

MC78XX/LM78XX

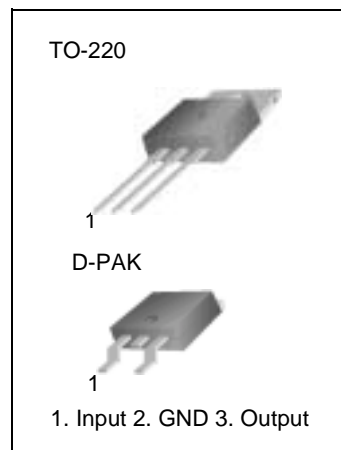
3-terminal 1A positive voltage regulator

Features

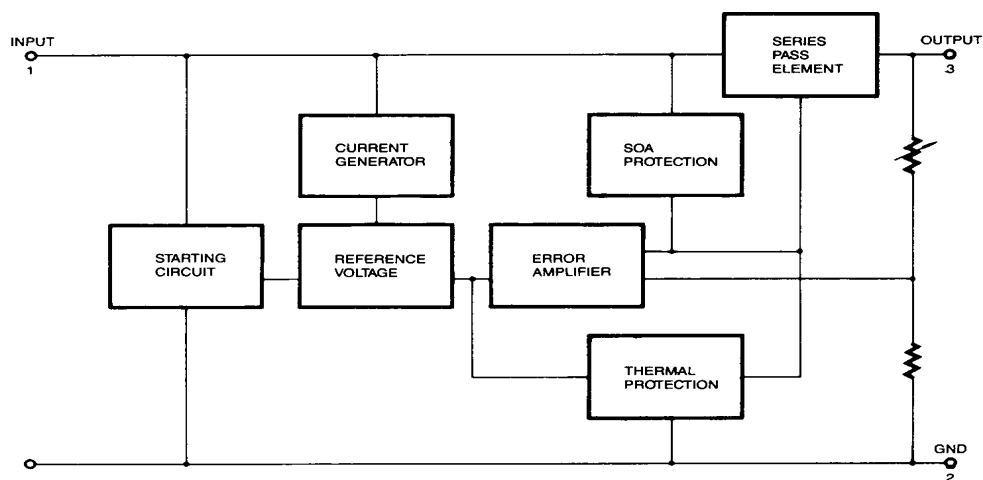
- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 10, 11, 12, 15, 18, 24V
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating area Protection

Description

The MC78XX/LM78XX series of three-terminal positive regulators are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut-down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.



Internal Block Diagram



Absolute Maximum Ratings

Parameter	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	$R_{\theta JC}$	5	$^{\circ}C/W$
Thermal Resistance Junction-Air	$R_{\theta JA}$	65	$^{\circ}C/W$
Operating Temperature Range (MC78XXCT/LM78XXCT/MC78XXCDT)	T_{OPR}	0 ~ +125	$^{\circ}C$
Storage Temperature Range	T_{STG}	-65 ~ +150	$^{\circ}C$

Electrical Characteristics (MC7805/LM7805)

(Refer to test circuit, $0^{\circ}C < T_J < 125^{\circ}C$, $I_O = 500mA$, $V_I = 10V$, $C_I = 0.33\mu F$, $C_O = 0.1\mu F$, unless otherwise specified)

Parameter	Symbol	Conditions	MC7805/LM7805			Unit	
			Min.	Typ.	Max.		
Output Voltage	V_O	$T_J = +25^{\circ}C$	4.8	5.0	5.2	V	
		$5.0mA \leq I_O \leq 1.0A$, $P_O \leq 15W$ $V_I = 7V$ to $20V$ $V_I = 8V$ to $20V$	4.75	5.0	5.25		
Line Regulation	ΔV_O	$T_J = +25^{\circ}C$	$V_O = 7V$ to $25V$	-	4.0	100	mV
			$V_I = 8V$ to $12V$	-	1.6	50	
Load Regulation	ΔV_O	$T_J = +25^{\circ}C$	$I_O = 5.0mA$ to $1.5A$	-	9	100	mV
			$I_O = 250mA$ to $750mA$	-	4	50	
Quiescent Current	I_Q	$T_J = +25^{\circ}C$	-	5.0	8	mA	
Quiescent Current Change	ΔI_Q	$I_O = 5mA$ to $1.0A$	-	0.03	0.5	mA	
		$V_I = 7V$ to $25V$	-	0.3	1.3		
Output Voltage Drift	$\Delta V_O / \Delta T$	$I_O = 5mA$	-	-0.8	-	mV/ $^{\circ}C$	
Output Noise Voltage	V_N	$f = 10Hz$ to $100KHz$, $T_A = +25^{\circ}C$	-	42	-	μV	
Ripple Rejection	RR	$f = 120Hz$ $V_O = 8V$ to $18V$	62	73	-	dB	
Dropout Voltage	V_O	$I_O = 1A$, $T_J = +25^{\circ}C$	-	2	-	V	
Output Resistance	R_O	$f = 1KHz$	-	15	-	$m\Omega$	
Short Circuit Current	I_{SC}	$V_I = 35V$, $T_A = +25^{\circ}C$	-	230	-	mA	
Peak Current	I_{PK}	$T_J = +25^{\circ}C$	-	2.2	-	A	

- 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 is used.

