SP78MXX SERIES

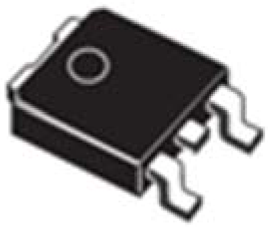
Precision 500 mA regulators

DESCRIPTION

The SP78MxxA series of three-terminal positive regulators is available in TO-252 packages and with several fixed output voltages, making it useful in a wide range of applications. These regulators can provide local on-card regulation eliminating the distribution problems associated with single point regulation. Each type employs internal current limiting, thermal shutdown and safe area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 0.5 A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltage and currents.

Features

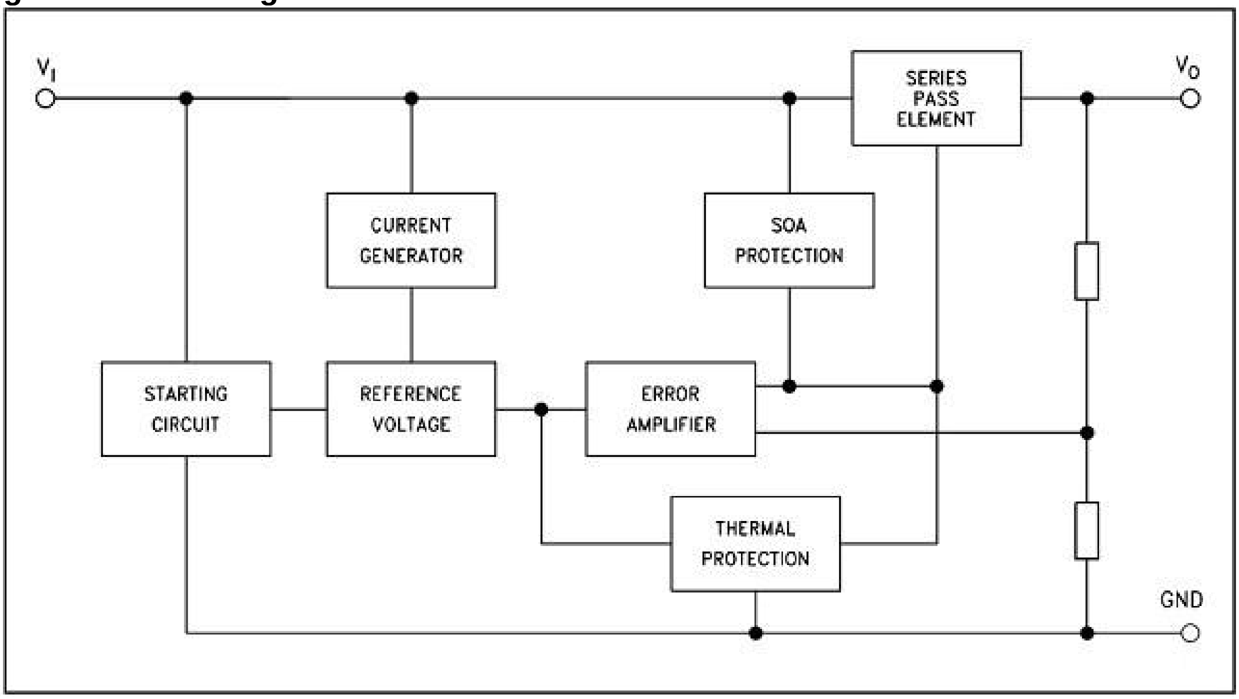
- Output current to 0.5 A
- Output voltages of 5; 6; 8; 9; 10; 12V
- Thermal overload protection
- Short circuit protection
- Output transition SOA protection
- ± 2 % Output voltage tolerance
- Guaranteed in extended temperature range



TO-252

Diagram

Figure 1. Block diagram



Pin configuration

Figure 2. Pin connections (top view)

