Dual NPN Transistors for Driving LEDs

NSM4002MR6

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_1 (T_A = 25 °C)

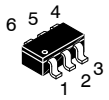
Symbol	Rating	Value	Unit
V_{CEO}	Collector - Emitter Voltage	40	Vdc
V_{CBO}	Collector - Base Voltage	60	Vdc
V_{EBO}	Emitter - Base Voltage	6.0	Vdc
I_C	Collector Current - Continuous	200	mAdc

MAXIMUM RATINGS Q_2 (T_A = 25 °C)

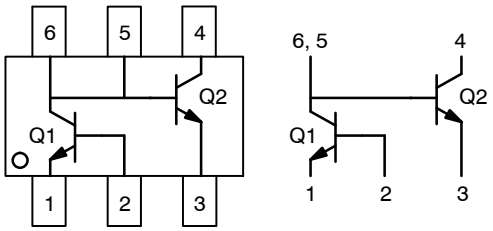
Symbol	Rating	Value	Unit
V_{CEO}	Collector - Emitter Voltage	45	Vdc
V_{CBO}	Collector - Base Voltage	50	Vdc
V_{EBO}	Emitter - Base Voltage	5.0	Vdc
I_C	Collector Current - Continuous	500	mAdc

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.

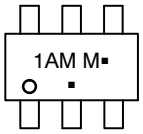
Dual NPN Transistors for Driving LEDs



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)	3,000 / 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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THERMAL CHARACTERISTICS

Symbol	Rating	Max	Unit
P_D (Note 1)	Total Device Dissipation T_A = 25 °C Derate above 25 °C	 260 2.08	 mW mW/°C
$R_{\theta JA}$ (Note 1)	Thermal Resistance, Junction-to-Ambient	480	°C/W
P_D (Note 2)	Total Device Dissipation T_A = 25 °C Derate above 25 °C	 300 2.4	 mW mW/°C
$R_{\theta JA}$ (Note 2)	Thermal Resistance, Junction-to-Ambient	416	°C/W
T_J, T_{stg}	Junction and Storage Temperature Range	−55 to +150	°C

1. FR−4, 100 mm^2, 2 oz. Cu.
2. FR−4, 500 mm^2, 2 oz. Cu.

Table 1. ELECTRICAL CHARACTERISTICS Q_1 (T_A = 25 °C, unless otherwise noted)

Symbol	Characteristic	Min	Max	Unit
OFF CHARACTERISTICS				
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	40	–	Vdc
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	60	–	Vdc
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	6.0	–	Vdc
I_{CEX}	Collector Cutoff Current (V_{CE} = 30 Vdc, $V_{EB(OFF)}$ = 3.0 Vdc)	–	50	nAdc
I_{BL}	Base Cutoff Current (V_{CE} = 30 Vdc, $V_{EB(OFF)}$ = 3.0 Vdc)	–	50	nAdc
ON CHARACTERISTICS				
h_{FE}	DC Current Gain (Note 3) (I_C = 100 μA, V_{CE} = 1.0 V) (I_C = 1.0 mA, V_{CE} = 1.0 V) (I_C = 10 mA, V_{CE} = 1.0 V) (I_C = 50 mA, V_{CE} = 1.0 V) (I_C = 100 mA, V_{CE} = 1.0 V)	 40 70 100 60 30	 – – 300 – –	
$V_{CE(sat)}$	Collector−Emitter Saturation Voltage (Note 3) (I_C = 10 mA, I_B = 1.0 mA) (I_C = 50 mA, I_B = 5.0 mA)	 – –	 0.20 0.30	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage (Note 3) (I_C = 10 mA, I_B = 1.0 mA) (I_C = 50 mA, I_B = 5.0 mA)	 0.65 –	 0.85 0.95	V
f_T	Cutoff Frequency (I_C = 10 mA, V_{CE} = 20 V, f = 100 MHz)	300	–	MHz
C_{obo}	Output Capacitance (V_{CB} = 5.0 V, f = 1.0 MHz)	–	4.0	pF
C_{obo}	Input Capacitance (V_{EB} = 0.5 V, f = 1.0 MHz)	–	8.0	pF

