LTC1542

Micropower Op Amp and Comparator

April 1998

FEATURES

- **Quiescent Current: 5µA Typ**
- **Outputs Swing Rail-to-Rail**
- **Low Op Amp Offset Voltage: 700µV Max**
- Low Input Bias Current: 1nA Max
- Internal ±3mV Comparator Hysteresis
- Comparator and Op Amp Input Range Includes Ground
- Op Amp Capable of Driving Up to 1000pF Load
- Unity-Gain Stable with 12kHz Bandwidth
- 2.5V to 12.6V Supply Voltage Range
- Pin Compatible Upgrade for MAX953

APPLICATIONS

- Battery- or Solar-Powered Systems
- Automotive Keyless Entry
- Low Frequency, Local Area Alarms/Detectors
- Infrared Receivers for Remote Controls
- Smoke Detectors and Safety Sensors
- GSM Portable Phones

DESCRIPTION

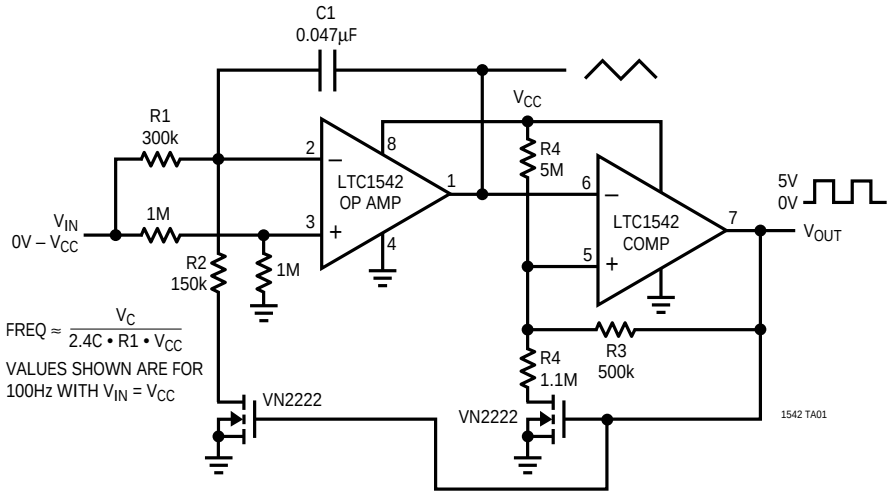
The LTC®1542 combines a micropower amplifier and comparator in an 8-pin package. The part operates from a single 2.5V to 12.6V or dual ±1.25V to ±6.3V supply with a typical supply current of 5µA. Both the op amp and comparator feature a common mode input voltage range that extends from the negative supply to within 1.3V of the positive supply. The op amp output stage swings from rail to rail. The input current is 10pA typical for both op amp and comparator.

The op amp is internally compensated to be unity-gain stable with typical GBW at 12kHz and slew rate of 8V/ms. The comparator has ±3mV of internal hysteresis to ensure clean output switching, even with slow moving input signals.

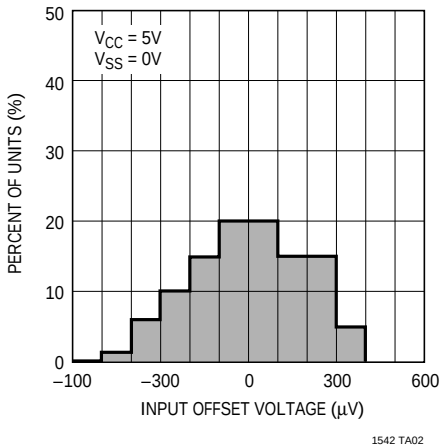
The LTC1542 is available in MSOP and SO-8 packages.

