

# NSM4002MR6

## Dual NPN Transistors for Driving LEDs

NSM4002MR6 contains a single two NPN transistors. The base of the Q2 NPN transistor is internally connected to the collector of the Q1 NPN transistor. This device is designed to replace a discrete solution that is common for providing a constant current by integrating these two components into a single device. NSM4002MR6 is housed in a SC-74 package which is ideal for surface mount applications in space constrained applications.

### Features

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Typical Applications

- LED Lighting
- Driver Circuits

#### MAXIMUM RATINGS Q<sub>1</sub> (T<sub>A</sub> = 25°C)

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V <sub>CEO</sub>	40	Vdc
Collector–Base Voltage	V <sub>CBO</sub>	60	Vdc
Emitter–Base Voltage	V <sub>EBO</sub>	6.0	Vdc
Collector Current – Continuous	I <sub>C</sub>	200	mAdc

#### MAXIMUM RATINGS Q<sub>2</sub> (T<sub>A</sub> = 25°C)

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V <sub>CEO</sub>	45	Vdc
Collector–Base Voltage	V <sub>CBO</sub>	50	Vdc
Emitter–Base Voltage	V <sub>EBO</sub>	5.0	Vdc
Collector Current – Continuous	I <sub>C</sub>	500	mAdc

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Total Device Dissipation T <sub>A</sub> = 25°C Derate above 25°C	P <sub>D</sub> (Note 1)	260 2.08	mW mW/°C
Thermal Resistance, Junction–to–Ambient	R <sub>θJA</sub> (Note 1)	480	°C/W
Total Device Dissipation T <sub>A</sub> = 25°C Derate above 25°C	P <sub>D</sub> (Note 2)	300 2.4	mW mW/°C
Thermal Resistance, Junction–to–Ambient	R <sub>θJA</sub> (Note 2)	416	°C/W
Junction and Storage Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	–55 to +150	°C

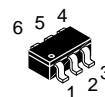
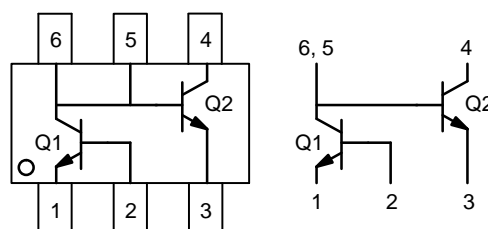
1. FR-4, 100 mm<sup>2</sup>, 2 oz. Cu.
2. FR-4, 500 mm<sup>2</sup>, 2 oz. Cu.



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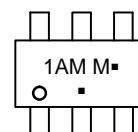
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## Dual NPN Transistors for Driving LEDs



SC-74  
CASE 318F

### MARKING DIAGRAM



1AM = Device Code  
M = Date Code\*  
■ = Pb-Free Package

(Note: Microdot may be in either location)  
\*Date Code orientation may vary depending upon manufacturing location.

### ORDERING INFORMATION

Device	Package	Shipping†
NSM4002MR6T1G	SC-74 (Pb-Free)	3000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

