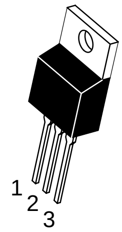
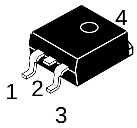
1.0 A Positive Voltage Regulators

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 1.0 A. Although designed primarily as a fixed voltage regulator, these devices can be used with external components to obtain adjustable voltages and currents.

- Output Current in Excess of 1.0 A
- No External Components Required
- Internal Thermal Overload Protection
- Internal Short Circuit Current Limiting
- Output Transistor Safe−Area Compensation
- Output Voltage Offered in 2% and 4% Tolerance
- Available in Surface Mount D^2PAK, DPAK and Standard 3−Lead Transistor Packages
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes
- Pb−Free Packages are Available



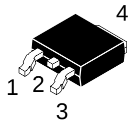
TO−220



Pin 1. Input
2. Ground
3. Output

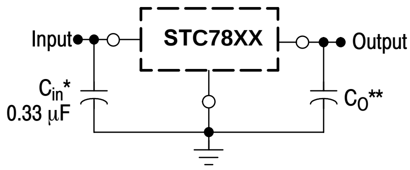
D^2PAK

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



DPAK

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.

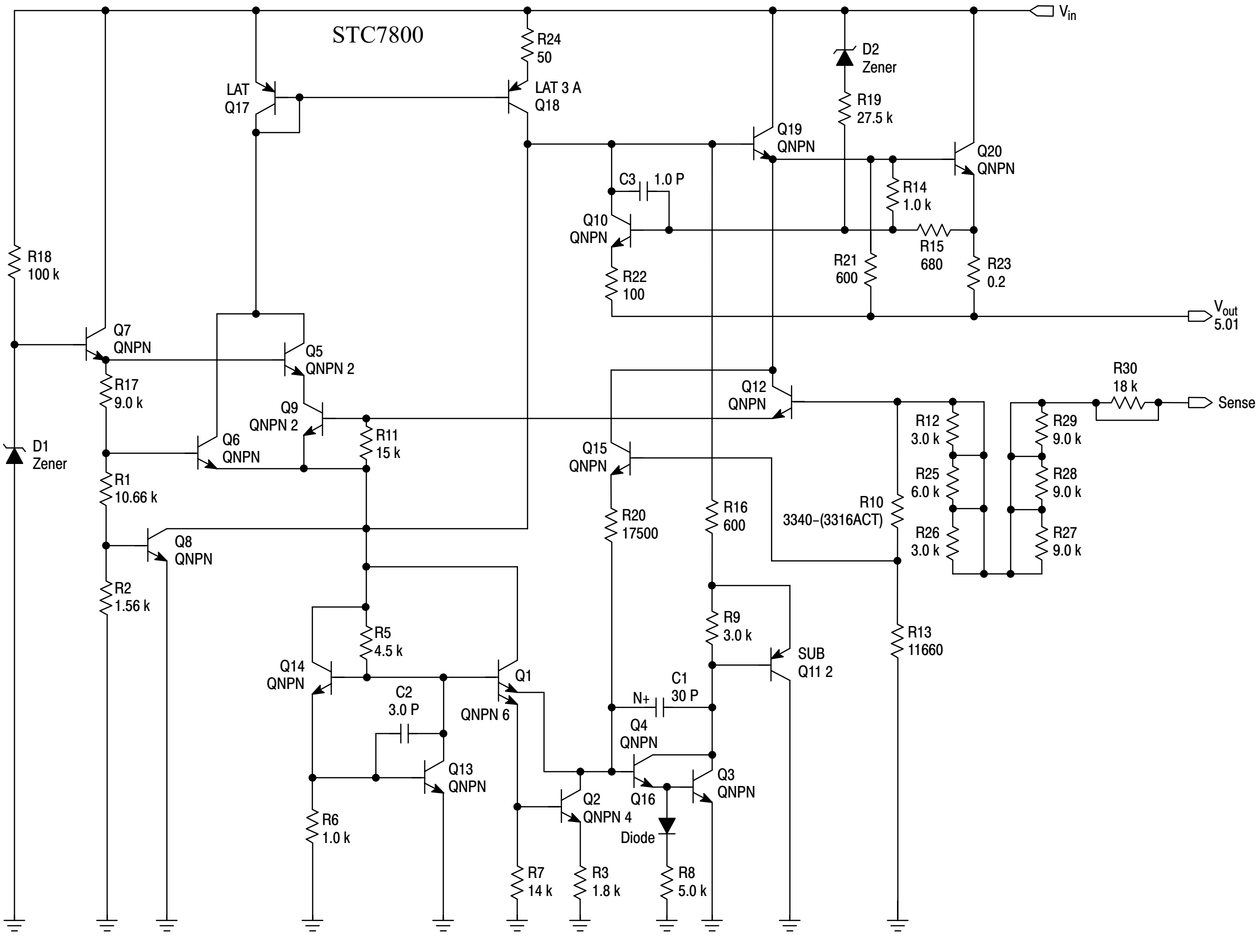
** C_O is not needed for stability; however, it does improve transient response. Values of less than 0.1 μF could cause instability.

