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## High-Input Voltage, Adjustable, 3-Terminal, Linear Regulator

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### Features

- 13.2-450V Input Voltage Range
- Adjustable 1.20-438V Output Regulation
- 5% Output Voltage Tolerance
- Output Current Limiting
- 10  $\mu$ A Typical ADJ Current
- Internal Junction Temperature Limiting

### Applications

- Offline SMPS startup circuits
- Adjustable high-voltage constant current source
- Industrial controls
- Motor controls
- Battery chargers
- Power supplies

### General Description

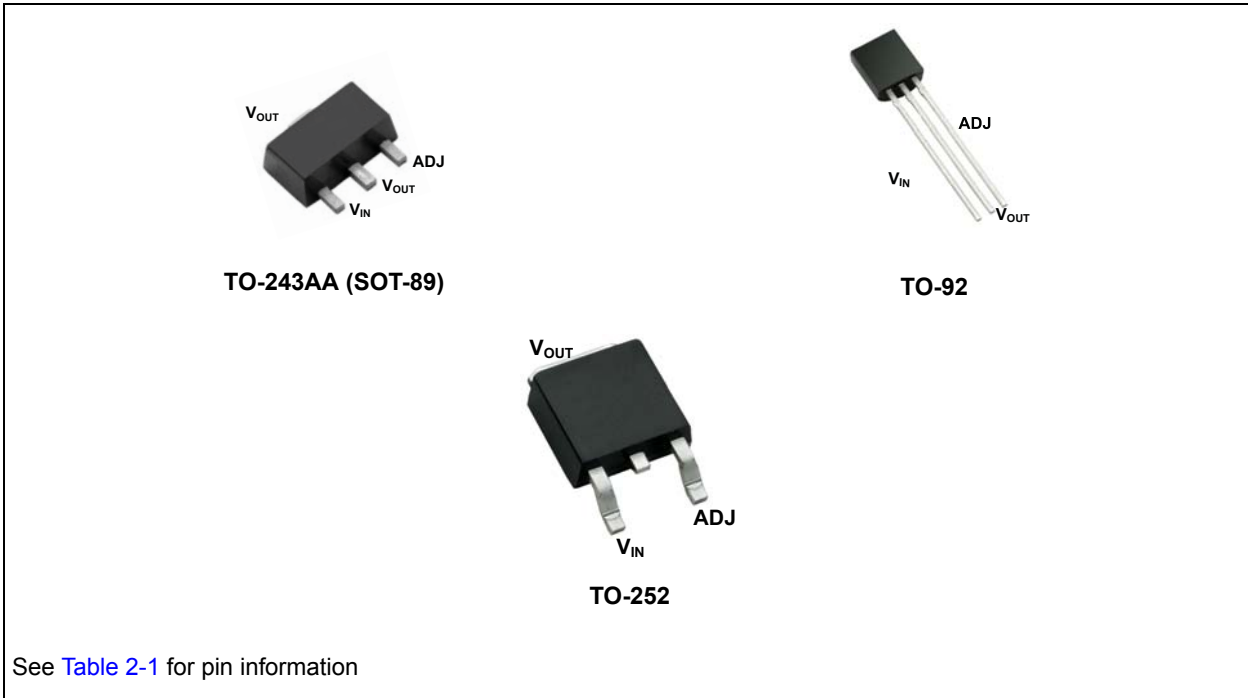
LR8 is a high-voltage, low-output current, adjustable linear regulator. This regulator has a wide operating input voltage range of 13.2-450V. The output voltage can be adjusted from 1.20-438V, provided that the input voltage is at least 12V greater than the output voltage. The output voltage can be adjusted by means of two external resistors,  $R_1$  and  $R_2$ , as shown in the typical application circuits. LR8 regulates the voltage difference between  $V_{OUT}$  and ADJ pins to a nominal value of 1.20V. The 1.20V is amplified by the external resistor ratio  $R_1$  and  $R_2$ . An internal constant bias current, of typically 10  $\mu$ A, is connected to the ADJ pin. This increases  $V_{OUT}$  by a constant voltage of 10  $\mu$ A times  $R_2$ .

LR8 provides both current and temperature limiting. The output current limit is typically 20 mA and the minimum temperature limit is +125°C. An output short-circuit current will therefore be limited to 20 mA. When the junction temperature reaches its temperature limit, the output current and/or output voltage will decrease to prevent the junction temperature from exceeding its temperature limit. For SMPS start-up circuit applications, LR8 turns off when an external voltage greater than the output voltage of the LR8 is applied to  $V_{OUT}$  of the LR8. To maintain stability, a bypass capacitor of 1.0  $\mu$ F or larger and a minimum DC output current of 500  $\mu$ A are required.

