

# DTC114EET1 SERIES

## 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-75/SOT-416 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- The SC-75/SOT-416 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, 7 inch/3000 Unit Tape & Reel

#### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	$V_{CB0}$	50	Vdc
Collector-Emitter Voltage	$V_{CEO}$	50	Vdc
Collector Current	$I_C$	100	mAdc

#### DEVICE MARKING AND RESISTOR VALUES

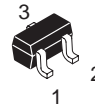
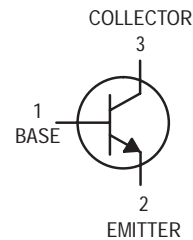
Device	Marking	R1 (K)	R2 (K)	Shipping
DTC114EET1	8A	10	10	3000/Tape & Reel
DTC124EET1	8B	22	22	
DTC144EET1	8C	47	47	
DTC114YET1	8D	10	47	
DTC143TET1	8F	4.7	$\infty$	
DTC123EET1	8H	2.2	2.2	
DTC143EET1	8J	4.7	4.7	
DTC143ZET1	8K	4.7	47	
DTC124XET1	8L	22	47	
DTC123JET1	8M	2.2	47	



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### NPN SILICON BIAS RESISTOR TRANSISTORS



**CASE 463  
SOT-416/SC-75  
STYLE 1**

## DTC114EET1 SERIES

### Thermal Characteristics

Characteristic	Symbol	Max	Unit
Total Device Dissipation, FR-4 Board (1.) @ T <sub>A</sub> = 25°C Derate above 25°C	P <sub>D</sub>	200 1.6	mW mW/°C
Thermal Resistance, Junction to Ambient (1.)	R <sub>θJA</sub>	600	°C/W
Total Device Dissipation, FR-4 Board (2.) @ T <sub>A</sub> = 25°C Derate above 25°C	P <sub>D</sub>	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient (2.)	R <sub>θJA</sub>	400	°C/W
Junction and Storage Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	-55 to +150	°C

### Electrical Characteristics (T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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### Off Characteristics

Collector-Base Cutoff Current (V <sub>CB</sub> = 50 V, I <sub>E</sub> = 0)	I <sub>CBO</sub>	—	—	100	nAdc
Collector-Emitter Cutoff Current (V <sub>CE</sub> = 50 V, I <sub>B</sub> = 0)	I <sub>CEO</sub>	—	—	500	nAdc
Emitter-Base Cutoff Current (V <sub>EB</sub> = 6.0 V, I <sub>C</sub> = 0)	I <sub>EBO</sub>	—	—	0.5	mAdc
DTC114EET1		—	—	0.2	
DTC124EET1		—	—	0.1	
DTC144EET1		—	—	0.2	
DTC114YET1		—	—	1.9	
DTC143TET1		—	—	2.3	
DTC123EET1		—	—	1.5	
DTC143EET1		—	—	0.18	
DTC143ZET1		—	—	0.13	
DTC124XET1		—	—	0.2	
DTC123JET1		—	—		
Collector-Base Breakdown Voltage (I <sub>C</sub> = 10 μA, I <sub>E</sub> = 0)	V <sub>(BR)CBO</sub>	50	—	—	Vdc
Collector-Emitter Breakdown Voltage (3.) (I <sub>C</sub> = 2.0 mA, I <sub>B</sub> = 0)	V <sub>(BR)CEO</sub>	50	—	—	Vdc

### On Characteristics (3.)

DC Current Gain (V <sub>CE</sub> = 10 V, I <sub>C</sub> = 5.0 mA)	h <sub>FE</sub>	35	60	—	
DTC114EET1		60	100	—	
DTC124EET1		80	140	—	
DTC144EET1		80	140	—	
DTC114YET1		160	350	—	
DTC143TET1		8.0	15	—	
DTC123EET1		15	30	—	
DTC143EET1		80	200	—	
DTC143ZET1		80	150	—	
DTC124XET1		80	140	—	
DTC123JET1					
Collector-Emitter Saturation Voltage (I <sub>C</sub> = 10 mA, I <sub>B</sub> = 0.3 mA) (I <sub>C</sub> = 10 mA, I <sub>B</sub> = 5 mA) DTC123EET1 (I <sub>C</sub> = 10 mA, I <sub>B</sub> = 1 mA) DTC143TET1 DTC143ZET1/DTC124XET1	V <sub>CE(sat)</sub>	—	—	0.25	Vdc
Output Voltage (on) (V <sub>CC</sub> = 5.0 V, V <sub>B</sub> = 2.5 V, R <sub>L</sub> = 1.0 kΩ)	V <sub>OL</sub>	—	—	0.2	Vdc
DTC114EET1		—	—	0.2	
DTC124EET1		—	—	0.2	
DTC114YET1		—	—	0.2	
DTC143TET1		—	—	0.2	
DTC123EET1		—	—	0.2	
DTC143EET1		—	—	0.2	
DTC143ZET1		—	—	0.2	
DTC124XET1		—	—	0.2	
DTC123JET1		—	—	0.2	
DTC144EET1		—	—	0.2	
(V <sub>CC</sub> = 5.0 V, V <sub>B</sub> = 3.5 V, R <sub>L</sub> = 1.0 kΩ)					

