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MC7800 Series

THREE-TERMINAL POSITIVE FIXED VOLTAGE REGULATORS

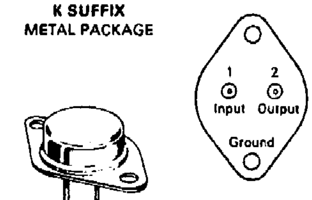
SILICON MONOLITHIC INTEGRATED CIRCUITS

THREE-TERMINAL 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 ampere. 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 Ampere
- 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

K SUFFIX
METAL PACKAGE

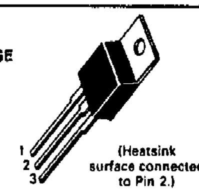


(Bottom View)

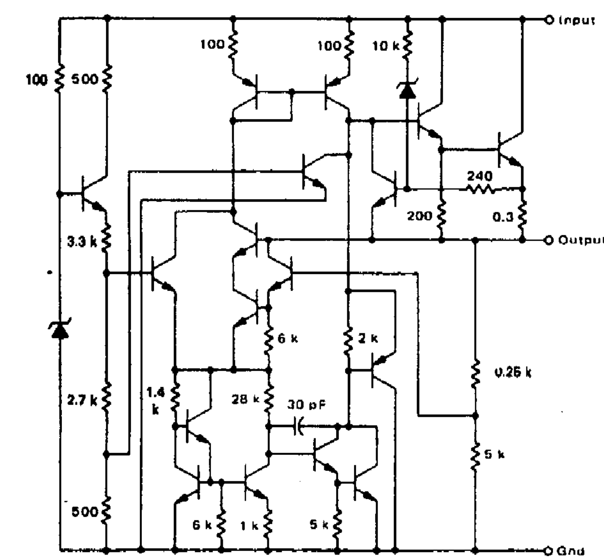
Pins 1 and 2 electrically isolated from case. Case is third electrical connection.

T SUFFIX
PLASTIC PACKAGE

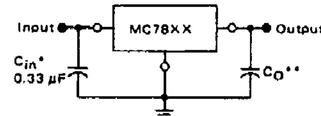
PIN 1. INPUT
2. GROUND
3. OUTPUT



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.

XX indicates nominal voltage

ORDERING INFORMATION

Device	Output Voltage Tolerance	Tested Operating Junction Temp. Range	Package
MC78XXK	4%	−55 to +150°C	Metal Power
MC78XXAK*	2%		
MC78XXCK	4%	0 to +125°C	
MC78XXACK*	2%		
MC78XXCT	4%		Plastic Power
MC78XXACT	2%		
MC78XXBT	4%	−40 to +125°C	

*2% regulators in Metal Power packages are available in 5, 12 and 15 volt devices.

TYPE NO./VOLTAGE			
MC7805	5.0 Volts	MC7812	12 Volts
MC7806	6.0 Volts	MC7815	15 Volts
MC7808	8.0 Volts	MC7818	18 Volts
MC7809	9.0 Volts	MC7824	24 Volts

Quality Semi-Conductors

MC7808, B, C

ELECTRICAL CHARACTERISTICS (V_{in} = 14 V, I_O = 500 mA, T_J = T_{low} to T_{high} [Note 1] unless otherwise noted).

