National Semiconductor

LM340/LM78XX Series
3-Terminal Positive Regulators

General Description

The LM140/LM340A/LM340/LM78XXC monolithic 3-terminal positive voltage regulators employ internal current-limiting, thermal shutdown and safe-area compensation, making them essentially indestructible. If adequate heat sinking is provided, they can deliver over 1.0A output current. They are intended as fixed voltage regulators in a wide range of applications including local (on-card) regulation for elimination of noise and distribution problems associated with single-point regulation. In addition to use as fixed voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents.

Considerable effort was expended to make the entire series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

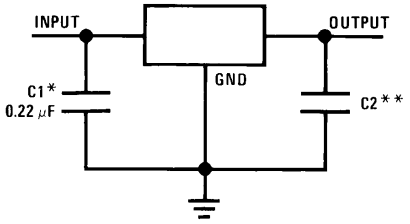
The 5V, 12V, and 15V regulator options are available in the steel TO-3 power package. The LM340A/LM340/LM78XXC series is available in the TO-220 plastic power package, and the LM340-5.0 is available in the SOT-223 package, as well as the LM340-5.0 and LM340-12 in the surface-mount TO-263 package.

Features

- Complete specifications at 1A load
- Output voltage tolerances of ±2% at T_j = 25˚C and ±4% over the temperature range (LM340A)
- Line regulation of 0.01% of V_{OUT}/V of ΔV_{IN} at 1A load (LM340A)
- Load regulation of 0.3% of V_{OUT}/A (LM340A)
- Internal thermal overload protection
- Internal short-circuit current limit
- Output transistor safe area protection
- P^+ Product Enhancement tested

Typical Applications

Fixed Output Regulator



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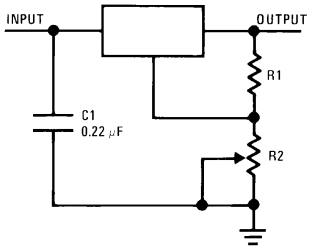
*Required if the regulator is located far from the power supply filter.

**Although no output capacitor is needed for stability, it does help transient response. (If needed, use 0.1 µF, ceramic disc).

Adjustable Output Regulator



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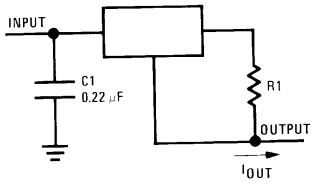
V_{OUT} = 5V + (5V/R1 + I_Q) R2 5V/R1 > 3 I_Q,
load regulation (L_r) ≈ [(R1 + R2)/R1] (L_r of LM340-5).

Current Regulator



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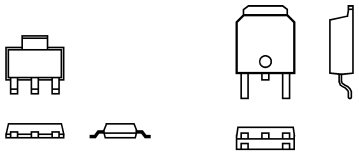
$$I_{OUT} = \frac{V2\text{-}3}{R1} + I_Q$$

ΔI_Q = 1.3 mA over line and load changes.

Comparison between SOT-223 and D-Pak (TO-252) Packages



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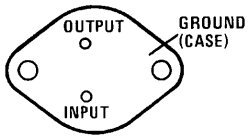
Scale 1:1

Ordering Information

Package	Temperature Range	Part Number	Packaging Marking	Transport Media	NSC Drawing
3-Lead TO-3	-55˚C to +125˚C	LM140K-5.0	LM140K 5.0P+	50 Per Tray	K02A
		LM140K-12	LM140K 12P+	50 Per Tray	
		LM140K-15	LM140K 15P+	50 Per Tray	
	0˚C to +125˚C	LM340K-5.0	LM340K 5.0 7805P+	50 Per Tray	
		LM340K-12	LM340K 12 7812P+	50 Per Tray	
		LM340K-15	LM340K 15 7815P+	50 Per Tray	
3-lead TO-220	0˚C to +125˚C	LM340AT-5.0	LM340AT 5.0 P+	45 Units/Rail	T03B
		LM340T-5.0	LM340T5 7805 P+	45 Units/Rail	
		LM340T-12	LM340T12 7812 P+	45 Units/Rail	
		LM340T-15	LM340T15 7815 P+	45 Units/Rail	
		LM7808CT	LM7808CT	45 Units/Rail	
3-Lead TO-263	0˚C to +125˚C	LM340S-5.0	LM340S-5.0 P+	45 Units/Rail	TS3B
		LM340SX-5.0		500 Units Tape and Reel	
		LM340S-12	LM340S-12 P+	45 Units/Rail	
		LM340SX-12		500 Units Tape and Reel	
		LM340AS-5.0	LM340AS-5.0 P+	45 Units/Rail	
		LM340ASX-5.0		500 Units Tape and Reel	
4-Lead SOT-223	0˚C to +125˚C	LM340MP-5.0	N00A	1k Units Tape and Reel	MP04A
		LM340MPX-5.0		2k Units Tape and Reel	
Unpackaged Die	–55˚C to 125˚C	LM140KG-5 MD8		Waffle Pack or Gel Pack	DL069089
		LM140KG-12 MD8		Waffle Pack or Gel Pack	DL059093
		LM140KG-15 MD8		Waffle Pack or Gel Pack	DL059093
	0˚C to +125˚C	LM340-5.0 MDA		Waffle Pack or Gel Pack	DI074056
		LM7808C MDC		Waffle Pack or Gel Pack	DI074056

