



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.

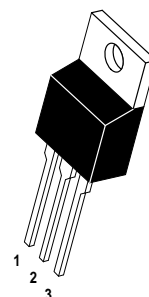
- $\pm 1\%$ Output Voltage Tolerance @ 25°C
- $\pm 2\%$ Output Voltage Tolerance over Full Operating Temperature Range
- Internal Short Circuit Current Limiting
- Internal Thermal Overload Protection
- Output Transistor Safe-Area Compensation
- No External Components Required
- Pinout Compatible with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

THREE-TERMINAL POSITIVE FIXED VOLTAGE REGULATORS

SEMICONDUCTOR TECHNICAL DATA

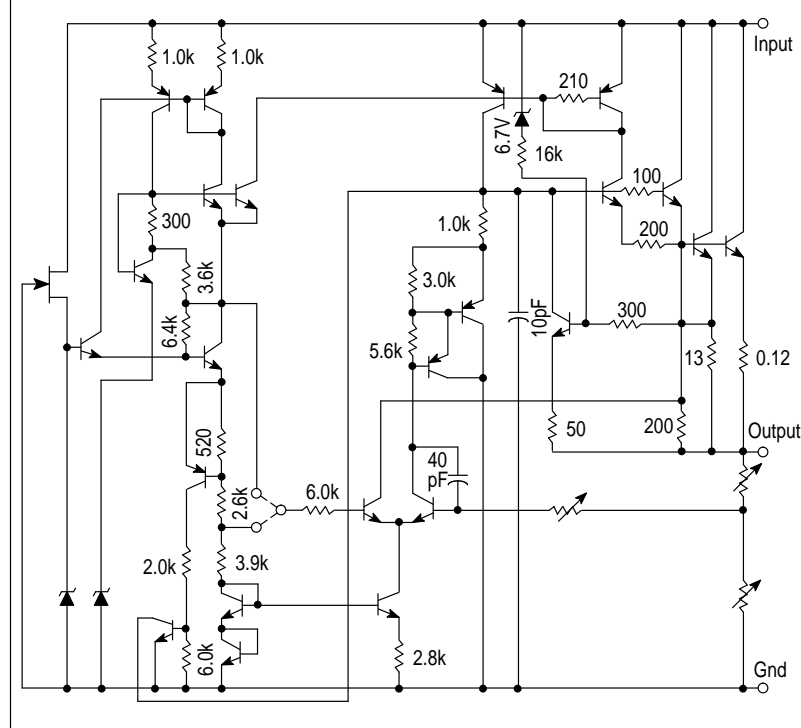
KC SUFFIX
PLASTIC PACKAGE
CASE 221A

- Pin 1. Input
2. Ground
3. Output

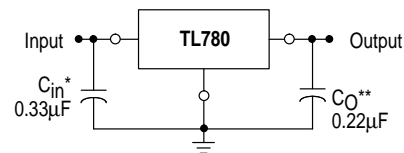


Heatsink surface is connected to Pin 2.

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	$T_J = 0^{\circ} \text{ to } 125^{\circ}\text{C}$
12 V	TL780-12CKC	
15 V	TL780-15CKC	

TL780 Series

MAXIMUM RATINGS

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

ELECTRICAL CHARACTERISTICS ($V_{in} = 10\text{ V}$, $I_O = 500\text{ mA}$, $0^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$, unless otherwise noted [Note 1].)

