SCSI Bus CONVERTER

Single-Ended to/from Differential

for 'UltraSCSI'

MODEL #SED-608/616SHF

USER's MANUAL

Revision: 2.0

March 1997
(Converted November 2002)

ANCOT CORPORATION

1024 Hamilton Court
Menlo Park, California 94025
Tel: (415) 322-5322 Fax: (415) 322-0455 e-mail: sales@ancot.com
Web page: http://www.ancot.com

Part # 60018-020

FEDERAL COMMUNICATIONS COMMISSION NOTICE:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna,
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio or television technician for help.

MODIFICATIONS:
The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by ANCOT Corporation may void the user's authority to operate the equipment.

CABLES:
Connections to this equipment must be made with shielded cables with metallic RFI/EMI connector hoods to maintain compliance with FCC Rules and Regulations.

EUROPEAN NOTICE:

Products with the CE Marking comply with both the EMC Directive (89/336/EEC) and the Low Voltage Directive (73/23/EEC) issued by the Commission of the European Community.
Compliance with these directives implies conformity to the following European Norms (in brackets are the equivalent international standards):

- EN55022 (CISPR 22)-Radio Frequency Interference
- EN50082-1 (IEC 801-2, IEC 801-3, IEC 801-4)-Electromagnetic Immunity
- EN60950 (IEC 950)-Product Safety

NOTE:
The SED converter has been tested to comply with the EN55022 and EN50082-1 standards.Only 5 volt DC is used in the SED converter, therefore EN60950 certification is not required. The external power supply has been tested to comply with all three standards - the EN55022, EN50082-1, and EN60950.

TABLE OF CONTENTS

Paragraph: **Page:**

SECTION 1.
INTRODUCTION

1.1 General 1
1.2 Product highlights 2
1.3 Switching characteristics 2
1.4 Power requirements 2
1.5 FCC and CE certification 2
1.6 MTBF 3
1.7 Ordering information 3
1.8 Warranty 4

SECTION 2.
SETUP AND INSTALLATION

2.1 Board setup 5
2.2 Installation 6

SECTION 3.
OPERATION

3.1 Theory of operation 7
3.2 Performance consideration 8
3.3 SCSI bus extenders & signal quality 9
3.4 SCSI-2 FAST & UltraSCSI 10
3.5 Synchronous & asynchronous 10
3.6 Software integration 10

APPENDIX A.
CONNECTORS, DIP SWITCH & POWER

A.1 SCSI connectors 11
A.2 DIP switch 12
A.3 LED indicators 12
A.4 Power connectors 13

APPENDIX B.
SCSI FACTS & TIPS

B.1 Cabling 14
B.2 Electrical connection on the SCSI bus 14
B.3 Termination 15
Single-Ended 16
HVD (High Voltage Differential) 16
LVD (Low Voltage Differential) 17
B.4 The Termination Power ('TERMPWR') 17
B.5 SCSI Initiators & Targets 18
B.6 Wide & Fast & UltraSCSI 18
B.7 SCSI device addressing & SCAM 19
B.8 SCSI data parity 20
B.9 Mixing SE & Diff SCSI devices 20
B.10 SCSI signal quality 20
B.11 SCSI cable length 21
B.12 Extending the SCSI cable 22

APPENDIX C.
BIBLIOGRAPHY

C.1 Bibliography 23

SECTION 1.

INTRODUCTION

1.1 GENERAL

SCSI Bus devices use either the Single-Ended or differential interfaces, which cannot be mixed directly on the same bus. The Ancot SED converters allow inter-connection of the two interfaces; by using SED converters, a SCSI Host Bus Adapter with Single-Ended (or Differential) interface can communicate with a mix of peripherals - some with Single-Ended, and some with Differential interfaces. Operation of the SED converter is bi-directional.

Another application for the SED converters is using them as SCSI BUS EXTENDERS. The SCSI standard specifies maximum length for the cable to be 6 meters or 25 meters for the Single-Ended or Differential interface respectively if used at the Fast/10 rates. With two SED converters connected by a cable back-to-back, the length of the Single-Ended SCSI bus cable can be extended by another 25 meters (Differential branch), plus 6 meters (the second Single-Ended branch) to a total of 37 meters (6 + 25 + 6 meters). Length of the Differential SCSI cable can be extended by another 6 meters (Single-Ended branch), plus 25 meters (the second Differential branch) to a total of 56 meters (25 + 6 + 25 meters). Applications using Fast/20 rates ('UltraSCSI') use cables of half the Fast/10 lengths.

All signals on Ancot SED converters are received and subsequently re-generated, thus allowing extension of the total maximum cable length.

1.2 PRODUCT HIGHLIGHTS

- Allows interconnection of Single-Ended & Differential SCSI Busses
- All signals are bi-directional, and can be driven from either the Single- Ended or Differential side

- Automatic operation, no programming or setup required
- SCSI-2 NARROW (single byte) - for availability inquire with the factory -
- SCSI-2 WIDE (2 bytes) supported - SCSI-3 Fast/20 ('UltraSCSI') supported. REQ & ACK are re-synchronized and signal skew is eliminated.
- Operation at all industry supported transfer rates up to Fast/20:
  The SCSI-2 Fast/10 (10 MHz) provides 10 MBytes/s on NARROW,
  or 20 MBytes/s on WIDE bus (2 bytes). The SCSI-3 Fast/20 (20 MHz), 'UltraSCSI',
  provides 20 MBytes/s on NARROW, or 40 MBytes/s on WIDE bus (2 bytes).
- Synchronous or Asynchronous Transfer, SCSI-2/3

- Support for arbitration, parity, disconnect/reconnect, SCAM, and mix of SCSI Targets and Initiators on either side
- SCSI bus termination built-in: Single-Ended side has active terminator, Differential side has resistor type terminator. Both terminators enabled by DIP-Switch, and their status indicated by LEDs.
- TERMPWR to SCSI connectors is fused (auto-reset), enabled by jumpers
- CE Class A certified, comply with FCC Class A regulations
- Compact configuration, available as PCB only, or packaged in a metal enclosure with external power supply
- Uses external +5 Volt regulated Power Source

1.3 SWITCHING CHARACTERISTICS

- serial delay: less than 20 nanoseconds
- Single-Ended receivers/drivers: 74LS14/74F38/ABT125 (48mA) type
- Differential receivers/drivers: DS3695/74FCT162827/74FCT132 or equiv.

