LM340

LM340/LM78XX Series 3-Terminal Positive Regulators



Literature Number: SNOSBT0H



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.

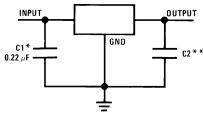
The 5V, 12V, and 15V regulator options are available in the steel TO-3 power package. The LM340A/LM340/LM78XXC series is available in the TO-220 plastic power package, and the LM340-5.0 is available in the SOT-223 package, as well as the LM340-5.0 and LM340-12 in the surface-mount TO-263 package.

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 ∆V_{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

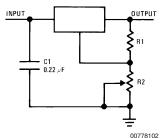
Typical Applications

Fixed Output Regulator



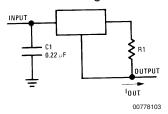
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Adjustable Output Regulator



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

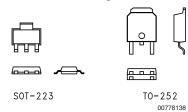
Current Regulator



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

 ΔI_{Q} = 1.3 mA over line and load changes.

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



Scale 1:1

^{*}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 μ F, ceramic disc).

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	LIVI3403-3.0 F +	500 Units Tape and Reel	
		LM340S-12	LM340S-12 P+	45 Units/Rail	
		LM340SX-12	LIVI3403-12 F +	500 Units Tape and Reel	
		LM340AS-5.0	LM340AS-5.0 P+	45 Units/Rail	
		LM340ASX-5.0	LIVI340A3-3.0 F +	500 Units Tape and Reel	
4-Lead	0°C to +125°C	LM340MP-5.0	N00A	1k Units Tape and Reel	MP04A
SOT-223		LM340MPX-5.0	INUUA	2k Units Tape and Reel	
Unpackaged	–55°C to 125°C	LM140KG-5 MD8		Waffle Pack or Gel Pack	DL069089
Die		LM140KG-12 MD8		Waffle Pack or Gel Pack	DL059093
		LM140KG-15 MD8		Waffle Pack or Gel Pack	DL059093

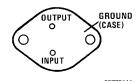
Connection Diagrams

TO-3 Metal Can Package (K)

LM340-5.0 MDA

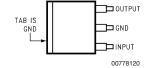
LM7808C MDC

0°C to +125°C



Bottom View See Package Number K02A

TO-263 Surface-Mount Package (S)



Top View See Package Number TS3B

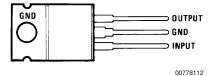
TO-220 Power Package (T)

Waffle Pack or Gel Pack

Waffle Pack or Gel Pack

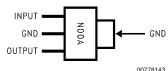
DI074056

DI074056



Top View See Package Number T03B

3-Lead SOT-223



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 Lead Temperature (Soldering, 10 sec.)

TO-3 Package (K) 300°C

TO-220 Package (T), TO-263 Package (S)

Package (S) 230°C ESD Susceptibility (Note 3) 2 kV

Operating Conditions (Note 1)

Temperature Range (T_A) (Note 2)

LM340A Electrical Characteristics

 I_{OUT} = 1A, $0^{\circ}C \leq T_{J} \leq +$ 125 $^{\circ}C$ (LM340A) unless otherwise specified (Note 4)

