

# 18 Line Hot-Insertable Active SCSI Terminator

## GENERAL DESCRIPTION

The ML6518 BiCMOS 18 line SCSI terminator provides active termination in SCSI systems using single-ended drivers and receivers. Active SCSI termination helps to effectively control analog transmission line effects such as ringing, noise, crosstalk, and ground bounce. In addition, the ML6518 provides support for hot insertability on the SCSI bus.

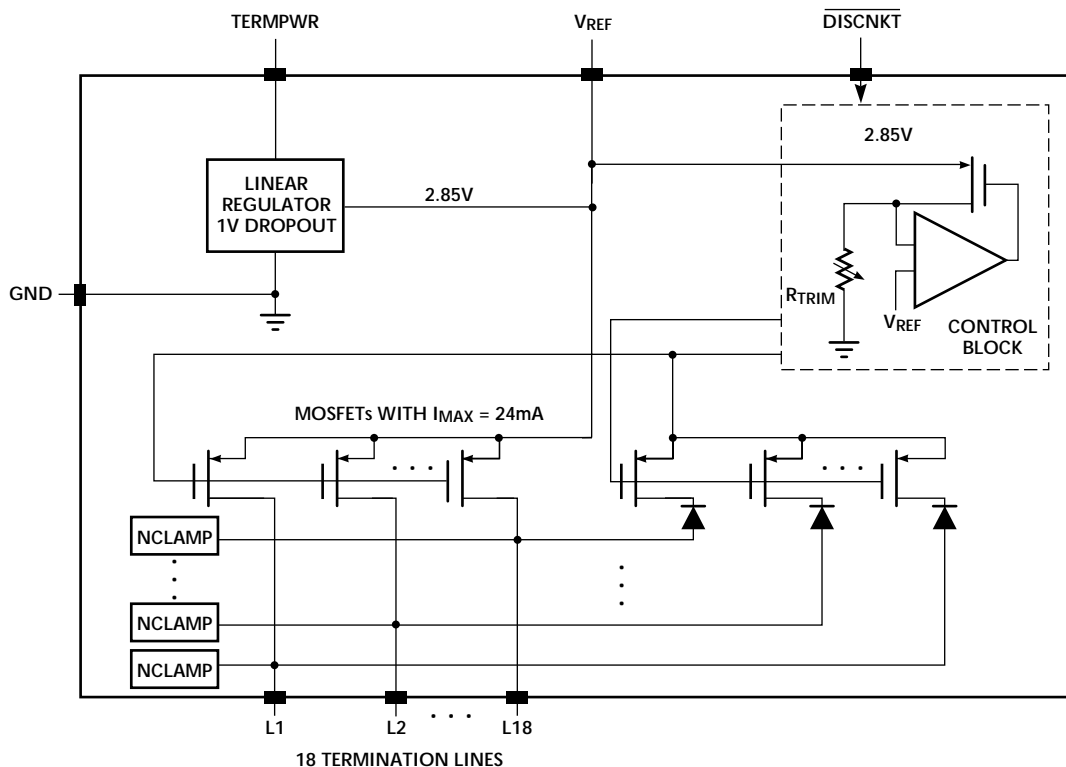
The ML6518 provides a V-I characteristic optimized to minimize transmission line effects during both signal negation and assertion using a MOSFET-based architecture. The desired V-I characteristic is achieved by trimming one resistor in the control block. Internal clamping controls signal assertion transients and provides current sink capability to handle active negation driver overshoots above 2.85V. It provides a 2.85V reference through an internal low dropout (1V) linear regulator.

The ML6518 also provides a disconnect function which effectively removes the terminator from the SCSI bus. The disconnect mode capacitance is typically less than 5pF per line. Current limiting and thermal shutdown protection are also included.

