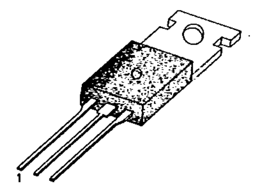
3-TERMINAL 0.5A POSITIVE VOLTAGE REGULATOR

The MC78MXXC series of three-terminal positive regulators is available TO-220 package with several fixed output voltages, making it useful in a wide range of applications. These reglators 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 0.5A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

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**

ORDERING INFORMATION

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

** Under Development

BLOCK DIAGRAM

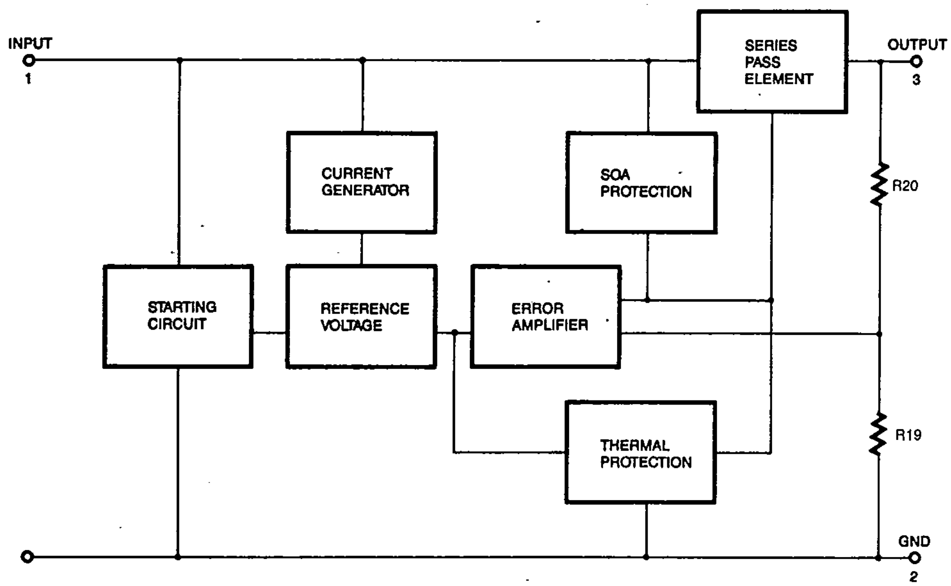


Fig. 1

MC78MXXC SERIES — LINEAR INTEGRATED CIRCUIT

SCHEMATIC DIAGRAM

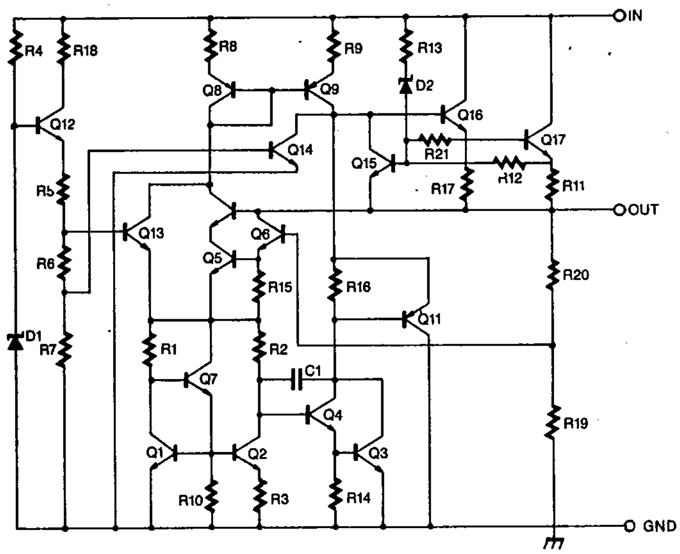


Fig. 2

ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Value	Unit
DC Input Voltage (for $V_o = 5V$ to 18V)	V_i	35	V
(for $V_o = 20, 24V$)	V_i	40	V
Thermal Resistance Junction-Cases	Θ_{JC}	5	°C/W
Junction-Air	Θ_{JA}	70	°C/W
Operating Junction Temperature MC78MXXI	T_{opr}	$-40 \sim +150$	°C
MC78MXXC		$0 \sim +150$	°C
Storage Temperature	T_{stg}	$-65 \sim +150$	°C

