

78XX Series

3 TERMINAL 1.0A POSITIVE VOLTAGE REGULATORS

DESCRIPTION

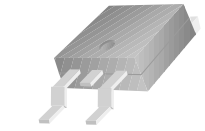
The 78XX series of three-terminal positive regulators are available in TO-220 packages. Each type employs internal current limiting, thermal shut-down and safe area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1.0A output current. Although designed as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltage and currents.

1.IN
2.GND
3.OUT



1 2 3

TO-220



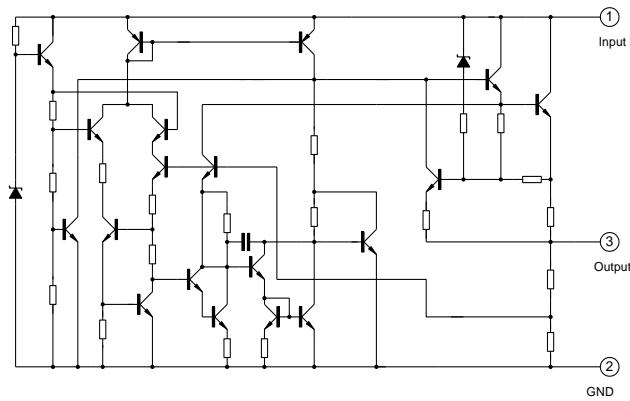
1 2 3

TO-252

FEATURES

- *Output current up to 1.0A
- *Thermal overload protection
- *Short circuit protection
- *Output transistor SOA protection

BLOCK DIAGRAM



3 TERMINAL 1.0A POSITIVE VOLTAGE REGULATORS

ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)

Characteristic	Symbol	Value	Unit
Input voltage	Vi	35	V
Thermal resistance junction-air	R(JA)	65	°C/W
Thermal resistance junction-cases	RθJC	5	°C/W
Operating Temperature	Topr	-20~+125	°C
Storage Temperature	Tstg	-65~+150	°C

7805 ELECTRICAL CHARACTERISTICS

(Refer to test circuits, 0<Tj<125°C, Io=500mA, Vi=10V, Ci=0.33μF, Co=0.1μF, unless otherwise specified)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Units
Output voltage	Vo	Tj=25°C	4.8	5.0	5.2	V
		5.0mA<Io<1.0A, Po<15W Vi=8V to 20V	4.75	5.00	5.25	V
Line regulation	ΔVo	Tj=25°C, Vi=7.5V to 20V		4	100	mV
		Tj=25°C, Vi=8V to 12V		2	50	mV
Load regulation	ΔVo	Tj=25°C, Io=5.0mA to 1.0A		9	100	mV
		Tj=25°C, Io=250mA to 750mA		4	50	mV
Quiescent current	Iq	Tj=25°C		4.2	8	mA
Quiescent current change	ΔIq	Io=5mA to 1.0A		0.03	0.5	mA
		Vi=8V to 25V, Io=500mA		0.3	0.8	mA
Output voltage drift	ΔVo/ΔT	Io=5mA		0.8		mV/°C
Output noise voltage	VN	f=10Hz to 100kHz, Ta=25°C		42		μV/Vo
Ripple rejection	RR	f=120Hz, Vi=8V to 18V	62	73		dB
Dropout voltage	Vo	Io=1.0A, Tj=25°C		2		V
Output resistance	Ro	f=1kHz		15		mΩ
Short circuit current	Isc	Vi=35V, Ta=25°C		200		mA

7806 ELECTRICAL CHARACTERISTICS

(Refer to test circuits, 0<Tj<125°C, Io=500mA, Vi=11V, Ci=0.33μF, Co=0.1μF, unless otherwise specified)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Units
Output voltage	Vo	Tj=25°C	5.75	6	6.25	V
		5.0mA<Io<1.0A, Po<15W Vi=9V to 21V	5.65	6	6.25	V
Line regulation	ΔVo	Tj=25°C, Vi=8.5V to 25V			120	mV
		Tj=25°C, Vi=9V to 13V			60	mV
Load regulation	ΔVo	Tj=25°C, Io=5.0mA to 1.0A			120	mV
		Tj=25°C, Io=250mA to 750mA			60	mV
Quiescent current	Iq	Tj=25°C		4.3	8	mA
Quiescent current change	ΔIq	Io=5mA to 1.0A			0.5	mA
		Vi=9V to 25V, Io=500mA			0.8	mA
Output voltage drift	ΔVo/ΔT	Io=5mA		0.8		mV/°C
Output noise voltage	VN	f=10Hz to 100kHz, Ta=25°C		42		μV/Vo
Ripple rejection	RR	f=120Hz, Vi=9V to 19V		68		dB
Dropout voltage	Vo	Io=1.0A, Tj=25°C		2		V
Output resistance	Ro	f=1kHz		17		mΩ
Short circuit current	Isc	Vi=35V, Ta=25°C		200		mA