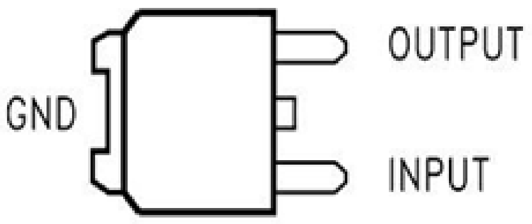
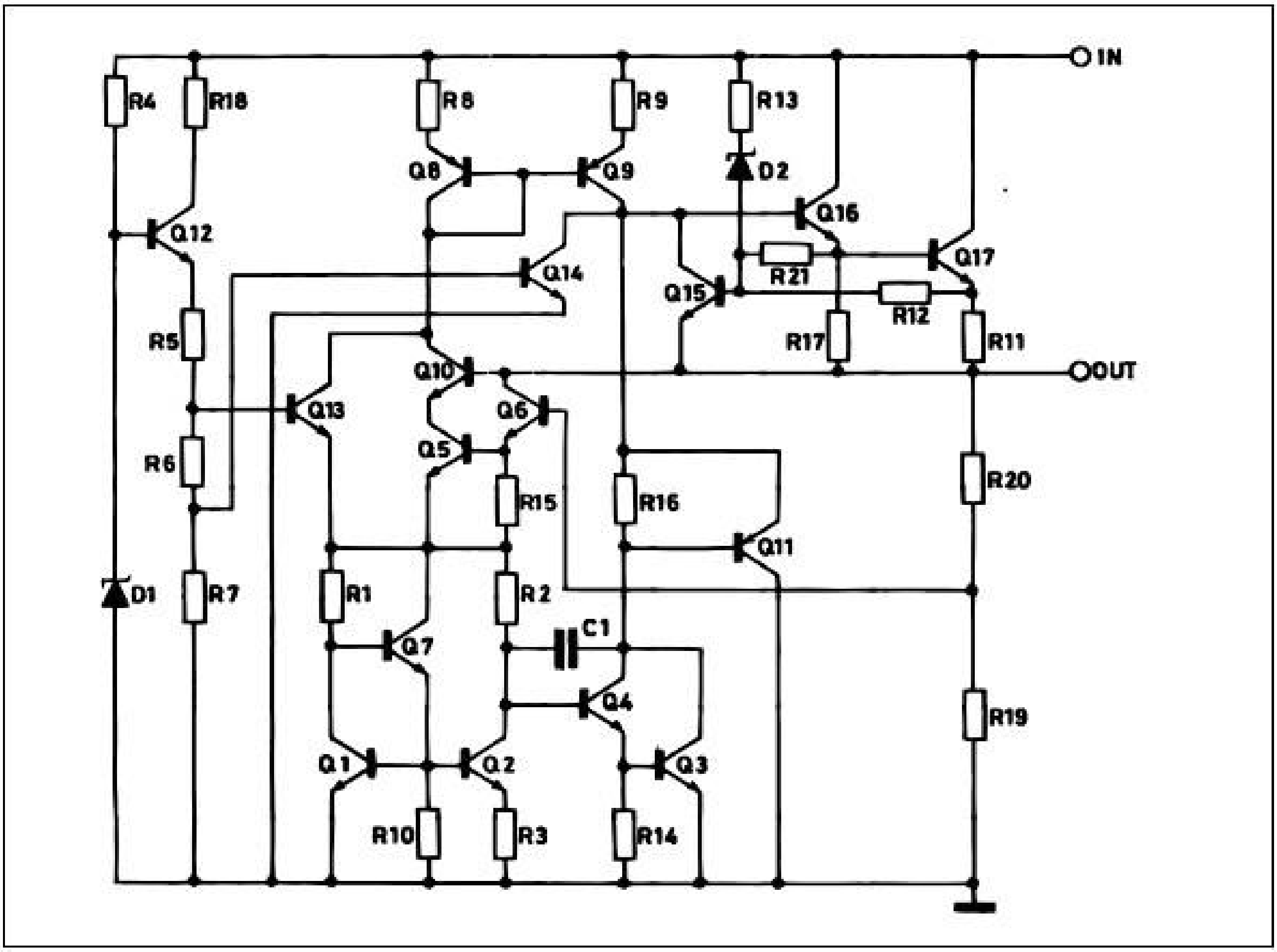


Figure 3. Schematic diagram



Maximum ratings

Table 2. Absolute maximum ratings

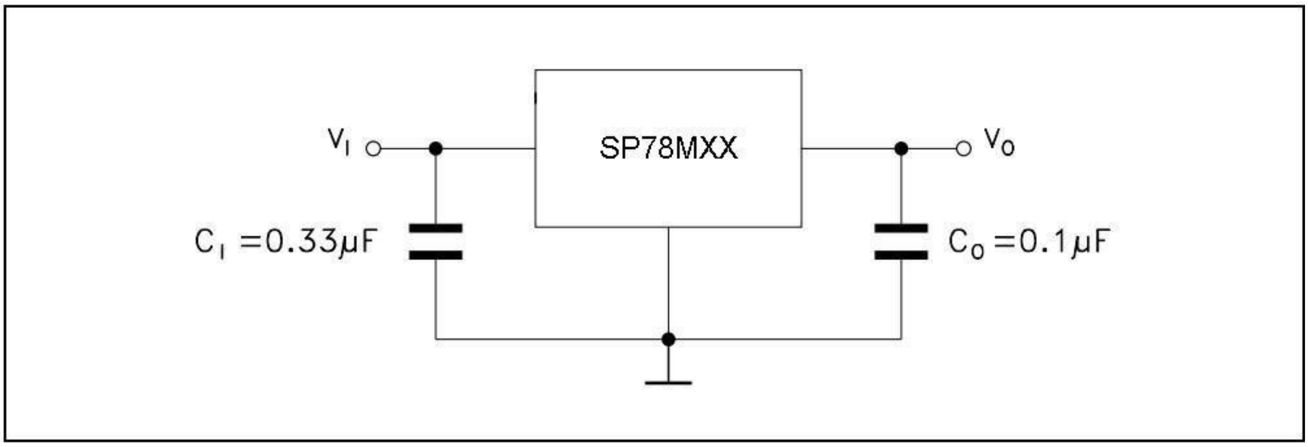
Symbol	Parameter	Value	Unit
V_I	DC input voltage	36	V
I_O	Output current	Internally limited	mA
P_D	Power dissipation	Internally limited	mW
T_{STG}	Storage temperature range	-65 to 150	° C
T_{OP}	Operating junction temperature range	0 to 125	° C

Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

Table 3. Thermal data

Symbol	Parameter	TO-252	Unit
RthJC	Thermal resistance junction-case	8	° C/W
RthJA	Thermal resistance junction-ambient	100	° C/W

