



**THE DATASHEET OF  
1655MTF**



# FAN1655

## 3A DDR Bus Termination Regulator

### Description

The FAN1655 is a low-cost bi-directional LDO specifically designed for terminating DDR memory bus. It can both sink and source up to 2.1A continuous, 3A peak, providing enough current for most DDR applications. Load regulation meets the JEDEC spec,  $V_{TT} = V_{REFOUT} \pm 40mV$ .

The FAN1655 includes a buffered reference voltage capable of supplying up to 5mA current. On-chip thermal limiting provides protection against a combination of power overload and ambient temperature that would create an excessive junction temperature. A shutdown input puts the FAN1655 into a low power mode.

The FAN1655 regulator is available in a power-enhanced eTSSOP™-16, standard SOIC-14, and an 8-Lead MLP package.

### Features

- Sinks and sources 2.1A continuous, 3A peak
- 0 to +125°C operating temperature range
- 5mA Buffered VREFOUT = VDDQ/2
- Load regulation:  $V_{TT} = V_{REFOUT} \pm 40mV$
- On-chip thermal limiting
- Low Cost SO-14, Power-Enhanced eTSSOP or 8-pin 5x6mm MLP packages
- Low-Current Shutdown Mode
- Output Short Circuit Protection

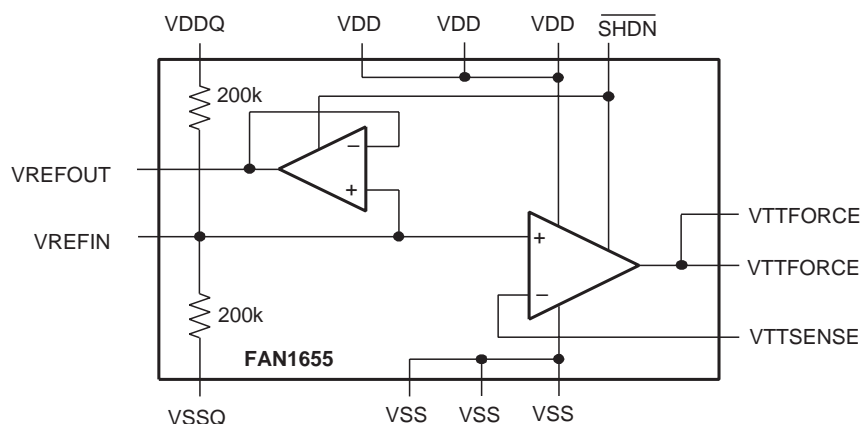
### Applications

- DDR Terminator VTT supply

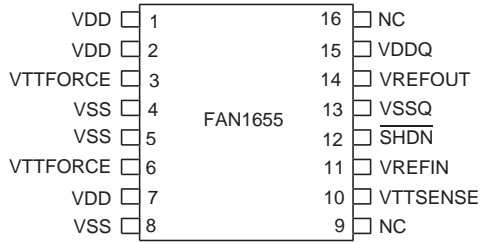
### Ordering Information

Part Number	Temperature Range	Package	Packing
FAN1655M	0°C to 125°C	SOIC-14	Rails
FAN1655MX	0°C to 125°C	SOIC-14	Tape and Reel
FAN1655MTF	0°C to 125°C	eTSSOP-16	Rails
FAN1655MTFX	0°C to 125°C	eTSSOP-16	Tape and Reel
FAN1655MPX	0°C to 125°C	MLP-8	Tape and Reel