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7808 ELECTRICAL CHARACTERISTICS

(Refer to test circuits, $0 < T_j < 125^\circ\text{C}$, $I_o = 500\text{mA}$, $V_i = 14\text{V}$, $C_i = 0.33\mu\text{F}$, $C_o = 0.1\mu\text{F}$, unless otherwise specified)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Units
Output voltage	V_o	$T_j = 25^\circ\text{C}$	7.84	8	8.16	V
		$5.0\text{mA} < I_o < 1.0\text{A}$, $P_o < 15\text{W}$ $V_i = 11.5\text{V}$ to 23V	7.7	8	8.3	V
Line regulation	ΔV_o	$T_j = 25^\circ\text{C}$, $V_i = 10.5\text{V}$ to 25V			160	mV
		$T_j = 25^\circ\text{C}$, $V_i = 11\text{V}$ to 17V			80	mV
Load regulation	ΔV_o	$T_j = 25^\circ\text{C}$, $I_o = 5.0\text{mA}$ to 1.0A			160	mV
		$T_j = 25^\circ\text{C}$, $I_o = 250\text{mA}$ to 750mA			80	mV
Quiescent current	I_q	$T_j = 25^\circ\text{C}$		4.3	8	mA
Quiescent current change	ΔI_q	$I_o = 5\text{mA}$ to 1.0A			0.5	mA
		$V_i = 11.5\text{V}$ to 25V , $I_o = 500\text{mA}$			0.8	mA
Output voltage drift	$\Delta V_o / \Delta T$	$I_o = 5\text{mA}$		1.0		mV/ $^\circ\text{C}$
Output noise voltage	V_N	$f = 10\text{Hz}$ to 100kHz , $T_a = 25^\circ\text{C}$		42		$\mu\text{V}/V_o$
Ripple rejection	RR	$f = 120\text{Hz}$, $V_i = 11.5\text{V}$ to 21.5V		62		dB
Dropout voltage	V_o	$I_o = 1.0\text{A}$, $T_j = 25^\circ\text{C}$		2		V
Output resistance	R_o	$f = 1\text{kHz}$		18		$\text{m}\Omega$
Short circuit current	Isc	$V_i = 35\text{V}$, $T_a = 25^\circ\text{C}$		200		mA

7809 ELECTRICAL CHARACTERISTICS

(Refer to test circuits, $0 < T_j < 125^\circ\text{C}$, $I_o = 500\text{mA}$, $V_i = 15\text{V}$, $C_i = 0.33\mu\text{F}$, $C_o = 0.1\mu\text{F}$, unless otherwise specified)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Units
Output voltage	V_o	$T_j = 25^\circ\text{C}$	8.82	9	9.18	V
		$5.0\text{mA} < I_o < 1.0\text{A}$, $P_o < 15\text{W}$ $V_i = 12.5\text{V}$ to 24V	8.65	9	9.35	V
Line regulation	ΔV_o	$T_j = 25^\circ\text{C}$, $V_i = 11.5\text{V}$ to 26V			180	mV
		$T_j = 25^\circ\text{C}$, $V_i = 12\text{V}$ to 18V			90	mV
Load regulation	ΔV_o	$T_j = 25^\circ\text{C}$, $I_o = 5.0\text{mA}$ to 1.0A			180	mV
		$T_j = 25^\circ\text{C}$, $I_o = 250\text{mA}$ to 750mA			90	mV
Quiescent current	I_q	$T_j = 25^\circ\text{C}$		4.3	8	mA
Quiescent current change	ΔI_q	$I_o = 5\text{mA}$ to 1.0A			0.5	mA
		$V_i = 12.5\text{V}$ to 25V , $I_o = 500\text{mA}$			0.8	mA
Output voltage drift	$\Delta V_o / \Delta T$	$I_o = 5\text{mA}$		1.2		mV/ $^\circ\text{C}$
Output noise voltage	V_N	$f = 10\text{Hz}$ to 100kHz , $T_a = 25^\circ\text{C}$		42		$\mu\text{V}/V_o$
Ripple rejection	RR	$f = 120\text{Hz}$, $V_i = 12.5\text{V}$ to 22.5V		61		dB
Dropout voltage	V_o	$I_o = 1.0\text{A}$, $T_j = 25^\circ\text{C}$		2		V
Output resistance	R_o	$f = 1\text{kHz}$		18		$\text{m}\Omega$
Short circuit current	Isc	$V_i = 35\text{V}$, $T_a = 25^\circ\text{C}$		200		mA