Figure 4. Application circuit



Test circuits

Figure 5. DC parameter

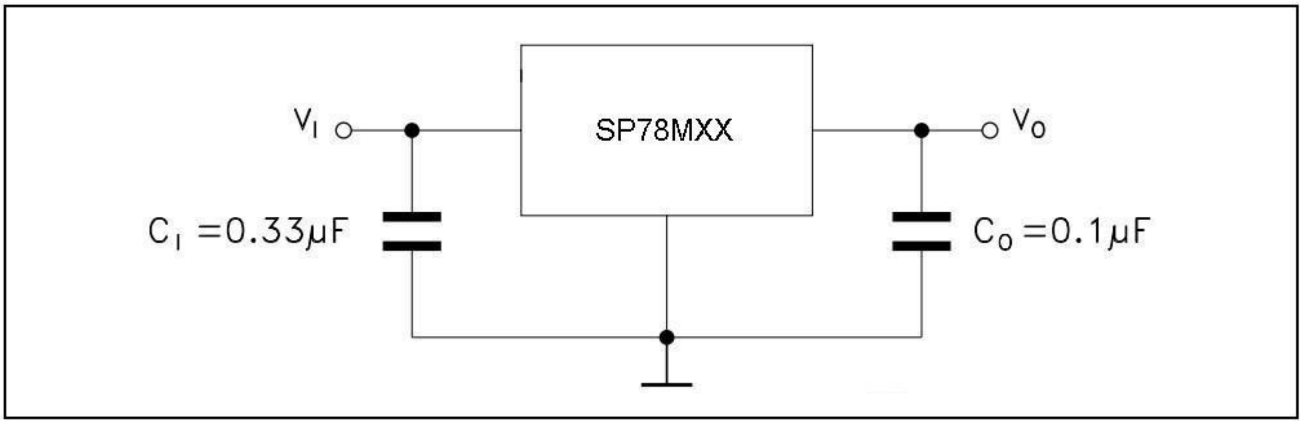


Figure 6. Load regulation

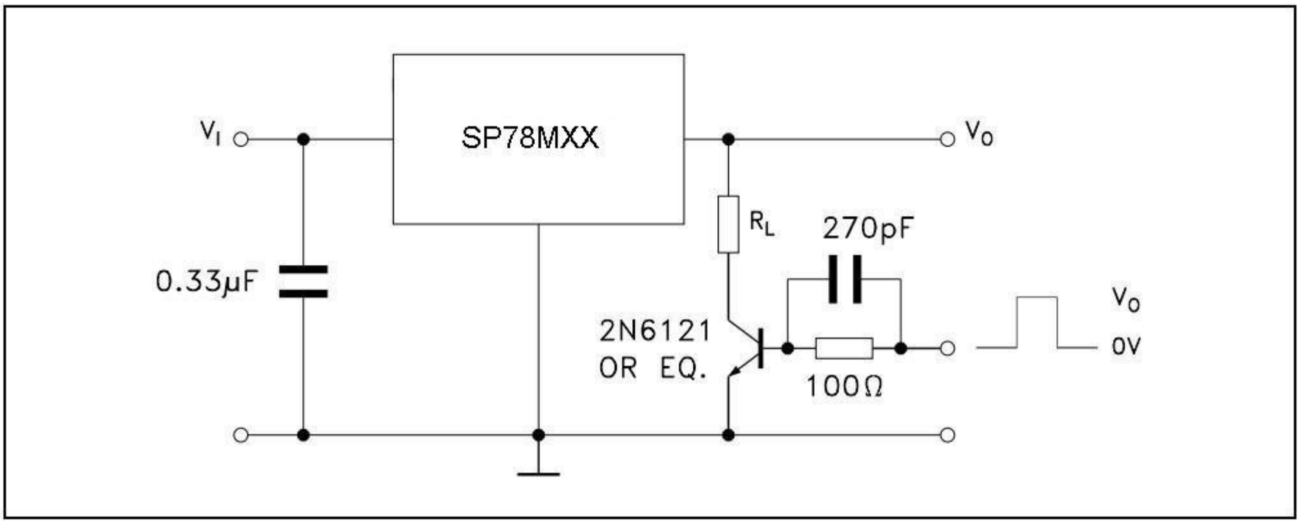
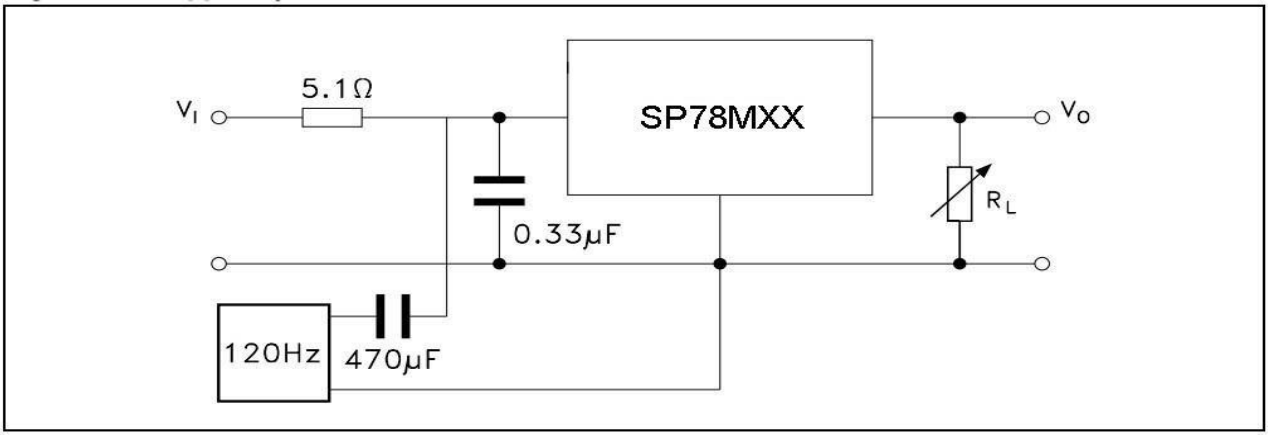


Figure 7. Ripple rejection



Electrical characteristics

Refer to the test circuits, V_I = 10 V, I_O = 350 mA, C_I = 0.33 μF, C_O = 0.1 μF, T_J = 0 to 125 °C unless otherwise specified.

