Micropower Low Dropout References

FEATURES

- **200mV Max Dropout at 10mA Output Current**
- **4μA 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

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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.

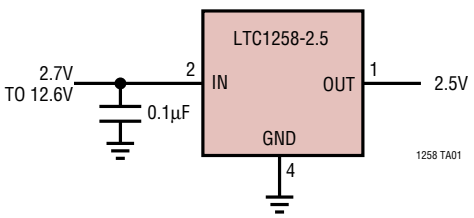
This series of references uses curvature compensation to obtain low temperature coefficient and trimmed thin-film resistors to achieve high output accuracy. These references can source up to 10mA and sink up to 2mA, making them ideal for precision regulator applications. They are stable without an output bypass capacitor, but are also stable with capacitance up to 1μF. 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.

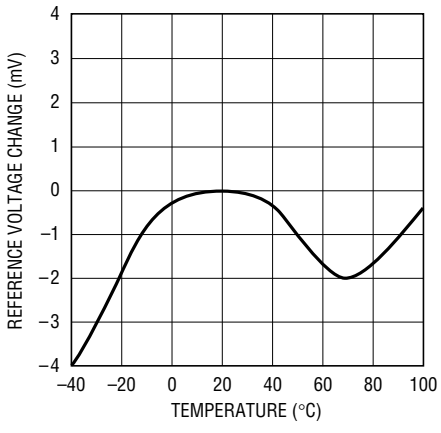
The LTC1258 series is available in the 8-pin MSOP and SO packages.

TYPICAL APPLICATION

2.5V Battery-Powered Reference



LTC1258-2.5 Temperature Drift



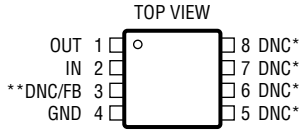
ABSOLUTE MAXIMUM RATINGS

(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

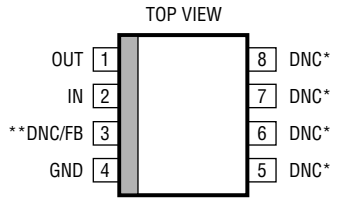


MS8 PACKAGE
8-LEAD PLASTIC MSOP

* 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°C, θ_{JA} = 250°C/W

ORDER PART NUMBER
LTC1258CMS8
LTC1258CMS8-2.5
LTC1258CMS8-3
LTC1258CMS8-4.1
LTC1258CMS8-5
MS8 PART MARKING
LTEL
LTCF
LTEU
LTEN
LTEM



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°C, θ_{JA} = 190°C/W

ORDER PART NUMBER
LTC1258CS8
LTC1258CS8-2.5
LTC1258CS8-3
LTC1258CS8-4.1
LTC1258CS8-5
S8 PART MARKING
1258
12582
12583
125841
12585

Consult factory for Industrial and Military grade parts.

AVAILABLE OPTIONS

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

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the specified temperature range, otherwise specifications are T_A = 25°C. V_{IN} = $V_{OUT(NOMINAL)}$ + 0.2V, I_{OUT} = 0mA, 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	 ●			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)	0.1Hz ≤ f ≤ 10Hz			8		ppm_{P-P}
TC	Output Voltage Temp Coefficient (Note 6)	$T_{MIN} \le T_J \le T_{MAX}$ (S8) $T_{MIN} \le T_J \le T_{MAX}$ (MS8)	● ●		15	40 60	ppm/°C ppm/°C
V_{OUT}/V_{IN}	Line Regulation	V_{IN} = ($V_{OUT(NOMINAL)}$ + 0.2V) to 12.6V	●		30	90	ppm/V
V_{OUT}/I_{OUT}	Load Regulation (Note 7)	Sourcing 0mA to 10mA	●		0.1	0.3	mV/mA
		Sinking 0mA to 2mA	 ●		1.75	4.0 6.5	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, $\Delta V_{OUT} \le 0.1\%$ I_{OUT} = 10mA, $\Delta V_{OUT} \le 0.1\%$	● ●			100 200	mV mV
V_{HYST}	Output Hysteresis (Note 9)	ΔT = –40°C to 85°C ΔT = 0°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.