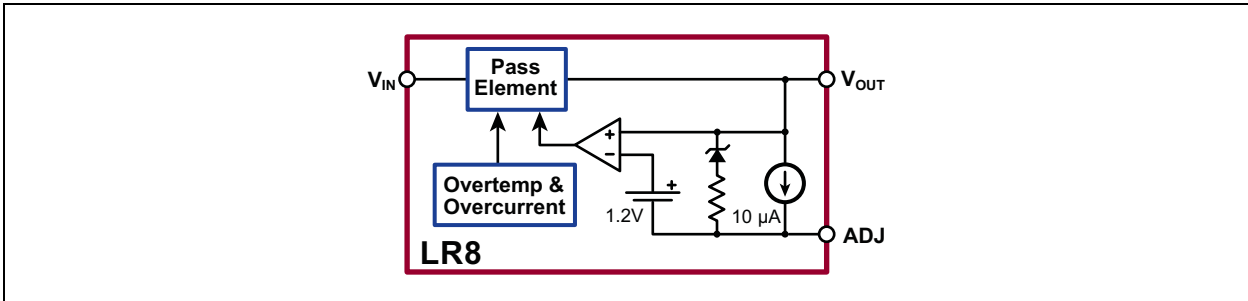
LR8 is available in TO-243AA (SOT-89), TO-252 (D-PAK) and TO-92 packages.

# LR8

## Package Type



## Functional Block Diagram



## 1.0 ELECTRICAL CHARACTERISTICS

### ABSOLUTE MAXIMUM RATINGS†

$V_{IN}$ Input voltage (voltages ref to ADJ).....	-0.5 to +480V
Output voltage range.....	0.5 to +470V
Operating ambient temperature range.....	-40°C to +85°C
Operating junction temperature range.....	-40°C to +125°C
Storage temperature.....	-65°C to +150°C

† **Notice:** Stresses above those listed under “Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS <sup>1</sup>

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
Input to output voltage difference	$V_{IN} - V_{OUT}$	12		450	V	
Overall output voltage regulation	$V_{OUT}$	1.14	1.20	1.26	V	$13.2V < V_{IN} < 400V$ , $R_1 = 2.4\text{ k}\Omega$ , $R_2 = 0$
		375	400	425	V	$R_1 = 2.4\text{ k}\Omega$ , $R_2 = 782\text{ k}\Omega$
Line regulation	$\Delta V_{OUT}$		0.003	0.01	%/V	$17V < V_{IN} < 400V$ , $V_{OUT} = 5V$ , $I_{OUT} = 0.5\text{mA}$
Load regulation			1.4	3.0	%	$V_{IN} = 17V$ , $V_{OUT} = 5V$ , $0.5\text{ mA} < I_{OUT} < 10\text{ mA}$
Temperature regulation			-1		+1	%
Output current limit	$I_{OUT}$	10		30	mA	$T_J < 85^\circ\text{C}$ , $V_{IN} - V_{OUT} = 12V$
				0.5	mA	$T_J > 125^\circ\text{C}$ , $V_{IN} - V_{OUT} = 450V$
Minimum output current	$I_{OUT}$		0.3	0.5	mA	Includes $R_1$ and load current
Adjust output current	$I_{ADJ}$	5.0	10	15	$\mu\text{A}$	
Minimum output load capacitance	$C_{LOAD}$	1.0			$\mu\text{F}$	
Ripple rejection ratio	$\Delta V_{OUT}/\Delta V_{IN}$	50	60		dB	120 Hz, $V_{OUT} = 5V$
Junction temperature limit	$T_{LIMIT}$	125			$^\circ\text{C}$	

<sup>1</sup> Test Conditions unless otherwise specified:  $-40^\circ\text{C} < T_A < 85^\circ\text{C}$ .

**TABLE 1-1: TYPICAL THERMAL RESISTANCE**

Package	$\theta_{ja}$
TO-252 (D-PAK)	81 $^\circ\text{C}/\text{W}$
TO-92	132 $^\circ\text{C}/\text{W}$
TO-243AA (SOT-89)	133 $^\circ\text{C}/\text{W}$

**TABLE 1-2: THERMAL CHARACTERISTICS**

Package	Power Dissipation @ $T_A = 2.5^\circ\text{C}$	$\theta_{jc}$ $^\circ\text{C}/\text{W}$	$\theta_{ja}$ $^\circ\text{C}/\text{W}$
TO-92	0.74W	125	170
TO-243AA (SOT-89)	1.6W	15	78 <sup>1</sup>
TO-252 (D-PAK)	2.5W	6.25	50 <sup>1</sup>

