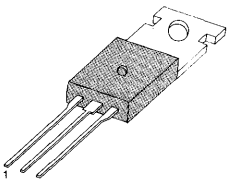
3-TERMINAL 0.5A POSITIVE VOLTAGE REGULATOR

The MC78MXXC/I series of three-terminal positive regulators are available in the TO-220 package 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 shut-down 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 voltages and currents. MC78MXXC is characterized for operation from 0°C to 125°C, and MC78MXXI from −40°C to 125°C.

TO-220



1: Input 2: GND 3: Output

FEATURES

- **Output Current up to 0.5A**
- **Output Voltages of 5; 6; 8; 10; 12; 15; 18; 20; 24V**
- **Thermal Overload Protection**
- **Short Circuit Protection**
- **Output Transistor SOA Protection**
- **Industrial and commercial temperature range**

ORDERING INFORMATION

Device	Package	Operating Temperature
MC78MXXCT	TO-220	0 ~ +125°C
MC78MXXIT	TO-220	−40 ~ +125°C

BLOCK DIAGRAM

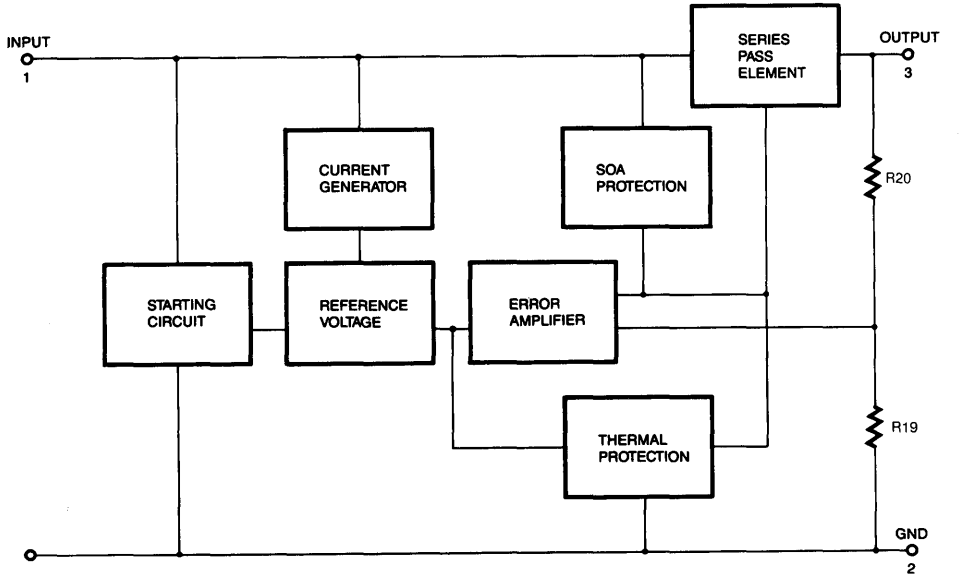


Fig. 1

SCHEMATIC DIAGRAM

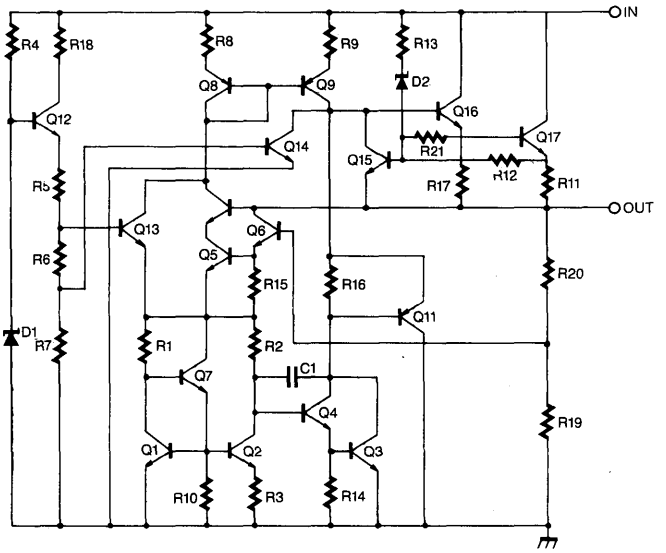


Fig. 2

ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Value	Unit
Input Voltage (for V_O = 5V to 18V) (for V_O = 24V)	V_i V_i	35 40	V V
Thermal Resistance Junction-Cases	θ_{JC}	5	°C/W
Thermal Resistance Junction-Air	θ_{JA}	65	°C/W
Operating Temperature Range MC78XXI MC78XXC/AC	T_{opr}	− 40 ~ + 125 0 ~ + 125	°C °C
Storage Temperature Range	T_{stg}	− 65 ~ + 150	°C

ELECTRICAL CHARACTERISTICS MC78M05