### Block Diagram



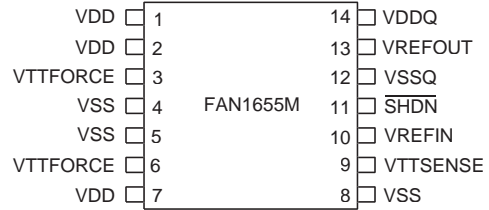
## Pin Assignments



**16-Lead Plastic eTSSOP-16**

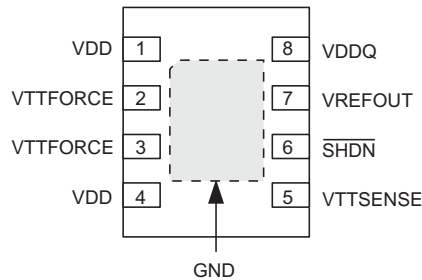
$\theta_{JC} = 4^{\circ}\text{C/W}^*$

\*Thermal impedance is measured with the power pad soldered to a 0.5 square inch copper area. The copper area should be connected to Vss (ground) and positioned over an internal power or ground plane to assist in heat dissipation.



**14-Lead Plastic SOIC**

$\theta_{JC} = 37^{\circ}\text{C/W}$ ,  $\theta_{JA} = 88^{\circ}\text{C/W}$



**8-Lead MLP Package (5x6mm)**

$\theta_{JC} = 4^{\circ}\text{C/W}$ ,  $\theta_{JA} = 34^{\circ}\text{C/W}$

as measured on FAN1655MP Eval Board

## Pin Definitions

Pin			Pin Name	Pin Function
MLP	eTSSOP	SOIC-14		
1, 4	1, 2, 7	1, 2, 7	VDD	Input power for the LDO.
2, 3	3, 6	3, 6	VTTFORCE	The VTT output voltage.
PAD	4, 5, 8	4, 5, 8	VSS	IC Ground.
5	10	9	VTTSSENSE	Feedback for remote sense of the VTT voltage.
	11	10	VREFIN	Alternative input for direct control of VTTOUT and VREFOUT.
6	12	11	SHDN	Shutdown. This active low shutdown turns off both VTT and VREFOUT. This pin has an internal pull-down, and must be externally driven high for the IC to be on.
	13	12	VSSQ	Signal Ground.
7	14	13	VREFOUT	Buffered Voltage Reference Output.
8	15	14	VDDQ	VDDQ Input. Attach this pin to the VDDQ supply to generate VTT and VREFOUT.
	9, 16		NC	No Internal Connection
PAD	PAD			Connect PAD to Vss Ground Plane

## Typical Application

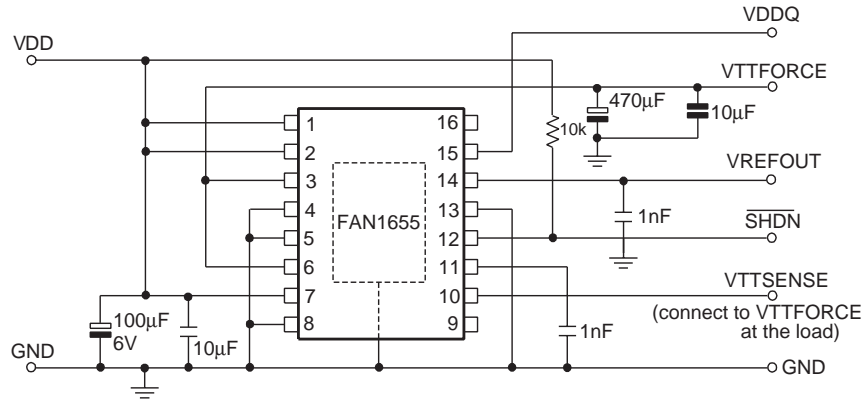


Figure 1. (eTSSOP pinout shown)

