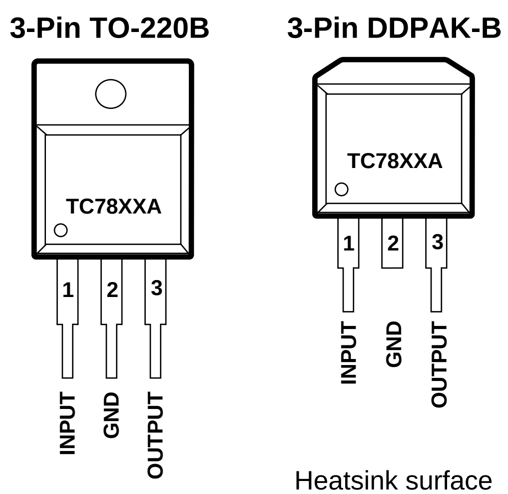
TC7800A Series

Three-Terminal Positive Voltage Regulators

FEATURES

- **Output Current in Excess of 1.0A**
- **No External Components Required**
- **Internal Thermal Overload Protection**
- **Internal Short Circuit Current Limiting**
- **Output Transistor Safe–Area Compensation**
- **Output Voltage Offered in 2% Tolerance**
- **Available in Surface Mount DDPAK and Standard 3–Lead Transistor Packages**
- **Previous Commercial Temperature Range has been Extended to a Junction Temperature Range of –40°C to +125°C**



Heatsink surface connected to Pin 2.

Heatsink surface (shown as terminal 4 in case outline drawing) connected to Pin 2.

GENERAL DESCRIPTION

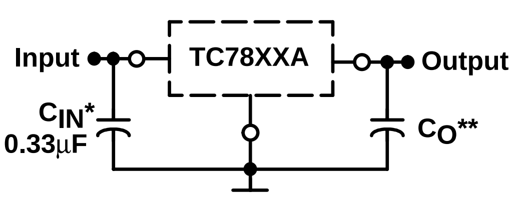
These voltage regulators are monolithic integrated circuits designed as fixed–voltage regulators for a wide variety of applications including local, on–card regulation. These regulators employ internal current limiting, thermal shutdown, and safe–area compensation. With adequate heatsinking they can deliver output currents in excess of 1.0A. Although designed primarily as a fixed voltage regulator, these devices can be used with external components to obtain adjustable voltages and currents.

ORDERING INFORMATION

Part Number*	Package	Temperature Range
TC7805A-5.0VBB	3-Pin TO-220B	–40° to + 125°C
TC7812A-12.0VBB	3-Pin TO-220B	–40° to + 125°C
TC7815A-15.0VBB	3-Pin TO-220B	–40° to + 125°C
TC7805A-5.0VRB	3-Pin DDPAK-B	–40° to + 125°C
TC7812A-12.0VRB	3-Pin DDPAK-B	–40° to + 125°C
TC7815A-15.0VRB	3-Pin DDPAK-B	–40° to + 125°C
TC7824A-24.0VRB	3-Pin DDPAK-B	–40° to + 125°C

Note: Contact company about other voltage and package options.

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 nominal 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. Values of less than 0.1µF could cause instability.

TC7800A Series

ABSOLUTE MAXIMUM RATINGS*

(T_A = 25°C, unless otherwise noted.)

Input Voltage

(5.0 – 18V) .... $V_{IN} = 35V_{DC}$

(24V) .... $V_{IN} = 40V_{DC}$

Power Dissipation (T_A = 25°C) .. P_D = Internally Limited W

Case TO-220B

Thermal Resistance,

Junction-to-Ambient .... θ_{JA} = 65˚C/W

Junction-to-Case .... θ_{JC} = 5.0˚C/W

Power Dissipation (T_A = 25°C) ..... PD = Internally Limited W

DDPAK-B

Thermal Resistance,

Junction-to-Ambient .... θ_{JA} = (See Figure 13) ˚C/W

Junction-to-Case .... θ_{JA} = 5.0˚C/W

Storage Junction

Temperature Range .... T_{STG} = –65°C to +150°C

Operating Junction Temperature .... T_J = +150˚C

*Note: ESD Data Available upon request.