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

Rating	Symbol	Value			Unit
Input Voltage (5.0 − 18 V)	V_I	35			Vdc
Power Dissipation	P_D	Internally Limited			W
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	92	65	Figure 14	°C/W
Thermal Resistance, Junction−to−Case	$R_{\theta JC}$	5.0	5.0	5.0	°C/W
Storage Junction Temperature Range	T_{stg}	−65 to +150			°C
Operating Junction Temperature	T_J	+150			°C

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

NOTE: ESD data available upon request.



This device contains 22 active transistors.

Figure 1. Representative Schematic Diagram

ELECTRICAL CHARACTERISTICS (V_{in} = 10 V, I_O = 1.0 A, T_J = T_{low} to T_{high} (Note 1), unless otherwise noted)

Characteristic	Symbol	STC7805			Unit
		Min	Typ	Max	
Output Voltage (T_J = 25°C)	V_O	4.9	5.0	5.1	Vdc
Output Voltage (5.0 mA ≤ I_O ≤ 1.0 A, P_D ≤ 15 W) 7.5 Vdc ≤ V_{in} ≤ 20 Vdc	V_O	4.8	5.0	5.2	Vdc
Line Regulation (Note 2)	Reg_{line}				mV
7.5 Vdc ≤ V_{in} ≤ 25 Vdc, I_O = 500 mA		–	0.5	10	
8.0 Vdc ≤ V_{in} ≤ 12 Vdc, I_O = 1.0 A		–	0.8	12	
8.0 Vdc ≤ V_{in} ≤ 12 Vdc, I_O = 1.0 A, T_J = 25°C		–	1.3	4.0	
7.3 Vdc ≤ V_{in} ≤ 20 Vdc, I_O = 1.0 A, T_J = 25°C		–	4.5	10	
Load Regulation (Note 2)	Reg_{load}				mV
5.0 mA ≤ I_O ≤ 1.5 A, T_J = 25°C		–	1.3	25	
5.0 mA ≤ I_O ≤ 1.0 A		–	0.8	25	
250 mA ≤ I_O ≤ 750 mA		–	0.53	15	
Quiescent Current	I_B	–	3.2	6.0	mA
Quiescent Current Change	ΔI_B				mA
8.0 Vdc ≤ V_{in} ≤ 25 Vdc, I_O = 500 mA		–	0.3	0.8	
7.5 Vdc ≤ V_{in} ≤ 20 Vdc, T_J = 25°C		–	–	0.8	
5.0 mA ≤ I_O ≤ 1.0 A		–	0.08	0.5	
Ripple Rejection 8.0 Vdc ≤ V_{in} ≤ 18 Vdc, f = 120 Hz, I_O = 500 mA	RR	68	83	–	dB
Dropout Voltage (I_O = 1.0 A, T_J = 25°C)	$V_I - V_O$	–	2.0	–	Vdc
Output Noise Voltage (T_A = 25°C) 10 Hz ≤ f ≤ 100 kHz	V_n	–	10	–	μV/V_O
Output Resistance (f = 1.0 kHz)	r_O	–	0.9	–	mΩ
Short Circuit Current Limit (T_A = 25°C) V_{in} = 35 Vdc	I_{SC}	–	0.2	–	A
Peak Output Current (T_J = 25°C)	I_{max}	–	2.2	–	A
Average Temperature Coefficient of Output Voltage	TCV_O	–	−0.3	–	mV/°C

1. T_{low} = 0°C for STC7800 Series T_{high} = +125°C for STC7800 Series
2. Load and line 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} = 11 V, I_O = 1.0 A, T_J = T_{low} to T_{high} (Note 3), unless otherwise noted)