<sup>1</sup> Mounted on FR4 board, 25 mm x 2 mm x 1.57 mm

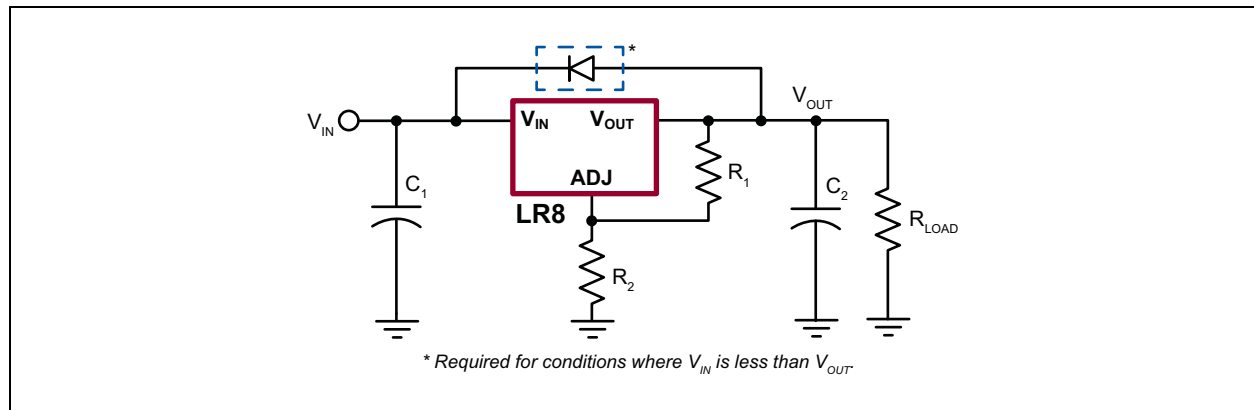
## 2.0 PIN DESCRIPTION

The locations of the pins are listed in [Package Type](#).

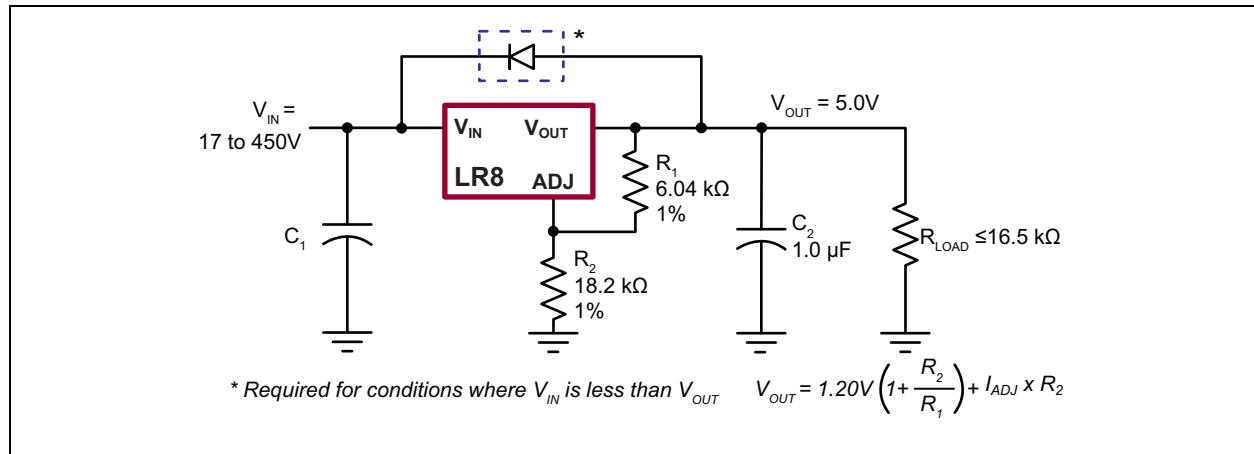
**TABLE 2-1: PIN DESCRIPTION**

Function	Description
V <sub>IN</sub>	Regulator input. 13.2-450V.
V <sub>OUT</sub>	Regulator output.
ADJ	Output voltage adjust.