-65°C to +150°C

		Output Vol	tage		5V			12V			15V		
Symbol	Input Volta	age (unless o	therwise noted)		10V			19V			23V		Units
	Parameter		Conditions	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	
Vo	Output Voltage	$T_J = 25^{\circ}C$		4.9	5	5.1	11.75	12	12.25	14.7	15	15.3	V
		$P_D \le 15W$, 5 mA $\le I_O \le 1A$				5.2	11.5		12.5	14.4		15.6	V
		$V_{MIN} \le V_{IN} \le V_{MAX}$			≤ V _{IN}	≤ 20)	(14.8	≤ V _{IN}	≤ 27)	(17.9	≤ V _{IN}	≤ 30)	V
ΔV_{O}	Line Regulation	$I_{\rm O} = 500 \text{mA}$	ı.			10			18			22	mV
		ΔV_{IN}		(7.5	≤ V _{IN}	≤ 20)	(14.8	$\leq V_{IN}$	≤ 27)	(17.9	$\leq V_{IN}$	≤ 30)	V
		$T_J = 25^{\circ}C$			3	10		4	18		4	22	mV
		ΔV_{IN}		(7.5	≤ V _{IN}	≤ 20)	(14.5	≤ V _{IN}	≤ 27)	(17.5	$\leq V_{IN}$	≤ 30)	V
		$T_J = 25^{\circ}C$				4			9			10	mV
		Over Tempe	rature			12			30			30	mV
		ΔV_{IN}		(8 ≤	V _{IN} ≤	(12)	(16 ≤	V _{IN} s	≤ 22)	(20 ≤	V _{IN} ≤	≤ 26)	V
ΔV_{O}	Load Regulation	$T_J = 25^{\circ}C$	5 mA ≤ I _O ≤ 1.5A		10	25		12	32		12	35	mV
			250 mA ≤ I _O ≤ 750			15			19			21	mV
			mA										
		Over Tempe				25			60			75	mV
		5 mA ≤ I _O ≤	1A										
I _Q	Quiescent	$T_J = 25^{\circ}C$				6			6			6	mA
	Current												_
		Over Tempe				6.5			6.5			6.5	mA
ΔI_{Q}	Quiescent Current	5 mA ≤ I _O ≤	1A		0.5			0.5			0.5		mA
	Change	T _{.1} = 25°C, I ₀	_ 1Λ			0.8			0.8			0.8	mA
	Change	$V_{\text{MIN}} \leq V_{\text{IN}} \leq V_{$		(7.5.	≤ V _{IN}		/1/ Ω	< V	50.6≤ 27)	(17.9	< V/		V
		$I_{O} = 500 \text{ mA}$		(7.5	- vIN	0.8	(14.0	- vIN	0.8	(17.3	- VIN	0.8	mA
		$V_{MIN} \le V_{IN} \le$		(8 <	V _{IN} ≤		(15 <	≤ V _{IN} ≤		(17.9	< V		V
V_{N}	Output Noise		0 Hz ≤ f ≤ 100 kHz	(0 -	40	20)	(10 -	75	3 00)	(17.5	90	_ 00)	μV
N N	Voltage	1 A = 25 O, 1	0 112 3 1 3 100 KHZ		40			75			50		μV
ΔV_{IN}	Ripple Rejection	T ₁ = 25°C, f	= 120 Hz, I _O = 1A	68	80		61	72		60	70		dB
$\frac{\Delta V_{\text{IN}}}{\Delta V_{\text{OUT}}}$,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	_	z, I _O = 500 mA,	68			61			60			dB
		Over Tempe	-										
		$V_{MIN} \le V_{IN} \le$	V _{MAX}	(8 ≤	V _{IN} ≤	(18)	(15 ≤	≤ V _{IN} ≤	≤ 25)	(18.	5 ≤ V ₁	_{INI} ≤	V
		IVIIIV IIV	WAX	\	114	,	,	114	,		28.5)		
R _o	Dropout Voltage	$T_{J} = 25^{\circ}C, I_{c}$	_D = 1A		2.0			2.0			2.0		V
	Output	f = 1 kHz			8			18			19		mΩ
	Resistance												
	Short-Circuit	$T_J = 25^{\circ}C$			2.1			1.5			1.2		Α
	Current												

LM340A Electrical Characteristics (Continued) $I_{OUT} = 1A$, $0^{\circ}C \le T_{J} \le + 125^{\circ}C$ (LM340A) unless otherwise specified (Note 4)

		5V			12V							
Symbol	Input Voltage (unless otherwise noted)			10V			19V			23V		
	Parameter	Conditions	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	
	Peak Output	$T_J = 25^{\circ}C$		2.4			2.4			2.4		Α
	Current											
	Average TC of	Min, $T_J = 0$ °C, $I_O = 5$ mA		-0.6			-1.5			-1.8		mV/°C
	Vo											
V _{IN}	Input Voltage	$T_J = 25^{\circ}C$										
	Required to		7.5			14.5			17.5			V
	Maintain											
	Line Regulation											

LM140 Electrical Characteristics (Note 4)