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7810 ELECTRICAL CHARACTERISTICS

(Refer to test circuits, $0 < T_j < 125^\circ\text{C}$, $I_o = 500\text{mA}$, $V_i = 16\text{V}$, $C_i = 0.33\mu\text{F}$, $C_o = 0.1\mu\text{F}$, unless otherwise specified)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Units
Output voltage	V_o	$T_j = 25^\circ\text{C}$	9.7	10	10.3	V
		$5.0\text{mA} < I_o < 1.0\text{A}$, $P_o < 15\text{W}$ $V_i = 13.5\text{V}$ to 25V	9.6	10	10.4	V
Line regulation	ΔV_o	$T_j = 25^\circ\text{C}$, $V_i = 12.5\text{V}$ to 28V		8	200	mV
		$T_j = 25^\circ\text{C}$, $V_i = 14\text{V}$ to 20V		4	100	mV
Load regulation	ΔV_o	$T_j = 25^\circ\text{C}$, $I_o = 5.0\text{mA}$ to 1.0A		18	200	mV
		$T_j = 25^\circ\text{C}$, $I_o = 250\text{mA}$ to 750mA		8	100	mV
Quiescent current	I_q	$T_j = 25^\circ\text{C}$		4.3	8	mA
Quiescent current change	ΔI_q	$I_o = 5\text{mA}$ to 1.0A			0.5	mA
		$V_i = 13\text{V}$ to 28V , $I_o = 500\text{mA}$			0.8	mA
Output voltage drift	$\Delta V_o / \Delta T$	$I_o = 5\text{mA}$		1.3		mV/ $^\circ\text{C}$
Output noise voltage	V_N	$f = 10\text{Hz}$ to 100kHz , $T_a = 25^\circ\text{C}$		42		$\mu\text{V}/V_o$
Ripple rejection	RR	$f = 120\text{Hz}$, $V_i = 13\text{V}$ to 23V		61		dB
Dropout voltage	V_o	$I_o = 1.0\text{A}$, $T_j = 25^\circ\text{C}$		2		V
Output resistance	R_o	$f = 1\text{kHz}$		18		$\text{m}\Omega$
Short circuit current	Isc	$V_i = 35\text{V}$, $T_a = 25^\circ\text{C}$		200		mA

7812 ELECTRICAL CHARACTERISTICS

(Refer to test circuits, $0 < T_j < 125^\circ\text{C}$, $I_o = 500\text{mA}$, $V_i = 19\text{V}$, $C_i = 0.33\mu\text{F}$, $C_o = 0.1\mu\text{F}$, unless otherwise specified)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Units
Output voltage	V_o	$T_j = 25^\circ\text{C}$	11.5	12	12.5	V
		$5.0\text{mA} < I_o < 1.0\text{A}$, $P_o < 15\text{W}$ $V_i = 15.5\text{V}$ to 27V	11.4	12	12.6	V
Line regulation	ΔV_o	$T_j = 25^\circ\text{C}$, $V_i = 14.5\text{V}$ to 30V			240	mV
		$T_j = 25^\circ\text{C}$, $V_i = 16\text{V}$ to 22V			120	mV
Load regulation	ΔV_o	$T_j = 25^\circ\text{C}$, $I_o = 5.0\text{mA}$ to 1.0A			240	mV
		$T_j = 25^\circ\text{C}$, $I_o = 250\text{mA}$ to 750mA			120	mV
Quiescent current	I_q	$T_j = 25^\circ\text{C}$		4.4	8	mA
Quiescent current change	ΔI_q	$I_o = 5\text{mA}$ to 1.0A			0.5	mA
		$V_i = 15\text{V}$ to 30V , $I_o = 500\text{mA}$			0.8	mA
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 100kHz , $T_a = 25^\circ\text{C}$		42		$\mu\text{V}/V_o$
Ripple rejection	RR	$f = 120\text{Hz}$, $V_i = 15\text{V}$ to 25V		60		dB
Dropout voltage	V_o	$I_o = 1.0\text{A}$, $T_j = 25^\circ\text{C}$		2		V
Output resistance	R_o	$f = 1\text{kHz}$		18		$\text{m}\Omega$
Short circuit current	Isc	$V_i = 35\text{V}$, $T_a = 25^\circ\text{C}$		200		mA