(Refer to the test circuits, $T_{min} \leq T_j \leq 125°C$, $I_o = 350mA$, $V_i = 10V$, unless otherwise specified, $C_i = 0.33\mu F$, $C_o = 0.1\mu F$)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
Output Voltage	V_o	$T_j = 25°C$	4.8	5	5.2	V
		$I_o = 5$ to $350mA$ $V_i = 7$ to $20V$	4.75	5	5.25	
Line Regulation	$\triangle V_o$	$I_o = 200mA$, $T_j = 25°C$, $V_i = 7$ to $25V$			100	mV
		$I_o = 200mA$, $T_j = 25°C$, $V_i = 8$ to $25V$			50	
Load Regulation	$\triangle V_o$	$I_o = 5mA$ to $0.5A$, $T_j = 25°C$			100	mV
		$I_o = 5mA$ to $200mA$, $T_j = 25°C$			50	
Quiescent Current	I_d	$T_j = 25°C$		4.0	6	mA
Quiescent Current Change	$\triangle I_d$	$I_o = 5mA$ to $350mA$			0.5	mA
		$I_o = 200mA$ $V_i = 8$ to $25V$			0.8	
Output Voltage Drift	$\frac{\triangle V_o}{\triangle T}$	$I_o = 5mA$ $T_j = 0$ to $125°C$		-0.5		mV/°C
Output Noise Voltage	V_N	$f = 10Hz$ to $100KHz$		40		μV
Ripple Rejection	RR	$f = 120Hz$ $I_o = 300mA$ $V_i = 8$ to $18V$	62			dB
Dropout Voltage	V_D	$T_j = 25°C$, $I_o = 500mA$		2		V
Short Circuit Current	I_{sc}	$T_j = 25°C$, $V_i = 35V$		300		mA
Peak Current	I_{peak}	$T_j = 25°C$		700		mA

* T_{min}
MC78MXXI: $T_{min} = -40°C$
MC78MXXC: $T_{min} = 0°C$

* Load and line regulation are specified at constant junction temperature. Change in V_o due to heating effects must be taken into account separately. Pulse testing with low duty is used.