## 3.0 TYPICAL APPLICATION CIRCUITS

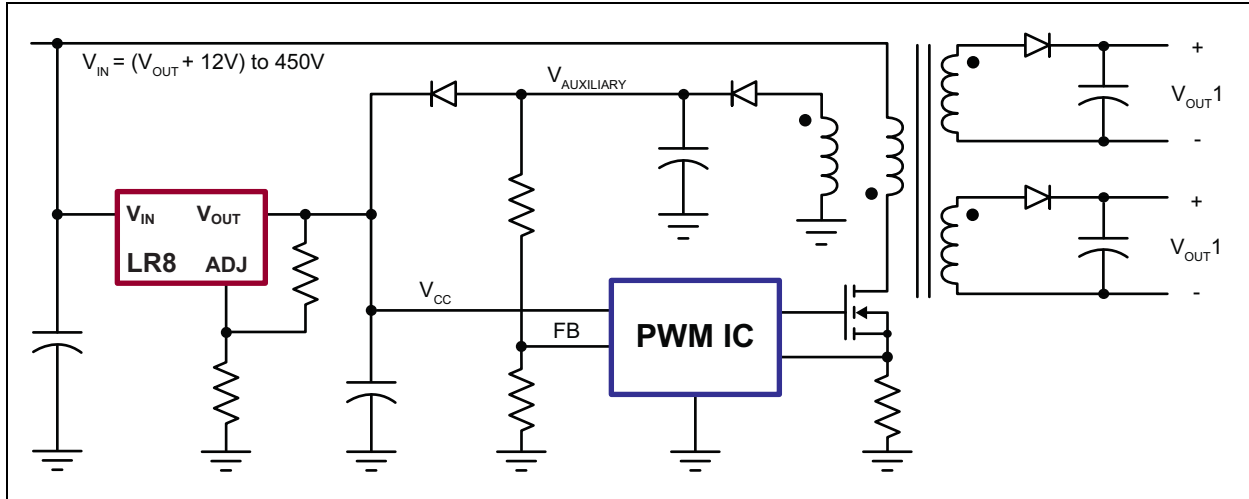


**FIGURE 3-1:** Typical Application Circuit.

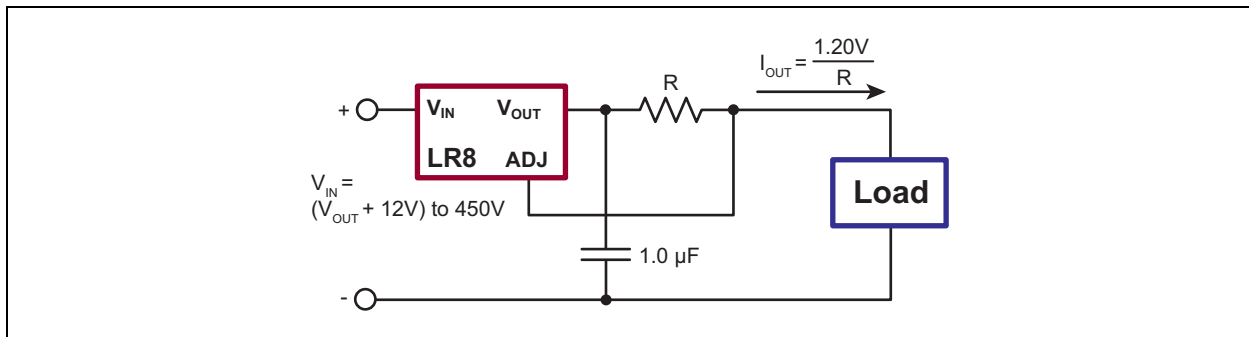


**FIGURE 3-2:** High-input Voltage, 5.0V Output Linear Regulator.

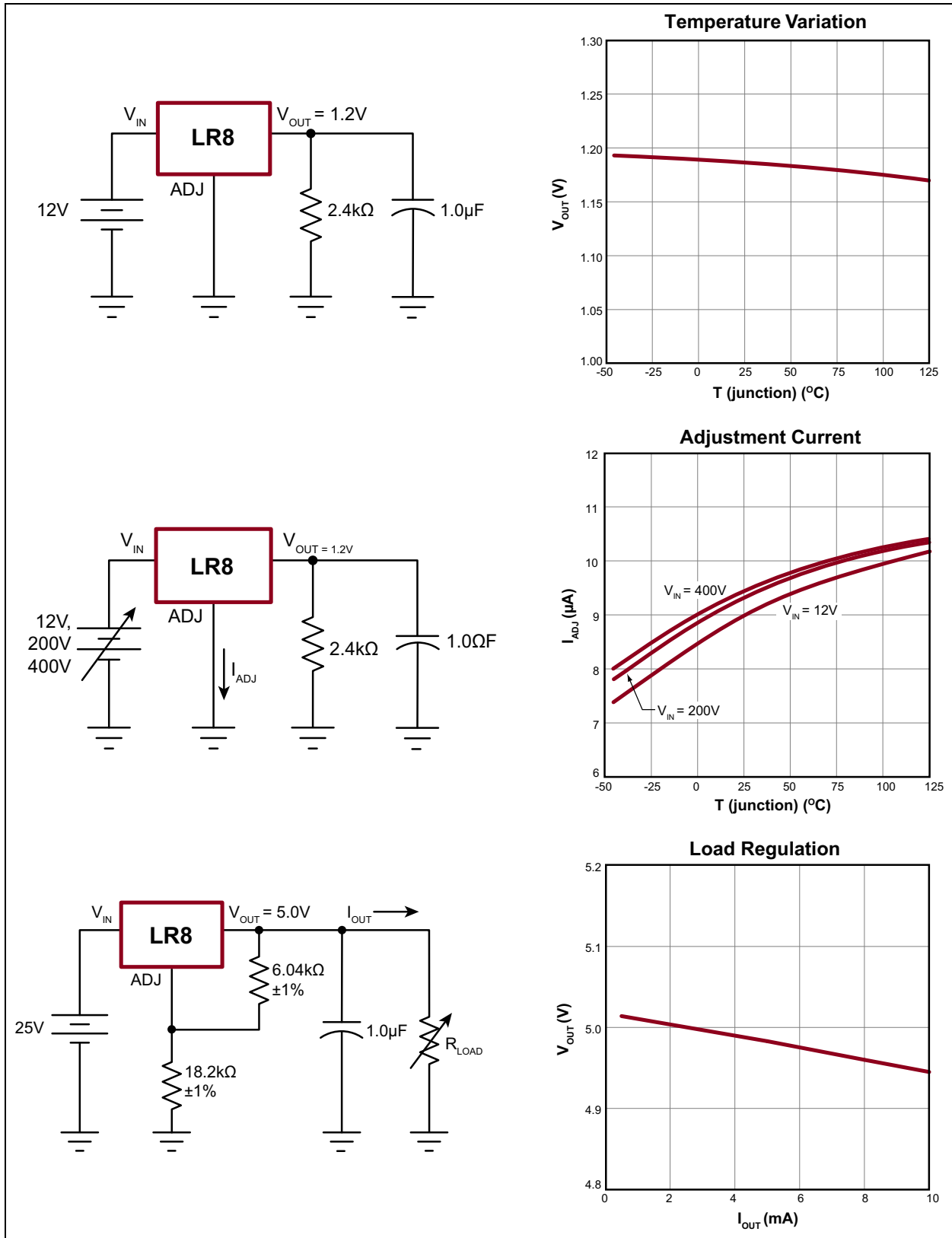
