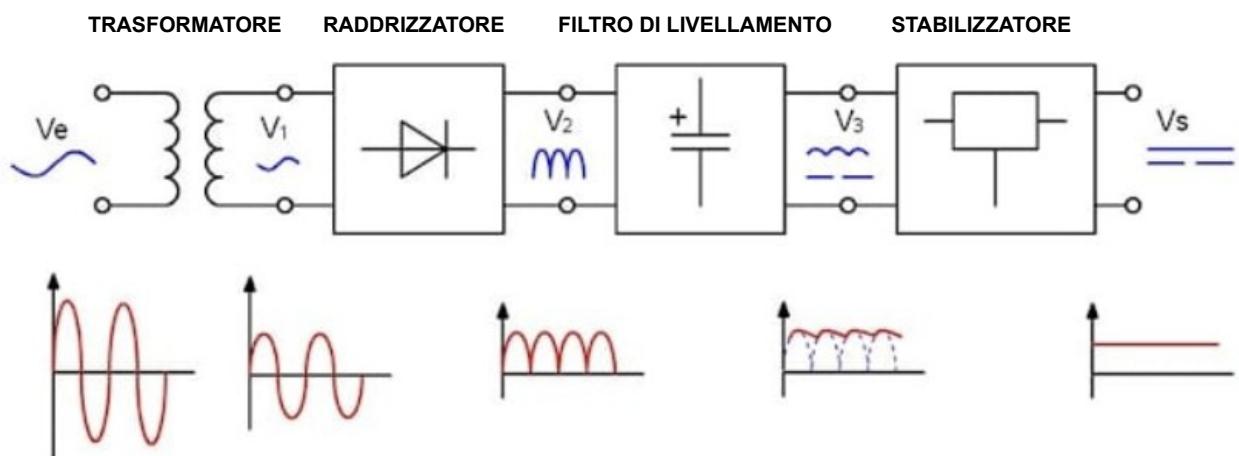


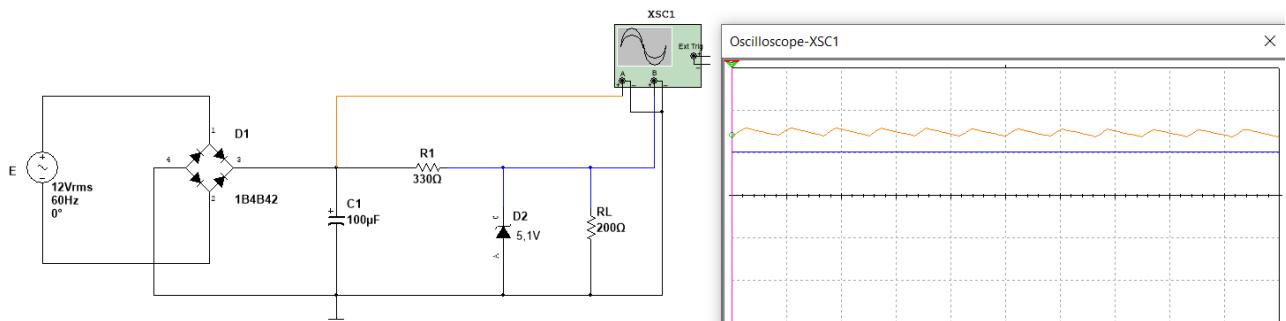
STABILIZZATORI DI TENSIONE

Gli stabilizzatori di tensione sono quei circuiti o componenti, che in un alimentatore in continua vengono inseriti prima del carico. Rappresentano l'ultimo stadio di un alimentatore DC.



Il TRASFORMATORE riduce la tensione alternata, il RADDRIZZATORE la rende tutta positiva, il FILTRO DI LIVELLAMENTO riduce l'oscillazione, lo STABILIZZATORE rende costante la tensione al variare del carico.

Il più semplice circuito per stabilizzare una tensione, è quello costituito da un diodo zener.



Nella figura vediamo le due forme d'onda prima e dopo lo zener. La forma d'onda ai capi del condensatore presenta un'oscillazione tra un massimo ed un minimo dovuta alla carica e scarica del condensatore. Calcolando opportunamente la resistenza $R1$ per un carico di 200 Ohm, si può ottenere una tensione perfettamente costante sul carico RL .

In caso di un carico di minor valore il calcolo della resistenza $R1$ dovrà essere effettuato nuovamente, pertanto questo tipo di stabilizzatore, viene utilizzato quando è ben noto il valore del carico da collegare in uscita.

In commercio esistono dei circuiti integrati che ci permettono di realizzare dei semplici stabilizzatori di tensione con carichi variabili, ma anche con tensioni variabili vediamone qualcuno.

STABILIZZATORI DI TENSIONE FISSI

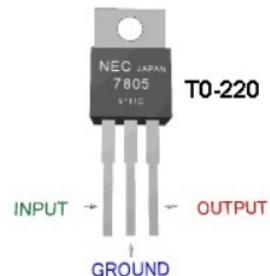
Appartengono a questa famiglia tutti gli stabilizzatori con la sigla 78XX e 79XX, dove con XX viene indicato il valore di tensione stabilizzata.

Ad esempio il 7805, è in grado di fornire una tensione di uscita costante di 5Volt fino ad una corrente massima di circa 1,5 A. Allo stesso modo il 7812 potrà fornire una tensione di uscita di 12 Volt sempre con la stessa corrente massima.

A differenza della serie 78XX la serie 79XX fornisce tensioni negative, ma il funzionamento è lo stesso.

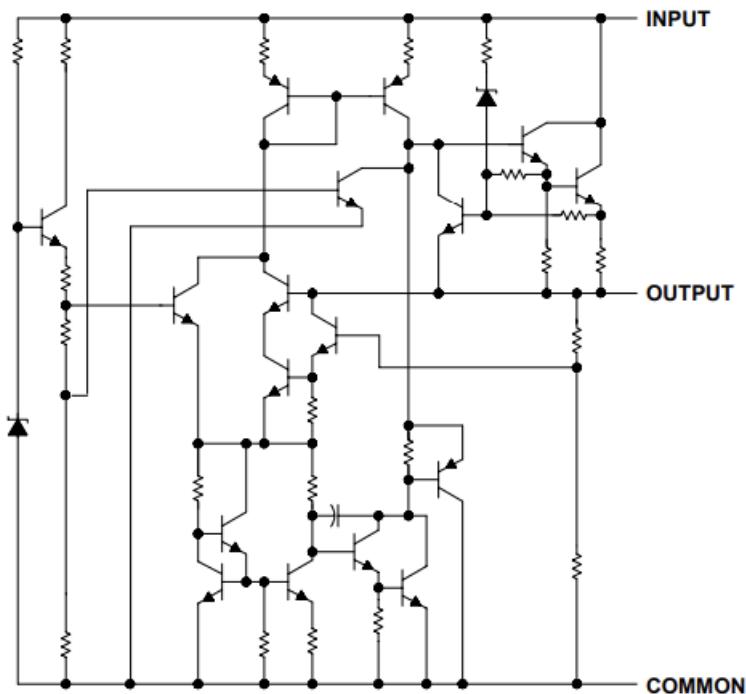
Uno dei contenitori più comuni di questo tipo di integrati è il TO220, la piedinatura è quella in figura.

La tensione di ingresso andrà applicata tra il terminale INPUT e GROUND, la tensione di uscita andrà prelevata tra il terminale OUTPUT e GROUND.



In commercio la sigla completa

Al suo interno il circuito è composto da una rete di transistor e resistenze come quella di seguito rappresentata.



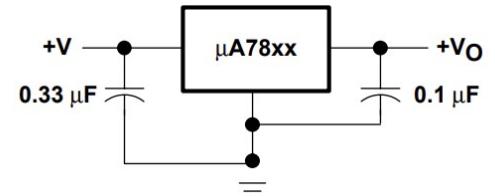
Leggendo il datasheet troviamo che la tensione può variare in un range ampio di valori e dipende dal valore della tensione di uscita.

Più esattamente il valore minimo della tensione di ingresso deve essere superiore di 2 Volt di quello della tensione di uscita. In pratica al minimo la caduta di tensione tra ingresso ed uscita sarà di 2 Volt.

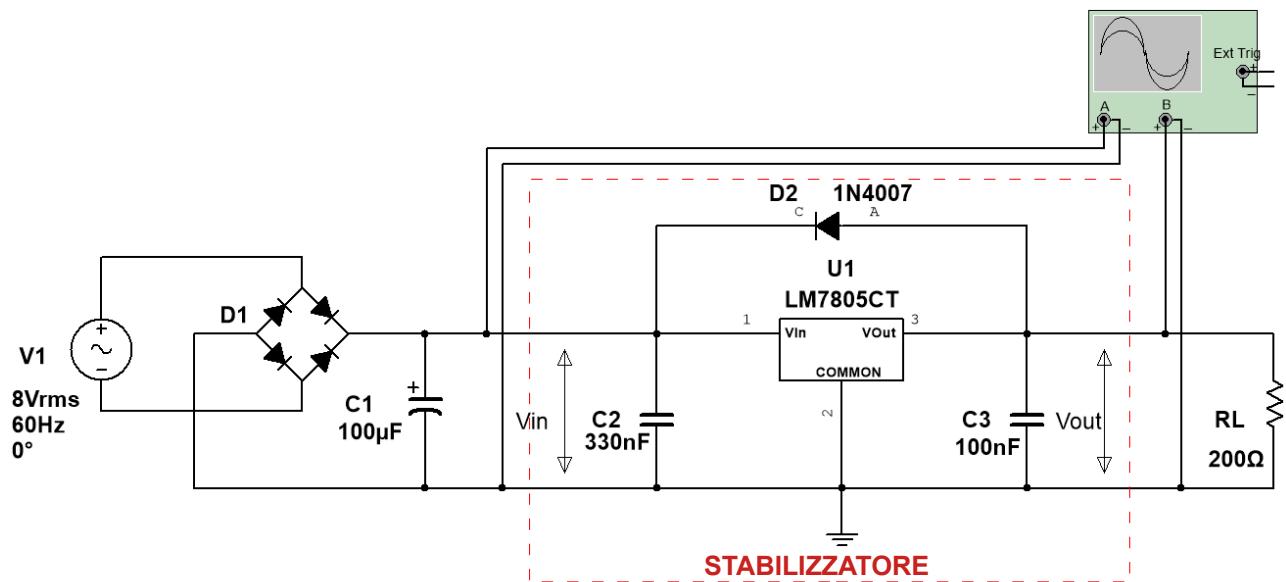
V_I	Input voltage	$\mu A7805C$	7	25	V
		$\mu A7808C$	10.5	25	
		$\mu A7810C$	12.5	28	
		$\mu A7812C$	14.5	30	
		$\mu A7815C$	17.5	30	
I_O	Output current	$\mu A7824C$	27	38	
				1.5	A

Questo valore di tensione viene definito **tensione di Dropout**.

Leggendo il datasheet del 7805, troviamo il seguente circuito d'esempio:



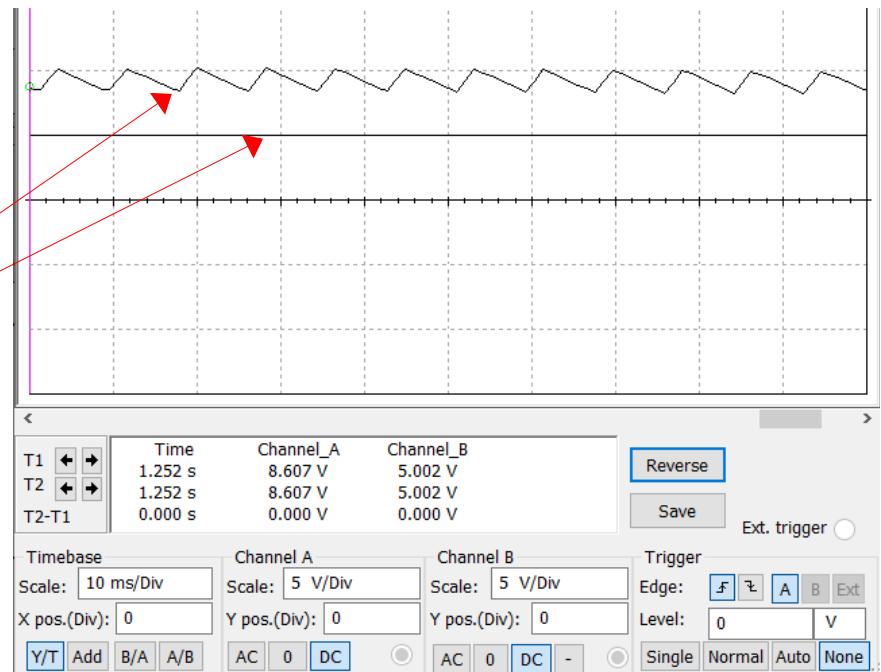
Lo schema completo di un semplice alimentatore diventerà pertanto il seguente:



- I condensatori C2 e C3 non influiscono sulla stabilizzazione della tensione, ma vengono messi per filtrare eventuali oscillazioni, il valore consigliato nel datasheet è quello dello schema, ma possono essere inseriti anche ulteriori condensatori elettrolitici di valore superiore ai 10uF.
- Il diodo D2 non influisce sulla stabilizzazione della tensione, ma viene messo per proteggere lo stesso integrato quando alimenta dei carichi capacitivi. In questo caso allo spegnimento del circuito, avremo una tensione residua in uscita che tramite il diodo D2 verrà riportata in ingresso anziché fatta scaricare sull'uscita stessa.

Le forme d'onda del circuito visto sopra quelle in figura.

Si può notare in alto un oscillazione della tensione in ingresso di circa 2 Volt (8 - 10V) ed in basso la tensione di uscita fissa a 5Volt.



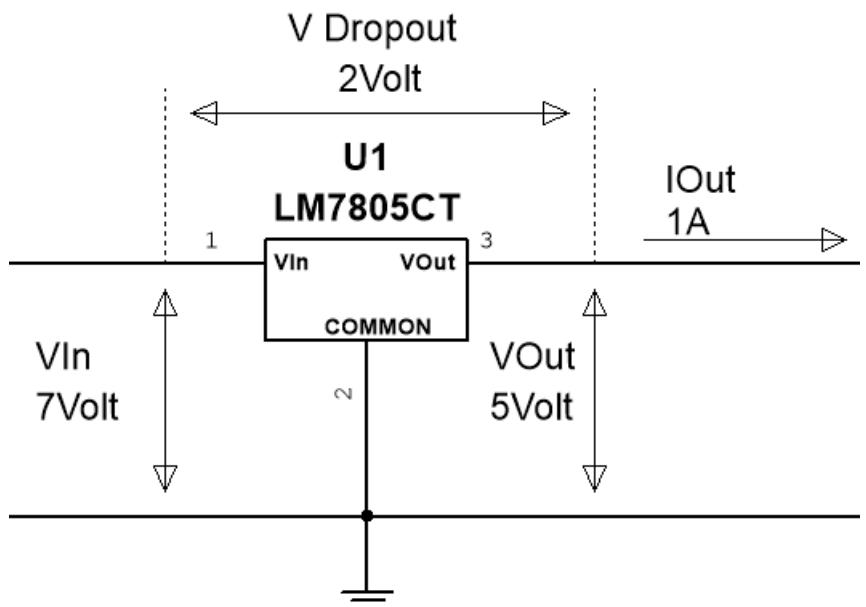
La corrente di uscita massima secondo il datasheet è di 1,5A, e superando questo valore interverrà un circuito di protezione interno.

Durante il progetto bisogna però fare attenzione alla tensione di dropout citata prima.

Supponendo infatti di alimentare un carico che assorbe una corrente di circa 1A, se la tensione di ingresso è superiore di 2 Volt di quella di uscita (condizione minima per stabilizzare) allora il componente dovrà dissipare una potenza di 2Watt.

E' importante pertanto non utilizzare mai una tensione troppo alta in ingresso, altrimenti la potenza da dissipare sarebbe troppo alta.

I 2 Watt sopra citati comunque, non sono una potenza bassa, in quanto rendono indispensabile un dissipatore di calore sul componente.

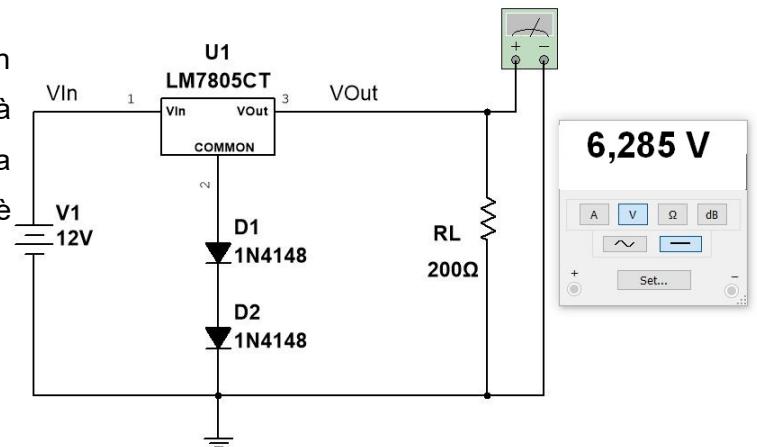


L'applicazione vista ora per questo tipo di integrato, è la più comune, ma in realtà può essere utilizzato anche in altro modo.

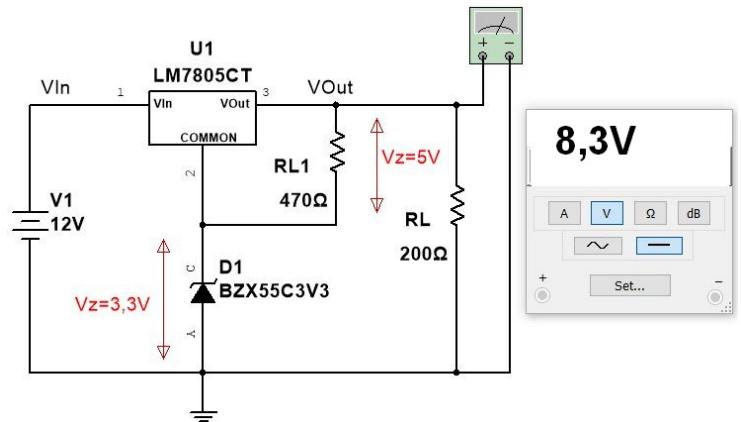
Approfondiamo ora altre possibili applicazioni.