Characteristics	Symbol	TL780-05C			Unit
		Min	Typ	Max	
Output Voltage $5.0\text{ mA} \leq I_O \leq 1.0\text{ A}$, $P \leq 15\text{ W}$ $7.0\text{ V} \leq V_{in} \leq 20\text{ V}$ $T_J = +25^{\circ}\text{C}$ $0^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$	V_O	4.95 4.90	5.0 —	5.05 5.10	V
Line Regulation ($T_J = +25^{\circ}\text{C}$) $7.0\text{ V} \leq V_{in} \leq 25\text{ V}$ $8.0\text{ V} \leq V_{in} \leq 12\text{ V}$	Regline	— —	0.5 0.5	5.0 5.0	mV
Load Regulation ($T_J = +25^{\circ}\text{C}$) $5.0\text{ mA} \leq I_O \leq 1.5\text{ A}$ $250\text{ mA} \leq I_O \leq 750\text{ mA}$	Regload	— —	4.0 1.5	25 15	mV
Ripple Rejection $8.0\text{ V} \leq V_{in} \leq 18\text{ V}$, $f = 120\text{ Hz}$	RR	70	80	—	dB
Output Resistance ($f = 1.0\text{ kHz}$)	r_O	—	0.0035	—	W
Average Temperature Coefficient of Output Voltage $I_O = 5.0\text{ mA}$	TCV_O	—	0.06	—	mV/ $^{\circ}\text{C}$
Output Noise Voltage ($T_J = +25^{\circ}\text{C}$) $10\text{ Hz} \leq f \leq 100\text{ kHz}$	V_n	—	75	—	μV
Dropout Voltage ($T_J = +25^{\circ}\text{C}$) $I_O = 1.0\text{ mA}$	$V_{in}-V_O$	—	2.0	—	V
Bias Current ($T_J = +25^{\circ}\text{C}$)	I_B	—	3.5	8.0	mA
Bias Current Change $7.0\text{ V} \leq V_{in} \leq 25\text{ V}$, $I_O = 500\text{ mA}$ $5.0\text{ mA} \leq I_O \leq 1.0\text{ A}$, $V_{in} \leq 10\text{ V}$	ΔI_B	— —	0.7 0.03	1.3 0.5	mA
Short Circuit Output Current ($T_J = +25^{\circ}\text{C}$) $V_{in} = 35\text{ V}$	I_{SC}	—	200	—	mA
Peak Output Current ($T_J = +25^{\circ}\text{C}$)	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 ($V_{in} = 19\text{ V}$, $I_O = 500\text{ mA}$, $0^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$, unless otherwise noted [Note 1].)

Characteristics	Symbol	TL780-12C			Unit
		Min	Typ	Max	
Output Voltage $5.0\text{ mA} \leq I_O \leq 1.0\text{ A}$, $P \leq 15\text{ W}$, $14.5 \leq V_{in} \leq 27\text{ V}$ $T_J = +25^{\circ}\text{C}$ $0^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$	V_O	11.88 11.76	12 —	12.12 12.24	V
Line Regulation ($T_J = +25^{\circ}\text{C}$) $14.5\text{ V} \leq V_{in} \leq 30$ $16\text{ V} \leq V_{in} \leq 22$	Regline	— —	1.2 1.2	12 12	mV

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ELECTRICAL CHARACTERISTICS ($V_{in} = 19\text{ V}$, $I_O = 500\text{ mA}$, $0^\circ\text{C} \leq T_J \leq +125^\circ\text{C}$, unless otherwise noted [Note 1].)

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

ELECTRICAL CHARACTERISTICS ($V_{in} = 23\text{ V}$, $I_O = 500\text{ mA}$, $0^\circ\text{C} \leq T_J \leq +125^\circ\text{C}$, unless otherwise noted [Note 1].)

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

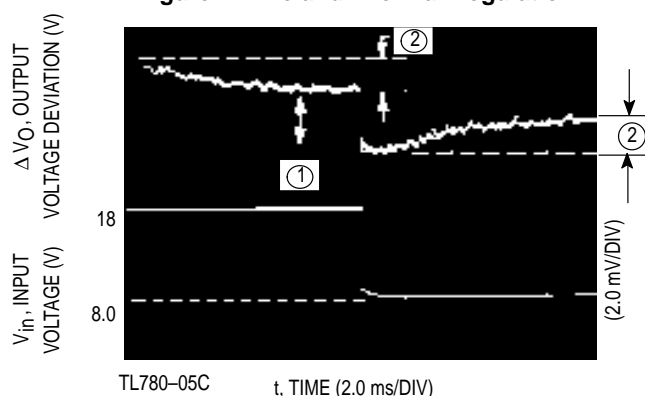
The performance of a voltage regulator is specified by its immunity to changes in load, input voltage, power dissipation, and temperature. Line and load regulation are tested with a pulse of short duration ($< 100 \mu\text{s}$) and are strictly a function of electrical gain. However, pulse widths of longer duration ($> 1.0 \text{ ms}$) 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.