1. FR-4 @ Minimum Pad

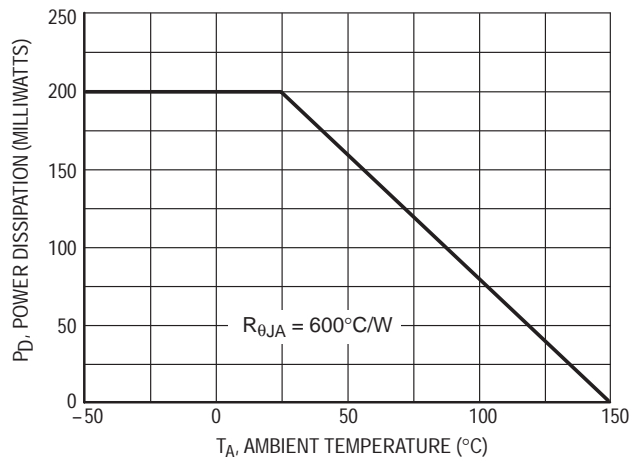
2. FR-4 @ 1.0 × 1.0 Inch Pad

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

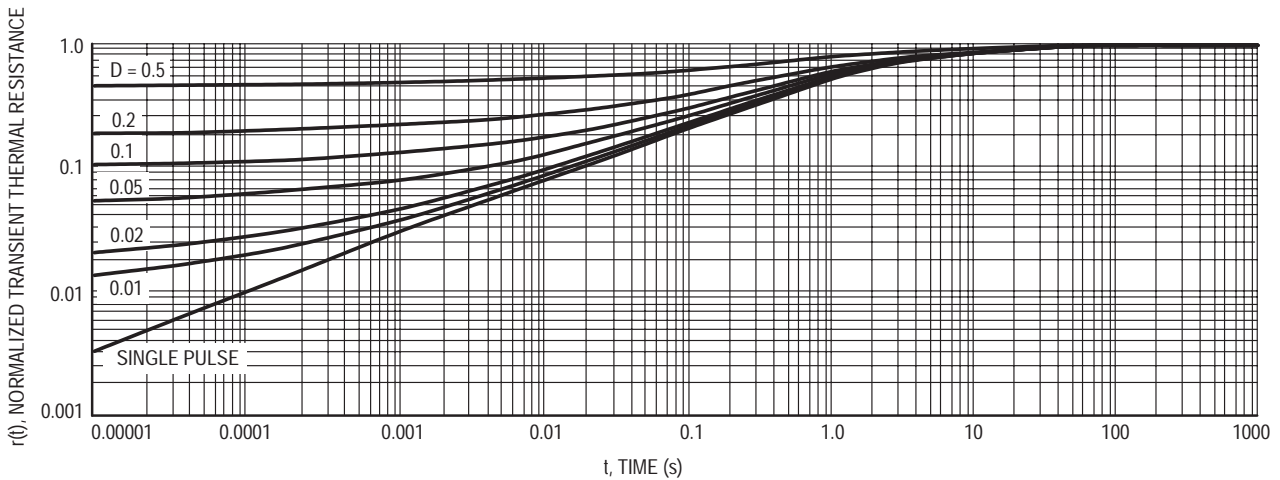
# DTC114EET1 SERIES

## ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
Output Voltage (off) (V <sub>CC</sub> = 5.0 V, V <sub>B</sub> = 0.5 V, R <sub>L</sub> = 1.0 kΩ) (V <sub>CC</sub> = 5.0 V, V <sub>B</sub> = 0.25 V, R <sub>L</sub> = 1.0 kΩ) DTC143TET1 DTC143ZET1	V <sub>OH</sub>	4.9	—	—	Vdc
Input Resistor DTC114EET1 DTC124EET1 DTC144EET1 DTC114YET1 DTC143TET1 DTC123EET1 DTC143EET1 DTC143ZET1 DTC124XET1 DTC123JET1	R1	7.0 15.4 32.9 7.0 3.3 1.5 3.3 3.3 15.4 1.54	10 22 47 10 4.7 2.2 4.7 4.7 22 2.2	13 28.6 61.1 13 6.1 2.9 6.1 6.1 28.6 2.86	kΩ
Resistor Ratio DTC114EET1/DTC124EET1/DTC144EET1 DTC114YET1 DTC143TET1 DTC123EET1/DTC143EET1 DTC143ZET1 DTC124XET1 DTC123JET1	R <sub>1</sub> /R <sub>2</sub>	0.8 0.17 — 0.8 0.055 0.38 0.038	1.0 0.21 — 1.0 0.1 0.47 0.047	1.2 0.25 — 1.2 0.185 0.56 0.056	