1.4 POWER & MECHANICAL

- Regulated +5 Volt, 2 Amp DC.
- External Power Source (optional) is a regulated switching AC/DC adapter.
- Dimensions:

  3.95"(W) x 5.55"(L) x .50"(H) PCB only
  4.55" x 5.94"(L) x 1.16"(H) in enclosure

The PCB can be mounted directly on a 3.5" form factor device. The SED-616SHF uses 2-56 female jackscrews with the 68-pin HD connectors.

1.5 FCC & CE CERTIFICATION

The SED-616SHF model is CE/FCC Class-B certified. The external power supply is CE, FCC, UL, and TUV certified. See the FCC notice and the European notice on the first pages of this manual.

1.6 MTBF PREDICTION

The MTBF calculations are based on MIL-HDBK-217E Notice 1, using the Parts Count Reliability Prediction method. The environment considered is Ground Benign. Calculations are for continuous operation.

SED-616: = 130,000 hours

1.7 ORDERING INFORMATION

SED-608SHF
8-bit SE to Diff Converter board supporting SCSI-2 and SCSI-3 FAST/20 ('UltraSCSI') & NARROW (single byte) with two 50-pin high density connectors

SED-616SHF
same as the above, except with support for SCSI-3 ,FAST/20 WIDE (two-bytes) bus with two 68-pin HD 'P' type connectors

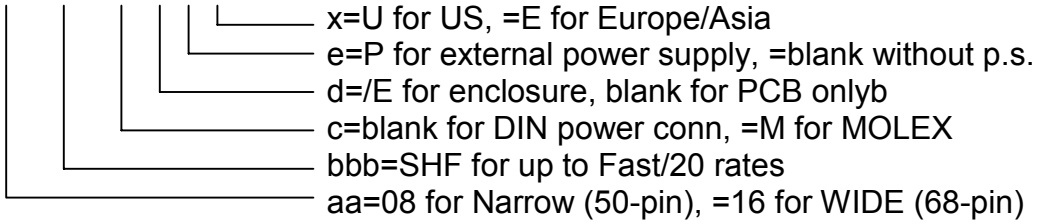
SED-616SHFM
same as the above, except with 4-pin MOLEX power connector instead of the standard DIN connector.

SED-608SHF/EPx
SED-608SHF in a metal enclosure w.ext.power supply

SED-616SHF/EPx
SED-616SHF in a metal enclosure w.ext.power supply

DEFINING THE P/N:

SED-6-aa-bbb-c/-d-e-x



1.8 WARRANTY

One year. Return to factory.

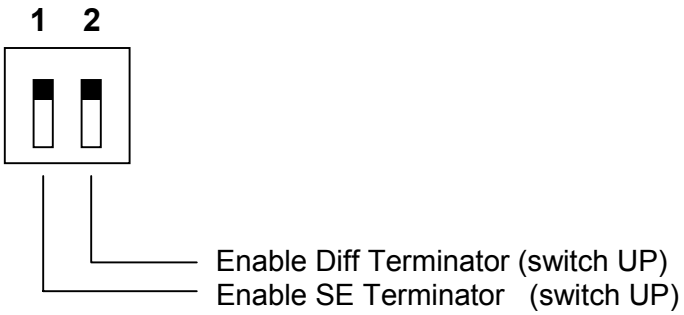
SECTION 2.

SETUP & INSTALLATION

2.1 BOARD SETUP

The SED-616SHF converters use a two position DIP Switch for enabling termination on the SE side and on the Differential side. They use two LEDs to indicate the status.

The DIP SWITCH setting is as follows:



The TERMPWR in both connectors (SE and Diff side) is enabled (as a default). It can be disabled by an internal jumper. It supplies 4.5Volt to the TERMPWR pin(s) on the SCSI connector, separate for each side. The internal built-in terminators (SE and the Diff) also use the same TERMPWR source.

TERMPWR, generated on the SED board is derived from the VCC using a Schotky diode, providing 4.5 Volt. The diode protects the on-board VCC against drain-in from outside sources. TERMPWR is protected against external shorts by an auto-resetting serial circuit breaker.

The **SE TERMINATOR** is enabled by the DIP switch pos. -1 (in the UP position).
The **Diff TERMINATOR** is enabled by the DIP switch pos. -2 (in the UP position).

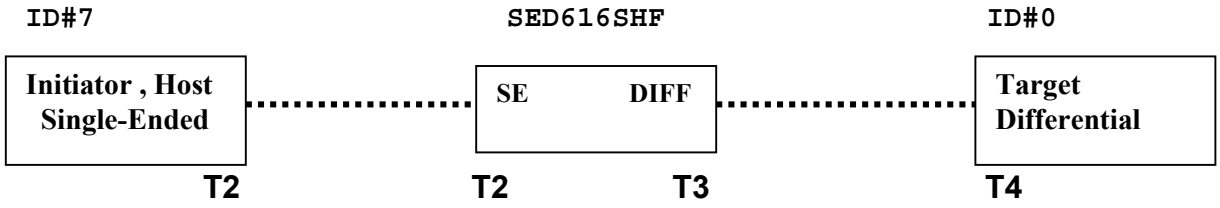
Two **LED Indicators** are positioned near the DIP switch on the SE side. The upper one indicates POWER and the lower one indicates BUSY.

