

FEATURES

- 200mV Max Dropout at 10mA Output Current
- 4 μ A Typical Quiescent Current
- 0.15% Max Initial Accuracy (S8)
- No Output Capacitor Required
- Output Sources 10mA, Sinks 2mA
- 40ppm/°C Max Drift (S8)
- Available in Small MSOP Package
- Voltage Options: 2.5V, 3V, 4.1V, 5V and Adjustable

APPLICATIONS

- Battery-Powered Systems
- Handheld Instruments
- Precision Power Supplies
- A/D and D/A Converters

DESCRIPTION

The LTC[®]1258/LTC1258-2.5/LTC1258-3/LTC1258-4.1/LTC1258-5 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. The output voltage is set by an external resistor divider for the adjustable LTC1258.

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

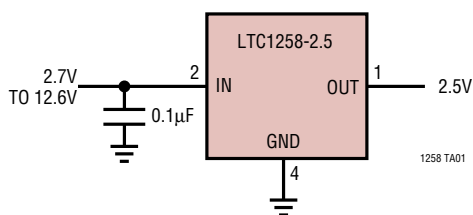
The LTC1258 series references provide power dissipation advantages over shunt references. In addition to supply current, shunt references must also idle the entire load current to operate.

The LTC1258 series is available in the 8-pin MSOP and SO packages.

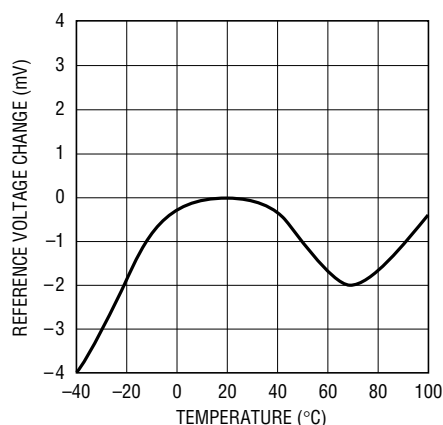
 LTC and LT are registered trademarks of Linear Technology Corporation.

TYPICAL APPLICATION

2.5V Battery-Powered Reference



LTC1258-2.5 Temperature Drift



1258 TA02

LTC1258 Series

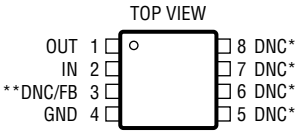
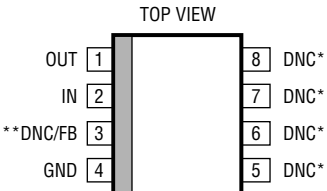
ABSOLUTE MAXIMUM RATINGS

(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 (Note 2) -40°C to 100°C
 Specified Temperature Range 0°C to 70°C
 Storage Temperature Range (Note 3) -65°C to 150°C
 Lead Temperature (Soldering, 10 sec) 300°C

PACKAGE/ORDER INFORMATION

 MS8 PACKAGE 8-LEAD PLASTIC MSOP * CONNECTED INTERNALLY. DO NOT CONNECT EXTERNAL CIRCUITRY TO THESE PINS ** DNC FOR LTC1258-2.5/LTC1258-3/LTC1258-4.1/LTC1258-5, FB FOR LTC1258 $T_{JMAX} = 125^{\circ}\text{C}$, $\theta_{JA} = 250^{\circ}\text{C/W}$	ORDER PART NUMBER	 S8 PACKAGE 8-LEAD PLASTIC SO * CONNECTED INTERNALLY. DO NOT CONNECT EXTERNAL CIRCUITRY TO THESE PINS ** DNC FOR LTC1258-2.5/LTC1258-3/LTC1258-4.1/LTC1258-5, FB FOR LTC1258 $T_{JMAX} = 125^{\circ}\text{C}$, $\theta_{JA} = 190^{\circ}\text{C/W}$	ORDER PART NUMBER
	MS8 PART MARKING		S8 PART MARKING
	LTEL LTCF LTEU LTEN LTEM		LTC1258CS8 LTC1258CS8-2.5 LTC1258CS8-3 LTC1258CS8-4.1 LTC1258CS8-5 1258 12582 12583 125841 12585

Consult factory for parts specified with wider operating temperature range.