Table 2. ELECTRICAL CHARACTERISTICS Q_2 (T_A = 25 °C, unless otherwise noted)

Symbol	Characteristic	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	45	–	–	Vdc
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	50	–	–	Vdc
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage (I_E = 1.0 μAdc, I_C = 0)	5.0	–	–	Vdc
I_{CBO}	Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	–	–	0.1	μAdc

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Table 2. ELECTRICAL CHARACTERISTICS Q_2 (T_A = 25 °C, unless otherwise noted)

Symbol	Characteristic	Min	Typ	Max	Unit
ON CHARACTERISTICS					
h_{FE}	DC Current Gain (Note 3) (I_C = 100 mA, V_{CE} = 1.0 V) (I_C = 500 mA, V_{CE} = 1.0 V)	 250 40	 – –	 600 –	
$V_{CE(sat)}$	Collector – Emitter Saturation Voltage (Note 3) (I_C = 500 mA, I_B = 50 mA)	–	–	0.7	V
$V_{BE(on)}$	Base – Emitter Turn-on Voltage (Note 3) (I_C = 500 mA, V_{CE} = 1.0 V)	–	–	1.2	V
f_T	Cutoff Frequency (I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz	100	–	–	MHz
C_{obo}	Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz	–	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%.

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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.

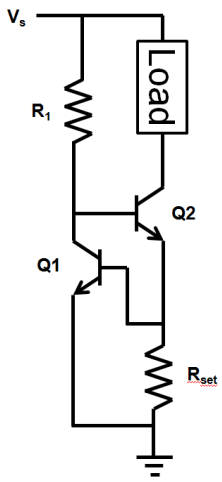


Figure 1. Typical Application Schematic

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 Votlage, 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:

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

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.

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TYPICAL CHARACTERISTICS – Q1