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**Table 1. ELECTRICAL CHARACTERISTICS Q<sub>1</sub>** (T<sub>A</sub> = 25°C, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
<b>OFF CHARACTERISTICS</b>				
Collector–Emitter Breakdown Voltage (I <sub>C</sub> = 1.0 mA, I <sub>B</sub> = 0)	V <sub>(BR)CEO</sub>	40	–	Vdc
Collector–Base Breakdown Voltage (I <sub>C</sub> = 10 μA, I <sub>E</sub> = 0)	V <sub>(BR)CBO</sub>	60	–	Vdc
Emitter–Base Breakdown Voltage (I <sub>E</sub> = 10 μA, I <sub>C</sub> = 0)	V <sub>(BR)EBO</sub>	6.0	–	Vdc
Collector Cutoff Current (V <sub>CE</sub> = 30 Vdc, V <sub>EB(OFF)</sub> = 3.0 Vdc)	I <sub>CEX</sub>	–	50	nAdc
Base Cutoff Current (V <sub>CE</sub> = 30 Vdc, V <sub>EB(OFF)</sub> = 3.0 Vdc)	I <sub>BL</sub>	–	50	nAdc
<b>ON CHARACTERISTICS</b>				
DC Current Gain (Note 3) (I <sub>C</sub> = 100 μA, V <sub>CE</sub> = 1.0 V) (I <sub>C</sub> = 1.0 mA, V <sub>CE</sub> = 1.0 V) (I <sub>C</sub> = 10 mA, V <sub>CE</sub> = 1.0 V) (I <sub>C</sub> = 50 mA, V <sub>CE</sub> = 1.0 V) (I <sub>C</sub> = 100 mA, V <sub>CE</sub> = 1.0 V)	h <sub>FE</sub>	40 70 100 60 30	– – 300 – –	
Collector–Emitter Saturation Voltage (Note 3) (I <sub>C</sub> = 10 mA, I <sub>B</sub> = 1.0 mA) (I <sub>C</sub> = 50 mA, I <sub>B</sub> = 5.0 mA)	V <sub>CE(sat)</sub>	– –	0.20 0.30	V
Base–Emitter Saturation Voltage (Note 3) (I <sub>C</sub> = 10 mA, I <sub>B</sub> = 1.0 mA) (I <sub>C</sub> = 50 mA, I <sub>B</sub> = 5.0 mA)	V <sub>BE(sat)</sub>	0.65 –	0.85 0.95	V
Cutoff Frequency (I <sub>C</sub> = 10 mA, V <sub>CE</sub> = 20 V, f = 100 MHz)	f <sub>T</sub>	300	–	MHz
Output Capacitance (V <sub>CB</sub> = 5.0 V, f = 1.0 MHz)	C <sub>obo</sub>	–	4.0	pF
Input Capacitance (V <sub>EB</sub> = 0.5 V, f = 1.0 MHz)	C <sub>obo</sub>	–	8.0	pF

**Table 2. ELECTRICAL CHARACTERISTICS Q<sub>2</sub>** (T<sub>A</sub> = 25°C, unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
Collector–Emitter Breakdown Voltage (I <sub>C</sub> = 10 mA, I <sub>B</sub> = 0)	V <sub>(BR)CEO</sub>	45	–	–	Vdc
Collector–Base Breakdown Voltage (I <sub>C</sub> = 10 μA, I <sub>E</sub> = 0)	V <sub>(BR)CBO</sub>	50	–	–	Vdc
Emitter–Base Breakdown Voltage (I <sub>E</sub> = 1.0 μA, I <sub>C</sub> = 0)	V <sub>(BR)EBO</sub>	5.0	–	–	Vdc
Collector Cutoff Current (V <sub>CB</sub> = 20 Vdc, I <sub>E</sub> = 0)	I <sub>CBO</sub>	–	–	0.1	μAdc
<b>ON CHARACTERISTICS</b>					
DC Current Gain (Note 3) (I <sub>C</sub> = 100 mA, V <sub>CE</sub> = 1.0 V) (I <sub>C</sub> = 500 mA, V <sub>CE</sub> = 1.0 V)	h <sub>FE</sub>	250 40	– –	600 –	
Collector – Emitter Saturation Voltage (Note 3) (I <sub>C</sub> = 500 mA, I <sub>B</sub> = 50 mA)	V <sub>CE(sat)</sub>	–	–	0.7	V
Base – Emitter Turn–on Voltage (Note 3) (I <sub>C</sub> = 500 mA, V <sub>CE</sub> = 1.0 V)	V <sub>BE(on)</sub>	–	–	1.2	V
Cutoff Frequency (I <sub>C</sub> = 10 mA, V <sub>CE</sub> = 5.0 V, f = 100 MHz)	f <sub>T</sub>	100	–	–	MHz
Output Capacitance (V <sub>CB</sub> = 10 V, f = 1.0 MHz)	C <sub>obo</sub>	–	10	–	pF

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. Pulsed Condition: Pulse Width = 300 msec, Duty Cycle ≤ 2%.

## Application Section

### Introduction

The NSM4002MR6 is designed to be used as a constant current driver for LEDs. The two resistors in Figure 1 are external from the NSM4002MR6 to allow for customization.  $R_{set}$  controls the current through the load, and  $R_1$  controls the bias current.

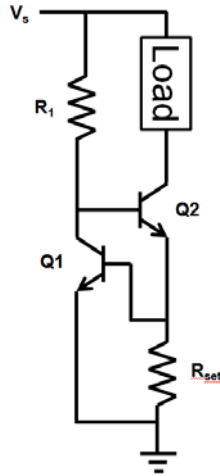


Figure 1. Typical Application Schematic

### Selecting $R_{set}$

The  $R_{set}$  resistor is used to set the driving current of the load. It is connected across the Base–Emitter junction of Q1. This  $V_{BE}$  voltage is what sets up the constant voltage across the  $R_{set}$  resistor. Figure 5 gives the typical values of  $V_{BE}$

based on the biasing current. To determine the  $R_{set}$  value simply divide the  $V_{BE}$  voltage by the desired driving current.