AVAILABLE OPTIONS

OUTPUT VOLTAGE (V)	TEMPERATURE RANGE (°C)	ACCURACY (%)	TEMPERATURE COEFFICIENT (ppm/°C)	PACKAGE TYPE			
				SO-8 (S8)		MSOP-8 (MS8)	
				ORDER NUMBER	PART MARKING	ORDER NUMBER	PART MARKING
2.5	0 to 70	0.15	40	LTC1258CS8-2.5	12582	LTC1258CMS8-2.5	LTCF
2.5	0 to 70	0.21	60				
3	0 to 70	0.15	40	LTC1258CS8-3	12583	LTC1258CMS8-3	LTEU
3	0 to 70	0.20	60				
4.096	0 to 70	0.15	40	LTC1258CS8-4.1	125841	LTC1258CMS8-4.1	LTEN
4.096	0 to 70	0.18	60				
5	0 to 70	0.15	40	LTC1258CS8-5	12585	LTC1258CMS8-5	LTEM
5	0 to 70	0.18	60				
Adjustable	0 to 70	0.4	40	LTC1258CS8	1258	LTC1258CMS8	LTEL
Adjustable	0 to 70	0.46	60				

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the specified temperature range, otherwise specifications are $T_A = 25^\circ\text{C}$.

$V_{IN} = V_{OUT(NOMINAL)} + 0.2\text{V}$, $I_{OUT} = 0\text{mA}$, $FB = OUT$ for the LTC1258 unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Voltage Range	●			12.6	V
I_{IN}	Input Current	$FB = OUT$ for LTC1258 ●		4	6.5 8.5	μA μA
V_{OUT}	Output Voltage (Note 4)	LTC1258 (S8), $FB = OUT$ LTC1258-2.5 (S8) LTC1258-3 (S8) LTC1258-4.1 (S8) LTC1258-5 (S8) LTC1258 (MS8), $FB = OUT$ LTC1258-2.5 (MS8) LTC1258-3 (MS8) LTC1258-4.1 (MS8) LTC1258-5 (MS8)	2.3755 2.4963 2.9955 4.090 4.9925 2.374 2.4948 2.994 4.0885 4.991	2.385 2.5 3 4.096 5 2.385 2.5 3 4.096 5	2.3945 2.5037 3.0045 4.102 5.0075 2.396 2.5052 3.006 4.1035 5.009	V V V V V V V V V V
e_n	Output Voltage Noise (Note 5)	$0.1\text{Hz} \leq f \leq 10\text{Hz}$		8		ppm _{p-p}
TC	Output Voltage Temp Coefficient (Note 6)	$T_{MIN} \leq T_J \leq T_{MAX}$ (S8) $T_{MIN} \leq T_J \leq T_{MAX}$ (MS8)	● ●	15	40 60	ppm/ $^\circ\text{C}$ ppm/ $^\circ\text{C}$
V_{OUT}/V_{IN}	Line Regulation	$V_{IN} = (V_{OUT(NOMINAL)} + 0.2\text{V})$ to 12.6V	●	30	120	ppm/V
V_{OUT}/I_{OUT}	Load Regulation (Note 7)	Sourcing 0mA to 10mA Sinking 0mA to 2mA	● ●	0.1	0.3 4.0 6.5	mV/mA mV/mA mV/mA
I_{SC}	Short-Circuit Output Current	V_{OUT} Shorted to GND V_{OUT} Shorted to V_{IN}		20 2	40 4	mA mA
ΔV_{DO}	Dropout Voltage (Note 8)	$I_{OUT} = 0$, $\Delta V_{OUT} \leq 0.1\%$ $I_{OUT} = 10\text{mA}$, $\Delta V_{OUT} \leq 0.1\%$	● ●		100 200	mV mV
V_{HYST}	Output Hysteresis (Note 9)	$\Delta T = -40^\circ\text{C}$ to 85°C $\Delta T = 0^\circ\text{C}$ to 70°C		200 50		ppm ppm
I_{FB}	FB Pin Input Current	LTC1258, $OUT = FB$		10		nA

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

Note 2: The LTC1258 is guaranteed functional over the operating temperature range of -40°C to 100°C .