Electrical Characteristics (MC7806)

(Refer to test circuit ,0°C < T_J < +125°C, I_O = 500mA, V_I = 11V, C_I= 0.33μF, C_O= 0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions	MC7806			Unit	
			Min.	Typ.	Max.		
Output Voltage	V _O	T _J = +25 °C	5.75	6.0	6.25	V	
		5.0mA ≤ I _O ≤ 1.0A, P _D ≤ 15W V _I = 8.0V to 21V V _I = 9.0V to 21V	5.7	6.0	6.3		
Line Regulation	ΔV _O	T _J = +25 °C	V _I = 8V to 25V	-	5	120	mV
			V _I = 9V to 13V	-	1.5	60	
Load Regulation	ΔV _O	T _J = +25 °C	I _O = 5mA to 1.5A	-	9	120	mV
			I _O = 250mA to 750A	-	3	60	
Quiescent Current	I _Q	T _J = +25 °C	-	5.0	8	mA	
Quiescent Current Change	ΔI _Q	I _O = 5mA to 1A	-	-	0.5	mA	
		V _I = 8V to 25V	-	-	1.3		
Output Voltage Drift	ΔV _O /ΔT	I _O = 5mA	-	-0.8	-	mV/°C	
Output Noise Voltage	V _N	f = 10Hz to 100KHz, T _A = +25 °C	-	45	-	μV	
Ripple Rejection	RR	f = 120Hz V _I = 9V to 19V	59	75	-	dB	
Dropout Voltage	V _O	I _O = 1A, T _J = +25 °C	-	2	-	V	
Output Resistance	R _O	f = 1KHz	-	19	-	mΩ	
Short Circuit Current	I _{SC}	V _I = 35V, T _A = +25 °C	-	250	-	mA	
Peak Current	I _{PK}	T _J = +25 °C	-	2.2	-	A	

- 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 is used.

Electrical Characteristics (MC7808)

(Refer to test circuit, $0^{\circ}\text{C} < T_J < +125^{\circ}\text{C}$, $I_O = 500\text{mA}$, $V_I = 14\text{V}$, $C_I = 0.33\mu\text{F}$, $C_O = 0.1\mu\text{F}$, unless otherwise specified)

Parameter	Symbol	Conditions	MC7808			Unit	
			Min.	Typ.	Max.		
Output Voltage	V_O	$T_J = +25^{\circ}\text{C}$	7.7	8.0	8.3	V	
		$5.0\text{mA} \leq I_O \leq 1.0\text{A}$, $P_O \leq 15\text{W}$ $V_I = 10.5\text{V to } 23\text{V}$ $V_I = 11.5\text{V to } 23\text{V}$	7.6	8.0	8.4		
Line Regulation	ΔV_O	$T_J = +25^{\circ}\text{C}$	$V_I = 10.5\text{V to } 25\text{V}$	-	5.0	160	mV
			$V_I = 11.5\text{V to } 17\text{V}$	-	2.0	80	
Load Regulation	ΔV_O	$T_J = +25^{\circ}\text{C}$	$I_O = 5.0\text{mA to } 1.5\text{A}$	-	10	160	mV
			$I_O = 250\text{mA to } 750\text{mA}$	-	5.0	80	
Quiescent Current	I_Q	$T_J = +25^{\circ}\text{C}$	-	5.0	8	mA	
Quiescent Current Change	ΔI_Q		$I_O = 5\text{mA to } 1.0\text{A}$	-	0.05	0.5	mA
			$V_I = 10.5\text{A to } 25\text{V}$	-	0.5	1.0	
			$V_I = 11.5\text{V to } 25\text{V}$	-		-	
Output Voltage Drift	$\Delta V_O/\Delta T$	$I_O = 5\text{mA}$	-	-0.8	-	mV/ $^{\circ}\text{C}$	
Output Noise Voltage	V_N	$f = 10\text{Hz to } 100\text{KHz}$, $T_A = +25^{\circ}\text{C}$	-	52	-	μV	
Ripple Rejection	RR	$f = 120\text{Hz}$, $V_I = 11.5\text{V to } 21.5$	56	73	-	dB	
Dropout Voltage	V_O	$I_O = 1\text{A}$, $T_J = +25^{\circ}\text{C}$	-	2	-	V	
Output Resistance	R_O	$f = 1\text{KHz}$	-	17	-	$\text{m}\Omega$	
Short Circuit Current	I_{SC}	$V_I = 35\text{V}$, $T_A = +25^{\circ}\text{C}$	-	230	-	mA	
Peak Current	I_{PK}	$T_J = +25^{\circ}\text{C}$	-	2.2	-	A	

- 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 is used.