## Typical Performance Characteristics

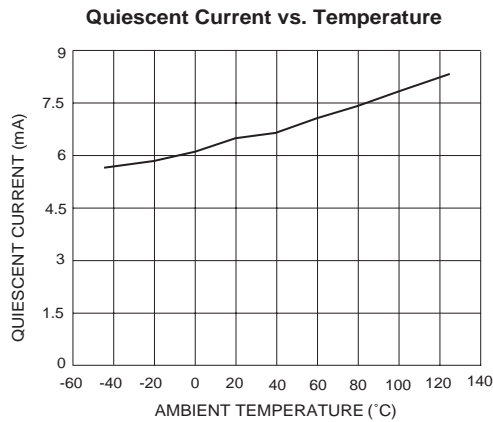


Figure 2. Quiescent Current vs. Ambient Temperature

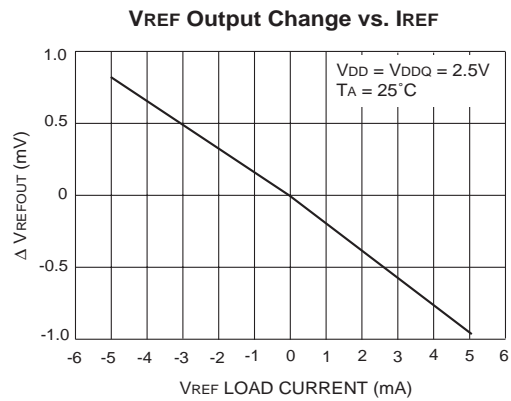


Figure 3. Reference Output Load Regulation

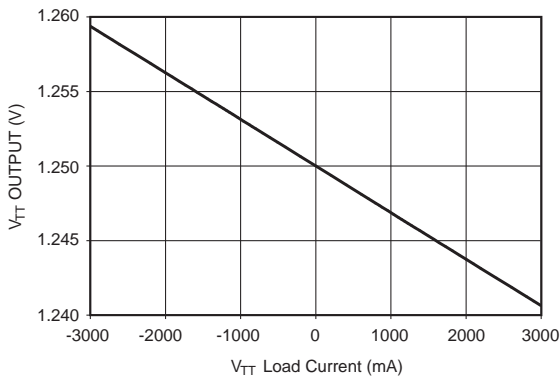


Figure 4.  $V_{TT}$  Load Regulation

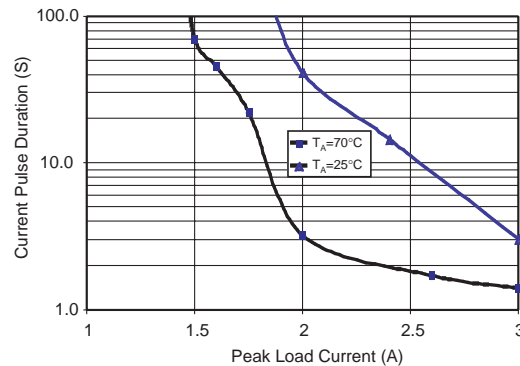


Figure 5. Maximum Non-Repetitive Output Current vs. Pulse Width (FAN1655M SO-14 Package)

### Absolute Maximum Ratings

Supply Voltage VDD, VDDQ		6V
Junction Temperature, T <sub>J</sub>		150°C
Storage Temperature		-65 to 150°C
Lead Soldering Temperature, 10 seconds		300°C
Power Dissipation, P <sub>D</sub>	FAN1655M (SOIC-14)	1.4W
	FAN1655MTF (e-TSSOP)	See "Power Dissipation and Derating"
	FAN1655MP (MLP)	

### Recommended Operating Conditions

Parameter	Conditions	Min.	Typ.	Max.	Units
Supply Voltage VDD		2.3	2.5	3.6	V
Supply Voltage VDDQ		2.2	2.5	3.0	V
Ambient Operating Temperature		0		125	°C
VREFIN		1.1	1.25	1.5	V

### Electrical Characteristics

(VDD = VDDQ = 2.5V ± 0.2V, and T<sub>A</sub> = 25°C using circuit in Figure 1, unless otherwise noted.)

The • denotes specifications which apply over the specified operating temperature range.