Note 3: If the part is stored outside of the specified operating temperature range, the output may shift due to hysteresis.

Note 4: ESD (Electrostatic Discharge) sensitive device. Extensive use of ESD protection devices are used internal to the LTC1258, however, high electrostatic discharge can damage or degrade the device. Use proper ESD handling precautions.

Note 5: Peak-to-peak noise is measured with a single pole highpass filter at 0.1Hz and 2-pole lowpass filter at 10Hz.

Note 6: Temperature coefficient is the change in output voltage divided by the nominal output voltage divided by the specified temperature range.

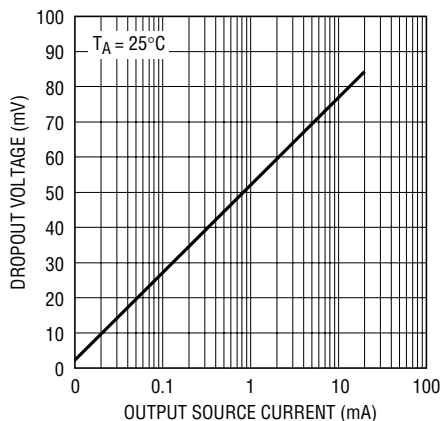
Note 7: Load regulation is measured on a pulse basis from no load to the specified load current. Output changes due to die temperature change must be taken into account separately.

Note 8: Dropout voltage is $(V_{IN} - V_{OUT})$ when V_{OUT} falls to 0.1% below its nominal value at $V_{IN} = V_{OUT} + 0.5\text{V}$.

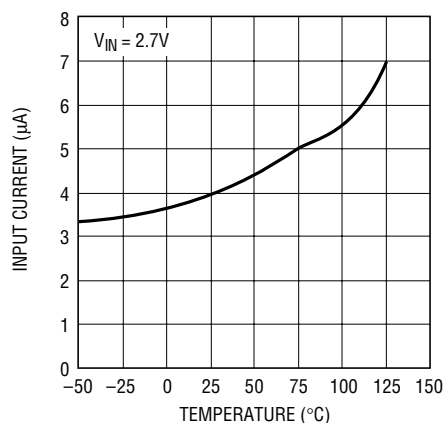
Note 9: Hysteresis in output voltage is created by package stress that differs depending on whether the IC was previously at a higher or lower temperature. Output voltage is always measured at 25°C , but the IC is cycled hot or cold before successive measurements. Hysteresis is not normally a problem for operational temperature excursions where the instrument might be stored at high or low temperature.

TYPICAL PERFORMANCE CHARACTERISTICS

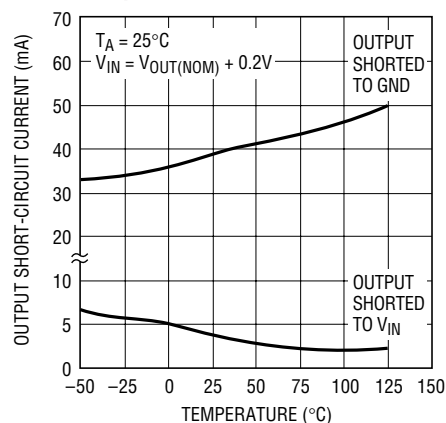
LTC1258-2.5*
Dropout Voltage vs
Output Source Current



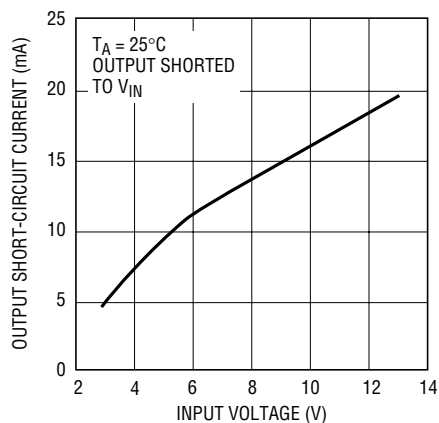
LTC1258-2.5*
Input Current vs Temperature