Electrical Characteristics (MC7809)

(Refer to test circuit , $0^{\circ}\text{C} < T_J < +125^{\circ}\text{C}$, $I_O = 500\text{mA}$, $V_I = 15\text{V}$, $C_I = 0.33\mu\text{F}$, $C_O = 0.1\mu\text{F}$, unless otherwise specified)

Parameter	Symbol	Conditions	MC7809			Unit	
			Min.	Typ.	Max.		
Output Voltage	V_O	$T_J = +25^{\circ}\text{C}$	8.65	9	9.35	V	
		$5.0\text{mA} \leq I_O \leq 1.0\text{A}$, $P_D \leq 15\text{W}$ $V_I = 11.5\text{V to } 24\text{V}$ $V_I = 12.5\text{V to } 24\text{V}$	8.6	9	9.4		
Line Regulation	ΔV_O	$T_J = +25^{\circ}\text{C}$	$V_I = 11.5\text{V to } 25\text{V}$	-	6	180	mV
			$V_I = 12\text{V to } 25\text{V}$	-	2	90	
Load Regulation	ΔV_O	$T_J = +25^{\circ}\text{C}$	$I_O = 5\text{mA to } 1.5\text{A}$	-	12	180	mV
			$I_O = 250\text{mA to } 750\text{mA}$	-	4	90	
Quiescent Current	I_Q	$T_J = +25^{\circ}\text{C}$	-	5.0	8	mA	
Quiescent Current Change	ΔI_Q		$I_O = 5\text{mA to } 1.0\text{A}$	-	-	0.5	mA
			$V_I = 11.5\text{V to } 26\text{V}$	-	-	1.3	
			$V_I = 12.5\text{V to } 26\text{V}$	-	-	-	
Output Voltage Drift	$\Delta V_O / \Delta T$	$I_O = 5\text{mA}$	-	-1	-	mV/ $^{\circ}\text{C}$	
Output Noise Voltage	V_N	$f = 10\text{Hz to } 100\text{KHz}$, $T_A = +25^{\circ}\text{C}$	-	58	-	μV	
Ripple Rejection	RR	$f = 120\text{Hz}$ $V_I = 13\text{V to } 23\text{V}$	56	71	-	dB	
Dropout Voltage	V_O	$I_O = 1\text{A}$, $T_J = +25^{\circ}\text{C}$	-	2	-	V	
Output Resistance	R_O	$f = 1\text{KHz}$	-	17	-	$\text{m}\Omega$	
Short Circuit Current	ISC	$V_I = 35\text{V}$, $T_A = +25^{\circ}\text{C}$	-	250	-	mA	
Peak Current	IPK	$T_J = +25^{\circ}\text{C}$	-	2.2	-	A	

- 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 is used.

Electrical Characteristics (MC7812)

(Refer to test circuit ,0°C < T_J < +125°C, I_O = 500mA, V_I = 19V, C_I= 0.33μF, C_O= 0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions	MC7812			Unit	
			Min.	Typ.	Max.		
Output Voltage	V _O	T _J = +25 °C	11.5	12	12.5	V	
		5.0mA ≤ I _O ≤ 1.0A, P _D ≤ 15W V _I = 14.5V to 27V V _I = 15.5V to 27V	11.4	12	12.6		
Line Regulation	ΔV _O	T _J = +25 °C	V _I = 14.5V to 30V	-	10	240	mV
			V _I = 16V to 22V	-	3.0	120	
Load Regulation	ΔV _O	T _J = +25 °C	I _O = 5mA to 1.5A	-	11	240	mV
			I _O = 250mA to 750mA	-	5.0	120	
Quiescent Current	I _Q	T _J = +25 °C	-	5.1	8	mA	
Quiescent Current Change	ΔI _Q	I _O = 5mA to 1.0A	-	0.1	0.5	mA	
		V _I = 14.5V to 30V	-	0.5	1.0		
		V _I = 15V to 30V	-	-	-		
Output Voltage Drift	ΔV _O /ΔT	I _O = 5mA	-	-1	-	mV/°C	
Output Noise Voltage	V _N	f = 10Hz to 100KHz, T _A = +25 °C	-	76	-	μV	
Ripple Rejection	RR	f = 120Hz V _I = 15V to 25V	55	71	-	dB	
Dropout Voltage	V _O	I _O = 1A, T _J = +25 °C	-	2	-	V	
Output Resistance	R _O	f = 1KHz	-	18	-	mΩ	
Short Circuit Current	I _{SC}	V _I = 35V, T _A = +25 °C	-	230	-	mA	
Peak Current	I _{PK}	T _J = +25 °C	-	2.2	-	A	

- 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 is used.

Electrical Characteristics (MC7815)

(Refer to test circuit ,0°C < T_J < +125°C, I_O = 500mA, V_I = 23V, C_I= 0.33μF, C_O= 0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions	MC7815			Unit	
			Min.	Typ.	Max.		
Output Voltage	V _O	T _J = +25 °C	14.4	15	15.6	V	
		5.0mA ≤ I _O ≤ 1.0A, P _D ≤ 15W V _I = 17.5V to 30V V _I = 18.5V to 30V	14.25	15	15.75		
Line Regulation	ΔV _O	T _J = +25 °C	V _I = 17.5V to 30V	-	11	300	mV
			V _I = 20V to 26V	-	3	150	
Load Regulation	ΔV _O	T _J = +25 °C	I _O = 5mA to 1.5A	-	12	300	mV
			I _O = 250mA to 750mA	-	4	150	
Quiescent Current	I _Q	T _J = +25 °C	-	5.2	8	mA	
Quiescent Current Change	ΔI _Q	I _O = 5mA to 1.0A	-	-	0.5	mA	
		V _I = 17.5V to 30V	-	-	1.0		
		V _I = 18.5V to 30V	-	-	-		
Output Voltage Drift	ΔV _O /ΔT	I _O = 5mA	-	-1	-	mV/ °C	
Output Noise Voltage	V _N	f = 10Hz to 100KHz, T _A = +25 °C	-	90	-	μV	
Ripple Rejection	RR	f = 120Hz V _I = 18.5V to 28.5V	54	70	-	dB	
Dropout Voltage	V _O	I _O = 1A, T _J = +25 °C	-	2	-	V	
Output Resistance	R _O	f = 1KHz	-	19	-	mΩ	
Short Circuit Current	I _{SC}	V _I = 35V, T _A = +25 °C	-	250	-	mA	
Peak Current	I _{PK}	T _J = +25 °C	-	2.2	-	A	