ELECTRICAL CHARACTERISTICS: (V_{IN} = 10V, I_{OUT} = 1.0A, T_J = T_{LOW} to T_{HIGH} [Note 1], unless otherwise noted.)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
TC7805A						
V_{OUT}	Output Voltage	T_J = 25°C	4.9	5.0	5.1	V_{DC}
V_{OUT}	Output Voltage	5.0mA ≤ I_{OUT} ≤ 0.1A, P_D ≤ 15W $7.5V_{DC} \le V_{IN} \le 20V_{DC}$	4.8	5.0	5.2	V_{DC}
REG_{LINE}	Line Regulation	Note 2 $7.5V_{DC} \le V_{IN} \le 25V_{DC}$, I_{OUT} = 500mA $8.0V_{DC} \le V_{IN} \le 12V_{DC}$, I_{OUT} = 1.0A $8.0V_{DC} \le V_{IN} \le 12V_{DC}$, I_{OUT} = 1.0A,T_J = 25˚C $7.3V_{DC} \le V_{IN} \le 20V_{DC}$, I_{OUT} = 1.0A,T_J = 25˚C	 — — — —	 0.5 0.8 1.3 4.5	 10 12 4.0 10	mV
REG_{LOAD}	Load Regulation	Note 2 5.0mA ≤ I_{OUT} ≤ 1.5A, T_J = 25˚C 5.0mA ≤ I_{OUT} ≤ 1.0A 250mA ≤ I_{OUT} ≤ 750mA	 — — —	 1.3 0.8 0.53	 25 25 15	mV
I_B	Quiescent Current		—	3.2	6.0	mA
ΔI_B	Quiescent Current Change	$8.0V_{DC} \le V_{IN} \le 25V_{DC}$, I_{OUT} = 500mA $7.5V_{DC} \le V_{IN} \le 20V_{DC}$, T_J = 25˚C 5.0mA ≤ I_{OUT} ≤ 1.0A	— — —	0.3 — 0.08	0.8 0.8 0.5	mA
RR	Ripple Rejection	$8.0V_{DC} \le V_{IN} \le 18V_{DC}$, f = 120Hz, I_{OUT} = 500mA	68	83	—	dB
$V_{IN} – V_{OUT}$	Dropout Voltage	I_{OUT} = 1.0A, T_J = 25°C	—	2.0	—	V_{DC}
V_N	Output Noise Voltage	T_A = 25°C 10Hz ≤ f ≤ 100kHz	—	10	—	µV/V_{OUT}
R_{OUT}	Output Resistance	f = 1.0kHz	—	0.9	—	mΩ
I_{SC}	Short Circuit Current Limit	T_A = 25°C $V_{IN} = 35V_{DC}$	—	0.2	—	A
I_{MAX}	Peak Output Current	T_J = 25°C	—	2.2	–	A
TCV_{OUT}	Average Temperature Coefficientof Output Voltage		—	-0.3	–	mV/°C

NOTES: 1. T_{LOW} = –40°C for TC78XXA, T_{HIGH} = +125°C for TC78XX

2. Load and line regulation are specified at constant junction temperature. Changes in V_{OUT} due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

ELECTRICAL CHARACTERISTICS: (V_{IN} = 19V, I_{OUT} = 1.0A, T_J = T_{LOW} to T_{HIGH} [Note 1], unless otherwise noted.)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
TC7812A						
V_{OUT}	Output Voltage	T_J = 25°C	11.75	12	12.25	V_{DC}
V_{OUT}	Output Voltage	5.0mA ≤ I_{OUT} ≤ 0.1A, P_D ≤ 15W 14.8V_{DC} ≤ V_{IN} ≤ 27V_{DC}	11.5	12	12.5	V_{DC}
REG_{LINE}	Line Regulation	Note 2 14.8V_{DC} ≤ V_{IN} ≤ 30V_{DC}, I_{OUT} = 500mA 16V_{DC} ≤ V_{IN} ≤ 22V_{DC}, I_{OUT} = 1.0A 14.5V_{DC} ≤ V_{IN} ≤ 27V_{DC}, T_J = 25°C	 — — —	 3.8 2.2 6.0	 18 20 120	mV
REG_{LOAD}	Load Regulation	Note 2 5.0mA ≤ I_{OUT} ≤ 1.5A, T_J = 25°C 5.0mA ≤ I_{OUT} ≤ 1.0A	 — —	 — —	 25 25	mV
I_B	Quiescent Current		—	3.4	6.0	mA
ΔI_B	Quiescent Current Change	15V_{DC} ≤ V_{IN} ≤ 30V_{DC}, I_{OUT} = 500mA 14.8V_{DC} ≤ V_{IN} ≤ 27V_{DC}, T_J = 25°C 5.0mA ≤ I_{OUT} ≤ 1.0A, T_J = 25°C	— — —	— — —	0.8 0.8 0.5	mA
RR	Ripple Rejection	15V_{DC} ≤ V_{IN} ≤ 25V_{DC}, f = 120Hz, I_{OUT} = 500mA	55	60	—	dB
V_{IN} – V_{OUT}	Dropout Voltage	I_{OUT} = 1.0A, T_J = 25°C	—	2.0	—	V_{DC}
V_N	Output Noise Voltage	T_A = 25°C 10Hz ≤ f ≤ 100kHz	—	10	—	µV/V_{OUT}
R_{OUT}	Output Resistance	f = 1.0kHz	—	1.1	—	mΩ
I_{SC}	Short Circuit Current Limit	T_A = 25°C V_{IN} = 35V_{DC}	—	0.2	—	A
I_{MAX}	Peak Output Current	T_J = 25°C	—	2.2	–	A
TCV_{OUT}	Average Temperature Coefficient of Output Voltage		—	–0.8	–	mV/°C