Table 4. Electrical characteristics of SP78M05

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	T_J = 25°C	4.9	5	5.1	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 7 to 20 V	4.8	5	5.2	V
ΔV_O	Line regulation	V_I = 7 to 25 V, I_O = 200 mA, T_J = 25°C			100	mV
		V_I = 8 to 25 V, I_O = 200 mA, T_J = 25°C			50	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25°C			100	mV
		I_O = 5 to 200 mA, T_J				
I_d	Quiescent current	T_J				
ΔI_d	Quiescent current change	I_O = 5 to 350 mA			0.5	mA
		I_O = 200 mA, V_I = 8 to 25 V			0.8	
ΔV_O/ΔT	Output voltage drift	I_O = 5 mA		-0.5		mV/°C
SVR	Supply voltage rejection	V_I = 8 to 18 V, f = 120Hz, I_O = 300mA, T_J = 25°C	62			dB
eN	Output noise voltage	B =10Hz to 100kHz, T_J = 25°C		40		μV
V_d	Dropout voltage	T_J = 25°C		2		V
I_{sc}	Short circuit current	T_J = 25°C, V_I = 35 V		300		mA
I_{scp}	Short circuit peak current	T_J = 25°C		700		mA

Refer to the test circuits, V_I = 11 V, I_O = 350 mA, C_I = 0.33 μF, C_O = 0.1 μF, T_J = 0 to 125 °C unless otherwise specified

Table 5. Electrical characteristics of SP78M06

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	T_J = 25°C	5.88	6	6.12	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 8 to 21 V	5.75	6	6.3	V
ΔV_O	Line regulation	V_I = 8 to 25 V, I_O = 200 mA, T_J = 25°C			100	mV
		V_I = 9 to 25 V, I_O = 200 mA, T_J = 25°C			30	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25°C			120	mV
		I_O = 5 to 200 mA, T_J = 25°C			60	
I_d	Quiescent current	T_J = 25°C			6	mA
ΔI_d	Quiescent current	I_O = 5 to 350 mA			0.5	mA

	change	I_O = 200 mA, V_I = 9 to 25 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA		-0.5		mV/°C
SVR	Supply voltage rejection	V_I = 9 to 19 V, f = 120Hz, I_O = 300mA, T_J = 25°C	59			dB
eN	Output noise voltage	B =10Hz to 100kHz, T_J = 25°C		45		μV
V_d	Dropout voltage	T_J = 25°C		2		V
I_{sc}	Short circuit current	T_J = 25°C, V_I = 35 V		270		mA
I_{scp}	Short circuit peak current	T_J = 25°C		700		mA

Refer to the test circuits, V_I = 14 V, I_O = 350 mA, C_I = 0.33 μF, C_O = 0.1 μF, T_J = 0 to 125 °C unless otherwise specified.

Table 6. Electrical characteristics of SP78M08

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	T_J = 25°C	7.84	8	8.16	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 10.5 to 23 V	7.7	8	8.3	V
ΔV_O	Line regulation	V_I = 10.5 to 25 V, I_O = 200 mA, T_J = 25°C			100	mV
		V_I = 11 to 25 V, I_O = 200 mA, T_J = 25°C			30	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25°C			160	mV
		I_O = 5 to 200 mA, T_J = 25°C			80	
I_d	Quiescent current	T_J = 25°C			6	mA
ΔI_d	Quiescent current change	I_O = 5 to 350 mA			0.5	mA
		I_O = 200 mA, V_I = 10.5 to 25 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA		-0.5		mV/°C
SVR	Supply voltage rejection	V_I = 11.5 to 21.5 V, f = 120Hz, I_O = 300mA, T_J = 25°C	56			dB
eN	Output noise voltage	B =10Hz to 100kHz, T_J = 25°C		52		μV
V_d	Dropout voltage	T_J = 25°C		2		V
I_{sc}	Short circuit current	T_J = 25°C, V_I = 35 V		250		mA
I_{scp}	Short circuit peak current	T_J = 25°C		700		mA

Refer to the test circuits, V_I = 15 V, IO = 350 mA, C_I = 0.33 µF, C_O = 0.1 µF, T_J = 0 to 125 °C unless otherwise specified.

Table 7. Electrical characteristics of SP78M09

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	T_J = 25°C	8.82	9	9.18	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 11.5 to 24 V	8.64	9	9.36	V
ΔV_O	Line regulation	V_I = 11.5 to 25 V, I_O = 200 mA, T_J = 25°C			100	mV
		V_I = 12 to 25 V, I_O = 200 mA, T_J = 25°C			30	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25°C			180	mV
		I_O = 5 to 200 mA, T_J = 25°C			90	
I_d	Quiescent current	T_J = 25°C			6	mA
ΔI_d	Quiescent current change	I_O = 5 to 350 mA			0.5	mA
		I_O = 200 mA, V_I = 11.5 to 25 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA		-0.5		mV/°C
SVR	Supply voltage rejection	V_I = 12.5 to 23 V, f = 120Hz, I_O = 300mA, T_J = 25°C	56			dB
eN	Output noise voltage	B =10Hz to 100kHz, T_J = 25°C		52		µV
V_d	Dropout voltage	T_J = 25°C		2		V
I_{sc}	Short circuit current	VI = 35 V, TJ = 25°C		250		mA
I_{scp}	Short circuit peak current	T_J = 25°C		700		mA

Refer to the test circuits, V_I = 16 V, I_O = 350 mA, C_I = 0.33 µF, C_O = 0.1 µF, T_J = 0 to 125 °C unless otherwise specified.