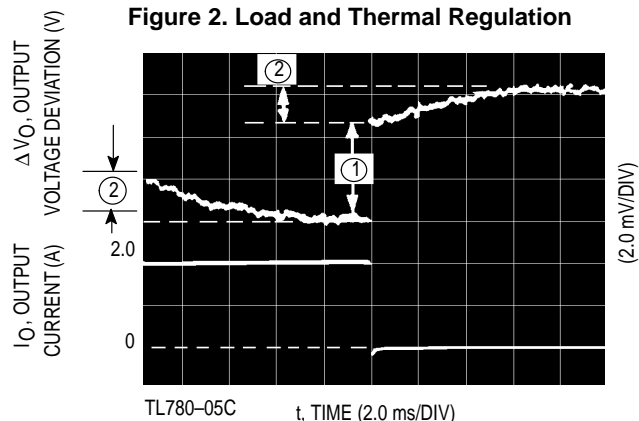
Figure 1. Line and Thermal Regulation



$V_{out} = 5.0 \text{ V}$
 $V_{in} = 8.0 \text{ V} \rightarrow 18 \text{ V} \rightarrow 8.0 \text{ V}$
 $I_{out} = 1.0 \text{ A}$

① = $\text{Reg}_{line} = 2.4 \text{ mV}$
 ② = $\text{Reg}_{therm} = 0.0030\% V_O/\text{W}$

Figure 2. Load and Thermal Regulation



$V_{out} = 5.0 \text{ V}$
 $V_{in} = 15 \text{ V}$
 $I_{out} = 0 \text{ A} \rightarrow 1.5 \text{ A} \rightarrow 0 \text{ A}$

① = $\text{Reg}_{line} = 4.4 \text{ mV}$
 ② = $\text{Reg}_{therm} = 0.0020\% V_O/\text{W}$