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7815 ELECTRICAL CHARACTERISTICS

(Refer to test circuits, $0 < T_j < 125^\circ\text{C}$, $I_o = 500\text{mA}$, $V_i = 21\text{V}$, $C_i = 0.33\mu\text{F}$, $C_o = 0.1\mu\text{F}$, unless otherwise specified)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Units
Output voltage	V_o	$T_j = 25^\circ\text{C}$	14.4	15	15.6	V
		$5.0\text{mA} < I_o < 1.0\text{A}$, $P_o < 15\text{W}$ $V_i = 17.5\text{V}$ to 30V	14.25	15	15.75	V
Line regulation	ΔV_o	$T_j = 25^\circ\text{C}$, $V_i = 17.5\text{V}$ to 30V		15	300	mV
		$T_j = 25^\circ\text{C}$, $V_i = 20\text{V}$ to 26V		7	150	mV
Load regulation	ΔV_o	$T_j = 25^\circ\text{C}$, $I_o = 5.0\text{mA}$ to 1.0A		25	300	mV
		$T_j = 25^\circ\text{C}$, $I_o = 250\text{mA}$ to 750mA		10	150	mV
Quiescent current	I_q	$T_j = 25^\circ\text{C}$		5	8	mA
Quiescent current change	ΔI_q	$I_o = 5\text{mA}$ to 1.0A			0.5	mA
		$V_i = 18\text{V}$ to 30V , $I_o = 500\text{mA}$			0.8	mA
Output voltage drift	$\Delta V_o / \Delta T$	$I_o = 5\text{mA}$		1.8		mV/ $^\circ\text{C}$
Output noise voltage	V_N	$f = 10\text{Hz}$ to 100kHz , $T_a = 25^\circ\text{C}$		42		$\mu\text{V}/V_o$
Ripple rejection	RR	$f = 120\text{Hz}$, $V_i = 18\text{V}$ to 28V		60		dB
Dropout voltage	V_o	$I_o = 1.0\text{A}$, $T_j = 25^\circ\text{C}$		2		V
Output resistance	R_o	$f = 1\text{kHz}$		18		$\text{m}\Omega$
Short circuit current	I_{sc}	$V_i = 35\text{V}$, $T_a = 25^\circ\text{C}$		200		mA