Table 8. Electrical characteristics of SP78M10

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	T_J = 25°C	9.8	10	10.2	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 12.5 to 25 V	9.8	10	10.4	V
ΔV_O	Line regulation	V_I = 12.5 to 30 V, I_O = 200 mA, T_J = 25°C			100	mV
		V_I = 13 to 30 V, I_O = 200 mA, T_J = 25°C			30	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25°C			200	mV
		I_O = 5 to 200 mA, T_J = 25°C			100	
I_d	Quiescent current	T_J = 25°C			6	mA
ΔI_d	Quiescent current	I_O = 5 to 350 mA			0.5	mA

	change	I_O = 200 mA, V_I = 12.5 to 30 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA		-0.5		mV/°C
SVR	Supply voltage rejection	V_I = 13.5 to 24 V, f = 120Hz, I_O = 300mA, T_J = 25°C	56			dB
eN	Output noise voltage	B =10Hz to 100kHz, T_J = 25°C		64		μV
V_d	Dropout voltage	T_J = 25°C		2		V
I_{sc}	Short circuit current	VI = 35 V, TJ = 25°C		245		mA
I_{scp}	Short circuit peak current	T_J = 25°C		700		mA

Refer to the test circuits, V_I = 19 V, I_O = 350 mA, C_I = 0.33 μF, C_O = 0.1 μF, T_J = 0 to 125 °C unless otherwise specified.

Table 9. Electrical characteristics of SP78M12

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	T_J = 25°C	11.75	12	12.25	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 14.5 to 27 V	11.5	12	12.5	V
ΔV_O	Line regulation	V_I = 14.5 to 30 V, I_O = 200 mA, T_J = 25°C			100	mV
		V_I = 16 to 30 V, I_O = 200 mA, T_J = 25°C			30	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25°C			240	mV
		I_O = 5 to 200 mA, T_J = 25°C			120	
I_d	Quiescent current	T_J = 25°C			6	mA
ΔI_d	Quiescent current change	I_O = 5 to 350 mA			0.5	mA
		I_O = 200 mA, V_I = 14.5 to 30 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA		-1		mV/°C
SVR	Supply voltage rejection	V_I = 15 to 25 V, f = 120Hz, I_O = 300mA, T_J = 25°C	55			dB
eN	Output noise voltage	B =10Hz to 100kHz, T_J = 25°C		75		μV
V_d	Dropout voltage	T_J = 25°C		2		V
I_{sc}	Short circuit current	VI = 35 V, TJ = 25°C		240		mA
I_{scp}	Short circuit peak current	T_J = 25°C		700		mA

Typical performance

Figure 8. Dropout voltage vs. junction temp.

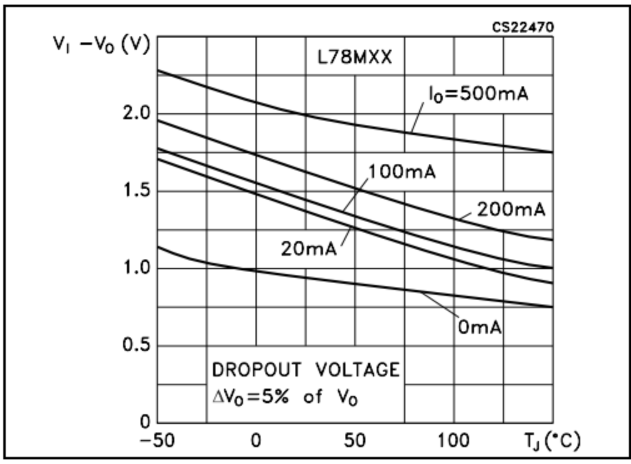


Figure 9. Dropout characteristics

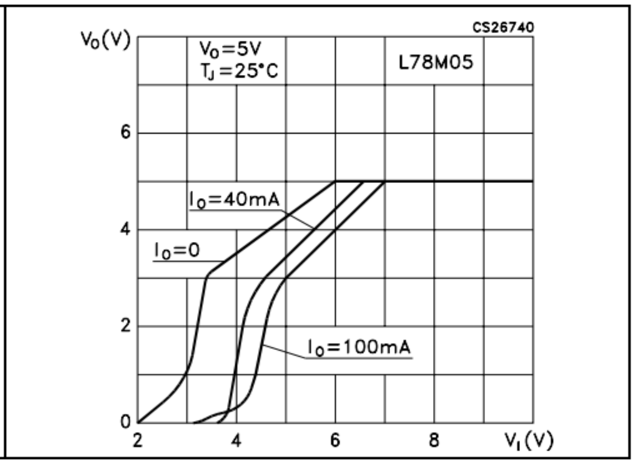


Figure 10. Peak output current vs. input-output differential voltage

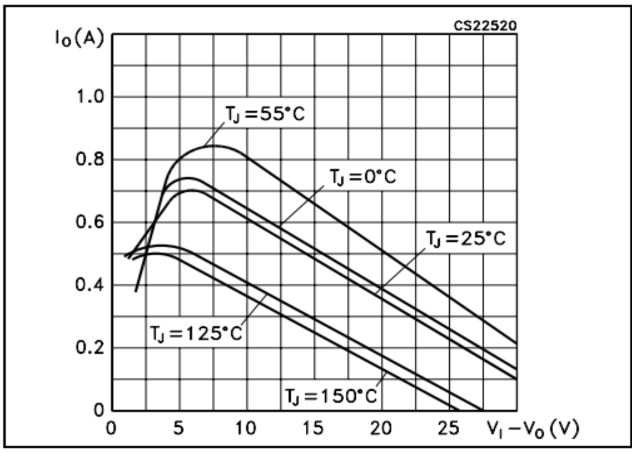


Figure 11. Output voltage vs. junction temperature

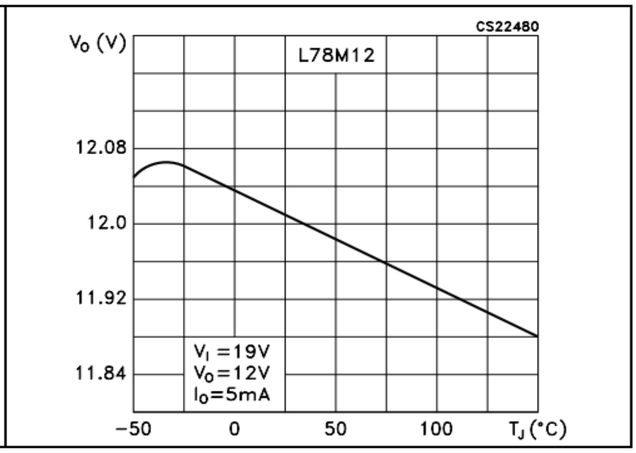


Figure 12. Supply voltage rejection vs. freq.