## FEATURES

- Fully monolithic IC solution providing active termination for 18 lines of the SCSI bus
- Provides onboard support for hot-insertability on the SCSI bus
- Low dropout voltage (1V) linear regulator, trimmed for accurate termination current
- Low disconnect capacitance (typically < 5pF)
- Logic pin with active pull-up to disconnect terminator from the SCSI bus
- Current sinking capability in excess of 8.3mA per line to handle active negation driver overshoots above 2.85V
- Negative clamping on all lines to handle signal assertion transients
- Regulator can source 400mA and sink 150mA while maintaining regulation
- Current limit and thermal shutdown protection

## BLOCK DIAGRAM

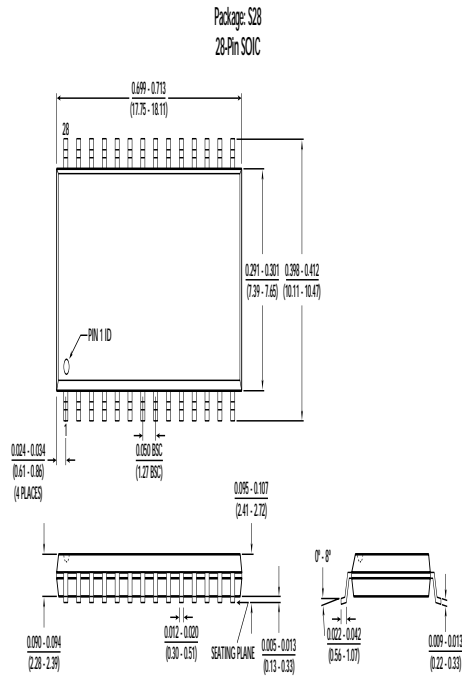


NCLAMP = Negative Clamp

Circuit design patent pending.

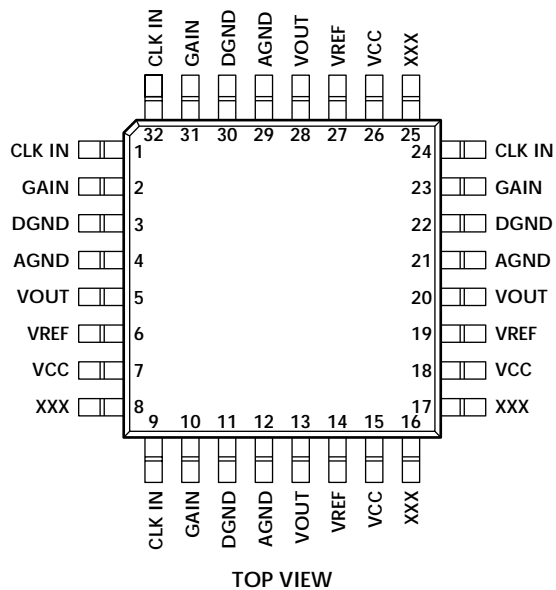
## PIN CONFIGURATIONS

### ML6518 28-Pin SOIC (S28)



### ML6518 32-Pin TQFP (H32-7)

### ML6518 32-Pin TQFP (H32-7)



## PIN DESCRIPTION

TQFP PIN#	SOIC PIN#	NAME	FUNCTION	TQFP PIN#	SOIC PIN#	NAME	FUNCTION
1	25	L1	Signal termination for SCSI bus line 1	16	11	L10	Signal termination for SCSI bus line 10
2	26	L2	Signal termination for SCSI bus line 2	17	12	L11	Signal termination for SCSI bus line 11
3	27	L3	Signal termination for SCSI bus line 3	18	13	L12	Signal termination for SCSI bus line 12
4	28	L4	Signal termination for SCSI bus line 4	19	14	L13	Signal termination for SCSI bus line 13
5	1	L5	Signal termination for SCSI bus line 5	20	15	L14	Signal termination for SCSI bus line 14
6	2	L6	Signal termination for SCSI bus line 6	21	16	L15	Signal termination for SCSI bus line 15
7	3	L7	Signal termination for SCSI bus line 7	22	17	L16	Signal termination for SCSI bus line 16
8	4	L8	Signal termination for SCSI bus line 8	23	18	L17	Signal termination for SCSI bus line 17
9	6	L9	Signal termination for SCSI bus line 9	24	19	L18	Signal termination for SCSI bus line 18
11–14, 27–30	7, 22, 23	GND	Ground	25, 26	20, 21	TERMPWR	Power should be connected to the SCSI TERMPWR line. A 22 $\mu$ F tantalum bypass capacitor is recommended as shown in the application diagram
15	8	$\overline{\text{DISCNKT}}$	Terminator disconnect. Logic input to disconnect the terminator from the bus when the SCSI device no longer needs termination. $\overline{\text{DISCNKT}}$ has a 200k $\Omega$ internal pull-up resistor connected to TERMPWR for use with a mechanical switch	31, 32	24	V <sub>REF</sub>	2.85V V <sub>REF</sub> output. External decoupling with a 10 $\mu$ F tantalum in parallel with a 0.1 $\mu$ F ceramic capacitor is recommended as shown in the application diagram

## ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

Signal Line Voltage ..... GND – 0.3V to TERMPWR + 0.3V  
 Regulator Output Current .....  $\pm 500\text{mA}$   
 TERMPWR Voltage ..... –0.3 to 7V

Junction Temperature ..... 150°C  
 Storage Temperature Range ..... –65°C to 150°C  
 Lead Temperature (Soldering 10 sec) ..... +260°C  
 Thermal Resistance ( $\theta_{JA}$ )  
     SOIC Package ..... 75°C/W  
     TQFP Package ..... 65°C/W

## OPERATING CONDITIONS

Temperature Range ..... 0°C to 70°C  
 TERMPWR Voltage Range ..... 4.0V to 5.25V

## ELECTRICAL CHARACTERISTICS

Unless otherwise specified, TERMPWR = 4V to 5.25V,  $T_A$  = Operating Temperature Range (Note 1)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>Supply</b>					
TERMPWR Supply Current	L1-L18 open, $\overline{\text{DISCNKT}}$ open		5	7	mA
	L1-L18 = 0.2V, $\overline{\text{DISCNKT}}$ open		450	500	mA
Disconnect Mode Current	$\overline{\text{DISCNKT}} = 0\text{V}$		75	100	$\mu\text{A}$
<b><math>\overline{\text{DISCNKT}}</math></b>					
Input Low Voltage				1.0	V
Input High Voltage		TERMPWR –1.0			V
<b>Output</b>					
Output High Voltage	Each line measured with other 17 lines high	2.8	2.85	2.9	V
Output Current (Normal Mode)	$V_{\text{OUT}} = 0.2\text{V}$ , each line measured with other 17 lines high	20		24	mA
Hot Insertion Peak Current	TERMPWR = 0V, $V_{\text{REF}} = 0\text{V}$ , Any or all signal lines = 2.85V		1	2	$\mu\text{A}$
Output Clamp Voltage	$I_{\text{OUT}} = -30\text{mA}$	–150		150	mV
Sinking Current (per line)	$V_{\text{OUT}} = 3.3\text{V}$	10	12		mA
Output Capacitance (Micro Linear method)	$\overline{\text{DISCNKT}} = 0\text{V}$ , 2V <sub>P-P</sub> 100kHz square wave biased at 1V applied to the output		4	5	pF
Output Capacitance (X3T9.2/855D method)	$\overline{\text{DISCNKT}} = 0\text{V}$ , 0.4V <sub>P-P</sub> 1MHz square wave biased at 0.5V applied to the output		6	7	pF
<b>Regulator</b>					
Output Voltage	Sourcing 0-400mA	2.8	2.85	2.9	V
	Sinking 0-150mA	2.8	2.85	2.9	V
Sinking Current	$V_{\text{LINE}} = 3.5$	240	300		mA
Short Circuit Current	$V_{\text{REF}} = 0\text{V}$		300		mA
	$V_{\text{REF}} = 5\text{V}$		600		mA
Dropout Voltage	L1–L18 = 0.2V		1.0	1.2	V
Thermal Shutdown			170		°C

**Note 1:** Limits are guaranteed by 100% testing, sampling, or correlation with worst case test conditions.

## FUNCTIONAL DESCRIPTION

SCSI terminators are used to decrease the transmission line effects of SCSI cable. Termination must be provided at the beginning and end of the SCSI bus to ensure that data errors due to reflections on the bus are eliminated. With the increasing use of higher data rates and cable lengths in SCSI subsystems, active termination has become necessary. Active termination also minimizes power dissipation and can be activated or deactivated under software control, thus eliminating the need for end user intervention. The V-I characteristics of popular SCSI termination schemes are shown in Figure 1. Theoretically, the desired V-I characteristics are the Boulay type for signal assertion (high to low) and the ideal type for signal negation (low to high). The ML6518 with its MOSFET-based nonlinear termination element provides the most optimum V-I characteristics for both signal assertion and negation.