TYPICAL APPLICATION

Voltage Control Oscillator



Op Amp V_{OS} Distribution, V_{CM} = 2.5V, SO-8 Package Total of 839 Units

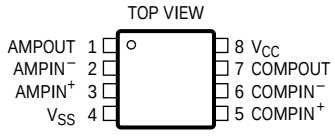


ABSOLUTE MAXIMUM RATINGS

Supply Voltage 13V
Input Voltage ..... –0.3V to 13V
Output Voltage ..... –0.3V to 13V
Output Short-Circuit Duration ..... Indefinite
Storage Temperature Range ..... –65°C to 150°C

Operating Temperature Range
Commercial ..... 0°C to 70°C
Industrial ..... –40°C to 85°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

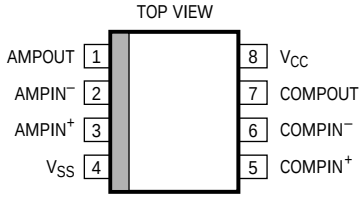
PACKAGE/ORDER INFORMATION



MS8 PACKAGE
8-LEAD PLASTIC MSOP

T_{JMAX} = 125°C, θ_{JA} = 250°C/W

ORDER PART NUMBER
LTC1542CMS8
MS8 PART MARKING
LTDE



S8 PACKAGE
8-LEAD PLASTIC SO

T_{JMAX} = 125°C, θ_{JA} = 150°C/W

ORDER PART NUMBER
LTC1542CS8 LTC1542IS8
S8 PART MARKING
1542 1542I

Consult factory for Military grade parts.

ELECTRICAL CHARACTERISTICS

V_{CC} = 5V, V_{SS} = 0V, T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Power Supply							
V_{CC}	Supply Voltage Range		●	2.5		12.6	V
I_{CC}	Supply Current (Note 1)				5	7.5	µA
		Commercial Grade	●			13	µA
		Industrial Grade	●			14	µA
Comparator							
V_{OS}	Input Offset Voltage (Note 2)	(SO-8)				1	mV
		Commercial Grade (SO-8)	●			1.5	mV
		Industrial Grade (SO-8)	●			2.0	mV
		(MSOP)				1.2	mV
			●			2.0	mV
V_{TRIP}	Trip Point (Note 3)	V_{CM} = 1/2V_{CC}		1.7	2.25	2.8	mV
			●	1		3.8	mV
I_{IN}	Input Leakage Current	$V_{COMPIN}^+ = V_{COMPIN}^-$ = 2.5V	●		0.01	1	nA
V_{CM}	Input Common Mode Range		●	V_{SS}		V_{CC} – 1.3V	V
CMRR	Common Mode Rejection Ratio	V_{CM} = V_{SS} to V_{CC} – 1.3V				0.25	mV/V
		Commercial Grade	●			0.30	mV/V
		Industrial Grade	●			0.35	mV/V
PSRR	Power Supply Rejection Ratio	V_{CC} = 3V to 12V				0.25	mV/V
		Commercial Grade	●			0.30	mV/V
		Industrial Grade	●			0.35	mV/V
t_{PD}	Propagation Delay	Overdrive = 10mV			20		µs
		Overdrive = 100mV			8		µs

ELECTRICAL CHARACTERISTICS

V_{CC} = 5V, V_{SS} = 0V, T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OH}	Output High Voltage	I_{OUT} = –2mA	●	V_{CC} – 0.2V			V
V_{OL}	Output Low Voltage	I_{OUT} = 1.8mA	●			V_{SS} + 0.3V	V
Op Amp							
V_{OS}	Input Offset Voltage	V_{CM} = 2.5V (SO-8)				0.7	mV
		Commercial Grade (SO-8)	●			1.25	mV
		Industrial Grade (SO-8)	●			1.5	mV
		V_{CM} = 2.5V (MSOP)				1.00	mV
			●			1.75	mV
I_B	Input Bias Current	V_{CM} = 2.5V	●		0.01	1	nA
A_{VOL}	Large-Signal Gain	AMPOUT = 0.5V to 4.5V, No Load		80	1000		V/mV
		AMPOUT = 0.5V to 4.5V, R_{LOAD} = 100k		60	500		V/mV
		Commercial Grade	●	38			V/mV
		Industrial Grade	●	35			V/mV
GBW	Gain Bandwidth	A_V = 1V/V			12		kHz
SR	Slew Rate	A_V = 1V/V			8		V/ms
V_{CM}	Input Common Mode Range		●	V_{SS}		V_{CC} – 1.3V	V
CMRR	Common Mode Rejection Ratio	V_{CM} = V_{SS} to V_{CC} – 1.3V				0.28	mV/V
		Commercial Grade	●			0.33	mV/V
		Industrial Grade	●			0.38	mV/V
PSRR	Power Supply Rejection Ratio	V_{CC} = 3V to 12V				0.19	mV/V
		Commercial Grade	●			0.21	mV/V
		Industrial Grade	●			0.23	mV/V
V_{OH}	Output High Voltage	R_{LOAD} = 100k to V_{SS}		V_{CC} – 0.07			V
		Commercial Grade	●	V_{CC} – 0.10			V
		Industrial Grade	●	V_{CC} – 0.12			V
V_{OL}	Output Low Voltage	R_{LOAD} = 100k to V_{SS}				V_{SS} + 0.05	V
		Commercial Grade	●			V_{SS} + 0.10	V
		Industrial Grade	●			V_{SS} + 0.12	V
I_{SOURCE}	Output Source Current			0.9	1.8		mA
			●	0.7			mA
I_{SINK}	Output Sink Current			1.3	1.8		mA
			●	0.9			mA
e_n	Input Noise Voltage	f_O = 0.1Hz to 10Hz			3		μV_{P-P}