Figure 3. Temperature Stability

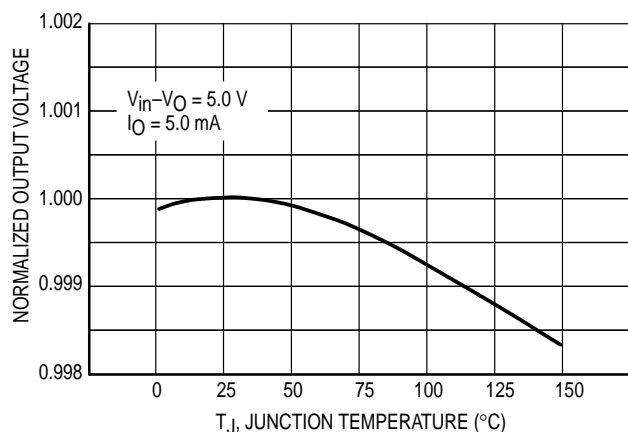


Figure 4. Output Impedance

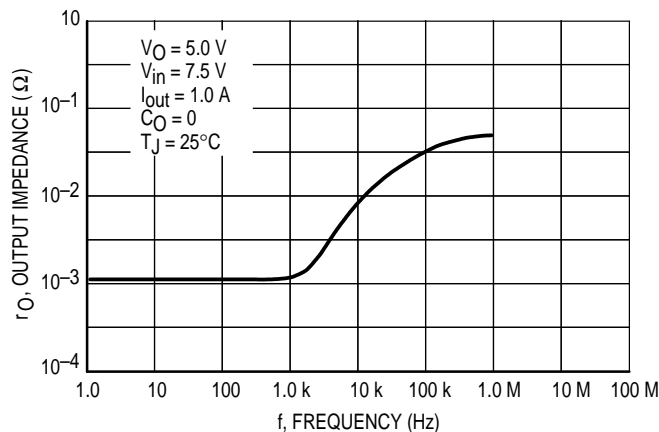


Figure 5. Ripple Rejection versus Frequency

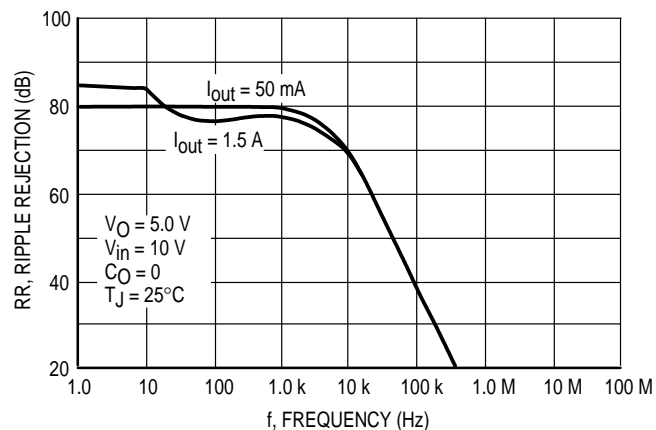


Figure 6. Ripple Rejection versus Output Current

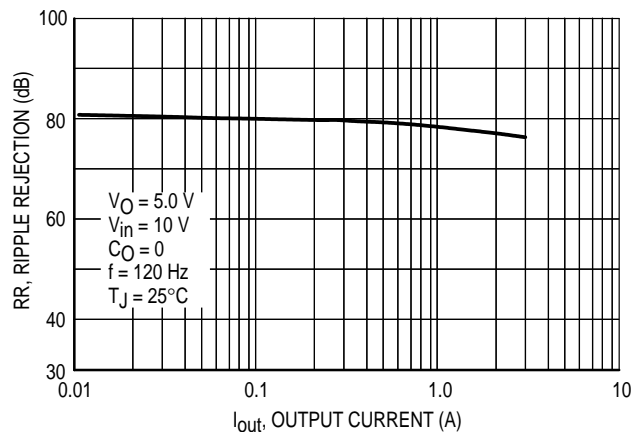


Figure 7. Bias Current versus Input Voltage

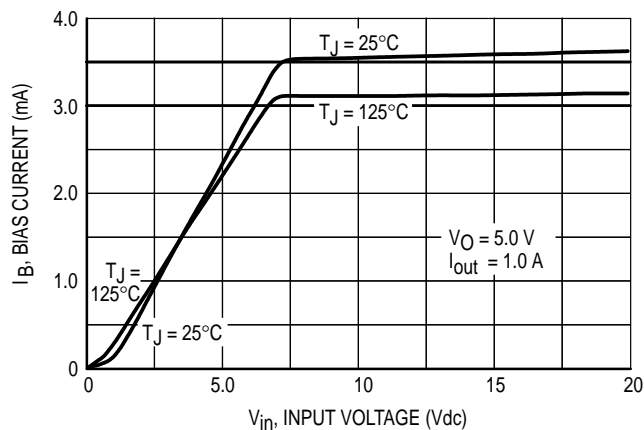


Figure 8. Bias Current versus Output Current

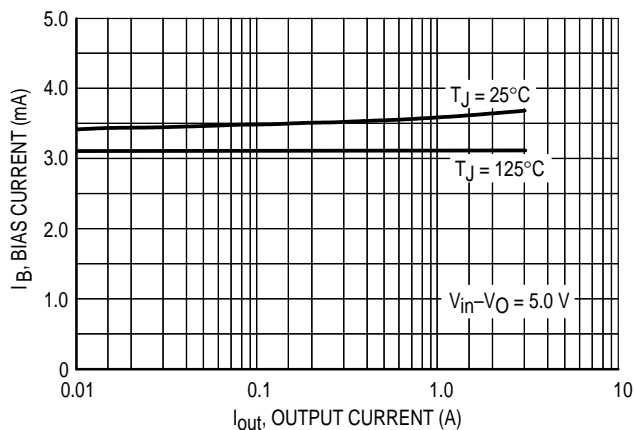


Figure 9. Dropout Voltage

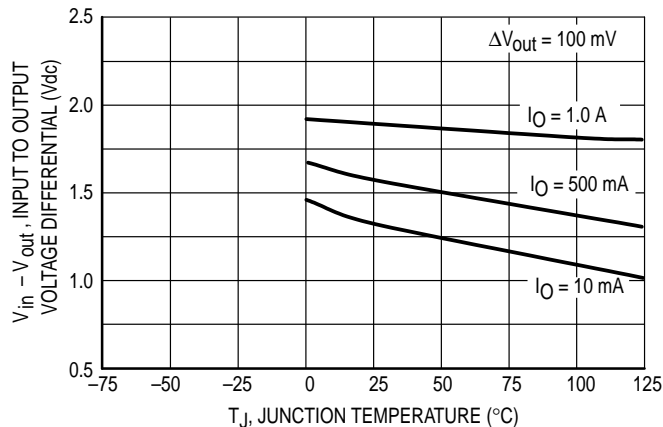


Figure 10. Peak Output Current