- 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 is used.

Electrical Characteristics (MC7818)

(Refer to test circuit ,0°C < T_J < +125°C, I_O = 500mA, V_I = 27V, C_I= 0.33μF, C_O= 0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions	MC7818			Unit	
			Min.	Typ.	Max.		
Output Voltage	V _O	T _J = +25 °C	17.3	18	18.7	V	
		5.0mA ≤ I _O ≤ 1.0A, P _D ≤ 15W V _I = 21V to 33V V _I = 22V to 33V	17.1	18	18.9		
Line Regulation	ΔV _O	T _J = +25 °C	V _I = 21V to 33V	-	15	360	mV
			V _I = 24V to 30V	-	5	180	
Load Regulation	ΔV _O	T _J = +25 °C	I _O = 5mA to 1.5A	-	15	360	mV
			I _O = 250mA to 750mA	-	5.0	180	
Quiescent Current	I _Q	T _J = +25 °C	-	5.2	8	mA	
Quiescent Current Change	ΔI _Q	I _O = 5mA to 1.0A	-	-	0.5	mA	
		V _I = 21V to 33V	-	-	1		
		V _I = 22V to 33V	-	-			
Output Voltage Drift	ΔV _O /ΔT	I _O = 5mA	-	-1	-	mV/°C	
Output Noise Voltage	V _N	f = 10Hz to 100KHz, T _A = +25 °C	-	110	-	μV	
Ripple Rejection	RR	f = 120Hz V _I = 22V to 32V	53	69	-	dB	
Dropout Voltage	V _O	I _O = 1A, T _J = +25 °C	-	2	-	V	
Output Resistance	R _O	f = 1KHz	-	22	-	mΩ	
Short Circuit Current	I _{SC}	V _I = 35V, T _A = +25 °C	-	250	-	mA	
Peak Current	I _{PK}	T _J = +25 °C	-	2.2	-	A	

- 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 is used.

Electrical Characteristics (MC7824)

(Refer to test circuit, $0^{\circ}\text{C} < T_J < +125^{\circ}\text{C}$, $I_O = 500\text{mA}$, $V_I = 33\text{V}$, $C_I = 0.33\mu\text{F}$, $C_O = 0.1\mu\text{F}$, unless otherwise specified)

Parameter	Symbol	Conditions	MC7824			Unit	
			Min.	Typ.	Max.		
Output Voltage	V_O	$T_J = +25^{\circ}\text{C}$	23	24	25	V	
		$5.0\text{mA} \leq I_O \leq 1.0\text{A}$, $P_D \leq 15\text{W}$ $V_I = 27\text{V to } 38\text{V}$ $V_I = 28\text{V to } 38\text{V}$	22.8	24	25.25		
Line Regulation	ΔV_O	$T_J = +25^{\circ}\text{C}$	$V_I = 27\text{V to } 38\text{V}$	-	17	480	mV
			$V_I = 30\text{V to } 36\text{V}$	-	6	240	
Load Regulation	ΔV_O	$T_J = +25^{\circ}\text{C}$	$I_O = 5\text{mA to } 1.5\text{A}$	-	15	480	mV
			$I_O = 250\text{mA to } 750\text{mA}$	-	5.0	240	
Quiescent Current	I_Q	$T_J = +25^{\circ}\text{C}$	-	5.2	8	mA	
Quiescent Current Change	ΔI_Q	$I_O = 5\text{mA to } 1.0\text{A}$	-	0.1	0.5	mA	
		$V_I = 27\text{V to } 38\text{V}$	-	0.5	1		
		$V_I = 28\text{V to } 38\text{V}$	-	-	-		
Output Voltage Drift	$\Delta V_O/\Delta T$	$I_O = 5\text{mA}$	-	-1.5	-	mV/ $^{\circ}\text{C}$	
Output Noise Voltage	V_N	$f = 10\text{Hz to } 100\text{KHz}$, $T_A = +25^{\circ}\text{C}$	-	60	-	μV	
Ripple Rejection	RR	$f = 120\text{Hz}$ $V_I = 28\text{V to } 38\text{V}$	50	67	-	dB	
Dropout Voltage	V_O	$I_O = 1\text{A}$, $T_J = +25^{\circ}\text{C}$	-	2	-	V	
Output Resistance	R_O	$f = 1\text{KHz}$	-	28	-	$\text{m}\Omega$	
Short Circuit Current	ISC	$V_I = 35\text{V}$, $T_A = +25^{\circ}\text{C}$	-	230	-	mA	
Peak Current	IPK	$T_J = +25^{\circ}\text{C}$	-	2.2	-	A	

- 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 is used.