ELECTRICAL CHARACTERISTICS MC78M05C

(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	ΔV_o	$I_o = 200mA$, $V_i = 7$ to 25V			100	mV
		$I_o = 200mA$, $V_i = 8$ to 25V			50	
Load Regulation	ΔV_o	$I_o = 5mA$ to 0.5A			100	mV
		$I_o = 5mA$ to 200mA			50	
Quiescent Current	I_d				6	mA
Quiescent Current Change	ΔI_d	$I_o = 5mA$ to 350mA			0.5	mA
		$I_o = 200mA$ $V_i = 8$ to 25V			0.8	
Output Voltage Drift	$\frac{\Delta V_o}{\Delta T}$	$I_o = 5mA$ $T_j = 0$ 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: $T_{min} = 0°C$

ELECTRICAL CHARACTERISTICS MC78M06C

(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	ΔV_o	$I_o = 200mA$	$V_i = 8$ to 25V			100	mV
			$V_i = 9$ to 25V			50	
Load Regulation	ΔV_o	$I_o = 5mA$ to 0.5A				120	mV
		$I_o = 5mA$ to 200mA				60	
Quiescent Current	I_d					6	mA
Quiescent Current Change	ΔI_d	$I_o = 5mA$ to 350mA				0.5	mA
		$I_o = 200mA$ $V_i = 9$ to 25V				0.8	
Output Voltage Drift	$\frac{\Delta V_o}{\Delta T}$	$I_o = 5mA$ $T_j = 0$ 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}	$T_j = 25°C$, $V_i = 35V$			270		mA
Peak Current	I_{peak}	$T_j = 25°C$			700		mA

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

ELECTRICAL CHARACTERISTICS MC78M08C

(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	ΔV_o	$I_o = 200mA$	$V_i = 10.5$ to 25V			100	mV
			$V_i = 11$ to 25V			50	
Load Regulation	ΔV_o	$I_o = 5mA$ to 0.5A				160	mV
		$I_o = 5mA$ to 200mA				80	
Quiescent Current	I_d					6	mA
Quiescent Current Change	ΔI_d	$I_o = 5mA$ to 350mA				0.5	mA
		$I_o = 200mA$ $V_i = 10.5$ to 25V				0.8	
Output Voltage Drift	$\frac{\Delta V_o}{\Delta T}$	$I_o = 5mA$ $T_j = 0$ 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}	$T_j = 25°C$, $V_i = 35V$			250		mA
Peak Current	I_{peak}	$T_j = 25°C$			700		mA

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

ELECTRICAL CHARACTERISTICS MC78M10C

(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 Condition		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	ΔV_o	$I_o = 200mA$	$V_i = 12.5$ to 25V			100	mV
			$V_i = 13$ to 25V			50	
Load Regulation	ΔV_o	$I_o = 5mA$ to 0.5A				200	mV
		$I_o = 5mA$ to 200mA				100	
Quiescent Current	I_d	$T_j = 25°C$				6	mA
Quiescent Current Change	ΔI_d	$I_o = 5mA$ to 350mA				0.5	mA
		$I_o = 200mA$ $V_i = 12.5$ to 25V				0.8	
Output Voltage Drift	$\frac{\Delta V_o}{\Delta T}$	$I_o = 5mA$ $T_j = 0$ 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}	$T_j = 25°C$, $V_i = 35V$			250		mA
Peak Current	I_{peak}	$T_j = 25°C$			700		mA

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

ELECTRICAL CHARACTERISTICS MC78M12C

(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 Condition	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	ΔV_o	$I_o = 200mA$, $V_i = 14.5$ to 30V			100	mV
		$I_o = 200mA$, $V_i = 16$ to 30V			50	
Load Regulation	ΔV_o	$I_o = 5mA$ to 0.5A			240	mV
		$I_o = 5mA$ to 200mA			120	
Quiescent Current	I_d	$T_j = 25°C$			6	mA
Quiescent Current Change	ΔI_d	$I_o = 5mA$ to 350mA			0.5	mA
		$I_o = 200mA$ $V_i = 14.5$ to 30V			0.8	
Output Voltage Drift	$\frac{\Delta V_o}{\Delta T}$	$I_o = 5mA$ $T_j = 0$ 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}	$T_j = 25°C$, $V_i = 35V$		240		mA
Peak Current	I_{peak}	$T_j = 25°C$		700		mA

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

ELECTRICAL CHARACTERISTICS MC78M15C

(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	ΔV_o	$I_o = 200mA$	$V_i = 17.5$ to 30V			100	mV
			$V_i = 20$ to 30V			50	
Load Regulation	ΔV_o	$I_o = 5mA$ to 0.5A				300	mV
		$I_o = 5mA$ to 200mA				150	
Quiescent Current	I_d					6	mA
Quiescent Current Change	ΔI_d	$I_o = 5mA$ to 350mA				0.5	mA
		$I_o = 200mA$, $V_i = 17.5$ to 30V				0.8	
Output Voltage Drift	$\frac{\Delta V_o}{\Delta T}$	$I_o = 5mA$, $T_j = 0$ 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}	$T_j = 25°C$, $V_i = 35V$			240		mA
Peak Current	I_{peak}	$T_j = 25°C$			700		mA