NOTES: 1. T_{LOW} = –40°C for TC78XXA, T_{HIGH} = +125°C for TC78XX

2. Load and line regulation are specified at constant junction temperature. Changes in V_{OUT} due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

TC7800A Series

ELECTRICAL CHARACTERISTICS: (V_{IN} = 23V, I_{OUT} = 1.0A, T_J = T_{LOW} to T_{HIGH} [Note 1], unless otherwise noted.)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
TC7815A						
V_{OUT}	Output Voltage	T_J = 25°C	14.7	15	15.3	V_{DC}
V_{OUT}	Output Voltage	5.0mA ≤ I_{OUT} ≤ 0.1A, P_D ≤ 15W 17.9V_{DC} ≤ V_{IN} ≤ 30V_{DC}	14.4	15	15.6	V_{DC}
REG_{LINE}	Line Regulation	Note 2 17.9V_{DC} ≤ V_{IN} ≤ 30V_{DC}, I_{OUT} = 500mA 20V_{DC} ≤ V_{IN} ≤ 26V_{DC} 17.5V_{DC} ≤ V_{IN} ≤ 30V_{DC}, I_{OUT} = 1.0A, T_J = 25°C	 — — —	 8.5 3.0 7.0	 20 22 20	mV
REG_{LOAD}	Load Regulation	Note 2 5.0mA ≤ I_{OUT} ≤ 1.5A, T_J = 25°C 5.0mA ≤ I_{OUT} ≤ 1.0A 250mA ≤ I_{OUT} ≤ 750mA	 — — —	 1.8 1.5 1.2	 25 25 15	mV
I_B	Quiescent Current		—	3.5	6.0	mA
ΔI_B	Quiescent Current Change	17.5V_{DC} ≤ V_{IN} ≤ 30V_{DC}, I_{OUT} = 500mA 17.5V_{DC}≤ V_{IN} ≤ 30V_{DC}, I_{OUT} = 1.0A, T_J = 25°C 5.0mA ≤ I_{OUT} ≤ 1.0A	— — —	— — —	0.8 0.8 0.5	mA
RR	Ripple Rejection	18.5V_{DC} ≤ V_{IN} ≤ 28.5V_{DC}, f = 120Hz, I_{OUT} = 500mA	60	80	—	dB
V_{IN} – V_{OUT}	Dropout Voltage	I_{OUT} = 1.0A, T_J = 25°C	—	2.0	—	V_{DC}
V_N	Output Noise Voltage	T_A = 25°C 10Hz ≤ f ≤ 10kHz	—	10	—	μV/V_{OUT}
R_{OUT}	Output Resistance	f = 1.0kHz	—	1.2	—	mΩ
I_{SC}	Short Circuit Current Limit	T_A = 25°C V_{IN} = 35V_{DC}	—	0.2	—	A
I_{MAX}	Peak Output Current	T_J = 25°C	—	2.2	–	A
TCV_{OUT}	Average Temperature Coefficient of Output Voltage		—	–1.0	–	mV/°C

NOTES: 1. T_{LOW} = –40°C for TC78XXA, T_{HIGH} = +125°C for TC78XX
2. Load and line regulation are specified at constant junction temperature. Changes in V_{OUT} due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