ELECTRICAL CHARACTERISTICS MC78M06

(Refer to the test circuits, $T_{min} \leq T_j \leq 125°C$, $I_o = 350mA$, $V_i = 11V$, unless otherwise specified, $C_i = 0.33\mu F$, $C_o = 0.1\mu F$)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
Output Voltage	V_o	$T_j = 25°C$	5.75	6	6.25	V
		$I_o = 5$ to $350mA$, $V_i = 8$ to $21V$	5.7	6	6.3	
Line Regulation	$\triangle V_o$	$I_o = 200mA$, $T_j = 25°C$, $V_i = 8$ to $25V$			100	mV
		$I_o = 200mA$, $T_j = 25°C$, $V_i = 9$ to $25V$			50	
Load Regulation	$\triangle V_o$	$I_o = 5mA$ to $0.5A$, $T_j = 25°C$			120	mV
		$I_o = 5mA$ to $200mA$, $T_j = 25°C$			60	
Quiescent Current	I_d	$T_j = 25°C$		4.0	6	mA
Quiescent Current Change	$\triangle I_d$	$I_o = 5mA$ to $350mA$			0.5	mA
		$I_o = 200mA$, $V_i = 9$ to $25V$			0.8	
Output Voltage Drift	$\frac{\triangle V_o}{\triangle T}$	$I_o = 5mA$, $T_j = 0$ to $125°C$		−0.5		mV/°C
Output Noise Voltage	V_N	$f = 10Hz$ to $100KHz$		45		μV
Ripple Rejection	RR	$f = 120Hz$ $I_o = 300mA$, $V_i = 9$ to $19V$	59			dB
Dropout Voltage	V_D	$T_j = 25°C$, $I_o = 500mA$		2		V
Short Circuit Current	I_{sc}	$T_j = 25°C$, $V_i = 35V$		300		mA
Peak Current	I_{peak}	$T_j = 25°C$		700		mA

* T_{min}
  MC78MXXI: $T_{min} = -40°C$
  MC78MXXC: $T_{min} = 0°C$
* Load and line regulation are specified at constant junction temperature. Change in V_o due to heating effects must be taken into account separately. Pulse testing with low duty is used.

ELECTRICAL CHARACTERISTICS MC78M08

(Refer to the test circuits, $T_{min} \leq T_j \leq 125°C$, $I_o = 350mA$, $V_i = 14V$, unless otherwise specified, $C_i = 0.33\mu F$, $C_o = 0.1\mu F$)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
Output Voltage	V_o	$T_j = 25°C$	7.7	8	8.3	V
		$I_o = 5$ to $350mA$ $V_i = 10.5$ to $23V$	7.6	8	8.4	
Line Regulation	$\triangle V_o$	$I_o = 200mA$, $T_j = 25°C$, $V_i = 10.5$ to $25V$			100	mV
		$I_o = 200mA$, $T_j = 25°C$, $V_i = 11$ to $25V$			50	
Load Regulation	$\triangle V_o$	$I_o = 5mA$ to $0.5A$, $T_j = 25°C$			160	mV
		$I_o = 5mA$ to $200mA$, $T_j = 25°C$			80	
Quiescent Current	I_d	$T_j = 25°C$		4.0	6	mA
Quiescent Current Change	$\triangle I_d$	$I_o = 5mA$ to $350mA$			0.5	mA
		$I_o = 200mA$ $V_i = 10.5$ to $25V$			0.8	
Output Voltage Drift	$\frac{\triangle V_o}{\triangle T}$	$I_o = 5mA$ $T_j = 0$ to $125°C$		-0.5		mV/°C
Output Noise Voltage	V_N	$f = 10Hz$ to $100KHz$		52		μV
Ripple Rejection	RR	$f = 120Hz$ $I_o = 300mA$ $V_i = 11.5$ to $21.5V$	56			dB
Dropout Voltage	V_D	$T_j = 25°C$, $I_o = 500mA$		2		V
Short Circuit Current	I_{sc}	$T_j = 25°C$, $V_i = 35V$		300		mA
Peak Current	I_{peak}	$T_j = 25°C$		700		mA

* T_{min}
  MC78MXXI: $T_{min} = -40°C$
  MC78MXXC: $T_{min} = 0°C$
* Load and line regulation are specified at constant junction temperature. Change in V_o due to heating effects must be taken into account separately. Pulse testing with low duty is used.