POWER for the SED converter is supplied externally. It uses a 5-pin DIN receptacle

type connector with +5Volt on pin 1 and 5, and the GROUND on remaining pins. Optionally, a MOLEX 4-pin male connector may be installed (at the factory). The pinout is the same as in the standard PC/AT chassis. The SED does not use 12 Volt, and the corresponding two pins on the MOLEX connector are not connected. You can use standard MOLEX power plugs provided in the PC/AT chassis.

2.2 INSTALLATION

The SED converter needs to be connected in the SCSI bus between the host (SCSI Initiator) and the device (SCSI target), when the host and the device have different interfaces: one with SE and the other with Differential. Physically, the SED converter is connected with its SE side to the SE device, and with its Diff side to the Diff device, thus creating two SCSI bus segments. Each of the physical segments is separate, and has to have its own two terminators matching the interface used (SE or Diff). Logically however, both physical segments appear to all SCSI devices as a single SCSI bus. Therefore, make sure that SCSI ID's are not duplicated. E.g. you can NOT have ID=0 on the SE segment and ID=0 also on the Diff segment.



This figure shows two separate SCSI busses (cables): the Single-Ended (SE) on the host side, and the Differential (DF) on the peripheral side. The 'T1' and 'T2' are SE terminators for the SE bus segment, the 'T3' and 'T4' are Differential terminators for the Differential bus segment. The 'T1' is usually built in the host adapter, the 'T2' and 'T3' are (built-in) on the SED converter, and the 'T4' is in the Target device. The 'T2' terminator in the SED converter is the SE 'active' type (enabled by DIP switch), the 'T3' terminator is the resistor network type in the Differential side (enabled by DIP switch).

SECTION 3.

OPERATION

3.1 THEORY OF OPERATION

The SED-608/616SHF SCSI bus interface converter is a non-addressable, logically transparent device. It is a passive device, which does not use any SCSI ID, and therefore allows a full number of SCSI devices to be used on the bus. SCSI devices, each with its own SCSI ID, can be distributed in any combination across the bus, on the SE and on the Diff side. Also, there is no limitation on the number or position of SCSI Targets or Initiators; any combination of Targets and Initiators is allowed on either side of the bus, as long as the total number of devices (SCSI ID's) does not exceed maximum count of eight on the 8-bit bus (SED-608), or sixteen on the 16-bit (SCSI-2/3 WIDE) bus (SED-616), and as long as SCSI IDs are not duplicated.

SCSI commands execute in phases. The SED converter is designed to switch the inter-connection of individual signal lines in changing directions, depending on positions of the currently active SCSI Initiator and Target, and also depending on execution phase of the current command. The switching is controlled by a built-in high speed state machine. In the following paragraphs we will explain how the internal switching works.

All SCSI commands start with the ARBITRATION phase, during which it is decided which device owns the bus (if more than one device arbitrate at the same time). During this initial stage, the SED converter is trying to detect activity on each line of the SCSI bus from either direction - from the SE or the Diff connector. It enables driver/receiver direction on each active signal line.

Next is the SELECTION phase (or RESELECTION phase if I/O line is driven). In this stage the Initiator tries to select a Target, and the Target responds giving the state machine (in the SED) enough information so that it can predict the direction on all remaining signal lines.

In the following information transfer phases (Data In/Out,..) the converter switches the direction of data flow depending on the polarity of the I/O signal. The end of a command is recognized when the BSY signal is deasserted, and at this stage all drivers are disabled.

The SCAM protocol is also fully supported.

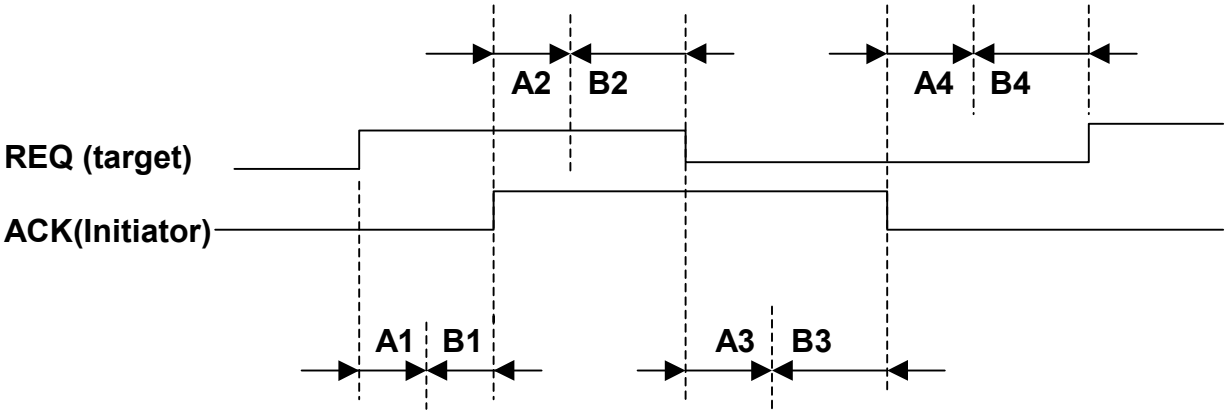
The SED converters, when used at the 'UltraSCSI' (Fast/20) transfer rates, operate under tighter timing conditions (than with the Fast/10 or slower rates). The setup and hold times are much shorter and the signal skew in the cable is extremely critical. For this reason, the 'UltraSCSI' converters re-synchronize all signals; the received signals

are (internally) latched and the data is re-positioned relative to REQ and ACK signals before being clocked out on the other side. The REQ and ACK strobes, if narrower than permitted by the SCSI specification, are always latched and re-generated to 15 nanosecond minimal width.

The SED-616SHF, if used in WIDE and FAST/20 mode ("UltraSCSI'), provides 40MBytes/sec throughput in the data phases. If used in NARROW (use a 68-to-50 pin connector adapter) and FAST/20 mode, it provides 20 MBytes/sec throughput.