### Selecting $R_1$

The  $R_1$  resistor is used to set the biasing current. The biasing current is split between the base of Q2 and the collector of Q1. When desiring the lowest overhead voltage  $R_1$  should be set as high as possible. It is important to ensure it is not set too high so that Q2 falls out of saturation. However, a lower  $R_1$  value will drive more current through Q1. This will reduce the change in the driving current as temperature is increased. It will also allow a higher driving current to be achieved while maintaining good current regulation. The side affect of a lower  $R_1$  value is that it reduces the overall efficiency because more power is being used in the driving circuit.

### Input Voltage, $V_s$

The maximum input voltage,  $V_s$ , is determined by the load. No more than 45 V can be applied across Q2. This leads to:

$$V_{s(max)} = V_{Load} + 45 \text{ V} \quad (\text{eq. 1})$$

### Overhead Voltage

The overhead voltage of this device to reach full current regulation is the combination of the  $V_{BE}$  voltages of the two transistors. Under typical conditions this overhead voltage will typically be 1.4 V.

# NSM4002MR6

## TYPICAL CHARACTERISTICS – Q1

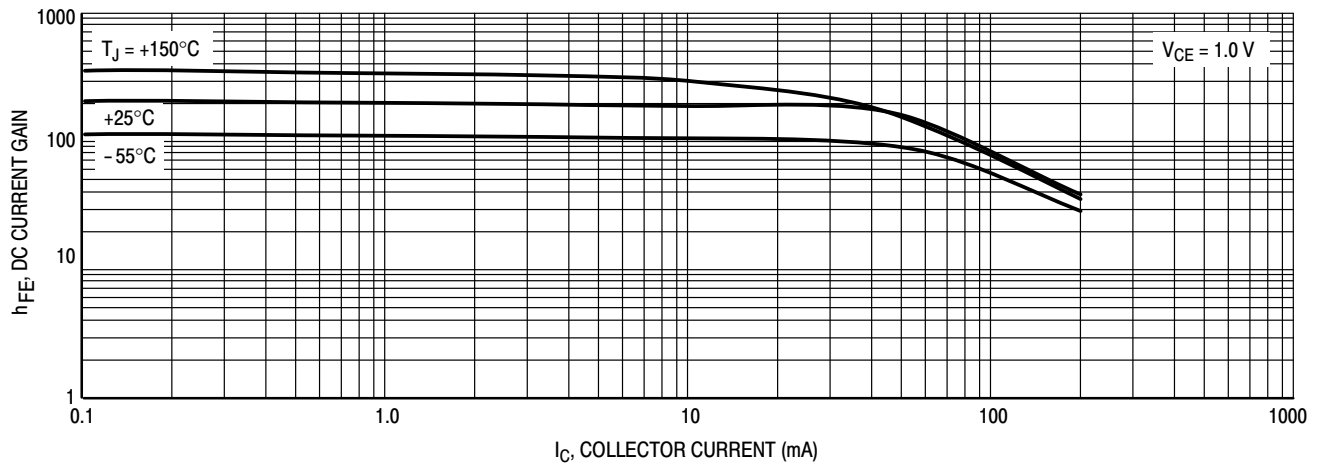


Figure 2. DC Current Gain

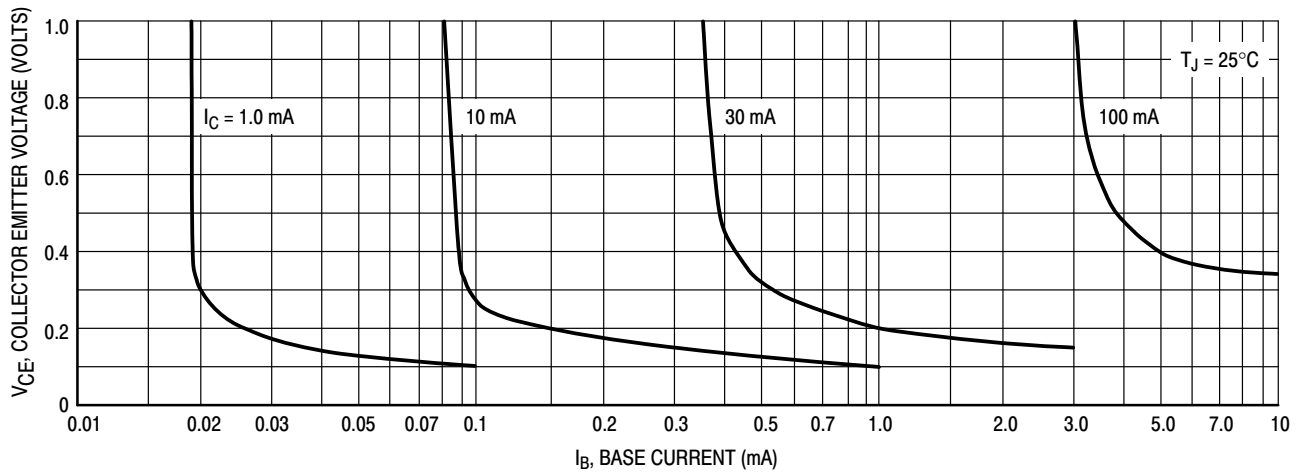


Figure 3. Collector Saturation Region

TYPICAL CHARACTERISTICS – Q1

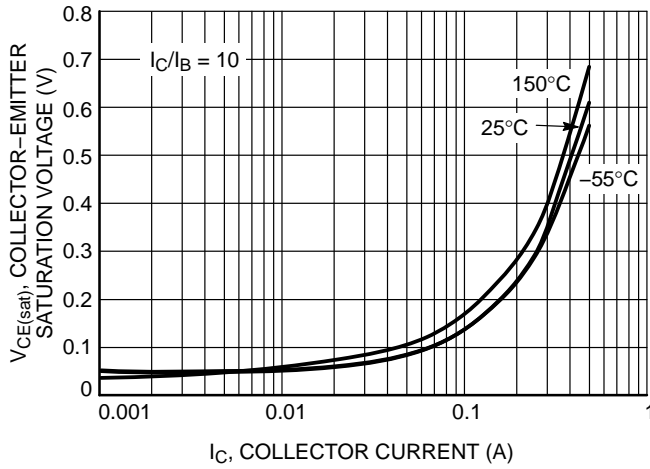


Figure 4. Collector Emitter Saturation Voltage vs. Collector Current

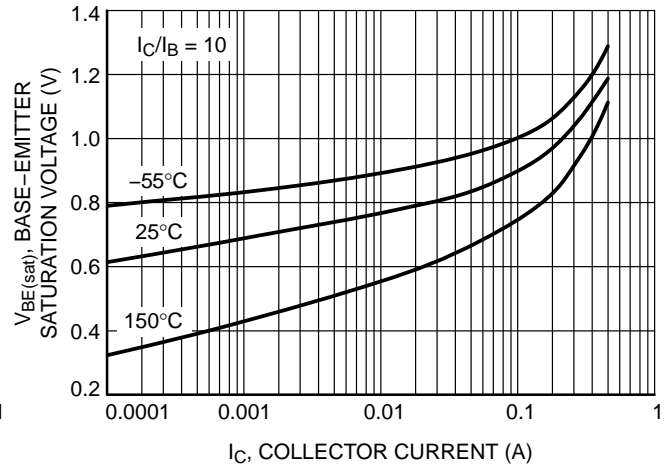