ELECTRICAL CHARACTERISTICS MC78M10

(Refer to the test circuits, $T_{min} \leq T_j \leq 125°C$, $I_o = 350mA$, $V_i = 17V$, unless otherwise specified, $C_i = 0.33\mu F$, $C_o = 0.1\mu F$)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
Output Voltage	V_o	$T_j = 25°C$	9.6	10	10.4	V
		$I_o = 5$ to $350mA$ $V_i = 12.5$ to $25V$	9.5	10	10.5	
Line Regulation	$\triangle V_o$	$I_o = 200mA$, $T_j = 25°C$, $V_i = 12.5$ to $25V$			100	mV
		$I_o = 200mA$, $T_j = 25°C$, $V_i = 13$ to $25V$			50	
Load Regulation	$\triangle V_o$	$I_o = 5mA$ to $0.5A$, $T_j = 25°C$			200	mV
		$I_o = 5mA$ to $200mA$, $T_j = 25°C$			100	
Quiescent Current	I_d	$T_j = 25°C$		4.1	6	mA
Quiescent Current Change	$\triangle I_d$	$I_o = 5mA$ to $350mA$			0.5	mA
		$I_o = 200mA$ $V_i = 12.5$ to $25V$			0.8	
Output Voltage Drift	$\frac{\triangle V_o}{\triangle T}$	$I_o = 5mA$ $T_j = 0$ to $125°C$		−0.5		mV/°C
Output Noise Voltage	V_N	$f = 10Hz$ to $100KHz$		65		μV
Ripple Rejection	RR	$f = 120Hz$, $I_o = 300mA$ $V_i = 13$ to $23V$	55			dB
Dropout Voltage	V_D	$T_j = 25°C$, $I_o = 500mA$		2		V
Short Circuit Current	I_{sc}	$T_j = 25°C$, $V_i = 35V$		300		mA
Peak Current	I_{peak}	$T_j = 25°C$		700		mA

* T_{min}
  MC78MXXI: $T_{min} = -40°C$
  MC78MXXC: $T_{min} = 0°C$
* Load and line regulation are specified at constant junction temperature. Change in V_o due to heating effects must be taken into account separately. Pulse testing with low duty is used.

ELECTRICAL CHARACTERISTICS MC78M12

(Refer to the test circuits, $T_{min} \leq T_j \leq 125°C$, $I_o = 350mA$, $V_i = 19V$, unless otherwise specified, $C_i = 0.33\mu F$, $C_o = 0.1\mu F$)

Characteristic	Symbol	Test Conditions		Min	Typ	Max	Unit
Output Voltage	V_o	$T_j = 25°C$		11.5	12	12.5	V
		$I_o = 5$ to $350mA$ $V_i = 14.5$ to $27V$		11.4	12	12.6	
Line Regulation	$\triangle V_o$	$I_o = 200mA$ $T_j = 25°C$	$V_i = 14.5$ to $30V$			100	mV
			$V_i = 16$ to $30V$			50	
Load Regulation	$\triangle V_o$	$I_o = 5mA$ to $0.5A$, $T_j = 25°C$				240	mV
		$I_o = 5mA$ to $200mA$, $T_j = 25°C$				120	
Quiescent Current	I_d	$T_j = 25°C$			4.1	6	mA
Quiescent Current Change	$\triangle I_d$	$I_o = 5mA$ to $350mA$				0.5	mA
		$I_o = 200mA$ $V_i = 14.5$ to $30V$				0.8	
Output Voltage Drift	$\frac{\triangle V_o}{\triangle T}$	$I_o = 5mA$ $T_j = 0$ to $125°C$			−0.5		mV/°C
Output Noise Voltage	V_N	$f = 10Hz$ to $100KHz$			75		μV
Ripple Rejection	RR	$f = 120Hz$, $I_o = 300mA$ $V_i = 15$ to $25V$		55			dB
Dropout Voltage	V_D	$T_j = 25°C$, $I_o = 500mA$			2		V
Short Circuit Current	I_{sc}	$T_j = 25°C$, $V_i = 35V$			300		mA
Peak Current	I_{peak}	$T_j = 25°C$			700		mA

* T_{min}
MC78MXXI: $T_{min} = -40°C$
MC78MXXC: $T_{min} = 0°C$

* Load and line regulation are specified at constant junction temperature. Change in V_o due to heating effects must be taken into account separately. Pulse testing with low duty is used.