V_{CC} = 3V, V_{SS} = 0V, T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Power Supply							
V_{CC}	Supply Voltage Range		●	2.5		12.6	V
I_{CC}	Supply Current (Note 1)				4.5	7.0	µA
		Commercial Grade	●			12	µA
		Industrial Grade	●			13	µA

ELECTRICAL CHARACTERISTICS

V_{CC} = 3V, V_{SS} = 0V, T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Comparator							
V_{OS}	Input Offset Voltage (Note 2)	(SO-8)				1.0	mV
		Commercial Grade (SO-8)	●			1.5	mV
		Industrial Grade (SO-8)	●			2.0	mV
		(MSOP)				1.2	mV
			●			2.0	mV
V_{TRIP}	Trip Point (Note 3)	V_{CM} = 1/2V_{CC}		1.8	2.35	2.9	mV
			●	1.00		3.9	mV
I_{IN}	Input Leakage Current	$V_{COMPIN}^+ = V_{COMPIN}^-$ = 1.5V	●		0.01	1	nA
V_{CM}	Input Common Mode Range		●	V_{SS}		V_{CC} – 1.3	V
CMRR	Common Mode Rejection Ratio	V_{CM} = V_{SS} to V_{CC} – 1.3V				0.35	mV/V
		Commercial Grade	●			0.40	mV/V
		Industrial Grade	●			0.45	mV/V
PSRR	Power Supply Rejection Ratio	V_{CC} = 3V to 12V				0.25	mV/V
		Commercial Grade	●			0.30	mV/V
		Industrial Grade	●			0.35	mV/V
t_{PD}	Propagation Delay	Overdrive = 10mV			25		µs
		Overdrive = 100mV			12		µs
V_{OH}	Output High Voltage	I_{OUT} = –2mA	●	V_{CC} – 0.2			V
V_{OL}	Output Low Voltage	I_{OUT} = 1.8mA	●			V_{SS} + 0.3	V
Op Amp							
V_{OS}	Input Offset Voltage	V_{CM} = 1.5V (SO-8)				0.70	mV
		Commercial Grade (SO-8)	●			1.25	mV
		Industrial Grade (SO-8)	●			1.50	mV
		V_{CM} = 1.5V (MSOP)				1.00	mV
			●			1.75	mV
I_B	Input Bias Current	V_{CM} = 1.5V	●		0.01	1	nA
A_{VOL}	Large-Signal Gain	AMPOUT = 0.5V to 2.5V, No Load		80.0	1000		V/mV
		AMPOUT = 0.5V to 2.5V, R_{LOAD} = 100k		45.5	500		V/mV
		Commercial Grade	●	22.0			V/mV
		Industrial Grade	●	20.0			V/mV
GBW	Gain Bandwidth	A_V = 1V/V			12		kHz
SR	Slew Rate	A_V = 1V/V			8		V/ms
V_{CM}	Input Common Mode Range		●	V_{SS}		V_{CC} – 1.3	V
CMRR	Common Mode Rejection Ratio	V_{CM} = V_{SS} to V_{CC} – 1.3V				0.4	mV/V
		Commercial Grade	●			0.5	mV/V
		Industrial Grade	●			1.0	mV/V
PSRR	Power Supply Rejection Ratio	V_{CC} = 3V to 12V				0.19	mV/V
		Commercial Grade	●			0.21	mV/V
		Industrial Grade	●			0.23	mV/V
V_{OH}	Output High Voltage	R_{LOAD} = 100k to V_{SS}		V_{CC} – 0.07			V
		Commercial Grade	●	V_{CC} – 0.10			V
		Industrial Grade	●	V_{CC} – 0.12			V
V_{OL}	Output Low Voltage	R_{LOAD} = 100k to V_{CC}				V_{CC} + 0.05	V
		Commercial Grade	●			V_{CC} + 0.10	V
		Industrial Grade	●			V_{CC} + 0.12	V