 $-55^{\circ}C \le T_{J} \le +150^{\circ}C$ unless otherwise specified

	Output Voltage Input Voltage (unless otherwise noted				5V			12V			15V		
Symbol	Input Volta	ige (unless oth	nerwise noted)		10V			19V		23V U			nits
	Parameter	C	Conditions	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	
V _O	Output Voltage	$T_J = 25^{\circ}C$, 5 mA $\leq I_O \leq 1$ A			5	5.2	11.5	12	12.5	14.4	15	15.6	V
		P _D ≤ 15W, 5 i	$mA \le I_O \le 1A$	4.75 5.25			11.4		12.6	14.25		15.75	V
		$V_{MIN} \le V_{IN} \le V_{MAX}$		(8 ≤	≤ V _{IN} s	≤ 20)	(15.5	≤ V _{IN}	≤ 27)	(18.5 ≤ V _{IN} ≤ 30)			V
ΔV_{O}	Line Regulation	I _O = 500 mA	$T_J = 25^{\circ}C$		3	50		4	120		4	150	mV
			ΔV_{IN}	(7 ≤	≤ V _{IN} s	≤ 25)	(14.5	≤ V _{IN}	≤ 30)	(17	.5 ≤ V 30)	ı _N ≤	V
			$-55^{\circ}\text{C} \le \text{T}_{\text{J}} \le +150^{\circ}\text{C}$			50			120			150	mV
			ΔV_{IN}	(8 ≤	≤ V _{IN} s	≤ 20)	(15 ±	≤ V _{IN} ≤	<u>(</u> 27)	(18	.5 ≤ V 30)	ı _N ≤	V
		I _O ≤ 1A	$T_J = 25^{\circ}C$			50			120			150	mV
			ΔV_{IN}	(7.5	$\leq V_{IN}$	≤ 20)	(14.6	≤ V _{IN}	≤ 27)	(17	.7 ≤ V 30)	ı _N ≤	V
			$-55^{\circ}\text{C} \le \text{T}_{\text{J}} \le +150^{\circ}\text{C}$			25			60			75	mV
			ΔV_{IN}	(8 ≤	≤ V _{IN} s	≤ 12)	(16 ≤	≤ V _{IN} ≤	£ 22)	(20 :	≤ V _{IN} :	≤ 26)	V
ΔV_{O}	Load Regulation	$T_J = 25^{\circ}C$	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,			50			120			150	mV
		5 mA ≤ I _O ≤ 1	A										
IQ	Quiescent Current	I _O ≤ 1A	$T_J = 25^{\circ}C$			6			6			6	mA
			$-55^{\circ}\text{C} \le \text{T}_{\text{J}} \le +150^{\circ}\text{C}$			7			7			7	mA
ΔI_{Q}	Quiescent Current	5 mA ≤ I _O ≤ 1			0.5			0.5			0.5		mA
	Change	$T_J = 25^{\circ}C, I_O$	≤ 1A			8.0			8.0			8.0	mA
		$V_{MIN} \le V_{IN} \le V_{IN}$	V _{MAX}	(8 ≤	≤ V _{IN} ≤	≤ 20)	(15 s	≤ V _{IN} ≤	£ 27)	(18	.5 ≤ V 30)	IN ≤	V
		$I_{O} = 500 \text{ mA},$	$-55^{\circ}\text{C} \le \text{T}_{\text{J}} \le +150^{\circ}\text{C}$			0.8			0.8			0.8	mA
		$V_{MIN} \le V_{IN} \le V_{IN}$	V _{MAX}	(8 ≤	≤ V _{IN} s	≤ 25)	(15 ≤	≤ V _{IN} ≤	30)	(18	.5 ≤ V 30)	IN ≤	V
V _N	Output Noise Voltage	$T_A = 25^{\circ}C, 10$) Hz ≤ f ≤ 100 kHz		40			75			90		μV

LM140 Electrical Characteristics (Note 4) (Continued)

 $-55^{\circ}C \leq T_{J} \leq +150^{\circ}C$ unless otherwise specified

		Output Voltage			5V			12V		15V			
Symbol	Input Volta	ge (unless oth	erwise noted)	10V				19V		23V		U	Inits
	Parameter	Conditions			Тур	Max	Min	Тур	Max	Min	Тур	Max]
$\frac{\Delta V_{\text{IN}}}{\Delta V_{\text{OUT}}}$	Ripple Rejection		$I_{O} \le 1A, T_{J} = 25^{\circ}C$ or	68	80		61	72		60	70		dB
		f = 120 Hz	$I_O \le 500 \text{ mA},$ $-55^{\circ}\text{C} \le \text{T}_\text{J} \le +150^{\circ}\text{C}$	68			61			60			dB
		$V_{MIN} \le V_{IN} \le V_{IN}$	V _{MAX}	(8 ≤ V _{IN} ≤ 18)			$(15 \le V_{IN} \le 25)$			$(18.5 \le V_{IN} \le 28.5)$			V
R _o	Dropout Voltage	$T_J = 25^{\circ}C, I_O$	= 1A		2.0		2.0		2.0			V	
	Output Resistance	f = 1 kHz			8			18			19		mΩ
	Short-Circuit Current	$T_J = 25^{\circ}C$			2.1		1.5			1.2		A	
	Peak Output Current	$T_J = 25^{\circ}C$			2.4			2.4			2.4		А
	Average TC of V _{OUT}	$0^{\circ}C \leq T_{J} \leq +1$	50° C, $I_{O} = 5 \text{ mA}$		-0.6			-1.5			-1.8	m	V/°C
V _{IN}	Input Voltage	$T_J = 25^{\circ}C, I_O$	≤ 1A										
	Required to Maintain			7.5			14.6			17.7			V
	Line Regulation												

LM340 Electrical Characteristics (Note 4)