ELECTRICAL CHARACTERISTICS: (V_{IN} = 33V, I_{OUT} = 1.0A, T_J = T_{LOW} to T_{HIGH} [Note 1], unless otherwise noted.)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
TC7824A						
V_{OUT}	Output Voltage	T_J = 25°C	23.5	24	24.5	V_{DC}
V_{OUT}	Output Voltage	5.0mA ≤ I_{OUT} ≤ 0.1A, P_D ≤ 15W 27.3V_{DC} ≤ V_{IN} ≤ 38V_{DC}	23.2	24	25.8	V_{DC}
REG_{LINE}	Line Regulation	Note 2 27V_{DC} ≤ V_{IN} ≤ 38V_{DC}, I_{OUT} = 500mA 30V_{DC} ≤ V_{IN} ≤ 36V_{DC}, I_{OUT} = 1.0A 30V_{DC} ≤ V_{IN} ≤ 36V_{DC}, T_J = 25°C 26.7V_{DC} ≤ V_{IN} ≤ 38V_{DC}, I_{OUT} = 1.0A, T_J = 25°C	 — — — —	 11.5 3.8 3.8 10	 25 28 12 25	mV
REG_{LOAD}	Load Regulation	Note 2 5.0mA ≤ I_{OUT} ≤ 1.5A, T_J = 25°C 5.0mA ≤ I_{OUT} ≤ 1.0A 250mA ≤ I_{OUT} ≤ 750mA	 — — —	 2.1 2.0 1.8	 15 25 15	mV
I_B	Quiescent Current		—	3.6	6.0	mA
ΔI_B	Quiescent Current Change	27.3V_{DC} ≤ V_{IN} ≤ 38V_{DC}, I_{OUT} = 500mA 27V_{DC} ≤ V_{IN} ≤ 38V_{DC}, T_J = 25°C 5.0mA ≤ I_{OUT} ≤ 1.0A	— — —	— — —	0.8 0.8 0.5	mA
RR	Ripple Rejection	28V_{DC} ≤ V_{IN} ≤ 38V_{DC}, f = 120Hz, I_{OUT} = 500mA	45	54	—	dB
$V_{IN} - V_{OUT}$	Dropout Voltage	I_{OUT} = 1.0A, T_J = 25°C	—	2.0	—	V_{DC}
V_N	Output Noise Voltage	T_A = 25°C 10Hz ≤ f ≤ 100kHz	—	10	—	µV/V_{OUT}
R_{OUT}	Output Resistance	f = 1.0kHz	—	1.4	—	mΩ
I_{SC}	Short Circuit Current Limit	T_A = 25°C V_{IN} = 35V_{DC}	—	0.2	—	A
I_{MAX}	Peak Output Current	T_J = 25°C	—	2.2	–	A
TCV_{OUT}	Average Temperature Coefficient of Output Voltage		—	–2.0	–	mV/°C

NOTES: 1. T_{LOW} = –40°C for TC78XXA, T_{HIGH} = +125°C for TC78XX

2. Load and line regulation are specified at constant junction temperature. Changes in V_{OUT} due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

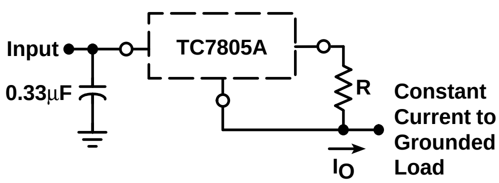
TC7800A Series

APPLICATIONS INFORMATION

Design Considerations

The TC7800A Series of fixed voltage regulators are designed with Thermal Overload Protection that shuts down the circuit when subjected to an excessive power overload condition, Internal Short Circuit Protection that limits the maximum current the circuit will pass, and Output Transistor Safe–Area Compensation that reduces the output short circuit current as the voltage across the pass transistor is increased.

In many low current applications, compensation capacitors are not required. However, it is recommended that the regulator input be bypassed with a capacitor if the regulator is connected to the power supply filter with long wire lengths, or if the output load capacitance is large. An input bypass capacitor should be selected to provide good high–frequency characteristics to insure stable operation under all load conditions. A 0.33µF or larger tantalum, mylar, or other capacitor having low internal impedance at high frequencies should be chosen. The bypass capacitor should be mounted with the shortest possible leads directly across the regulators input terminals. Normally good construction techniques should be used to minimize ground loops and lead resistance drops since the regulator has no external sense lead.



