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MOTOROLA

TL780 Series

Three-Terminal Positive Fixed Voltage Regulators

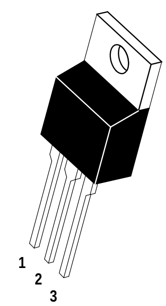
This family of precision fixed voltage regulators are monolithic integrated circuits capable of driving loads in excess of 1.5 A. Innovative design concepts, coupled with advanced thermal layout techniques have resulted in improved accuracy and excellent load, line and thermal regulation characteristics. Internal current limiting, thermal shutdown and safe–area compensation are employed, making these devices extremely rugged and virtually immune to overload.

- ±1% Output Voltage Tolerance @ 25°C
- ±2% Output Voltage Tolerance over Full Operating Temperature Range
- Internal Short Circuit Current Limiting
- Internal Thermal Overload Protection
- Output Transistor Safe–Area Compensation
- No External Components Required
- Pinout Compatible with MC7800 Series

THREE–TERMINAL POSITIVE FIXED VOLTAGE REGULATORS

SEMICONDUCTOR TECHNICAL DATA

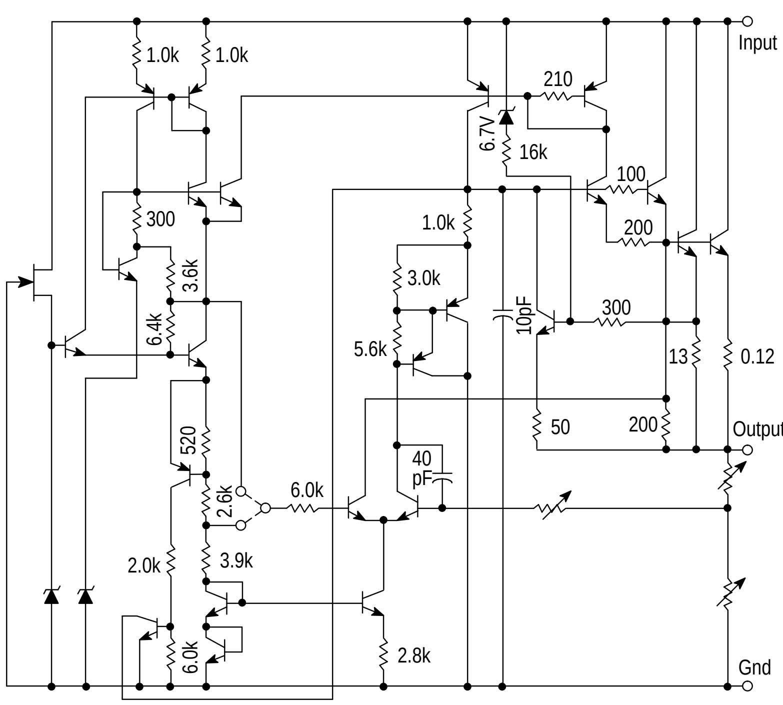
KC SUFFIX
PLASTIC PACKAGE
CASE 221A



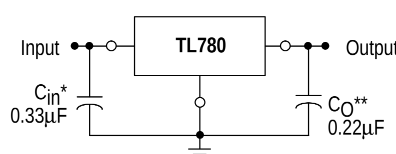
Pin 1. Input
2. Ground
3. Output

Heatsink surface is connected to Pin 2.

Representative Schematic Diagram



STANDARD APPLICATION



A common ground is required between the input and the output voltages. The input voltage must remain typically 2.0 V above the output voltage even during the low point on the input ripple voltage.

(XX), these two digits of the type number indicate voltage.

* C_{in} is required if regulator is located an appreciable distance from power supply filter.