ELECTRICAL CHARACTERISTICS MC78M15

(Refer to the test circuits, $T_{min} \leq T_j \leq 125°C$, $I_o = 350mA$, $V_i = 23V$, unless otherwise specified, $C_i = 0.33\mu F$, $C_o = 0.1\mu F$)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
Output Voltage	V_o	$T_j = 25°C$	14.4	15	15.6	V
		$I_o = 5$ to $350mA$ $V_i = 17.5$ to $30V$	14.25	15	15.75	
Line Regulation	$\triangle V_o$	$I_o = 200mA$, $T_j = 25°C$, $V_i = 17.5$ to $30V$			100	mV
		$I_o = 200mA$, $T_j = 25°C$, $V_i = 20$ to $30V$			50	
Load Regulation	$\triangle V_o$	$I_o = 5mA$ to $0.5A$, $T_j = 25°C$			300	mV
		$I_o = 5mA$ to $200mA$, $T_j = 25°C$			150	
Quiescent Current	I_d	$T_j = 25°C$		4.1	6	mA
Quiescent Current Change	$\triangle I_d$	$I_o = 5mA$ to $350mA$			0.5	mA
		$I_o = 200mA$ $V_i = 17.5$ to $30V$			0.8	
Output Voltage Drift	$\frac{\triangle V_o}{\triangle T}$	$I_o = 5mA$ $T_j = 0$ to $125°C$		-1		mV/°C
Output Noise Voltage	V_N	$f = 10Hz$ to $100KHz$		90		μV
Ripple Rejection	RR	$f = 120Hz$ $I_o = 300mA$ $V_i = 18.5$ to $28.5V$	54			dB
Dropout Voltage	V_D	$T_j = 25°C$, $I_o = 500mA$		2		V
Short Circuit Current	I_{sc}	$T_j = 25°C$, $V_i = 35V$		300		mA
Peak Current	I_{peak}	$T_j = 25°C$		700		mA

* T_{min}
  MC78MXXI: $T_{min} = -40°C$
  MC78MXXC: $T_{min} = 0°C$

* Load and line regulation are specified at constant junction temperature. Change in V_o due to heating effects must be taken into account separately. Pulse testing with low duty is used.

ELECTRICAL CHARACTERISTICS MC78M18

(Refer to the test circuits, $T_{min} \leq T_j \leq 125°C$, $I_o = 350mA$, $V_i = 26V$, unless otherwise specified, $C_i = 0.33\mu F$, $C_o = 0.1\mu F$)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
Output Voltage	V_o	$T_j = 25°C$	17.3	18	18.7	V
		$I_o = 5$ to $350mA$ $V_i = 20.5$ to $33V$	17.1	18	18.9	
Line Regulation	$\triangle V_o$	$I_o = 200mA$, $T_j = 25°C$, $V_i = 21$ to $33V$			100	mV
		$I_o = 200mA$, $T_j = 25°C$, $V_i = 24$ to $33V$			50	
Load Regulation	$\triangle V_o$	$I_o = 5mA$ to $0.5A$, $T_j = 25°C$			360	mV
		$I_o = 5mA$ to $200mA$, $T_j = 25°C$			180	
Quiescent Current	I_d	$T_j = 25°C$		4.2	6	mA
Quiescent Current Change	$\triangle I_d$	$I_o = 5mA$ to $350mA$			0.5	mA
		$I_o = 200mA$ $V_i = 21$ to $33V$			0.8	
Output Voltage Drift	$\frac{\triangle V_o}{\triangle T}$	$I_o = 5mA$ $T_j = 0$ to $125°C$		−1.1		mV/°C
Output Noise Voltage	V_N	$f = 10Hz$ to $100KHz$		100		μV
Ripple Rejection	RR	$f = 120Hz$ $I_o = 300mA$ $V_i = 22$ to $32V$	53			dB
Dropout Voltage	V_D	$T_j = 25°C$, $I_o = 500mA$		2		V
Short Circuit Current	I_{sc}	$T_j = 25°C$, $V_i = 35V$		300		mA
Peak Current	I_{peak}	$T_j = 25°C$		700		mA

* T_{min}
  MC78MXXI: $T_{min} = -40°C$
  MC78MXXC: $T_{min} = 0°C$
* Load and line regulation are specified at constant junction temperature. Change in V_o due to heating effects must be taken into account separately. Pulse testing with low duty is used.