Typical Performance Characteristics

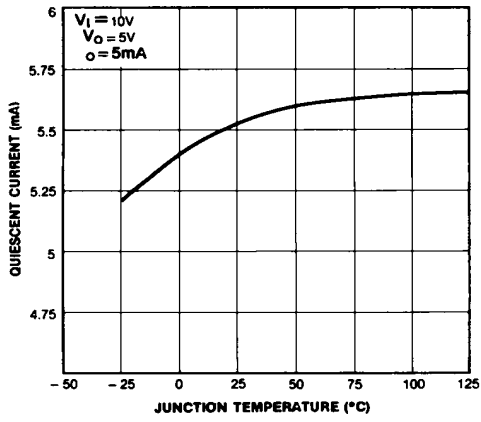


Figure 1. Quiescent Current

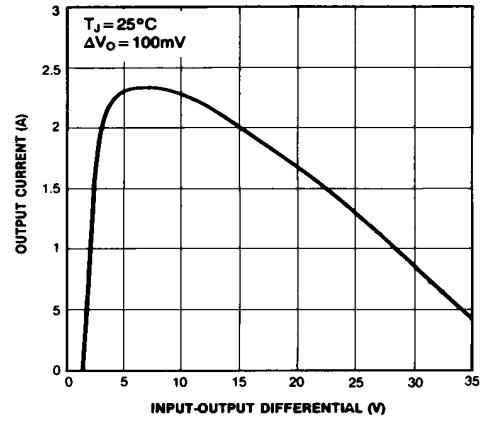


Figure 2. Peak Output Current

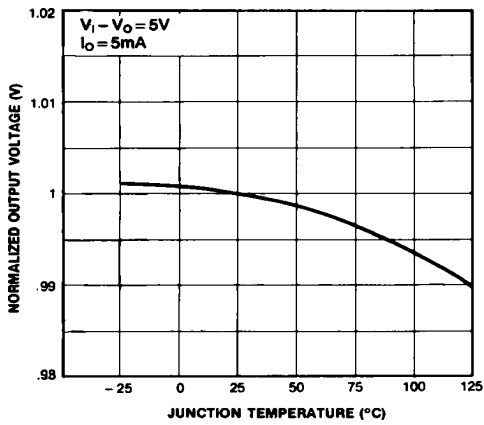


Figure 3. Output Voltage

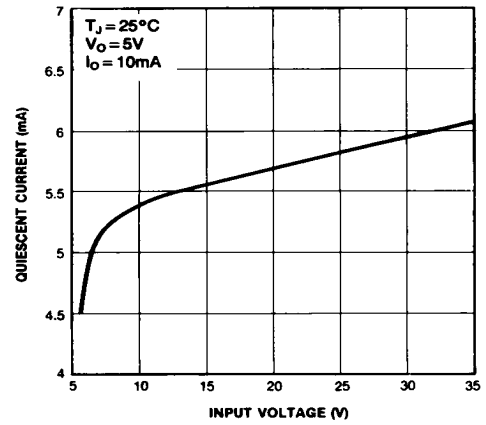


Figure 4. Quiescent Current

Typical Applications

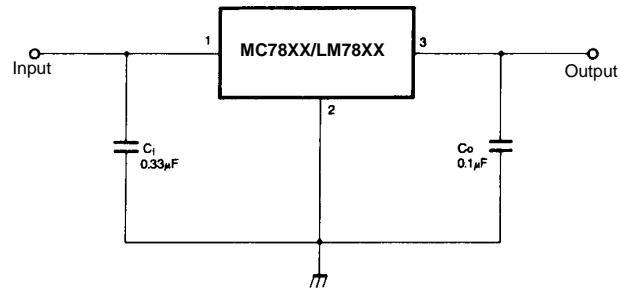


Figure 5. DC Parameters

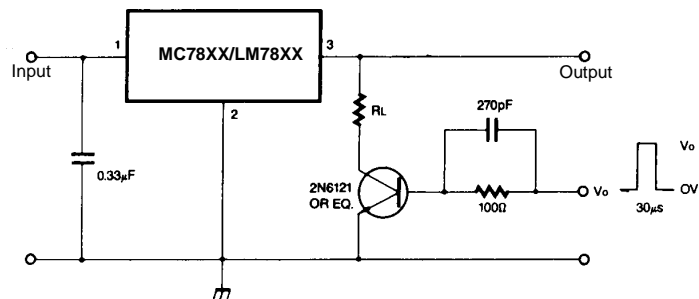


Figure 6. Load Regulation

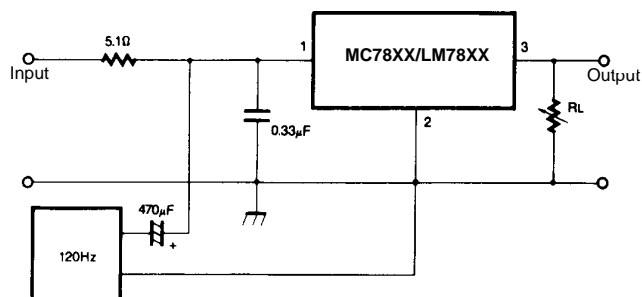


Figure 7. Ripple Rejection

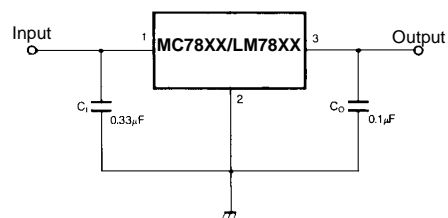


Figure 8. Fixed Output Regulator

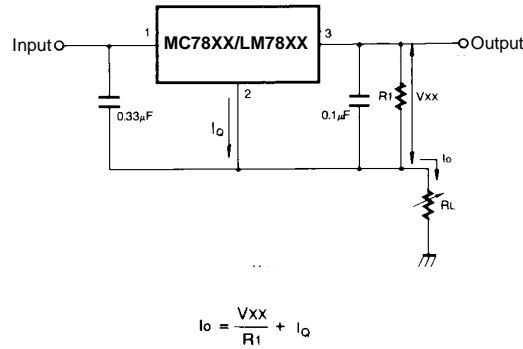


Figure 9. Constant Current Regulator

Notes:

- (1) To specify an output voltage, substitute voltage value for "XX." A common ground is required between the input and the Output voltage. The input voltage must remain typically 2.0V above the output voltage even during the low point on the input ripple voltage.
- (2) C_I is required if regulator is located an appreciable distance from power Supply filter.
- (3) C_O improves stability and transient response.

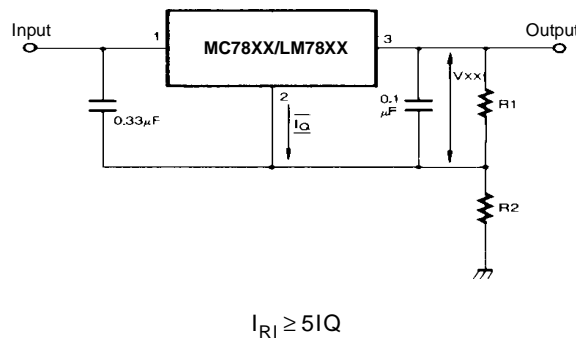


Figure 10. Circuit for Increasing Output Voltage

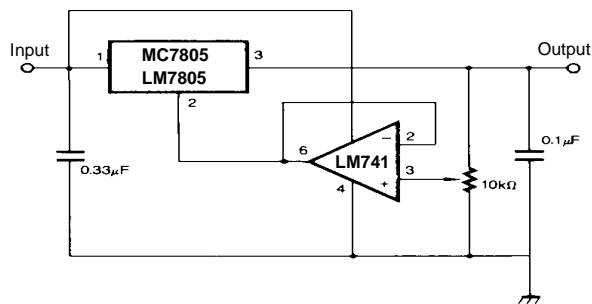


Figure 11. Adjustable Output Regulator (7 to 30V)

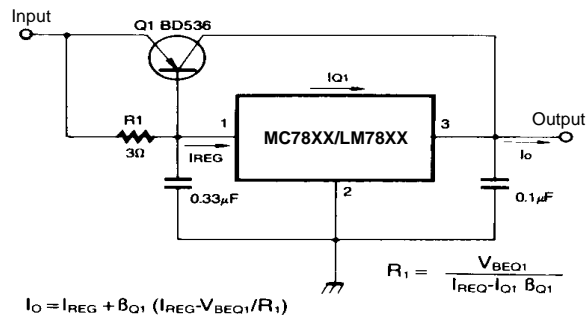


Figure 12. High Current Voltage Regulator

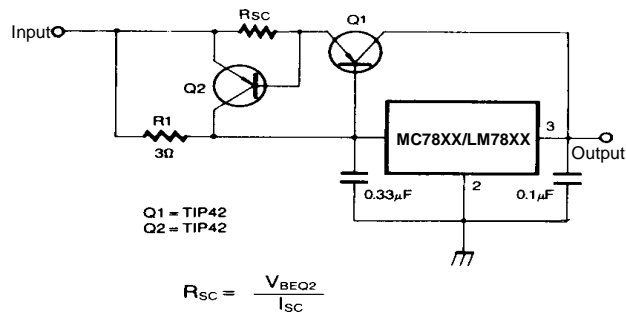


Figure 13. High Output Current with Short Circuit Protection

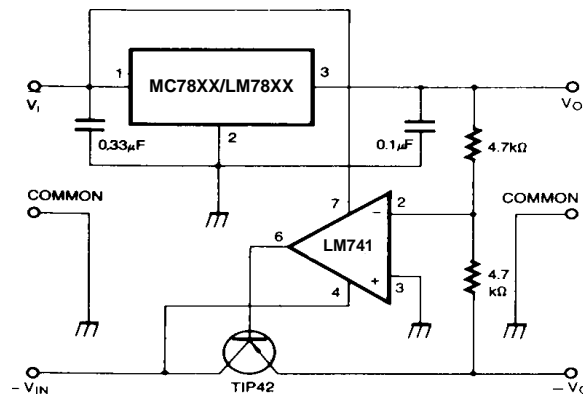


Figure 14. Tracking Voltage Regulator

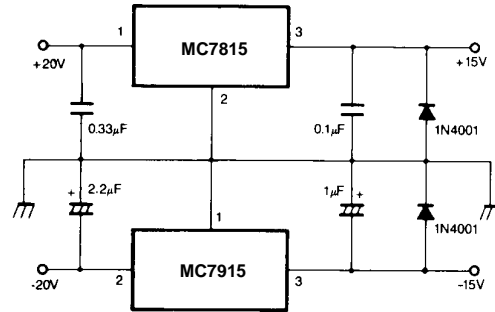


Figure 15. Split Power Supply (±15V-1A)