Characteristic	Symbol	STC7806			Unit
		Min	Typ	Max	
Output Voltage (T_J = 25°C)	V_O	5.88	6.0	6.12	Vdc
Output Voltage (5.0 mA ≤ I_O ≤ 1.0 A, P_D ≤ 15 W) 8.6 Vdc ≤ V_{in} ≤ 21 Vdc	V_O	5.76	6.0	6.24	Vdc
Line Regulation (Note 4) 8.6 Vdc ≤ V_{in} ≤ 25 Vdc, I_O = 500 mA 9.0 Vdc ≤ V_{in} ≤ 13 Vdc, I_O = 1.0 A	Reg_{line}	 – –	 5.0 1.4	 12 15	mV
Load Regulation (Note 4) 5.0 mA ≤ I_O ≤ 1.5 A, T_J = 25°C 5.0 mA ≤ I_O ≤ 1.0 A 250 mA ≤ I_O ≤ 750 mA	Reg_{load}	 – – –	 1.3 0.9 0.2	 25 25 15	mV
Quiescent Current	I_B	–	3.3	6.0	mA
Quiescent Current Change 9.0 Vdc ≤ V_{in} ≤ 25 Vdc, I_O = 500 mA 9.0 Vdc ≤ V_{in} ≤ 21 Vdc, I_O = 1.0 A, T_J = 25°C 5.0 mA ≤ I_O ≤ 1.0 A	ΔI_B	 – – –	 – – –	 0.8 0.8 0.5	mA
Ripple Rejection 9.0 Vdc ≤ V_{in} ≤ 19 Vdc, f = 120 Hz, I_O = 500 mA	RR	58	65	–	dB
Dropout Voltage (I_O = 1.0 A, T_J = 25°C)	$V_I - V_O$	–	2.0	–	Vdc
Output Noise Voltage (T_A = 25°C) 10 Hz ≤ f ≤ 100 kHz	V_n	–	10	–	$\mu V/V_O$
Output Resistance (f = 1.0 kHz)	r_O	–	0.9	–	mΩ
Short Circuit Current Limit (T_A = 25°C) V_{in} = 35 Vdc	I_{SC}	–	0.2	–	A
Peak Output Current (T_J = 25°C)	I_{max}	–	2.2	–	A
Average Temperature Coefficient of Output Voltage	TCV_O	–	−0.3	–	mV/°C

3. T_{low} = 0°C for STC7800 Series T_{high} = +125°C for STC7800 Series

4. Load and line 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} = 14 V, I_O = 1.0 A, T_J = T_{low} to T_{high} (Note 5), unless otherwise noted)

Characteristic	Symbol	STC7808			Unit
		Min	Typ	Max	
Output Voltage (T_J = 25°C)	V_O	7.84	8.0	8.16	Vdc
Output Voltage (5.0 mA ≤ I_O ≤ 1.0 A, P_D ≤ 15 W) 10.6 Vdc ≤ V_{in} ≤ 23 Vdc	V_O	7.7	8.0	8.3	Vdc
Line Regulation (Note 6) 10.6 Vdc ≤ V_{in} ≤ 25 Vdc, I_O = 500 mA 11 Vdc ≤ V_{in} ≤ 17 Vdc, I_O = 1.0 A 10.4 Vdc ≤ V_{in} ≤ 23 Vdc, T_J = 25°C	Reg_{line}	 – – –	 6.0 1.7 5.0	 15 18 15	mV
Load Regulation (Note 6) 5.0 mA ≤ I_O ≤ 1.5 A, T_J = 25°C 5.0 mA ≤ I_O ≤ 1.0 A 250 mA ≤ I_O ≤ 750 mA	Reg_{load}	 – – –	 1.4 1.0 0.22	 25 25 15	mV
Quiescent Current	I_B	–	3.3	6.0	mA
Quiescent Current Change 11 Vdc ≤ V_{in} ≤ 25 Vdc, I_O = 500 mA 10.6 Vdc ≤ V_{in} ≤ 23 Vdc, I_O = 1.0 A, T_J = 25°C 5.0 mA ≤ I_O ≤ 1.0 A	ΔI_B	 – – –	 – – –	 0.8 0.8 0.5	mA
Ripple Rejection 11.5 Vdc ≤ V_{in} ≤ 21.5 Vdc, f = 120 Hz, I_O = 500 mA	RR	56	62	–	dB
Dropout Voltage (I_O = 1.0 A, T_J = 25°C)	$V_I - V_O$	–	2.0	–	Vdc
Output Noise Voltage (T_A = 25°C) 10 Hz ≤ f ≤ 100 kHz	V_n	–	10	–	$\mu V/V_O$
Output Resistance f = 1.0 kHz	r_O	–	0.9	–	mΩ
Short Circuit Current Limit (T_A = 25°C) V_{in} = 35 Vdc	I_{SC}	–	0.2	–	A
Peak Output Current (T_J = 25°C)	I_{max}	–	2.2	–	A
Average Temperature Coefficient of Output Voltage	TCV_O	–	−0.4	–	mV/°C