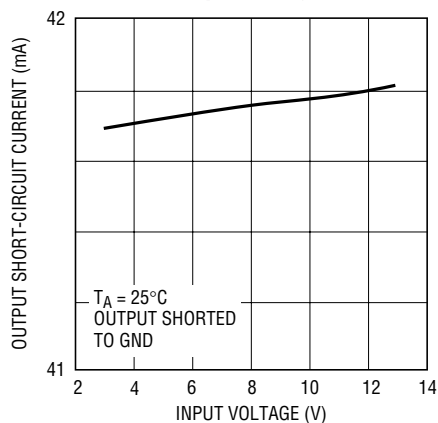
LTC1258 Series
Output Short-Circuit Current vs
Temperature



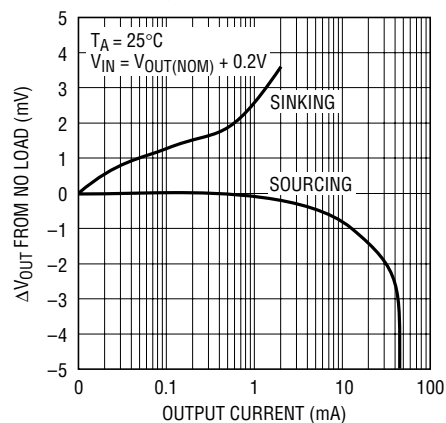
LTC1258-2.5* Output Short-Circuit
Current vs Input Voltage



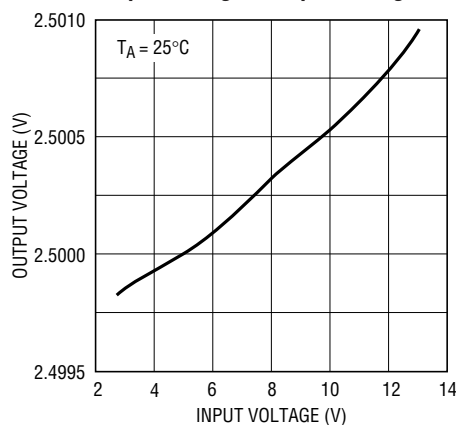
LTC1258-2.5* Output Short-Circuit
Current vs Input Voltage



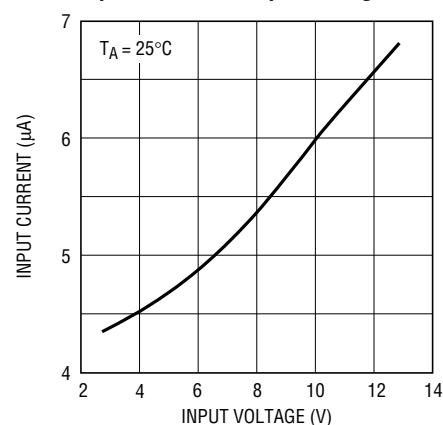
LTC1258 Series
Load Regulation



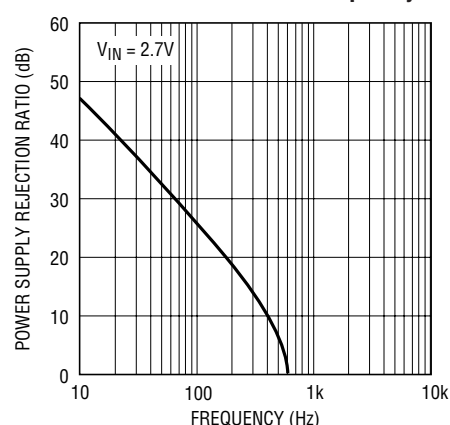
LTC1258-2.5
Output Voltage vs Input Voltage