 $0^{\circ}C \le T_{J} \le +125^{\circ}C$ unless otherwise specified

		Output Voltage	e		5V			12V			15V		
Symbol	Input Voltag	ge (unless othe	rwise noted)		10V			19V			Units		
	Parameter	Co	onditions	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	1
V _O	Output Voltage	$mA \le I_O \le 1A$	4.8	5	5.2	11.5	12	12.5	14.4	15	15.6	V	
		P _D ≤ 15W, 5	$mA \le I_O \le 1A$	4.75		5.25	11.4		12.6	14.25		15.75	V
		$V_{MIN} \leq V_{IN} \leq Y_{IN}$	$V_{MIN} \le V_{IN} \le V_{MAX}$		$(7.5 \le V_{IN} \le 20)$			5 ≤ V 27)	ı _N ≤	(17.5	≤ V _{IN}	ı ≤ 30)	V
ΔV_{O}	Line Regulation	I _O = 500 mA	$T_J = 25^{\circ}C$		3	50		4	120		4	150	mV
			ΔV_{IN}	(7 ≤	V _{IN} ≤	25)	(14.	5 ≤ V	ı _N ≤	(17.5	≤ V _{IN}	₁ ≤ 30)	V
								30)					
			$0^{\circ}\text{C} \le \text{T}_{\text{J}} \le +125^{\circ}\text{C}$			50			120			150	mV
			ΔV_{IN}	(8 ≤	V _{IN} ≤	20)	(15 ≤	V _{IN} :	≤ 27)	(18.5	$\leq V_{IN}$	₁ ≤ 30)	V
		I _O ≤ 1A	$T_J = 25^{\circ}C$			50			120			150	mV
			ΔV_{IN}	(7.5	≤ V _{IN}	≤ 20)	(14.	6 ≤ V	ı _N ≤	(17.7	$\leq V_{IN}$	ı ≤ 30)	V
								27)					
			$0^{\circ}\text{C} \le \text{T}_{\text{J}} \le +125^{\circ}\text{C}$			25			60			75	mV
			ΔV_{IN}	(8 ≤	V _{IN} ≤	(12)	(16 ≤	V _{IN} :	≤ 22)	(20	≤ V _{IN}	≤ 26)	V
ΔV_{O}	Load Regulation	$T_J = 25^{\circ}C$	5 mA ≤ I _O ≤ 1.5A		10	50		12	120		12	150	mV
			250 mA ≤ I _O ≤ 750 n	nΑ		25			60			75	mV
		5 mA ≤ I _O ≤ 1	A, $0^{\circ}C \leq T_{J} \leq$			50			120			150	mV
		+125°C											
I_Q	Quiescent Current	I _O ≤ 1A	$T_J = 25^{\circ}C$			8			8			8	mA
			$0^{\circ}\text{C} \le \text{T}_{\text{J}} \le +125^{\circ}\text{C}$			8.5			8.5			8.5	mA
ΔI_Q	Quiescent Current	5 mA ≤ I _O ≤ 1	A		0.5			0.5			0.5		mA
	Change	$T_J = 25^{\circ}C, I_O$	≤ 1A			1.0			1.0			1.0	mA

LM340 Electrical Characteristics (Note 4) (Continued)

 $0^{\circ}C \le T_{J} \le +125^{\circ}C$ unless otherwise specified

		Output Voltage	•		5V			12V			Units		
Symbol	Input Voltage	e (unless othe	rwise noted)		10V			19V		23V			
	Parameter	Conditions			Тур	Max	Min	Тур	Max	Min	Тур	Max]
		$V_{MIN} \le V_{IN} \le V_{IN}$	$V_{\text{MIN}} \le V_{\text{IN}} \le V_{\text{MAX}}$			≤ 20)) (14.8 ≤ V _{IN} ≤ 27)			$(17.9 \le V_{IN} \le 30)$			V
		$I_O \le 500 \text{ mA},$	$_{\rm O} \le 500 \text{ mA}, \ 0^{\circ}\text{C} \le \text{T}_{\rm J} \le +125^{\circ}\text{C}$			1.0			1.0			1.0	mA
		$V_{MIN} \le V_{IN} \le T_{IN}$	$V_{MIN} \le V_{IN} \le V_{MAX}$			$(7 \le V_{IN} \le 25)$			_{IN} ≤	(17.5	≤ V _{IN}	≤ 30)	V
V _N	Output Noise Voltage	$T_A = 25^{\circ}C, 10^{\circ}$	Hz ≤ f ≤ 100 kHz		40			75			90		μV
$\frac{\Delta V_{\text{IN}}}{\Delta V_{\text{OUT}}}$	Ripple Rejection		$I_O \le 1A, T_J = 25^{\circ}C$	62	80		55	72		54	70		dB
		f = 120 Hz	or $I_O \le 500 \text{ mA}$, $0^{\circ}\text{C} \le \text{T}_\text{J} \le +125^{\circ}\text{C}$	62			55			54			dB
		$V_{MIN} \le V_{IN} \le T_{IN}$	V _{MAX}	(8 ≤	≤ V _{IN} ≤	18)	(15 ≤	≤ V _{IN} ≤	≤ 25)	(18	.5 ≤ V 28.5)		V
R _o	Dropout Voltage	$T_J = 25^{\circ}C, I_O$	= 1A		2.0			2.0			2.0		V
	Output Resistance	f = 1 kHz			8			18			19		mΩ
	Short-Circuit Current	$T_J = 25^{\circ}C$			2.1			1.5			1.2		Α
	Peak Output Current	$T_J = 25^{\circ}C$			2.4			2.4			2.4		A
	Average TC of V _{OUT}	$0^{\circ}C \leq T_{J} \leq +1$	25°C, I _O = 5 mA		-0.6			-1.5			-1.8		mV/°C
V _{IN}	Input Voltage Required to Maintain	T _J = 25°C, I _O	≤ 1A	7.5			14.6			17.7			V
	Line Regulation												

Note 1: Absolute Maximum Ratings are limits beyond which damage to the device may occur. Operating Conditions are conditions under which the device functions but the specifications might not be guaranteed. For guaranteed specifications and test conditions see the Electrical Characteristics.