5. T_{low} = 0°C for STC7800 Series T_{high} = +125°C for STC7800 Series

6. Load and line 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 = 1.0 A, T_J = T_{low} to T_{high} (Note 7), unless otherwise noted)

Characteristic	Symbol	STC7812			Unit
		Min	Typ	Max	
Output Voltage (T_J = 25°C)	V_O	11.75	12	12.25	Vdc
Output Voltage (5.0 mA ≤ I_O ≤ 1.0 A, P_D ≤ 15 W) 14.8 Vdc ≤ V_{in} ≤ 27 Vdc	V_O	11.5	12	12.5	Vdc
Line Regulation (Note 8)	Reg_{line}				mV
14.8 Vdc ≤ V_{in} ≤ 30 Vdc, I_O = 500 mA		–	3.8	18	
16 Vdc ≤ V_{in} ≤ 22 Vdc, I_O = 1.0 A		–	2.2	20	
14.5 Vdc ≤ V_{in} ≤ 27 Vdc, T_J = 25°C		–	6.0	120	
Load Regulation (Note 8)	Reg_{load}				mV
5.0 mA ≤ I_O ≤ 1.5 A, T_J = 25°C		–	–	25	
5.0 mA ≤ I_O ≤ 1.0 A		–	–	25	
Quiescent Current	I_B	–	3.4	6.0	mA
Quiescent Current Change	ΔI_B				mA
15 Vdc ≤ V_{in} ≤ 30 Vdc, I_O = 500 mA		–	–	0.8	
14.8 Vdc ≤ V_{in} ≤ 27 Vdc, T_J = 25°C		–	–	0.8	
5.0 mA ≤ I_O ≤ 1.0 A, T_J = 25°C		–	–	0.5	
Ripple Rejection 15 Vdc ≤ V_{in} ≤ 25 Vdc, f = 120 Hz, I_O = 500 mA	RR	55	60	–	dB
Dropout Voltage (I_O = 1.0 A, T_J = 25°C)	$V_I - V_O$	–	2.0	–	Vdc
Output Noise Voltage (T_A = 25°C) 10 Hz ≤ f ≤ 100 kHz	V_n	–	10	–	$\mu V/V_O$
Output Resistance (f = 1.0 kHz)	r_O	–	1.1	–	mΩ
Short Circuit Current Limit (T_A = 25°C) V_{in} = 35 Vdc	I_{SC}	–	0.2	–	A
Peak Output Current (T_J = 25°C)	I_{max}	–	2.2	–	A
Average Temperature Coefficient of Output Voltage	TCV_O	–	−0.8	–	mV/°C

7. T_{low} = 0°C for STC7800 Series T_{high} = +125°C for STC7800 Series

8. Load and line 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} = 23 V, I_O = 1.0 A, T_J = T_{low} to T_{high} (Note 9), unless otherwise noted)