3.2 PERFORMANCE CONSIDERATION

The SED converter receives all signals from one side (either SE or Diff) and then drives the outputs on the other side (either Diff or SE). As you can see, the SED converter effectively inserts one receiver and one driver in series in each signal line, and consequently introduces certain delay, which should be considered. The delay is minimized by using high performance fast circuits, but it still results in a typical delay of 35 nanoseconds (55 nanoseconds max), marked 'An' in the following timing diagram.



Considering a system with infinitely short cable (propagation delay = 0), delays 'A1' through 'A4' are the delays in the receiver/driver circuitry of the SED converter. Delays 'B2' and 'B4' are internal in the Target inherent to each particular design/model. Delays 'B1' and 'B3' are analogous delays in the Initiator.

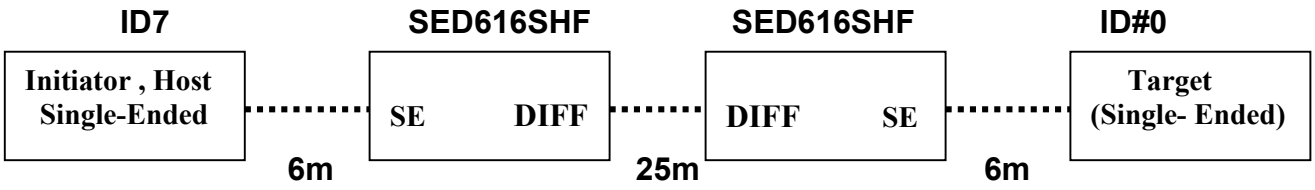
The effect of the SED internal delays ('A1' to 'A4') differs if considered for synchronous or asynchronous transfer modes. In synchronous modes, the effect is minimal, since it causes merely an offset of the entire data block by the 'A1'+'A2' `or 'A3'+'A4' value. In asynchronous modes however, the effect is cumulative; each REQ-ACK pair is delayed by 'A1'+'A2'+'A3'+'A4' value. This delay typically is still negligible compared to delay in the cable itself, however. We should also mention here that the asynchronous transfer mode is used for data transfer in systems where high performance is not a requirement.

3.3 SCSI BUS EXTENDERS & SIGNAL QUALITY

All signals are received and regenerated by on-board receivers and drivers and therefore there is no degradation of signal quality in the SED converter. For this same reason, the SED converters can also be used as line repeaters to extend the length of the SCSI cable. Remember however, that each SED connected in series adds a certain delay in the effective overall connection (in addition to delay in the cable), and maximum delay should not be exceeded (critical for allowable delays during the arbitration phase); we would not recommend using more than two pairs of SED converters in series.

See section B.9 for examples of SCSI bus extender configurations.

Example of an extended SCSI bus:



With two SED converters, the maximum length of a SCSI cable can be 37 meters (6m + 25m + 6m) if used with up to 5 MHz speeds. The lengths are shorter for Fast/20.

3.4 SCSI-2 FAST and 'UltraSCSI'

The SED converters support all SCSI-1, SCSI-2 or SCSI-3 specified transfer rates, including the 20 MHz FAST/20 with its associated timing.

The FAST rate (also refered to as FAST/10) allows throughput of 10 MBytes/sec over the NARROW bus (single-byte), or 20 MBytes/sec over the WIDE bus (two bytes).

If used at the FAST/20 rates (20 MHz, also called 'UltraSCSI') defined in the SCSI-3 specification, the SED converters allow throughput of 20 MBytes/sec over the NARROW or 40 MBytes/sec over the WIDE SCSI bus.

3.5 SYNCHRONOUS & ASYNCHRONOUS MODES

The SCSI specification allows two transmission modes: synchronous and asynchronous. The two modes differ in the way the strobe signals REQ and ACK handshake. They may either interlock (asynchronous) or not (synchronous). Some SCSI devices use asynchronous only, some use both modes. Actually, the 'synchronous devices' use the synchronous mode for data transmission phases only, and asynchronous mode for all other phases within the same command. Hosts can communicate with some devices in synchronous, with other devices in asynchronous, while both these devices are residing on the same SCSI cable.

The synchronous and asynchronous modes are transparent to the SED converter, and are not affected by it in any way.

3.6 SOFTWARE INTEGRATION

The SED converter is not a logically active SCSI device, and as such does not use SCSI ID. There is no need for setting up configuration, except for enabling termination and TERMPWR. The SED converter is transparent to the host's operation, and software installation or modification is not needed. See Section 2 for details on configuration.

A P P E N D I X A.

CONNECTORS, DIP SWITCH, POWER

A.1 SCSI CONNECTORS

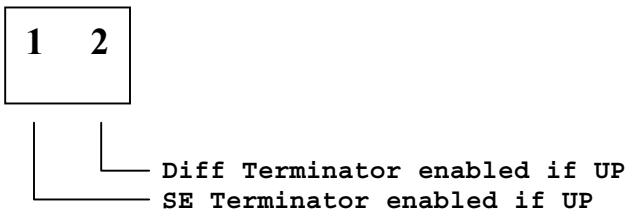
The JP1 and JP2 connectors on the SED-616SHF model are of the 68-pin female high-density 'P' type, wired for WIDE (2 bytes). JP1 is wired for single-ended, and JP2 for differential interface.

Model SED616SHF :