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

ELECTRICAL CHARACTERISTICS MC78M18C

(Refer to the test circuits, $T_{min} \le T_J \le 125°C$, $I_o = 350mA$, $V_i = 26V$, 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	ΔV_o	$I_o = 200mA$, $V_i = 21$ to 33V			100	mV
		$I_o = 200mA$, $V_i = 24$ to 33V			50	
Load Regulation	ΔV_o	$I_o = 5mA$ to 0.5A			360	mV
		$I_o = 5mA$ to 200mA			180	
Quiescent Current	I_d				6	mA
Quiescent Current Change	ΔI_d	$I_o = 5mA$ to 350mA			0.5	mA
		$I_o = 200mA$ $V_i = 21$ to 33V			0.8	
Output Voltage Drift	$\frac{\Delta V_o}{\Delta T}$	$I_o = 5mA$ $T_j = 0$ 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}	$T_j = 25°C$, $V_i = 35V$		240		mA
Peak Current	I_{peak}	$T_j = 25°C$		700		mA

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

ELECTRICAL CHARACTERISTICS MC78M20C

(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	ΔV_o	$I_o = 200mA$	$V_i = 23$ to 35V			100	mV
			$V_i = 24$ to 35V			50	
Load Regulation	ΔV_o	$I_o = 5mA$ to 0.5A				400	mV
		$I_o = 5mA$ to 200mA				200	
Quiescent Current	I_d					6	mA
Quiescent Current Change	ΔI_d	$I_o = 5mA$ to 350mA				0.5	mA
		$I_o = 200mA$ $V_i = 23$ to 35V				0.8	
Output Voltage Drift	$\frac{\Delta V_o}{\Delta T}$	$I_o = 5mA$ $T_j = 0$ 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}	$T_j = 25°C$, $V_i = 35V$			240		mA
Peak Current	I_{peak}	$T_j = 25°C$			700		mA

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

ELECTRICAL CHARACTERISTICS MC78M24C

(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	ΔV_o	$I_o = 200mA$	$V_i = 27$ to 38V			100	mV
			$V_i = 28$ to 38V			50	
Load Regulation	ΔV_o	$I_o = 5mA$ to 0.5A				480	mV
		$I_o = 5mA$ to 200mA				240	
Quiescent Current	I_d					6	mA
Quiescent Current Change	ΔI_d	$I_o = 5mA$ to 350mA				0.5	mA
		$I_o = 200mA$, $V_i = 27$ to 38V				0.8	
Output Voltage Drift	$\frac{\Delta V_o}{\Delta T}$	$I_o = 5mA$, $T_j = 0$ 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}	$V_i = 35V$			240		mA
Peak Current	I_{peak}	$T_j = 25°C$			700		mA

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

APPLICATION CIRCUIT

Fixed output regulator

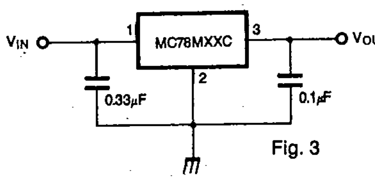


Fig. 3

Constant current regulator

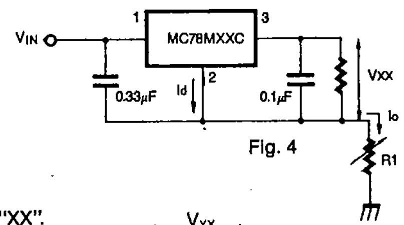


Fig. 4

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

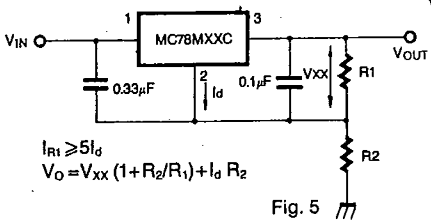
Notes:

(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.