Characteristic	Symbol	MC78MC7815			Unit
		Min	Typ	Max	
Output Voltage (T_J = 25°C)	V_O	14.7	15	15.3	Vdc
Output Voltage (5.0 mA ≤ I_O ≤ 1.0 A, P_D ≤ 15 W) 17.9 Vdc ≤ V_{in} ≤ 30 Vdc	V_O	14.4	15	15.6	Vdc
Line Regulation (Note 10)	Reg_{line}				mV
17.9 Vdc ≤ V_{in} ≤ 30 Vdc, I_O = 500 mA		–	8.5	20	
20 Vdc ≤ V_{in} ≤ 26 Vdc		–	3.0	22	
17.5 Vdc ≤ V_{in} ≤ 30 Vdc, I_O = 1.0 A, T_J = 25°C		–	7.0	20	
Load Regulation (Note 10)	Reg_{load}				mV
5.0 mA ≤ I_O ≤ 1.5 A, T_J = 25°C		–	1.8	25	
5.0 mA ≤ I_O ≤ 1.0 A		–	1.5	25	
250 mA ≤ I_O ≤ 750 mA		–	1.2	15	
Quiescent Current	I_B	–	3.5	6.0	mA
Quiescent Current Change	ΔI_B				mA
17.5 Vdc ≤ V_{in} ≤ 30 Vdc, I_O = 500 mA		–	–	0.8	
17.5 Vdc ≤ V_{in} ≤ 30 Vdc, I_O = 1.0 A, T_J = 25°C		–	–	0.8	
5.0 mA ≤ I_O ≤ 1.0 A		–	–	0.5	
Ripple Rejection 18.5 Vdc ≤ V_{in} ≤ 28.5 Vdc, f = 120 Hz, I_O = 500 mA	RR	60	80	–	dB
Dropout Voltage (I_O = 1.0 A, T_J = 25°C)	$V_I - V_O$	–	2.0	–	Vdc
Output Noise Voltage (T_A = 25°C) 10 Hz ≤ f ≤ 100 kHz	V_n	–	10	–	$\mu V/V_O$
Output Resistance f = 1.0 kHz	r_O	–	1.2	–	mΩ
Short Circuit Current Limit (T_A = 25°C) V_{in} = 35 Vdc	I_{SC}	–	0.2	–	A
Peak Output Current (T_J = 25°C)	I_{max}	–	2.2	–	A
Average Temperature Coefficient of Output Voltage	TCV_O	–	−1.0	–	mV/°C

9. T_{low} = 0°C for STC7800 Series T_{high} = +125°C for STC7800 Series

10. Load and line 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} = 27 V, I_O = 1.0 A, T_J = T_{low} to T_{high} (Note 11), unless otherwise noted)

Characteristic	Symbol	STC7818			Unit
		Min	Typ	Max	
Output Voltage (T_J = 25°C)	V_O	17.64	18	18.36	Vdc
Output Voltage (5.0 mA ≤ I_O ≤ 1.0 A, P_D ≤ 15 W) 21 Vdc ≤ V_{in} ≤ 33 Vdc	V_O	17.3	18	18.7	Vdc
Line Regulation (Note 12)	Reg_{line}				mV
21 Vdc ≤ V_{in} ≤ 33 Vdc, I_O = 500 mA		–	9.5	22	
24 Vdc ≤ V_{in} ≤ 30 Vdc, I_O = 1.0 A		–	3.2	25	
24 Vdc ≤ V_{in} ≤ 30 Vdc, I_O = 1.0 A, T_J = 25°C		–	3.2	10.5	
20.6 Vdc ≤ V_{in} ≤ 33 Vdc, I_O = 1.0 A, T_J = 25°C		–	8.0	22	
Load Regulation (Note 12)	Reg_{load}				mV
5.0 mA ≤ I_O ≤ 1.5 A, T_J = 25°C		–	2.0	25	
5.0 mA ≤ I_O ≤ 1.0 A		–	1.8	25	
250 mA ≤ I_O ≤ 750 mA		–	1.5	15	
Quiescent Current	I_B	–	3.5	6.0	mA
Quiescent Current Change	ΔI_B				mA
21 Vdc ≤ V_{in} ≤ 33 Vdc, I_O = 500 mA		–	–	0.8	
21.5 Vdc ≤ V_{in} ≤ 30 Vdc, T_J = 25°C		–	–	0.8	
5.0 mA ≤ I_O ≤ 1.0 A		–	–	0.5	
Ripple Rejection 22 Vdc ≤ V_{in} ≤ 32 Vdc, f = 120 Hz, I_O = 500 mA	RR	53	57	–	dB
Dropout Voltage (I_O = 1.0 A, T_J = 25°C)	$V_I - V_O$	–	2.0	–	Vdc
Output Noise Voltage (T_A = 25°C) 10 Hz ≤ f ≤ 100 kHz	V_n	–	10	–	μV/V_O
Output Resistance f = 1.0 kHz	r_O	–	1.3	–	mΩ
Short Circuit Current Limit (T_A = 25°C) V_{in} = 35 Vdc	I_{SC}	–	0.2	–	A
Peak Output Current (T_J = 25°C)	I_{max}	–	2.2	–	A
Average Temperature Coefficient of Output Voltage	TCV_O	–	−1.5	–	mV/°C