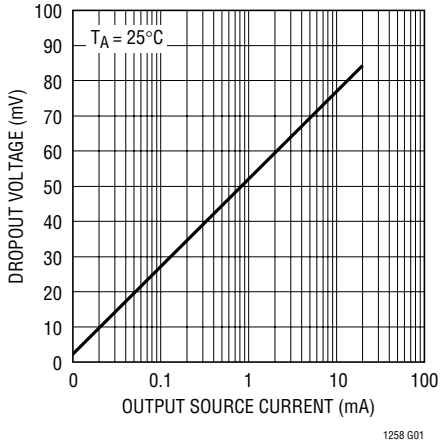
Note 7: Load regulation is measured on a pulse basis from no load to the specified load current. Output changes due to die temperature change must be taken into account separately.

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} + 0.5V.

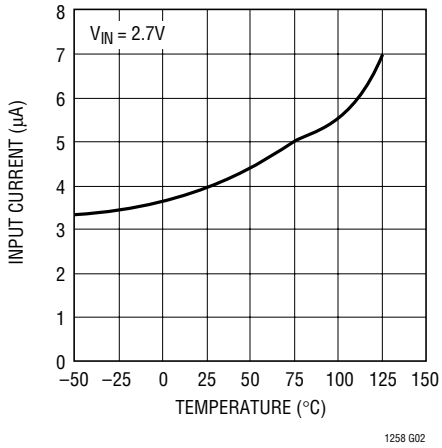
Note 9: Hysteresis in output voltage is created by package stress that differs depending on whether the IC was previously at a higher or lower temperature. Output voltage is always measured at 25°C, but the IC is cycled hot or cold before successive measurements. Hysteresis is not normally a problem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

TYPICAL PERFORMANCE CHARACTERISTICS

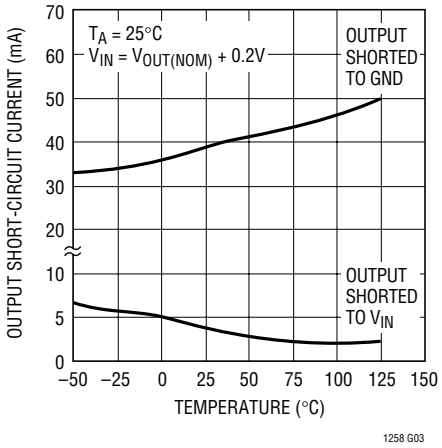
LTC1258-2.5*
Dropout Voltage vs
Output Source Current



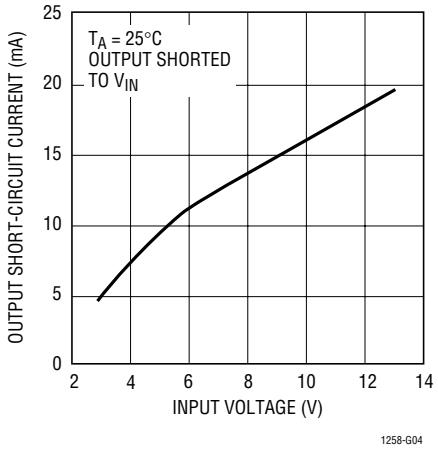
LTC1258-2.5*
Input Current vs Temperature



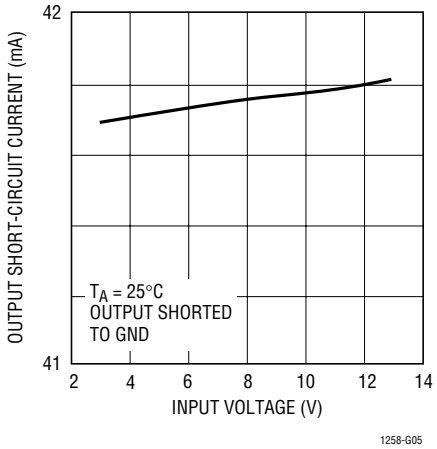
LTC1258 Series
Output Short-Circuit Current vs
Temperature



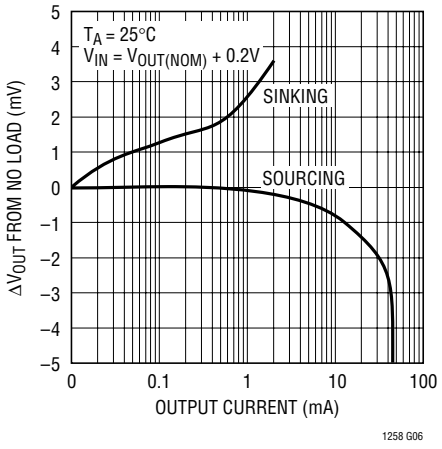
LTC1258-2.5* Output Short-Circuit
Current vs Input Voltage