JP1 - Single-Ended				JP2 - Differential			
1	GND	35	D12-	1	D12+	35	D12-
2	GND	36	D13-	2	D13+	36	D13-
3	GND	37	D14-	3	D14+	37	D14-
4	GND	38	D15-	4	D15+	38	D15-
5	GND	39	DPARH-	5	DPARH+	39	DPARH-
6	GND	40	D0-	6	GND	40	GND
7	GND	41	D1-	7	D0+	41	D0-
8	GND	42	D2-	8	D1+	42	D1-
9	GND	43	D3-	9	D2+	43	D2-
10	GND	44	D4-	10	D3+	44	D3-
11	GND	45	D5-	11	D4+	45	D4-
12	GND	46	D6-	12	D5+	46	D5-
13	GND	47	D7-	13	D6+	47	D6-
14	GND	48	DPAR-	14	D7+	48	D7-
15	GND	49	GND	15	DPAR+	49	DPAR-
16	GND	50	GND	16	DIFFSENS	50	GND
17	TRMPWR	51	TRMPWR	17	TRMPWR	51	TRMPWR
18	TRMPWR	52	TRMPWR	18	TRMPWR	52	TRMPWR
19	reserved	53	reserved	19	reserved	53	reserved
20	GND	54	GND	20	ATN+	54	ATN-
21	GND	55	ATN-	21	GND	55	GND
22	GND	56	GND	22	BSY+	56	BSY-
23	GND	57	BSY-	23	ACK+	57	ACK-
24	GND	59	RST-	25	MSG+	59	MSG-
26	GND	60	MSG-	26	SEL+	60	SEL-
27	GND	61	SEL-	27	C/D+	61	C/D-
28	GND	62	C/D-	28	REQ+	62	REQ-
29	GND	63	REQ-	29	I/O+	63	I/O-
30	GND	64	I/O-	30	GND	64	GND
31	GND	65	D8-	31	D8+	65	D8-
32	GND	66	D9-	32	D9+	66	D9-
33	GND	67	D10-	33	D10+	67	D10-
34	GND	68	D11-	34	D11+	68	D11

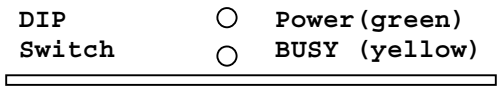
A.2 DIP SWITCH

The SED616SHF use two-position DIP SWITCH to control enabling of SE and Diff terminators.



A.3 LED INDICATORS

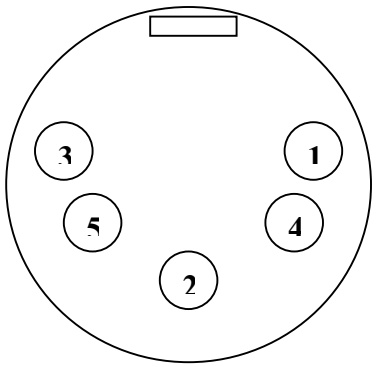
The SED-616SHF has two LEDs mounted on the SE side:



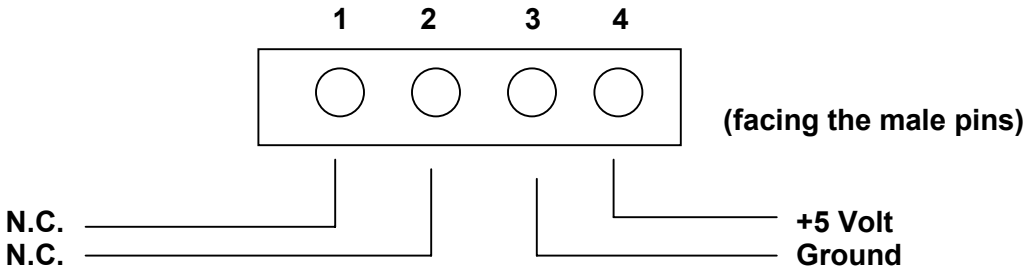
A.4 POWER CONNECTORS

The SED616SHF use a 5-pin DIN connector receptacle for 5 volt DC power.
The pin-out is as follows:

PIN # .. 1 = +5 volt
2 = Ground
3 = Ground
4 = Ground
5 = +5 volt



Optionally, the converters can be built (in the factory) with the 4-pin Molex connector. The pin-out is as follows:



APPENDIX B.

SCSI FACTS & TIPS

Before powering up the system, it is important to have all hardware correctly connected. Importance of proper cabling and termination can never be emphasized enough. Bad cabling or termination often results in erratic operation, or sometimes will cause the system not to operate at all. The erratic operation is the worst; the less frequently errors occur, the more difficult it is diagnosing their source. Speed of transmission over the bus is an important factor determining whether the marginal connection causes errors. Many existing devices on the market today transfer the data at rates under 1 MHz; the SCSI-2 specifies a FAST mode at 10 MHz with tighter timing tolerances. Devices of various speeds can be connected to the same bus, and you may find that only the faster devices cause transmission errors. This would be an important clue to consider for diagnosis.

B.1 CABLING

We recommend using good quality cables. Always use cable with twisted pairs, whether the flat or the round type. As a rule, NEVER use the non-twisted type. Its sensitivity to electrical noise and cross-talk often results in low signal quality and low electrical margin, and the resulting troubles are not worth the small financial savings. To ensure good quality, buy cables from a reputable vendor.

B.2 ELECTRICAL CONNECTION ON THE SCSI Bus

There are three alternatives: the Single-Ended, HVD (High Voltage Differential), and LVD (Low Voltage Differential) interfaces. These alternatives are mutually exclusive, and can not be mixed on the same SCSI bus system; all devices and both terminators on the same SCSI bus must use the same kind of interface. All signals should be terminated at both ends of the cable.

FAST SCSI (over 5 MHz), including FAST/20, should not use the single-ended alternative. THE FAST/40 ('Ultra-2') should use LVD only.

B.3 TERMINATION

The SCSI cable is used as a transmission line, and its termination is very important. According to the SCSI specifications, as well as to good engineering practice, the SCSI cable should be terminated on both physical ends. If more devices are connected to the

same cable, then only the physically last ones, as positioned on the SCSI cable, should have the terminators. Exactly two terminators should be used.

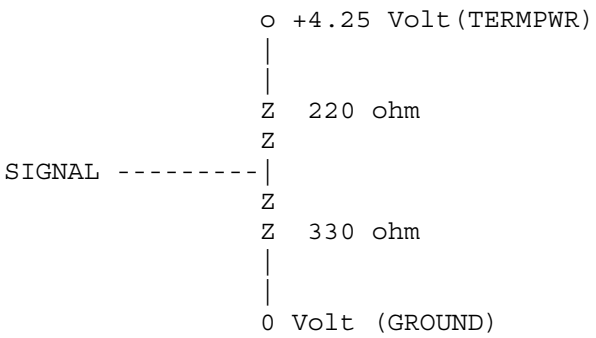
Termination is straightforward when using a SCSI adapter in the host computer connected to a single disk drive. In such case, terminators have to be installed in both: the SCSI Host Bus Adapter (HBA) and the disk. This is often the case when peripherals are built into the system, such as an internal hard disk drive.