**Figure 1. Derating Curve**



**Figure 2. Normalized Thermal Response**

# DTC114EET1 SERIES

## TYPICAL ELECTRICAL CHARACTERISTICS — DTC114EET1

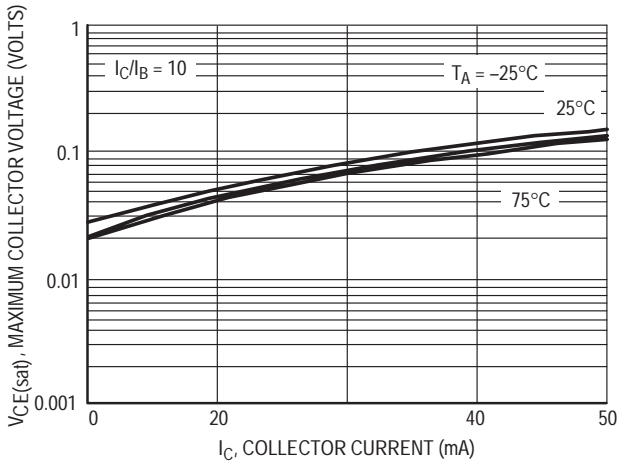


Figure 3.  $V_{CE(sat)}$  versus  $I_C$

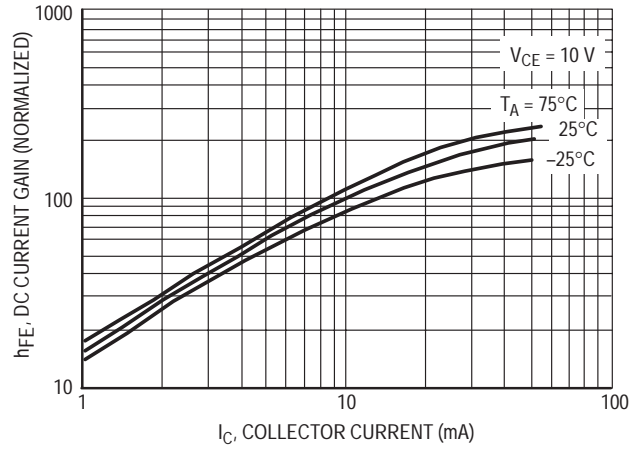


Figure 4. DC Current Gain

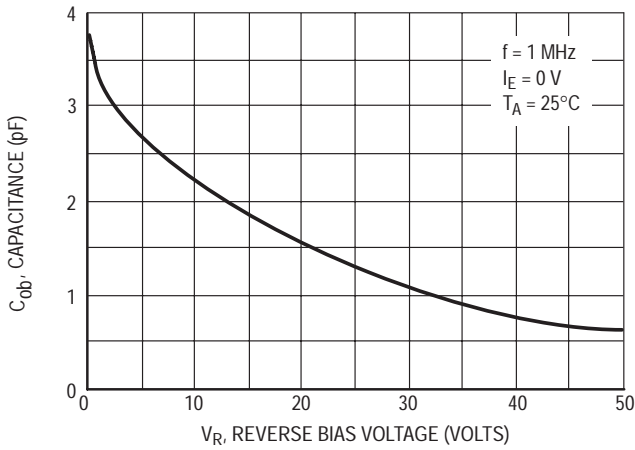


Figure 5. Output Capacitance

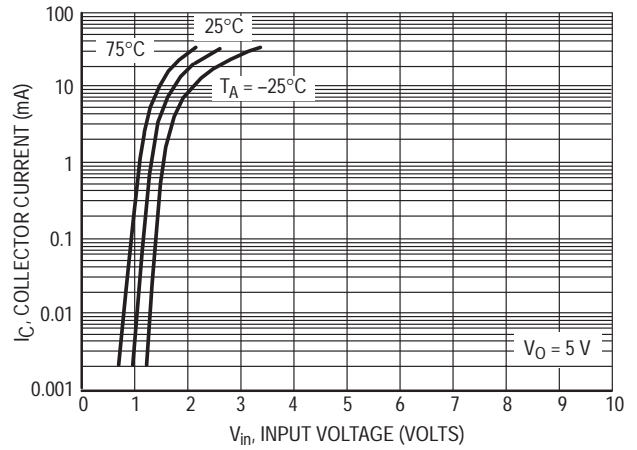


Figure 6. Output Current versus Input Voltage

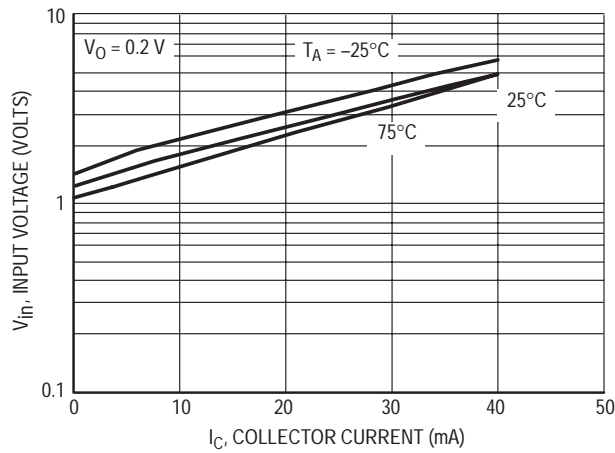


Figure 7. Input Voltage versus Output Current

# DTC114EET1 SERIES

## TYPICAL ELECTRICAL CHARACTERISTICS — DTC124EET1

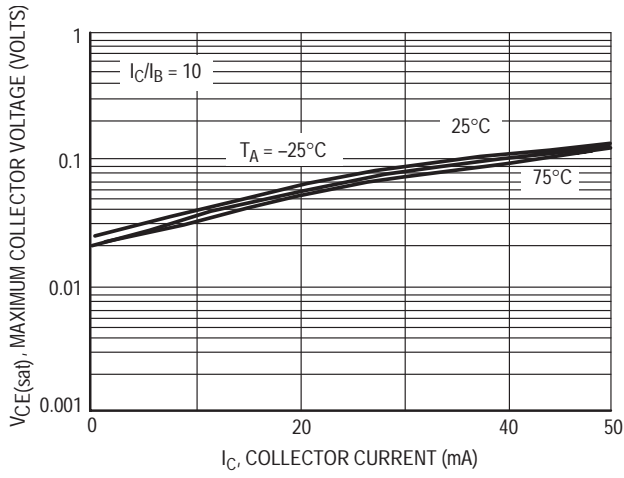


Figure 8.  $V_{CE(sat)}$  versus  $I_C$