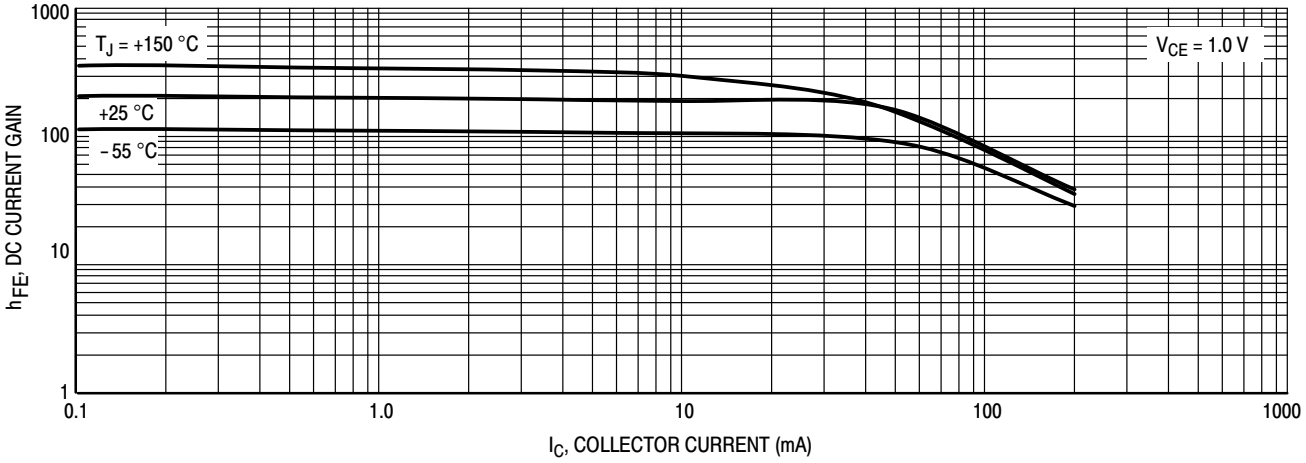


Figure 2. DC Current Gain

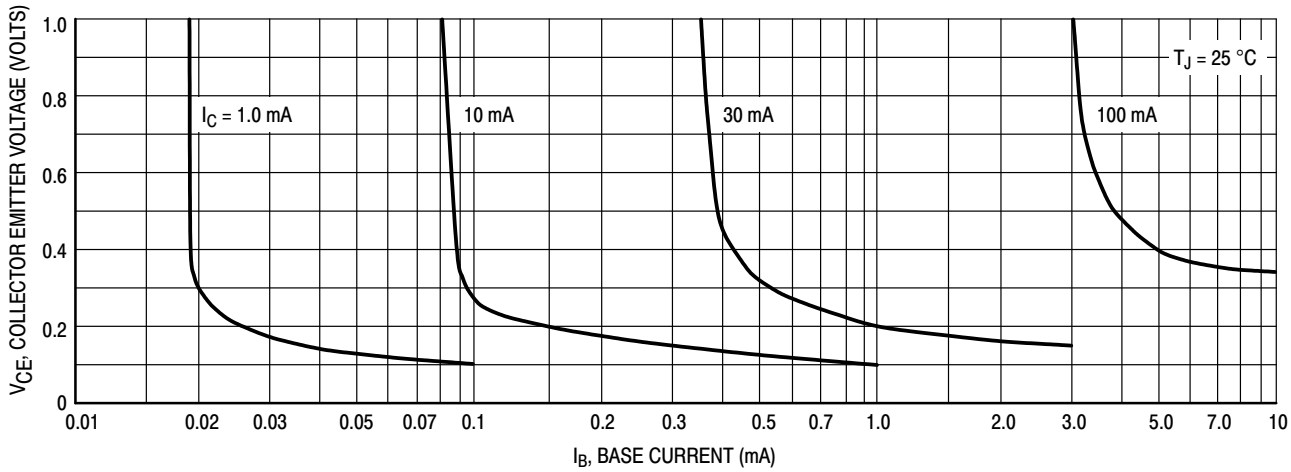


Figure 3. Collector Saturation Region

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TYPICAL CHARACTERISTICS – Q1