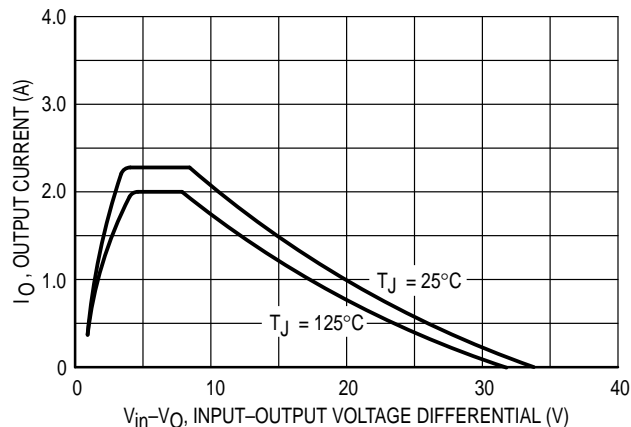


Figure 11. Line Transient Response

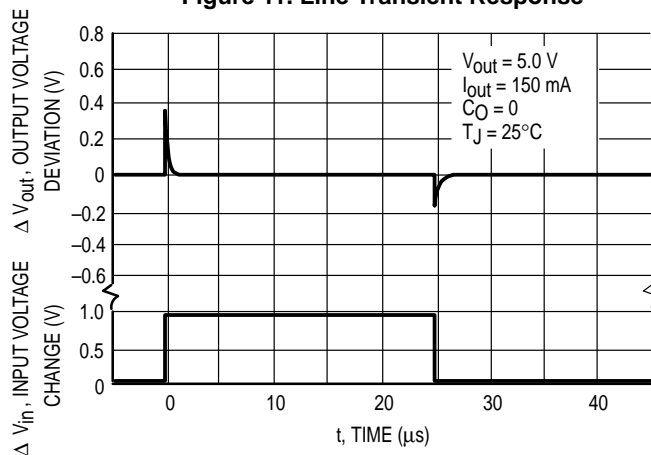


Figure 12. Load Transient Response

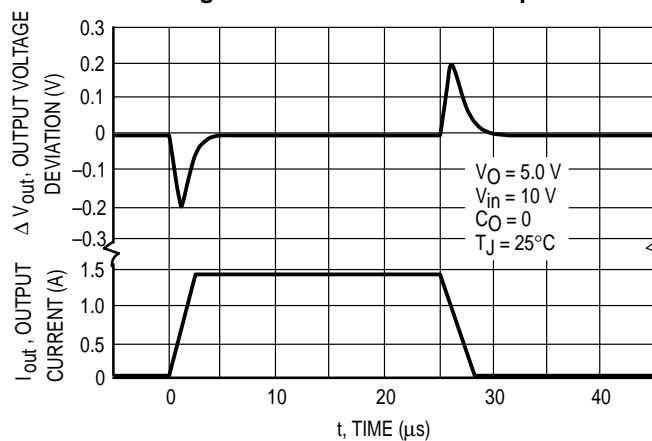
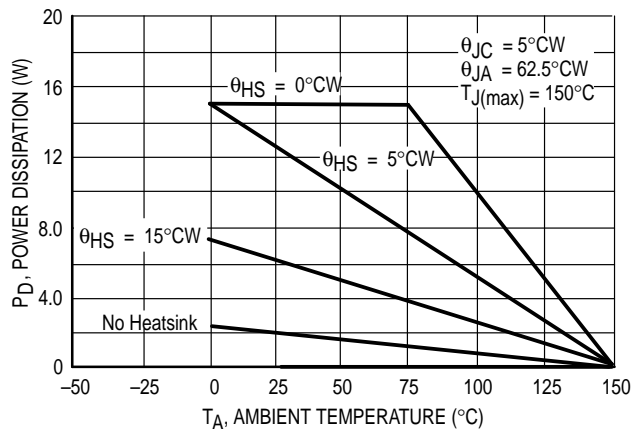


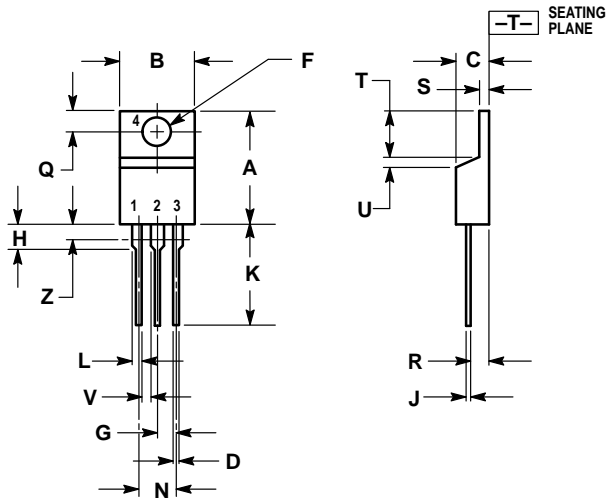
Figure 13. Worst Case Power Dissipation versus Ambient Temperature



TL780 Series

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.

DIM	INCHES		MILLIMETERS	
	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

TL780 Series

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TL780/D