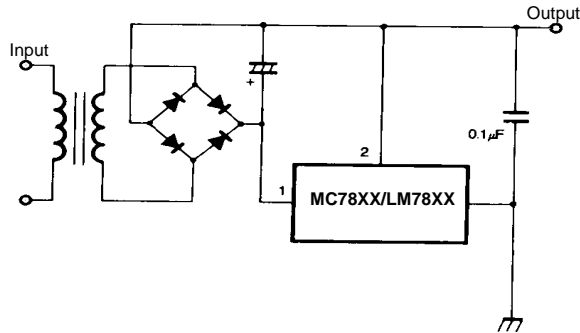


Figure 16. Negative Output Voltage Circuit

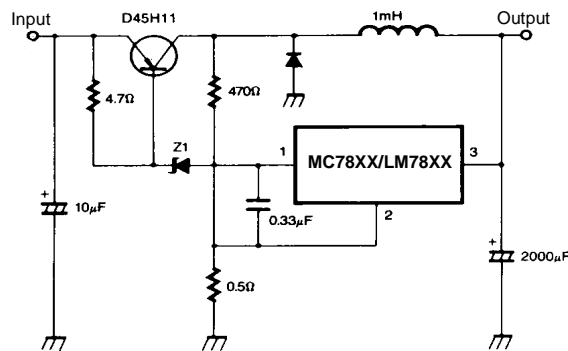
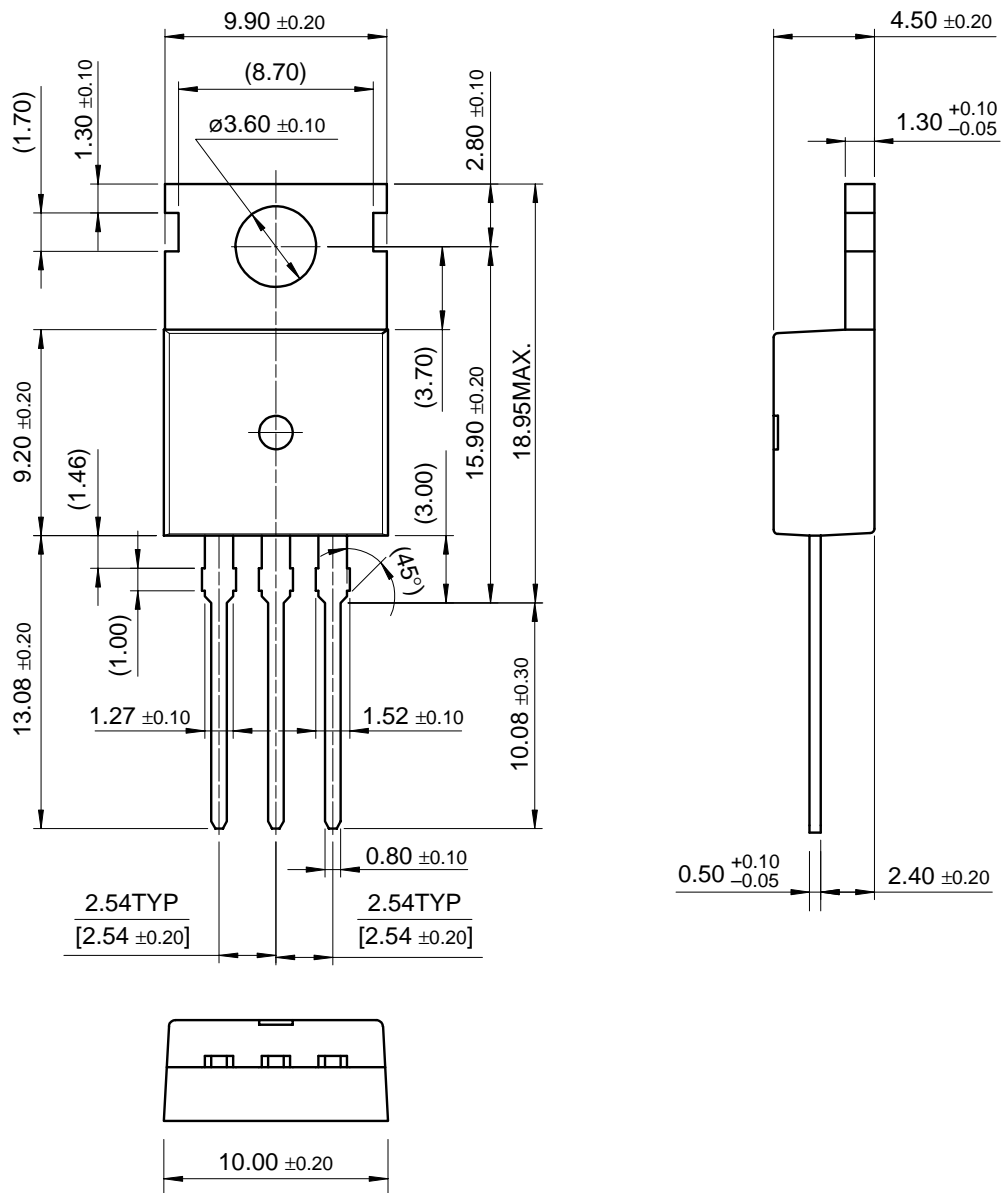