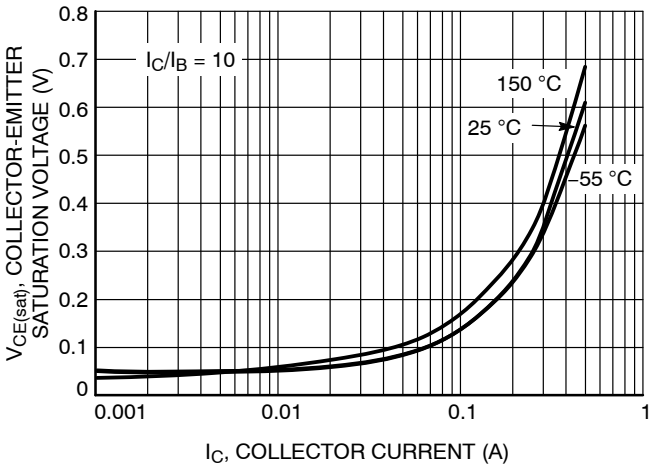


Figure 4. Collector Emitter Saturation Voltage vs. Collector Current

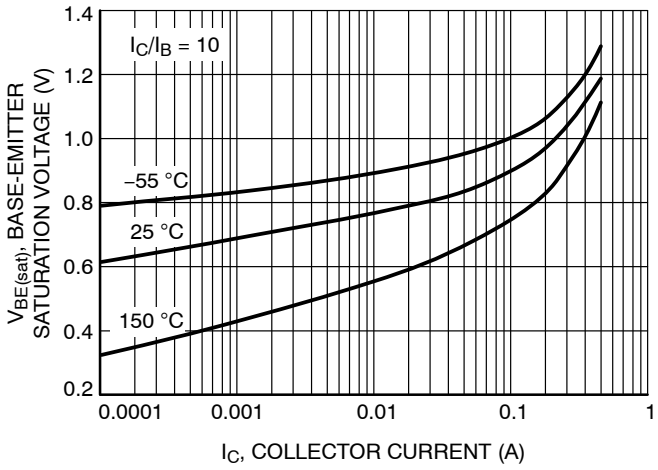


Figure 5. Base Emitter Saturation Voltage vs. Collector Current

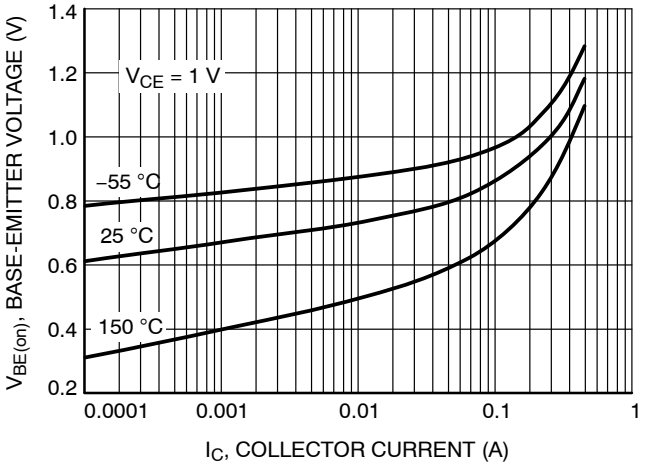


Figure 6. Base Emitter Voltage vs. Collector Current

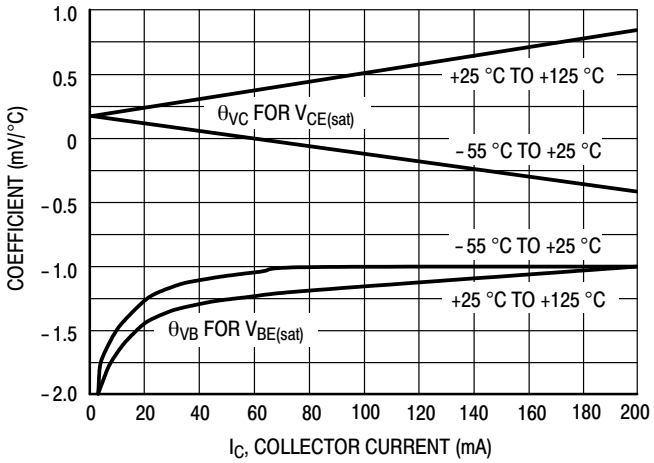


Figure 7. Temperature Coefficients

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TYPICAL CHARACTERISTICS – Q2

