MUN5211T1 Series

Preferred Devices

Bias Resistor Transistor

NPN Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC–70/SOT–323 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- The SC–70/SOT–323 package can be soldered using wave or reflow. The modified gull–winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
  Use the Device Number to order the 7 inch/3000 unit reel.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	202 (Note 1.) 310 (Note 2.) 1.6 (Note 1.) 2.5 (Note 2.)	mW mW/°C
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	618 (Note 1.) 403 (Note 2.)	°C/W
Thermal Resistance – Junction-to-Lead	$R_{\theta JL}$	280 (Note 1.) 332 (Note 2.)	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 x 1.0 inch Pad

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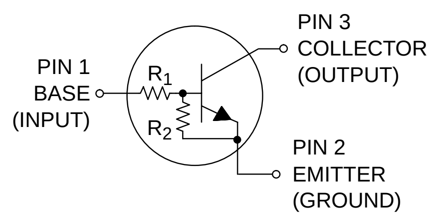
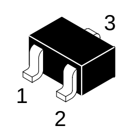
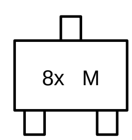
NPN SILICON BIAS RESISTOR TRANSISTORS





SC–70/SOT–323
CASE 419
STYLE 3

MARKING DIAGRAM



8x = Specific Device Code
x = (See Marking Table)
M = Date Code

DEVICE MARKING INFORMATION

See specific marking information in the device marking table on page 2 of this data sheet.

Preferred devices are recommended choices for future use and best overall value.

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DEVICE MARKING AND RESISTOR VALUES

Device	Package	Marking	R1 (K)	R2 (K)	Shipping
MUN5211T1	SC–70/SOT–323	8A	10	10	3000/Tape & Reel
MUN5212T1	SC–70/SOT–323	8B	22	22	3000/Tape & Reel
MUN5213T1	SC–70/SOT–323	8C	47	47	3000/Tape & Reel
MUN5214T1	SC–70/SOT–323	8D	10	47	3000/Tape & Reel
MUN5215T1 (Note 3.)	SC–70/SOT–323	8E	10	∞	3000/Tape & Reel
MUN5216T1 (Note 3.)	SC–70/SOT–323	8F	4.7	∞	3000/Tape & Reel
MUN5230T1 (Note 3.)	SC–70/SOT–323	8G	1.0	1.0	3000/Tape & Reel
MUN5231T1 (Note 3.)	SC–70/SOT–323	8H	2.2	2.2	3000/Tape & Reel
MUN5232T1 (Note 3.)	SC–70/SOT–323	8J	4.7	4.7	3000/Tape & Reel
MUN5233T1 (Note 3.)	SC–70/SOT–323	8K	4.7	47	3000/Tape & Reel
MUN5234T1 (Note 3.)	SC–70/SOT–323	8L	22	47	3000/Tape & Reel
MUN5235T1 (Note 3.)	SC–70/SOT–323	8M	2.2	47	3000/Tape & Reel
MUN5236T1 (Note 3.)	SC–70/SOT–323	8N	100	100	3000/Tape & Reel
MUN5237T1 (Note 3.)	SC–70/SOT–323	8P	47	22	3000/Tape & Reel

3. New devices. Updated curves to follow in subsequent data sheets.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector-Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter-Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	MUN5211T1	I_{EBO}	–	–	0.5	mAdc
	MUN5212T1		–	–	0.2	
	MUN5213T1		–	–	0.1	
	MUN5214T1		–	–	0.2	
	MUN5215T1		–	–	0.9	
	MUN5216T1		–	–	1.9	
	MUN5230T1		–	–	4.3	
	MUN5231T1		–	–	2.3	
	MUN5232T1		–	–	1.5	
	MUN5233T1		–	–	0.18	
	MUN5234T1		–	–	0.13	
	MUN5235T1		–	–	0.2	
	MUN5236T1		–	–	0.05	
	MUN5237T1		–	–	0.13	
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector-Emitter Breakdown Voltage (Note 4.) (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc
ON CHARACTERISTICS (Note 4.)						
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	MUN5211T1	h_{FE}	35	60	–	
	MUN5212T1		60	100	–	
	MUN5213T1		80	140	–	
	MUN5214T1		80	140	–	
	MUN5215T1		160	350	–	
	MUN5216T1		160	350	–	
	MUN5230T1		3.0	5.0	–	
	MUN5231T1		8.0	15	–	
	MUN5232T1		15	30	–	
	MUN5233T1		80	200	–	
	MUN5234T1		80	150	–	
	MUN5235T1		80	140	–	
	MUN5236T1		80	150	–	
	MUN5237T1		80	140	–	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.3 mA) (I_C = 10 mA, I_B = 5 mA) MUN5230T1/MUN5231T1 (I_C = 10 mA, I_B = 1 mA) MUN5215T1/MUN5216T1/ MUN5232T1/MUN5233T1/MUN5234T1		$V_{CE(sat)}$	–	–	0.25	Vdc
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)	MUN5211T1		–	–	0.2	
	MUN5212T1		–	–	0.2	
	MUN5214T1		–	–	0.2	
	MUN5215T1		–	–	0.2	
	MUN5216T1		–	–	0.2	
	MUN5230T1		–	–	0.2	
	MUN5231T1		–	–	0.2	
	MUN5232T1		–	–	0.2	
	MUN5233T1		–	–	0.2	
	MUN5234T1		–	–	0.2	
	MUN5235T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	MUN5213T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 5.5 V, R_L = 1.0 kΩ)	MUN5236T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 4.0 V, R_L = 1.0 kΩ)	MUN5237T1		–	–	0.2	

4. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Note 5.) (Continued)						
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ)		V_{OH}	4.9	–	–	Vdc
(V_{CC} = 5.0 V, V_B = 0.050 V, R_L = 1.0 kΩ)	MUN5230T1					
(V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ)	MUN5215T1					
	MUN5216T1					
	MUN5233T1					
Input Resistor	MUN5211T1	R_1	7.0	10	13	kΩ
	MUN5212T1		15.4	22	28.6	
	MUN5213T1		32.9	47	61.1	
	MUN5214T1		7.0	10	13	
	MUN5215T1		7.0	10	13	
	MUN5216T1		3.3	4.7	6.1	
	MUN5230T1		0.7	1.0	1.3	
	MUN5231T1		1.5	2.2	2.9	
	MUN5232T1		3.3	4.7	6.1	
	MUN5233T1		3.3	4.7	6.1	
	MUN5234T1		15.4	22	28.6	
	MUN5235T1		1.54	2.2	2.86	
	MUN5236T1		70	100	130	
	MUN5237T1		32.9	47	61.1	
Resistor Ratio	MUN5211T1/MUN5212T1/MUN5213T1/ MUN5236T1	R_1/R_2	0.8	1.0	1.2	
	MUN5214T1		0.17	0.21	0.25	
	MUN5215T1/MUN5216T1		–	–	–	
	MUN5230T1/MUN5231T1/MUN5232T1		0.8	1.0	1.2	
	MUN5233T1		0.055	0.1	0.185	
	MUN5234T1		0.38	0.47	0.56	
	MUN5235T1		0.038	0.047	0.056	
	MUN5237T1		1.7	2.1	2.6	

5. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

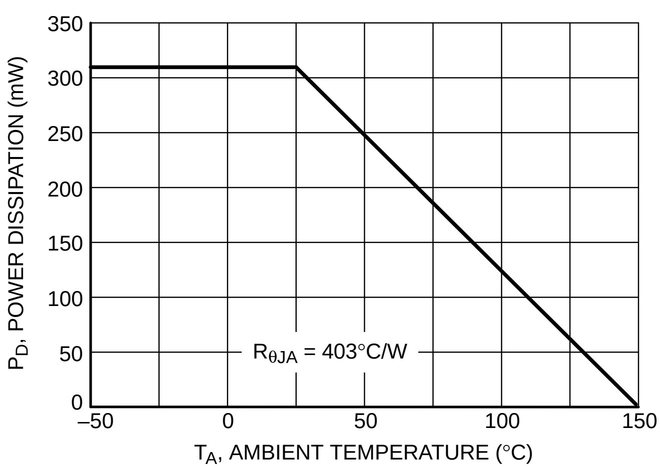


Figure 1. Derating Curve

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5211T1

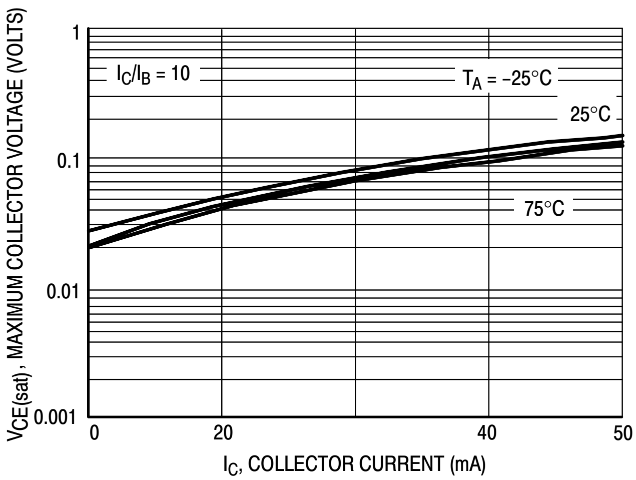


Figure 2. $V_{CE(sat)}$ versus I_C

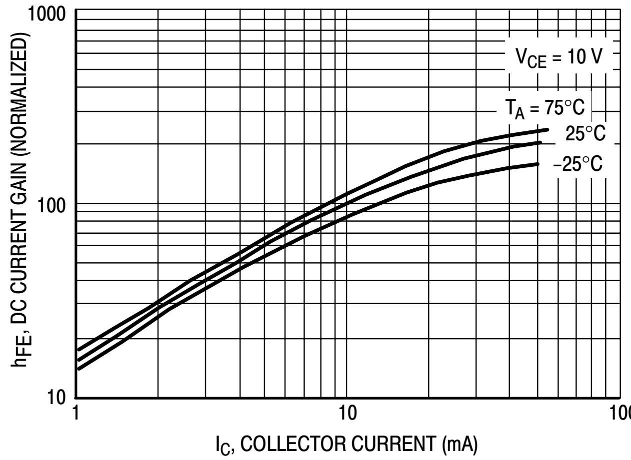


Figure 3. DC Current Gain

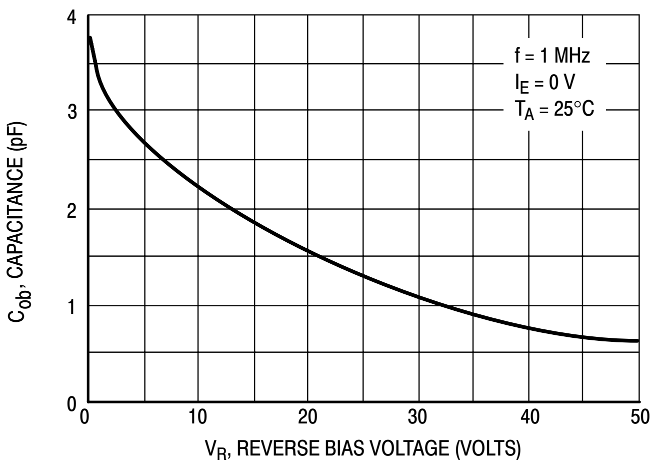


Figure 4. Output Capacitance

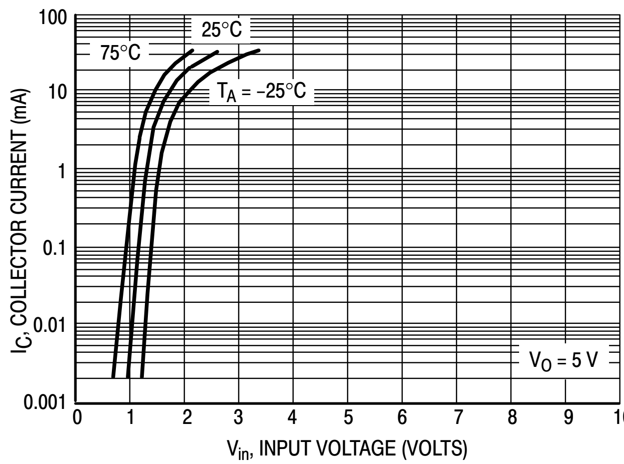


Figure 5. Output Current versus Input Voltage

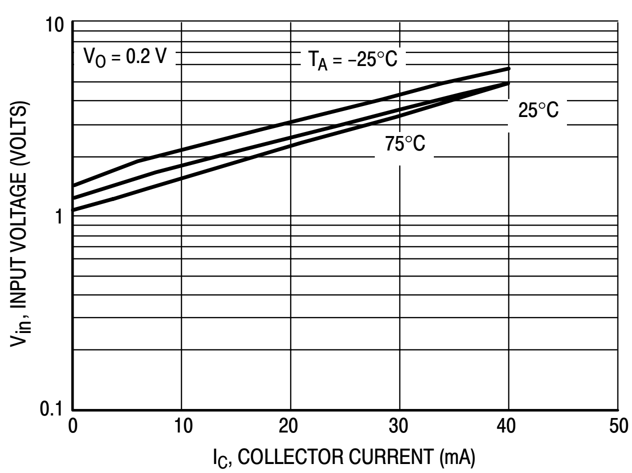


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5212T1

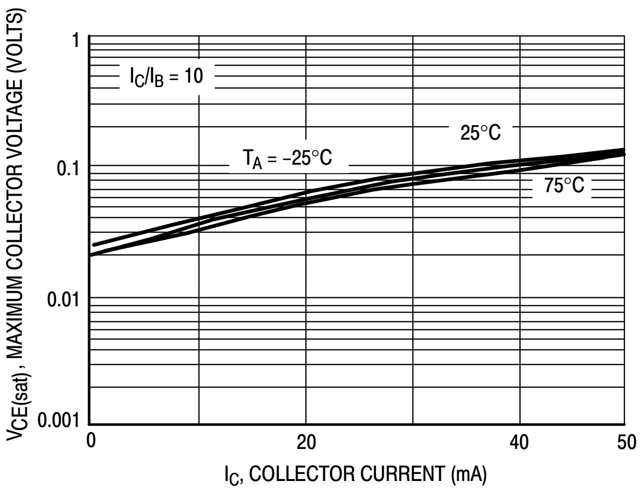


Figure 7. $V_{CE(sat)}$ versus I_C

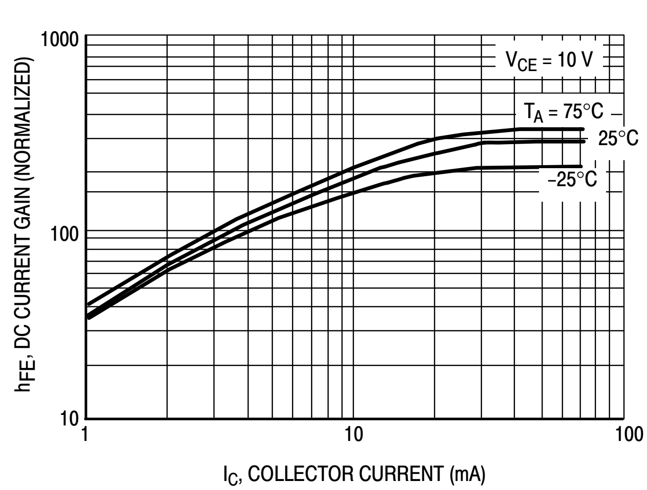


Figure 8. DC Current Gain