Partiamo innanzitutto da un presupposto, il pin centrale identificato con COMMON, non deve obbligatoriamente essere collegato alla GND del circuito, in quanto il regolatore fornisce una tensione di 5Volt tra il pin di uscita ed il pin Comune.

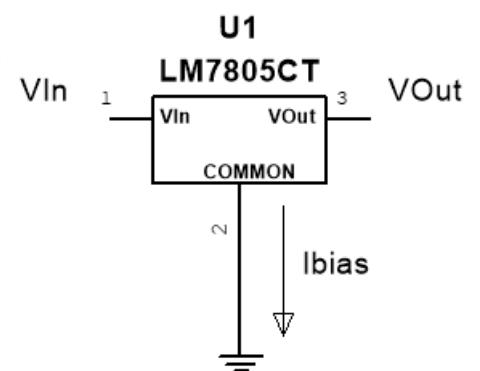
Pertanto se inseriamo due diodi in serie tra il pin COMMON e la GND, la tensione di uscita sarà data dalla tensione di 5Volt sommata a quella presente sul pin COMMON che con due diodi è di circa 1,3Volt.



Allo stesso modo utilizzando un diodo zener connesso al pin COMMON, avremo che la tensione di uscita sarà aumentata del valore di V_z .



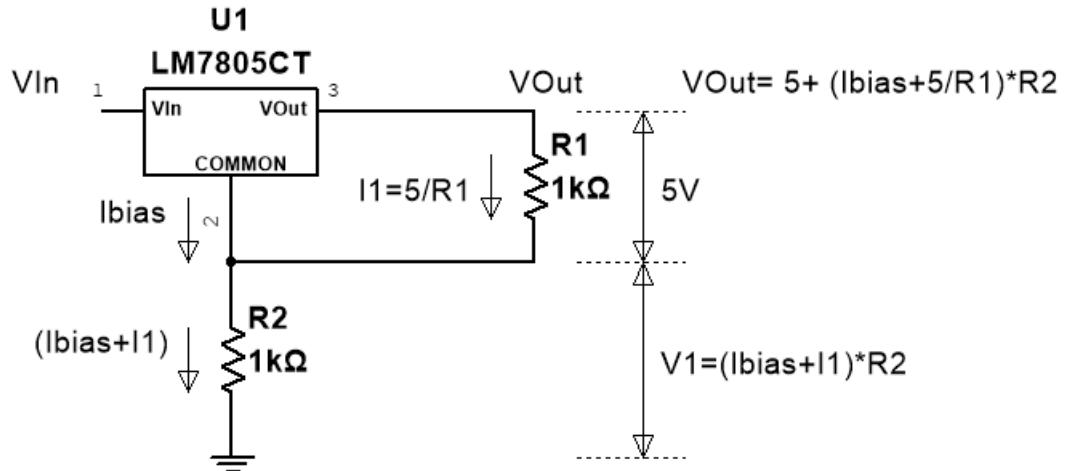
Un'altra informazione importante è quella relativa alla corrente di bias, cioè la corrente che esce dal terminale COMMON.



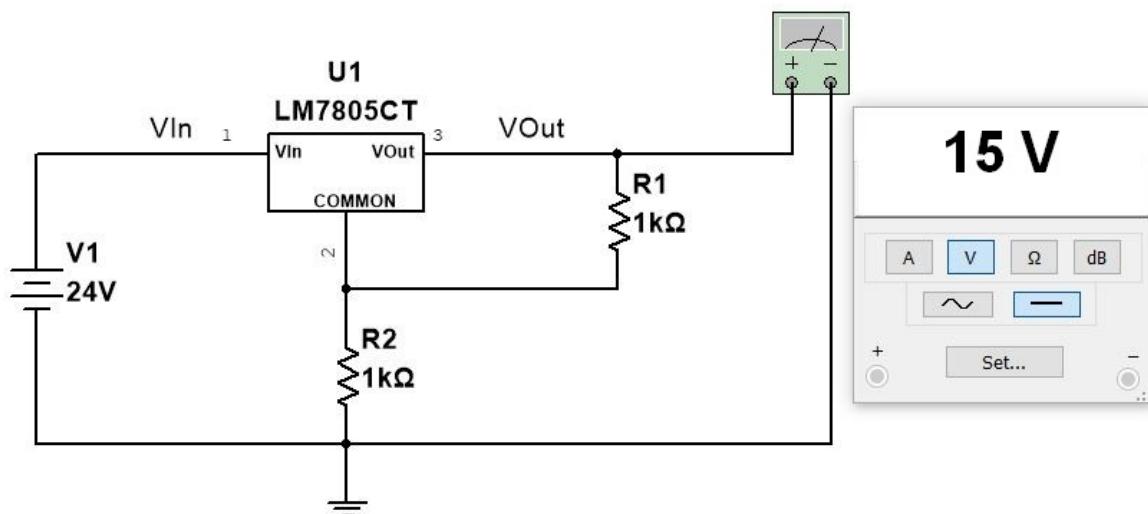
Leggendo il datasheet troviamo il valore della corrente di Bias e la sua massima variazione. Possiamo pertanto ipotizzare un valore medio di circa 5mA.

Bias current		25°C	4.2	8	mA
Bias current change	$V_I = 7 \text{ V to } 25 \text{ V}$ $I_O = 5 \text{ mA to } 1 \text{ A}$	$0^\circ\text{C to } 125^\circ\text{C}$	1.3	0.5	mA

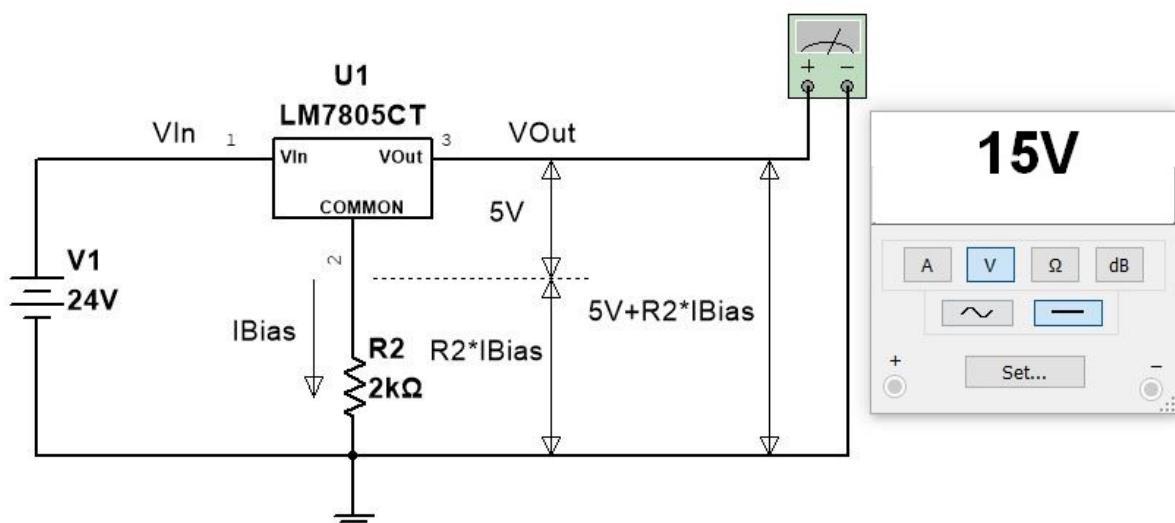
Possiamo utilizzare questa corrente di 5 mA per creare con una resistenza, una tensione sul pin COMMON in modo da avere un'uscita dipendente dal valore della resistenza.



Ad esempio nel circuito in figura la tensione di uscita sarebbe pari a 15 Volt, ovviamente la V_{in} dovrà essere almeno 17 Volt perché vale sempre la relazione $V_{in} = V_{out} + V_{Dropout}$, cioè $V_{in} = V_{out} + 2V$.

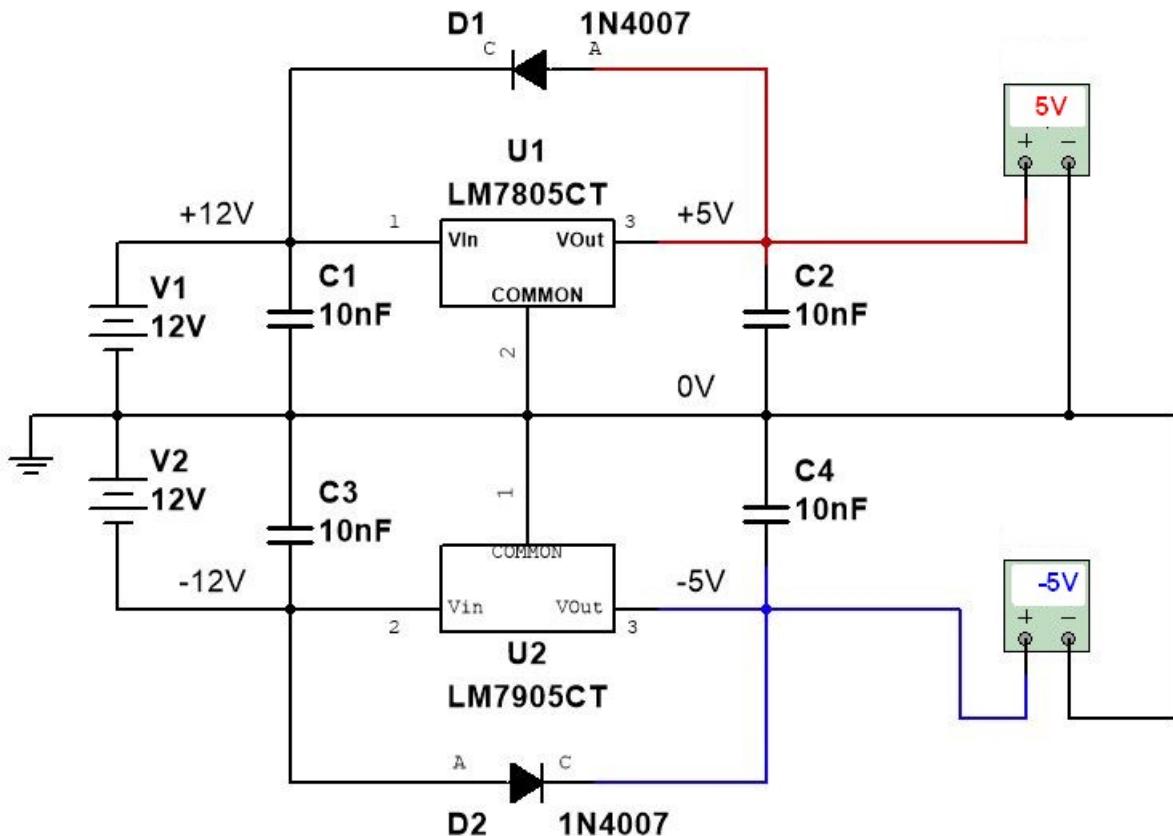


Lo stesso risultato lo possiamo ottenere inserendo una sola resistenza.

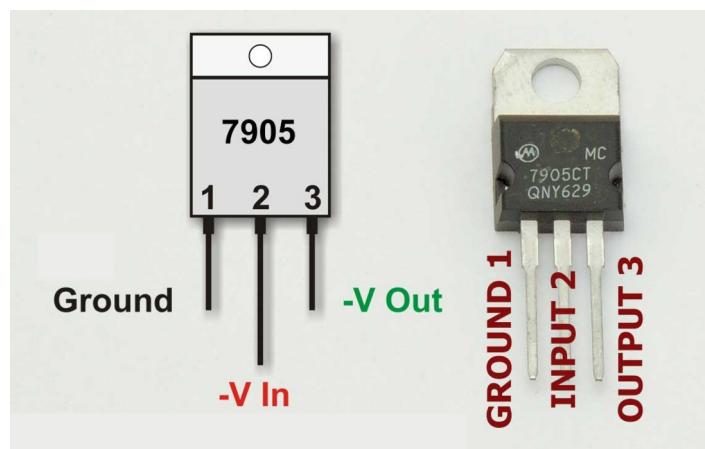


STABILIZZATORI DI TENSIONE NEGATIVI SERIE 79XX

Quanto detto sopra vale esattamente allo stesso modo per gli stabilizzatori di tensione negativi, un esempio di utilizzo degli stabilizzatori di tensione negativi è il seguente:



Inoltre gli integrati della serie 79XX, presentano una piedinatura differente rispetto ai 78XX



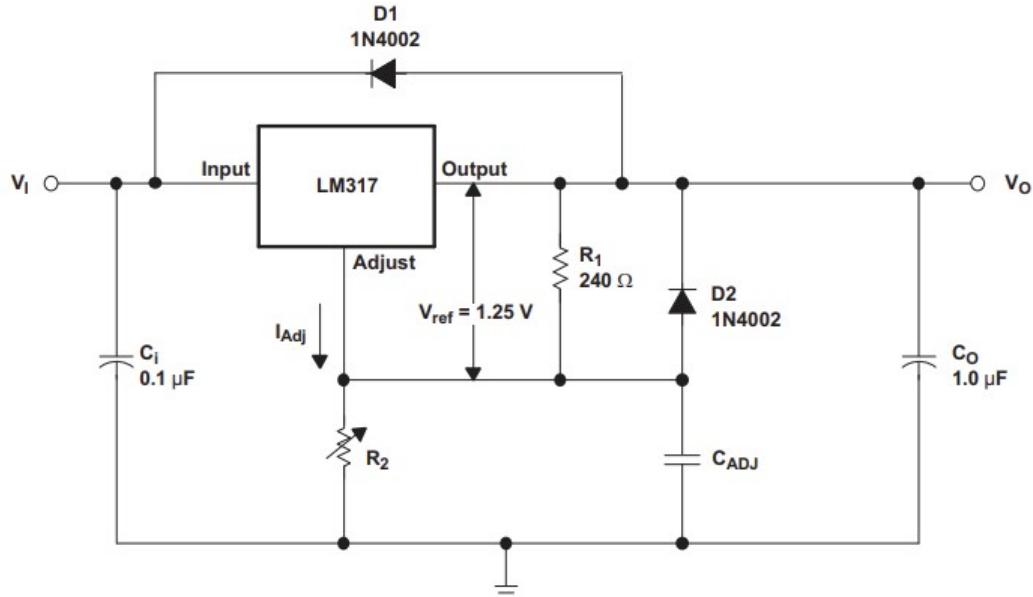
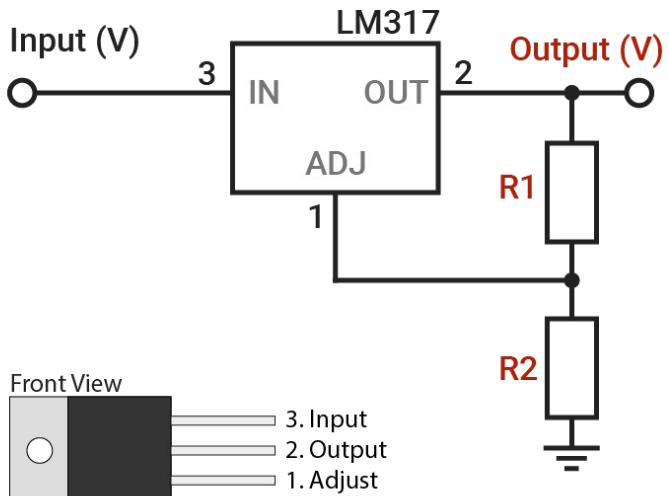
STABILIZZATORI DI TENSIONE VARIABILI

Uno dei più noti stabilizzatori di tensione variabili, è l'integrato LM317.

In questo integrato ritroviamo parte dei ragionamenti fatti per gli stabilizzatori di tensione fissi.

Anche in questo caso ad esempio vengono inseriti dei condensatori in ingresso ed in uscita, ed un diodo tra l'uscita e l'ingresso.

Sul datasheet dell'integrato troviamo il seguente schema d'esempio.



Come si può notare oltre ai due condensatori Ci e Co di ingresso e di uscita presenti anche negli stabilizzatori fissi c'è un condensatore sul terminale Adjust. Ed oltre al diodo D1, c'è un diodo tra il pin Output ed Adjust. **Questi componenti sono aggiuntivi e non pregiudicano il funzionamento dell'integrato come regolatore di tensione.**

Considerando che l'integrato mantiene una tensione Vref costante ad un valore di 1,25 Volt tra il pin Out ed Adjust, la tensione di uscita sarà data dalla seguente formula:

$$V_{Out} = V_{ref} \cdot \left(1 + \frac{R_2}{R_1}\right) + I_{ADJ} \cdot R_2 \quad \text{Considerando che } I_{ADJ} = 50 \mu\text{A} \text{ possiamo approssimare e}$$

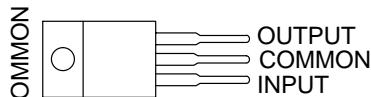
considerare la seguente formula. $V_{Out} = V_{ref} \cdot \left(1 + \frac{R_2}{R_1}\right)$.

Nei datasheet allegati di seguito vengono fornite ulteriori indicazioni, come il tipo di contenitori o altre possibili applicazioni.

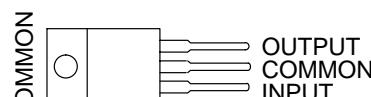
- 3-Terminal Regulators
- Output Current up to 1.5 A
- Internal Thermal-Overload Protection

- High Power-Dissipation Capability
- Internal Short-Circuit Current Limiting
- Output Transistor Safe-Area Compensation

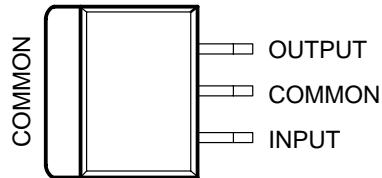
KC (TO-220) PACKAGE
(TOP VIEW)



KCS (TO-220) PACKAGE
(TOP VIEW)



KTE PACKAGE
(TOP VIEW)



description/ordering information

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 1.5 A of output current. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload. In addition to use as fixed-voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents, and also can be used as the power-pass element in precision regulators.