It becomes more complicated if the same SCSI bus is connected to devices in the enclosure (to internal drives) and also to external devices (like an external CD-ROM drive or backup tape drive). In such cases, you have to determine what are the physical ends of the cable, and place terminators in those devices. Terminators in all other devices should be removed. In systems with the internal cable brought out to the back panel, where you would be attaching external peripherals (such as a backup tape drive) only occasionally, it may be practical to use one terminator permanently installed in the SCSI adapter (HBA) inside the chassis, and to use a removable external 'plug-in' terminator in the external SCSI connector on the back panel of the host chassis. This external terminator may then be removed when attaching an additional external SCSI peripheral (e.g., tape for back-up), and inserted in the second daisy chained SCSI connector on the external peripheral.

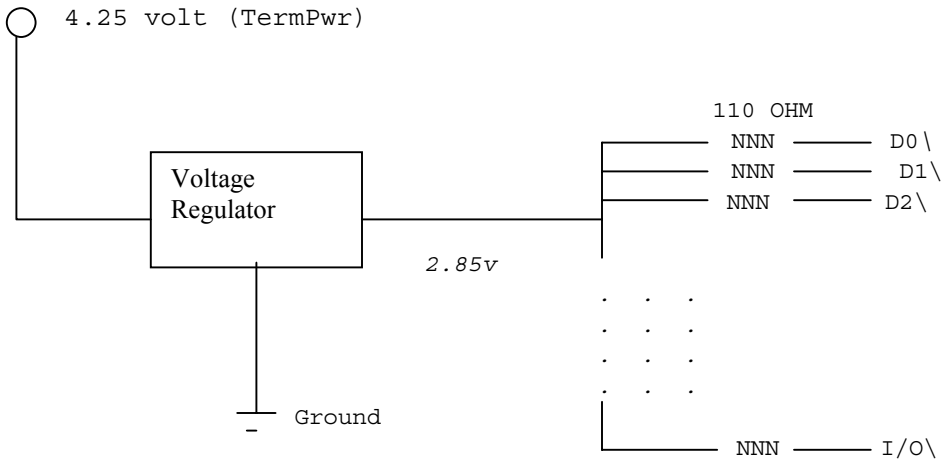
SINGLE-ENDED ALTERNATIVE

Uses transfer over a single "live" line in reference to GROUND. "True" signal is defined as a low level (0 to .8 V), and "False" signal is defined as a high level (2.0 to 5.25 V).

(passive/resistor type)



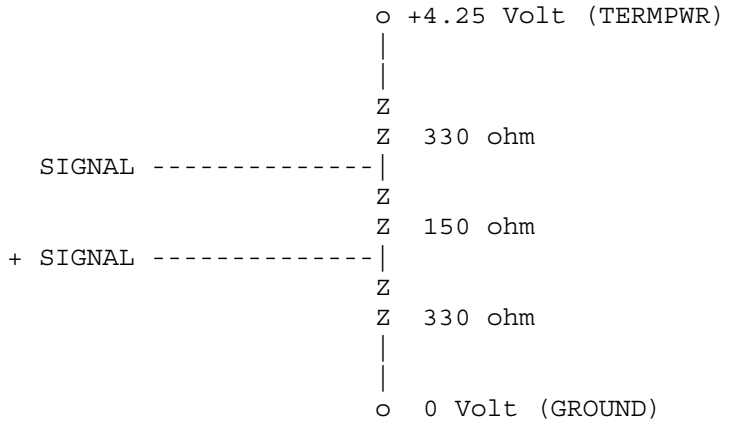
Single-Ended termination:
(active type)



HVD - HIGH VOLTAGE DIFFERENTIAL ALTERNATIVE

uses transfers over two electrically symmetrical lines denoted +SIGNAL and -SIGNAL. "True" signal is defined as +SIGNAL more positive than -SIGNAL, the "False" signal is defined as +SIGNAL more negative than -SIGNAL.

Differential termination:

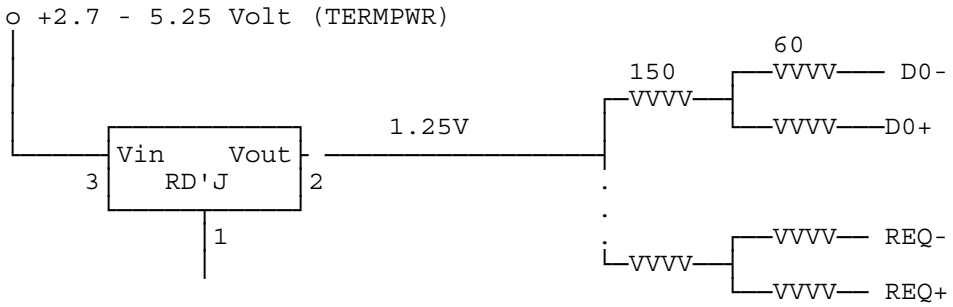


The UltraSwitch SCSI switch uses the differential interface with 'passive/resistor' type differential terminators.

LVD - LOW VOLTAGE DIFFERENTIAL ALTERNATIVE

Uses transfers over two electrically symmetrical lines denoted +SIGNAL and -SIGNAL. "True" signal is defined as +SIGNAL more positive than -SIGNAL, the "False" signal is defined as +SIGNAL more negative than -SIGNAL.

LVD termination:
(active type)



NOTE & WARNING:

It is important to remember that the terminator must match the interface type: single-ended interfaces must use single-ended terminators, HVD interfaces must use HVD terminators, and LVD interfaces must use LVD terminators. In case of single-ended terminators, there are two types available: 'passive' and 'active' type. The 'active' type SE terminator is electrically better since it provides better noise immunity. It is totally permissible to mix the two: you can use the 'passive' type on one end of the SCSI cable, and the 'active' type terminator on the other end of the same cable.