Figure 5. Base Emitter Saturation Voltage vs. Collector Current

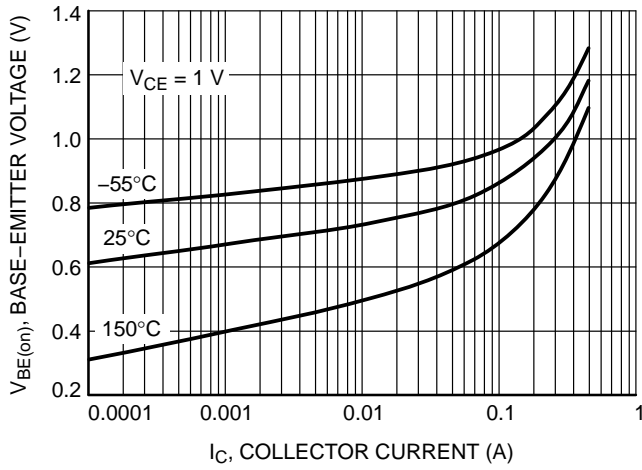


Figure 6. Base Emitter Voltage vs. Collector Current

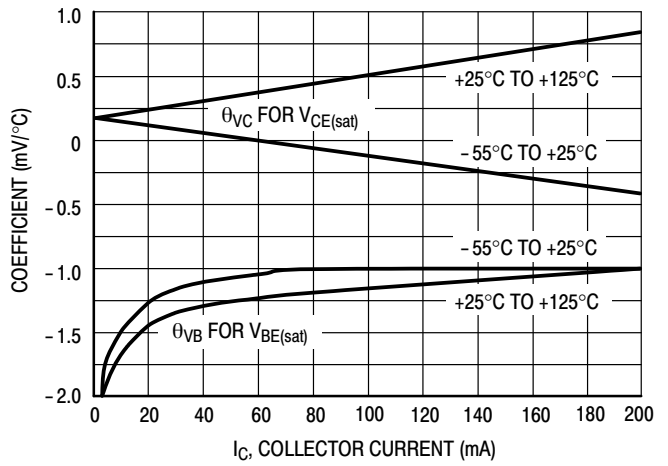


Figure 7. Temperature Coefficients

TYPICAL CHARACTERISTICS – Q2

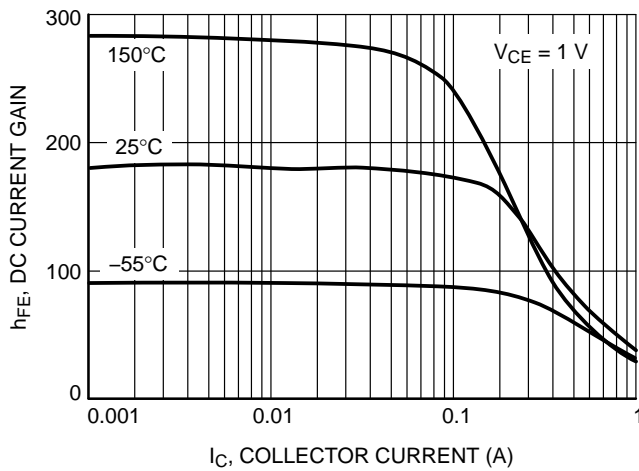


Figure 8. DC Current Gain vs. Collector Current

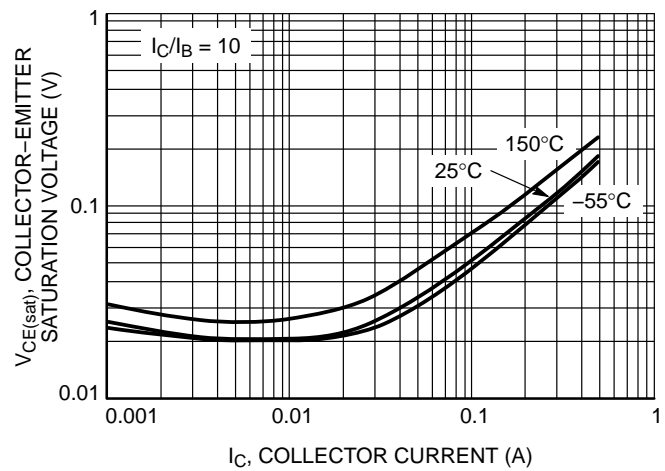


Figure 9. Collector Emitter Saturation Voltage vs. Collector Current

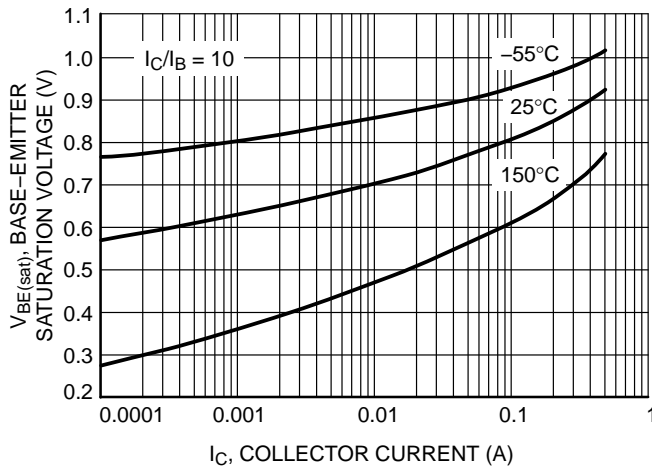


Figure 10. Base Emitter Saturation Voltage vs. Collector Current

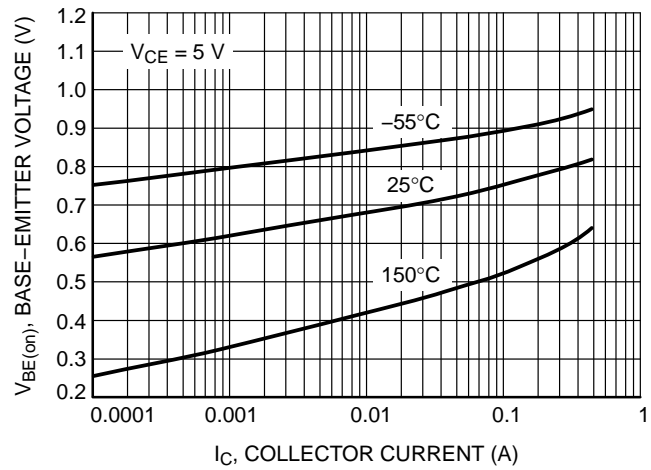


Figure 11. Base Emitter Voltage vs. Collector Current

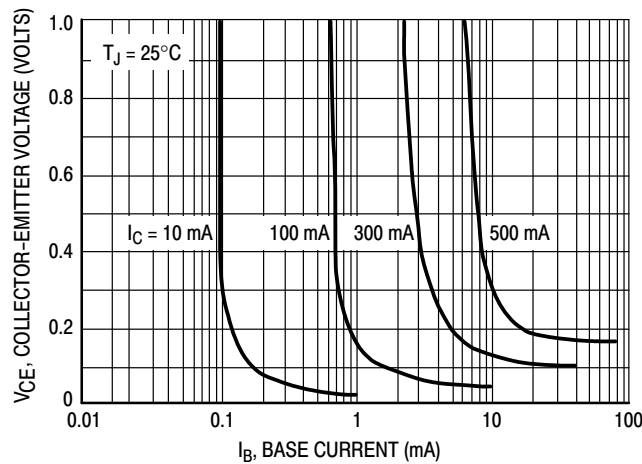
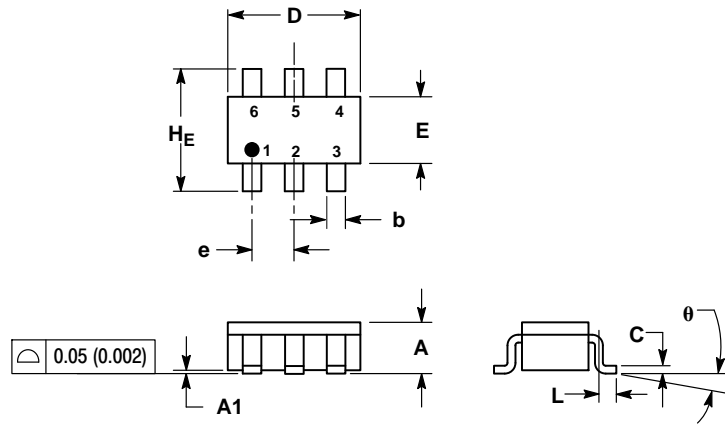


Figure 12. Saturation Region