# LR8



**FIGURE 3-3:** SMPS Start-Up Circuit.



**FIGURE 3-4:** High-voltage, Adjustable, Constant-Current Source.



**FIGURE 3-5:** Typical Performance Curves 1 of 3.

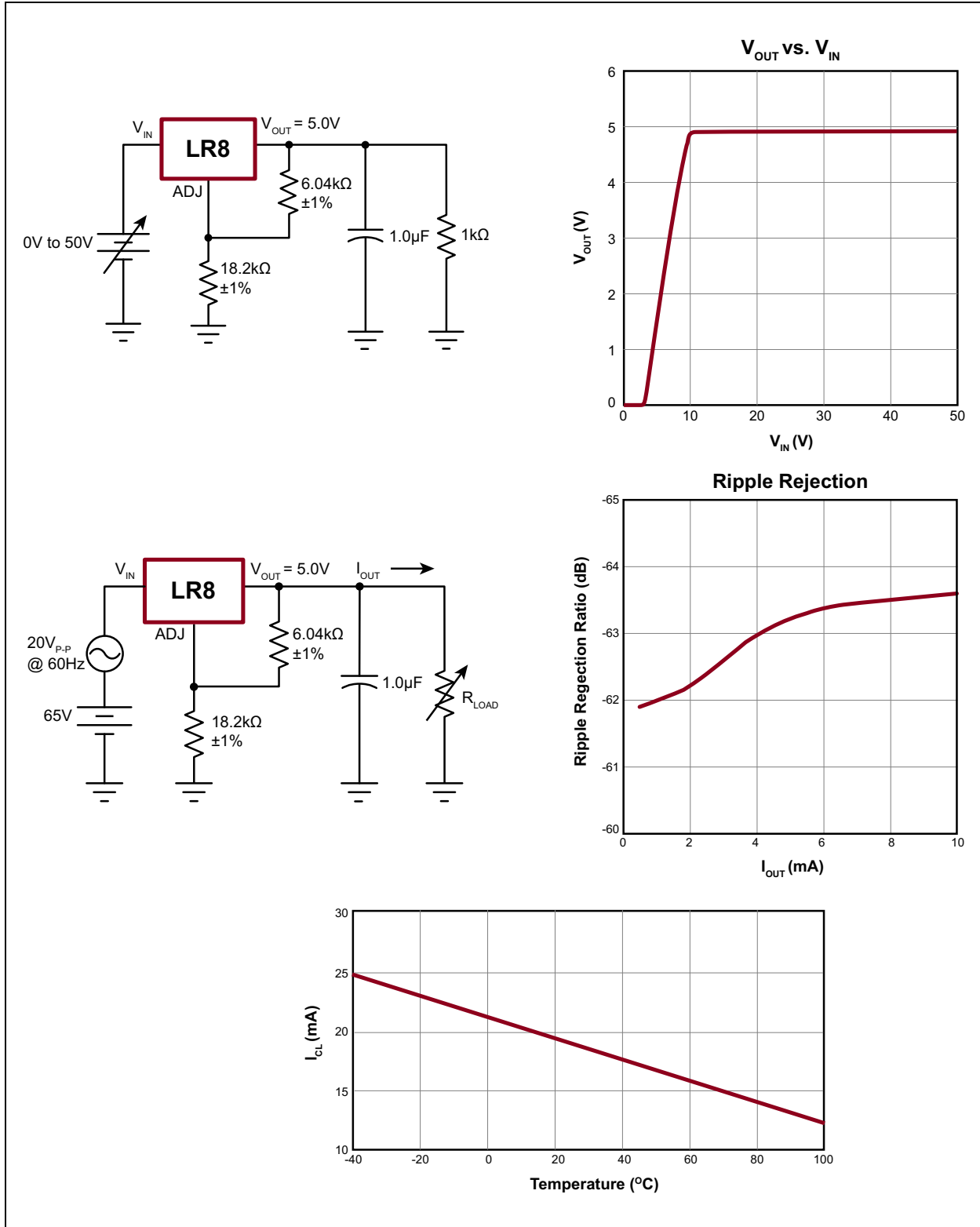
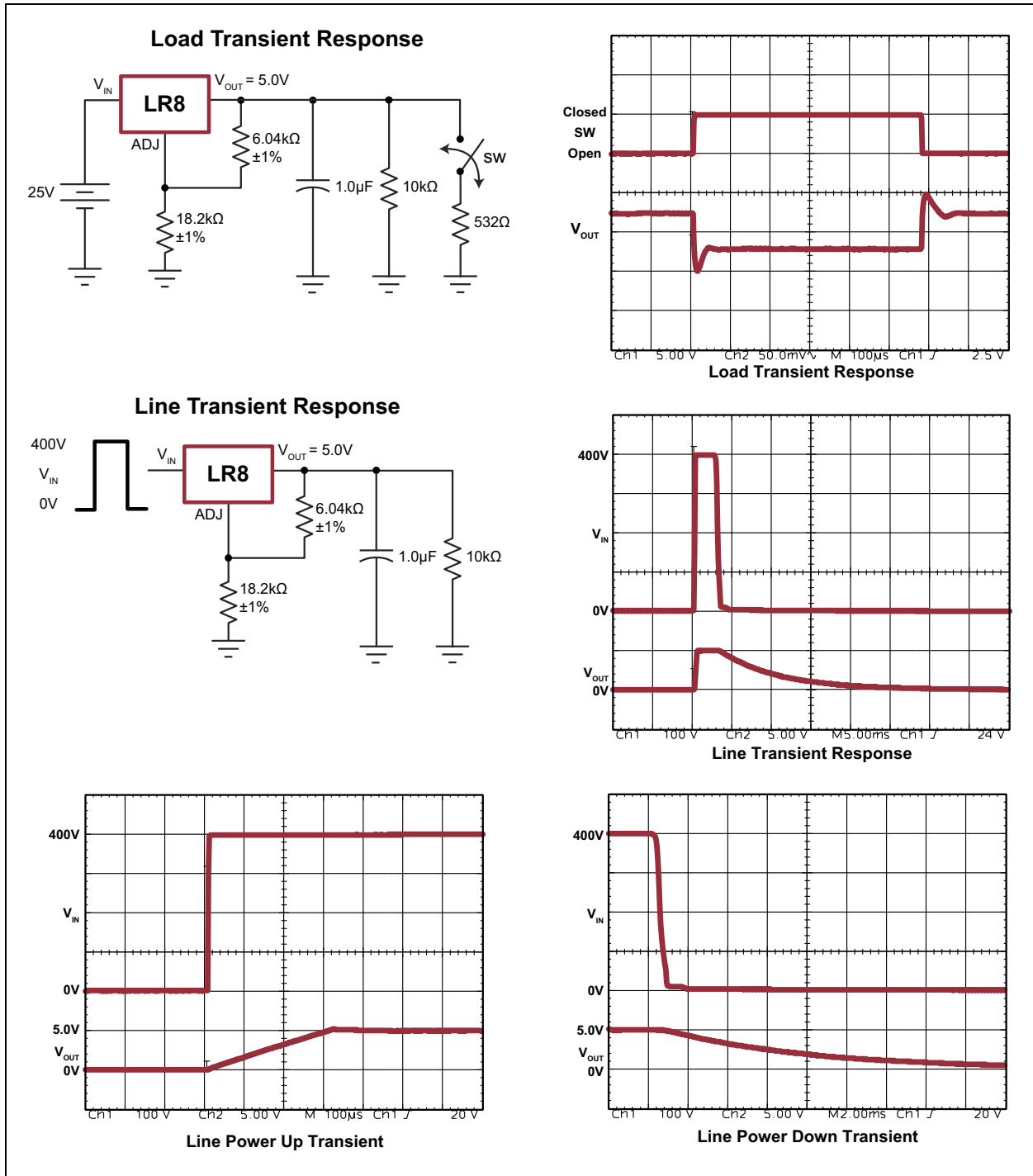