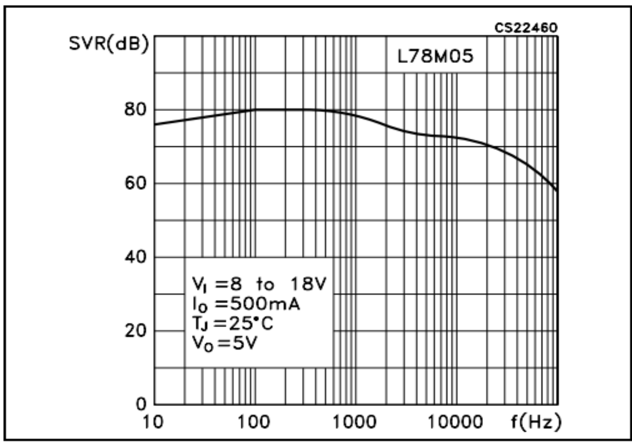


Figure 13. Quiescent current vs. junction temp.

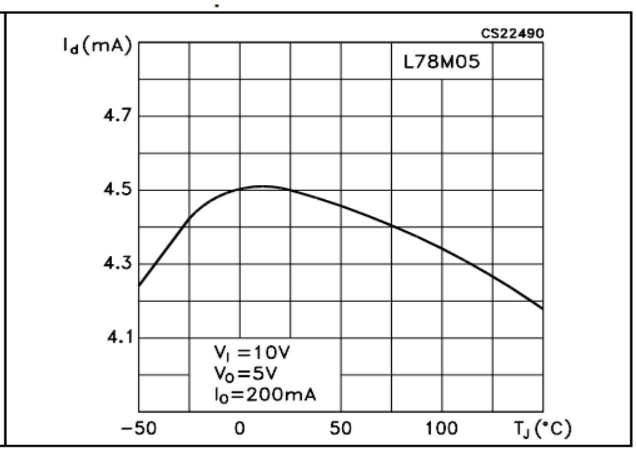


Figure 14. Load transient response

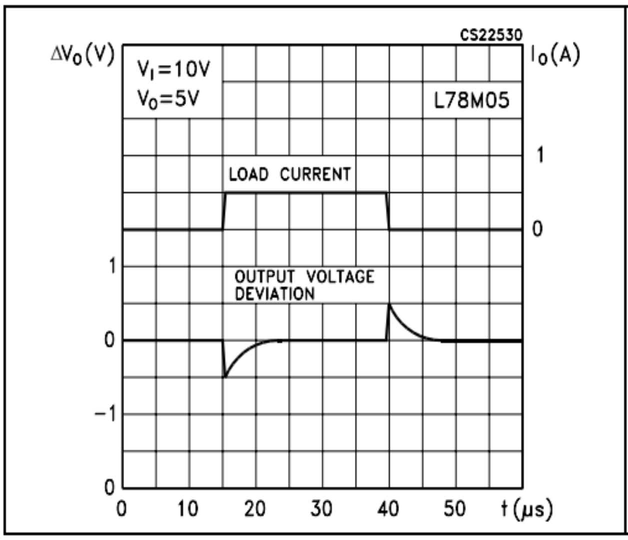


Figure 15. Line transient response

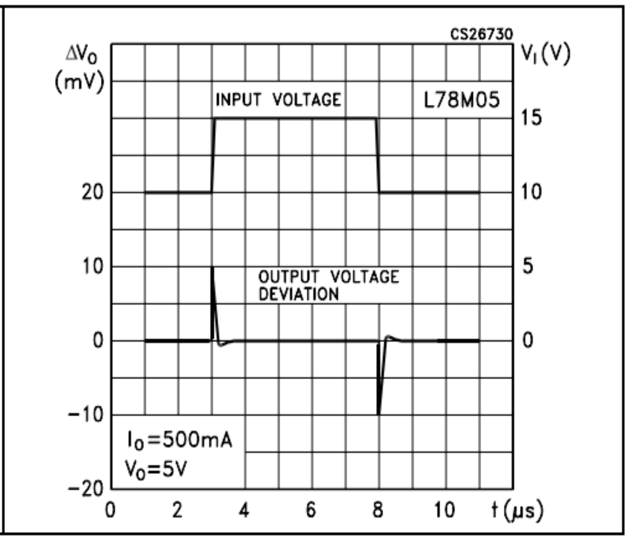
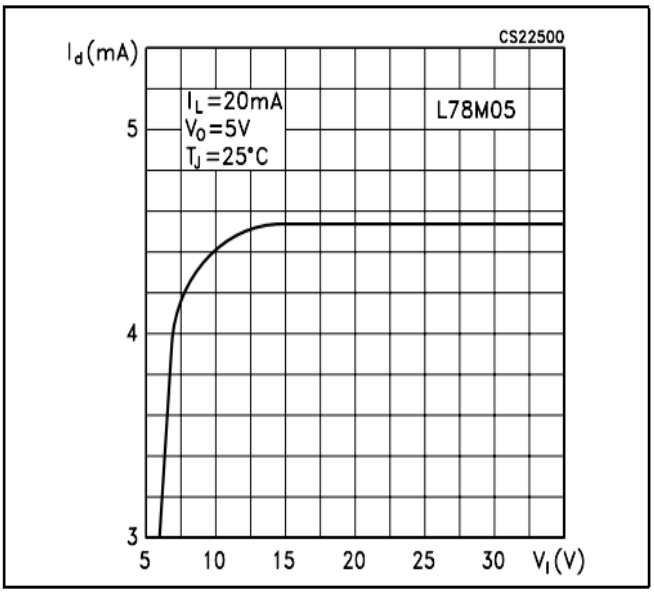


Figure 16. Quiescent current vs. input voltage



7 Applications information

7.1 Design considerations

The SP78MxxA 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 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 0.33 μF 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.