Parameter	Conditions	Min.	Typ.	Max.	Units	
VTT Output Voltage	I <sub>OUT</sub> = 0A, VREFIN = open	VDDQ = 2.3V •	1.135	1.150	1.165	V
		VDDQ = 2.5V •	1.235	1.250	1.265	V
		VDDQ = 2.7V •	1.335	1.350	1.365	V
	I <sub>OUT</sub> = ±2.1A, VREFIN = open	VDDQ = 2.3V	1.110	1.150	1.190	V
		VDDQ = 2.5V	1.210	1.250	1.290	V
		VDDQ = 2.7V	1.310	1.350	1.390	V
VTT Output Slew Rate	C <sub>load</sub> = 10μF		0.3		V/μS	
VTT Leakage Current	$\overline{\text{SHDN}}$ = 0V	• -50		50	μA	
VTT Current Limit		±3.1			A	
VREFIN Input Impedance			100		KΩ	
VREFOUT Output Voltage	No load	VREFIN = 1.150V •	1.145	1.150	1.155	V
		VREFIN = 1.250V •	1.245	1.250	1.255	V
		VREFIN = 1.350V •	1.345	1.350	1.355	V
VREFOUT Output Current	VDDQ = 2.3V	• -5		5	mA	
VREFOUT Leakage Current	$\overline{\text{SHDN}}$ = 0V	• -10		10	μA	
$\overline{\text{SHDN}}$ Logic High		• 1.667			V	
$\overline{\text{SHDN}}$ Logic Low		•		0.800	V	
IDD Supply Current	No load, $\overline{\text{SHDN}}$ = 2.7V	•	7.5	20	mA	
VDDQ Leakage Current	$\overline{\text{SHDN}}$ = 0V	•	6	10	μA	
VDD Leakage Current	$\overline{\text{SHDN}}$ = 0V	•	3	50	μA	
$\overline{\text{SHDN}}$ Input Current	$\overline{\text{SHDN}}$ = 2.7V	•	50	75	μA	
Over-Temperature Shutdown			155		°C	
Over-Temperature Hysteresis			30		°C	

## Applications Information

### Output Capacitor selection

The JEDEC specification for DDR termination requires that VTT stay within  $\pm 40\text{mV}$  of VREF, which must track VDDQ/2 within 1%. During the initial load transient, the output capacitor keeps the output within spec. To stay within the 40mV window, the “load step” due to the load transient current dropping across the output capacitor’s ESR should be kept to around 25mV: where ESR <

$\frac{25}{\Delta I}$  is given in m $\Omega$ , and  $\Delta I$  is the maximum load current.

For example, to handle a 3A maximum load transient, the ESR should be no greater than 8m $\Omega$ . Furthermore, the output capacitor must be able to hold the load in spec while the regulator recovers (about 15 $\mu\text{S}$ ). A minimum value of 470 $\mu\text{F}$  is recommended.

The FAN1655 requires a minimum of 100 $\mu\text{F}$  of input capacitance with a maximum ESR value of 100m $\Omega$  to insure stability.

### Power Dissipation and Derating

The maximum output current (sink or source) for a 1.25V output is:

$$I_{\text{OUT(MAX)}} = \frac{P_{\text{D(MAX)}}}{1.25}$$

where  $P_{\text{D(MAX)}}$  is the maximum power dissipation which is:

$$P_{\text{D(MAX)}} = \frac{T_{\text{J(MAX)}} - T_{\text{A}}}{\theta_{\text{JA}}}$$