FIGURE 3-6: Typical Performance Curves 2 of 3.





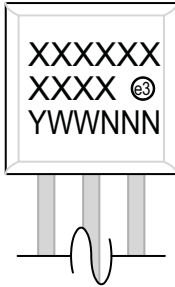
**FIGURE 3-7:** Typical Performance Curves 3 of 3.

# LR8

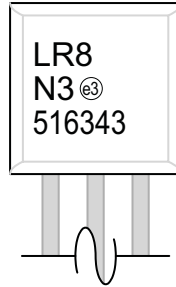
## 4.0 PACKAGING INFORMATION

### 4.1 Package Marking Information

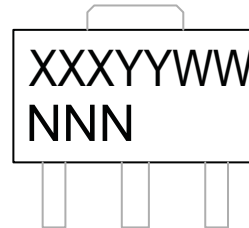
3-lead TO-92



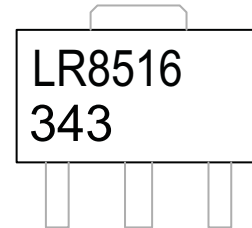
Example



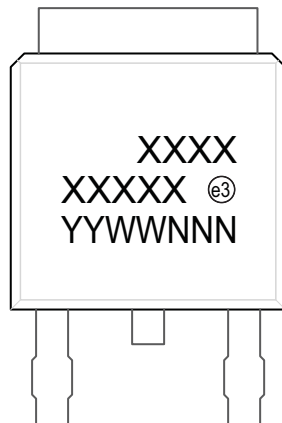
3-lead TO-243AA \*  
(SOT-89)