Note 2: The maximum allowable power dissipation at any ambient temperature is a function of the maximum junction temperature for operation ($T_{JMAX} = 125^{\circ}C$ or 150°C), the junction-to-ambient thermal resistance (θ_{JA}), and the ambient temperature (T_{A}). $P_{DMAX} = (T_{JMAX} - T_{A})/\theta_{JA}$. If this dissipation is exceeded, the die temperature will rise above T_{JMAX} and the electrical specifications do not apply. If the die temperature rises above 150°C, the device will go into thermal shutdown. For the TO-3 package (K, KC), the junction-to-ambient thermal resistance (θ_{JC}) is 39°C/W. When using a heatsink, θ_{JA} is the sum of the 4°C/W junction-to-case thermal resistance (θ_{JC}) of the TO-3 package and the case-to-ambient thermal resistance of the heatsink. For the TO-220 package (T), θ_{JA} is 54°C/W and θ_{JC} is 4°C/W. If SOT-223 is used, the junction-to-ambient thermal resistance is 174°C/W and can be reduced by a heatsink (see Applications Hints on heatsinking).

If the TO-263 package is used, the thermal resistance can be reduced by increasing the PC board copper area thermally connected to the package: Using 0.5 square inches of copper area, θ_{JA} is 50°C/W; with 1 square inch of copper area, θ_{JA} is 32°C/W.

Note 3: ESD rating is based on the human body model, 100 pF discharged through 1.5 k Ω .

Note 4: All characteristics are measured with a 0.22 μ F capacitor from input to ground and a 0.1 μ F 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 $\le 5\%$). Output voltage changes due to changes in internal temperature must be taken into account separately.

Note 5: Military datasheets are available upon request. At the time of printing, the military datasheet specifications for the LM140K-5.0/883, LM140K-12/883, and LM140K-15/883 complied with the min and max limits for the respective versions of the LM140. The LM140H and LM140K may also be procured as JAN devices on slash sheet JM38510/107.

LM7808C Electrical Characteristics

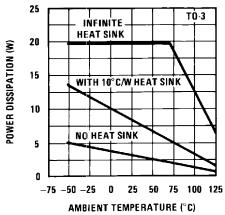
 $0^{\circ}C \leq T_{J} \leq +150^{\circ}C,~V_{I}=14V,~I_{O}=500~mA,~C_{I}=0.33~\mu F,~C_{O}=0.1~\mu F,~unless~otherwise~specified$

Symbol	Paramet	er	Conditions (Note 6)			LM78080	Units	
				Min	Тур	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 ≤ I _O ≤ 1.5A		12	160	mV
				$250 \text{ mA} \leq I_{O} \leq 750$ mA		4.0	80	
Vo	Output Voltage		$11.5V \le V_1 \le 23V, 5.0$	7.6		8.4	V	
I _Q	Quiescent Current		$T_J = 25^{\circ}C$		4.3	8.0	mA	
ΔI_Q	Quiescent	With Line	$11.5V \le V_I \le 25V$	$11.5V \le V_1 \le 25V$				mA
	Current Change	With Load	5.0 mA ≤ I _O ≤ 1.0A				0.5	
V _N	Noise		$T_A = 25^{\circ}C, 10 \text{ Hz} \le f \le 10^{\circ}$	≤ 100 kHz		52		μV
$\Delta V_I / \Delta V_O$	Ripple Rejection		f = 120 Hz, I _O = 350 m	nA, T _J = 25°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		Α
I _{PK}	Peak Output Curren	t	$T_J = 25^{\circ}C$			2.2		Α
$\Delta V_{O}/\Delta T$	Average Temperatu	re	I _O = 5.0 mA			0.8		mV/°C
	Coefficient of Outpu	t Voltage						

Note 6: All characteristics are measured with a 0.22 μ F capacitor from input to ground and a 0.1 μ F 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 $\le 5\%$). Output voltage changes due to changes in internal temperature must be taken into account separately.