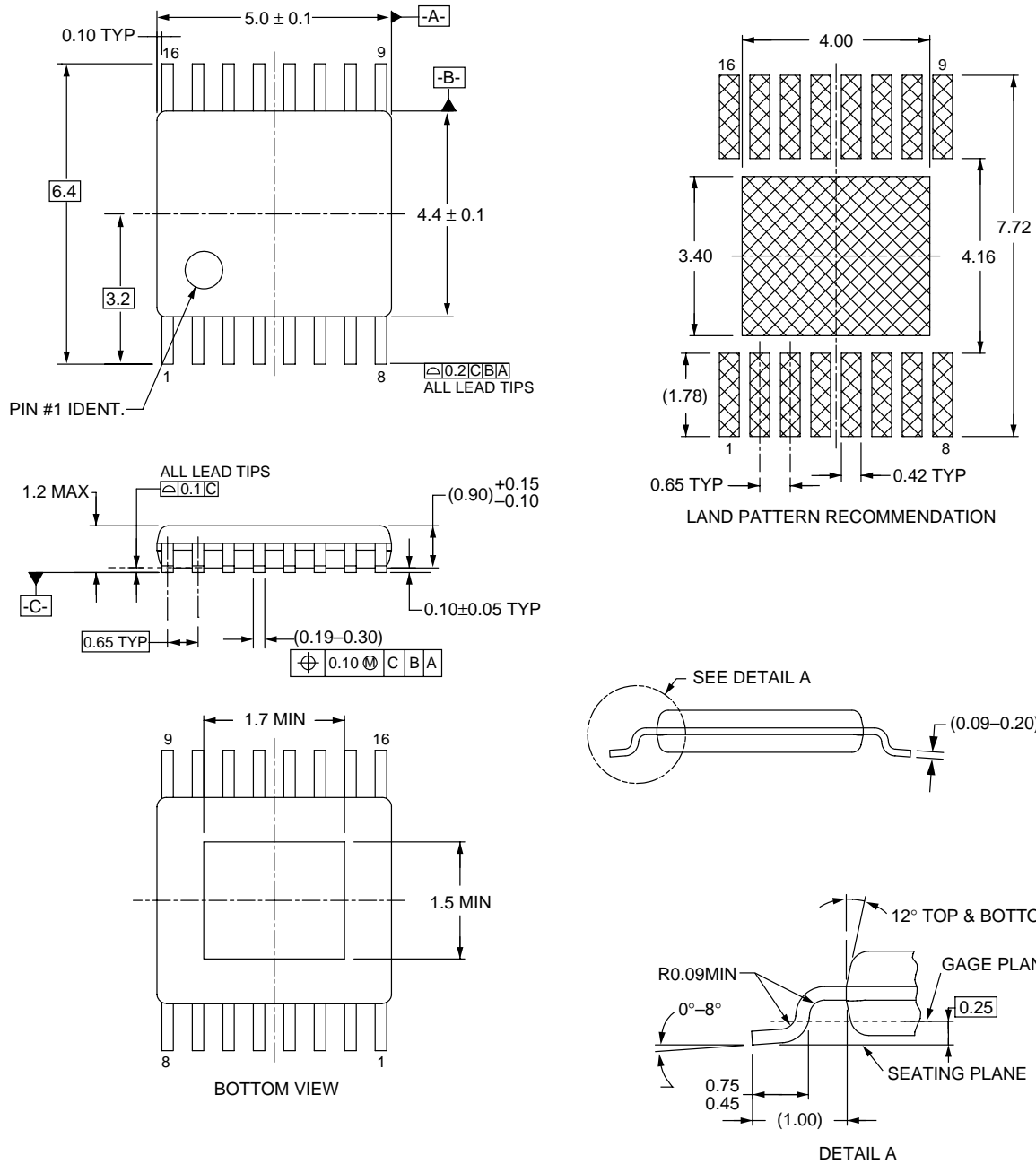
where  $T_{\text{J(MAX)}}$  is the maximum die temperature of the IC and  $T_{\text{A}}$  is the operating ambient temperature.

FAN1655 has an internal thermal limit at 150°C, which defines  $T_{\text{J(MAX)}}$ . For the SOIC-14 package,  $\theta_{\text{JA}}$  is given at 88°C/W. Using equation 2, the maximum dissipation at  $T_{\text{A}} = 25^\circ\text{C}$  is 1.4W, which is its rated maximum dissipation.