Figure 17. Switching Regulator

Mechanical Dimensions

Package

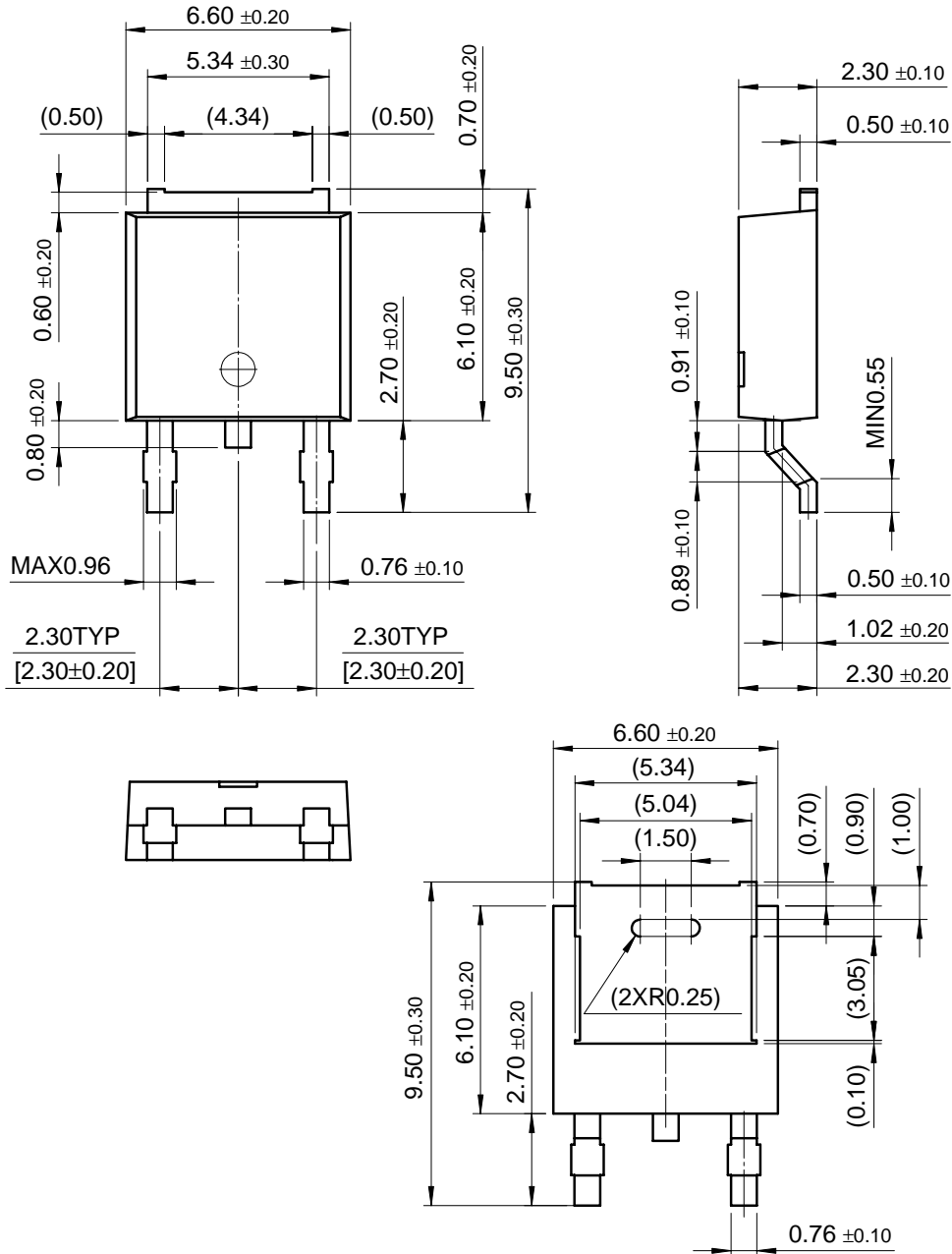
TO-220



Mechanical Dimensions (Continued)

Package

D-PAK



Ordering Information

Product Number	Output Voltage Tolerance	Package	Operating Temperature
LM7805CT	±4%	TO-220	0 ~ + 125°C

Product Number	Output Voltage Tolerance	Package	Operating Temperature
MC7805CT	±4%	TO-220	0 ~ + 125°C
MC7806CT			
MC7808CT			
MC7809CT			
MC7812CT			
MC7815CT			
MC7818CT			
MC7824CT			
MC7809CDT		D-PAK	

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