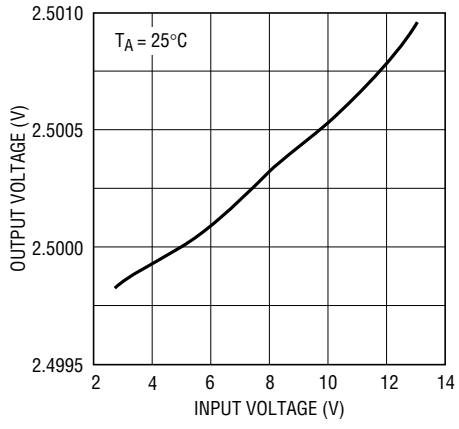
LTC1258-2.5* Output Short-Circuit
Current vs Input Voltage



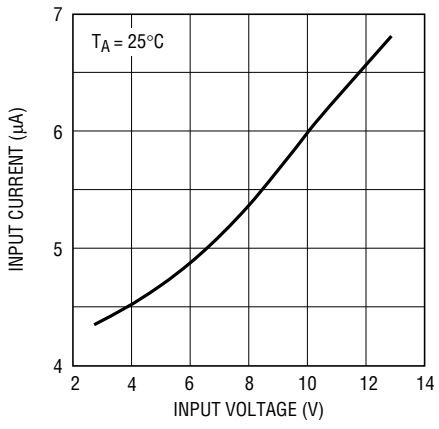
LTC1258 Series
Load Regulation



LTC1258-2.5
Output Voltage vs Input Voltage



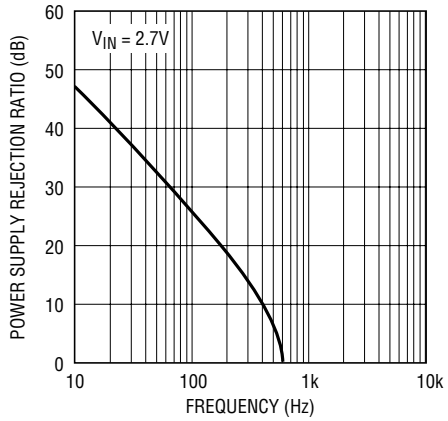
LTC1258-2.5
Input Current vs Input Voltage



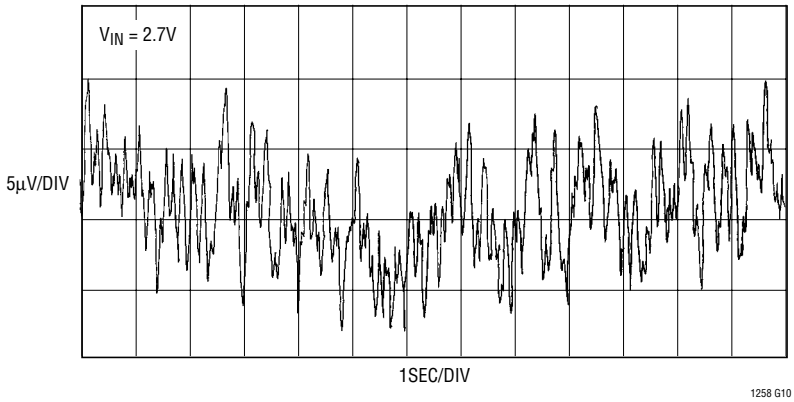
*Similar performance characteristics can be expected for all voltage options.

TYPICAL PERFORMANCE CHARACTERISTICS

LTC1258-2.5 PSRR vs Frequency



LTC1258-2.5 0.1Hz to 10Hz Noise



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.

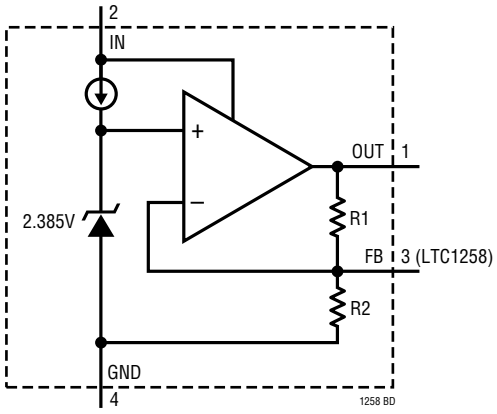
FB (Pin 3): (LT1258) Resistor Divider Feedback Pin. Connect a resistor divider from OUT to GND and the center tap to FB. This pin sets the output potential.