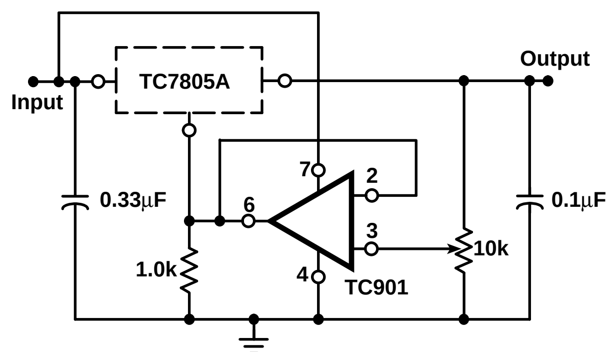
The TC7800A regulators can also be used as a current source when connected as above. In order to minimize dissipation the TC7805A is chosen in this application. Resistor R determines the current as follows:

$$I_{OUT} = \frac{5.0V}{R} = I_B$$

$I_B \cong$ **3.2mA over line and load charges.**

For example, a 1.0A current source would require R to be a 5.0Ω, 10W resistor and the output voltage compliance would be the input voltage less 7.0V.

Figure 1. Current Regulator

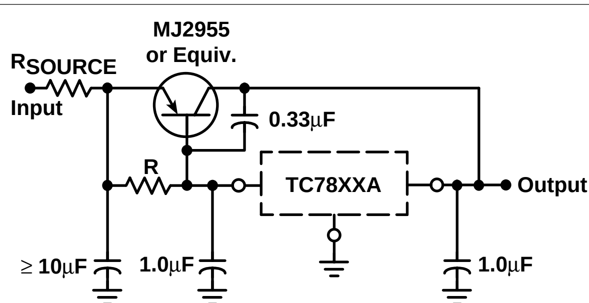


V_O **= 7.0V to 20V**

$V_{IN} = V_O \geq$ **2.0V**

The addition of an operational amplifier allows adjustment to higher or intermediate values while retaining regulation characteristics. The minimum voltage obtainable with this arrangement is 2.0V greater than the regulator voltage.

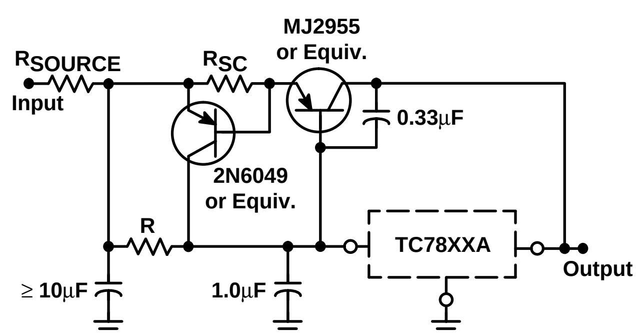
Figure 2. Adjustable Output Regulator



XX = 2 digits of type number indicating voltage.

The TC7800A series can be current boosted with a PNP transistor. The MJ2955 provides current to 5.0A. Resistor R in conjunction with the V_{BE} of the PNP determines when the pass transistor begins conducting; this circuitis not short circuit proof. Input/output differential voltage minimum is increased by V_{BE} of the pass transistor.

Figure 3. Current Boost Regulator



XX = 2 digits of type number indicating voltage.

The circuit of Figure 3 can be modified to provide supply protection against short circuits by adding a short circuit sense resistor, R_{SC}, and an additional PNP transistor.The current sensing PNP must be able to handle the short circuit current of the three–terminal regulator. Therefore, a four–ampere plastic power transistor is specified.