Connection Diagrams

TO-3 Metal Can Package (K)



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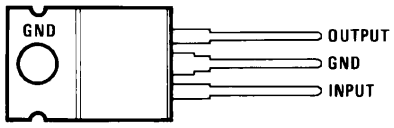
Bottom View
See Package Number K02A

TO-220 Power Package (T)



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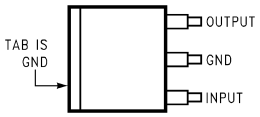
Top View
See Package Number T03B

TO-263 Surface-Mount Package (S)



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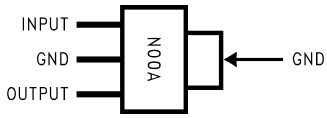
Top View
See Package Number TS3B

3-Lead SOT-223



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Top View
See Package Number MP04A

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

(Note 5)

DC Input Voltage	35V
Internal Power Dissipation (Note 2)	Internally Limited
Maximum Junction Temperature	150˚C
Storage Temperature Range	−65˚C to +150˚C
Lead Temperature (Soldering, 10 sec.)	
TO-3 Package (K)	300˚C
TO-220 Package (T), TO-263 Package (S)	230˚C
ESD Susceptibility (Note 3)	2 kV

Operating Conditions (Note 1)

Temperature Range (T_A) (Note 2)	
LM140	−55˚C to +125˚C
LM340A, LM340	0˚C to +125˚C
LM7808C	0˚C to +125˚C

LM340A Electrical Characteristics

I_{OUT} = 1A, 0˚C ≤ T_J ≤ + 125˚C (LM340A) unless otherwise specified (Note 4)

Symbol	Output Voltage		5V			12V			15V			Units
	Input Voltage (unless otherwise noted)		10V			19V			23V			
	Parameter	Conditions	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_O	Output Voltage	T_J = 25˚C	4.9	5	5.1	11.75	12	12.25	14.7	15	15.3	V
		P_D ≤ 15W, 5 mA ≤ I_O ≤ 1A	4.8		5.2	11.5		12.5	14.4		15.6	V
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}	(7.5 ≤ V_{IN} ≤ 20)			(14.8 ≤ V_{IN} ≤ 27)			(17.9 ≤ V_{IN} ≤ 30)			V
ΔV_O	Line Regulation	I_O = 500 mA			10			18			22	mV
		ΔV_{IN}	(7.5 ≤ V_{IN} ≤ 20)			(14.8 ≤ V_{IN} ≤ 27)			(17.9 ≤ V_{IN} ≤ 30)			V
		T_J = 25˚C		3	10		4	18		4	22	mV
		ΔV_{IN}	(7.5 ≤ V_{IN} ≤ 20)			(14.5 ≤ V_{IN} ≤ 27)			(17.5 ≤ V_{IN} ≤ 30)			V
		T_J = 25˚C			4			9			10	mV
		Over Temperature			12			30			30	mV
		ΔV_{IN}	(8 ≤ V_{IN} ≤ 12)			(16 ≤ V_{IN} ≤ 22)			(20 ≤ V_{IN} ≤ 26)			V
ΔV_O	Load Regulation	T_J = 25˚C, 5 mA ≤ I_O ≤ 1.5A		10	25		12	32		12	35	mV
		T_J = 25˚C, 250 mA ≤ I_O ≤ 750 mA			15			19			21	mV
		Over Temperature, 5 mA ≤ I_O ≤ 1A			25			60			75	mV
I_Q	Quiescent Current	T_J = 25˚C			6			6			6	mA
		Over Temperature			6.5			6.5			6.5	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_O ≤ 1A		0.5			0.5			0.5		mA
		T_J = 25˚C, I_O = 1A			0.8			0.8			0.8	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}	(7.5 ≤ V_{IN} ≤ 20)			(14.8 ≤ V_{IN} ≤ 27)			(17.9 ≤ V_{IN} ≤ 30)			V
		I_O = 500 mA			0.8			0.8			0.8	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}	(8 ≤ V_{IN} ≤ 25)			(15 ≤ V_{IN} ≤ 30)			(17.9 ≤ V_{IN} ≤ 30)			V
V_N	Output Noise Voltage	T_A = 25˚C, 10 Hz ≤ f ≤ 100 kHz		40			75			90		µV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	T_J = 25˚C, f = 120 Hz, I_O = 1A	68	80		61	72		60	70		dB
		or f = 120 Hz, I_O = 500 mA, Over Temperature,	68			61			60			dB
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}	(8 ≤ V_{IN} ≤ 18)			(15 ≤ V_{IN} ≤ 25)			(18.5 ≤ V_{IN} ≤ 28.5)			V
R_O	Dropout Voltage	T_J = 25˚C, I_O = 1A		2.0			2.0			2.0		V
	Output Resistance	f = 1 kHz		8			18			19		mΩ
	Short-Circuit Current	T_J = 25˚C		2.1			1.5			1.2		A