LTC1258-2.5
Input Current vs Input Voltage



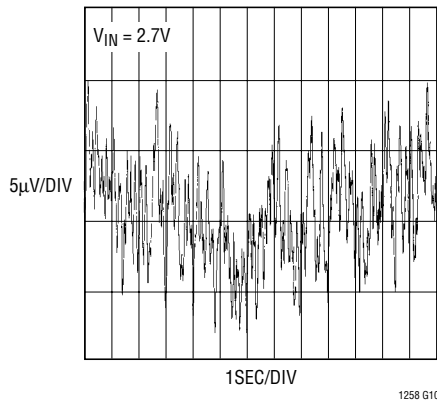
LTC1258-2.5 PSRR vs Frequency



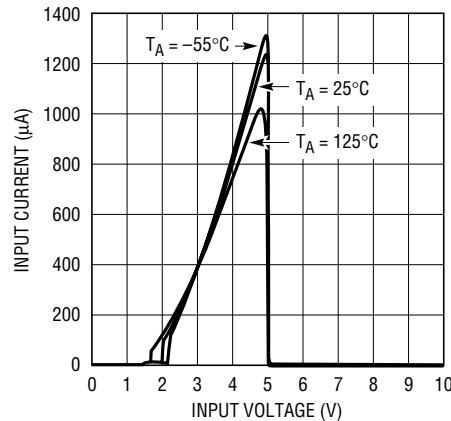
*Similar performance characteristics can be expected for all voltage options.

TYPICAL PERFORMANCE CHARACTERISTICS

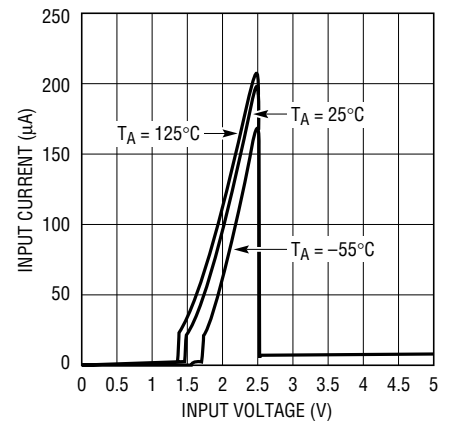
LTC1258-2.5 0.1Hz to 10Hz Noise



LTC1258-5 Input Current vs Input Voltage in Dropout



LTC1258-2.5 Input Current vs Input Voltage in Dropout



PIN FUNCTIONS

OUT (Pin 1): Reference Output. The output can source up to 10mA and sink up to 2mA. It is stable with output bypass capacitor ranging from 0μF to 1μF.

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

DNC (Pin 3): (LTC1258-2.5/LTC1258-3/LTC1258-4.1/LTC1258-5) Do Not Connect. Connected internally for post package trim. This pin must be left unconnected.

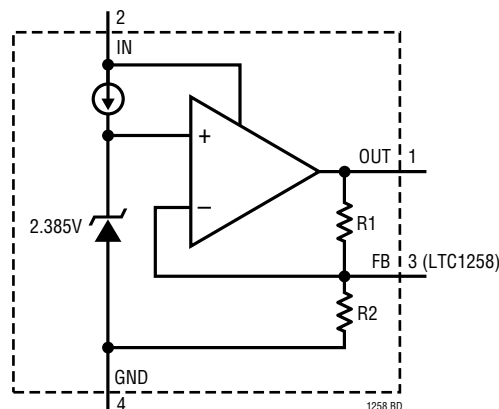
FB (Pin 3): (LT1258) Resistor Divider Feedback Pin. Connect a resistor divider from OUT to GND and the center tap to FB. This pin sets the output potential.

$$V_{OUT} = 2.385V \left(\frac{R1 + R2}{R2} \right);$$
 R1 is connected from OUT to FB and R2 from FB to GND.

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

DNC (Pins 5, 6, 7, 8): Do Not Connect. Connected internally for post package trim. These pins must be left unconnected.

BLOCK DIAGRAM



NOTE: R1 AND R2 ARE NOT CONNECTED FOR LTC1258

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 series low dropout references do not require a current setting resistor and can operate with any supply voltage from ($V_{OUT(NOMINAL)} + 0.2V$) to 12.6V. When the circuitry being regulated does not demand current, the LTC1258 series reduces its dissipation and battery life is extended. If the reference is not delivering load current it dissipates only $10.8\mu W$ when operating on a 2.7V supply for LTC1258-2.5, yet the same connection can deliver 10mA of load current when demanded.

Output Bypass Capacitor

The LTC1258 series is 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 at a premium.

In applications with significant output loading changes, an output bypass capacitor of up to $1\mu F$ can be used to improve the output transient response. Figure 1 shows the response of the reference to a 1mA to 0mA load step with a $1\mu F$ output capacitor. If more than $1\mu F$ of output capaci-

tance is required, a resistor in series with the capacitor is recommended to reduce the output ringing. Figure 2 illustrates the use of a damping resistor for capacitive loads greater than $1\mu F$. Figure 3 shows the resistor and capacitor values required to achieve critical damping.