Characteristic	Symbol	MC7808			MC7808B			MC7808C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	7.7	8.0	8.3	7.7	8.0	8.3	7.7	8.0	8.3	Vdc
Output Voltage (5.0 mA ≤ I_O ≤ 1.0 A, P_O ≤ 15 W) 10.6 Vdc ≤ V_{in} ≤ 23 Vdc 11.5 Vdc ≤ V_{in} ≤ 23 Vdc	V_O	 — 7.6	 — 8.0	 — 8.4	 — 7.6	 — 8.0	 — 8.4	 7.6 —	 8.0 —	 8.4 —	Vdc
Line Regulation (T_J = +25°C, Note 2) 10.5 Vdc ≤ V_{in} ≤ 25 Vdc 11 Vdc ≤ V_{in} ≤ 17 Vdc	Reg_{line}	 — —	 3.0 2.0	 80 40	 — —	 12 5.0	 160 80	 — —	 12 5.0	 160 80	mV
Load Regulation (T_J = +25°C, Note 2) 5.0 mA ≤ I_O ≤ 1.5 A 250 mA ≤ I_O ≤ 750 mA	Reg_{load}	 — —	 28 9.0	 100 40	 — —	 45 16	 160 80	 — —	 45 16	 160 80	mV
Quiescent Current (T_J = +25°C)	I_B	—	3.2	6.0	—	4.3	8.0	—	4.3	8.0	mA
Quiescent Current Change 10.5 Vdc ≤ V_{in} ≤ 25 Vdc 11.5 Vdc ≤ V_{in} ≤ 25 Vdc 5.0 mA ≤ I_O ≤ 1.0 A	ΔI_B	 — — —	 — 0.3 0.04	 — 0.8 0.5	 — — —	 — — —	 — 1.0 0.5	 — — —	 — — —	 1.0 — 0.5	mA
Ripple Rejection 11.5 Vdc ≤ V_{in} ≤ 21.5 Vdc, f = 120 Hz	RR	62	70	—	—	62	—	—	62	—	dB
Dropout Voltage (I_O = 1.0 A, T_J = +25°C)	$V_{in}-V_O$	—	2.0	2.5	—	2.0	—	—	2.0	—	Vdc
Output Noise Voltage (T_A = +25°C) 10 Hz ≤ f ≤ 100 kHz	V_n	—	10	40	—	10	—	—	10	—	µV/ V_O
Output Resistance f = 1.0 kHz	r_O	—	18	—	—	18	—	—	18	—	mΩ
Short-Circuit Current Limit (T_A = +25°C) V_{in} = 35 Vdc	I_{sc}	—	0.2	1.2	—	0.2	—	—	0.2	—	A
Peak Output Current (T_J = +25°C)	I_{max}	1.3	2.5	3.3	—	2.2	—	—	2.2	—	A
Average Temperature Coefficient of Output Voltage	TCV_O	—	±1.0	—	—	−0.8	—	—	−0.8	—	mV/ °C

MC7808AC

ELECTRICAL CHARACTERISTICS (V_{in} = 14 V, I_O = 1.0 A, T_J = T_{low} to T_{high} [Note 1] unless otherwise noted).

Characteristics	Symbol	MC7808AC			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_O ≤ 15 W) 10.6 Vdc ≤ V_{in} ≤ 23 Vdc	V_O	7.7	8.0	8.3	Vdc
Line Regulation (Note 2) 10.6 Vdc ≤ V_{in} ≤ 25 Vdc, I_O = 500 mA 11 Vdc ≤ V_{in} ≤ 17 Vdc 11 Vdc ≤ V_{in} ≤ 17 Vdc, T_J = +25°C 10.4 Vdc ≤ V_{in} ≤ 23 Vdc, T_J = +25°C	Reg_{line}	 — — — —	 12 15 5.0 12	 80 80 40 80	mV
Load Regulation (Note 2) 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, T_J = +25°C 250 mA ≤ I_O ≤ 750 mA	Reg_{load}	 — — — —	 45 45 — 16	 100 100 — 50	mV
Quiescent Current T_J = +25°C	I_B	— —	— 4.3	6.0 6.0	mA
Quiescent Current Change 11 Vdc ≤ V_{in} ≤ 25 Vdc, I_O = 500 mA 10.6 Vdc ≤ V_{in} ≤ 23 Vdc, 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, T_J = +25°C 11.5 Vdc ≤ V_{in} ≤ 21.5 Vdc, f = 120 Hz, I_O = 500 mA	RR	 — —	 — 62	 — —	dB
Dropout Voltage (I_O = 1.0 A, T_J = +25°C)	$V_{in}-V_O$	—	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	—	18	—	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

NOTES: 1. T_{low} = −55°C for MC78XX; = 0° for MC78XXC, AC; = −40°C for MC78XXB. T_{high} = +150°C for MC78XX; = +125°C for MC78XXC, AC, B

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.

MC7800 Series

MC7809CT

ELECTRICAL CHARACTERISTICS (V_{in} = 15 V, I_O = 500 mA, T_J = 0°C to +125°C unless otherwise noted).