ORDERING INFORMATION

T _J	V _{O(NOM)} (V)	PACKAGE [†]	ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 125°C	5	POWER-FLEX (KTE)	Reel of 2000	μA7805CKTER
		TO-220 (KC)	Tube of 50	μA7805CKC
		TO-220, short shoulder (KCS)	Tube of 20	μA7805CKCS
	8	POWER-FLEX (KTE)	Reel of 2000	μA7808CKTER
		TO-220 (KC)	Tube of 50	μA7808CKC
		TO-220, short shoulder (KCS)	Tube of 20	μA7808CKCS
	10	POWER-FLEX (KTE)	Reel of 2000	μA7810CKTER
		TO-220 (KC)	Tube of 50	μA7810CKC
		TO-220, short shoulder (KCS)	Tube of 20	μA7810CKCS
	12	POWER-FLEX (KTE)	Reel of 2000	μA7812CKTER
		TO-220 (KC)	Tube of 50	μA7812CKC
		TO-220, short shoulder (KCS)	Tube of 20	μA7812CKCS
	15	POWER-FLEX (KTE)	Reel of 2000	μA7815CKTER
		TO-220 (KC)	Tube of 50	μA7815CKC
		TO-220, short shoulder (KCS)	Tube of 20	μA7815CKCS
	24	POWER-FLEX (KTE)	Reel of 2000	μA7824CKTER
		TO-220 (KC)	Tube of 50	μA7824CKC

[†] Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

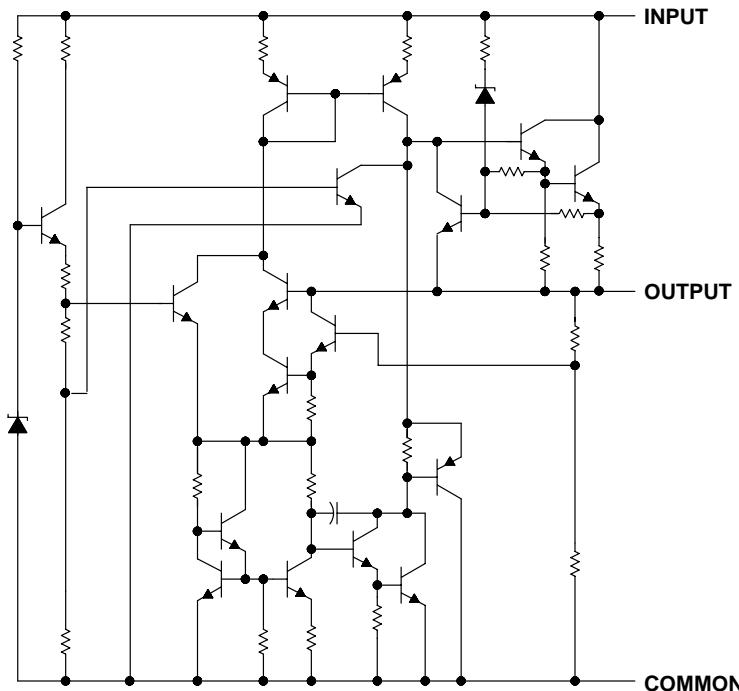


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

μ A7800 SERIES POSITIVE-VOLTAGE REGULATORS

SLVS056J – MAY 1976 – REVISED MAY 2003

schematic



absolute maximum ratings over virtual junction temperature range (unless otherwise noted)[†]

Input voltage, V_I : μ A7824C	.....	40 V
All others	.....	35 V
Operating virtual junction temperature, T_J	.....	150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	.....	260°C
Storage temperature range, T_{stg}	.....	-65°C to 150°C

[†] Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

package thermal data (see Note 1)

PACKAGE	BOARD	θ_{JC}	θ_{JA}
POWER-FLEX (KTE)	High K, JESD 51-5	3°C/W	23°C/W
TO-220 (KC/KCS)	High K, JESD 51-5	3°C/W	19°C/W

NOTE 1: Maximum power dissipation is a function of $T_J(\max)$, θ_{JA} , and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(\max) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

recommended operating conditions

		MIN	MAX	UNIT
V _I Input voltage	μA7805C	7	25	V
	μA7808C	10.5	25	
	μA7810C	12.5	28	
	μA7812C	14.5	30	
	μA7815C	17.5	30	
	μA7824C	27	38	
I _O Output current			1.5	A
T _J Operating virtual junction temperature	μA7800C series	0	125	°C

electrical characteristics at specified virtual junction temperature, V_I = 10 V, I_O = 500 mA (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T _J [†]	μA7805C			UNIT
			MIN	TYP	MAX	
Output voltage	I _O = 5 mA to 1 A, V _I = 7 V to 20 V, P _D ≤ 15 W	25°C	4.8	5	5.2	V
		0°C to 125°C	4.75		5.25	
Input voltage regulation	V _I = 7 V to 25 V	25°C		3	100	mV
	V _I = 8 V to 12 V			1	50	
Ripple rejection	V _I = 8 V to 18 V, f = 120 Hz	0°C to 125°C	62	78		dB
Output voltage regulation	I _O = 5 mA to 1.5 A	25°C		15	100	mV
	I _O = 250 mA to 750 mA			5	50	
Output resistance	f = 1 kHz	0°C to 125°C		0.017		Ω
Temperature coefficient of output voltage	I _O = 5 mA	0°C to 125°C		-1.1		mV/°C
Output noise voltage	f = 10 Hz to 100 kHz	25°C		40		µV
Dropout voltage	I _O = 1 A	25°C		2		V
Bias current		25°C		4.2	8	mA
Bias current change	V _I = 7 V to 25 V	0°C to 125°C		1.3		mA
	I _O = 5 mA to 1 A			0.5		
Short-circuit output current		25°C		750		mA
Peak output current		25°C		2.2		A

[†] Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-µF capacitor across the input and a 0.1-µF capacitor across the output.

μA7800 SERIES POSITIVE-VOLTAGE REGULATORS

SLVS056J – MAY 1976 – REVISED MAY 2003

electrical characteristics at specified virtual junction temperature, $V_I = 14 \text{ V}$, $I_O = 500 \text{ mA}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_J^\dagger	μA7808C			UNIT
			MIN	TYP	MAX	
Output voltage	$I_O = 5 \text{ mA to } 1 \text{ A}$, $V_I = 10.5 \text{ V to } 23 \text{ V}$, $P_D \leq 15 \text{ W}$	25°C	7.7	8	8.3	V
		0°C to 125°C	7.6		8.4	
Input voltage regulation	$V_I = 10.5 \text{ V to } 25 \text{ V}$	25°C		6	160	mV
	$V_I = 11 \text{ V to } 17 \text{ V}$			2	80	
Ripple rejection	$V_I = 11.5 \text{ V to } 21.5 \text{ V}$, $f = 120 \text{ Hz}$	0°C to 125°C	55	72		dB
Output voltage regulation	$I_O = 5 \text{ mA to } 1.5 \text{ A}$	25°C		12	160	mV
	$I_O = 250 \text{ mA to } 750 \text{ mA}$			4	80	
Output resistance	$f = 1 \text{ kHz}$	0°C to 125°C		0.016		Ω
Temperature coefficient of output voltage	$I_O = 5 \text{ mA}$	0°C to 125°C		-0.8		mV/°C
Output noise voltage	$f = 10 \text{ Hz to } 100 \text{ kHz}$	25°C		52		μV
Dropout voltage	$I_O = 1 \text{ A}$	25°C		2		V
Bias current		25°C		4.3	8	mA
Bias current change	$V_I = 10.5 \text{ V to } 25 \text{ V}$	0°C to 125°C			1	mA
	$I_O = 5 \text{ mA to } 1 \text{ A}$				0.5	
Short-circuit output current		25°C		450		mA
Peak output current		25°C		2.2		A

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-μF capacitor across the input and a 0.1-μF capacitor across the output.

electrical characteristics at specified virtual junction temperature, $V_I = 17 \text{ V}$, $I_O = 500 \text{ mA}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_J^\dagger	μA7810C			UNIT
			MIN	TYP	MAX	
Output voltage	$I_O = 5 \text{ mA to } 1 \text{ A}$, $V_I = 12.5 \text{ V to } 25 \text{ V}$, $P_D \leq 15 \text{ W}$	25°C	9.6	10	10.4	V
		0°C to 125°C	9.5	10	10.5	
Input voltage regulation	$V_I = 12.5 \text{ V to } 28 \text{ V}$	25°C		7	200	mV
	$V_I = 14 \text{ V to } 20 \text{ V}$			2	100	
Ripple rejection	$V_I = 13 \text{ V to } 23 \text{ V}$, $f = 120 \text{ Hz}$	0°C to 125°C	55	71		dB
Output voltage regulation	$I_O = 5 \text{ mA to } 1.5 \text{ A}$	25°C		12	200	mV
	$I_O = 250 \text{ mA to } 750 \text{ mA}$			4	100	
Output resistance	$f = 1 \text{ kHz}$	0°C to 125°C		0.018		Ω
Temperature coefficient of output voltage	$I_O = 5 \text{ mA}$	0°C to 125°C		-1		mV/°C
Output noise voltage	$f = 10 \text{ Hz to } 100 \text{ kHz}$	25°C		70		μV
Dropout voltage	$I_O = 1 \text{ A}$	25°C		2		V
Bias current		25°C		4.3	8	mA
Bias current change	$V_I = 12.5 \text{ V to } 28 \text{ V}$	0°C to 125°C			1	mA
	$I_O = 5 \text{ mA to } 1 \text{ A}$				0.5	
Short-circuit output current		25°C		400		mA
Peak output current		25°C		2.2		A

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-μF capacitor across the input and a 0.1-μF capacitor across the output.



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electrical characteristics at specified virtual junction temperature, $V_J = 19\text{ V}$, $I_O = 500\text{ mA}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_J^\dagger	$\mu A7812C$			UNIT
			MIN	TYP	MAX	
Output voltage	$I_O = 5\text{ mA to } 1\text{ A}$, $V_J = 14.5\text{ V to } 27\text{ V}$, $P_D \leq 15\text{ W}$	25°C	11.5	12	12.5	V
		0°C to 125°C	11.4		12.6	
Input voltage regulation	$V_J = 14.5\text{ V to } 30\text{ V}$ $V_J = 16\text{ V to } 22\text{ V}$	25°C		10	240	mV
				3	120	
Ripple rejection	$V_J = 15\text{ V to } 25\text{ V}$, $f = 120\text{ Hz}$	0°C to 125°C	55	71		dB
Output voltage regulation	$I_O = 5\text{ mA to } 1.5\text{ A}$ $I_O = 250\text{ mA to } 750\text{ mA}$	25°C		12	240	mV
				4	120	
Output resistance	$f = 1\text{ kHz}$	0°C to 125°C		0.018		Ω
Temperature coefficient of output voltage	$I_O = 5\text{ mA}$	0°C to 125°C		-1		mV/°C
Output noise voltage	$f = 10\text{ Hz to } 100\text{ kHz}$	25°C		75		µV
Dropout voltage	$I_O = 1\text{ A}$	25°C		2		V
Bias current		25°C		4.3	8	mA
Bias current change	$V_J = 14.5\text{ V to } 30\text{ V}$ $I_O = 5\text{ mA to } 1\text{ A}$	0°C to 125°C		1		mA
				0.5		
Short-circuit output current		25°C		350		mA
Peak output current		25°C		2.2		A

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-µF capacitor across the input and a 0.1-µF capacitor across the output.

electrical characteristics at specified virtual junction temperature, $V_J = 23\text{ V}$, $I_O = 500\text{ mA}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_J^\dagger	$\mu A7815C$			UNIT
			MIN	TYP	MAX	
Output voltage	$I_O = 5\text{ mA to } 1\text{ A}$, $V_J = 17.5\text{ V to } 30\text{ V}$, $P_D \leq 15\text{ W}$	25°C	14.4	15	15.6	V
		0°C to 125°C	14.25		15.75	
Input voltage regulation	$V_J = 17.5\text{ V to } 30\text{ V}$ $V_J = 20\text{ V to } 26\text{ V}$	25°C		11	300	mV
				3	150	
Ripple rejection	$V_J = 18.5\text{ V to } 28.5\text{ V}$, $f = 120\text{ Hz}$	0°C to 125°C	54	70		dB
Output voltage regulation	$I_O = 5\text{ mA to } 1.5\text{ A}$ $I_O = 250\text{ mA to } 750\text{ mA}$	25°C		12	300	mV
				4	150	
Output resistance	$f = 1\text{ kHz}$	0°C to 125°C		0.019		Ω
Temperature coefficient of output voltage	$I_O = 5\text{ mA}$	0°C to 125°C		-1		mV/°C
Output noise voltage	$f = 10\text{ Hz to } 100\text{ kHz}$	25°C		90		µV
Dropout voltage	$I_O = 1\text{ A}$	25°C		2		V
Bias current		25°C		4.4	8	mA
Bias current change	$V_J = 17.5\text{ V to } 30\text{ V}$ $I_O = 5\text{ mA to } 1\text{ A}$	0°C to 125°C		1		mA
				0.5		
Short-circuit output current		25°C		230		mA
Peak output current		25°C		2.1		A

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-µF capacitor across the input and a 0.1-µF capacitor across the output.

μ A7800 SERIES POSITIVE-VOLTAGE REGULATORS

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electrical characteristics at specified virtual junction temperature, $V_I = 33$ V, $I_O = 500$ mA (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_J^\dagger	μ A7824C			UNIT
			MIN	TYP	MAX	
Output voltage	$I_O = 5$ mA to 1 A, $V_I = 27$ V to 38 V, $P_D \leq 15$ W	25°C	23	24	25	V
		0°C to 125°C	22.8		25.2	
Input voltage regulation	$V_I = 27$ V to 38 V	25°C		18	480	mV
	$V_I = 30$ V to 36 V			6	240	
Ripple rejection	$V_I = 28$ V to 38 V, $f = 120$ Hz	0°C to 125°C	50	66		dB
Output voltage regulation	$I_O = 5$ mA to 1.5 A	25°C		12	480	mV
	$I_O = 250$ mA to 750 mA			4	240	
Output resistance	$f = 1$ kHz	0°C to 125°C		0.028		Ω
Temperature coefficient of output voltage	$I_O = 5$ mA	0°C to 125°C		-1.5		mV/°C
Output noise voltage	$f = 10$ Hz to 100 kHz	25°C		170		μ V
Dropout voltage	$I_O = 1$ A	25°C		2		V
Bias current		25°C		4.6	8	mA
Bias current change	$V_I = 27$ V to 38 V	0°C to 125°C			1	mA
	$I_O = 5$ mA to 1 A				0.5	
Short-circuit output current		25°C		150		mA
Peak output current		25°C		2.1		A

[†] Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33- μ F capacitor across the input and a 0.1- μ F capacitor across the output.



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APPLICATION INFORMATION

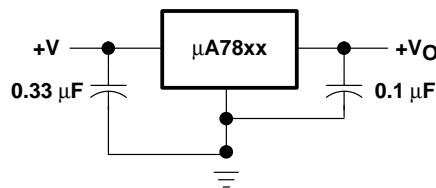


Figure 1. Fixed-Output Regulator

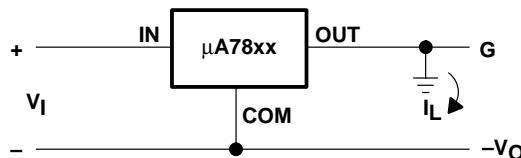
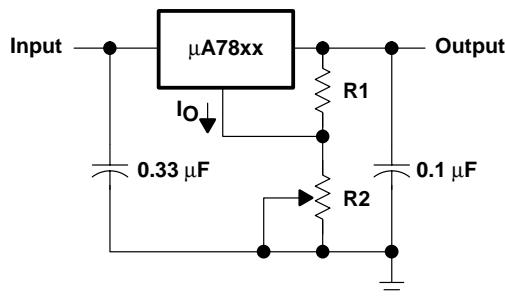


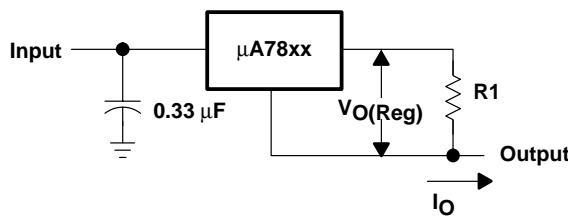
Figure 2. Positive Regulator in Negative Configuration (V_I Must Float)



NOTE A: The following formula is used when V_{XX} is the nominal output voltage (output to common) of the fixed regulator:

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

Figure 3. Adjustable-Output Regulator



$$I_O = (V_O/R_1) + I_Q \text{ Bias Current}$$

Figure 4. Current Regulator

μ A7800 SERIES POSITIVE-VOLTAGE REGULATORS

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APPLICATION INFORMATION

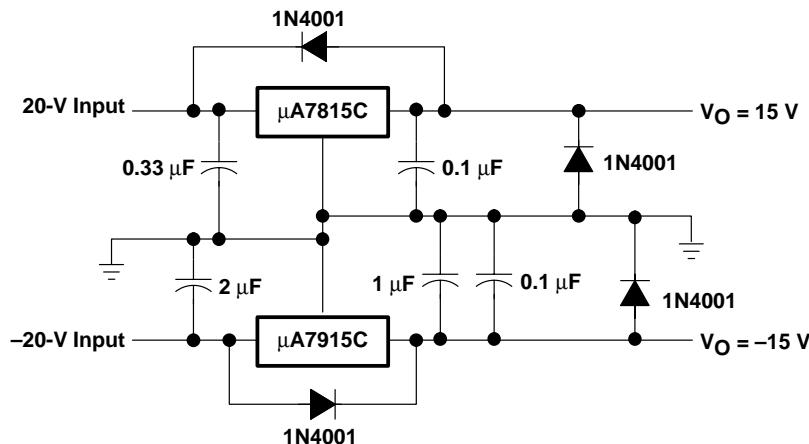


Figure 5. Regulated Dual Supply

operation with a load common to a voltage of opposite polarity

In many cases, a regulator powers a load that is not connected to ground but, instead, is connected to a voltage source of opposite polarity (e.g., operational amplifiers, level-shifting circuits, etc.). In these cases, a clamp diode should be connected to the regulator output as shown in Figure 6. This protects the regulator from output polarity reversals during startup and short-circuit operation.