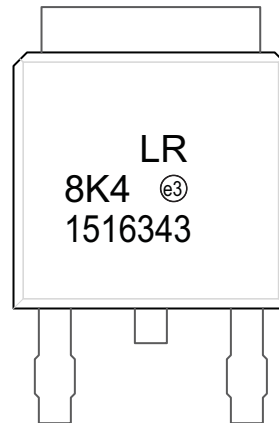
Example



3-lead TO-252  
(D-PAK)



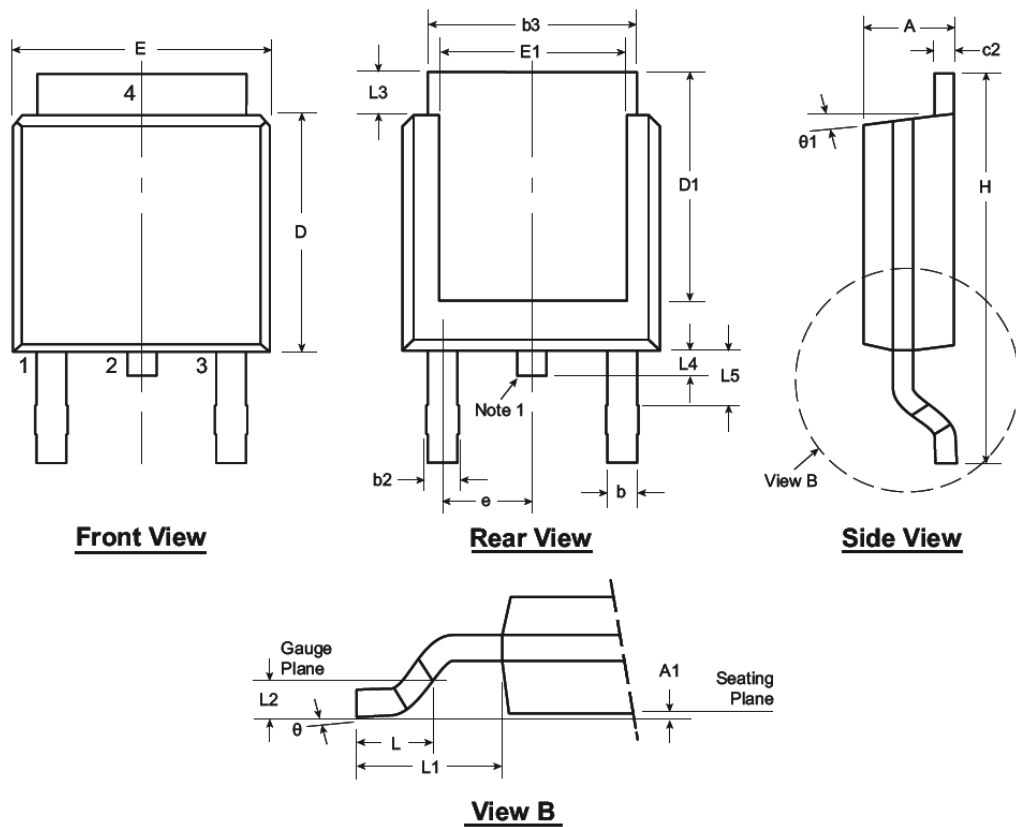
Example



<b>Legend:</b>	XX...X	Product Code or Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator (e3) can be found on the outer packaging for this package.

**Note:** In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for product code or customer-specific information. Package may or not include the corporate logo.

### 3-Lead TO-252 (D-PAK) Package Outline (K4)



Note: For the most current package drawings, see the Microchip Packaging Specification at [www.microchip.com/packaging](http://www.microchip.com/packaging).

**Note:**

1. Although 4 terminal locations are shown, only 3 are functional. Lead number 2 was removed.

Symbol	A	A1	b	b2	b3	c2	D	D1	E	E1	e	H	L	L1	L2	L3	L4	L5	θ	θ1
Dimension (inches)	MIN	.086	.000*	.025	.030	.195	.018	.235	.205	.250	.170	.370	.055	.108 REF	.020 BSC	.035	.025*	.035†	0°	0°
	NOM	-	-	-	-	-	.240	-	-	-	.090 BSC	-	.060	-	-	-	-	-	-	-
	MAX	.094	.005	.035	.045	.215	.035	.245	.217*	.265	.200*	.410	.070	-	.050	.040	.060	10°	15°	

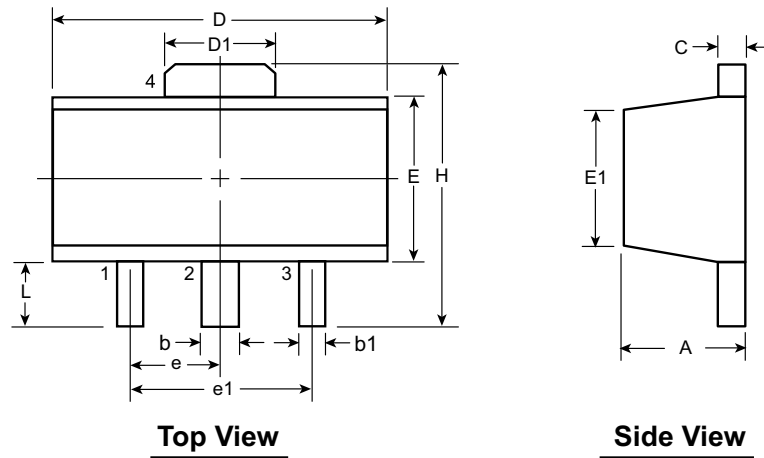
JEDEC Registration TO-252, Variation AA, Issue E, June 2004.