11. T_{low} = 0°C for STC7800 Series T_{high} = +125°C for STC7800 Series

12. Load and line 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.

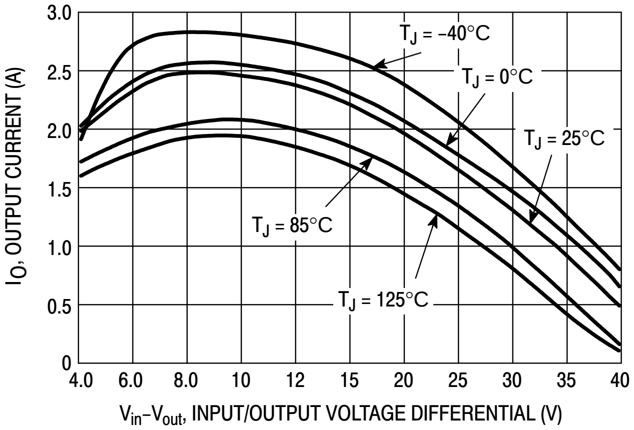


Figure 2. Peak Output Current as a Function of Input/Output Differential Voltage

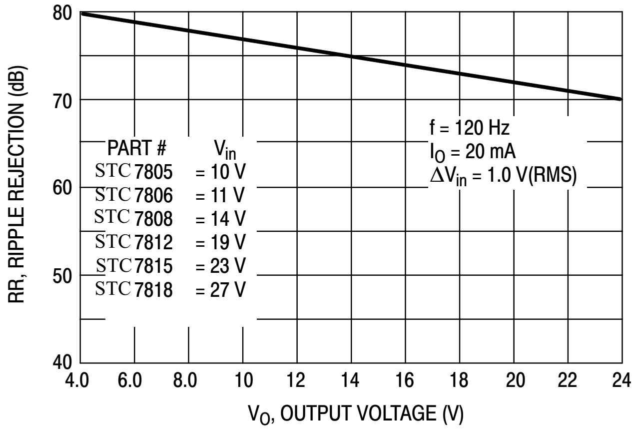


Figure 3. Ripple Rejection as a Function of Output Voltages

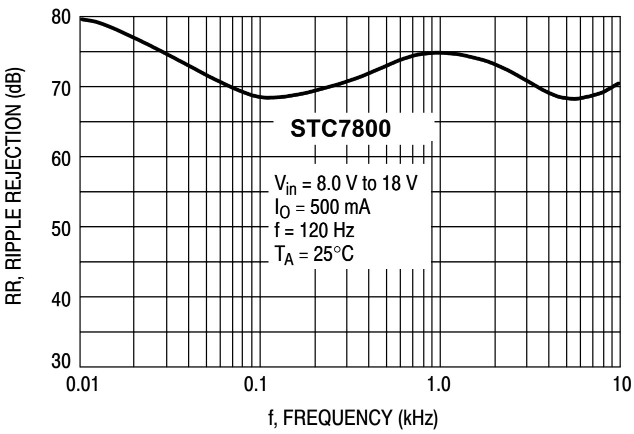


Figure 4. Ripple Rejection as a Function of Frequency

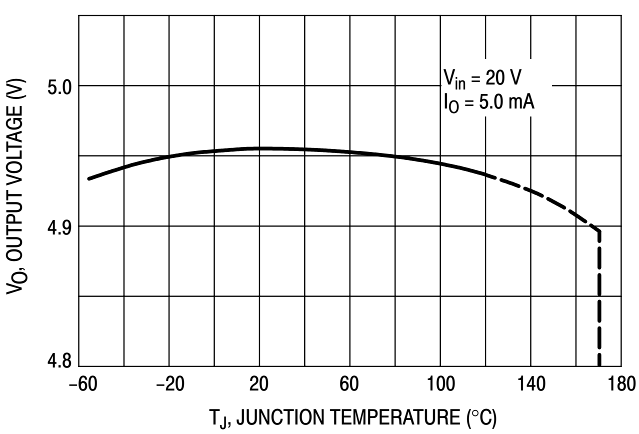


Figure 5. Output Voltage as a Function of Junction Temperature (STC7805)