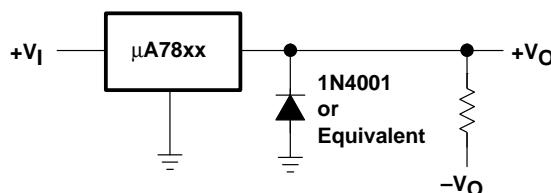


Figure 6. Output Polarity-Reversal-Protection Circuit

reverse-bias protection

Occasionally, the input voltage to the regulator can collapse faster than the output voltage. This can occur, for example, when the input supply is crowbarred during an output overvoltage condition. If the output voltage is greater than approximately 7 V, the emitter-base junction of the series-pass element (internal or external) could break down and be damaged. To prevent this, a diode shunt can be used as shown in Figure 7.

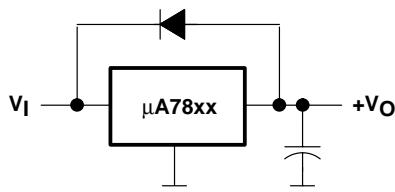
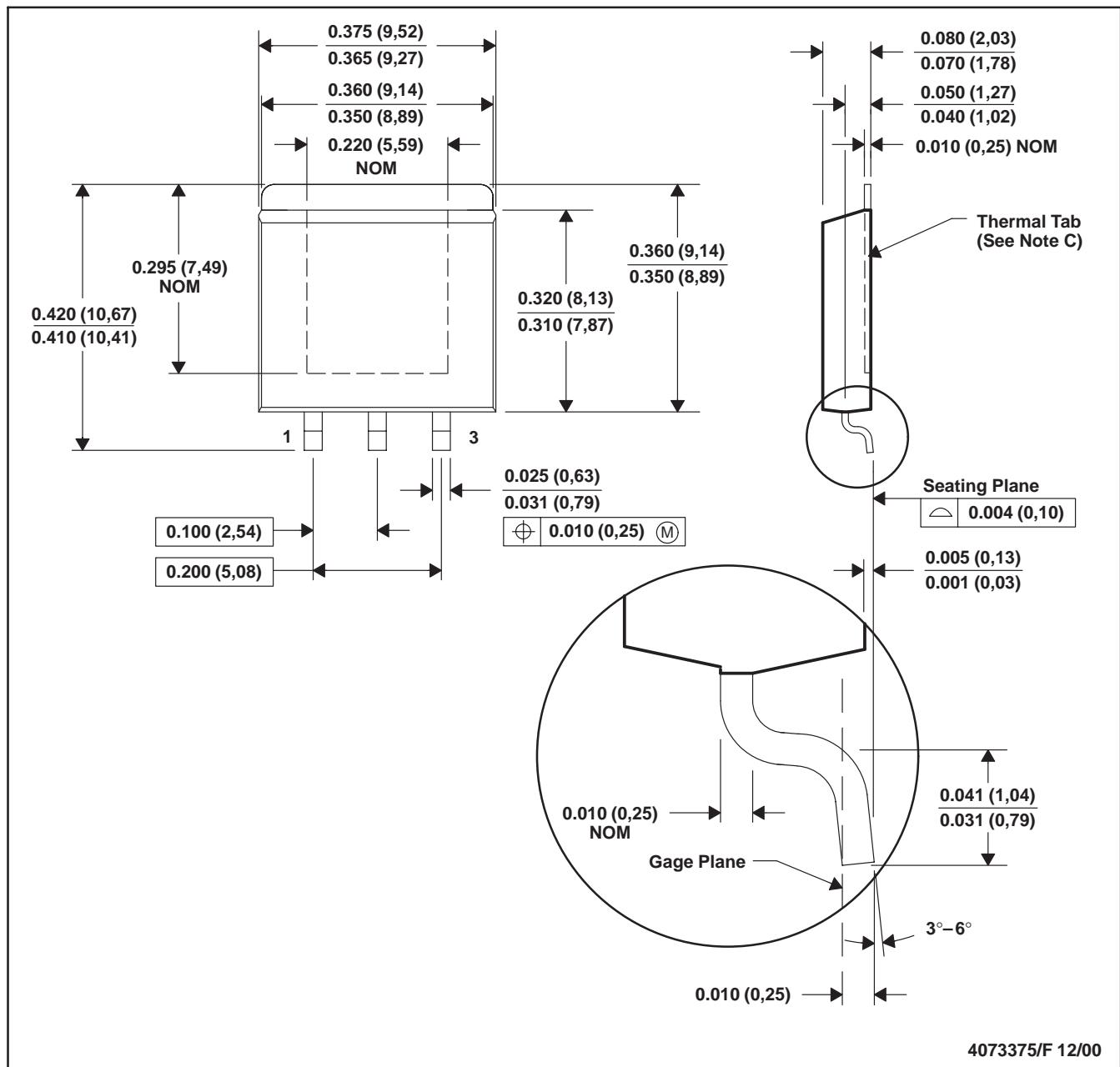


Figure 7. Reverse-Bias-Protection Circuit

KTE (R-PSFM-G3)

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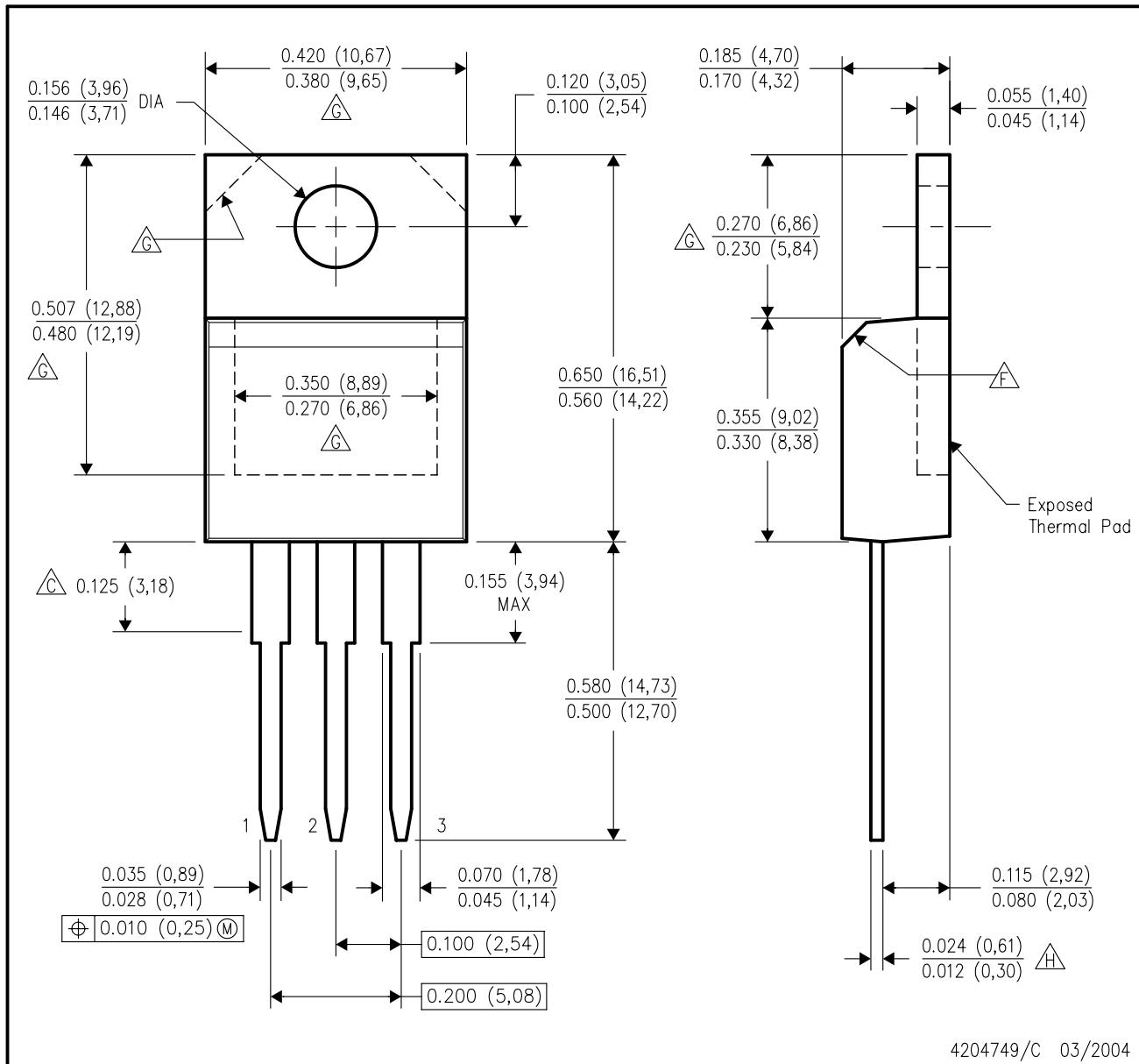


- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. The center lead is in electrical contact with the thermal tab.
 D. Dimensions do not include mold protrusions, not to exceed 0.006 (0.15).
 E. Falls within JEDEC MO-169

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KCS (R-PSFM-T3)

PLASTIC FLANGE-MOUNT PACKAGE



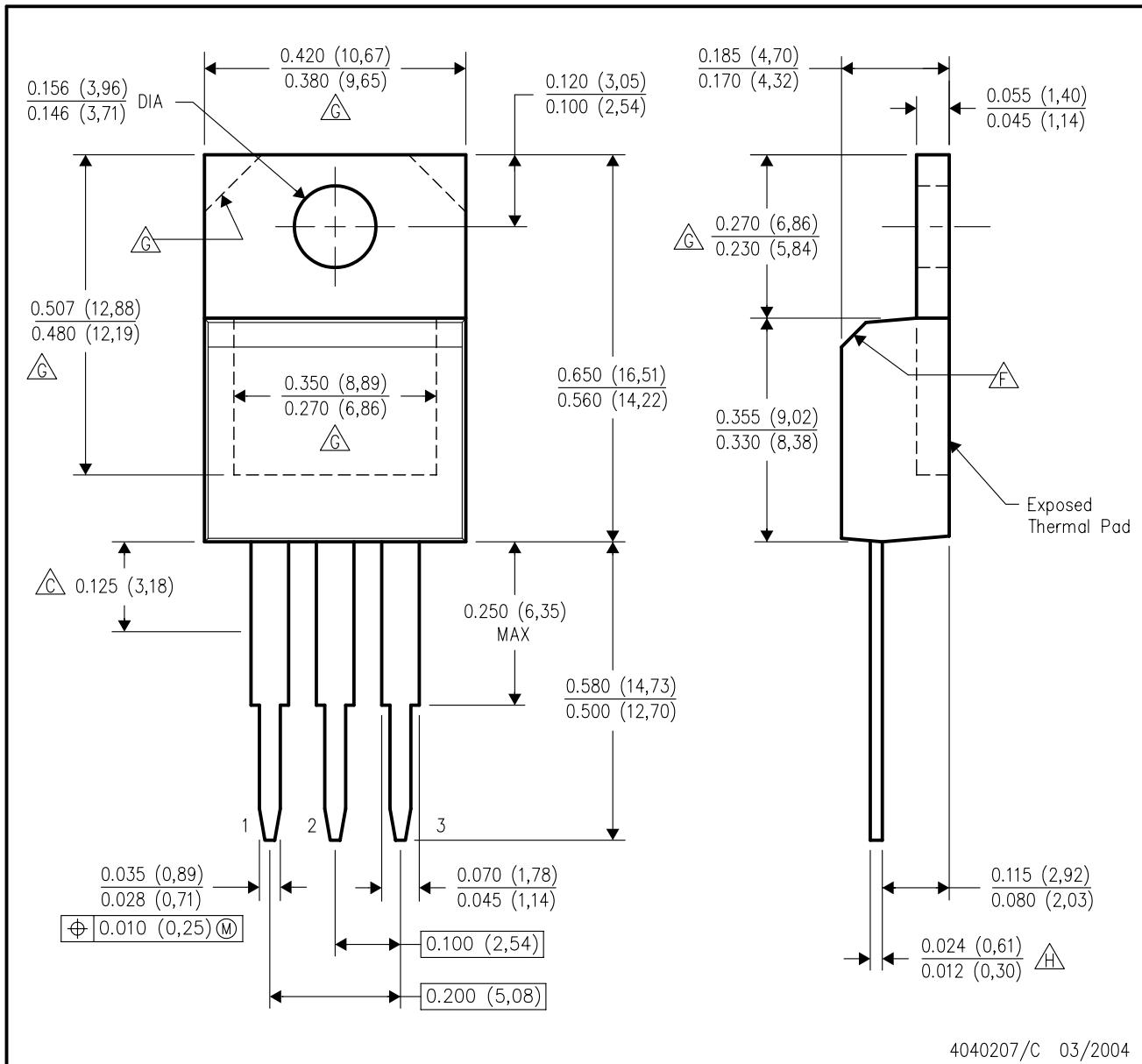
4204749/C 03/2004

- NOTES:

 - A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 -  C. Lead dimensions are not controlled within this area.
 - D. All lead dimensions apply before solder dip.
 - E. The center lead is in electrical contact with the mounting tab.
 -  F. The chamfer is optional.
 -  G. Thermal pad contour optional within these dimensions.
 -  H. Falls within JEDEC TO-220 variation AB, except minimum lead thickness.

KC (R-PSFM-T3)

PLASTIC FLANGE-MOUNT PACKAGE



4040207/C 03/2004

- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - $\triangle C$: Lead dimensions are not controlled within this area.
 - All lead dimensions apply before solder dip.
 - The center lead is in electrical contact with the mounting tab.
 - $\triangle F$: The chamfer is optional.
 - $\triangle G$: Thermal pad contour optional within these dimensions.
 - $\triangle H$: Falls within JEDEC TO-220 variation AB, except minimum lead thickness.

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LM317 3-Terminal Adjustable Regulator

1 Features

- Output voltage range adjustable from 1.25 V to 37 V
- Output current greater than 1.5 A
- Internal short-circuit current limiting
- Thermal overload protection
- Output safe-area compensation

2 Applications

- ATCA solutions
- DLP: 3D biometrics, hyperspectral imaging, optical networking, and spectroscopy
- DVR and DVS
- Desktop PCs
- Digital signage and still cameras
- ECG electrocardiograms
- EV HEV chargers: levels 1, 2, and 3
- Electronic shelf labels
- Energy harvesting
- Ethernet switches
- Femto base stations
- Fingerprint and iris biometrics
- HVAC: heating, ventilating, and air conditioning
- High-speed data acquisition and generation
- Hydraulic valves
- IP phones: wired and wireless
- Intelligent occupancy sensing
- Motor controls: brushed DC, brushless DC, low-voltage, permanent magnet, and stepper motors
- Point-to-point microwave backhauls
- Power bank solutions
- Power line communication modems
- Power over ethernet (PoE)
- Power quality meters
- Power substation controls
- Private branch exchanges (PBX)
- Programmable logic controllers
- RFID readers
- Refrigerators
- Signal or waveform generators
- Software-defined radios (SDR)
- Washing machines: high-end and low-end
- X-rays: baggage scanners, medical, and dental

3 Description

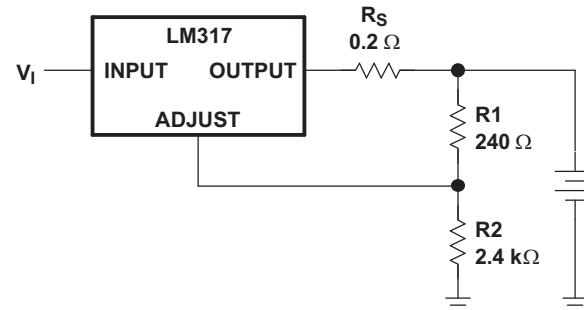
The LM317 device is an adjustable three-terminal positive-voltage regulator capable of supplying more than 1.5 A over an output-voltage range of 1.25 V to 37 V. It requires only two external resistors to set the output voltage. The device features a typical line regulation of 0.01% and typical load regulation of 0.1%. It includes current limiting, thermal overload protection, and safe operating area protection. Overload protection remains functional even if the ADJUST terminal is disconnected.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
LM317DCY	SOT-223 (4)	6.50 mm × 3.50 mm
LM317KCS	TO-220 (3)	10.16 mm × 9.15 mm
LM317KCT	TO-220 (3)	10.16 mm × 8.59 mm
LM317KTT	TO-263 (3)	10.16 mm × 9.01 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Battery-Charger Circuit



An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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4 Revision History

Changes from Revision X (September 2016) to Revision Y

	Page
• Added <i>Device Comparison Table</i>	3
• Changed V_{IN} to I_{OUT} in <i>Load Transient Response</i> figures	7
• Added missing caption to second y-axis in second <i>Load Transient Response</i> figure	7
• Changed V_{OUT} and output impedance equations in <i>Battery-Charger Circuit</i> section	14

Changes from Revision W (January 2015) to Revision X

	Page
• Changed body size dimensions for KCS TO-220 Package on <i>Device information</i> table	1
• Changed body size dimensions for KTT TO-263 Package on <i>Device information</i> table	1
• Changed V_O Output Voltage max value from 7 to 37 on <i>Recommended Operating Conditions</i> table	5
• Added min value to I_O Output Current in <i>Recommended Operating Conditions</i> table	5
• Changed values in the Thermal Information table to align with JEDEC standards	5
• Added KCT package data to <i>Thermal Information</i> table	5
• Deleted Section 9.3.6 "Adjusting Multiple On-Card Regulators with a Single Control"	14
• Updated Adjustable 4-A Regulator Circuit graphic	16
• Added <i>Receiving Notification of Documentation Updates</i> section and <i>Community Resources</i> section	19