\* This dimension is not specified in the JEDEC drawing.

† This dimension differs from the JEDEC drawing.

**Drawings not to scale.**

## 3-Lead TO-243AA (SOT-89) Package Outline (N8)



Note: For the most current package drawings, see the Microchip Packaging Specification at [www.microchip.com/packaging](http://www.microchip.com/packaging).

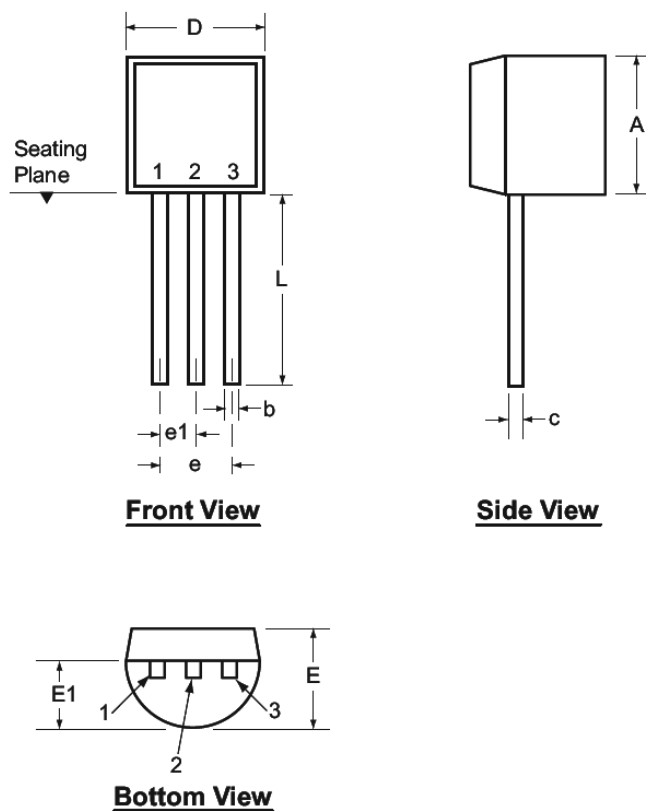
Symbol	A	b	b1	C	D	D1	E	E1	e	e1	H	L		
Dimensions (mm)	MIN	1.40	0.44	0.36	0.35	4.40	1.62	2.29	2.00 <sup>†</sup>	1.50 BSC	3.00 BSC	3.94	0.73 <sup>†</sup>	
	NOM	-	-	-	-	-	-	-	-			-	-	-
	MAX	1.60	0.56	0.48	0.44	4.60	1.83	2.60	2.29			4.25	1.20	

JEDEC Registration TO-243, Variation AA, Issue C, July 1986.

<sup>†</sup> This dimension differs from the JEDEC drawing

Drawings not to scale.

## 3-Lead TO-92 Package Outline (L/LL/N3)



Note: For the most current package drawings, see the Microchip Packaging Specification at [www.microchip.com/packaging](http://www.microchip.com/packaging).

Symbol		A	b	c	D	E	E1	e	e1	L
Dimensions (inches)	MIN	.170	.014 <sup>†</sup>	.014 <sup>†</sup>	.175	.125	.080	.095	.045	.500
	NOM	-	-	-	-	-	-	-	-	-
	MAX	.210	.022 <sup>†</sup>	.022 <sup>†</sup>	.205	.165	.105	.105	.055	.610*

JEDEC Registration TO-92.

\* This dimension is not specified in the JEDEC drawing.

† This dimension differs from the JEDEC drawing.

Drawings not to scale.

# LR8

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NOTES:

## **APPENDIX A: REVISION HISTORY**

### **Revision B (November 2017)**

The following is the list of modifications:

1. Updated [Figure 3-2](#).
2. Various typographical edits.

### **Revision A (June 2015)**

- Original Release of this Document.

# LR8

## PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

<u>PART NO.</u>	<u>XX</u>	-	<u>X</u>	-	<u>X</u>
Device	Package Options		Environmental		Media Type
Device:	LR8	=	High-Input Voltage, Adjustable, 3-Terminal, Linear Regulator		
Package:	N3	=	TO-92		
	K4	=	TO-252 (D-PAK)		
	N8	=	TO-243AA (SOT-89)		
Environmental	G	=	Lead (Pb)-free/ROHS-compliant package		
Media Type:	(blank)	=	1000/Bag for N3 packages		
		=	2000/Reel for K4 packages		
		=	2000/Reel for N8 packages		
	P003	=	2000/Reel for N3 package		

**Examples:**

- a) LR8N3-G TO-92 package, 1000/bag
- b) LR8N3-G-P003: TO-92 package, 2000/reel.
- c) LR8K4-G TO-252 package, 2000/reel
- d) LR8N8-G TO-243AA package, 2000/reel



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