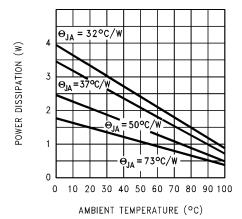
Typical Performance Characteristics

Maximum Average Power Dissipation

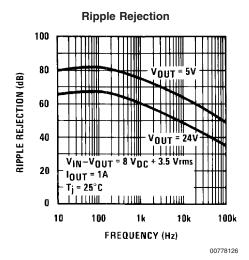


00778122

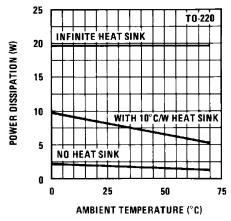
Maximum Power Dissipation (TO-263) (See Note 2)



00778124

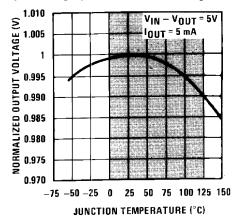


Maximum Average Power Dissipation



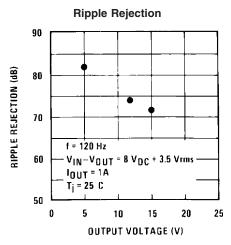
00778123

Output Voltage (Normalized to 1V at $T_J = 25^{\circ}C$)



00778125

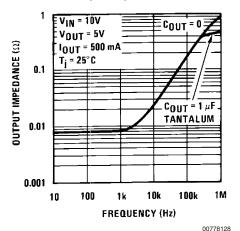
Note: Shaded area refers to LM340A/LM340, LM7805C, LM7812C and LM7815C.



00778127

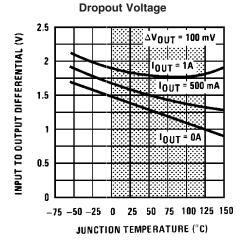
Typical Performance Characteristics (Continued)

Output Impedance



Quiescent Current VIN = 10V VOUT = 5V IOUT = 5 mA 4.5 -75 -50 -25 0 25 50 75 100 125 150 JUNCTION TEMPERATURE (°C)

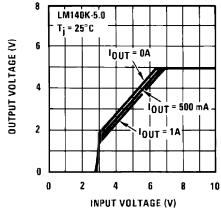
Note: Shaded area refers to LM340A/LM340, LM7805C, LM7812C and LM7815C.



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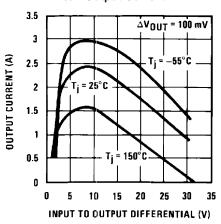
Note: Shaded area refers to LM340A/LM340, LM7805C, LM7812C and LM7815C.

Dropout Characteristics



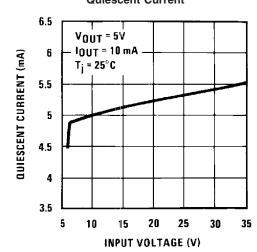
00778129

Peak Output Current

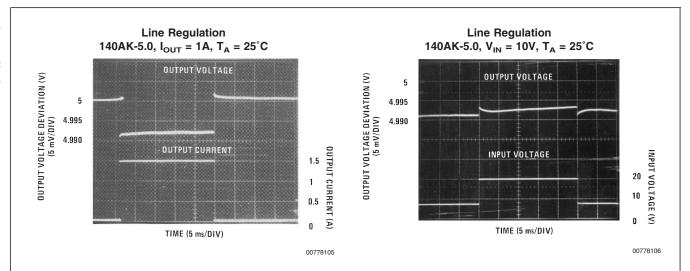


00778131

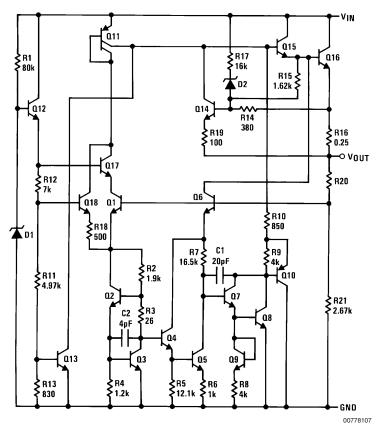
Quiescent Current



00778133



Equivalent Schematic



Application Hints

The LM340/LM78XX series is designed with thermal protection, output short-circuit protection and output transistor safe area protection. However, as with *any* IC regulator, it becomes necessary to take precautions to assure that the regulator is not inadvertently damaged. The following describes possible misapplications and methods to prevent damage to the regulator.

SHORTING THE REGULATOR INPUT

When using large capacitors at the output of these regulators, a protection diode connected input to output (Figure~1) may be required if the input is shorted to ground. Without the protection diode, an input short will cause the input to rapidly approach ground potential, while the output remains near the initial V_{OUT} because of the stored charge in the large output capacitor. The capacitor will then discharge through a large internal input to output diode and parasitic transistors. If the energy released by the capacitor is large enough, this diode, low current metal and the regulator will be destroyed. The fast diode in Figure~1~ will shunt most of the capacitors discharge current around the regulator. Generally no protection diode is required for values of output capacitance $\leq 10~$ u.E.

RAISING THE OUTPUT VOLTAGE ABOVE THE INPUT VOLTAGE

Since the output of the device does not sink current, forcing the output high can cause damage to internal low current paths in a manner similar to that just described in the "Shorting the Regulator Input" section.