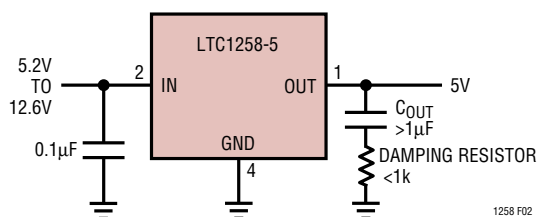


Figure 2. Adding a Damping Resistor with Output Capacitors Greater Than $1\mu F$

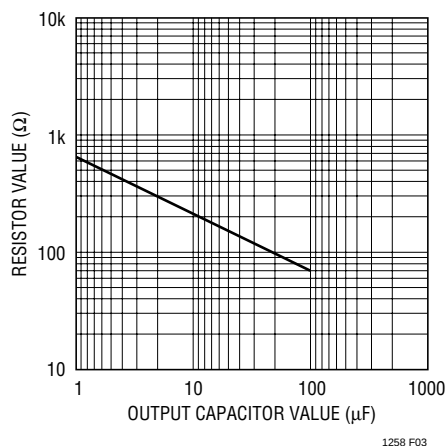


Figure 3. Damping Resistance vs Output Capacitor Value

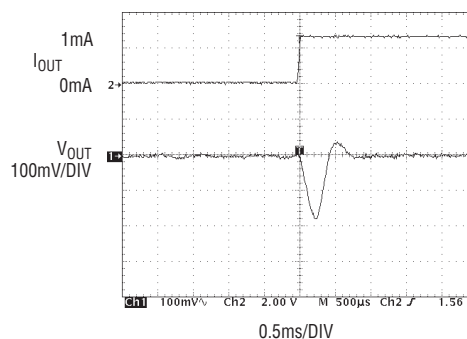
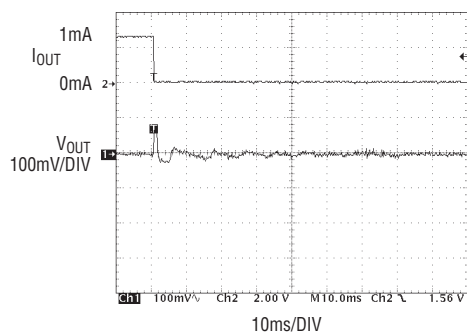


Figure 1. Reference Output Load Transient Response, $1\mu F$ Output Capacitor

APPLICATIONS INFORMATION

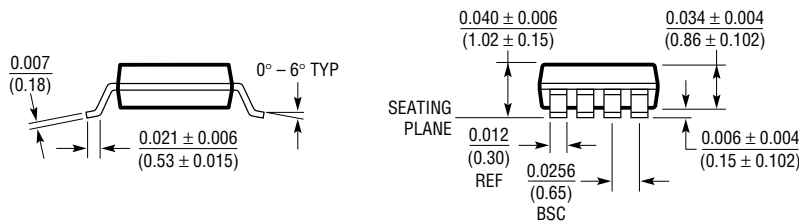
Internal P-Channel Pass Transistor

The LTC1258 series features an internal P-channel MOSFET pass transistor. This provides several advantages over similar designs using a PNP bipolar pass transistor.

These references consume only 4 μ 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 series provides a lower dropout voltage (200mV max) than PNP-based references.

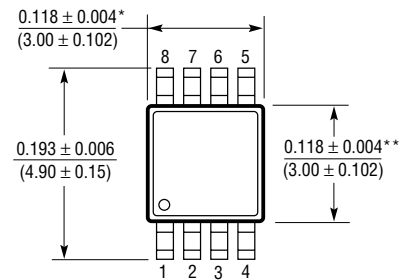
PACKAGE DESCRIPTION Dimensions in inches (millimeters) unless otherwise noted.