Characteristic	Symbol	MC7809CT			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	8.65	9.0	9.35	Vdc
Output Voltage (5.0 mA ≤ I_O ≤ 1.0 A, P_O ≤ 15 W) 11.5 Vdc ≤ V_{in} ≤ 24 Vdc	V_O	8.55	9.0	9.45	Vdc
Line Regulation (T_J = +25°C, Note 1) 11.5 Vdc ≤ V_{in} ≤ 26 Vdc 11.5 Vdc ≤ V_{in} ≤ 17 Vdc	Reg_{line}	 — —	 12 5.0	 50 25	mV
Load Regulation (T_J = +25°C, Note 1) 5.0 mA ≤ I_O ≤ 1.5 A 250 mA ≤ I_O ≤ 750 mA	Reg_{load}	 — —	 35 12	 50 25	mV
Quiescent Current (T_J = +25°C)	I_B	—	4.3	8.0	mA
Quiescent Current Change 11.5 Vdc ≤ V_{in} ≤ 26 Vdc 5.0 mA ≤ I_O ≤ 1.0 A	ΔI_B	 — —	 — —	 1.0 0.5	mA
Ripple Rejection 11.5 Vdc ≤ V_{in} ≤ 21.5 Vdc, f = 120 Hz	RR	—	61	—	dB
Dropout Voltage (I_O = 1.0 A, T_J = +25°C)	$V_{in} - V_O$	—	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	—	18	—	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

NOTE 1: 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.

MC7800 Series

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

Rating	Symbol	Value	Unit
Input Voltage (5.0 V − 18 V) (24 V)	V_{in}	35 40	Vdc
Power Dissipation and Thermal Characteristics Plastic Package T_A = +25°C Derate above T_A = +25°C Thermal Resistance, Junction to Air	 P_D $1/\theta_{JA}$ θ_{JA}	 Internally Limited 15.4 65	 Watts mW/°C °C/W
T_C = +25°C Derate above T_C = +75°C (See Figure 1) Thermal Resistance, Junction to Case	P_D $1/\theta_{JC}$ θ_{JC}	Internally Limited 200 5.0	Watts mW/°C °C/W
Metal Package T_A = +25°C Derate above T_A = +25°C Thermal Resistance, Junction to Air	 P_D $1/\theta_{JA}$ θ_{JA}	 Internally Limited 22.5 45	 Watts mW/°C °C/W
T_C = +25°C Derate above T_C = +65°C (See Figure 2) Thermal Resistance, Junction to Case	P_D $1/\theta_{JC}$ θ_{JC}	Internally Limited 182 5.5	Watts mW/°C °C/W
Storage Junction Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature Range MC7800,A MC7800C,AC MC7800B	T_J	 −55 to +150 0 to +150 −40 to +150	°C

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 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.

TYPICAL CHARACTERISTICS
(T_A = +25°C unless otherwise noted.)

FIGURE 1 — WORST CASE POWER DISSIPATION versus AMBIENT TEMPERATURE (Case 221A)

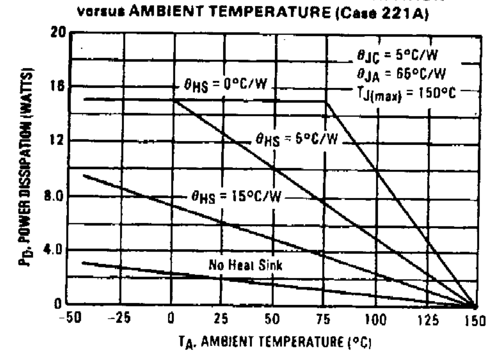


FIGURE 2 — WORST CASE POWER DISSIPATION versus AMBIENT TEMPERATURE (Case 1)

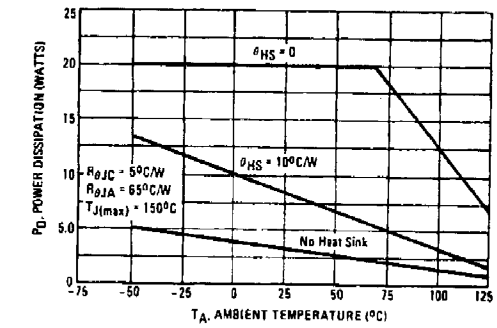


FIGURE 3 — INPUT OUTPUT DIFFERENTIAL AS A FUNCTION OF JUNCTION TEMPERATURE (MC78XXC, AC, B)