The e-TSSOP or MLP package, however, use the PCB copper to cool the IC through the thermal pad on the package bottom. For maximum dissipation, this pad should be soldered to the PCB copper, with as much copper area as possible surrounding it to cool the package. Thermal vias should be placed as close to the thermal pad as possible to transfer heat to other layers of copper on the PCB. With large areas of PCB copper for heat sinking, a  $\theta_{\text{JA}}$  of under 40°C/W can easily be achieved.

### Mechanical Dimensions

#### 16-Lead eTSSOP

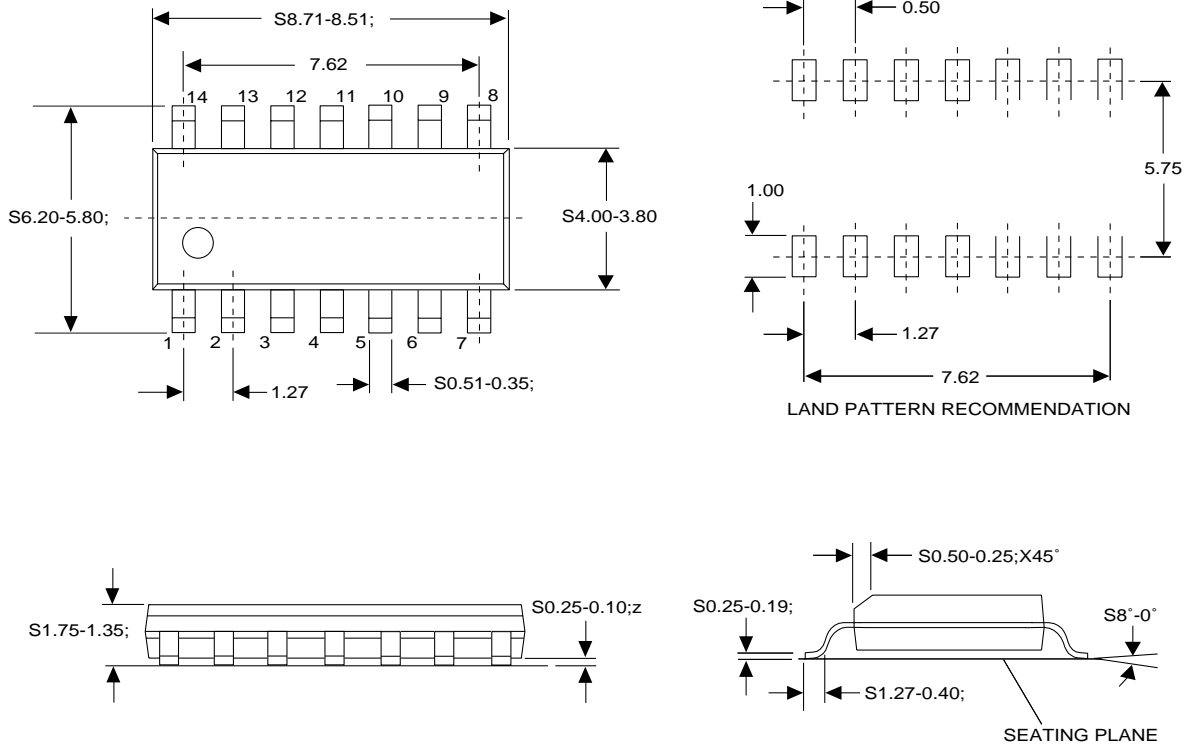


NOTES:

- A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION ABT, DATED 10/97.
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND THE BAR EXTENSIONS.
- D. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.