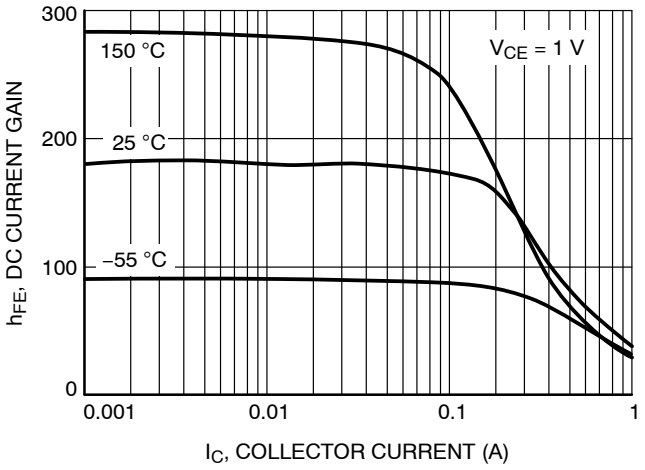


Figure 8. DC Current Gain vs. Collector Current

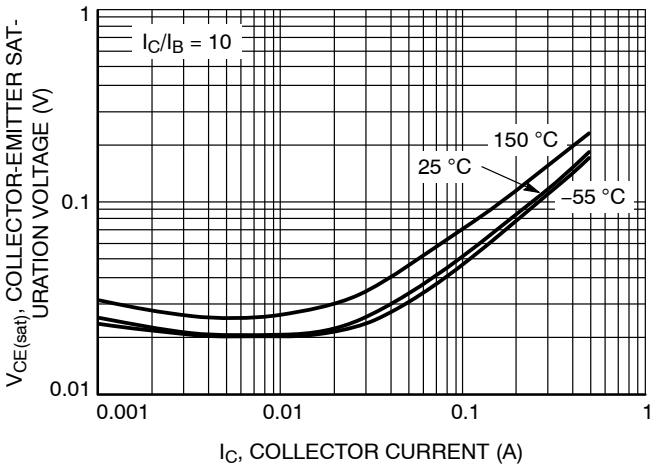


Figure 9. Collector Emitter Saturation Voltage vs. Collector Current

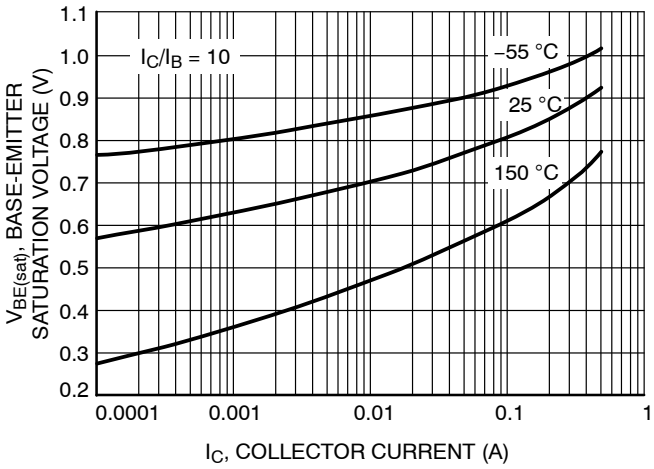


Figure 10. Base Emitter Saturation Voltage vs. Collector Current

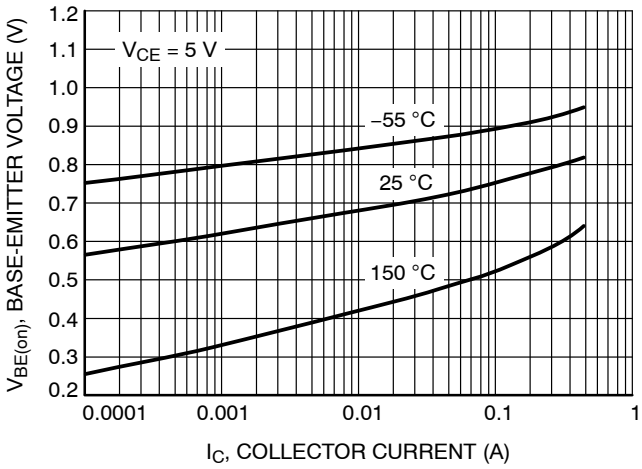


Figure 11. Base Emitter Voltage vs. Collector Current

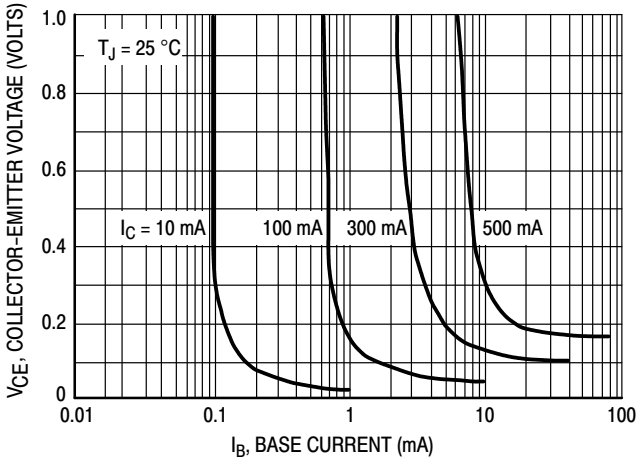


Figure 12. Saturation Region

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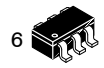
REVISION HISTORY

Revision	Description of Changes	Date
2	Rebranded the Data Sheet to **onsemi** format.	9/11/2025

This document has undergone updates prior to the inclusion of this revision history table. The changes tracked here only reflect updates made on the noted approval dates.