The ML6518 provides active termination for 18 signal lines, thus accommodating basic SCSI which requires 18 lines to be terminated. When used with the ML6599, wide SCSI, which requires 27, 36 or 45 lines to be terminated, can also be accommodated. The ML6518 integrates an accurate voltage reference (1V dropout voltage) and 18 MOSFET-based termination lines. A single internal resistor is trimmed to tune the V-I characteristic of the MOSFETs. The voltage reference circuit produces a precise 2.85V level and is capable of sourcing 24mA into each of the nine terminating lines when low (active). When the signal line is negated (driver turns off), the terminator pulls the signal line back to 2.85V. The regulator will source 400mA and sink 150mA while maintaining regulation of 2.85V.

The ML6518 SCSI terminator provides an active low control signal ( $\overline{\text{DISCNKT}}$ ) which has an internal 200k $\Omega$  pull-up resistor. The  $\overline{\text{DISCNKT}}$  input isolates the ML6518 from the signal lines and effectively removes the terminator from the SCSI bus with a disconnect mode current of less than 100 $\mu\text{A}$  when pulled low. In addition, the ML6518 provides for negative clamping of signal transients and also supports current sink capability in excess of 8.3mA per signal line to handle active negation driver overshoot above 2.85V, a common occurrence with SCSI transceivers.

Disconnect mode capacitance is a very critical parameter in SCSI systems. The ML6518 provides a capacitance contribution of only 5pF.

### HOT INSERTABILITY

“Hot” insertion of a SCSI device refers to the act of plugging a SCSI device which is initially unpowered into a powered SCSI bus. The SCSI device subsequently draws power from the TERMPWR line during its startup routine and thereafter. “Hot” removal refers to the act of removing a powered SCSI device from a powered SCSI bus. A device which performs both tasks with no physical damage to itself or other devices on the bus, nor which alters the existing state of the bus by drawing excessive currents, is termed “hot-swappable.”

The ML6518 hot-insertable SCSI terminator typically draws 1 $\mu\text{A}$  from any given output line (L1–L18) during a hot insertion/removal procedure, thereby protecting itself and preserving the state of the bus. The low insertion current is achieved by effectively shorting the gate to drain of the output PMOS device until the 2.85V reference ( $V_{\text{REF}}$ ) has powered up. A second PMOS in series with a Schottky diode is used as the shorting bypass device. After  $V_{\text{REF}}$  reaches a sufficient level, the bypass device is turned off and the part operates normally.