REGULATOR FLOATING GROUND (Figure 2)

When the ground pin alone becomes disconnected, the output approaches the unregulated input, causing possible damage to other circuits connected to $V_{\rm OUT}.$ If ground is reconnected with power "ON", damage may also occur to the regulator. This fault is most likely to occur when plugging in regulators or modules with on card regulators into powered up sockets. Power should be turned off first, thermal limit ceases operating, or ground should be connected first if power must be left on.

TRANSIENT VOLTAGES

If transients exceed the maximum rated input voltage of the device, or reach more than 0.8V below ground and have sufficient energy, they will damage the regulator. The solution is to use a large input capacitor, a series input breakdown diode, a choke, a transient suppressor or a combination of these.

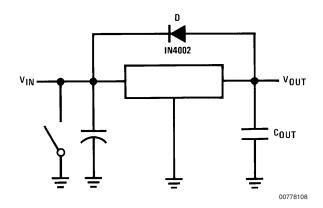


FIGURE 1. Input Short

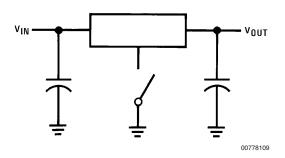


FIGURE 2. Regulator Floating Ground

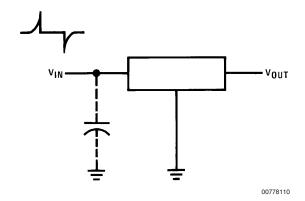


FIGURE 3. Transients

When a value for $\theta_{(H-A)}$ is found using the equation shown, a heatsink must be selected that has a value that is less than or equal to this number.

 $\theta_{(H-A)}$ is specified numerically by the heatsink manufacturer in this catalog, or shown in a curve that plots temperature rise vs power dissipation for the heatsink.

Application Hints (Continued)

HEATSINKING TO-263 AND SOT-223 PACKAGE PARTS

Both the TO-263 ("S") and SOT-223 ("MP") packages use a copper plane on the PCB and the PCB itself as a heatsink. To optimize the heat sinking ability of the plane and PCB, solder the tab of the plane.

shows for the TO-263 the measured values of $\theta_{(J-A)}$ for different copper area sizes using a typical PCB with 1 ounce copper and no solder mask over the copper area used for heatsinking.

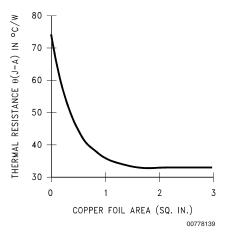


FIGURE 4. $\theta_{(J-A)}$ vs Copper (1 ounce) Area for the TO-263 Package

As shown in the figure, increasing the copper area beyond 1 square inch produces very little improvement. It should also be observed that the minimum value of $\theta_{(J-A)}$ for the TO-263 package mounted to a PCB is $32\,^{\circ}\text{C/W}.$

As a design aid, *Figure 5* shows the maximum allowable power dissipation compared to ambient temperature for the TO-263 device (assuming $\theta_{(J-A)}$ is 35°C/W and the maximum junction temperature is 125°C).

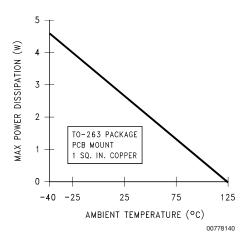


FIGURE 5. Maximum Power Dissipation vs $T_{\rm AMB}$ for the TO-263 Package

Figures 6, 7 show the information for the SOT-223 package. Figure 6 assumes a $\theta_{(J-A)}$ of 74°C/W for 1 ounce copper and 51°C/W for 2 ounce copper and a maximum junction temperature of 125°C.

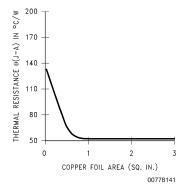


FIGURE 6. $\theta_{(J-A)}$ vs Copper (2 ounce) Area for the SOT-223 Package

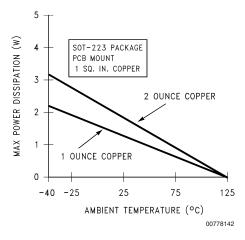
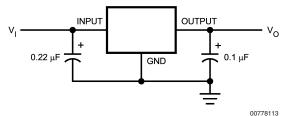


FIGURE 7. Maximum Power Dissipation vs T_{AMB} for the SOT-223 Package

Please see AN-1028 for power enhancement techniques to be used with the SOT-223 package.

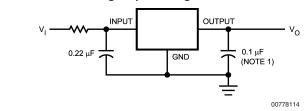
Typical Applications

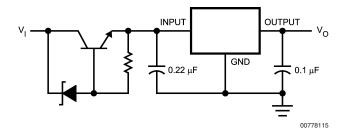
Fixed Output Regulator



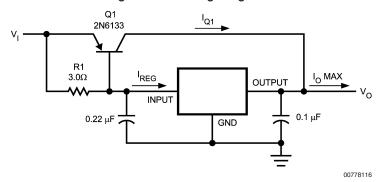
Note: Bypass capacitors are recommended for optimum stability and transient response, and should be located as close as possible to the regulator.