** C_O is not needed for stability; however, it does improve transient response.

ORDERING INFORMATION

Nominal Output	Device	Operating Temperature Range
5.0 V	TL780–05CKC	T_J = 0° to 125°C
12 V	TL780–12CKC	
15 V	TL780–15CKC	

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input Voltage	V_{in}	35	Vdc
Power Dissipation and Thermal Characteristics			
T_A = +25°C	P_D	2.0	W
Derate above T_A = +25°C	$1/\theta_{JA}$	16	mW/°C
Thermal Resistance, Junction–to–Air	θ_{JA}	62.5	°C/W
T_A = +25°C	P_D	15	W
Derate above T_C = +75°C (See Figure 1)	$1/\theta_{JC}$	200	mW/°C
Thermal Resistance, Junction–to–Case	θ_{JC}	5.0	°C/W
Operating Junction Temperature Range	T_J	0 to +150	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

ELECTRICAL CHARACTERISTICS (V_{in} = 10 V, I_O = 500 mA, 0°C ≤ T_J ≤ +125°C, unless otherwise noted [Note 1].)

Characteristics	Symbol	TL780–05C			Unit
		Min	Typ	Max	
Output Voltage	V_O				V
5.0 mA ≤ I_O ≤ 1.0 A, P ≤ 15 W					
7.0 V ≤ V_{in} ≤ 20 V					
T_J = +25°C		4.95	5.0	5.05	
0°C ≤ T_J ≤ +125°C		4.90	—	5.10	
Line Regulation (T_J = +25°C)	Reg_{line}				mV
7.0 V ≤ V_{in} ≤ 25 V		—	0.5	5.0	
8.0 V ≤ V_{in} ≤ 12 V		—	0.5	5.0	
Load Regulation (T_J = +25°C)	Reg_{load}				mV
5.0 mA ≤ I_O ≤ 1.5 A		—	4.0	25	
250 mA ≤ I_O ≤ 750 mA		—	1.5	15	
Ripple Rejection	RR				dB
8.0 V ≤ V_{in} ≤ 18 V, f = 120 Hz		70	80	—	
Output Resistance (f = 1.0 kHz)	r_O	—	0.0035	—	W
Average Temperature Coefficient of Output Voltage	TCV_O				mV°C
I_O = 5.0 mA		—	0.06	—	
Output Noise Voltage (T_J = +25°C)	V_n				µV
10 Hz ≤ f ≤ 100 kHz		—	75	—	
Dropout Voltage (T_J = +25°C)	$V_{in}–V_O$				V
I_O = 1.0 mA		—	2.0	—	
Bias Current (T_J = +25°C)	I_B	—	3.5	8.0	mA
Bias Current Change	ΔI_B				mA
7.0 V ≤ V_{in} ≤ 25 V, I_O = 500 mA		—	0.7	1.3	
5.0 mA ≤ I_O ≤ 1.0 A, V_{in} ≤ 10 V		—	0.03	0.5	
Short Circuit Output Current (T_J = +25°C)	I_{SC}				mA
V_{in} = 35 V		—	200	—	
Peak Output Current (T_J = +25°C)	I_P	—	2.2	—	A

NOTE: 1. Line and load regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

ELECTRICAL CHARACTERISTICS (V_{in} = 19 V, I_O = 500 mA, 0°C ≤ T_J ≤ +125°C, unless otherwise noted [Note 1].)

Characteristics	Symbol	TL780–12C			Unit
		Min	Typ	Max	
Output Voltage	V_O				V
5.0 mA ≤ I_O ≤ 1.0 A, P ≤ 15 W, 14.5 ≤ V_{in} ≤ 27 V					
T_J = +25°C		11.88	12	12.12	
0°C ≤ T_J ≤ +125°C		11.76	—	12.24	
Line Regulation (T_J = +25°C)	Reg_{line}				mV
14.5 V ≤ V_{in} ≤ 30		—	1.2	12	
16 V ≤ V_{in} ≤ 22		—	1.2	12	

ELECTRICAL CHARACTERISTICS (V_{in} = 19 V, I_O = 500 mA, 0°C ≤ T_J ≤ +125°C, unless otherwise noted [Note 1].)