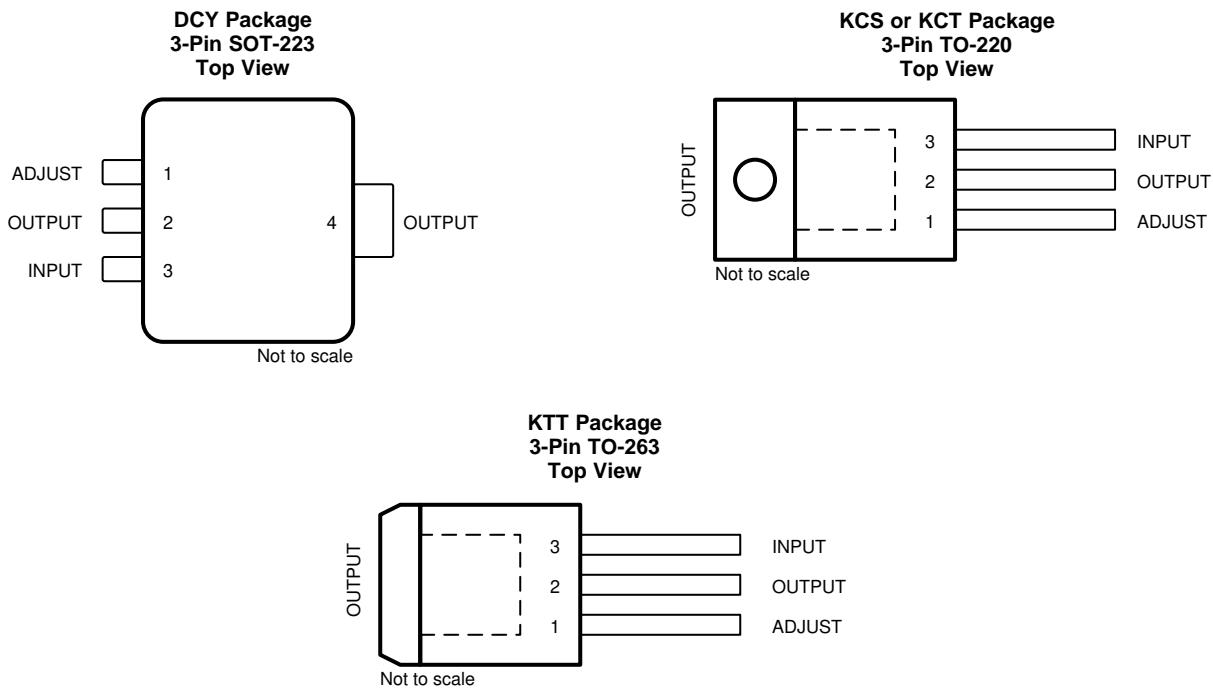
Changes from Revision V (February 2013) to Revision W

	Page
• Added <i>Applications</i> , <i>Device Information</i> table, <i>Pin Functions</i> table, <i>ESD Ratings</i> table, <i>Thermal Information</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section	1
• Deleted <i>Ordering Information</i> table	1

5 Device Comparison Table

I _{OUT}	PARAMETER	LM317	LM317-N	LM317A	LM317HV	UNIT
1.5 A	Input voltage range	4.25 - 40	4.25 - 40	4.25 - 40	4.25 - 60	V
	Load regulation accuracy	1.5	1.5	1	1.5	%
	PSRR (120 Hz)	64	80	80	65	dB
	Recommended operating temperature	0 to 125	0 to 125	-40 to 125	0 to 125	°C
	TO-220 (NDE) T _{JA}	23.5	23.2	23.3	23	°C/W
	TO-200 (KCT) T _{JA}	37.9	N/A	N/A		°C/W
	TO-252 T _{JA}	N/A	54	54		°C/W
	TO-263 T _{JA}	38	41	N/A		°C/W
	SOT-223 T _{JA}	66.8	59.6	59.6		°C/W
	TO-92 T _{JA}	N/A	186	186		°C/W
0.5 A	LM317M					
	Input voltage range	3.75 - 40				V
	Load regulation accuracy	1.5				%
	PSRR (120 Hz)	80				dB
	Recommended operating temperature	-40 - 125				°C
	SOT-223 T _{JA}	60.2				°C/W
0.1 A	LM317L	LM317L-N				
	Input voltage range	3.75 - 40	4.25 - 40			V
	Load regulation accuracy	1	1.5			%
	PSRR (120 Hz)	62	80			dB
	Recommended operating temperature	-40 to 125	-40 to 125			°C
	SOT-23 T _{JA}	167.8	N/A			°C/W
	SO-8 T _{JA}	N/A	165			°C/W
	DSBGA T _{JA}	N/A	290			°C/W
	TO-92 T _{JA}	N/A	180			°C/W

6 Pin Configuration and Functions



Pin Functions

PIN			I/O	DESCRIPTION
NAME	TO-263, TO-220	SOT-223		
ADJUST	1	1	I	Output voltage adjustment pin. Connect to a resistor divider to set V_O
INPUT	3	3	I	Supply input pin
OUTPUT	2	2, 4	O	Voltage output pin

7 Specifications

7.1 Absolute Maximum Ratings

over virtual junction temperature range (unless otherwise noted)⁽¹⁾

		MIN	MAX	UNIT
$V_I - V_O$	Input-to-output differential voltage		40	V
T_J	Operating virtual junction temperature		150	°C
	Lead temperature 1.6 mm (1/16 in) from case for 10 s		260	°C
T_{stg}	Storage temperature	-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

7.2 ESD Ratings

		MAX	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	2500
		Charged device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	1000

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

7.3 Recommended Operating Conditions

		MIN	MAX	UNIT
V_O	Output voltage	1.25	37	V
$V_I - V_O$	Input-to-output differential voltage	3	40	V
I_O	Output current	0.01	1.5	A
T_J	Operating virtual junction temperature	0	125	°C

7.4 Thermal Information

THERMAL METRIC ⁽¹⁾		LM317				UNIT
		DCY (SOT-223)	KCS (TO-220)	KCT (TO-220)	KTT (TO-263)	
				4 PINS	3 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	66.8	23.5	37.9	38.0	°C/W
$R_{\theta JC(\text{top})}$	Junction-to-case (top) thermal resistance	43.2	15.9	51.1	36.5	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	16.9	7.9	23.2	18.9	°C/W
ψ_{JT}	Junction-to-top characterization parameter	3.6	3.0	13.0	6.9	°C/W
ψ_{JB}	Junction-to-board characterization parameter	16.8	7.8	22.8	17.9	°C/W
$R_{\theta JC(\text{bot})}$	Junction-to-case (bottom) thermal resistance	NA	0.1	4.2	1.1	°C/W

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC package thermal metrics application report](#).

7.5 Electrical Characteristics

over recommended ranges of operating virtual junction temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS ⁽¹⁾		MIN	TYP	MAX	UNIT	
Line regulation ⁽²⁾	$V_I - V_O = 3 \text{ V to } 40 \text{ V}$		$T_J = 25^\circ\text{C}$	0.01	0.04	%/ V	
			$T_J = 0^\circ\text{C to } 125^\circ\text{C}$	0.02	0.07		
Load regulation	$I_O = 10 \text{ mA to } 1500 \text{ mA}$	$C_{ADJ}^{(3)} = 10 \mu\text{F}$, $T_J = 25^\circ\text{C}$	$V_O \leq 5 \text{ V}$	25	25	mV	
			$V_O \geq 5 \text{ V}$	0.1	0.5	%/ V_O	
		$T_J = 0^\circ\text{C to } 125^\circ\text{C}$	$V_O \leq 5 \text{ V}$	20	70	mV	
			$V_O \geq 5 \text{ V}$	0.3	1.5	%/ V_O	
Thermal regulation	20-ms pulse,	$T_J = 25^\circ\text{C}$		0.03	0.07	%/ V_O/W	
ADJUST terminal current				50	100	μA	
Change in ADJUST terminal current	$V_I - V_O = 2.5 \text{ V to } 40 \text{ V}$, $P_D \leq 20 \text{ W}$, $I_O = 10 \text{ mA to } 1500 \text{ mA}$			0.2	5	μA	
Reference voltage	$V_I - V_O = 3 \text{ V to } 40 \text{ V}$, $P_D \leq 20 \text{ W}$, $I_O = 10 \text{ mA to } 1500 \text{ mA}$			1.2	1.25	1.3	V
Output-voltage temperature stability	$T_J = 0^\circ\text{C to } 125^\circ\text{C}$			0.7	0.7	%/ V_O	
Minimum load current to maintain regulation	$V_I - V_O = 40 \text{ V}$			3.5	10	mA	
Maximum output current	$V_I - V_O \leq 15 \text{ V}$,		$P_D < P_{MAX}^{(4)}$	1.5	2.2	A	
	$V_I - V_O \leq 40 \text{ V}$,		$P_D < P_{MAX}^{(4)}$, $T_J = 25^\circ\text{C}$	0.15	0.4		
RMS output noise voltage (% of V_O)	$f = 10 \text{ Hz to } 10 \text{ kHz}$, $T_J = 25^\circ\text{C}$			0.003	0.003	%/ V_O	
Ripple rejection	$V_O = 10 \text{ V}$,	$f = 120 \text{ Hz}$	$C_{ADJ} = 0 \mu\text{F}^{(3)}$	57	57	dB	
			$C_{ADJ} = 10 \mu\text{F}^{(3)}$	62	64		
Long-term stability	$T_J = 25^\circ\text{C}$			0.3	1	%/1k hr	

(1) Unless otherwise noted, the following test conditions apply: $|V_I - V_O| = 5 \text{ V}$ and $I_{O\text{MAX}} = 1.5 \text{ A}$, $T_J = 0^\circ\text{C to } 125^\circ\text{C}$. Pulse testing techniques are used to maintain the junction temperature as close to the ambient temperature as possible.

(2) Line regulation is expressed here as the percentage change in output voltage per 1-V change at the input.

(3) C_{ADJ} is connected between the ADJUST terminal and GND.

(4) Maximum power dissipation is a function of $T_J(\text{max})$, θ_{JA} , and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(\text{max}) - T_A) / \theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

7.6 Typical Characteristics

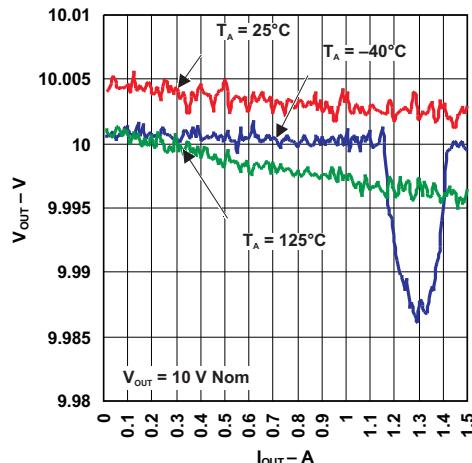


Figure 1. Load Regulation

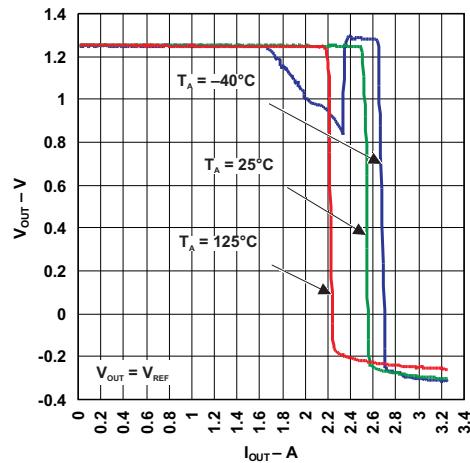


Figure 2. Load Regulation

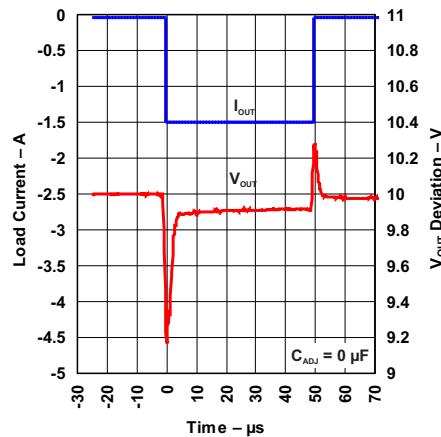


Figure 3. Load Transient Response

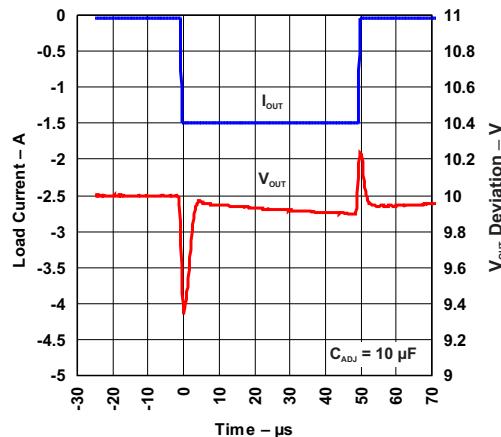


Figure 4. Load Transient Response

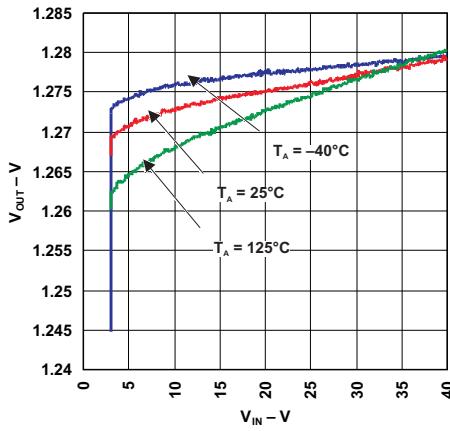
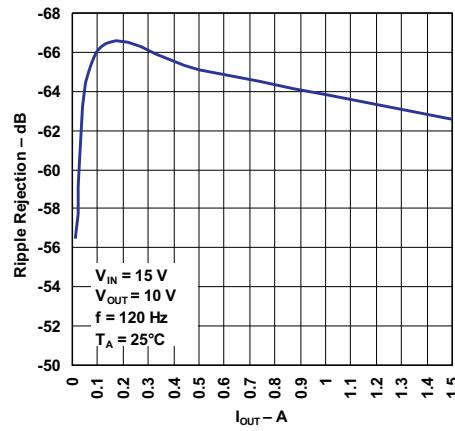
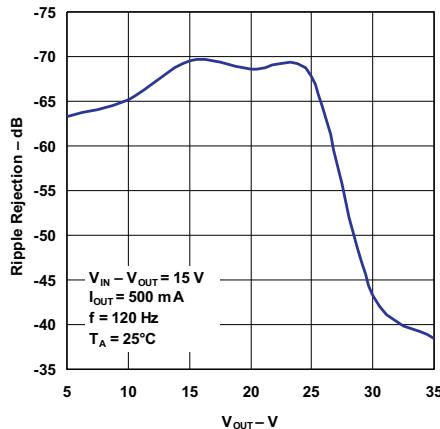


Figure 5. Line Regulation

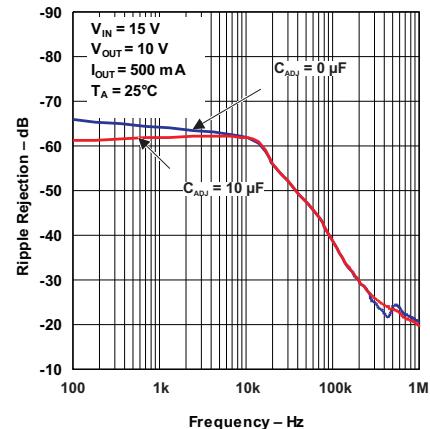


**Figure 6. Ripple Rejection
vs Output Current**

Typical Characteristics (continued)



**Figure 7. Ripple Rejection
vs Output Voltage**



**Figure 8. Ripple Rejection
vs Frequency**

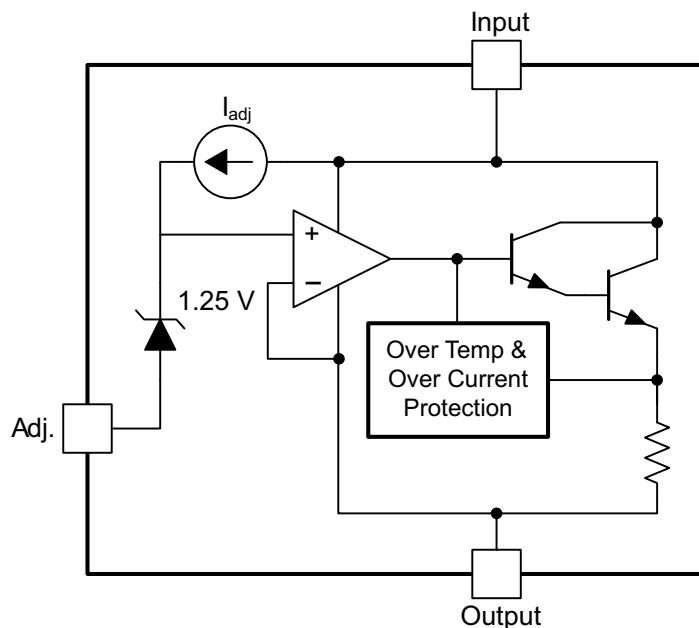
8 Detailed Description

8.1 Overview

The LM317 device is an adjustable three-terminal positive-voltage regulator capable of supplying up to 1.5 A over an output-voltage range of 1.25 V to 37 V. It requires only two external resistors to set the output voltage. The device features a typical line regulation of 0.01% and typical load regulation of 0.1%. It includes current limiting, thermal overload protection, and safe operating area protection. Overload protection remains functional even if the ADJUST terminal is disconnected.

The LM317 device is versatile in its applications, including uses in programmable output regulation and local on-card regulation. Or, by connecting a fixed resistor between the ADJUST and OUTPUT terminals, the LM317 device can function as a precision current regulator. An optional output capacitor can be added to improve transient response. The ADJUST terminal can be bypassed to achieve very high ripple-rejection ratios, which are difficult to achieve with standard three-terminal regulators.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 NPN Darlington Output Drive

NPN Darlington output topology provides naturally low output impedance and an output capacitor is optional. 3-V headroom is recommended ($V_I - V_O$) to support maximum current and lowest temperature.

8.3.2 Overload Block

Over-current and over-temperature shutdown protects the device against overload or damage from operating in excessive heat.