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TEST CIRCUITS

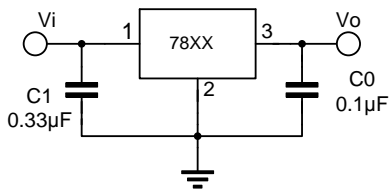


FIG.1 DC PARAMETERS

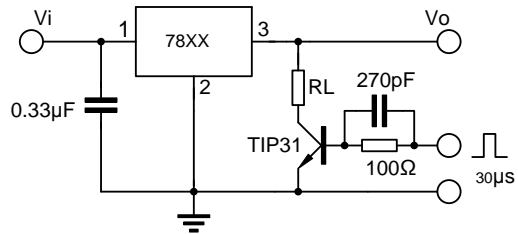


FIG.2 LOAD REGULATION

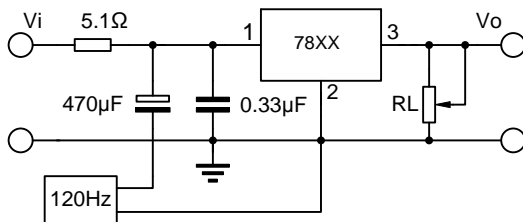


FIG.3 RIPPLE REJECTION

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APPLICATION CIRCUITS

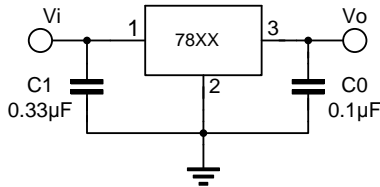


Fig.4 Fixed output regulator

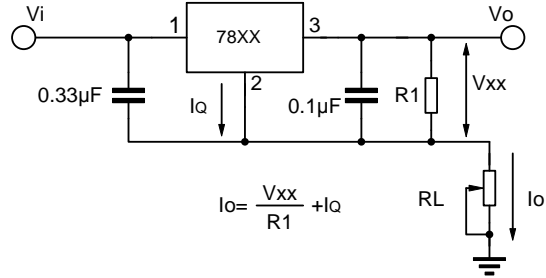


Fig.5 Constant current regulator

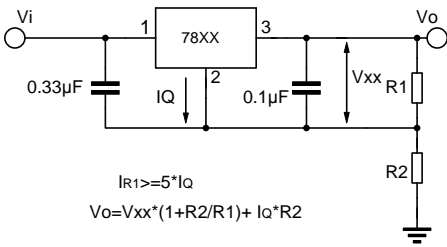


Fig.6 Circuit for increasing Regulator output voltage

$$I_{R1} \geq 5 \cdot I_Q$$

$$V_o = V_{xx} \cdot (1 + R_2/R_1) + I_Q \cdot R_2$$

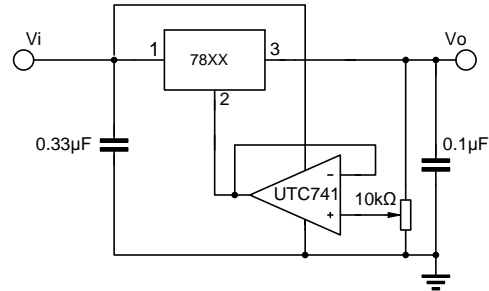


Fig.7 Adjustable output

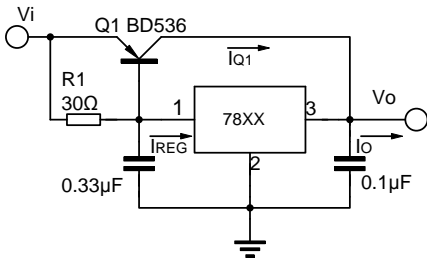


Fig.8 High current with voltage regulator

$$I_o = I_{REG} \cdot (I_{REG} - V_{BEQ1}/R_1)$$

$$R_1 = V_{BEQ1}/(I_{REG} - I_{Q1} \cdot Q_1)$$

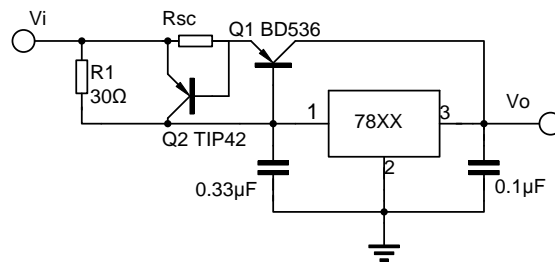


Fig.9 High output current short circuit protection

$$R_{sc} = V_{BEQ2} / I_{sc}$$

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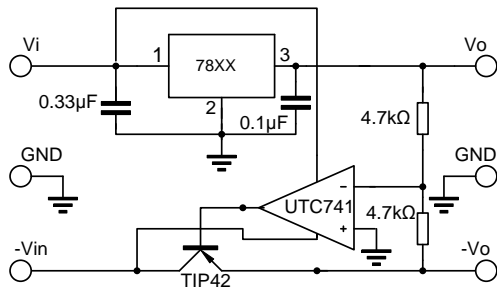