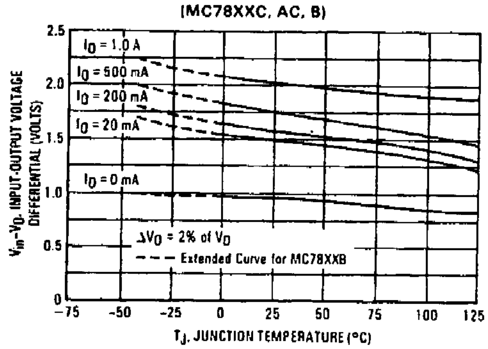


FIGURE 4 — INPUT OUTPUT DIFFERENTIAL AS A FUNCTION OF JUNCTION TEMPERATURE (MC78XX, A)

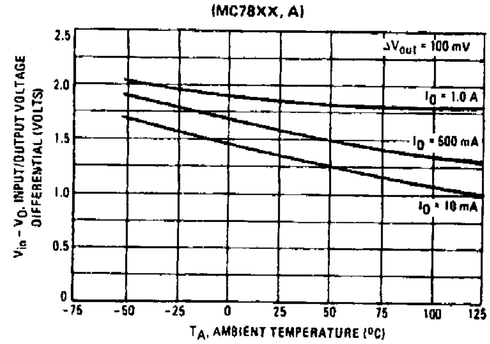


FIGURE 5 — PEAK OUTPUT CURRENT AS A FUNCTION OF INPUT-OUTPUT DIFFERENTIAL VOLTAGE (MC78XXC, AC, B)

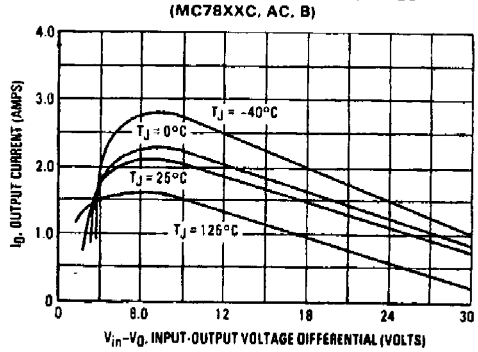
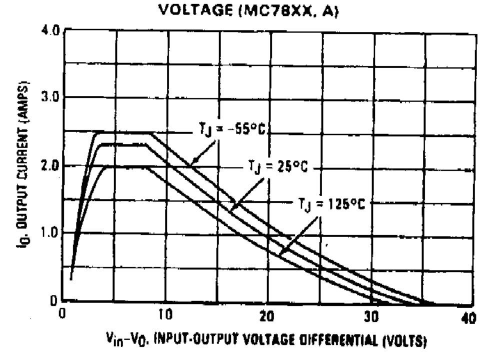


FIGURE 6 — PEAK OUTPUT CURRENT AS A FUNCTION OF INPUT-OUTPUT DIFFERENTIAL VOLTAGE (MC78XX, A)



TYPICAL CHARACTERISTICS (continued)
(T_A = 25°C unless otherwise noted.)

FIGURE 7 — RIPPLE REJECTION AS A FUNCTION OF OUTPUT VOLTAGES (MC78XXC, AC)

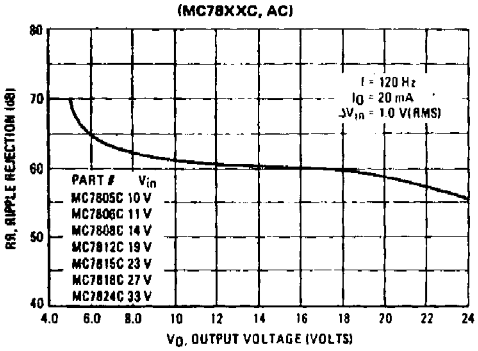


FIGURE 8 — RIPPLE REJECTION AS A FUNCTION OF FREQUENCY (MC78XXC, AC, A)