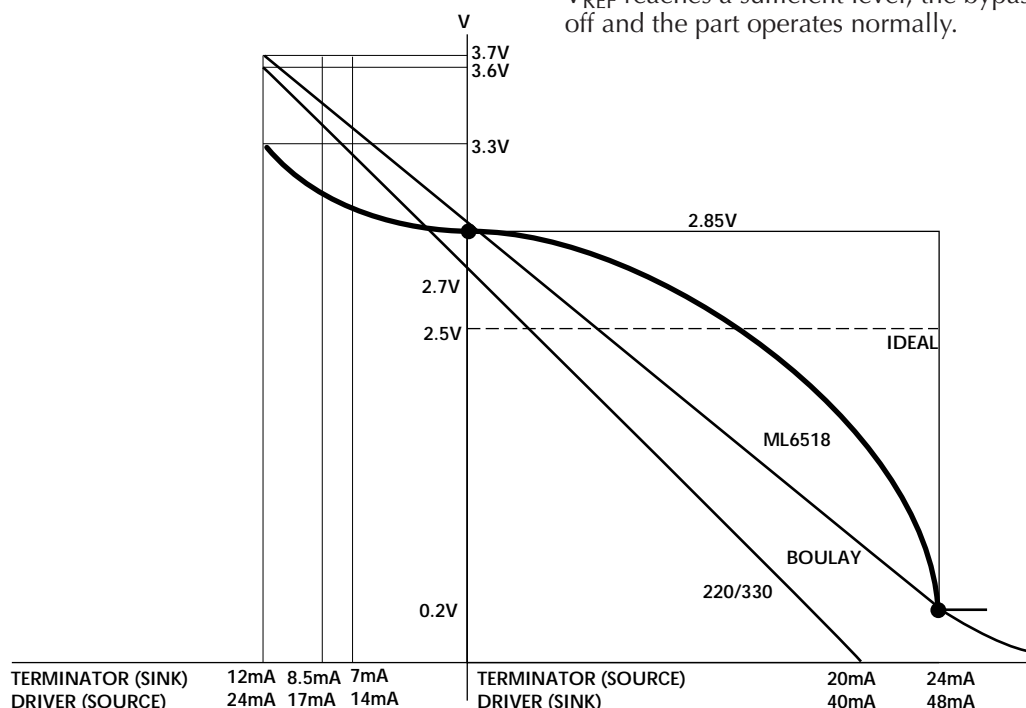


Figure 1. V-I Characteristics of Various SCSI Termination Schemes

# ML6518

As outlined in Annex G of the ANSI SCSI-3 Parallel Interface Specification (X3T9.2/855D), "The SCSI bus termination shall be external to the device being inserted or removed." In other words, any terminator connected to a device being hot inserted/removed should be inactive (accomplished by grounding the **DISCNKT** pin in the case of the ML6518). If the terminator being inserted/removed were in the active state, at some point in time the bus would be terminated by either 1 or 3 terminators. In either case, data integrity on the bus will be compromised.

Figure 2 gives an application diagram showing a typical SCSI bus configuration. To ensure proper operation, the **TERMPWR** pin must be connected to the SCSI **TERMPWR** line. Each ML6518 requires parallel  $0.1\mu\text{F}$  and  $10\mu\text{F}$  capacitors connected between the  $V_{\text{REF}}$  and **GND** pins and the **TERMPWR** line needs a  $10\mu\text{F}$  bypass capacitor at one node in the system.

In an 8-bit wide SCSI bus arrangement ("A" Cable), a single ML6518 would be needed at each end of the SCSI cable in order to terminate the 18 active signal lines. 16-bit wide SCSI would use one ML6518 and one ML6599, while 32-bit wide SCSI bus would require two ML6518s and one ML6599.

In a typical SCSI subsystem, the open collector driver in the SCSI transceiver pulls low when asserted. The termination resistance serves as the pull-up when negated. Figure 2 also shows a typical cable response to a pulse. The receiving end of the cable will exhibit a single time delay. When negated, the initial step will reach an intermediate level ( $V_{\text{STEP}}$ ). With higher SCSI data rates, sampling could occur during this step portion. In order to get the most noise margin, the step needs to be as high as possible to prevent false triggering. For this reason the regulator voltage and the resistor defining the MOSFET characteristic are trimmed to ensure that the  $I_{\text{O}}$  is as close as possible to the SCSI maximum current specification.  $V_{\text{STEP}}$  is defined as:

$$V_{\text{STEP}} = V_{\text{OL}} + (I_{\text{O}} \infty Z_{\text{O}})$$

where  $V_{\text{OL}}$  is the driver output low voltage,  $I_{\text{O}}$  is the current from the receiving terminator, and  $Z_{\text{O}}$  is the characteristic impedance of the cable.

This is a very important characteristic that the terminator helps to overcome by increasing the noise margin and boosting the step as high as possible.