8.3.3 Programmable Feedback

Op amp with 1.25-V offset input at the ADJUST terminal provides easy output voltage or current (not both) programming. For current regulation applications, a single resistor whose resistance value is $1.25 \text{ V}/I_O$ and power rating is greater than $(1.25 \text{ V})^2/R$ should be used. For voltage regulation applications, two resistors set the output voltage.

8.4 Device Functional Modes

8.4.1 Normal Operation

The device OUTPUT pin will source current necessary to make OUTPUT pin 1.25 V greater than ADJUST terminal to provide output regulation.

8.4.2 Operation With Low Input Voltage

The device requires up to 3-V headroom ($V_I - V_O$) to operate in regulation. The device may drop out and OUTPUT voltage will be INPUT voltage minus drop out voltage with less headroom.

8.4.3 Operation at Light Loads

The device passes its bias current to the OUTPUT pin. The load or feedback must consume this minimum current for regulation or the output may be too high. See the *Electrical Characteristics* table for the minimum load current needed to maintain regulation.

8.4.4 Operation In Self Protection

When an overload occurs the device shuts down Darlington NPN output stage or reduces the output current to prevent device damage. The device will automatically reset from the overload. The output may be reduced or alternate between on and off until the overload is removed.

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

The flexibility of the LM317 allows it to be configured to take on many different functions in DC power applications.

9.2 Typical Application

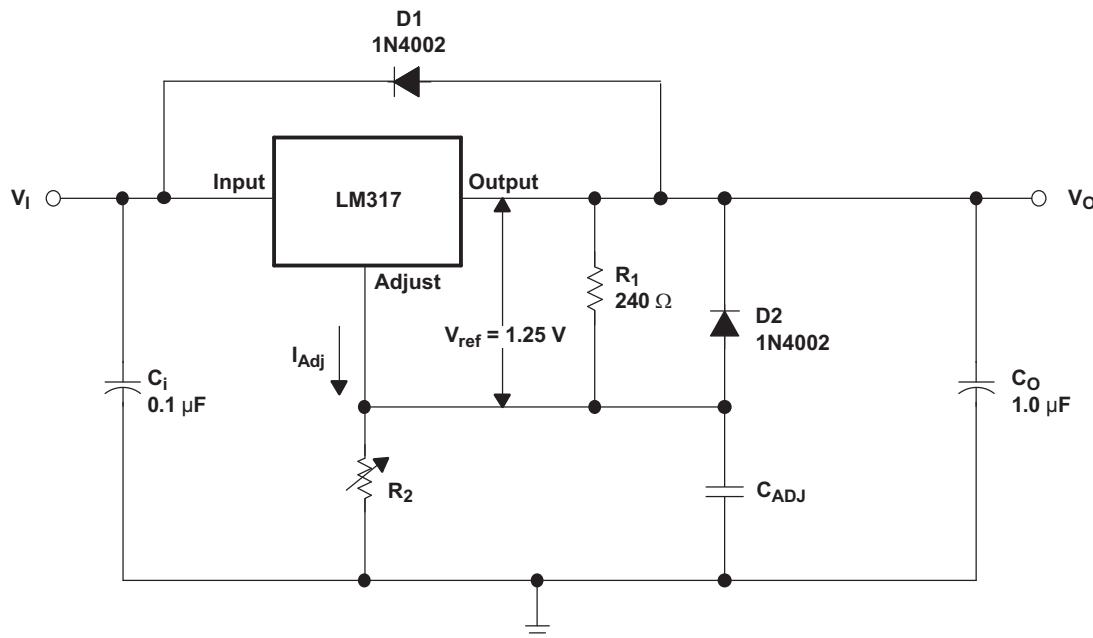


Figure 9. Adjustable Voltage Regulator

9.2.1 Design Requirements

- R1 and R2 are required to set the output voltage.
- C_{ADJ} is recommended to improve ripple rejection. It prevents amplification of the ripple as the output voltage is adjusted higher.
- C_i is recommended, particularly if the regulator is not in close proximity to the power-supply filter capacitors. A 0.1-μF or 1-μF ceramic or tantalum capacitor provides sufficient bypassing for most applications, especially when adjustment and output capacitors are used.
- C_O improves transient response, but is not needed for stability.
- Protection diode D2 is recommended if C_{ADJ} is used. The diode provides a low-impedance discharge path to prevent the capacitor from discharging into the output of the regulator.
- Protection diode D1 is recommended if C_O is used. The diode provides a low-impedance discharge path to prevent the capacitor from discharging into the output of the regulator.

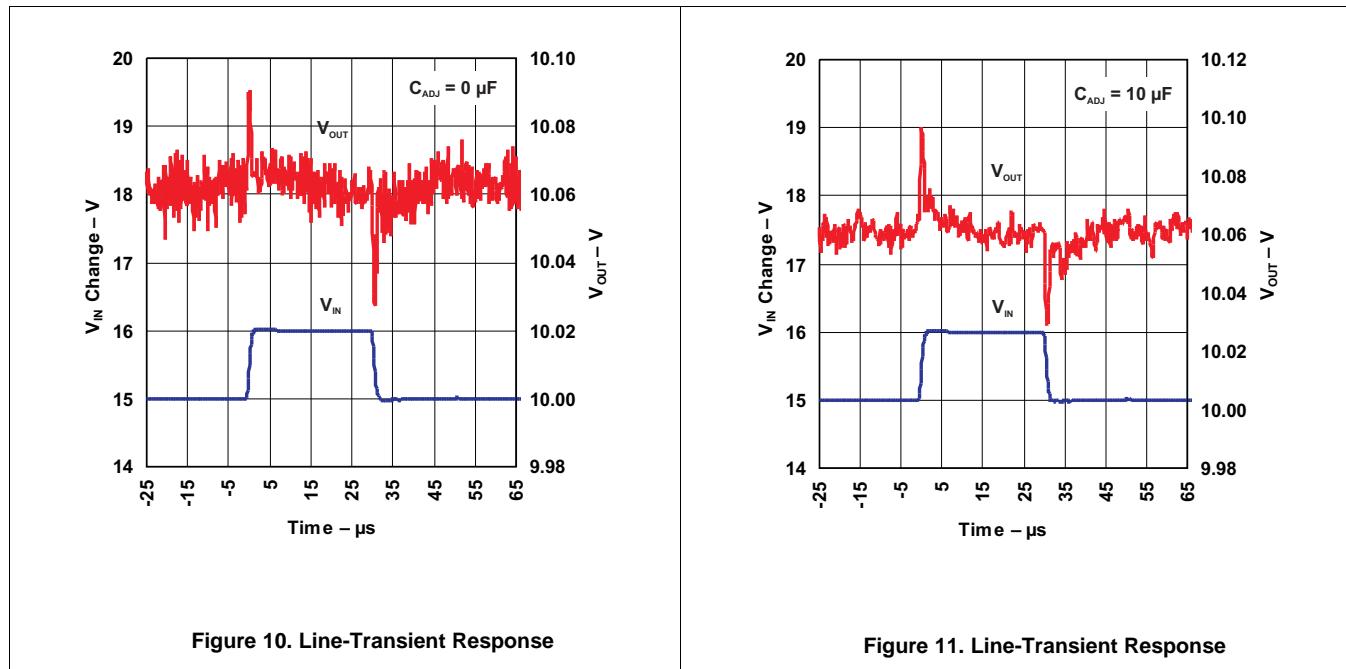
9.2.2 Detailed Design Procedure

V_O is calculated as shown in [Equation 1](#). I_{ADJ} is typically 50 μA and negligible in most applications.

$$V_O = V_{REF} \left(1 + R_2 / R_1 \right) + (I_{ADJ} \times R_2) \quad (1)$$

Typical Application (continued)

9.2.3 Application Curves



9.3 System Examples

9.3.1 0-V to 30-V Regulator Circuit

Here, the voltage is determined by

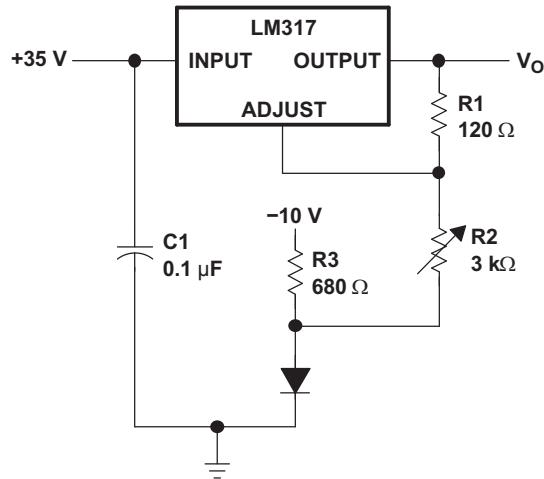
$$V_{\text{OUT}} = V_{\text{REF}} \left(1 + \frac{R_2 + R_3}{R_1} \right) - 10 \text{ V}$$


Figure 12. 0-V to 30-V Regulator Circuit

System Examples (continued)

9.3.2 Adjustable Regulator Circuit With Improved Ripple Rejection

C2 helps to stabilize the voltage at the adjustment pin, which helps reject noise. Diode D1 exists to discharge C2 in case the output is shorted to ground.

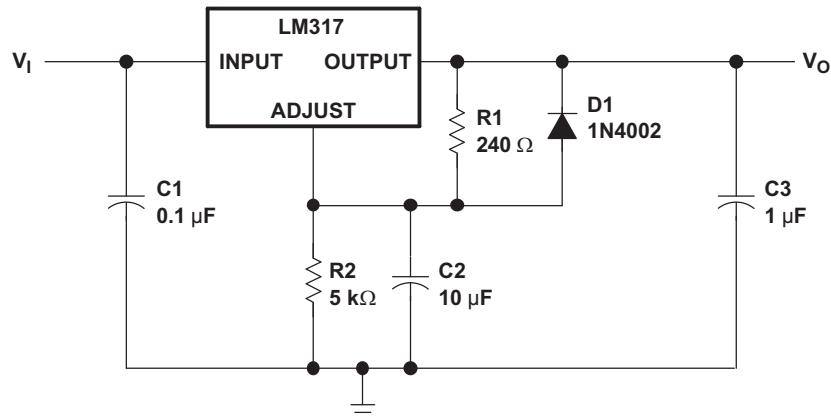


Figure 13. Adjustable Regulator Circuit with Improved Ripple Rejection

9.3.3 Precision Current-Limiter Circuit

This application limits the output current to the I_{LIMIT} in the diagram.

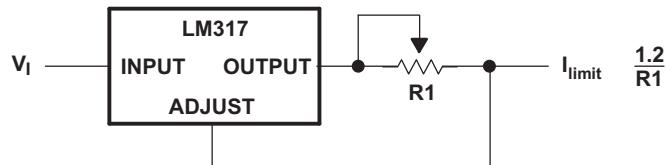


Figure 14. Precision Current-Limiter Circuit

9.3.4 Tracking Preregulator Circuit

This application keeps a constant voltage across the second LM317 in the circuit.

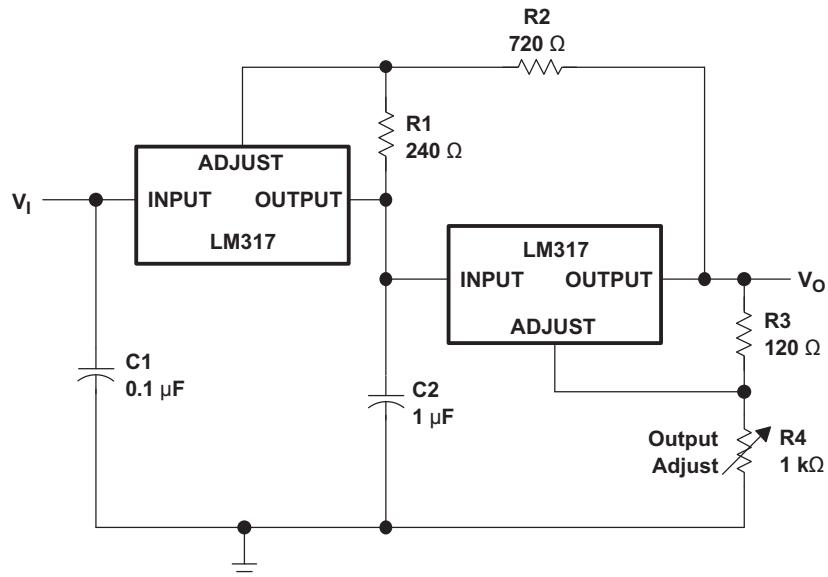


Figure 15. Tracking Preregulator Circuit

System Examples (continued)

9.3.5 1.25-V to 20-V Regulator Circuit With Minimum Program Current

Because the value of V_{REF} is constant, the value of R1 determines the amount of current that flows through R1 and R2. The size of R2 determines the IR drop from ADJUSTMENT to GND. Higher values of R2 translate to higher V_{OUT} .

$$V_{OUT} = V_{REF} \left(1 + \frac{R_2 + R_3}{R_1} \right) - 10V \quad (2)$$

$$(R_1 + R_2)_{min} = V_{out\text{reg(min)}} \quad (3)$$

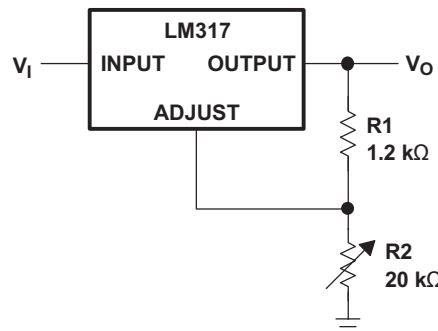


Figure 16. 1.25-V to 20-V Regulator Circuit With Minimum Program Current

9.3.6 Battery-Charger Circuit

The series resistor limits the current output of the LM317, minimizing damage to the battery cell.

$$V_{OUT} = 1.25 V \times \left(1 + \frac{R_2}{R_1} \right) \quad (4)$$

$$I_{OUT(\text{short})} = \frac{1.25V}{R_S} \quad (5)$$

$$\text{Output Impedance} = R_S \times \left(1 + \frac{R_2}{R_1} \right) \quad (6)$$

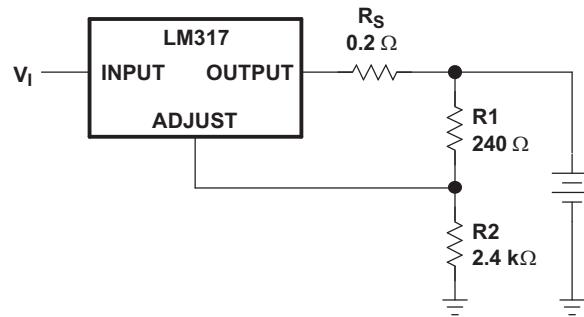


Figure 17. Battery-Charger Circuit

System Examples (continued)

9.3.7 50-mA Constant-Current Battery-Charger Circuit

The current limit operation mode can be used to trickle charge a battery at a fixed current. $I_{CHG} = 1.25 \text{ V} \div 24 \Omega$. V_I should be greater than $V_{BAT} + 4.25 \text{ V}$. (1.25 V [V_{REF}] + 3 V [headroom])

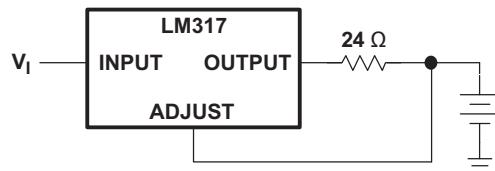


Figure 18. 50-mA Constant-Current Battery-Charger Circuit

9.3.8 Slow Turn-On 15-V Regulator Circuit

The capacitor C1, in combination with the PNP transistor, helps the circuit to slowly start supplying voltage. In the beginning, the capacitor is not charged. Therefore output voltage starts at $V_{C1} + V_{BE} + 1.25 \text{ V} = 0 \text{ V} + 0.65 \text{ V} + 1.25 \text{ V} = 1.9 \text{ V}$. As the capacitor voltage rises, V_{OUT} rises at the same rate. When the output voltage reaches the value determined by R1 and R2, the PNP will be turned off.

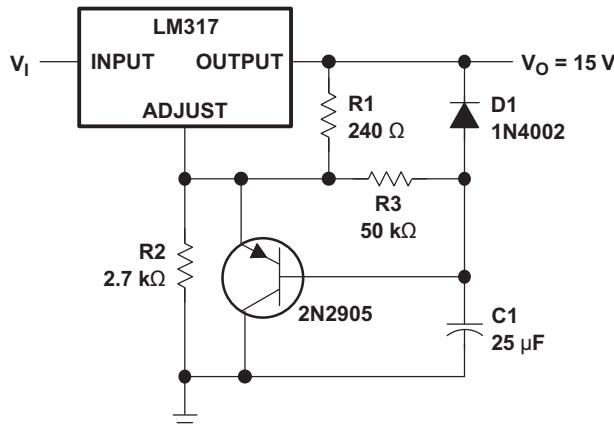


Figure 19. Slow Turn-On 15-V Regulator Circuit

9.3.9 AC Voltage-Regulator Circuit

These two LM317s can regulate both the positive and negative swings of a sinusoidal AC input.

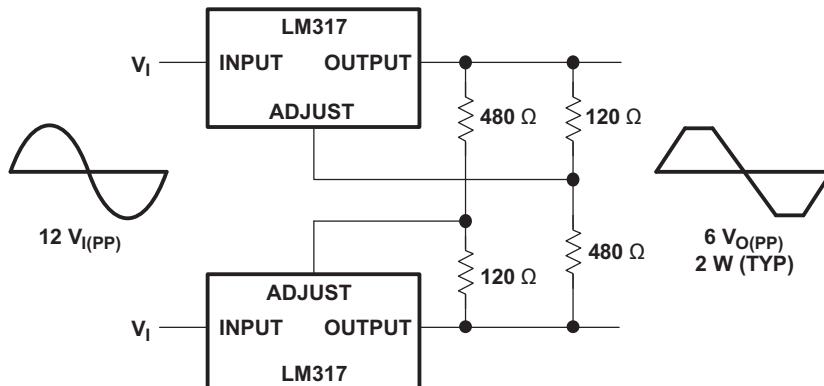


Figure 20. AC Voltage-Regulator Circuit

System Examples (continued)

9.3.10 Current-Limited 6-V Charger Circuit

As the charge current increases, the voltage at the bottom resistor increases until the NPN starts sinking current from the adjustment pin. The voltage at the adjustment pin drops, and consequently the output voltage decreases until the NPN stops conducting.

