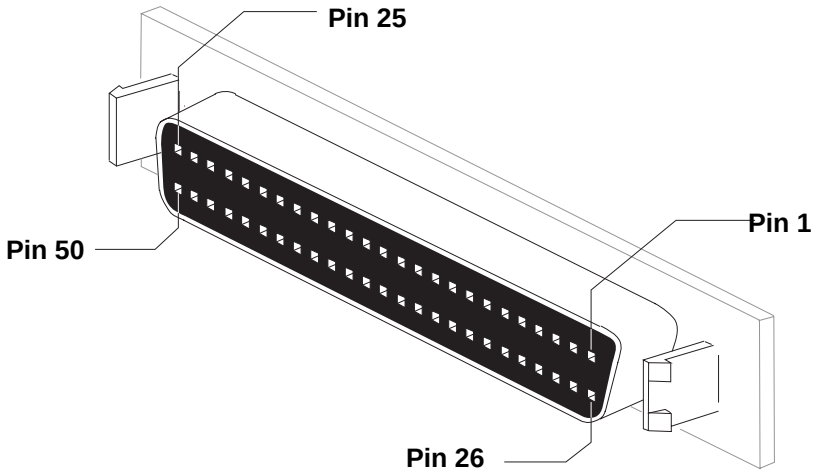

Figure 4-28 SCSI-2 (Narrow) High Density Connector

4.4.7.2 Pinout

The pinout for the SCSI-2 High Density connection is the same as for the SCSI-1 (Centronics) connection. Consult Table 4-39, on page -50, for that pinout.

4.4.7.3 Termination

Termination is typically done via a separate terminator assembly. This assembly usually is placed on the external SCSI connector.

Systems shipped with SCSI-1 capability were equipped with a passive terminator for attaching to the end of the SCSI bus (the SCSI bus connector as shipped from the factory).

Starting with the systems that shipped with SCSI-2 buses, the systems were equipped with active terminators. Given the higher speed of the SCSI-2 bus, the active termination is required. Using passive termination on SCSI-2 systems may cause disk problems.

It cannot be overemphasized how important termination is for proper system operation. Many customer problems result from missing or improper termination.

4.4.8 SCSI-2 Wide Interface

Both the single ended and differential types of SCSI-2 connections use the same 68 pin connector. The pinouts are slightly different. The tables that follow show the pinouts for each type of connection.

4.4.8.1 Connector Drawing

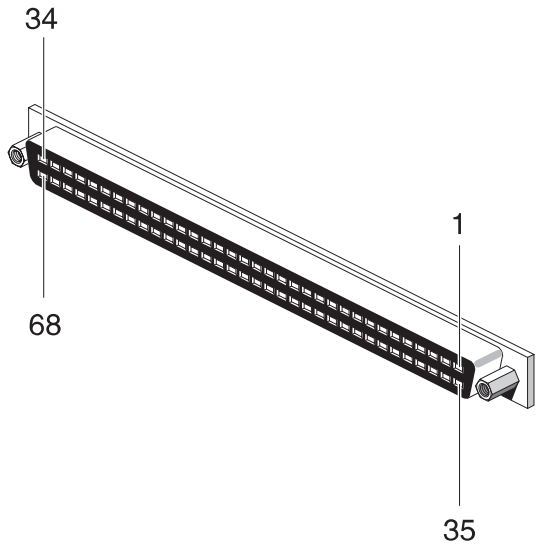

Figure 4-29 SCSI-2 (Wide) Hi Density Connector

4.4.8.2 Single Ended Pinout

Table 4-40 SCSI-2 Wide, Single Ended Connector Pinout

Pin	Signal Name	Description
1	GND	Ground
2	GND	Ground
3	GND	Ground
4	GND	Ground
5	GND	Ground
6	GND	Ground
7	GND	Ground
8	GND	Ground
9	GND	Ground
10	GND	Ground
11	GND	Ground
12	GND	Ground
13	GND	Ground
14	GND	Ground
15	GND	Ground
16	GND	Ground
17	TERMPWR	Terminator Power
18	TERMPWR	Terminator Power
19	RESERVED	Reserved
20	GND	Ground
21	GND	Ground
22	GND	Ground
23	GND	Ground
24	GND	Ground
25	GND	Ground
26	GND	Ground
27	GND	Ground
28	GND	Ground
29	GND	Ground
30	GND	Ground
31	GND	Ground
32	GND	Ground
33	GND	Ground
34	GND	Ground