$V_{OUT} = 2.385V\left(\frac{R1+R2}{R2}\right)$; 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 10.8µW 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 1µF can be used to improve the output transient response. Figure 1 shows the response of the reference to a 1mA to 0µA load step with a 1µF output capacitor. If more than 1µF of output capacitance 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 1µF. Figure 3 shows the resistor and capacitor values required to achieve critical damping.

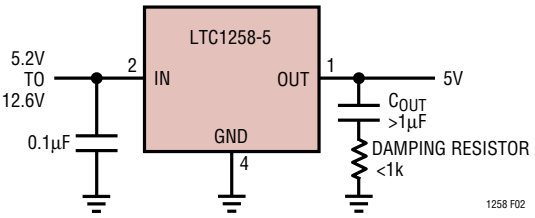


Figure 2. Adding a Damping Resistor with Output Capacitors Greater Than 1µF

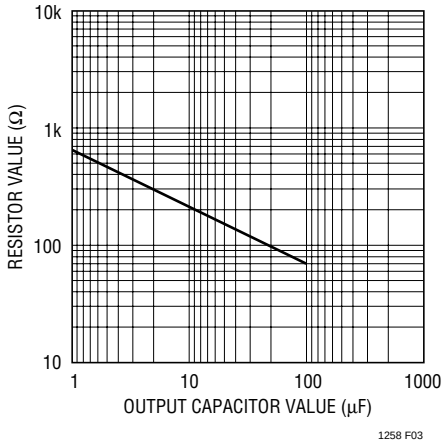
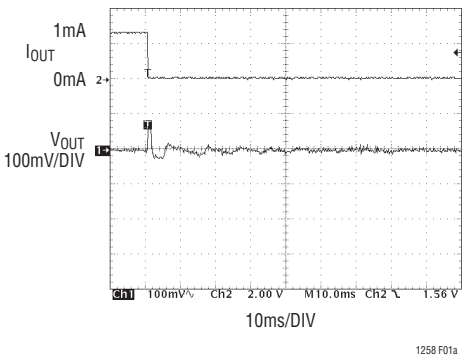


Figure 3. Damping Resistance vs Output Capacitor Value



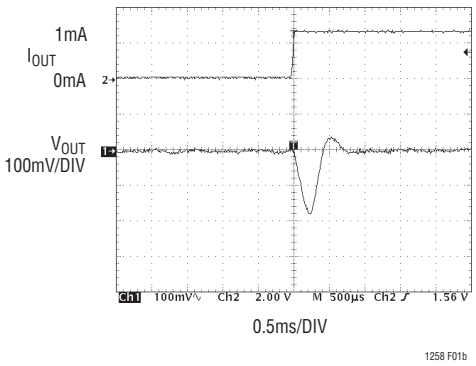


Figure 1. Reference Output Load Transient Response, 1µF Output Capacitor

APPLICATIONS INFORMATION

Internal P-Channel Pass Transistor

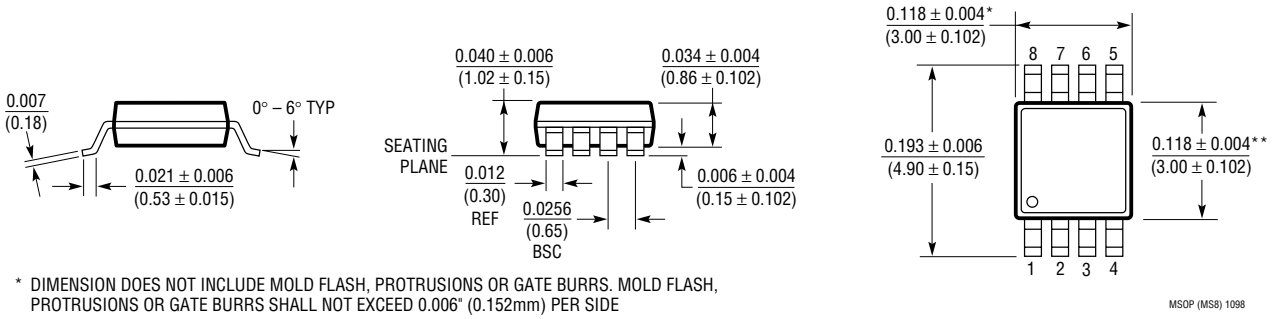
The LTC1258 series features an internal P-channel MOSFET pass transistor. This provides several advantages over similar designs using a PNP bipolar pass transistor.