ELECTRICAL CHARACTERISTICS MC78M20

(Refer to the test circuits, $T_{min} \leq T_j \leq 125°C$, $I_o = 350mA$, $V_i = 29V$, unless otherwise specified, $C_i = 0.33\mu F$, $C_o = 0.1\mu F$)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
Output Voltage	V_o	$T_j = 25°C$	19.2	20	20.8	V
		$I_o = 5$ to $350mA$, $V_i = 23$ to $35V$	19	20	21	
Line Regulation	$\triangle V_o$	$I_o = 200mA$, $T_j = 25°C$, $V_i = 23$ to $35V$			100	mV
		$I_o = 200mA$, $T_j = 25°C$, $V_i = 24$ to $35V$			50	
Load Regulation	$\triangle V_o$	$I_o = 5mA$ to $0.5A$, $T_j = 25°C$			400	mV
		$I_o = 5mA$ to $200mA$, $T_j = 25°C$			200	
Quiescent Current	I_d	$T_j = 25°C$		4.2	6	mA
Quiescent Current Change	$\triangle I_d$	$I_o = 5mA$ to $350mA$			0.5	mA
		$I_o = 200mA$, $V_i = 23$ to $35V$			0.8	
Output Voltage Drift	$\frac{\triangle V_o}{\triangle T}$	$I_o = 5mA$, $T_j = 0$ to $125°C$		-1.1		mV/°C
Output Noise Voltage	V_N	$f = 10Hz$ to $100KHz$		110		μV
Ripple Rejection	RR	$f = 120Hz$ $I_o = 300mA$, $V_i = 24$ to $34V$	53			dB
Dropout Voltage	V_D	$T_j = 25°C$, $I_o = 500mA$		2		V
Short Circuit Current	I_{sc}	$T_j = 25°C$, $V_i = 35V$		300		mA
Peak Current	I_{peak}	$T_j = 25°C$		700		mA

* T_{min}
  MC78MXXI: $T_{min} = -40°C$
  MC78MXXC: $T_{min} = 0°C$
* Load and line regulation are specified at constant junction temperature. Change in V_o due to heating effects must be taken into account separately. Pulse testing with low duty is used.

ELECTRICAL CHARACTERISTICS MC78M24

(Refer to the test circuits, $T_{min} \leq T_j \leq 125°C$, $I_o = 350mA$, $V_i = 33V$, unless otherwise specified, $C_i = 0.33\mu F$, $C_o = 0.1\mu F$)