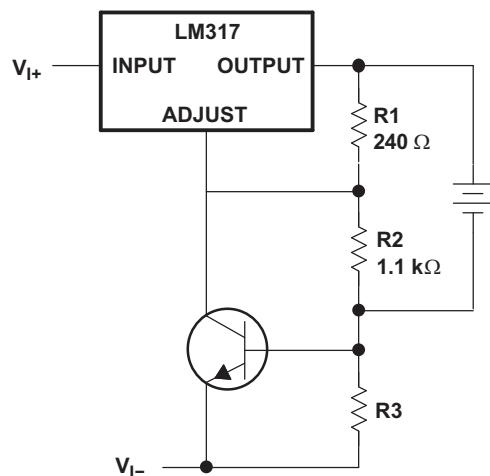


Figure 21. Current-Limited 6-V Charger Circuit

9.3.11 Adjustable 4-A Regulator Circuit

This application keeps the output current at 4 A while having the ability to adjust the output voltage using the adjustable ($1.5\text{ k}\Omega$ in schematic) resistor.

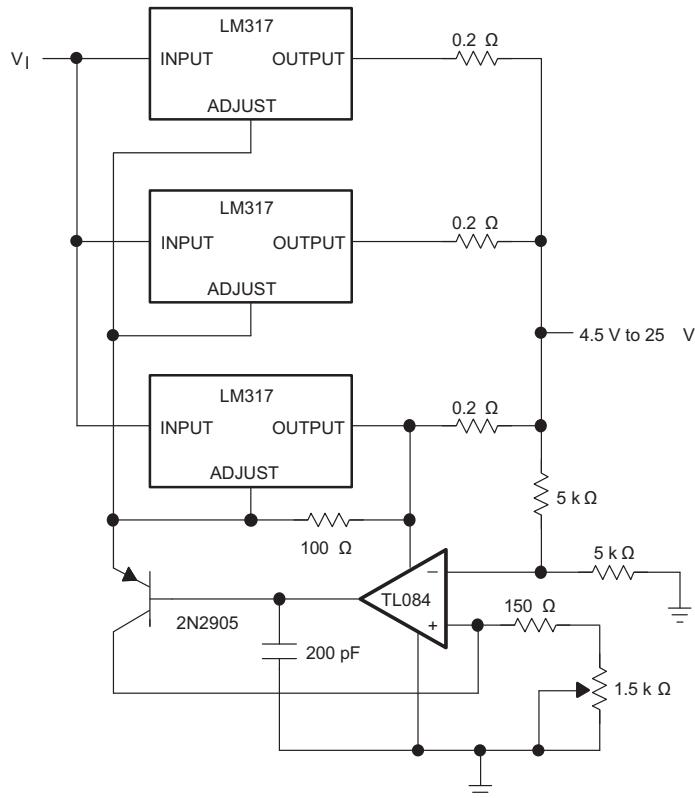


Figure 22. Adjustable 4-A Regulator Circuit

System Examples (continued)

9.3.12 High-Current Adjustable Regulator Circuit

The NPNs at the top of the schematic allow higher currents at V_{OUT} than the LM317 can provide, while still keeping the output voltage at levels determined by the adjustment pin resistor divider of the LM317.

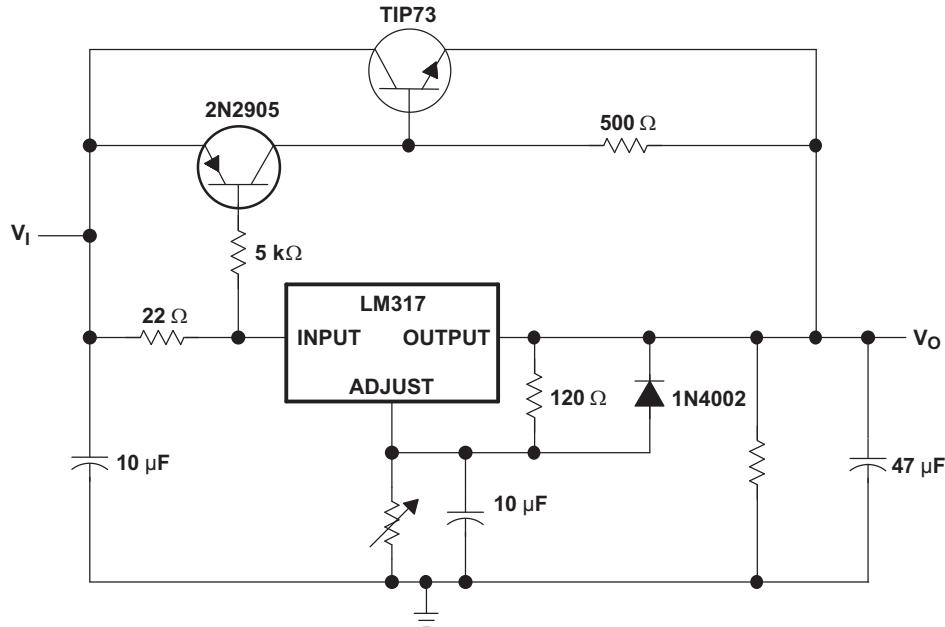


Figure 23. High-Current Adjustable Regulator Circuit

10 Power Supply Recommendations

The LM317 is designed to operate from an input voltage supply range between 1.25 V to 37 V greater than the output voltage. If the device is more than six inches from the input filter capacitors, an input bypass capacitor, 0.1 μF or greater, of any type is needed for stability.

11 Layout

11.1 Layout Guidelines

- TI recommends that the input terminal be bypassed to ground with a bypass capacitor.
- The optimum placement is closest to the input terminal of the device and the system GND. Take care to minimize the loop area formed by the bypass-capacitor connection, the input terminal, and the system GND.
- For operation at full rated load, TI recommends to use wide trace lengths to eliminate $I \times R$ drop and heat dissipation.

11.2 Layout Example

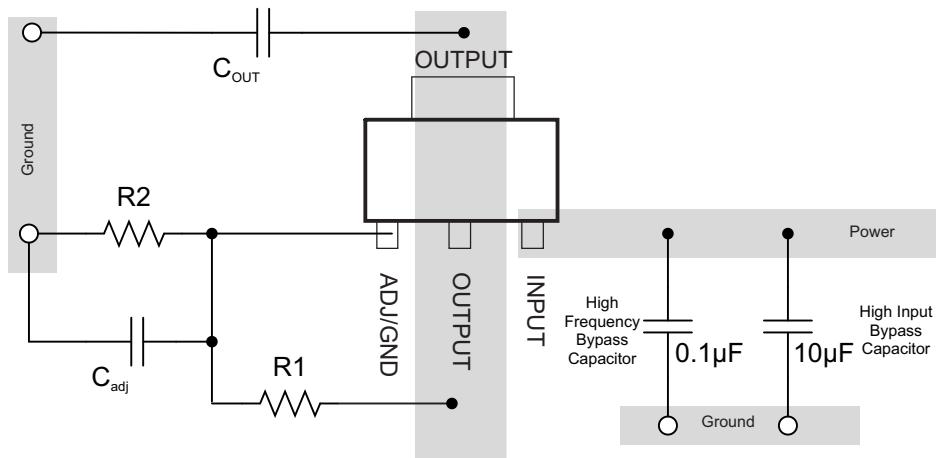


Figure 24. Layout Example

12 Device and Documentation Support

12.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

12.2 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

12.3 Trademarks

E2E is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.

12.4 Electrostatic Discharge Caution

 This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

 ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

12.5 Glossary

[SLYZ022 — TI Glossary](#).

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM317DCY	ACTIVE	SOT-223	DCY	4	80	RoHS & Green	SN	Level-2-260C-1 YEAR	0 to 125	L3	Samples
LM317DCYG3	ACTIVE	SOT-223	DCY	4	80	RoHS & Green	SN	Level-2-260C-1 YEAR	0 to 125	L3	Samples
LM317DCYR	ACTIVE	SOT-223	DCY	4	2500	RoHS & Green	SN	Level-2-260C-1 YEAR	0 to 125	L3	Samples
LM317DCYRG3	ACTIVE	SOT-223	DCY	4	2500	RoHS & Green	SN	Level-2-260C-1 YEAR	0 to 125	L3	Samples
LM317KCS	LIFEBUY	TO-220	KCS	3	50	RoHS & Green	SN	N / A for Pkg Type	0 to 125	LM317	
LM317KCSE3	LIFEBUY	TO-220	KCS	3	50	RoHS & Green	SN	N / A for Pkg Type	0 to 125	LM317	
LM317KTTR	ACTIVE	DDPAK/ TO-263	KT	3	500	RoHS & Green	SN	Level-3-245C-168 HR	0 to 125	LM317	Samples
LM317KTTRG3	ACTIVE	DDPAK/ TO-263	KT	3	500	RoHS & Green	SN	Level-3-245C-168 HR	0 to 125	LM317	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

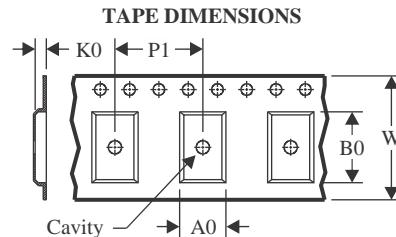
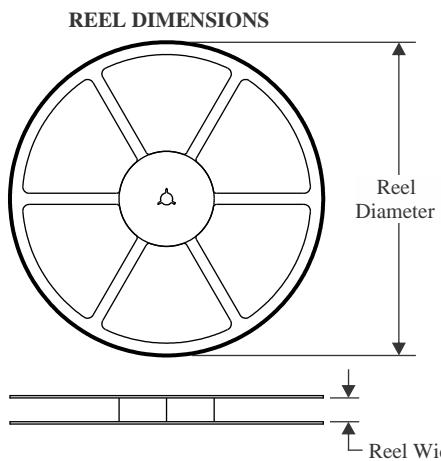
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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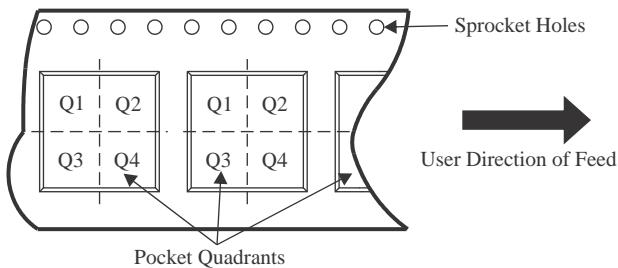
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION



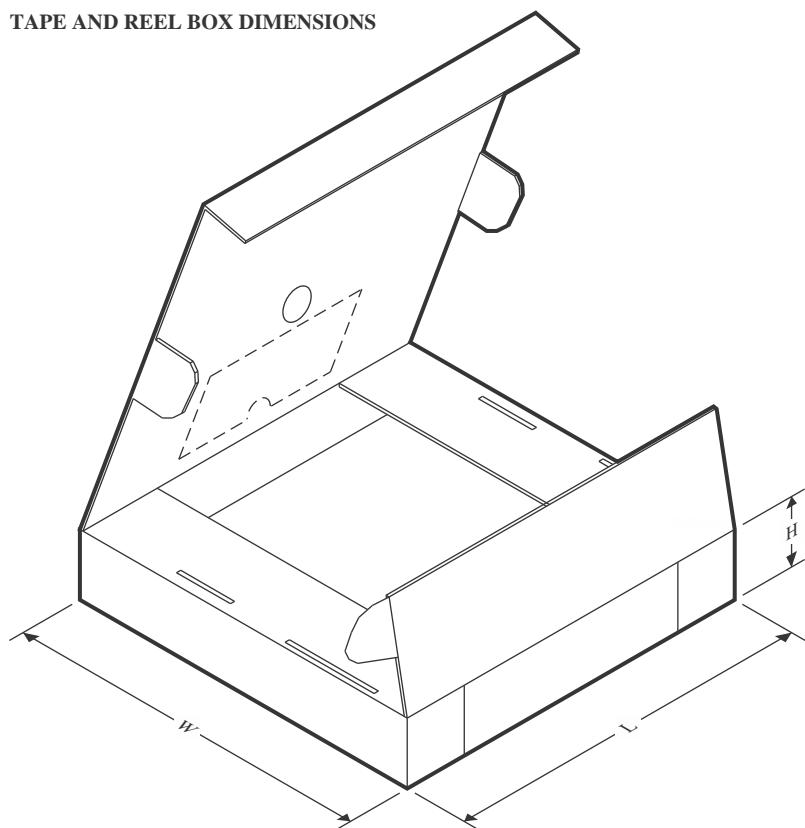
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

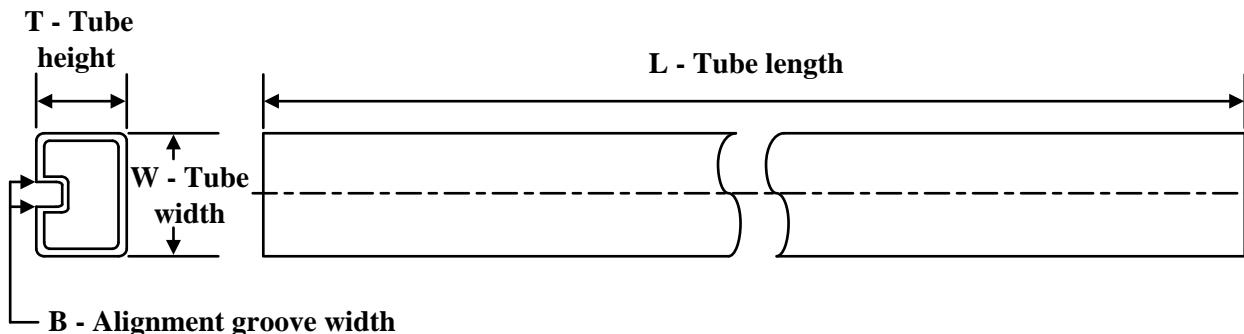
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM317DCYR	SOT-223	DCY	4	2500	330.0	12.4	7.05	7.4	1.9	8.0	12.0	Q3
LM317DCYR	SOT-223	DCY	4	2500	330.0	12.4	6.55	7.25	1.9	8.0	12.0	Q3
LM317KTTR	DDPAK/ TO-263	KT	3	500	330.0	24.4	10.8	16.1	4.9	16.0	24.0	Q2
LM317KTTR	DDPAK/ TO-263	KT	3	500	330.0	24.4	10.8	16.3	5.11	16.0	24.0	Q2

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM317DCYR	SOT-223	DCY	4	2500	340.0	340.0	38.0
LM317DCYR	SOT-223	DCY	4	2500	336.0	336.0	48.0
LM317KTTR	DDPAK/TO-263	KTT	3	500	350.0	334.0	47.0
LM317KTTR	DDPAK/TO-263	KTT	3	500	340.0	340.0	38.0

TUBE

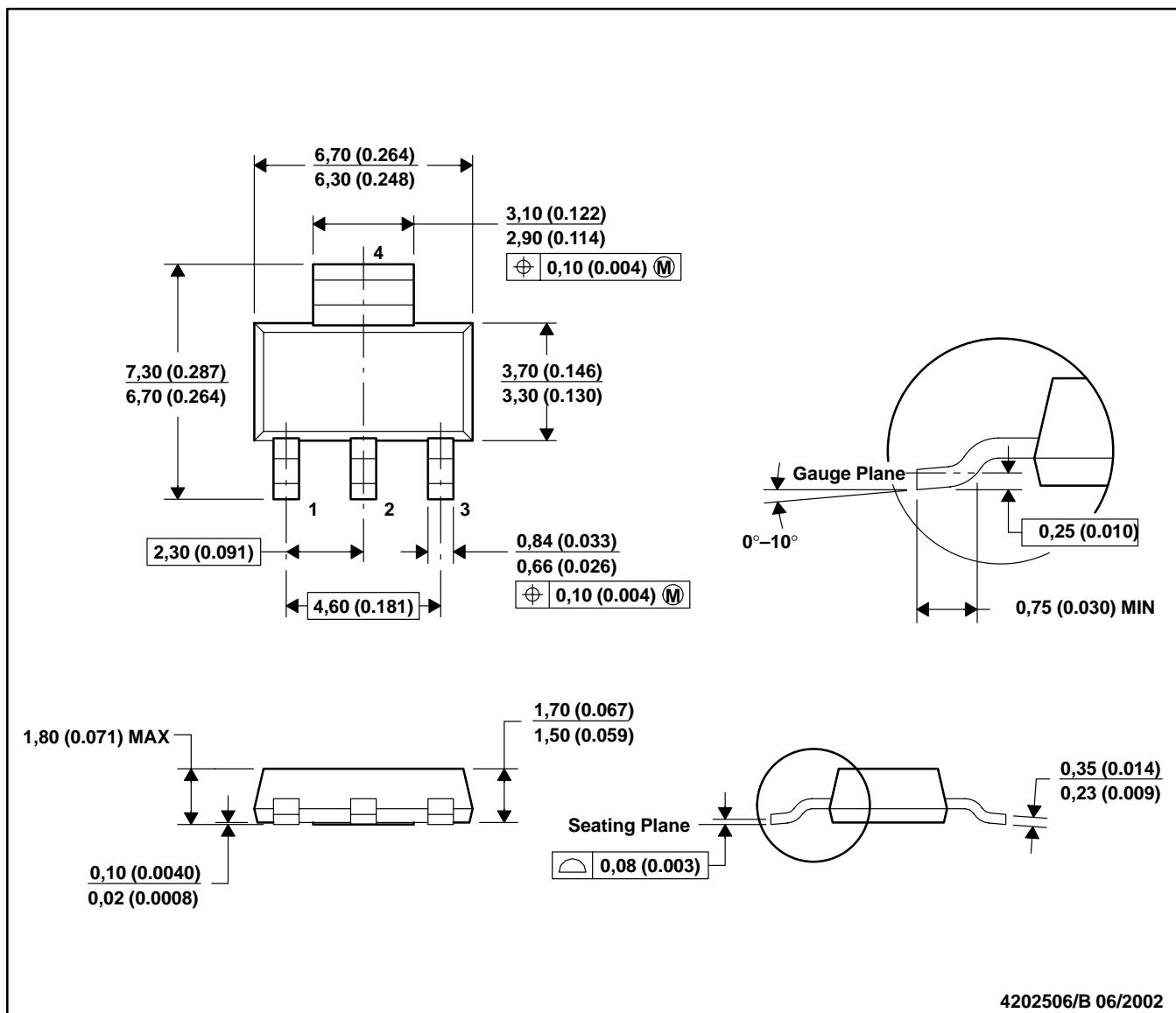


*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μ m)	B (mm)
LM317DCY	DCY	SOT-223	4	80	559	8.6	500	3.6
LM317DCY	DCY	SOT-223	4	80	542.9	8.6	3606	2.67
LM317DCYG3	DCY	SOT-223	4	80	559	8.6	500	3.6
LM317DCYG3	DCY	SOT-223	4	80	542.9	8.6	3606	2.67
LM317KCS	KCS	TO-220	3	50	532	34.1	700	9.6
LM317KCS	KCS	TO-220	3	50	532	34.1	700	9.6
LM317KCSE3	KCS	TO-220	3	50	532	34.1	700	9.6
LM317KCSE3	KCS	TO-220	3	50	532	34.1	700	9.6

DCY (R-PDSO-G4)

PLASTIC SMALL-OUTLINE



NOTES:

- A. All linear dimensions are in millimeters (inches).
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion.
- D. Falls within JEDEC TO-261 Variation AA.