ELECTRICAL CHARACTERISTICS

V_{CC} = 3V, V_{SS} = 0V, T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
I_{SOURCE}	Output Source Current		 ●	0.6 0.4	0.95		mA mA
I_{SINK}	Output Sink Current		 ●	1.2 0.8	1.8		mA mA
e_n	Input Noise Voltage	f_O = 0.1Hz to 10Hz			3		μV_{P-P}

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

Note 1: Supply current is tested with $COMPIN^+$ = 0V, $COMPIN^-$ = 100mV.

Note 2: Input offset voltage is defined as the center of the input referred hysteresis, $V_{CM} = 1/2V_{CC}$.

Note 3: Trip point is defined as the differential input voltage required to make the comparator output change state. The difference between upper and lower trip point is equal to the width of the input referred hysteresis.

PIN FUNCTIONS

AMPOUT (Pin 1): Op Amp Output. The output can swing from rail to rail while driving a capacitive load of up to 1000pF. The output can source and sink 0.7mA minimum.

$AMPIN^-$ (Pin 2): Inverting Input of Op Amp. The input common mode ranges from V_{SS} to V_{CC} – 1.3V. The input current is typically 10pA at 25°C.

$AMPIN^+$ (Pin 3): Noninverting Input of Op Amp. The input common mode ranges from V_{SS} to V_{CC} – 1.3V. The input current is typically 10pA at 25°C.

V_{SS} (Pin 4): Negative Supply or Ground Connection.

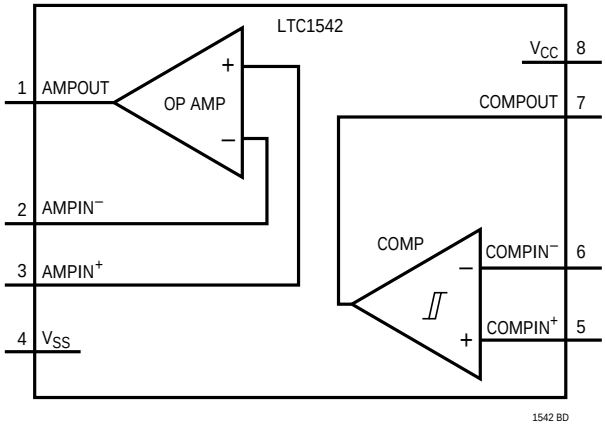
$COMPIN^+$ (Pin 5): Noninverting Input of Comparator. The input common mode ranges from V_{SS} to V_{CC} – 1.3V. The input current is typically 10pA at 25°C.

$COMPIN^-$ (Pin 6): Inverting Input of Comparator. The input common mode ranges from V_{SS} to V_{CC} –1.3V. The input current is typically 10pA at 25°C.

COMPOUT (Pin 7): Comparator Output. The output can source 20mA and sink 5mA.

V_{CC} (Pin 8): Positive Supply, 2.5V ≤ V_{CC} ≤ 12.6V. The supply bypass capacitors are not required if the supply impedance is low. For single supply applications, it is a good general practice to bypass V_{CC} with a 0.1µF capacitor to ground.