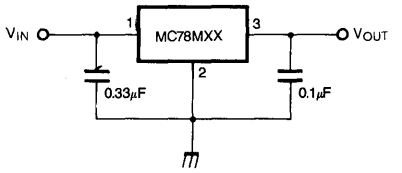
Characteristic	Symbol	Test Conditions	Min	Typ	Max	
Output Voltage	V_o	$T_j = 25°C$	23	24	25	V
		$I_o = 5$ to $350mA$, $V_i = 27$ to $38V$	22.8	24	25.2	
Line Regulation	$\triangle V_o$	$I_o = 200mA$, $T_j = 25°C$, $V_i = 27$ to $38V$			100	mV
		$I_o = 200mA$, $T_j = 25°C$, $V_i = 28$ to $38V$			50	
Load Regulation	$\triangle V_o$	$I_o = 5mA$ to $0.5A$, $T_j = 25°C$			480	mV
		$I_o = 5mA$ to $200mA$, $T_j = 25°C$			240	
Quiescent Current	I_d	$T_j = 25°C$		4.2	6	mA
Quiescent Current Change	$\triangle I_d$	$I_o = 5mA$ to $350mA$			0.5	mA
		$I_o = 200mA$, $V_i = 27$ to $38V$			0.8	
Output Voltage Drift	$\frac{\triangle V_o}{\triangle T}$	$I_o = 5mA$, $T_j = 0$ to $125°C$		-1.2		mV/°C
Output Noise Voltage	V_N	$f = 10Hz$ to $100KHz$		170		μV
Ripple Rejection	RR	$f = 120Hz$ $I_o = 300mA$, $V_i = 28$ to $38V$	50			dB
Dropout Voltage	V_D	$T_j = 25°C$, $I_o = 500mA$		2		V
Short Circuit Current	I_{sc}	$V_i = 35V$		300		mA
Peak Current	I_{peak}	$T_j = 25°C$		700		mA

* T_{min}
MC78MXXI: $T_{min} = -40°C$
MC78MXXC: $T_{min} = 0°C$

* Load and line regulation are specified at constant junction temperature. Change in V_o due to heating effects must be taken into account separately. Pulse testing with low duty is used.

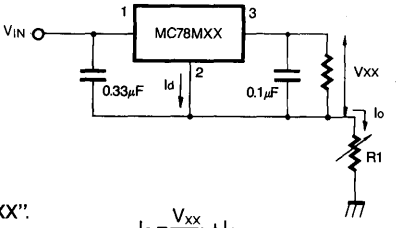
APPLICATION CIRCUIT

Fig. 1 Fixed output regulator



Notes:
(1) To specify an output voltage, substitute voltage value for "XX".
(2) Although no output capacitor is needed for stability, it does improve transient response.
(3) Required if regulator is located an appreciable distance from power supply filter.

Fig. 2 Constant current regulator



$$I_O = \frac{V_{XX}}{R_1} + I_d$$

Fig. 3 Circuit for increasing output voltage

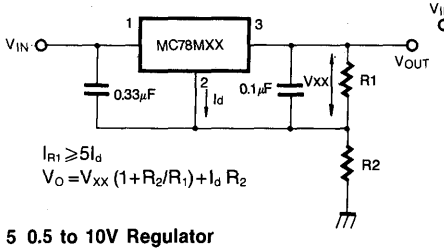


Fig. 4 Adjustable output regulator (7 to 30V)

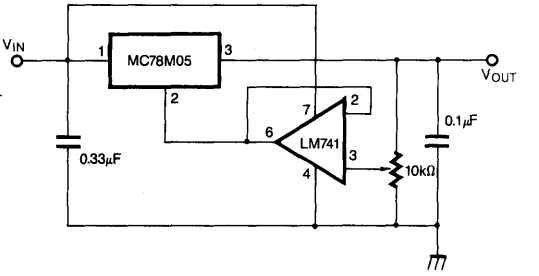
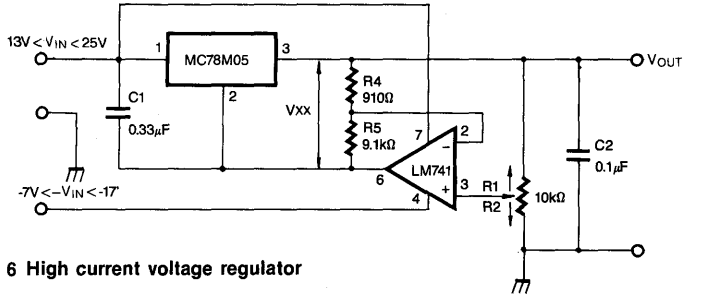
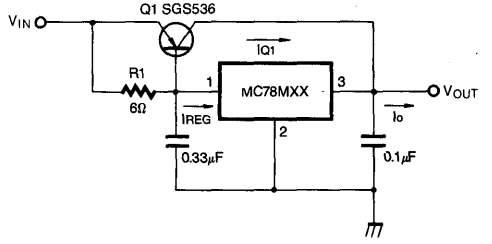


