



## Micropower Low Dropout Reference

November 1998

### FEATURES

- 200mV Max Dropout at 10mA Output Current
- 4 $\mu$ A Typical Quiescent Current
- 0.15% Max Initial Accuracy
- No Output Capacitor Required
- Output Sources 10mA, Sinks 2mA
- 40ppm/ $^{\circ}$ C Max Drift Over Commercial Temp Range
- Load Regulation Over Temperature:  
0.1mV/mA, Source up to 10mA  
1.75mV/mA, Sink up to 2mA
- 3.2V to 12.6V Supply Voltage Range (LTC1258-3)
- 4.3V to 12.6V Supply Voltage Range (LTC1258-4.1)

### APPLICATIONS

- Battery-Powered Systems
- Hand-Held Instruments
- Precision Power Supply
- A/D and D/A Converters

### DESCRIPTION

The LTC<sup>®</sup>1258-3/LTC1258-4.1 are micropower bandgap references that combine high accuracy and low drift with very low supply current and small package size. The combination of ultralow quiescent current and low dropout voltage of only 200mV max makes them ideal for battery-powered equipment.

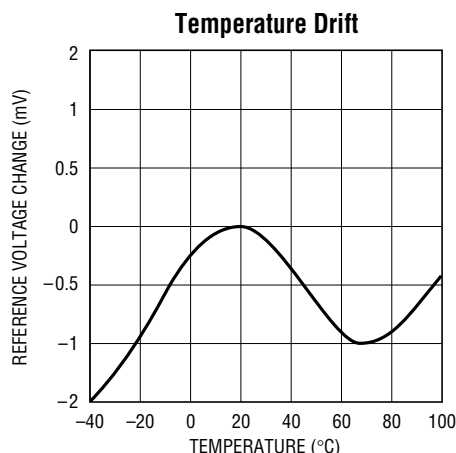
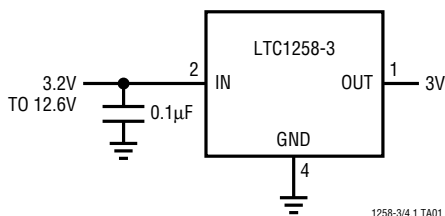
These references uses curvature compensation to obtain low temperature coefficient and trimmed thin-film resistors to achieve high output accuracy. These references can supply up to 10mA and sink up to 2mA, making them ideal for precision regulator applications. The LTC1258-3/LTC1258-4.1 are stable without an output bypass capacitor, but are also stable with capacitance up to 1 $\mu$ F. This feature is important in critical applications where PC board space is a premium and fast settling is demanded.

Series references provide power dissipation advantages over shunt references. In addition to supply current, shunt references must also idle the entire load current to operate.

The LTC1258-3/LTC1258-4.1 are available in the 8-pin SO package.

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### TYPICAL APPLICATION



1258-3/4.1 TA02

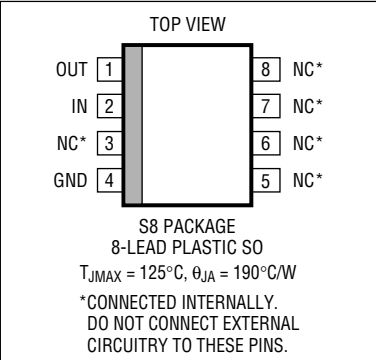
# LTC1258-3/LTC1258-4.1

## ABSOLUTE MAXIMUM RATINGS

(Note 1)

Supply Voltage .....	13V
Input Voltages .....	–0.3V to 13V
Output Voltages .....	–0.3V to 13V
Output Short Circuit Duration .....	Indefinite
Operating Temperature Range .....	0°C to 70°C
Storage Temperature Range (Note 2) ...	–65°C to 150°C
Lead Temperature (Soldering, 10 sec) .....	300°C

## PACKAGE/ORDER INFORMATION

	ORDER PART NUMBER	
	LTC1258CS8-3 LTC1258CS8-4.1	
	S8 PART MARKING	
	12583 125841	

Consult factory for Industrial and Military grade parts.