Figure 4. Short Circuit Protection

TYPICAL CHARACTERISTICS

Figure 5. Peak Output Current as a Function of Input/Output Differential Voltage

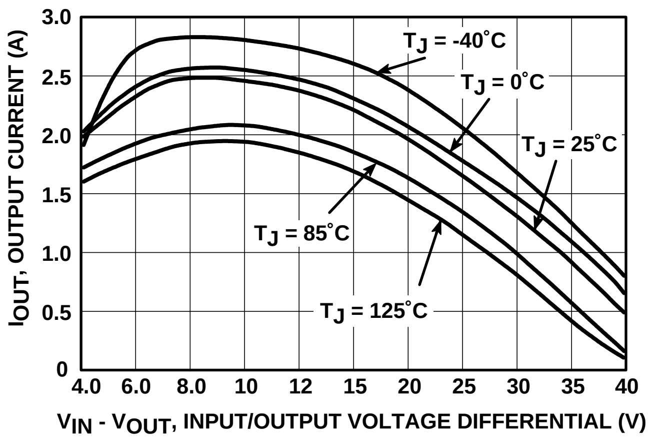


Figure 6. Ripple Rejection as a Function of Output Voltages

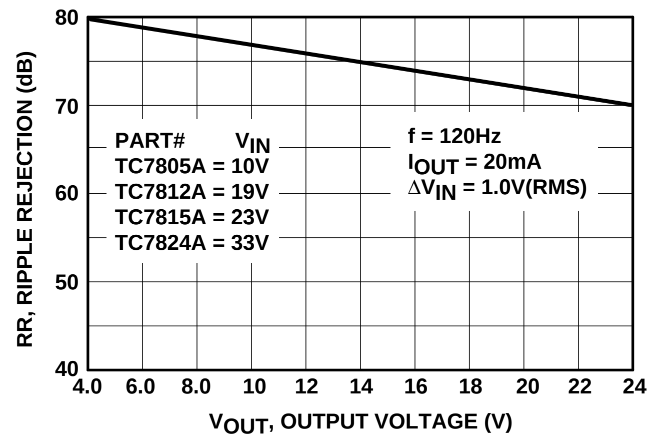


Figure 7. Ripple Rejection as a Function of Frequency

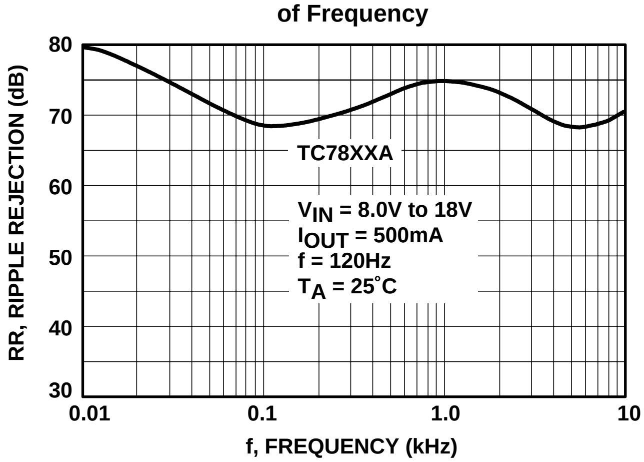


Figure 8. Output Voltage as a Function of Junction Temperature (TC7805A)