Fig.10 Tracking voltage regulator

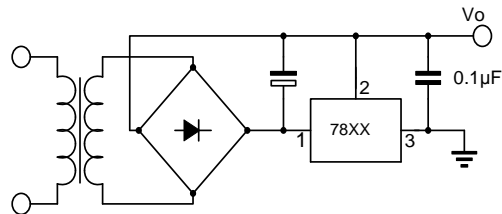


Fig.11 Negative output voltage circuit

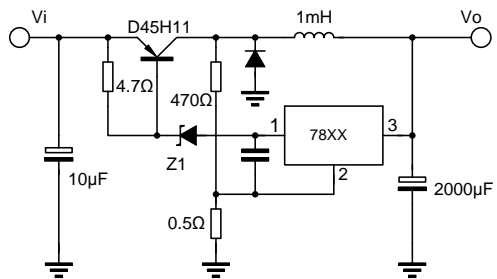
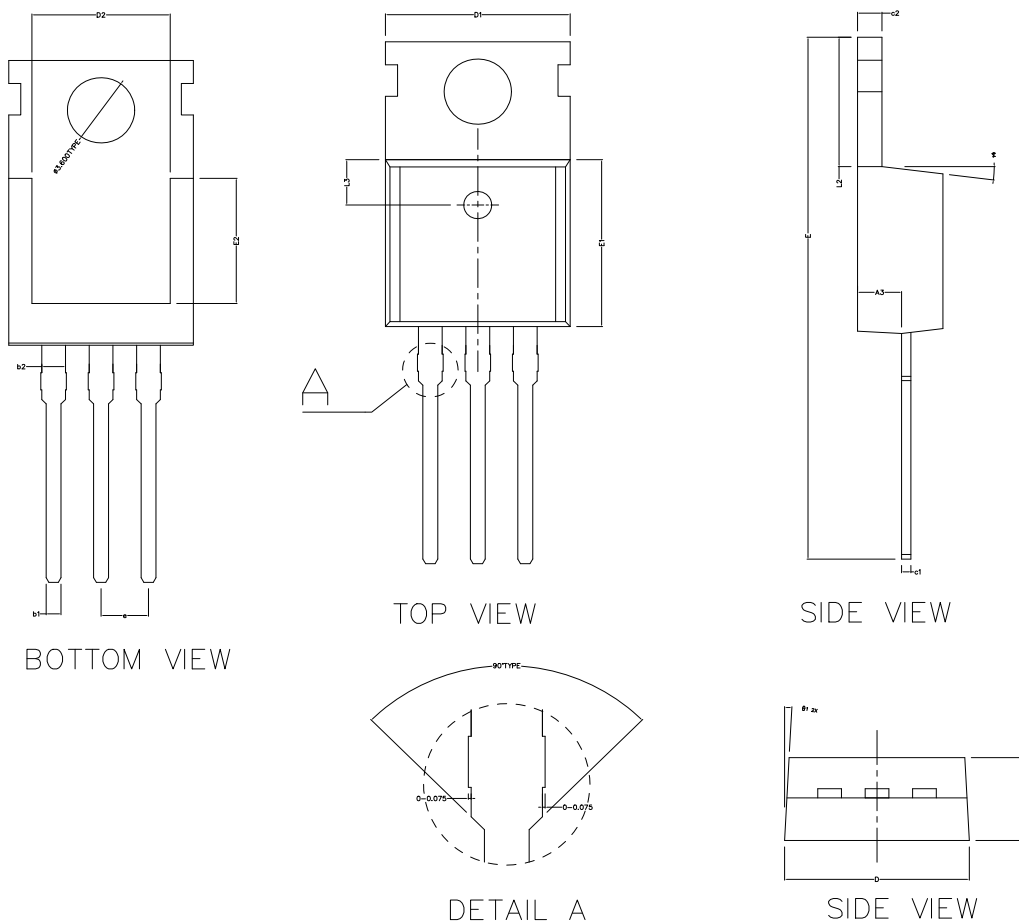