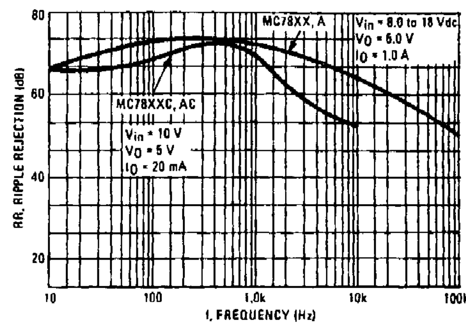


FIGURE 9 — OUTPUT VOLTAGE AS A FUNCTION OF JUNCTION TEMPERATURE (MC78XXC, AC, B)

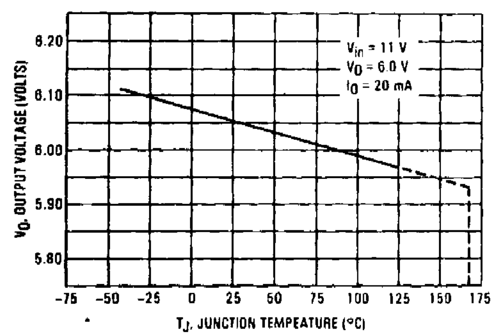


FIGURE 10 — OUTPUT IMPEDANCE AS A FUNCTION OF OUTPUT VOLTAGE (MC78XXC, AC)

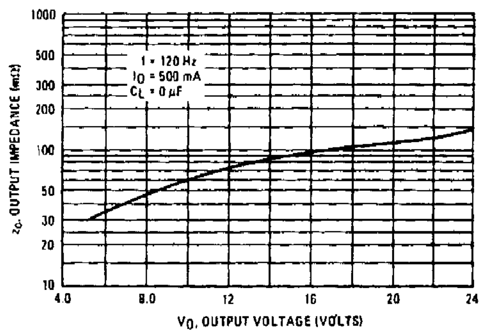


FIGURE 11 — QUIESCENT CURRENT AS A FUNCTION OF TEMPERATURE (MC78XXC, AC, B)

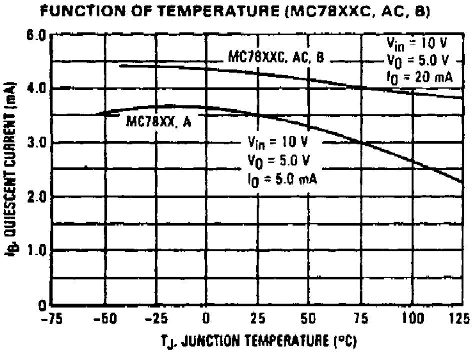
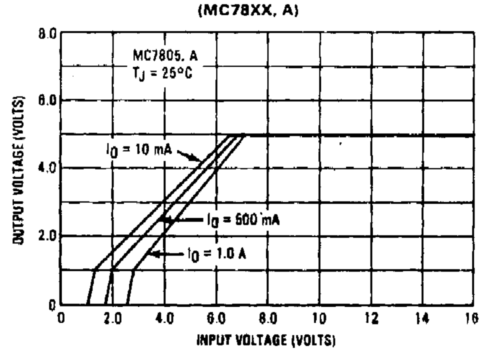


FIGURE 12 — DROPOUT CHARACTERISTICS (MC78XX, A)



K SUFFIX
METAL PACKAGE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
B	—	22.23	—	0.875
C	6.35	11.43	0.250	0.450
D	0.97	1.09	0.038	0.043
E	—	3.43	—	0.135
F	30.15 BSC		1.187 BSC	
G	10.92 BSC		0.430 BSC	
H	5.46 BSC		0.215 BSC	
J	16.89 BSC		0.665 BSC	
K	7.92	—	0.312	—
Q	3.84	4.09	0.151	0.161
R	—	13.34	—	0.525
T	—	4.78	—	0.188
V	3.84	4.09	0.151	0.161

$R_{\theta JA}$ = 45°C/W (TYP)
(TO-3)

NOTES:
1. DIAMETER V AND SURFACE W ARE DATUMS.
2. POSITIONAL TOLERANCE FOR HOLE Q:
   ⌖ | ϕ 0.25 (0.010) Ⓜ | W | V Ⓜ
3. POSITIONAL TOLERANCE FOR LEADS:
   ⌖ | ϕ 0.30 (0.012) Ⓜ | W | V Ⓜ | Q Ⓜ