These references consume only 4μA 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

Dimenshions in inches (millimeters) unless otherwise noted.

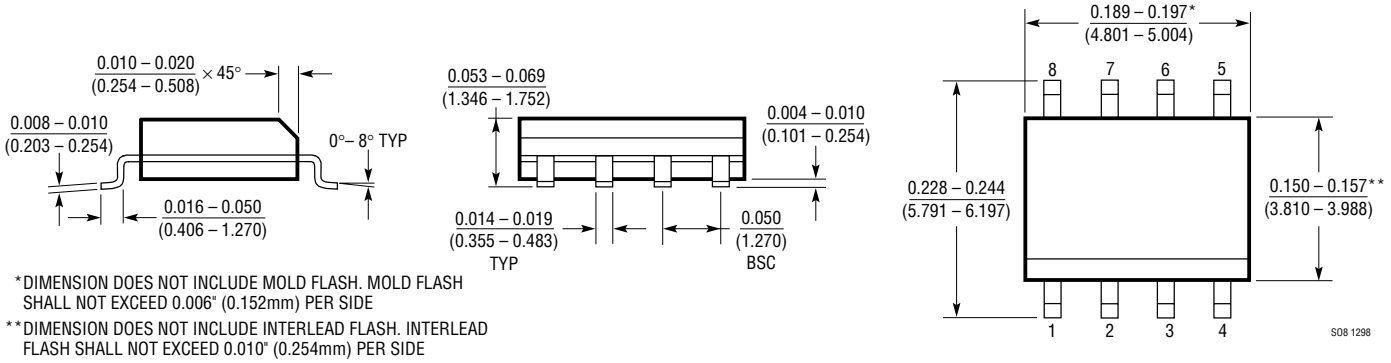
MS8 Package
8-Lead Plastic MSOP
(LTC DWG # 05-08-1660)



* 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

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



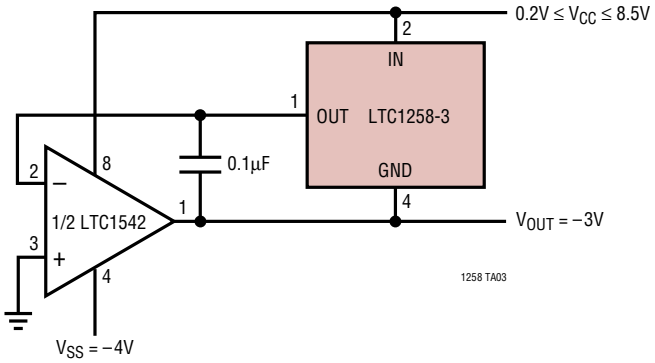
*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

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

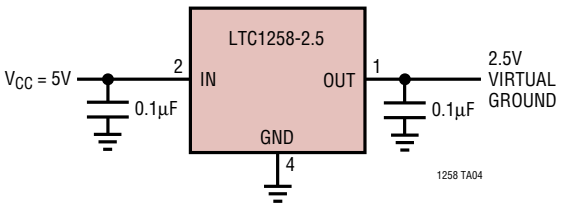
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TYPICAL APPLICATIONS

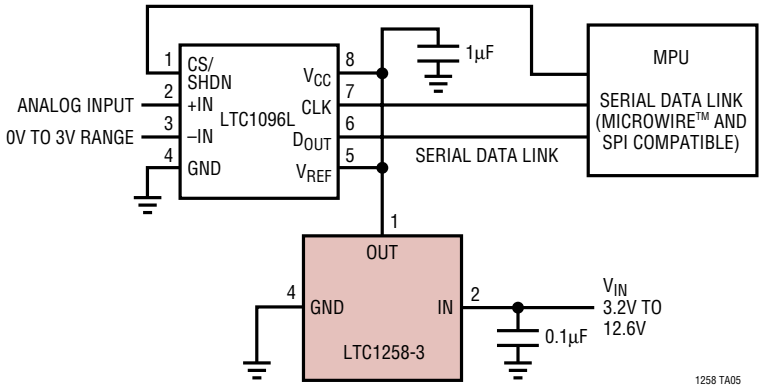
Micropower Low Dropout Negative Reference



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
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

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