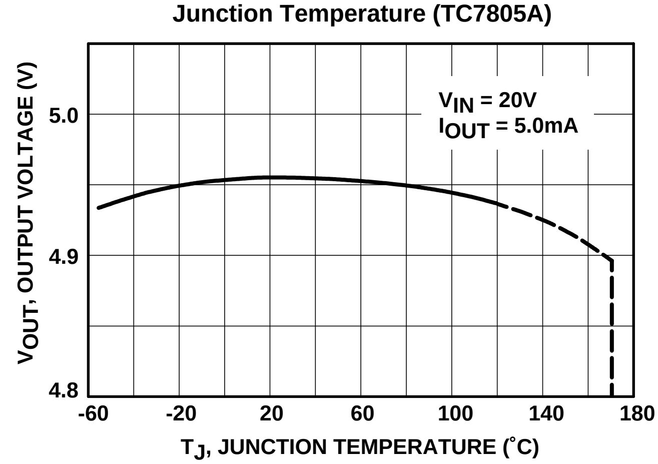


Figure 9. Output Impedance as a Function of Output Voltage

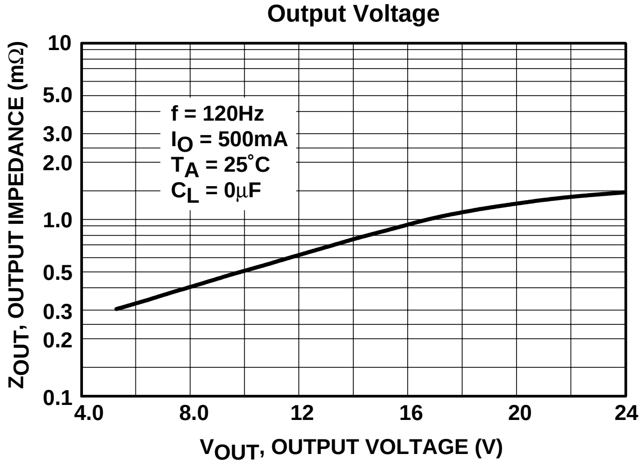
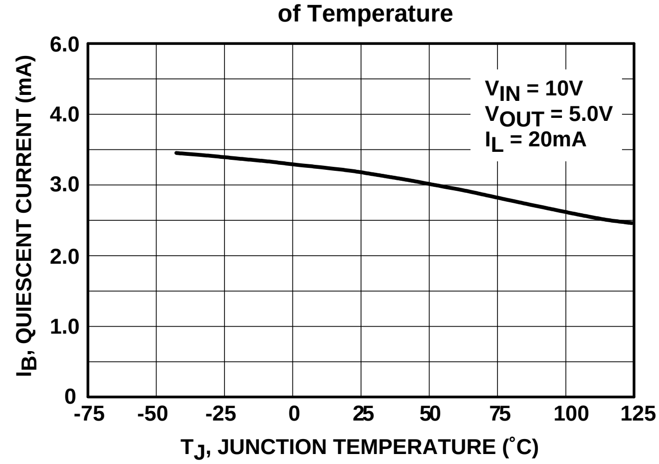


Figure 10. Quiescent Current as a Function of Temperature



TC7800A Series

Figure 11. Worst Case Power Dissipation versus Ambient Temperature (TO-220B)

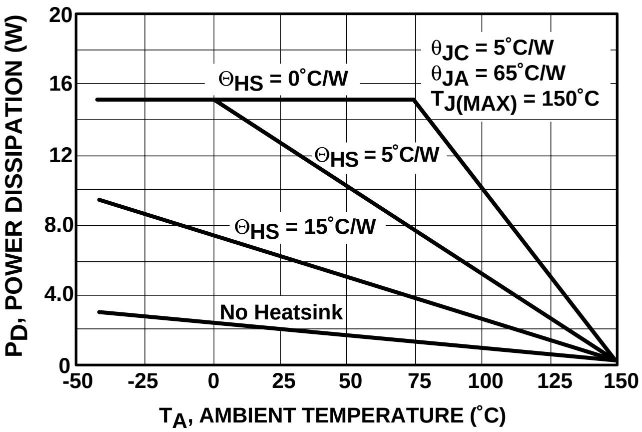


Figure 12. Input Output Differential as a Function of Junction Temperature

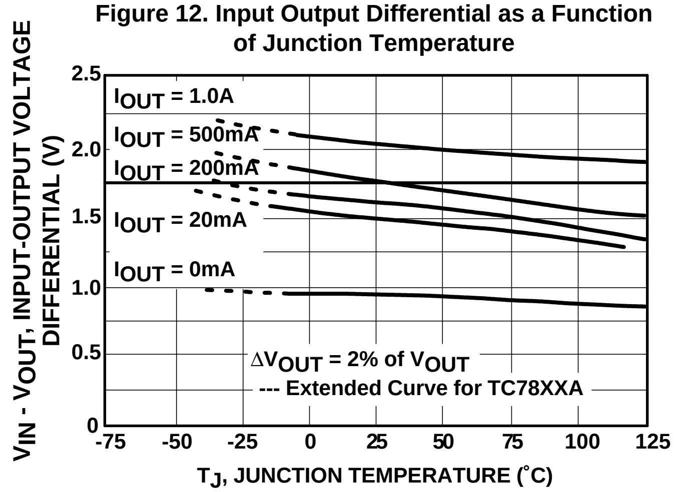
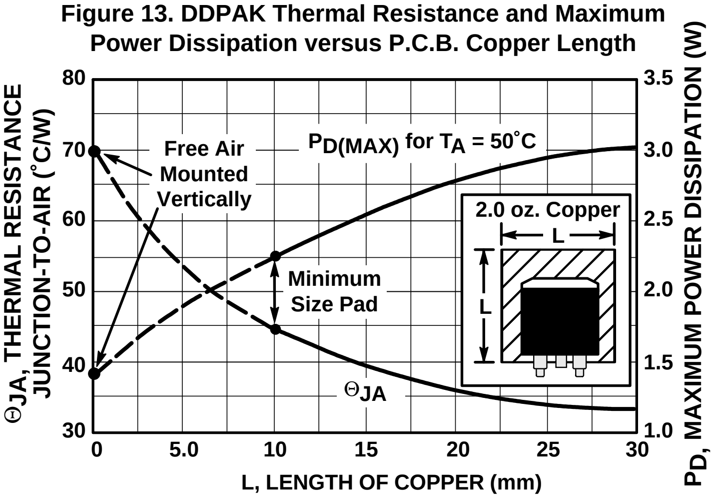


Figure 13. DDPAK Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length



DEFINITIONS

Line Regulation – The change in output voltage for a change in the input voltage. The measurement is made under conditions of low dissipation or by using pulse techniques such that the average chip temperature is not significantly affected.