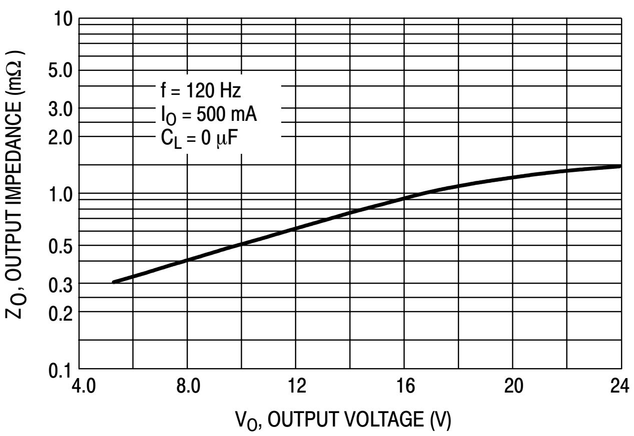


Figure 6. Output Impedance as a Function of Output Voltage

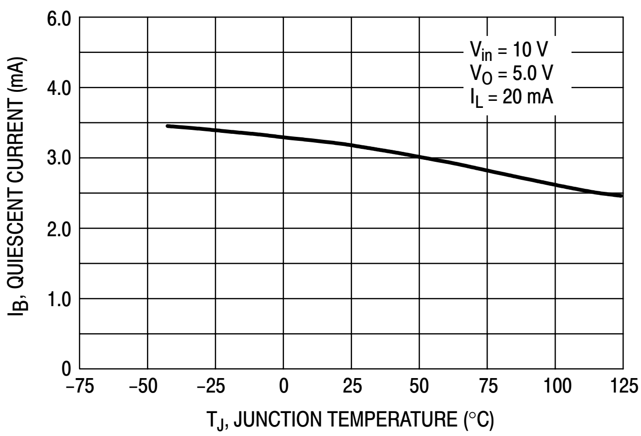


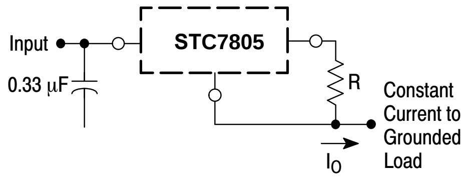
Figure 7. Quiescent Current as a Function of Temperature

APPLICATIONS INFORMATION

Design Considerations

The STC7800 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 lar ge. An input bypass capacitor should be selected to provide good high−frequency characteristics to insure stable operation under all load conditions. A 0.33 µF or lar ger 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.



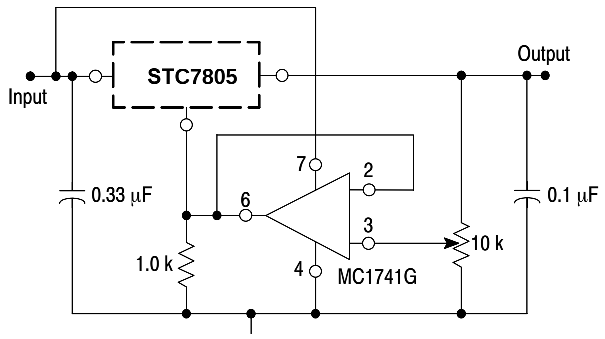
The STC7800 regulators can also be used as a current source when connected as above. In order to minimize dissipation the STC7800 is chosen in this application. Resistor R determines the current as follows:

$$I_O = \frac{5.0\ V}{R} + I_B$$

$I_B \cong$ 3.2 mA over line and load changes.

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

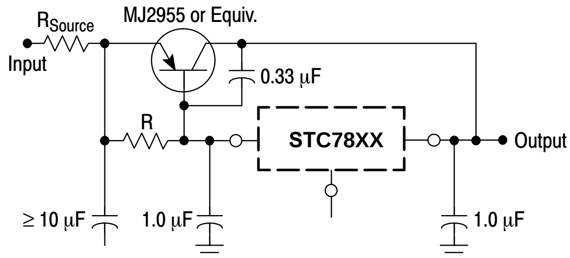
Figure 8. Current Regulator



V_O = 7.0 V to 20 V
$V_{IN} = V_O \geq$ 2.0 V

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 2.0 V greater than the regulator voltage.

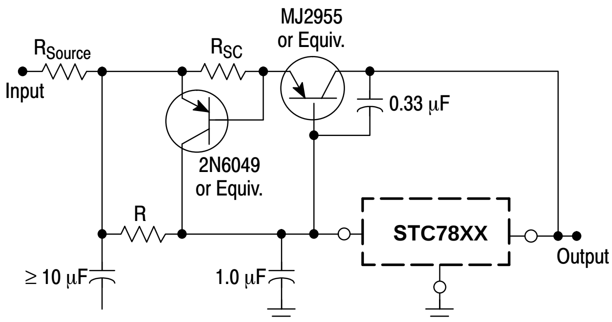
Figure 9. Adjustable Output Regulator



XX = 2 digits of type number indicating voltage.

The STC7800 series can be current boosted with a PNP transistor. The MJ2955 provides current to 5.0 A. Resistor R in conjunction with the V_{BE} of the PNP determines when the pass transistor begins conducting; this circuit is not short circuit proof. Input/output differential voltage minimum is increased by V_{BE} of the pass transistor.