High Input Voltage Circuits





High Current Voltage Regulator

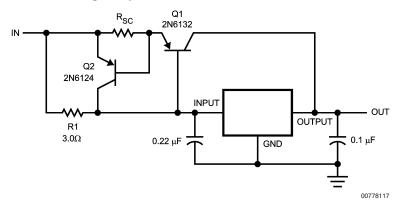


$$\beta(Q1) \ge \frac{I_{O Max}}{I_{REG Max}}$$

$$R1 = \frac{0.9}{I_{REG}} = \frac{\beta(Q1) \ V_{BE(Q1)}}{I_{REG \ Max} (\beta + 1) - I_{O \ Max}}$$

Typical Applications (Continued)

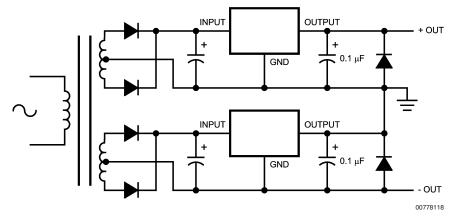
High Output Current, Short Circuit Protected



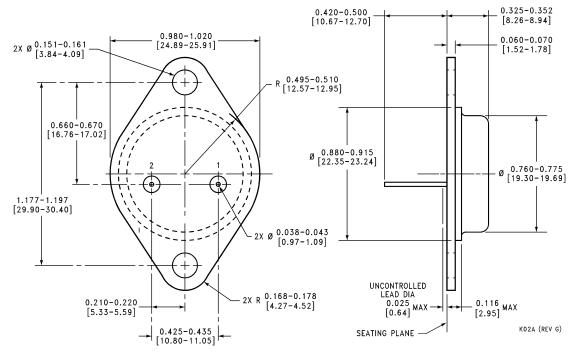
$$R_{SC} = \frac{0.8}{I_{SC}}$$

$$R1 = \frac{\beta V_{BE(Q1)}}{I_{REG Max}(\beta + 1) - I_{O Max}}$$

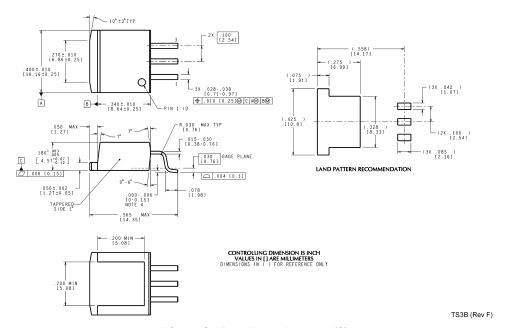
Positive and Negative Regulator



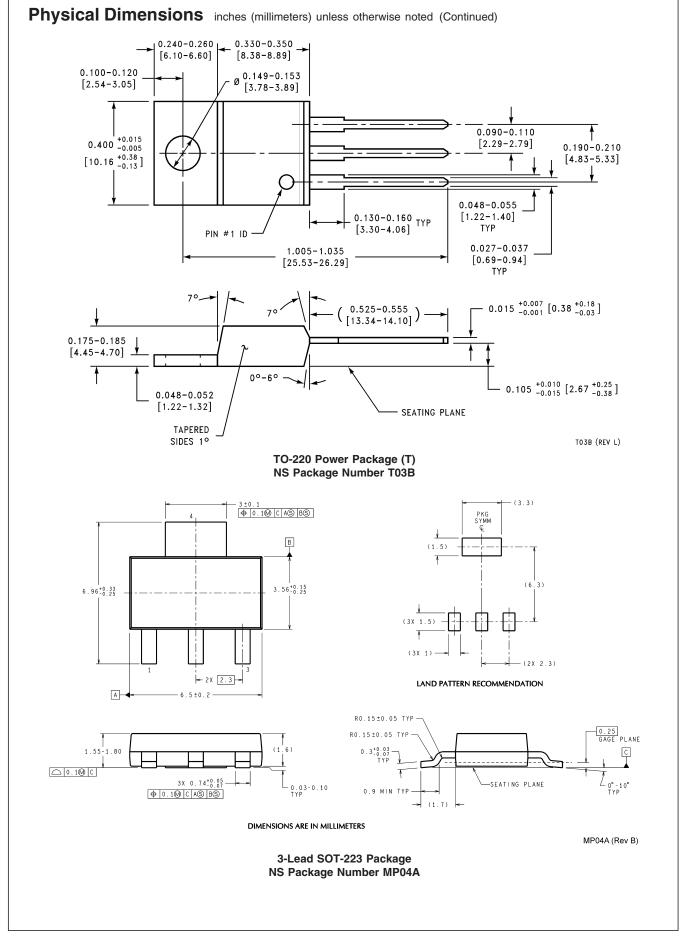
Physical Dimensions inches (millimeters) unless otherwise noted



TO-3 Metal Can Package (K) NS Package Number K02A



TO-263 Surface-Mount Package (S) NS Package Number TS3B



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