LM340A Electrical Characteristics (Continued)

I_{OUT} = 1A, 0˚C ≤ T_J ≤ + 125˚C (LM340A) unless otherwise specified (Note 4)

Symbol	Output Voltage		5V			12V			15V			Units
	Input Voltage (unless otherwise noted)		10V			19V			23V			
	Parameter	Conditions	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
	Peak Output Current	T_J = 25˚C		2.4			2.4			2.4		A
	Average TC of V_O	Min, T_J = 0˚C, I_O = 5 mA		−0.6			−1.5			−1.8		mV/˚C
V_{IN}	Input Voltage Required to Maintain Line Regulation	T_J = 25˚C	7.5			14.5			17.5			V

LM140 Electrical Characteristics (Note 4)

−55˚C ≤ T_J ≤ +150˚C unless otherwise specified

Symbol	Output Voltage			5V			12V			15V			Units
	Input Voltage (unless otherwise noted)			10V			19V			23V			
	Parameter	Conditions		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_O	Output Voltage	T_J = 25˚C, 5 mA ≤ I_O ≤ 1A		4.8	5	5.2	11.5	12	12.5	14.4	15	15.6	V
		P_D ≤ 15W, 5 mA ≤ I_O ≤ 1A		4.75		5.25	11.4		12.6	14.25		15.75	V
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		($8 ≤ V_{IN} ≤ 20$)			($15.5 ≤ V_{IN} ≤ 27$)			($18.5 ≤ V_{IN} ≤ 30$)			V
ΔV_O	Line Regulation	I_O = 500 mA	T_J = 25˚C		3	50		4	120		4	150	mV
			ΔV_{IN}	($7 ≤ V_{IN} ≤ 25$)			($14.5 ≤ V_{IN} ≤ 30$)			($17.5 ≤ V_{IN} ≤ 30$)			V
			−55˚C ≤ T_J ≤ +150˚C			50			120			150	mV
			ΔV_{IN}	($8 ≤ V_{IN} ≤ 20$)			($15 ≤ V_{IN} ≤ 27$)			($18.5 ≤ V_{IN} ≤ 30$)			V
		I_O ≤ 1A	T_J = 25˚C			50			120			150	mV
			ΔV_{IN}	($7.5 ≤ V_{IN} ≤ 20$)			($14.6 ≤ V_{IN} ≤ 27$)			($17.7 ≤ V_{IN} ≤ 30$)			V
			−55˚C ≤ T_J ≤ +150˚C			25			60			75	mV
			ΔV_{IN}	($8 ≤ V_{IN} ≤ 12$)			($16 ≤ V_{IN} ≤ 22$)			($20 ≤ V_{IN} ≤ 26$)			V
ΔV_O	Load Regulation	T_J = 25˚C	5 mA ≤ I_O ≤ 1.5A		10	50		12	120		12	150	mV
			250 mA ≤ I_P ≤ 750 mA			25			60			75	mV
		−55˚C ≤ T_J ≤ +150˚C, 5 mA ≤ I_O ≤ 1A				50			120			150	mV
I_Q	Quiescent Current	I_O ≤ 1A	T_J = 25˚C			6			6			6	mA
			−55˚C ≤ T_J ≤ +150˚C			7			7			7	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_O ≤ 1A			0.5			0.5			0.5		mA
		T_J = 25˚C, I_O ≤ 1A				0.8			0.8			0.8	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		($8 ≤ V_{IN} ≤ 20$)			($15 ≤ V_{IN} ≤ 27$)			($18.5 ≤ V_{IN} ≤ 30$)			V
		I_O = 500 mA, −55˚C ≤ T_J ≤ +150˚C				0.8			0.8			0.8	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		($8 ≤ V_{IN} ≤ 25$)			($15 ≤ V_{IN} ≤ 30$)			($18.5 ≤ V_{IN} ≤ 30$)			V
V_N	Output Noise Voltage	T_A = 25˚C, 10 Hz ≤ f ≤ 100 kHz			40			75			90		µV