Fig. 5 0.5 to 10V Regulator



$$V_O = V_{XX}\frac{R_4}{R_1}$$

Fig. 6 High current voltage regulator



$$R_1 = \frac{V_{BEQ1}}{I_{REQ} - \frac{I_{Q1}}{\beta_{Q1}}}$$

$$I_O = I_{REG} + \beta_{Q1}\left(I_{REG} - \frac{V_{BEQ1}}{R_{R1}}\right)$$

APPLICATION CIRCUIT (continued)

Fig. 7 High output current with short circuit protection

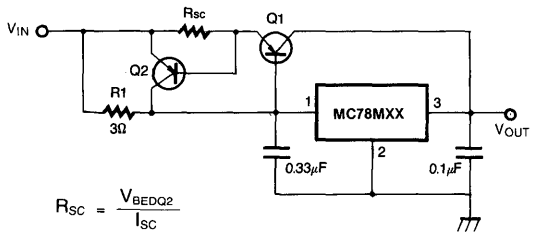


Fig. 8 Tracking voltage regulator

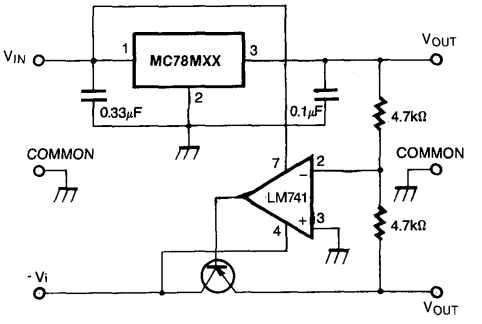


Fig. 9 High input voltage circuit

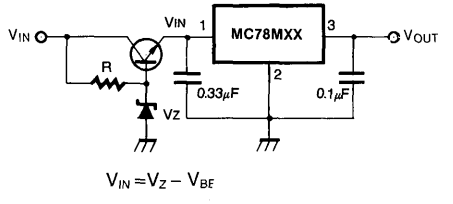


Fig. 10 Reducing power dissipation with dropping resistor

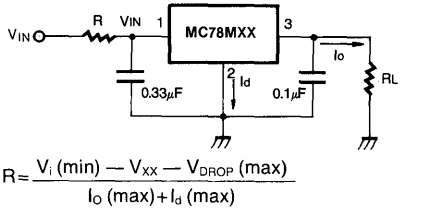
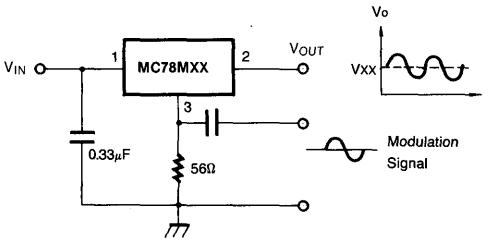
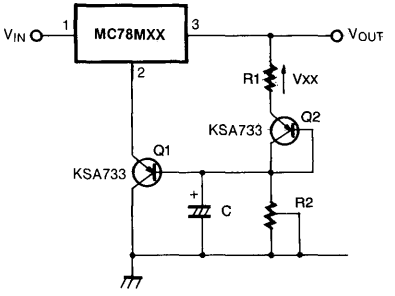


Fig. 11
(unity voltage gain, $I_O \leq 0.5$)



Note: *The circuit performs well up to 100 KHz.*

Fig. 12 Adjustable output voltage with temperature compensation



Note: Q2 is connected as a diode in order to compensate the variation of the Q1 V_{BE} with the temperature. C allows a slow rise-time of the V_O

$$V_O = V_{XX}\left(1 + \frac{R_2}{R_1}\right) + V_{BE}$$