## ELECTRICAL CHARACTERISTICS

$V_{IN} = 3.2V$  (LTC1258-3),  $V_{IN} = 4.3$  (LTC1258-4.1),  $I_{OUT} = 0mA$ ,  $T_A = 25^\circ C$  unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
$V_{IN}$	Input Voltage Range	LTC1258-3	●	3.2	12.6	V
		LTC1258-4.1	●	4.3	12.6	V
$I_{IN}$	Input Current		●		6.5	$\mu A$
					8.5	$\mu A$
$V_{OUT}$	Output Voltage (Note 3)	LTC1258-3	2.9955	3	3.0045	V
		LTC1258-4.1	4.090	4.096	4.102	V
$e_n$	Output Voltage Noise (Note 4)	$0.1Hz \leq f \leq 10Hz$		40		$\mu Vp-p$
TC	Output Voltage Temp Coefficient (Note 5)	$T_{MIN} \leq T_J \leq T_{MAX}$	●	15	40	ppm/ $^\circ C$
$V_{OUT}/V_{IN}$	Line Regulation	$V_{IN} = 3.2V$ to 12.6V (LTC1258-3)	●	75	150	$\mu V/V$
		$V_{IN} = 4.3V$ to 12.6V (LTC1258-4.1)	●	75	150	$\mu V/V$
$V_{OUT}/I_{OUT}$	Load Regulation (Note 6)	Sourcing 0mA to 10mA	●	0.1	0.2	mV/mA
		Sinking 0mA to 2mA	●	1.75	0.3	mV/mA
					6.5	mV/mA
$I_{SC}$	Short-Circuit Output Current	$V_{OUT}$ Shorted to GND		20	40	mA
		$V_{OUT}$ Shorted to $V_{IN}$		2	4	mA
$\Delta V_{DO}$	Dropout Voltage (Note 7)	$I_{OUT} = 0$ , $\Delta V_{OUT} \leq 0.1\%$	●		100	mV
		$I_{OUT} = 10mA$ , $\Delta V_{OUT} \leq 0.1\%$	●		200	mV
$V_{HYST}$	Output Hysteresis (Note 8)	$\Delta T = -40^\circ C$ to $85^\circ C$		200		ppm
		$\Delta T = 0^\circ C$ to $70^\circ C$		50		ppm

The ● denotes specifications which apply over the full operating temperature range.

**Note 1:** Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

**Note 2:** If the part is stored outside of the specified operating temperature range, the output may shift due to hysteresis.

**Note 3:** ESD (Electrostatic Discharge) sensitive device. Extensive use of ESD protection devices are used internal to the LTC1258-3/LTC1258-4.1, however, high electrostatic discharge can damage or degrade the device. Use proper ESD handling precautions.

**Note 4:** Peak-to-peak noise is measured with a single highpass filter at 0.1Hz and 2-pole lowpass filter at 10Hz.

**Note 5:** Temperature coefficient is measured by dividing the change in output voltage by the specified operating temperature range.

**Note 6:** Load regulation is measured on a pulse basis from no load to the specified load current. Output changes due to die temperature change must be taken into account separately.

**Note 7:** Dropout voltage is  $(V_{IN} - V_{OUT})$  when  $V_{OUT}$  falls to 0.1% below its nominal value at  $V_{IN} = V_{OUT} + 0.5V$ .

**Note 8:** Hysteresis in output voltage is created by package stress that differs depending on whether the IC was previously at a higher or lower temperature. Output voltage is always measured at 25°C, but the IC is cycled to 85°C or –40°C before successive measurements. Hysteresis is roughly proportional to the square of the temperature change. Hysteresis is not normally a problem for operational temperature excursions where the instrument might be stored at high or low temperature.

## PIN FUNCTIONS

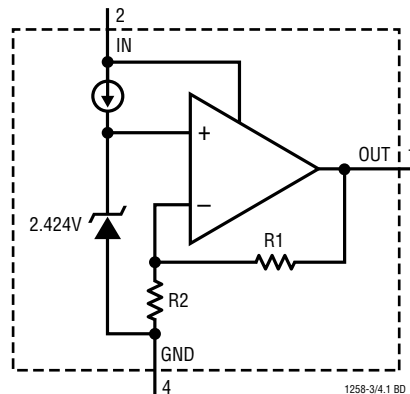
**OUT (Pin 1):** Reference Output. The output can source up to 10mA and sink up to 2mA. Stable with output bypass capacitor ranges from 0 $\mu$ F to 1 $\mu$ F.

**IN (Pin 2):** Positive Supply. Bypass with a 0.1 $\mu$ F capacitor is recommended if the output loading changes.  
 $(V_{OUT} + 0.2V) \leq V_{IN} \leq 12.6V$ .

**NC (Pins 3, 5, 6, 7, 8):** No Connection. Connected internally for post package trim. These pins should be left unconnected.

**GND (Pin 4):** Negative Supply or Ground Connection.

## BLOCK DIAGRAM



## APPLICATIONS INFORMATION

### Longer Battery Life

Series references have an advantage over shunt style references. To operate, shunt references require a resistor between the power supply and the output. This resistor must be chosen to supply the maximum current that is demanded by the circuit being regulated. When the circuit being controlled is not operating at this maximum current, the shunt reference must always sink this current, resulting in high power dissipation and short battery life.

The LTC1258-3/LTC1258-4.1 series low dropout references do not require a current setting resistor and can operate with any supply voltage from  $(V_{OUT} + 0.2V)$  to 12.6V. When the circuitry being regulated does not demand current, the LTC1258-3/LTC1258-4.1 reduces its dissipation and battery life is extended. If the reference is not delivering load current it dissipates only 13.2 $\mu$ W on a 3.3V supply (LTC1258-3), yet the same connection can deliver 10mA of load current when demanded.