MS8 Package
8-Lead Plastic MSOP
(LTC DWG # 05-08-1660)



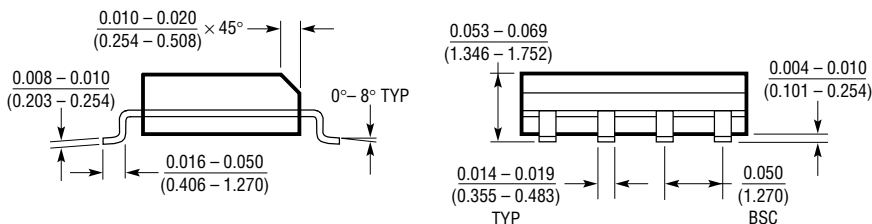
* DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

** DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE



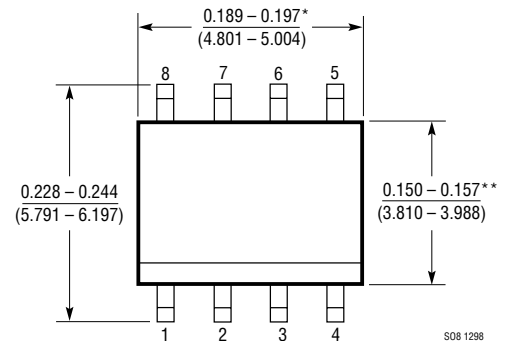
MSOP (MS8) 1098

S8 Package
8-Lead Plastic Small Outline (Narrow 0.150)
(LTC DWG # 05-08-1610)



* DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

** DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

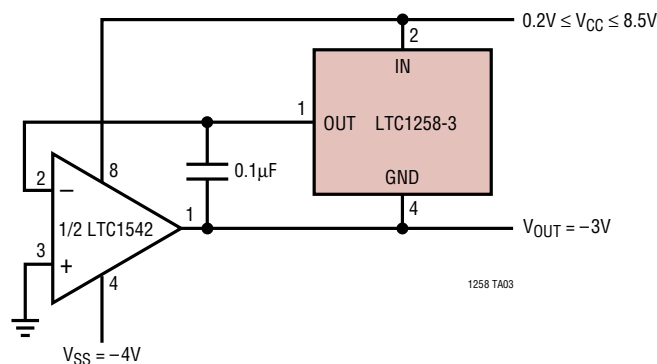


S08 1298

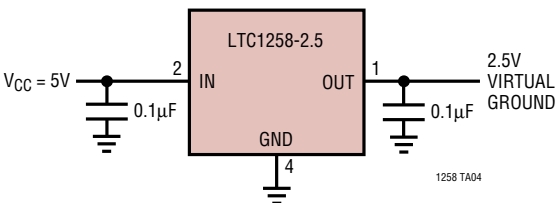
LTC1258 Series

TYPICAL APPLICATIONS

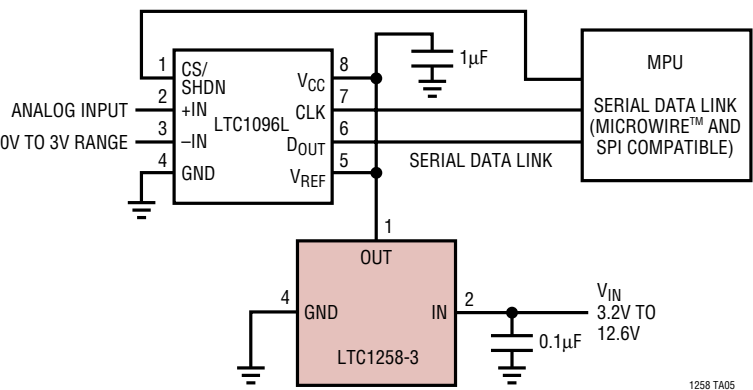
Micropower Low Dropout Negative Reference



Supply Splitter



Low Power, Low Voltage Supply Reference for LTC1096L



MICROWIRE is a trademark of National Semiconductor Corp.

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT [®] 1389	Nanopower Precision Shunt Voltage Reference	800nA Quiescent Current, 0.05% Max, 10ppm/°C Max Drift, 1.25V and 2.5V Versions, SO-8 Package
LT1634	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
LT1461	LDO Micropower Precision Reference	0.04% Max, 3ppm/°C Max Drift in SO-8
LT1790	SOT-23, LDO Micropower Precision Reference	0.05% Max, 10ppm/°C Max