Figure 10. Current Boost Regulator



XX = 2 digits of type number indicating voltage.

The circuit of Figure 10 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 11. Short Circuit Protection

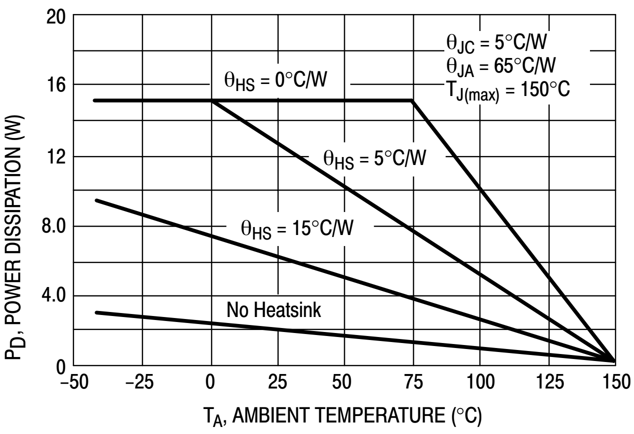


Figure 12. Worst Case Power Dissipation versus Ambient Temperature

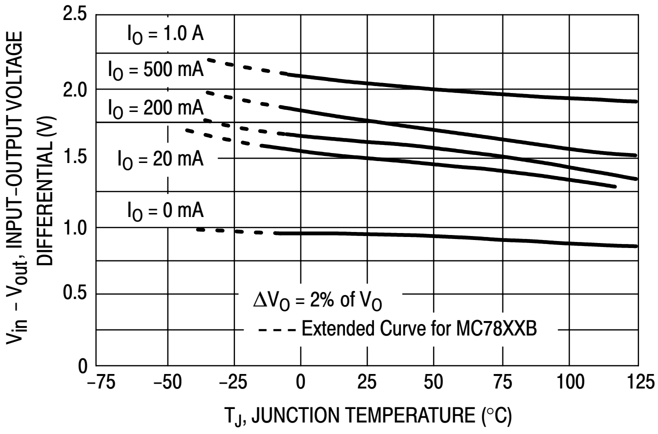


Figure 13. Input Output Differential as a Function of Junction Temperature

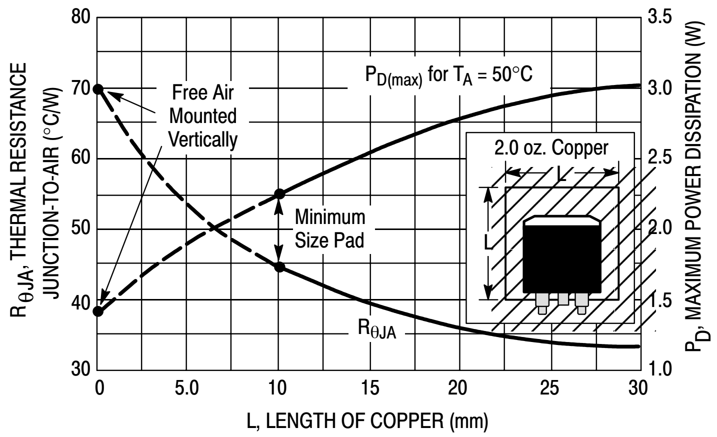


Figure 14. D²PAK Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length

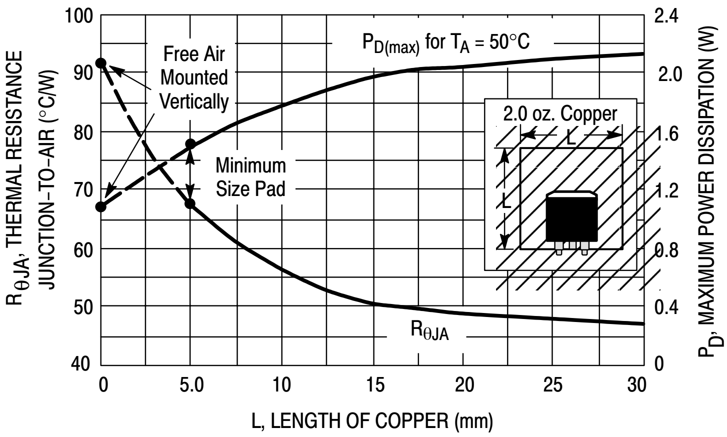


Figure 15. DPAK Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length