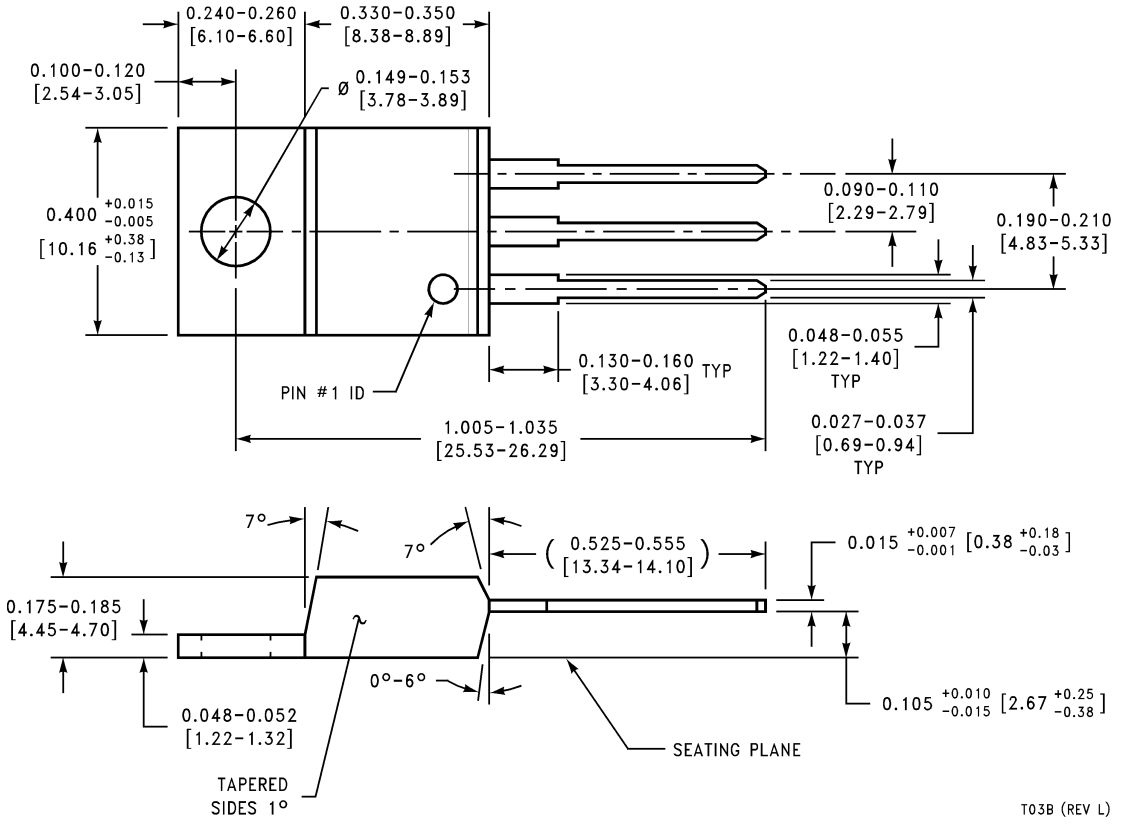
LM7808C
Electrical Characteristics

$0^{\circ}C \le T_J \le +150^{\circ}C$, $V_I = 14V$, $I_O = 500$ mA, $C_I = 0.33$ µF, $C_O = 0.1$ µF, unless otherwise specified