Pin	Signal Name	Description
35	-DB(12)	Data Bit 12
36	-DB(13)	Data Bit 13
37	-DB(14)	Data Bit 14
36	-DB(15)	Data Bit 15
39	-DB(P1)	Data Parity Bit 1
40	-DB(0)	Data Bit 0
41	-DB(1)	Data Bit 1
42	-DB(2)	Data Bit 2
43	-DB(3)	Data Bit 3
44	-DB(4)	Data Bit 4
45	-DB(5)	Data Bit 5
46	-DB(6)	Data Bit 6
47	-DB(7)	Data Bit 7
48	-DB(P)	Data Parity Bit 0
49	GND	Ground
50	GND	Ground
51	TERMPWR	Terminator Power
52	TERMPWR	Terminator Power
53	RESERVED	Reserved
54	GND	Ground
55	-ATN	Attention
56	GND	Ground
57	-BSY	Busy
58	-ACK	Acknowledge
59	-RST	Reset
60	-MSG	Message
61	-SEL	Select
62	-C/D	Control/Data
63	-REQ	Request
64	-I/O	Input/Output
65	-DB(8)	Data Bit 8
66	-DB(9)	Data Bit 9
67	-DB(10)	Data Bit 10
68	-DB(11)	Data Bit 11

4.4.8.3 DIfferential Pinout

Table 4-41 SCSI-2 Wide, Differential Connector Pinout

Pin	Signal Name	Description
1	+DB(12)	Data Bit 12
2	+DB(13)	Data Bit 13
3	+DB(14)	Data Bit 14
4	+DB(15)	Data Bit 15
5	+DB(P1)	Data Parity Bit 1
6	GND	Ground
7	+DB(0)	Data Bit 0
8	+DB(1)	Data Bit 1
9	+DB(2)	Data Bit 2
10	+DB(3)	Data Bit 3
11	+DB(4)	Data Bit 4
12	+DB(5)	Data Bit 5
13	+DB(6)	Data Bit 6
14	+DB(7)	Data Bit 7
15	+DB(P)	Data Parity Bit 0
16	DIFFSENS	DIfferential Sense
17	TERMPWR	Terminator Power
18	TERMPWR	Terminator Power
19	RESERVED	Reserved
20	+ATN	Attention
21	GND	Ground
22	+BSY	Busy
23	+ACK	Acknowledge
24	+RST	Reset
25	+MSG	Message
26	+SEL	Select
27	+C/D	Control/Data
28	+REQ	Request
29	+I/O	Input/Output
30	GND	Ground
31	+DB(8)	Data Bit 8
32	+DB(9)	Data Bit 9
33	+DB(10)	Data Bit 10
34	+DB(11)	Data Bit 11

Pin	Signal Name	Description
35	-DB(12)	Data Bit 12
36	-DB(13)	Data Bit 13
37	-DB(14)	Data Bit 14
38	-DB(15)	Data Bit 15
39	-DB(P1)	Data Parity Bit 1
40	GND	Ground
41	-DB(0)	Data Bit 0
42	-DB(1)	Data Bit 1
43	-DB(2)	Data Bit 2
44	-DB(3)	Data Bit 3
45	-DB(4)	Data Bit 4
46	-DB(5)	Data Bit 5
47	-DB(6)	Data Bit 6
48	-DB(7)	Data Bit 7
49	-DB(P)	Data Parity Bit 0
50	GND	Ground
51	TERMPWR	Terminator Power
52	TERMPWR	Terminator Power
53	RESERVED	Reserved
54	-ATN	Attention
55	GND	Ground
56	-BSY	Busy
57	-ACK	Acknowledge
58	-RST	Reset
59	-MSG	Message
60	-SEL	Select
61	-C/D	Control/Data
62	-REQ	Request
63	-I/O	Input/Output
64	GND	Ground
65	-DB(8)	Data Bit 8
66	-DB(9)	Data Bit 9
67	-DB(10)	Data Bit 10
68	-DB(11)	Data Bit 11