Characteristics	Symbol	TL780–12C			Unit
		Min	Typ	Max	
Load Regulation (T_J = +25°C)	Reg_{load}				mV
5.0 mA ≤ I_O ≤ 1.5 A		—	6.5	60	
250 mA ≤ I_O ≤ 750 mA		—	2.5	36	
Ripple Rejection	RR				dB
15 V ≤ V_{in} ≤ 25 V, f = 120 Hz		65	77	—	
Output Resistance (f = 1.0 kHz)	r_O	—	0.0035	—	W
Average Temperature Coefficient of Output Voltage	TCV_O				mV°C
I_O = 5.0 mA		—	0.15	—	
Output Noise Voltage (T_J = +25°C)	V_n				µV
10 Hz ≤ f ≤ 100 kHz		—	180	—	
Dropout Voltage (T_J = +25°C)	$V_{in}–V_O$				V
I_O = 1.0 mA		—	2.0	—	
Bias Current (T_J = +25°C)	I_B	—	3.5	8.0	mA
Bias Current Change	ΔI_B				mA
14.5 V ≤ V_{in} ≤ 30 V, I_O = 500 mA		—	0.4	1.3	
5.0 mA ≤ I_O ≤ 1.0 A, V_{in} ≤ 19 V		—	0.03	0.5	
Short Circuit Output Current (T_J = +25°C)	I_{SC}				mA
V_{in} = 35 V		—	200	—	
Peak Output Current (T_J = +25°C)	I_P	—	2.2	—	A

ELECTRICAL CHARACTERISTICS (V_{in} = 23 V, I_O = 500 mA, 0°C ≤ T_J ≤ +125°C, unless otherwise noted [Note 1].)

Characteristics	Symbol	TL780–15C			Unit
		Min	Typ	Max	
Output Voltage	V_O				V
5.0 mA ≤ I_O ≤ 1.0 A, P ≤ 15 W, 17.5 V ≤ V_{in} ≤ 30 V					
T_J = +25°C		14.85	15	15.15	
0°C ≤ T_J ≤ +125°C		14.70	—	15.30	
Line Regulation (T_J = +25°C)	Reg_{line}				mV
17.5 V ≤ V_{in} ≤ 30 V		—	1.5	15	
20 V ≤ V_{in} ≤ 26 V		—	1.5	15	
Load Regulation (T_J = +25°C)	Reg_{load}				mV
5.0 mA ≤ I_O ≤ 1.5 A		—	7.0	75	
250 mA ≤ I_O ≤ 750 mA		—	2.5	45	
Ripple Rejection	RR				dB
18.5 V ≤ V_{in} ≤ 28.5 V, f = 120 Hz		60	75	—	
Output Resistance (f = 1.0 kHz)	r_O	—	0.0035	—	W
Average Temperature Coefficient of Output Voltage	TCV_O				mV°C
I_O = 5.0 mA		—	0.18	—	
Output Noise Voltage (T_J = +25°C)	V_n				µV
10 Hz ≤ f ≤ 100 kHz		—	225	—	
Dropout Voltage (T_J = +25°C)	$V_{in}–V_O$				V
I_O = 1.0 A		—	2.0	—	
Bias Current (T_J = +25°C)	I_B	—	3.6	8.0	mA
Bias Current Change	ΔI_B				mA
17.5 V ≤ V_{in} ≤ 30 V, I_O = 500 mA		—	0.4	1.3	
5.0 mA ≤ I_O ≤ 1.0 A, V_{in} ≤ 23 V		—	0.02	0.5	
Short Circuit Output Current (T_J = +25°C)	I_{SC}				mA
V_{in} = 35 V		—	200	—	
Peak Output Current (T_J = +25°C)	I_P	—	2.2	—	A

NOTE: 1. Line and load regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

VOLTAGE REGULATOR PERFORMANCE

The performance of a voltage regulator is specified by its immunity to changes in load, input voltage, power dissipation, and temperature. Line and load regulation are tested with a pulse of short duration (< 100 μs) and are strictly a function of electrical gain. However, pulse widths of longer duration (> 1.0 ms) are sufficient to affect temperature gradients across the die. These temperature gradients can cause a change in the output voltage, in addition to changes by line and load regulation. Longer pulse widths and thermal gradients make it desirable to specify thermal regulation.