Fig.12 Switching regulator

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Packaging Information

TO-220 Outline Dimensions



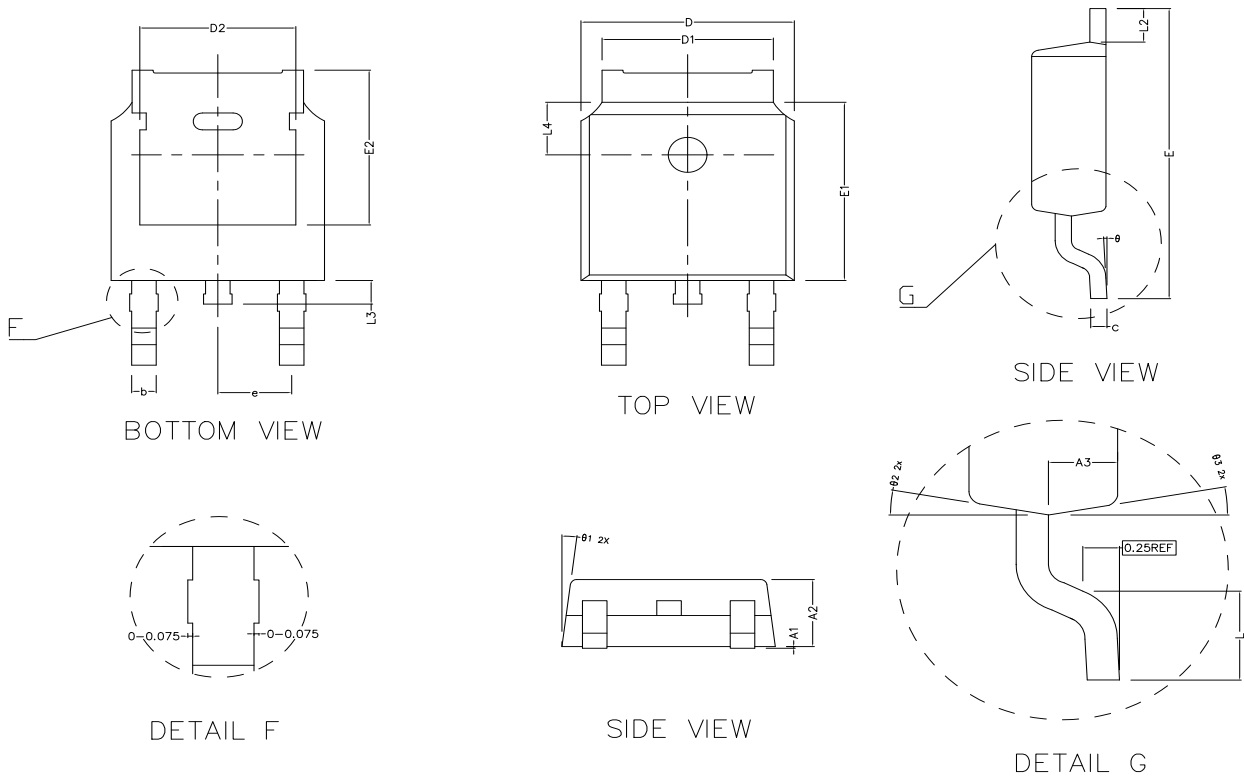
COMMON DIMENSIONS (UNITS OF MEASURE IS mm)			
	MIN	NORMAL	MAX
A2	4.470	4.570	4.670
A3	2.300	2.350	2.400
b1	0.750	0.800	0.850
b2	1.27 TYPE		
c1	0.450	0.500	0.550
c2	1.250	1.300	1.380
▲ D	9.900	10.000	10.100
▲ D1	10.000TYPE		
▲ D2	8.000TYPE		
▲ E	28.660	28.860	29.060
▲ E1	9.000	9.100	9.200
▲ E2	7.000TYPE		
e	2.540TYPE		
L2	6.350	6.500	6.650
L3	2.50TYPE		
$\theta1$	3° TYPE		
$\theta2$	3° TYPE		
$\theta3$	7° TYPE		
$\theta4$	7° TYPE		

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Packaging Information

TO-252 Outline Dimensions



COMMON DIMENSIONS (UNITS OF MEASURE IS mm)			
	MIN	NORMAL	MAX
A1	0.000	0.100	0.150
A2	2.200	2.300	2.400
A3	1.020	1.070	1.120
b	0.710	0.760	0.810
c	0.460	0.508	0.550
D	6.500	6.600	6.700
D1	5.330REF		
D2	4.830REF		
E	9.900	10.100	10.300
E1	6.000	6.100	6.200
E2	5.600REF		
e	2.286TYPE		
L	1.400	1.550	1.700
L2	1.10REF		
L3	0.80REF		
L4	1.80REF		
θ	0~8°		
θ1	7° TYPE		
θ2	10° TYPE		
θ3	10° TYPE		