Load Regulation – The change in output voltage for a change in the load current at constant chip temperature.

Maximum Power Dissipation – The maximum total device dissipation for which the regulator will operate within specifications.

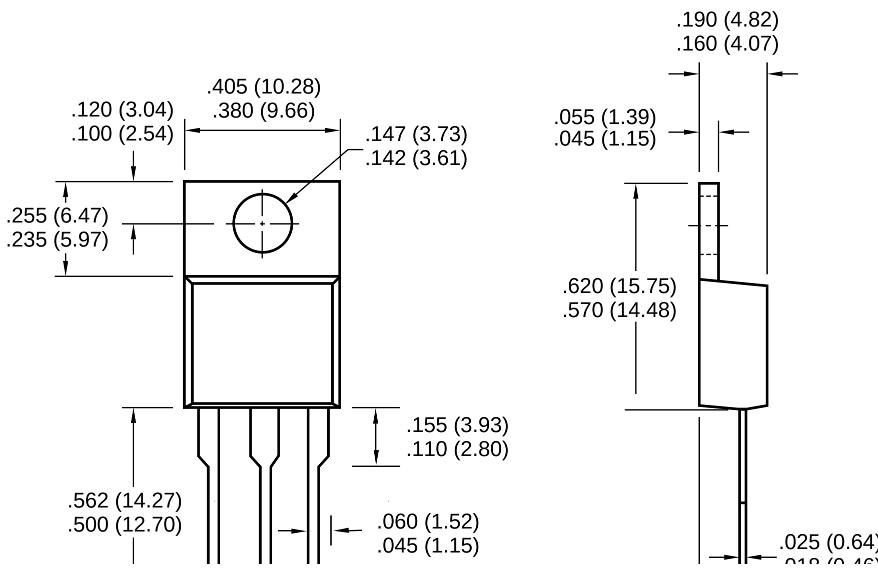
Quiescent Current – That part of the input current that is not delivered to the load.

Output Noise Voltage – The rms AC voltage at the output, with constant load and no input ripple, measured over a specified frequency range.

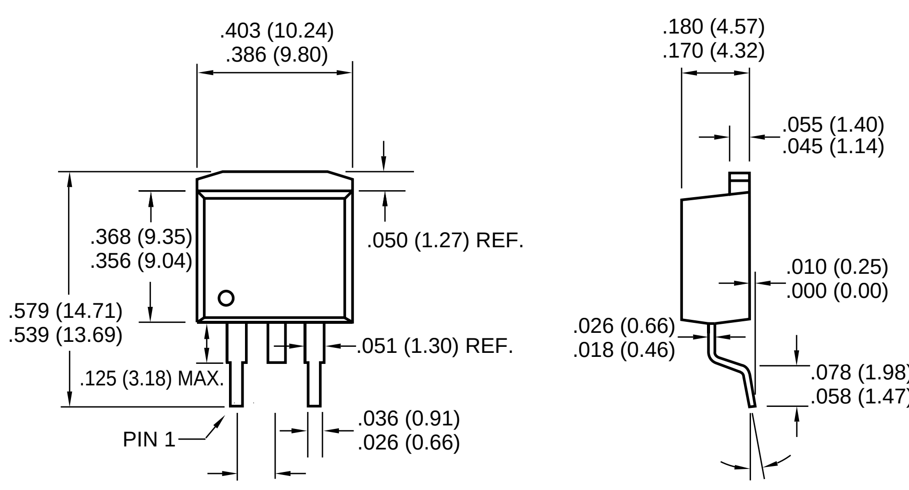
Long Term Stability – Output voltage stability under accelerated life test conditions with the maximum rated voltage listed in the devices' electrical characteristics and maximum power dissipation.

PACKAGE DIMENSIONS

3-Pin TO-220B



3-Pin DDPAK-B



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