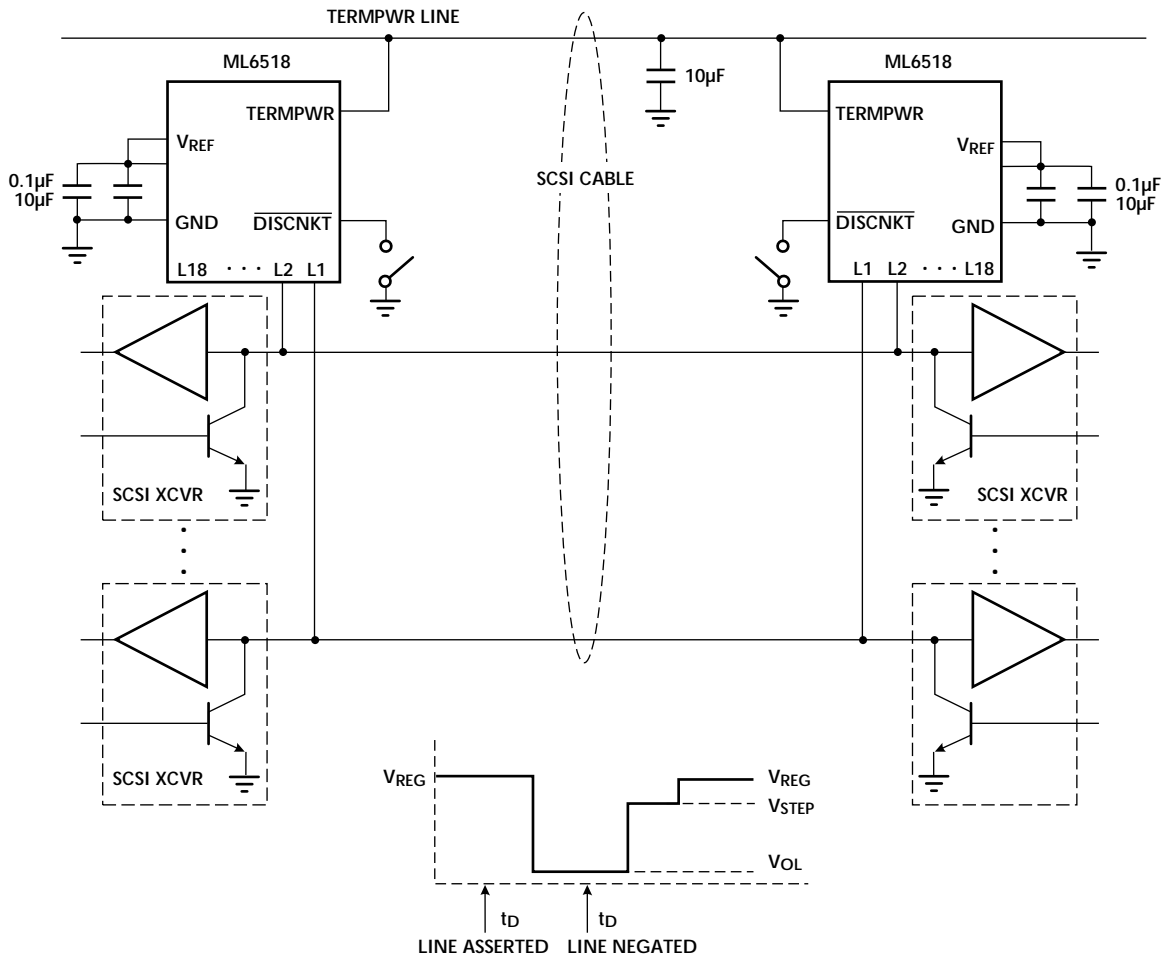
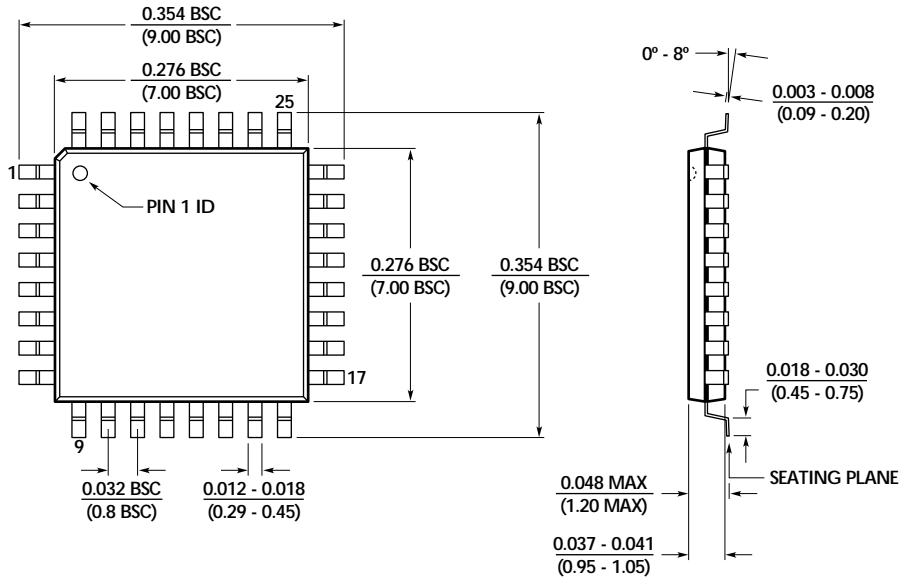