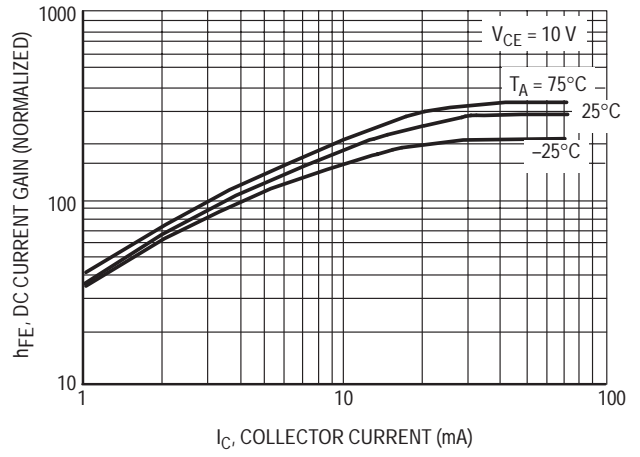


Figure 9. DC Current Gain

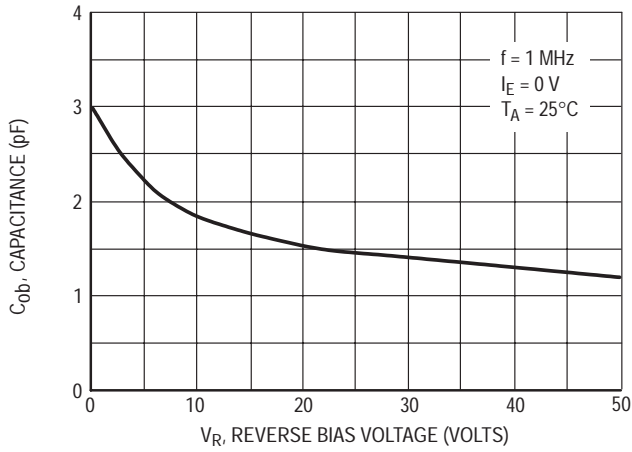


Figure 10. Output Capacitance

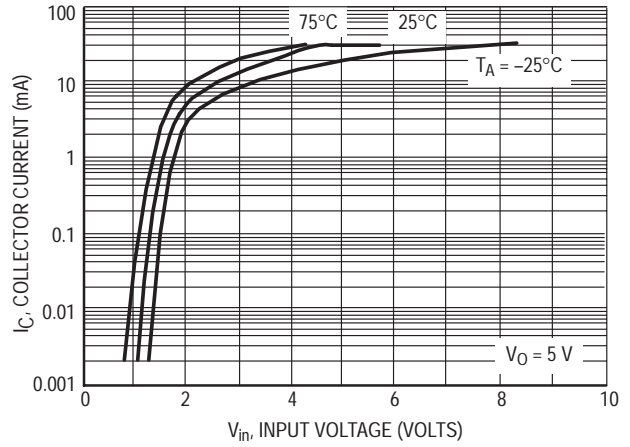


Figure 11. Output Current versus Input Voltage

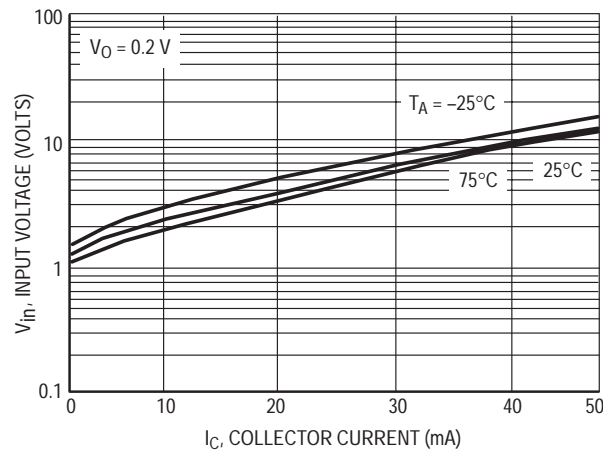


Figure 12. Input Voltage versus Output Current

# DTC114EET1 SERIES

## TYPICAL ELECTRICAL CHARACTERISTICS — DTC114EET1

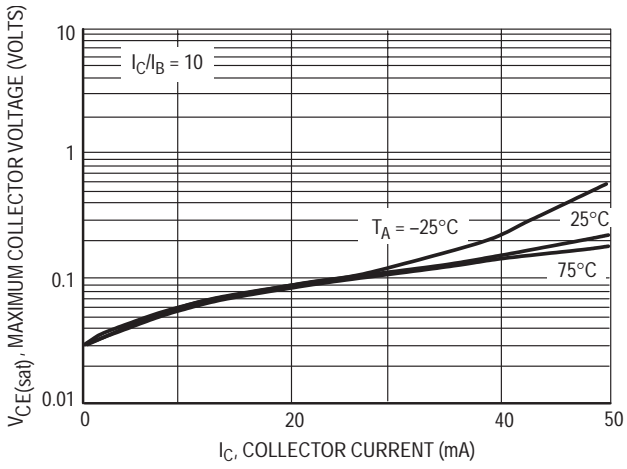


Figure 13.  $V_{CE(sat)}$  versus  $I_C$

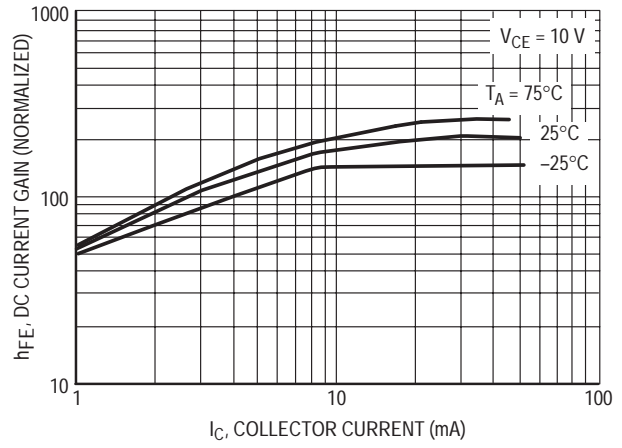


Figure 14. DC Current Gain

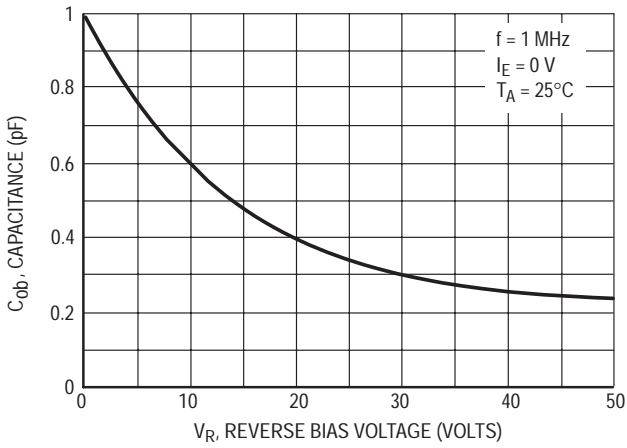


Figure 15. Output Capacitance

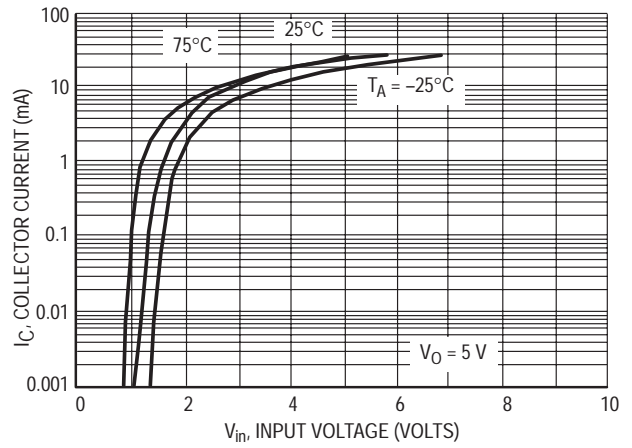


Figure 16. Output Current versus Input Voltage