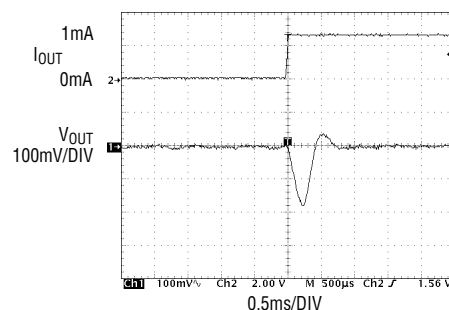
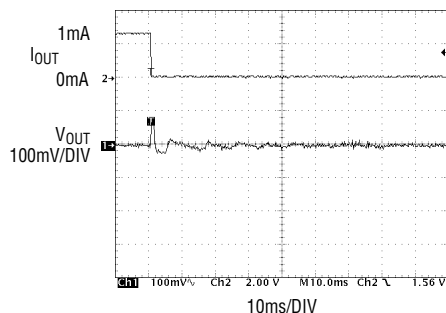


Figure 1. Reference Output Load Transient Response

## APPLICATIONS INFORMATION

### Output Bypass Capacitor

The LTC1258-3/LTC1258-4.1 are designed to be stable with or without capacitive loads. With no capacitive load, the reference is ideal for fast settling applications, or where PC board space is a premium.

In applications with significant output loading changes, an output bypass capacitor of up to  $1\mu\text{F}$  can be used to improve the output transient response. Figure 1 shows the response of the reference to a  $1\text{mA}$  to  $0\mu\text{A}$  load step with a  $1\mu\text{F}$  output capacitor. If more than  $1\mu\text{F}$  of output capacitance is required, a resistor in series with the capacitor is recommended to reduce the output ringing. Figure 2 shows the resistor and capacitor values required to achieve critical damping.

### Internal P-Channel Pass Transistor

The LTC1258-3/LTC1258-4.1 feature an internal P-channel MOSFET pass transistor. This provides several advantages over similar designs using a PNP bipolar pass transistor.

The LTC1258-3/LTC1258-4.1 consume only  $4\mu\text{A}$  of quiescent current under light and heavy loads as well as in dropout; whereas, PNP based references waste considerable amounts of current when the pass transistor is saturated. In addition, the LTC1258-3/LTC1258-4.1 provide a lower dropout voltage ( $200\text{mV}$  max) than PNP based references.

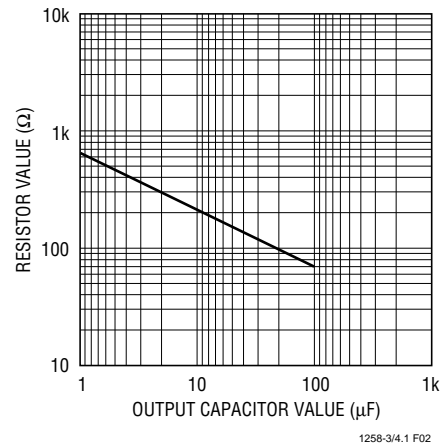
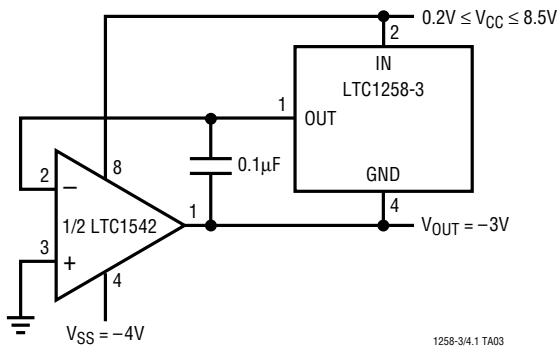


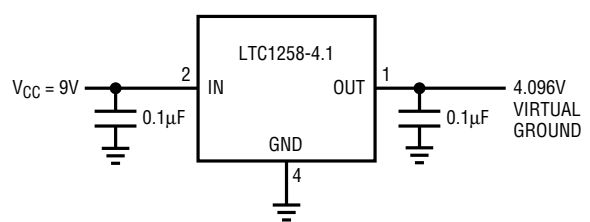
Figure 2. Damping Resistance vs Output Capacitor Value

## TYPICAL APPLICATIONS

### Micropower Low Dropout Negative Reference



### Supply Splitter



## RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT <sup>®</sup> 1634	Micropower Precision Shunt Voltage Reference	0.05% Max, 25ppm/°C Max Drift, 1.25V, 2.5V, 4.096V and 5V Outputs
LT1460	Micropower Series Reference	0.075% Max, 10ppm/°C Max Drift, 2.5V, 5V and 10V Outputs
LTC1440	Micropower Comparator with Reference	3.7μA Max $I_{CC}$ , 1% 1.182V Reference, Adjustable Hysteresis
LTC1540	Nanopower Comparator with Reference	600nA Max $I_{CC}$ , 2% 1.182V Reference, Adjustable Hysteresis