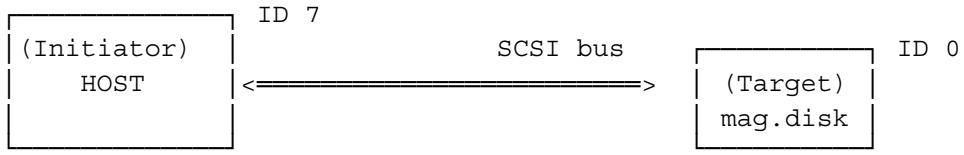
B.4 THE TERMINATION POWER ('TERMPWR'):

The terminators are often implemented as SIP resistors (the 'passive' type) which are inserted in a socket near the SCSI connector on the device itself, or on the SCSI adapter. Sometimes, the terminators are in a form of an external "through-connector" type plug-ins. The SCSI devices usually provide the power('TERMPWR') for their own terminators internally; however, do not rely on that. The TERMPWR is specified to be at least 4.0 volts (SCSI-1 spec), or 4.25 volts (the newer SCSI-2 spec). Experiments show that the higher the TERMPWR (up to 5.25 volts maximum), the better the noise immunity. Also, it is not sufficient to measure TERMPWR level at the source. Sometimes a device does not provide its own TERMPWR, and uses TERMPWR from the SCSI cable. There may be no problems if the cable is short. However, if the cable is long, then you have to consider the voltage drop across the full length of the cable. You may discover that the TERMPWR at the terminator (where it is finally used) is lower than the specified limit.

The UltraSwitch switch supplies the TERMPWR to the cables. The TERMPWR generated by the UltraSwitch is protected by an automatically resettable circuit breaker.

B.5 SCSI INITIATORS & TARGETS

There are two kinds of devices on the SCSI bus: the SCSI Initiators start the communication, and the Targets respond. The Initiators are devices, which request that commands be carried out. Targets are devices, which carry out commands. SCSI host adapters are Initiators, but at times, the host adapter may need to act as a Target for some commands. SCSI peripheral devices are Targets, but for some commands e.g., a COPY command, the peripheral may need to act as an Initiator temporarily. The single-byte SCSI bus (SCSI-1 or SCSI-2 'NARROW') supports up to eight devices, in any mix of Initiators and Targets, with the limitation that at least one Initiator and at least one Target are present.



A SCSI system may be as simple as a single computer with SCSI host adapter connected by cable to a single SCSI Target device, such as a disk drive.

B.6 WIDE & FAST & UltraSCSI

The SCSI-1 specification defines width of the data on the SCSI cable to be one byte wide, plus parity. This is called the 'NARROW' SCSI bus. The term 'WIDE' in SCSI-2 defines the two-byte or four-byte wide data interface. Each data byte has its corresponding parity bit.

The SCSI-2 FAST is also referred to as FAST/10, the '10' meaning maximum transfer rate of 10MHz. In 1993, the SCSI-3 proposed even higher rates called FAST/20 or UltraSCSI, with maximum rate of 20MHz (see ANSI standards (draft) document X3T10/1071D called "SCSI-3 FAST/20"). The FAST/20 used on a WIDE bus will allow up to 40MBytes/sec transfer rate. And as if this was not enough, work has been started in the ANSI standards committee on defining FAST/40, and perhaps even FAST/80. With increasing rates the timing requirements get progressively tighter and only shorter cables will be allowed. The very high rates, if accepted, will not be used with cables, but most likely will be used on backplane where the transmission characteristics can be better controlled. Also, all rates starting at FAST/40 will be used only in connection with LVD (Low Voltage Differential) interface.

Compatibility between devices using different speeds and timings is guaranteed by a rule which requires that all devices (SCSI-1, SCSI-2 or SCSI-3) start up in a single byte (i.e. not WIDE) and in asynchronous mode (i.e. not synchronous nor FAST). Before using synchronous, FAST, or WIDE options, the Initiator and the corresponding Target must exchange messages negotiating the width used, synchronous mode, minimum transfer period, and REQ-ACK offset. The WDTR (Wide Data Transfer Request) and SDTR (Synchronous Data Transfer Request) negotiation is executed for each Target individually, allowing for a mix of transfer modes on the same bus.

Synchronous transfer mode as well as FAST and WIDE are optional and are used for data phases only. All other phases (message, command, or status) always use the standard asynchronous mode. When enabled, the synchronous FAST and WIDE are used in data phases of all commands, not only in Read or Write, but also in Inquiry, Request Sense, Mode Select, etc.

B.7 SCSI DEVICE ADDRESSING & SCAM

Each device on a SCSI cable must use its own ID# address. The SCSI ID# (initiator or target address) of each SCSI device connected must be selected by setting the proper jumpers or switches on the SCSI device itself. Each ID# must be unique; duplicate addresses may hang the whole SCSI bus, or may result in unpredictable behavior. This latter case may be very difficult to identify. You may not need to worry about ID#s on working systems. However, as a rule, always verify SCSI ID# selections when adding a new device to an existing SCSI system. Most SCSI peripherals are shipped from the factory with SCSI ID# set to 0.

The UltraSwitch switch is not an active SCSI device, and therefore does not use a SCSI ID#. Logically, it is transparent to the SCSI system; it may show as a small delay (4 nanoseconds, usually negligible), an equivalent of an additional 3 feet of cable.

Some of the newer SCSI devices (starting in 1994) can have their SCSI IDs assigned automatically without the need for mechanical jumpers. This method is defined by the SCSI-3 SCAM (SCSI Configured automatically) protocol standard. The SCAM enables assignment of SCSI IDs to individual devices in a automatic way, totally under software control. SCAM protocol also allows coexistence of legacy devices with hardwired IDs (jumpers) and the new SCAM-capable devices on the same SCSI cable.