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## PACKAGE DIMENSIONS

### SC-74 CASE 318F-05 ISSUE N



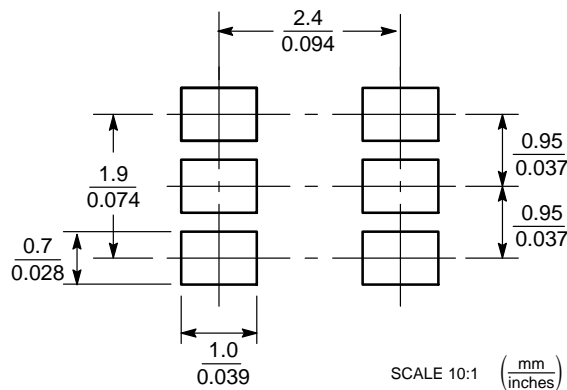
#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318F-01, -02, -03 OBSOLETE. NEW STANDARD 318F-04.


DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.90	1.00	1.10	0.035	0.039	0.043
A1	0.01	0.06	0.10	0.001	0.002	0.004
b	0.25	0.37	0.50	0.010	0.015	0.020
c	0.10	0.18	0.26	0.004	0.007	0.010
D	2.90	3.00	3.10	0.114	0.118	0.122
E	1.30	1.50	1.70	0.051	0.059	0.067
e	0.85	0.95	1.05	0.034	0.037	0.041
L	0.20	0.40	0.60	0.008	0.016	0.024
HE	2.50	2.75	3.00	0.099	0.108	0.118
theta						

0° 10° 0° 10°

#### SOLDERING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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