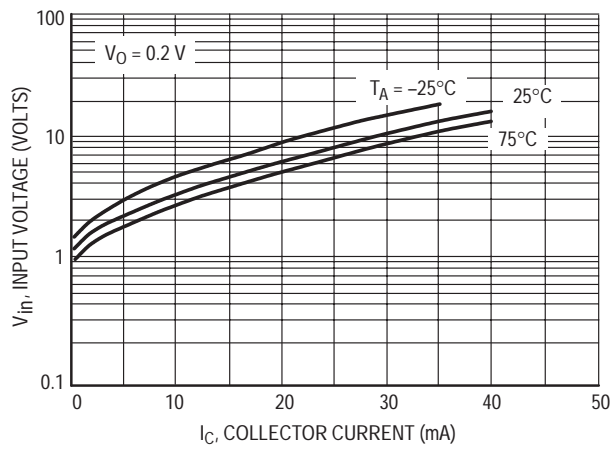


Figure 17. Input Voltage versus Output Current

# DTC114EET1 SERIES

## TYPICAL ELECTRICAL CHARACTERISTICS — DTC114YET1

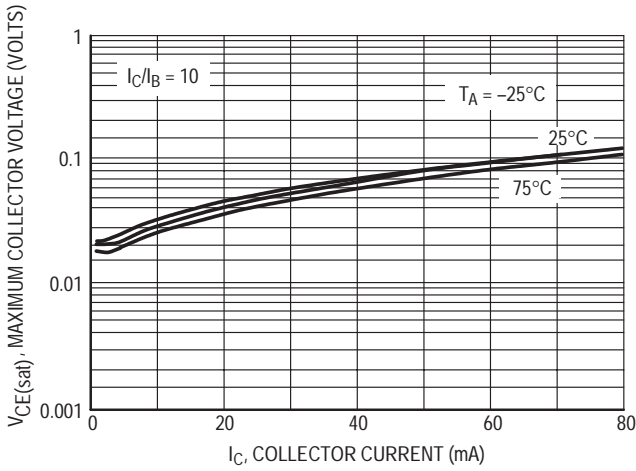


Figure 18.  $V_{CE(sat)}$  versus  $I_C$

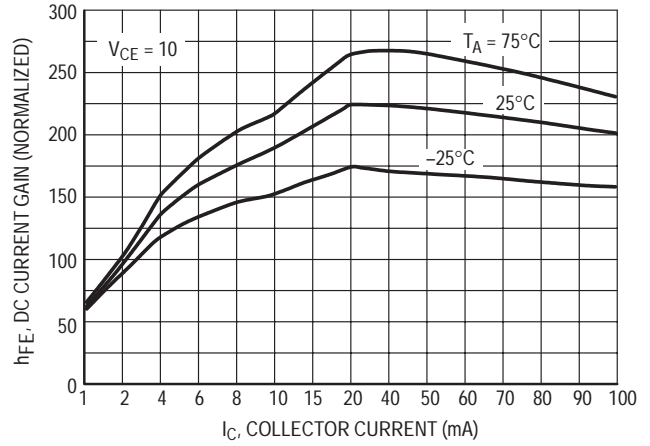


Figure 19. DC Current Gain

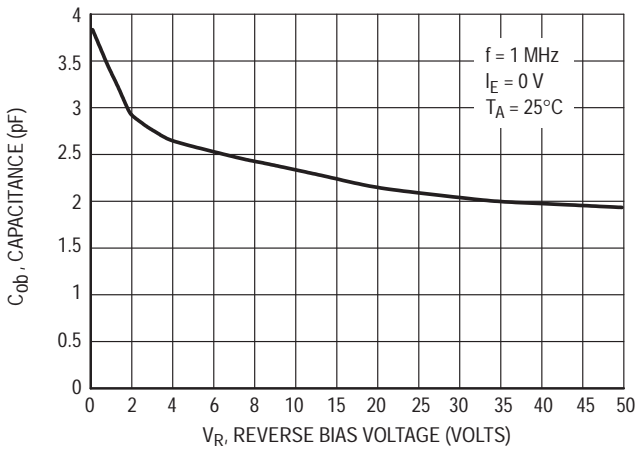


Figure 20. Output Capacitance

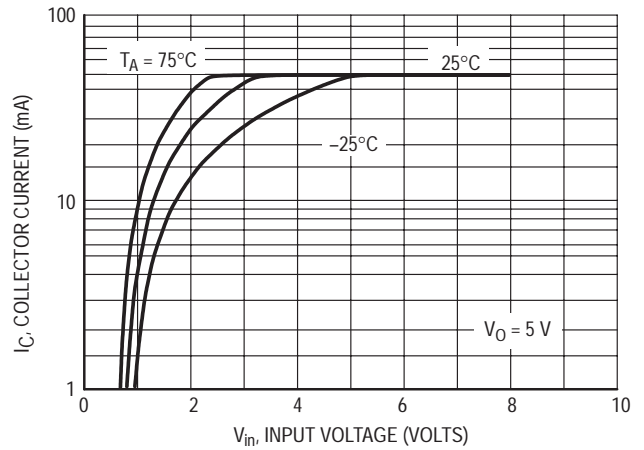


Figure 21. Output Current versus Input Voltage

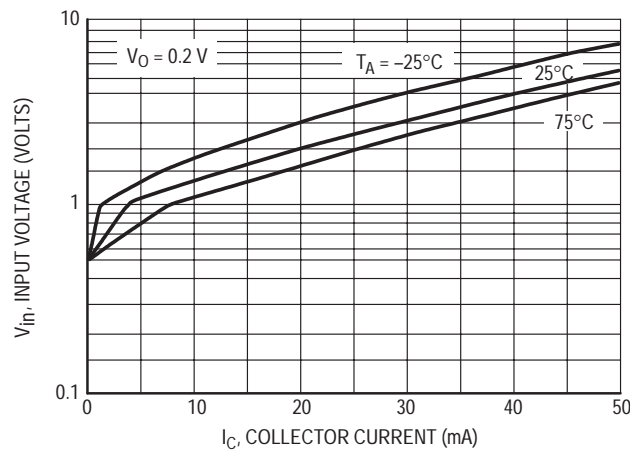


Figure 22. Input Voltage versus Output Current

# DTC114EET1 SERIES

## TYPICAL APPLICATIONS FOR NPN BRTs

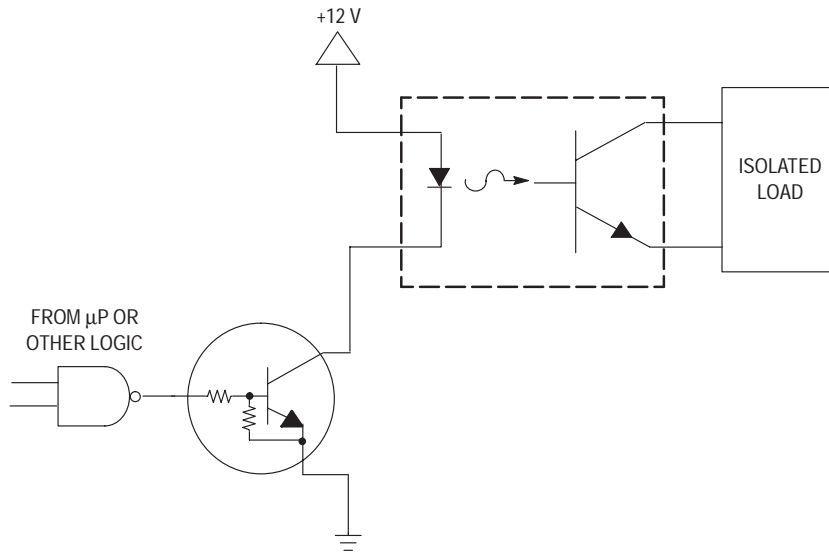


Figure 23. Level Shifter: Connects 12 or 24 Volt Circuits to Logic