B.8 SCSI DATA PARITY

The data path on the SCSI bus consists of 8 data lines and 1 parity line. SCSI-1 specified parity as an option, however in SCSI-2 it became mandatory. You can expect that practically all systems in operation today support parity. The only catch may be that on some devices of the SCSI-1 variety, parity could be disconnected and has to be enabled by a jumper. On some systems parity error, if detected, will be reported, but the system remains operational; on other systems, parity errors will cripple its operation entirely.

B.9 MIXING SE & DIFF SCSI DEVICES

The single-ended and differential interfaces are mutually exclusive. The SCSI bus must use either all single-ended, or all differential components. If your system is differential, then the switch must also be differential. In situations when you need to connect single-ended and differential devices together on the same SCSI bus, you must use a SE to Diff Converter, for example the ANCOT model SED-608SHF for the 'NARROW' bus, or model SED-616SHF for the 2-byte WIDE bus. Many of the newer peripherals are now using the differential interface.

The UltraSwitch SCSI switches available from ANCOT support both versions: with the single-ended and the differential interface. The Auto-termination feature is supported for the differential bus, it is not supported for the single-ended bus.

B.10 SCSI SIGNAL QUALITY

The SCSI switch with its internal circuitry introduces a series resistance of 3 to 7 ohm, and about 5 nanoseconds delay in each connected line. This could be seen as the equivalent of two to three feet of extra cable. Normally, this will not be noticeable on most systems. If the cabling is marginal however, this may be the last straw, causing the system to start behaving erratically. Make sure that you respect all applicable electrical rules when laying out the SCSI cable (daisy chaining, short stubs, termination, etc). Cable errors are a major reason for SCSI operational problems.

The SCSI switches can be cascaded to provide more switching options, but we would not recommend more than three levels. A better solution for situations like this would be using a different (multiport) SCSI switch

B.11 SCSI CABLE LENGTH

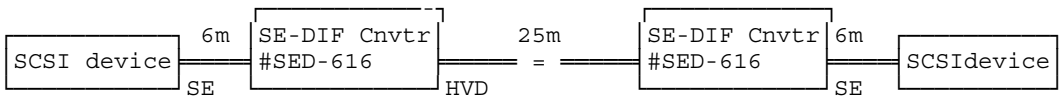
The maximum cable lengths recommended by the SCSI specification are 6 meters for the single-ended bus, and 25 meters for the differential bus. These lengths are recommended for configurations where you need to achieve the maximum specified performance. However, in many situations where longer lengths are required, maximum performance is not the issue, and it is possible to use longer distances. You should remember that you can extend the cable length significantly, especially in low noise environments, and/or if slower transfer rates are used and if all design standards are respected.

When using the SED, the maximum cable length should be counted as the total overall length: from the host to the SED, plus from the SED to the last external peripheral, plus about 1.5 feet equivalent to account for the added resistance and delays in the SED itself. This length should be calculated for each host separately.

B.12 EXTENDING THE SCSI CABLE

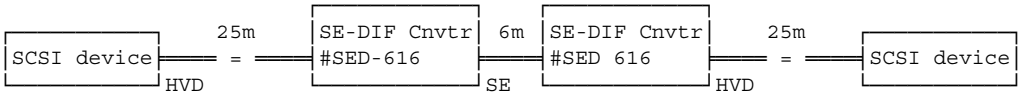
Total length of the cable (for maximum performance at the maximum transfer rates of 5 MHz), as recommended by the SCSI specification, is 6 meters for single-ended or 25 meters for differential configurations. It is possible to extend this length considerably by using single-ended to differential converters. Several schemes are possible, depending on how much distance is needed and which interface is used on the SCSI devices. See the following examples.

Example1:



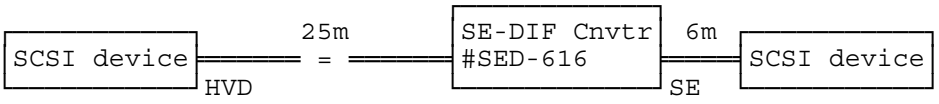
Total distance is 37 meters (6 + 25 + 6)

Example 2:



Total distance is 56 meters (25 + 6 + 25)

Example 3:



Total distance is 31 meters (25 + 6)

Total distance is 31 meters (25 + 6) The SED-616SHF Converter does not occupy any SCSI ID, and is functionally transparent to the SCSI devices connected.

WARNING !
It is very important that you use good quality cables in these 'maximum distance systems'. The deficiencies in the cable (crosstalk, capacitance, skew,..) will accumulate over the long length, and may exceed its allowable value.

It is possible to use more than two converters in series and thus achieve even longer distance. You may have no problem in systems which use a single SCSI host on one end and a single SCSI target on the other. The situation becomes more difficult in systems using several targets, especially if these targets use the disconnect feature.

A P P E N D I X C.

BIBLIOGRAPHY

For more information on the subject of SCSI, we recommend reading the following publications:

1. "Basics of SCSI" Third Edition (1996)
Free booklet, available directly from ANCOT Corporation

2. "The Book of SCSI" by Peter M. Ridge (1995) Available in most bookstores.

For more detailed information regarding operation of the SCSI Bus, we recommend the SCSI-2 and SCSI-3 specifications by ANSI:

1. ANSI document #X3.131-1993 Draft proposal SCSI-2 Revision: 10-L
Title: Information Technology - Small Computer System Interface

2. Collection of ANSI SCSI-3 draft proposals (SAM, SPC, SBC, SSC, SGC, SMC, SIP, SPI, SBP, FCP, GPP, etc).

Available from:

GLOBAL ENGINEERING DOCUMENTS
3031 South Harbor Blvd,
Suite 330, Santa Ana,
California 92704
phone: (800)854-7179

or directly from:

AMERICAN NATIONAL STANDARDS INSTITUTE, Inc.
1430 Broadway,
New York,
NY 10018
phone: (212)642-4900