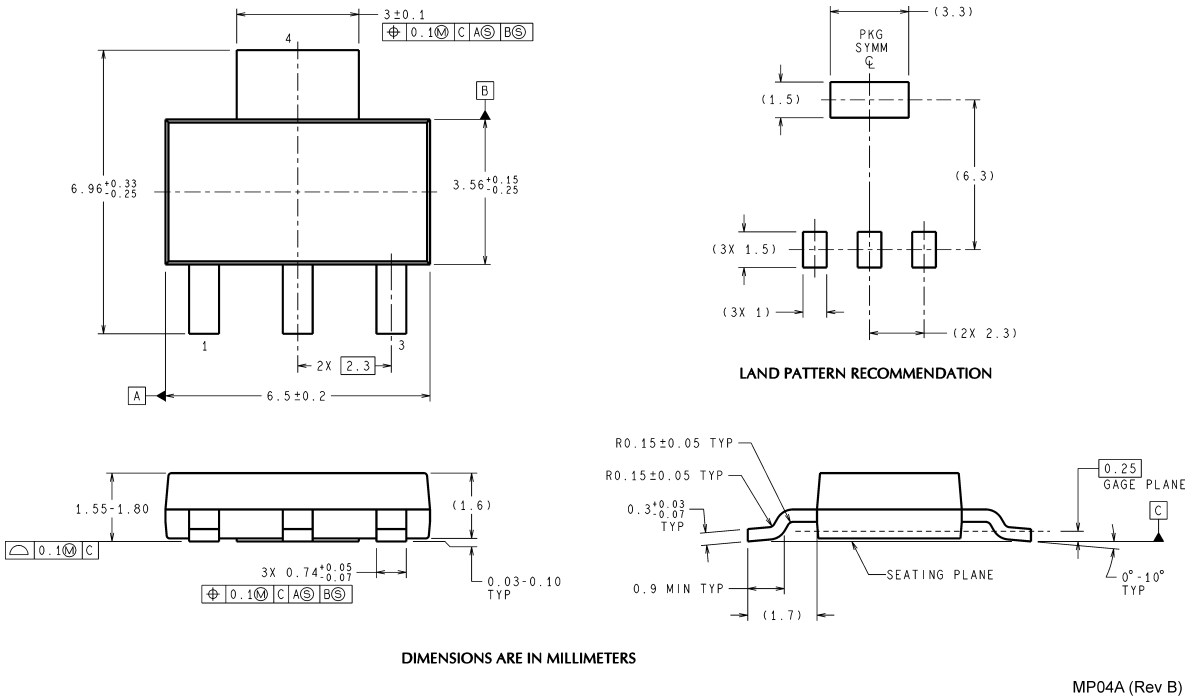
Symbol	Parameter		Conditions (Note 6)		LM7808C			Units
					Min	Typ	Max	
V_O	Output Voltage		$T_J = 25^{\circ}C$		7.7	8.0	8.3	V
ΔV_O	Line Regulation		$T_J = 25^{\circ}C$	$10.5V \le V_I \le 25V$		6.0	160	mV
				$11.0V \le V_I \le 17V$		2.0	80	
ΔV_O	Load Regulation		$T_J = 25^{\circ}C$	$5.0\ mA \le I_O \le 1.5A$		12	160	mV
				$250\ mA \le I_O \le 750\ mA$		4.0	80	
V_O	Output Voltage		$11.5V \le V_I \le 23V$, $5.0\ mA \le I_O \le 1.0A$, $P \le 15W$		7.6		8.4	V
I_Q	Quiescent Current		$T_J = 25^{\circ}C$			4.3	8.0	mA
ΔI_Q	Quiescent	With Line	$11.5V \le V_I \le 25V$				1.0	mA
	Current Change	With Load	$5.0\ mA \le I_O \le 1.0A$				0.5	
V_N	Noise		$T_A = 25^{\circ}C$, $10\ Hz \le f \le 100\ kHz$			52		µV
$\Delta V_I/\Delta V_O$	Ripple Rejection		f = 120 Hz, $I_O = 350$ mA, $T_J = 25^{\circ}C$		56	72		dB
V_{DO}	Dropout Voltage		$I_O = 1.0A$, $T_J = 25^{\circ}C$			2.0		V
R_O	Output Resistance		f = 1.0 kHz			16		mΩ
I_{OS}	Output Short Circuit Current		$T_J = 25^{\circ}C$, $V_I = 35V$			0.45		A
I_{PK}	Peak Output Current		$T_J = 25^{\circ}C$			2.2		A
$\Delta V_O/\Delta T$	Average Temperature Coefficient of Output Voltage		$I_O = 5.0$ mA			0.8		mV/°C

Note 6: All characteristics are measured with a 0.22 µF capacitor from input to ground and a 0.1 µF capacitor from output to ground. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ($t_w \le 10$ ms, duty cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



TO-220 Power Package (T)
NS Package Number T03B



3-Lead SOT-223 Package
NS Package Number MP04A