Figure 17. Current regulator

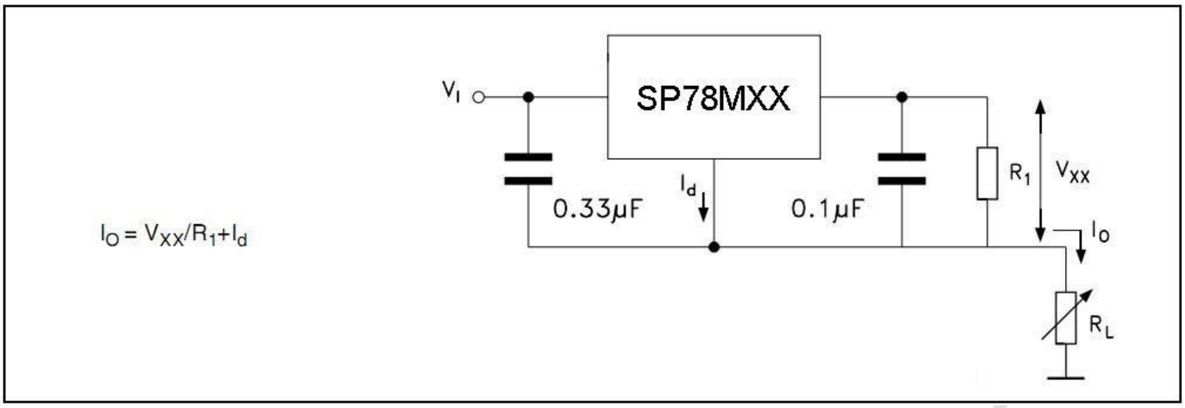


Figure 18. Adjustable output regulator

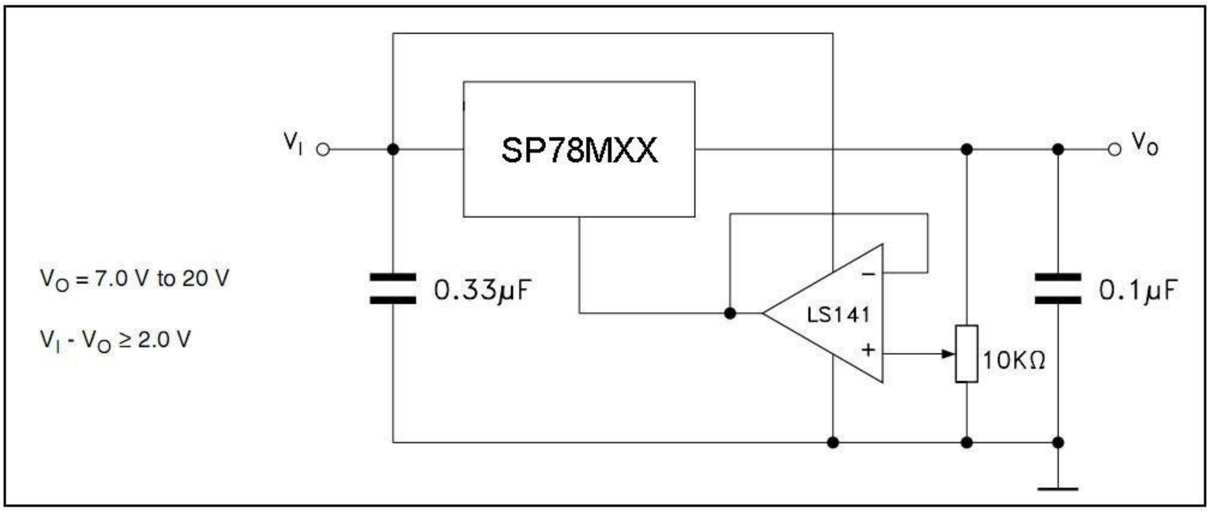


Figure 19. Current boost regulator

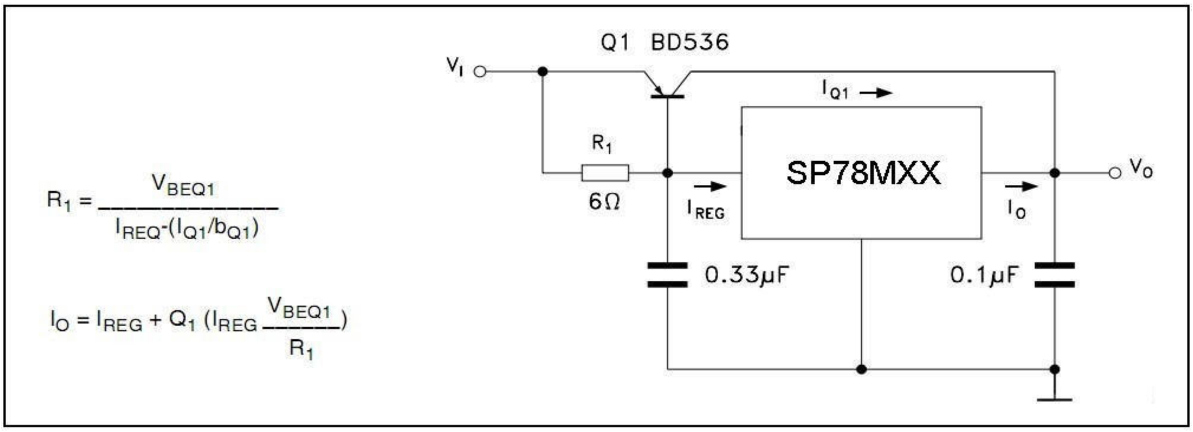
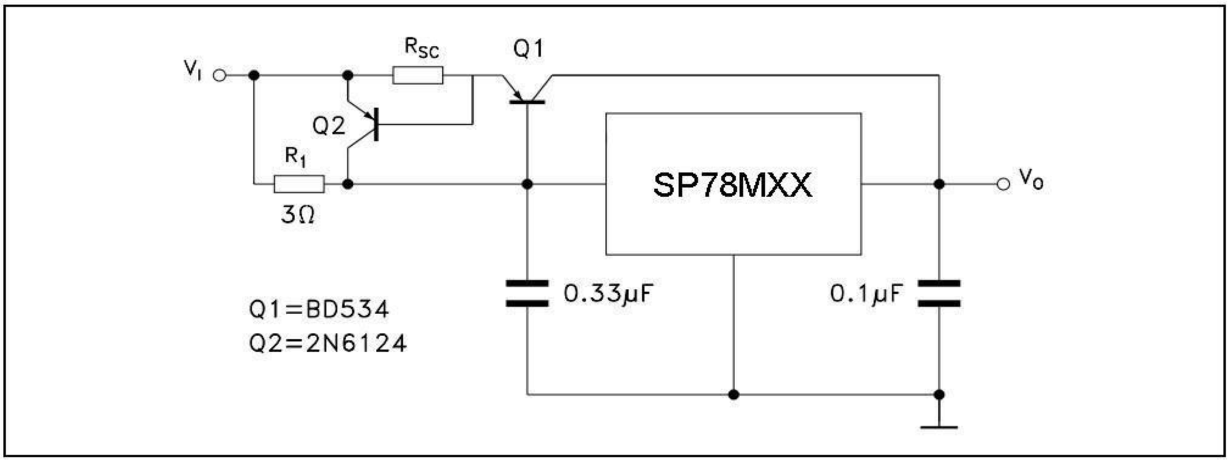


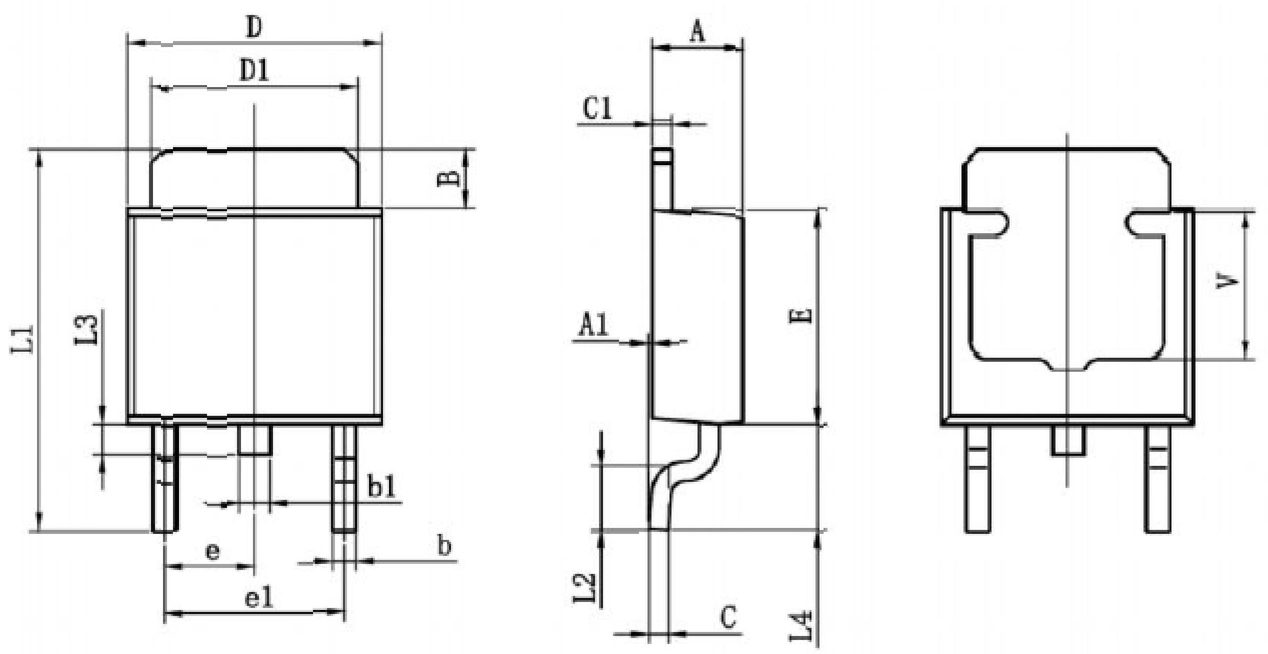
Figure 20. Short-circuit protection



Note: The circuit of Figure 19 can be modified to provide supply protection against short-circuits by adding a short-circuit sense resistor, RSC, 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.

PACKAGE DESCRIPTION

TO-252-2L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	2.200	2.400	0.087	0.094
A1	0.000	0.127	0.000	0.005
B	1.350	1.650	0.053	0.065
b	0.500	0.700	0.020	0.028
b1	0.700	0.900	0.028	0.035
c	0.430	0.580	0.017	0.023
c1	0.430	0.580	0.014	0.023
D	6.350	6.650	0.250	0.262
D1	5.200	5.400	0.205	0.213
E	5.400	5.700	0.213	0.224
e	2.300TYP		0.0901TYP	
e1	4.500	4.700	0.177	0.185
L1	9.500	9.900	0.374	0.390
L2	1.400	1.780	0.055	0.070
L3	0.650	0.950	0.026	0.037
L4	2.550	2.900	0.100	0.114
V	3.80REF		0.150REF	