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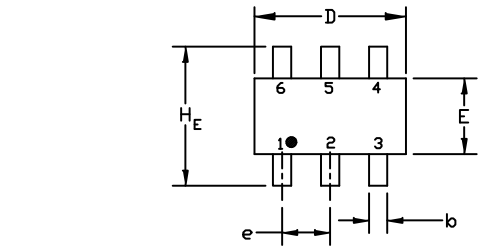
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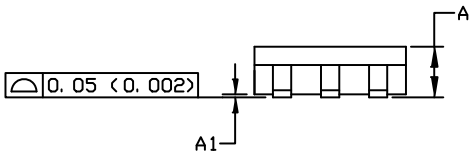
SCALE 2:1

SC−74
CASE 318F
ISSUE P

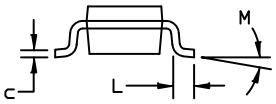
DATE 07 OCT 2021



TOP VIEW



SIDE VIEW

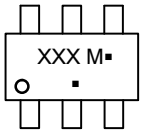


END VIEW

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994
2. CONTROLLING DIMENSION: INCHES
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.

	MILLIMETERS			INCHES		
DIM	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
H_E	2.50	2.75	3.00	0.099	0.108	0.118
L	0.20	0.40	0.60	0.008	0.016	0.024
M	0°	---	10°	0°	---	10°

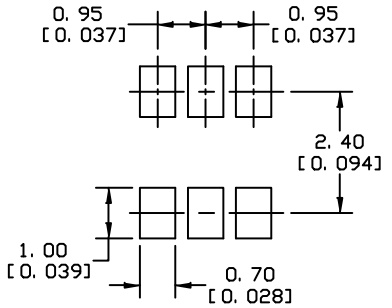
GENERIC MARKING DIAGRAM*



XXX = Specific Device Code
M = Date Code
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “▪”, may or may not be present. Some products may not follow the Generic Marking.



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

SOLDERING FOOTPRINT

STYLE 1:
PIN 1. CATHODE
2. ANODE
3. CATHODE
4. CATHODE
5. ANODE
6. CATHODE

STYLE 2:
PIN 1. NO CONNECTION
2. COLLECTOR
3. EMITTER
4. NO CONNECTION
5. COLLECTOR
6. BASE

STYLE 3:
PIN 1. EMITTER 1
2. BASE 1
3. COLLECTOR 2
4. EMITTER 2
5. BASE 2
6. COLLECTOR 1

STYLE 4:
PIN 1. COLLECTOR 2
2. EMITTER 1/EMITTER 2
3. COLLECTOR 1
4. EMITTER 3
5. BASE 1/BASE 2/COLLECTOR 3
6. BASE 3

STYLE 5:
PIN 1. CHANNEL 1
2. ANODE
3. CHANNEL 2
4. CHANNEL 3
5. CATHODE
6. CHANNEL 4

STYLE 6:
PIN 1. CATHODE
2. ANODE
3. CATHODE
4. CATHODE
5. CATHODE
6. CATHODE

STYLE 7:
PIN 1. SOURCE 1
2. GATE 1
3. DRAIN 2
4. SOURCE 2
5. GATE 2
6. DRAIN 1

STYLE 8:
PIN 1. EMITTER 1
2. BASE 2
3. COLLECTOR 2
4. EMITTER 2
5. BASE 1
6. COLLECTOR 1

STYLE 9:
PIN 1. EMITTER 2
2. BASE 2
3. COLLECTOR 1
4. EMITTER 1
5. BASE 1
6. COLLECTOR 2

STYLE 10:
PIN 1. ANODE/CATHODE
2. BASE
3. EMITTER
4. COLLECTOR
5. ANODE
6. CATHODE

STYLE 11:
PIN 1. EMITTER
2. BASE
3. ANODE/CATHODE
4. ANODE
5. CATHODE
6. COLLECTOR

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