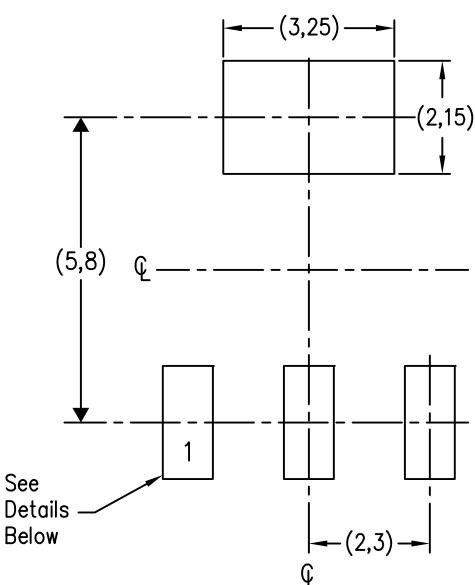
4202506/B 06/2002

LAND PATTERN DATA

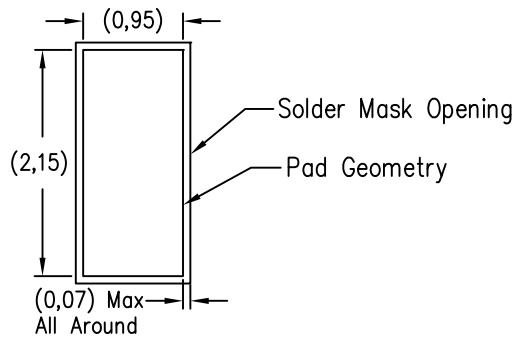
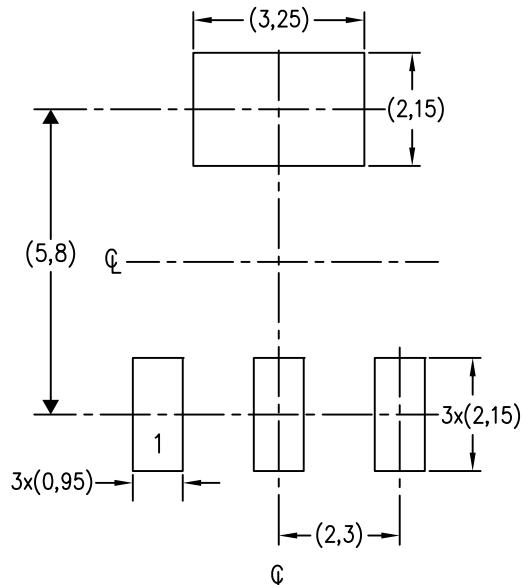
DCY (R-PDSO-G4)

PLASTIC SMALL OUTLINE

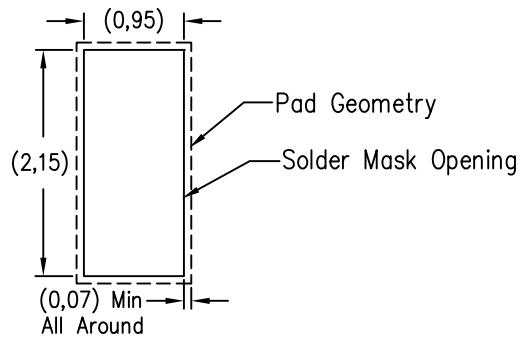
Example Board Layout



Example Stencil Design
0.125 Thick Stencil
(Note D)



Example, non-solder mask defined pad.
(Preferred)

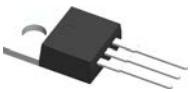


Example, solder mask defined pad.

4210278/C 07/13

NOTES:

- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Publication IPC-7351 is recommended for alternate designs.
- D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil recommendations. Refer to IPC 7525 for stencil design considerations.

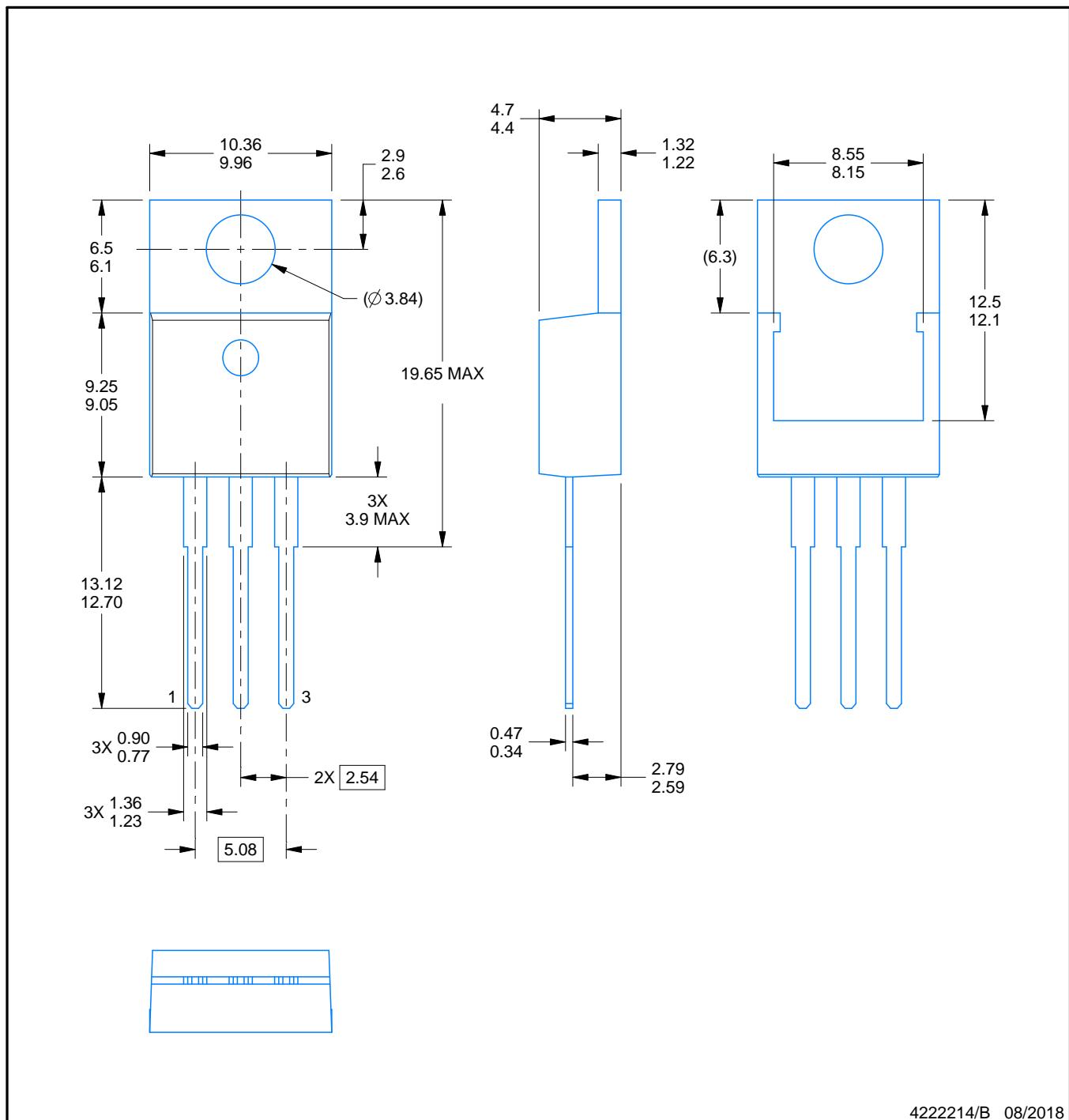


PACKAGE OUTLINE

KCS0003B

TO-220 - 19.65 mm max height

TO-220



4222214/B 08/2018

NOTES:

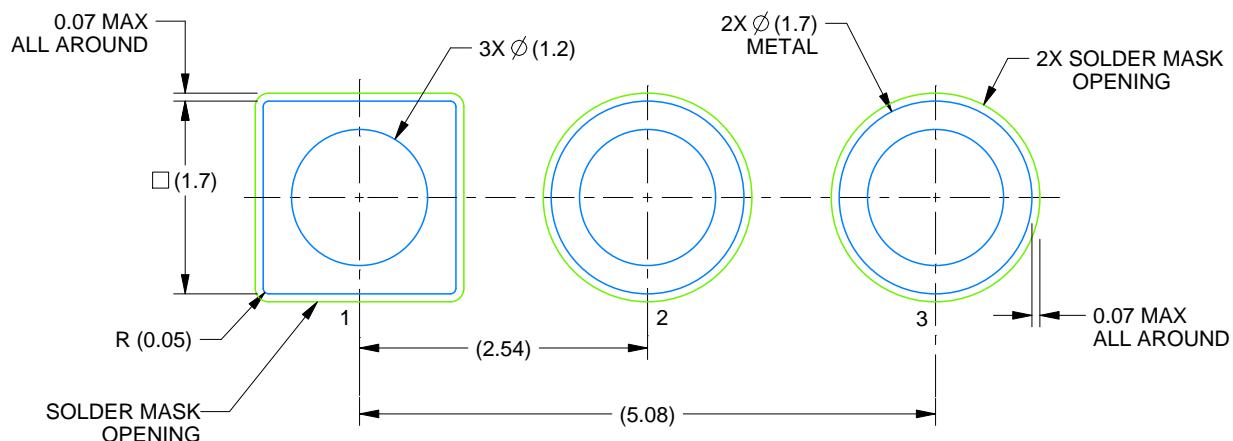
1. Dimensions are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
 2. This drawing is subject to change without notice.
 3. Reference JEDEC registration TO-220.

EXAMPLE BOARD LAYOUT

KCS0003B

TO-220 - 19.65 mm max height

TO-220



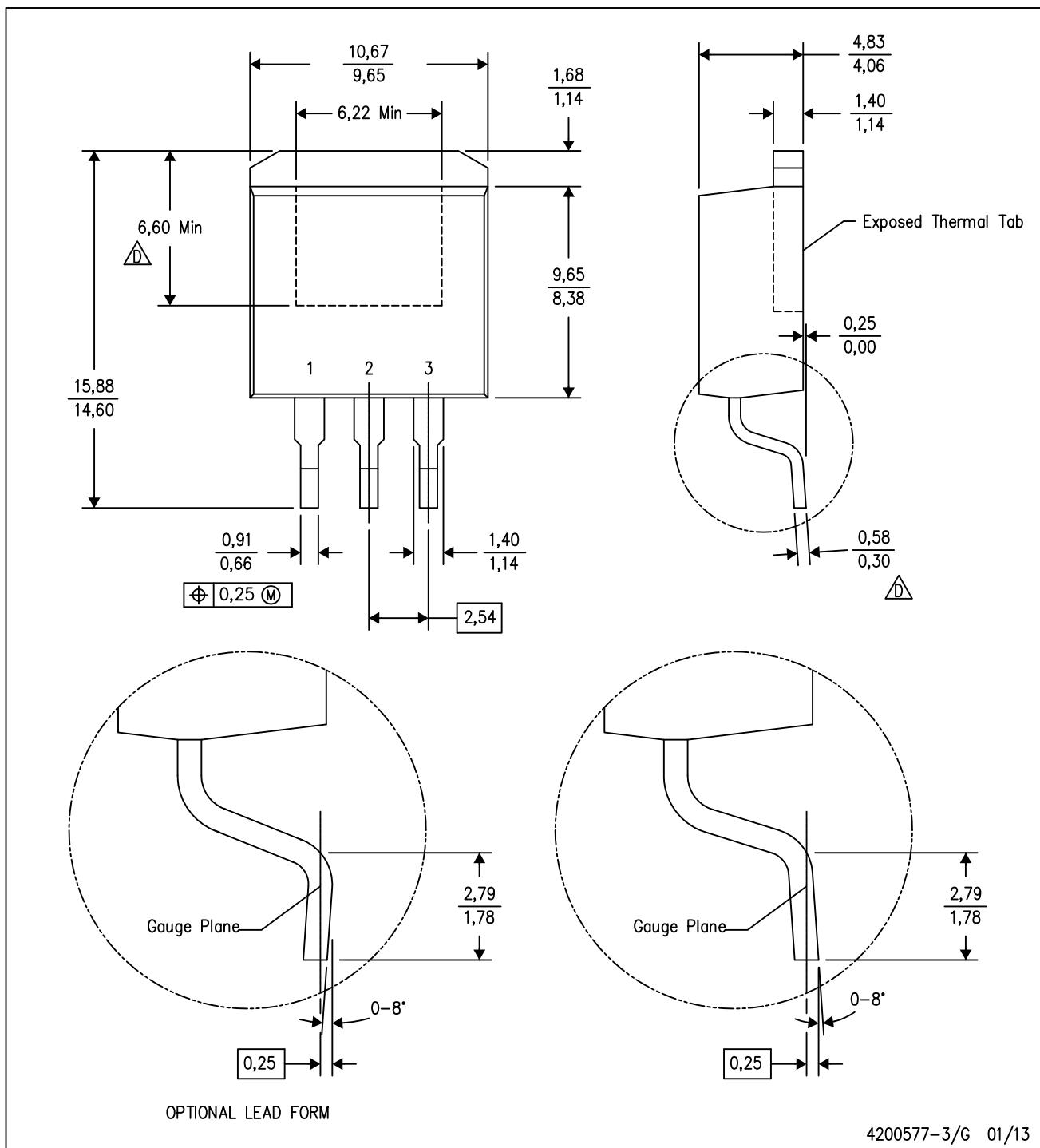
LAND PATTERN EXAMPLE
NON-SOLDER MASK DEFINED
SCALE:15X

4222214/B 08/2018

MECHANICAL DATA

KTT (R-PSFM-G3)

PLASTIC FLANGE-MOUNT PACKAGE



OPTIONAL LEAD FORM

4200577-3/G 01/13

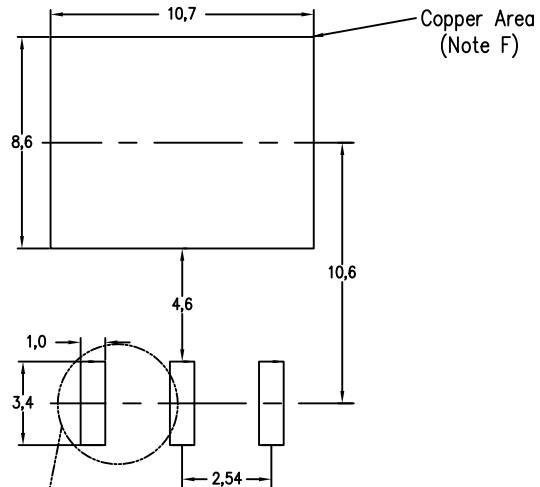
- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion. Mold flash or protrusion not to exceed 0.005 (0,13) per side.
- Falls within JEDEC TO-263 variation AA, except minimum lead thickness and minimum exposed pad length.

LAND PATTERN DATA

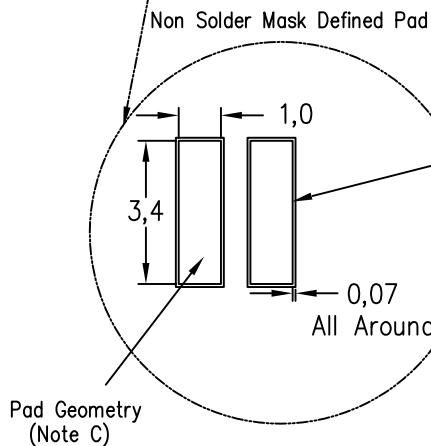
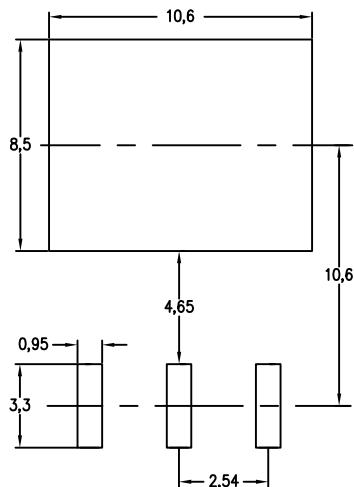
KTT (R-PSFM-G3)

PLASTIC FLANGE-MOUNT PACKAGE

Example Board Layout
(Note C)



Example Stencil Design
(Note D)



Example
Solder Mask Opening
(Note E)

4208208-2/C 08/12

- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-SM-782 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525.
 - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.
 - This package is designed to be soldered to a thermal pad on the board. Refer to the Product Datasheet for specific thermal information, via requirements, and recommended thermal pad size. For thermal pad sizes larger than shown a solder mask defined pad is recommended in order to maintain the solderable pad geometry while increasing copper area.

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