Circuit for increasing output voltage



$I_{R1} \geq 5I_d$

$V_O = V_{XX}(1 + R_2/R_1) + I_d R_2$

Fig. 5

Adjustable output regulator (7 to 30V)

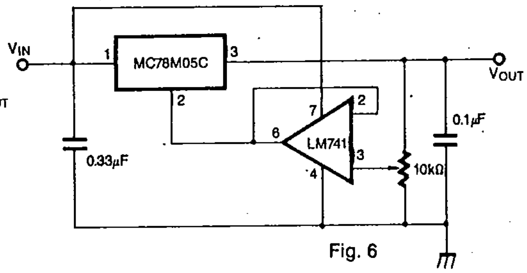


Fig. 6

0.5 to 10V regulator

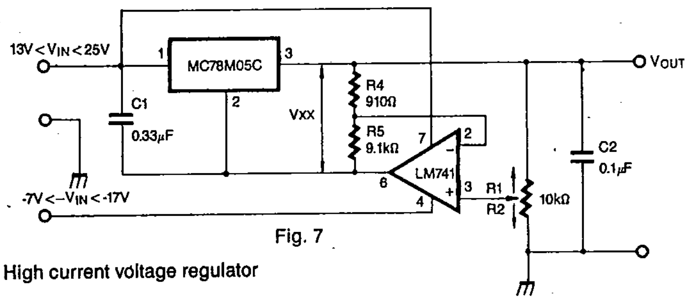


Fig. 7

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

High current voltage regulator

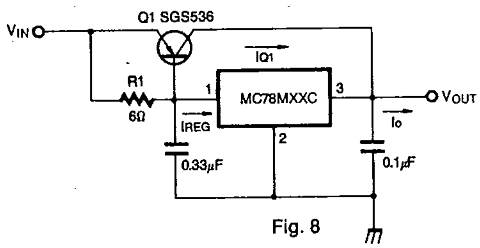


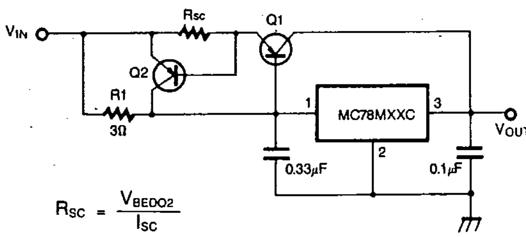
Fig. 8

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

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

APPLICATION CIRCUIT (continued)

High output current with short circuit protection



$$R_{SC} = \frac{V_{BEDO2}}{I_{SC}}$$

Fig. 9

Tracking voltage regulator

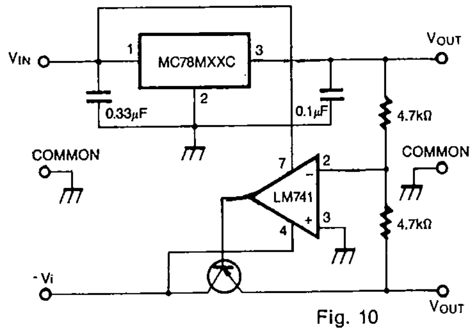
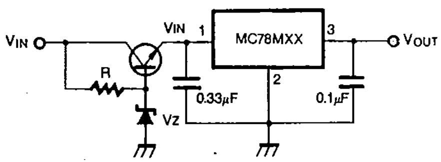


Fig. 10

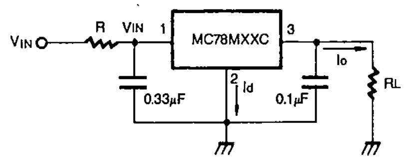
High input voltage circuit



$V_{IN} = V_Z - V_{BE}$

Fig. 11

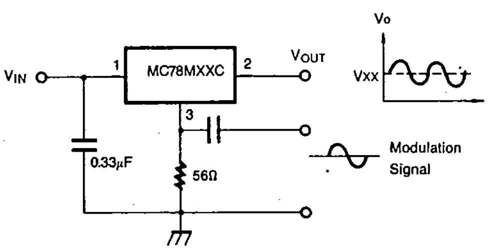
Reducing power dissipation with dropping resistor



$$R = \frac{V_i\,(min) - V_{XX} - V_{DROP}\,(max)}{I_O\,(max) + I_d\,(max)}$$

Fig. 12

Power AM modultor (unity voltage gain, $I_o \leq 0.5$)



Note: The circuit performs well up to 100 KHz.

Fig. 13

Adjustable output voltage with temperature compensation

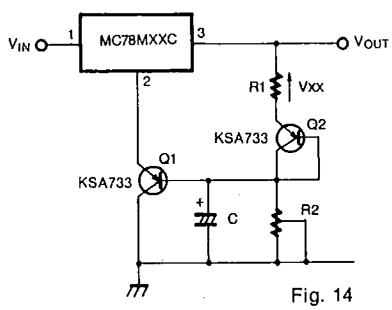


Fig. 14

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

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