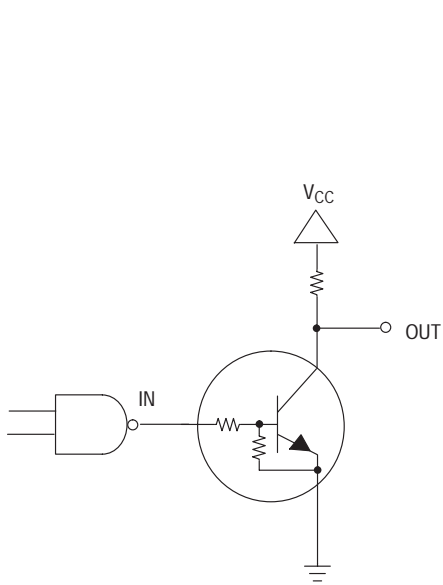


Figure 24. Open Collector Inverter: Inverts the Input Signal

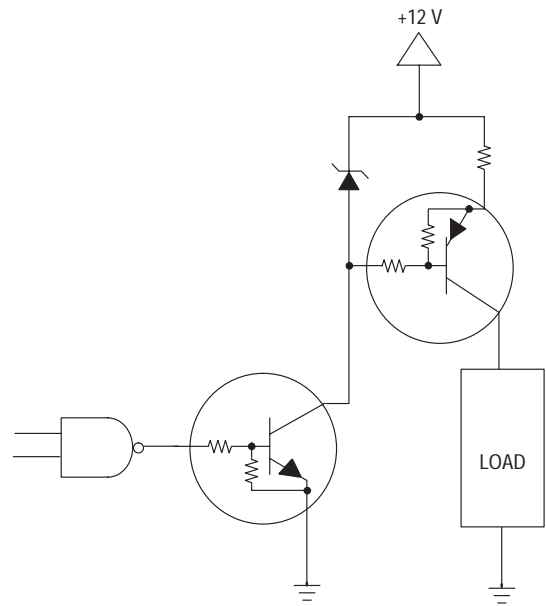


Figure 25. Inexpensive, Unregulated Current Source

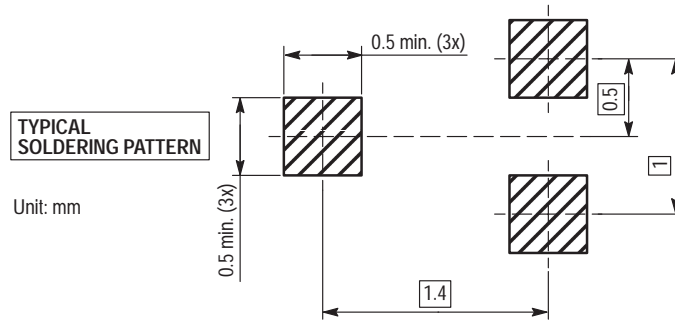


## DTC114EET1 SERIES

### 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.



### SOT-416/SC-75 POWER DISSIPATION

The power dissipation of the SOT-416/SC-75 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 200 milliwatts.

$$P_D = \frac{150^\circ\text{C} - 25^\circ\text{C}}{600^\circ\text{C/W}} = 200 \text{ milliwatts}$$

The 600°C/W assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 200 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, a