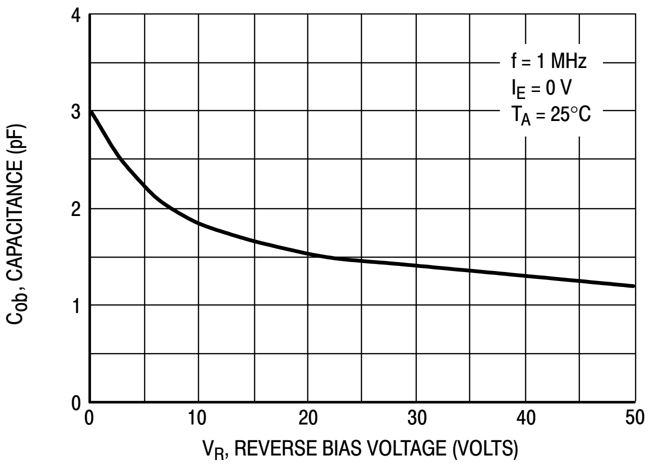


Figure 9. Output Capacitance

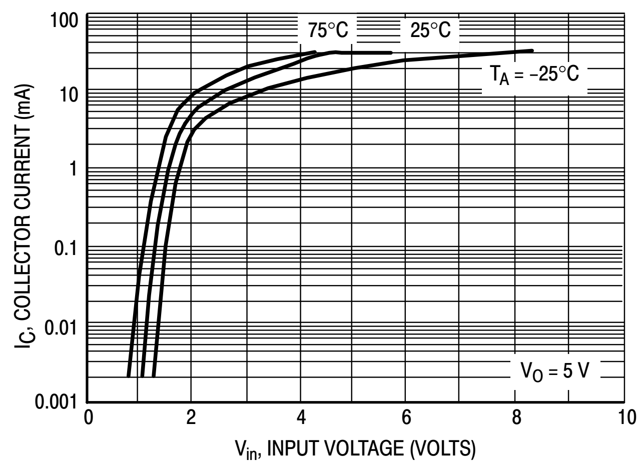


Figure 10. Output Current versus Input Voltage

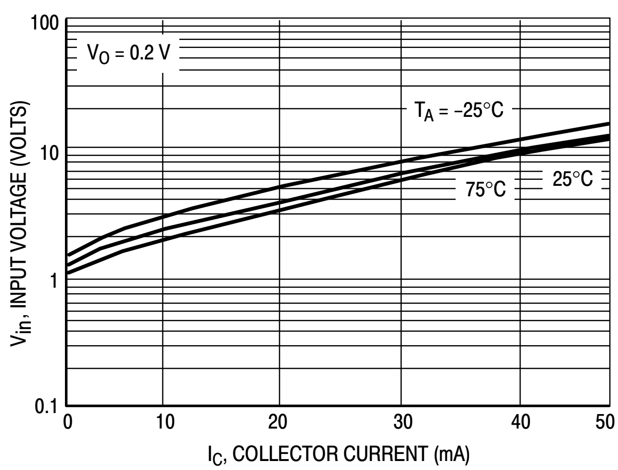


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5213T1

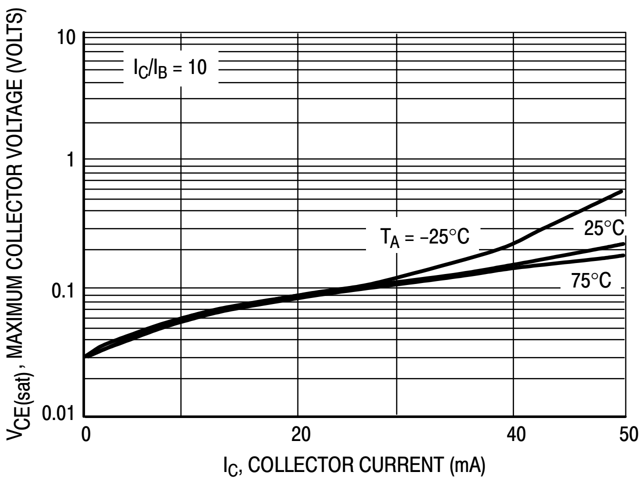


Figure 12. $V_{CE(sat)}$ versus I_C

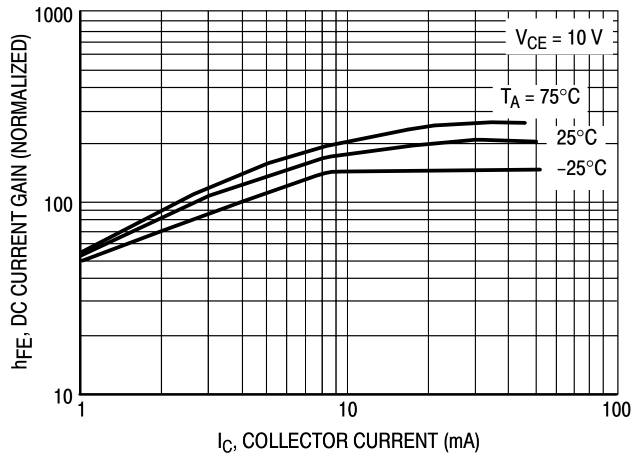


Figure 13. DC Current Gain

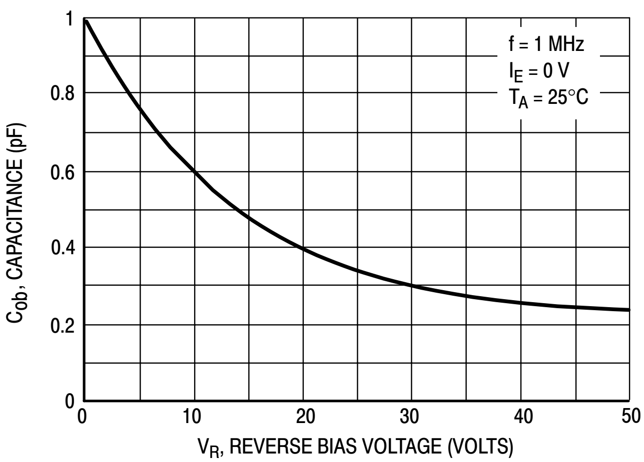


Figure 14. Output Capacitance

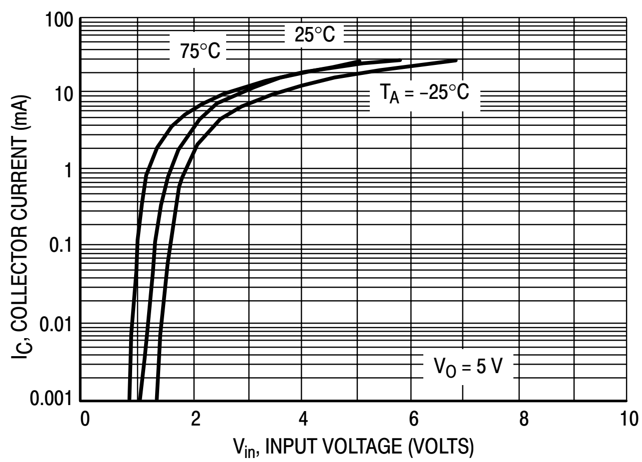


Figure 15. Output Current versus Input Voltage

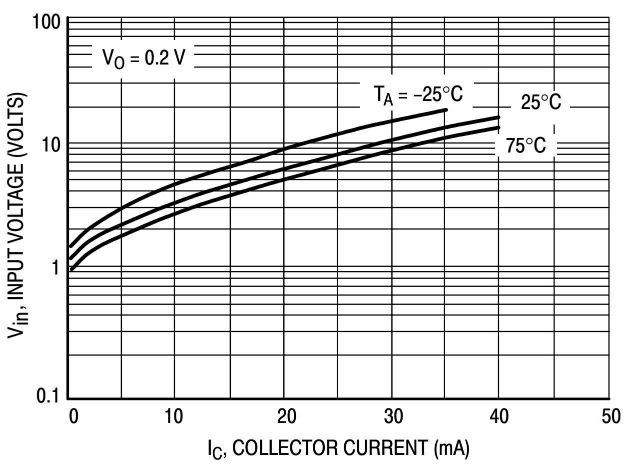


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5214T1

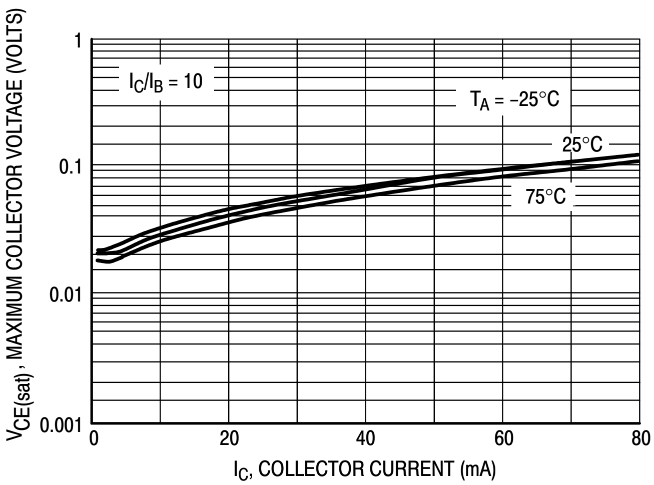


Figure 17. $V_{CE(sat)}$ versus I_C