Thermal regulation is defined as the change in output voltage caused by a change in dissipated power for a specified time, and is expressed as a percentage output voltage change per watt. The change in dissipated power can be caused by a change in either the input voltage or the load current. Thermal regulation is a function of IC layout and die attach techniques, and usually occurs within 10 ms of a change in power dissipation. After 10 ms, additional changes in the output voltage are due to the temperature coefficient of the device.

Figure 1 shows the line and thermal regulation response of a typical TL780–05C to a 10 W input pulse. The variation of the output voltage due to line regulation is labeled ① and the thermal regulation component is labeled ②. Figure 2 shows the load and thermal regulation response of a typical TL780–05C to a 15 W load pulse. The output voltage variation due to load regulation is labeled ① and the thermal regulation component is labeled ②.

Figure 1. Line and Thermal Regulation

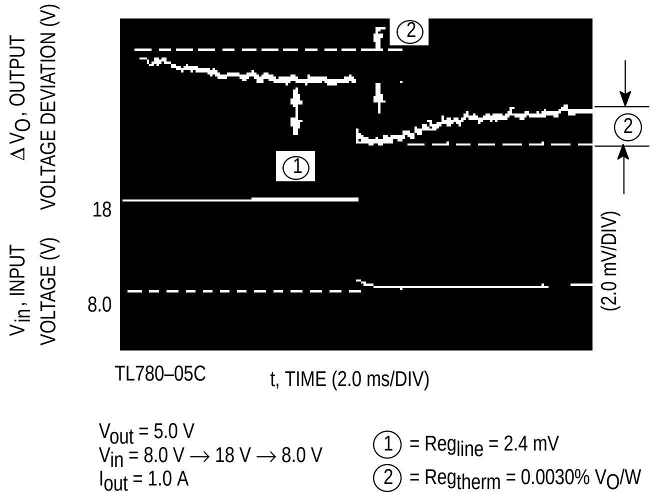


Figure 2. Load and Thermal Regulation

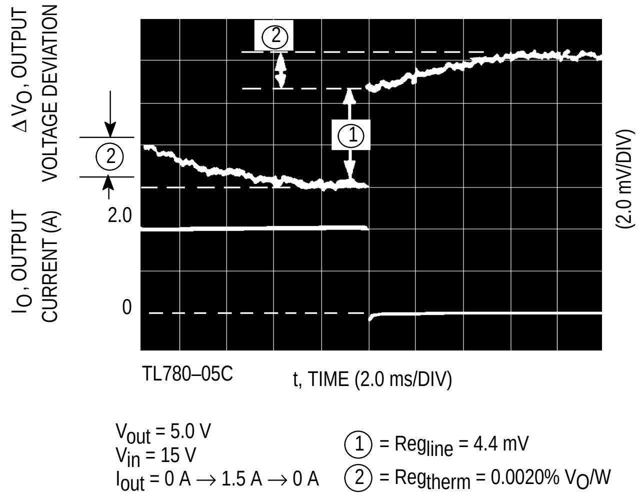


Figure 3. Temperature Stability

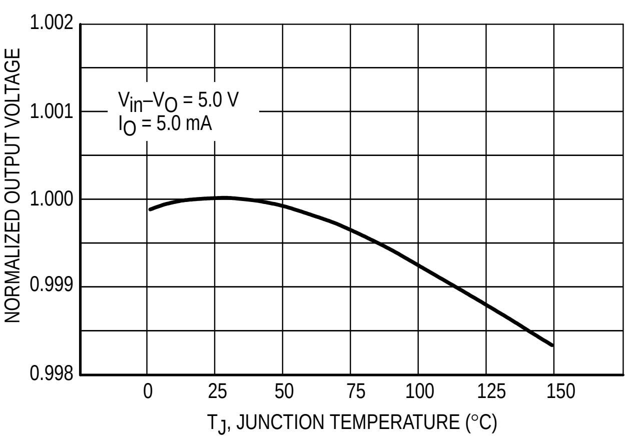


Figure 4. Output Impedance

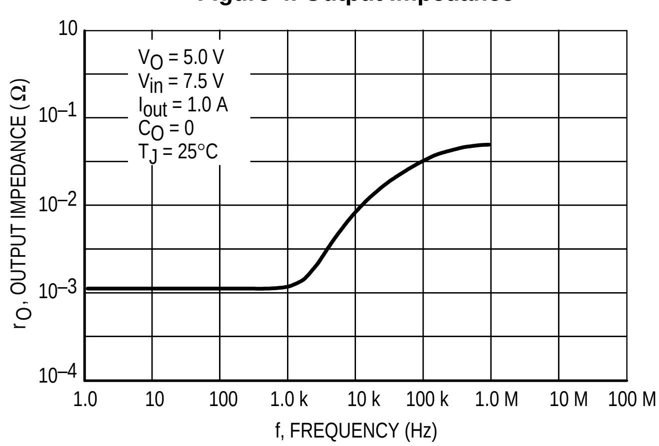


Figure 5. Ripple Rejection versus Frequency