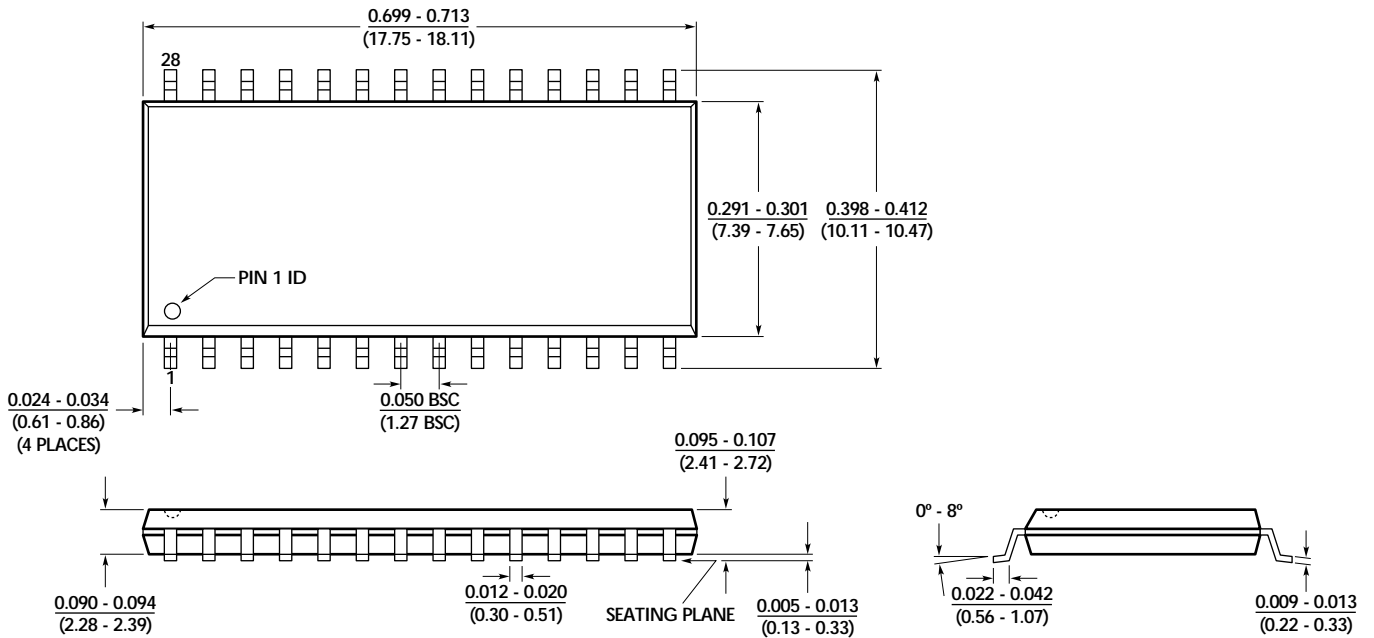
Figure 2. Application Diagram Showing Typical SCSI Bus Configuration with the ML6518

PHYSICAL DIMENSIONS inches (millimeters)

Package: H32-7  
32-Pin (7 x 7 x 1mm) TQFP



Package: S28  
28-Pin SOIC



## ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE
ML6518CH	0°C to 70°C	32-pin TQFP (H32-7)
ML6518CS	0°C to 70°C	28-pin SOIC (S28)

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