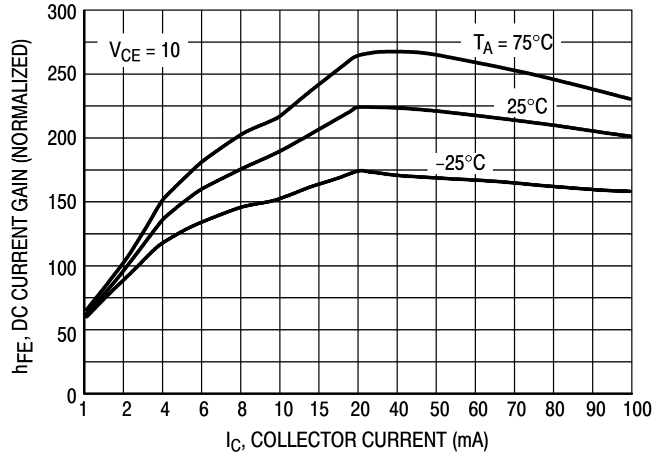


Figure 18. DC Current Gain

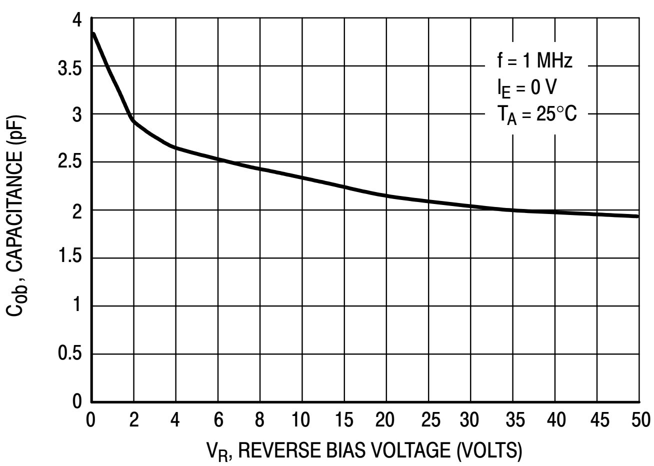


Figure 19. Output Capacitance

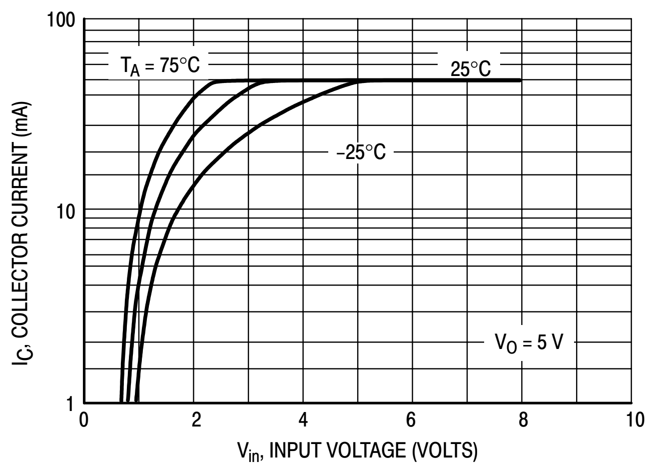


Figure 20. Output Current versus Input Voltage

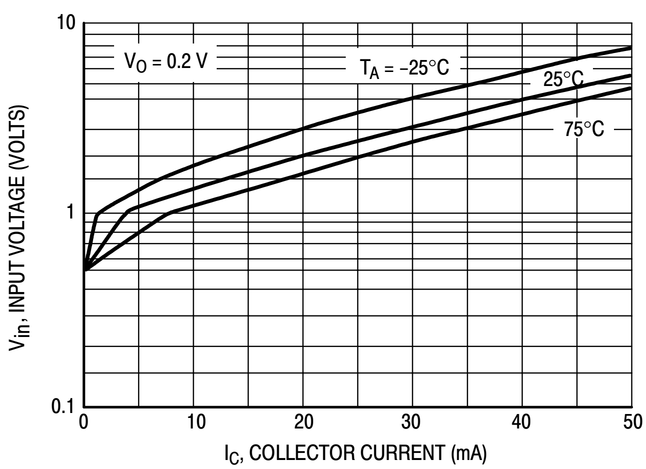


Figure 21. Input Voltage versus Output Current

TYPICAL APPLICATIONS FOR NPN BRTs

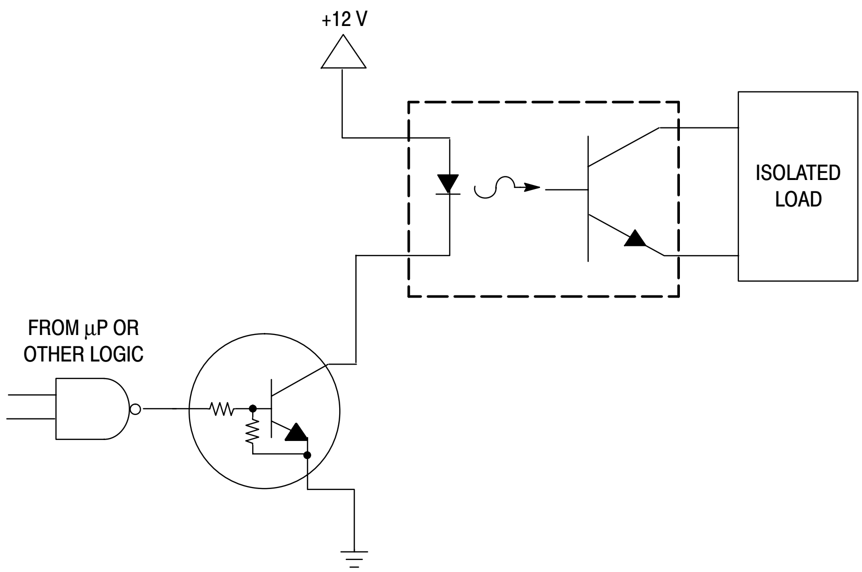


Figure 22. Level Shifter: Connects 12 or 24 Volt Circuits to Logic

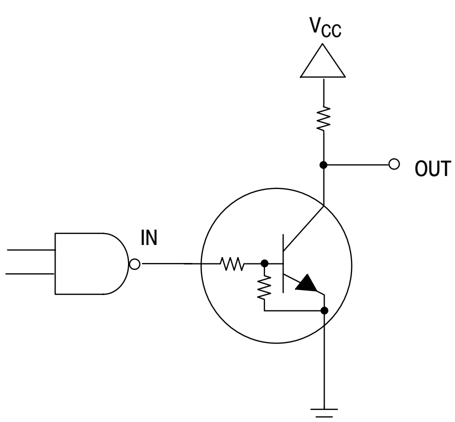


Figure 23. Open Collector Inverter: Inverts the Input Signal

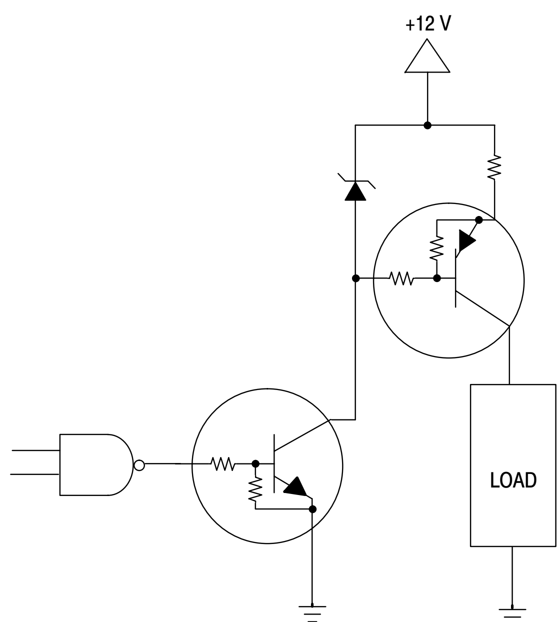
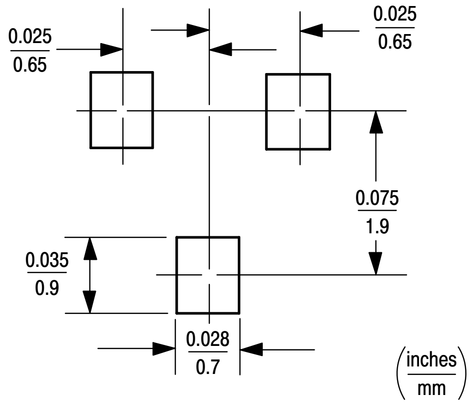


Figure 24. Inexpensive, Unregulated Current Source

MINIMUM RECOMMENDED FOOTPRINTS FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



SC–70/SOT–323 POWER DISSIPATION

The power dissipation of the SC–70/SOT–323 is a function of the pad size. This can vary from the minimum pad size for soldering to the pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient; and the operating temperature, T_A. Using the values provided on the data sheet, P_D can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device which in this case is 310 milliwatts.

$$P_D = \frac{150°C - 25°C}{403°C/W} = 310 \text{ milliwatts}$$

The 403°C/W assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 310 milliwatts. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad®. Using a board material such as Thermal Clad, the power dissipation can be doubled using the same footprint.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference should be a maximum of 10°C.
- The soldering temperature and time should not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient should be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

SOLDER STENCIL GUIDELINES

Prior to placing surface mount components onto a printed circuit board, solder paste must be applied to the pads. A solder stencil is required to screen the optimum amount of solder paste onto the footprint. The stencil is made of brass or stainless steel with a typical thickness of 0.008 inches. The stencil opening size for the surface mounted package should be the same as the pad size on the printed circuit board, i.e., a 1:1 registration.