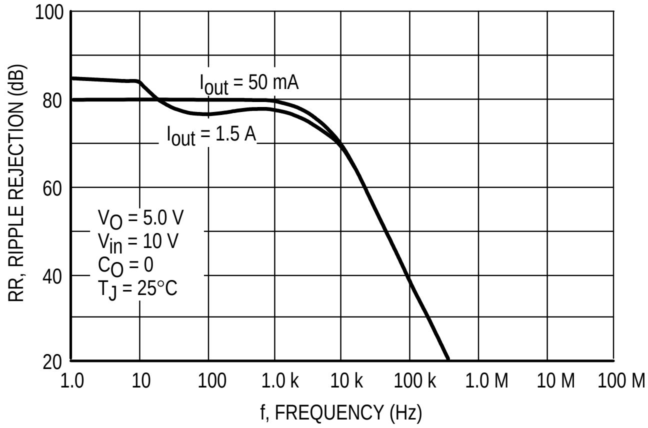


Figure 6. Ripple Rejection versus Output Current

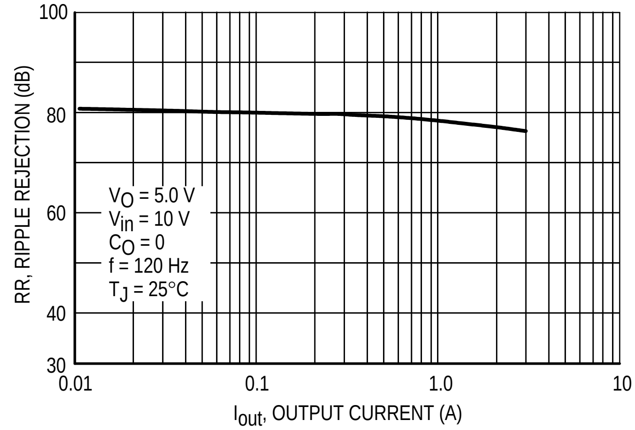


Figure 7. Bias Current versus Input Voltage

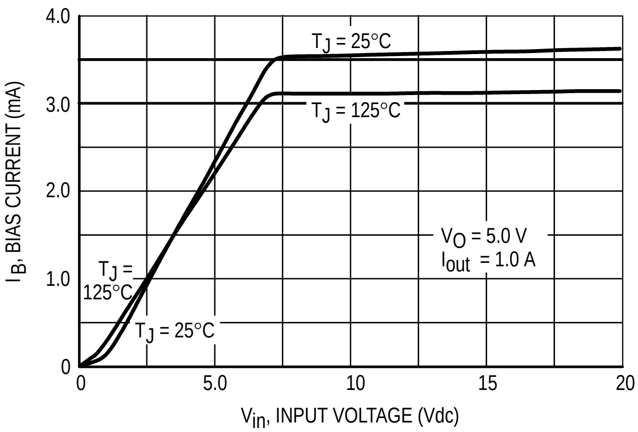


Figure 8. Bias Current versus Output Current

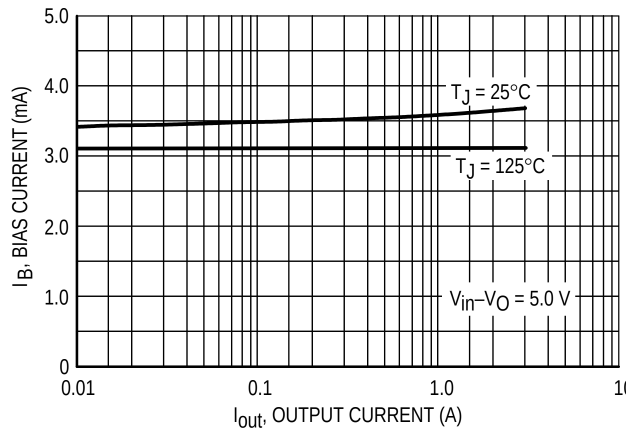


Figure 9. Dropout Voltage

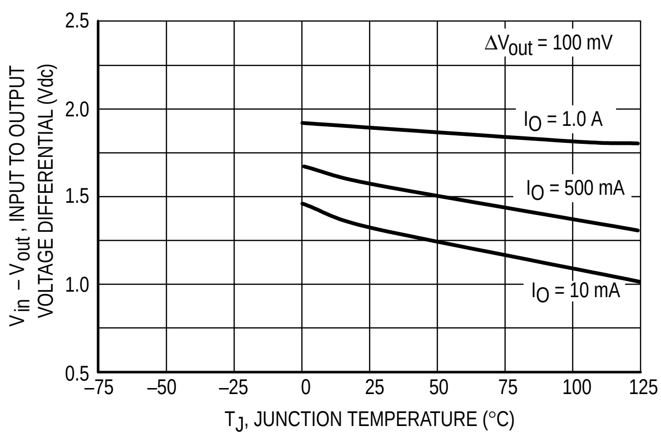


Figure 10. Peak Output Current

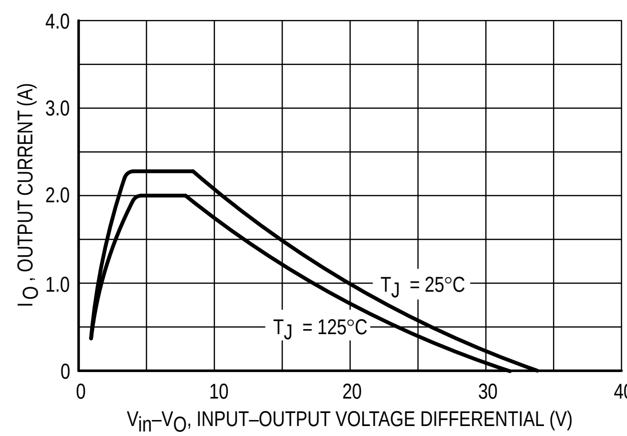


Figure 11. Line Transient Response

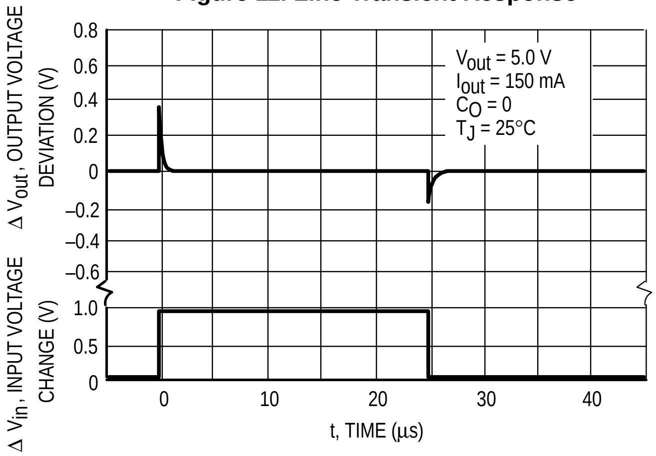


Figure 12. Load Transient Response

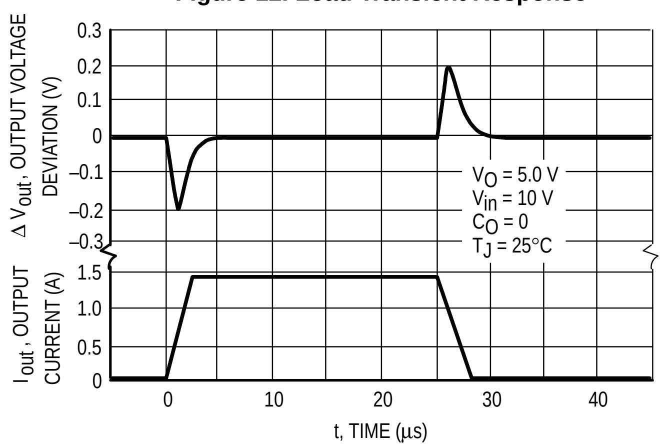
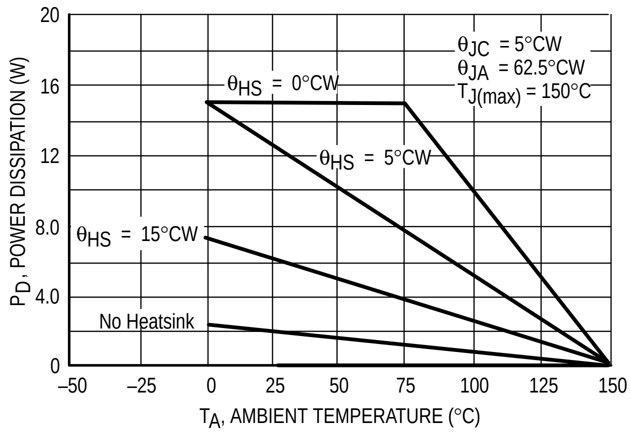
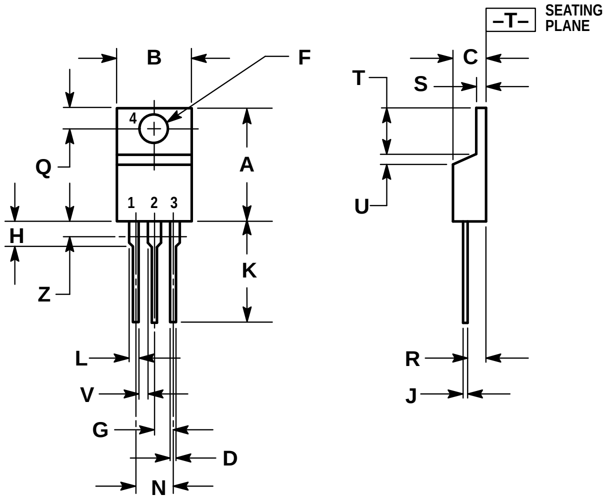


Figure 13. Worst Case Power Dissipation versus Ambient Temperature



OUTLINE DIMENSIONS

KC SUFFIX
PLASTIC PACKAGE
CASE 221A–06
ISSUE Y



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.570	0.620	14.48	15.75
B	0.380	0.405	9.66	10.28
C	0.160	0.190	4.07	4.82
D	0.025	0.035	0.64	0.88
F	0.142	0.147	3.61	3.73
G	0.095	0.105	2.42	2.66
H	0.110	0.155	2.80	3.93
J	0.018	0.025	0.46	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.060	1.15	1.52
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.110	2.04	2.79
S	0.045	0.055	1.15	1.39
T	0.235	0.255	5.97	6.47
U	0.000	0.050	0.00	1.27
V	0.045	—	1.15	—
Z	—	0.080	—	2.04

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