## Mechanical Dimensions

### 14-Lead SOIC

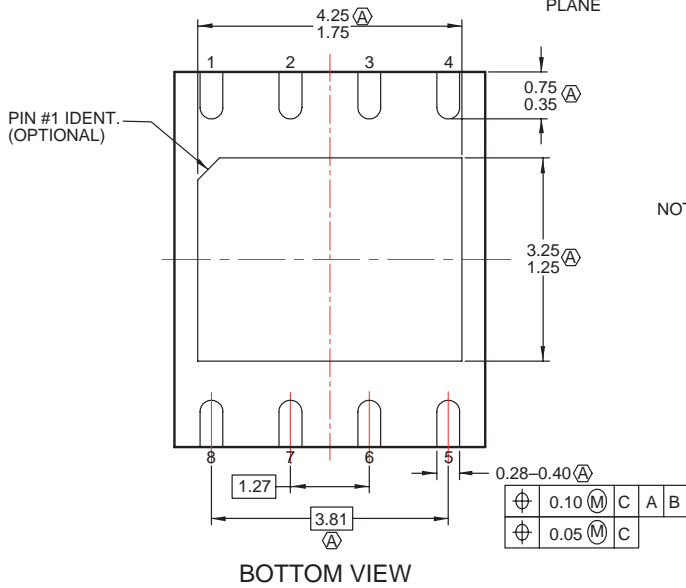
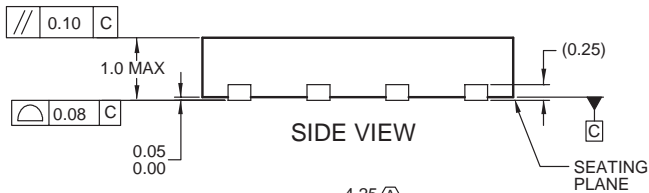
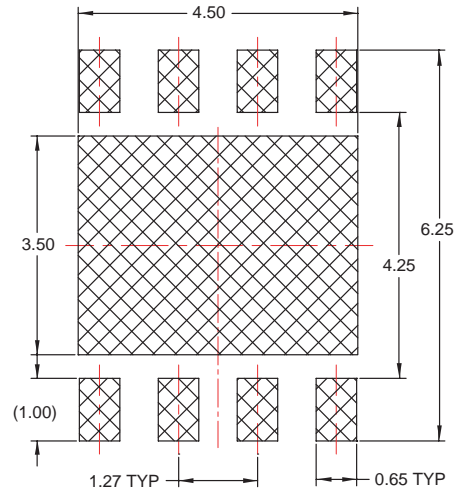
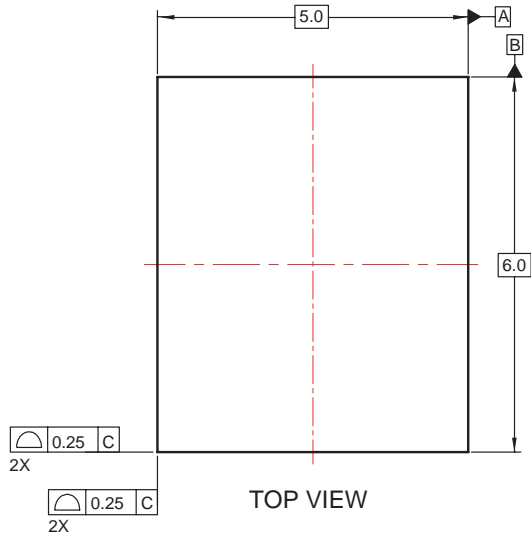


**Notes:**

1. This package conforms to JEDEC MS-012, variation AB, ISSUEC dated May, 1990.
2. All dimensions are in millimeters
3. Standard lead finished  
 200 microinches / 5.08 microns min.  
 Lead/Tin (solder) oncopper

### Mechanical Dimensions

#### 5mm x 6mm 8-Lead MLP



NOTES:

- A) DOES NOT FULLY CONFORM TO JEDEC REGISTRATION MO-229, DATED 11/2001.
- B) DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONING AND TOLERANCES PER ASME Y14.5-1994.

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