TYPICAL SOLDER HEATING PROFILE

For any given circuit board, there will be a group of control settings that will give the desired heat pattern. The operator must set temperatures for several heating zones, and a figure for belt speed. Taken together, these control settings make up a heating "profile" for that particular circuit board. On machines controlled by a computer, the computer remembers these profiles from one operating session to the next. Figure 25 shows a typical heating profile for use when soldering a surface mount device to a printed circuit board. This profile will vary among soldering systems but it is a good starting point. Factors that can affect the profile include the type of soldering system in use, density and types of components on the board, type of solder used, and the type of board or substrate material being used. This profile shows temperature versus time. The line on the graph shows the actual temperature that might be experienced on the surface of a test board at or near a central solder joint. The two profiles are based on a high density and a low density board. The Vitronics SMD310 convection/infrared reflow soldering system was used to generate this profile. The type of solder used was 62/36/2 Tin Lead Silver with a melting point between 177–189°C. When this type of furnace is used for solder reflow work, the circuit boards and solder joints tend to heat first. The components on the board are then heated by conduction. The circuit board, because it has a large surface area, absorbs the thermal energy more efficiently, then distributes this energy to the components. Because of this effect, the main body of a component may be up to 30 degrees cooler than the adjacent solder joints.

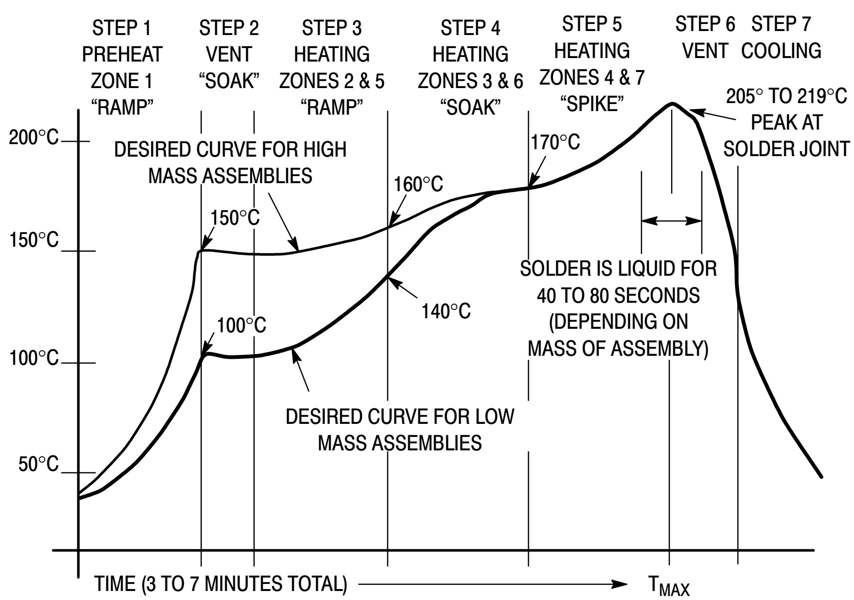
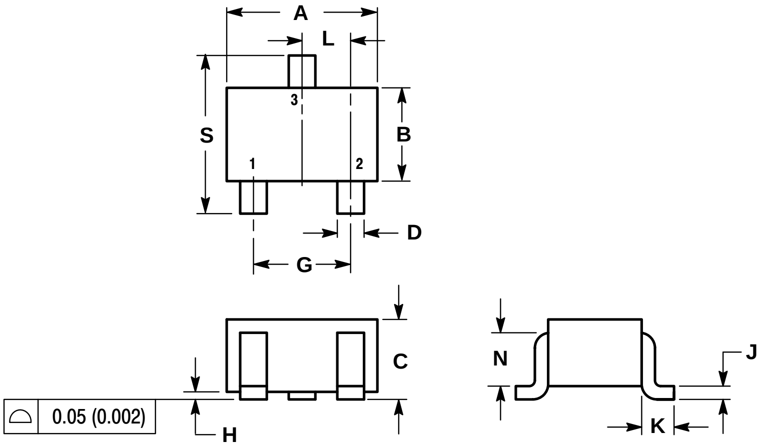


Figure 25. Typical Solder Heating Profile

PACKAGE DIMENSIONS

SC–70/SOT–323
CASE 419–04
ISSUE L



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.032	0.040	0.80	1.00
D	0.012	0.016	0.30	0.40
G	0.047	0.055	1.20	1.40
H	0.000	0.004	0.00	0.10
J	0.004	0.010	0.10	0.25
K	0.017 REF		0.425 REF	
L	0.026 BSC		0.650 BSC	
N	0.028 REF		0.700 REF	
S	0.079	0.095	2.00	2.40

STYLE 3:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

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