4.4.9 Single Ended Ultra SCSI

The Ultra SCSI interface is a 16 bit, single-ended interface. It is basically a faster version of the SCSI-2 Wide as documented in section 4.4.8. While the pin count on the interface connector is the same - 68 pins, the type of connector is different, especially in the area of the way the external connector is secured to the system.

Care must be taken when adding 8-bit SCSI devices to an Ultra SCSI bus. For proper operation, the upper data and control lines must be terminated using a specially constructed cable or adapter. In addition, any 8-bit devices should be placed at the end of the bus.

If there are any ultra SCSI compatible devices on the bus, the maximum bus length is 1.5 meters.

The pinout for this connection is almost identical to that shown in Table 4-40, “SCSI-2 Wide, Single Ended Connector Pinout”, on page 4-53. The difference is with pins 17, 18 and 19. For the Ultra SCSI interface these pins are all ground connections.

4.4.9.1 Connector Drawing

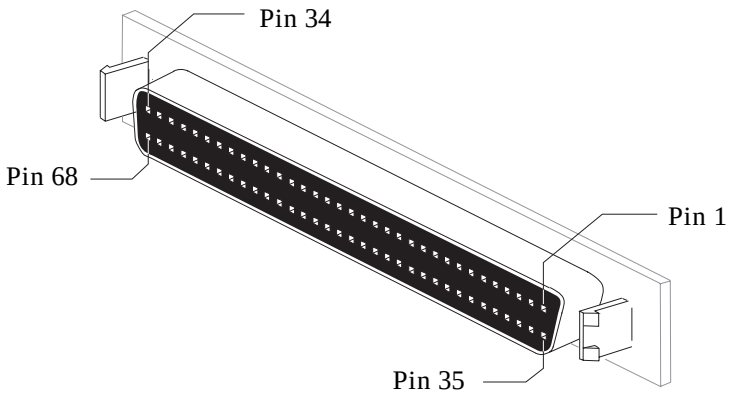

Figure 4-30 Ultra SCSI Connector

4.4.9.2 Pinout

Table 4-42 Single Ended Ultra SCSI Connector Pinout

Pin	Signal Description	Pin	Signal Description
1	Ground	35	-DB(12)
2	Ground	36	-DB(13)
3	Ground	37	-DB(14)
4	Ground	38	-DB(15)
5	Ground	39	-DB(P1)
6	Ground	40	-DB(0)
7	Ground	41	-DB(1)
8	Ground	42	-DB(2)
9	Ground	43	-DB(3)
10	Ground	44	-DB(4)
11	Ground	45	-DB(5)
12	Ground	46	-DB(6)
13	Ground	47	-DB(7)
14	Ground	48	-DB(P)
15	Ground	49	Ground
16	Ground	50	Ground
17	Ground	51	TERMPWR
18	Ground	52	TERMPWR
19	Ground	53	OPEN
20	Ground	54	GROUND
21	Ground	55	-ATN
22	Ground	56	GROUND
23	Ground	57	-BSY
24	Ground	58	-ACK
25	Ground	59	-RST
26	Ground	60	-MSG
27	Ground	61	-SEL
28	Ground	62	-C/D
29	Ground	63	-REQ
30	Ground	64	-I/O
31	Ground	65	-DB(8)
32	Ground	66	-DB(9)
33	Ground	67	-DB(10)
34	Ground	68	-DB(11)