higher power dissipation can be achieved 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.

# DTC114EET1 SERIES

## 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 26 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.

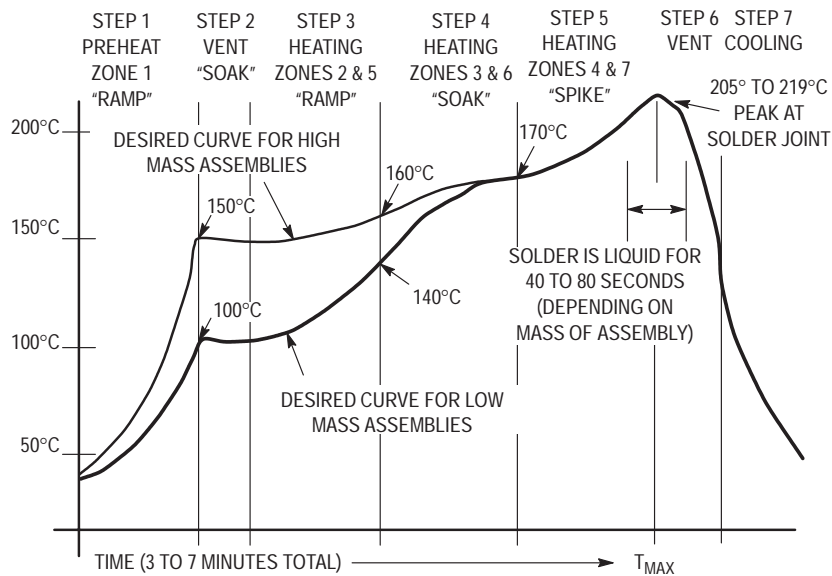
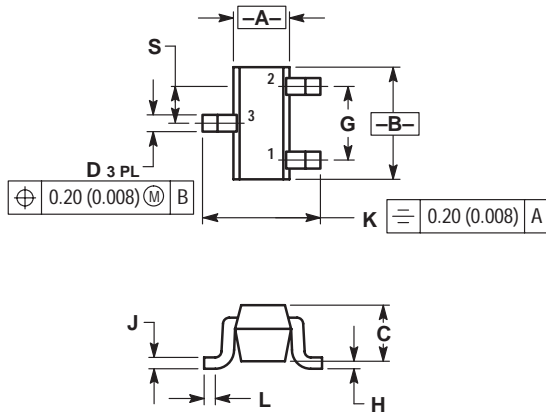


Figure 26. Typical Solder Heating Profile

# DTC114EET1 SERIES

## PACKAGE DIMENSIONS

SC-75  
(SOT-416)  
CASE 463-01  
ISSUE B



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

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.70	0.80	0.028	0.031
B	1.40	1.80	0.055	0.071
C	0.60	0.90	0.024	0.035
D	0.15	0.30	0.006	0.012
G	1.00 BSC		0.039 BSC	
H	---	0.10	---	0.004
J	0.10	0.25	0.004	0.010
K	1.45	1.75	0.057	0.069
L	0.10	0.20	0.004	0.008
S	0.50 BSC		0.020 BSC	

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


STYLE 2:  
PIN 1. ANODE  
2. N/C  
3. CATHODE

STYLE 3:  
PIN 1. ANODE  
2. ANODE  
3. CATHODE

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

# DTC114EET1 SERIES

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**Email:** ONlit-asia@hibbertco.com

**JAPAN:** ON Semiconductor, Japan Customer Focus Center  
4-32-1 Nishi-Gotanda, Shinagawa-ku, Tokyo, Japan 141-0031  
**Phone:** 81-3-5740-2745  
**Email:** r14525@onsemi.com

**ON Semiconductor Website:** <http://onsemi.com>

For additional information, please contact your local Sales Representative.