BLOCK DIAGRAM



APPLICATIONS INFORMATION

The LTC1542 is a combination of a micropower op amp and comparator in an 8-pin package. The supply voltage range is from 2.5V to 12.6V for a single supply and ±1.25V to ±6.3V for dual supplies. The supply current is a mere 5µA (typical) with a 5V single supply.

Op Amp

The op amp is internally compensated to be unity-gain stable, with typical GBW at 12kHz and slew rate of 8V/ms. The output can drive a capacitive load of up to 1000pF and swings from rail to rail. The input range is from the negative rail to within 1.3V of the positive rail. The input bias current is less than 1nA maximum at the extended temperature range.

Comparator

The comparator has a high impedance differential input stage with a common input range from the negative rail to within 1.3V of the positive rail. The CMOS output stage can swing from rail to rail and source up to 20mA continuously. The output stage has been designed to eliminate the power supply glitches that normally occur when the output changes logic state. In addition, an internal hysteresis (±3mV) ensures clean output switching even with slow moving input signals.

Op Amp Stability

Unlike other industry standard micropower CMOS op amps, the op amp in the LTC1542 maintains stability in unity-gain configuration while driving heavy capacitive loads of up to 1000pF.

Although this family is primarily designed for low frequency applications, good layout is extremely important. Low power, high impedance circuits may increase the effects of board leakage and stray capacitance. For example, the combination of a 10M resistance (from leakage between traces on a contaminated, poorly designed PC board) and a 1pF stray capacitance provides a pole at approximately 16kHz, which is near the amplifier's bandwidth. Board routing and layout should minimize leakage and stray capacitance. In some cases, stray capacitance may be unavoidable and it may be necessary to add a small capacitor across the feedback resistor to compensate (Figure 1); select the smallest capacitor value that ensures stability.

Inputs

The input common mode range for both the op amp and comparator is from the negative supply to within 1.3V of the positive supply. The inputs can be taken more than 300mV below the negative supply without damaging the device if the current out of the pin is limited to less than 1mA. Unlike the bipolar input op amp and comparator, the output of the LTC1542 will not reverse phase when the inputs are taken above the common mode input range.

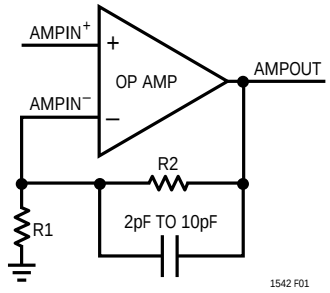
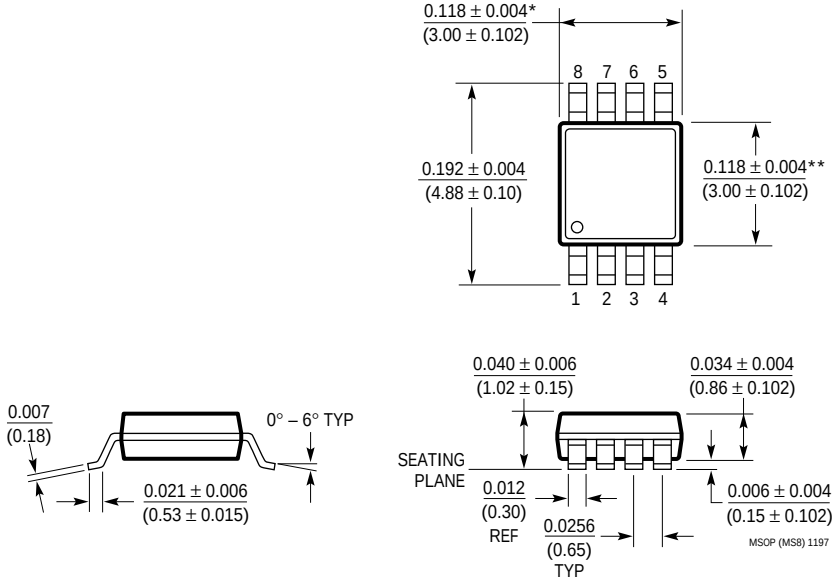


Figure 1. Compensation for Feedback Node Capacitance

PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

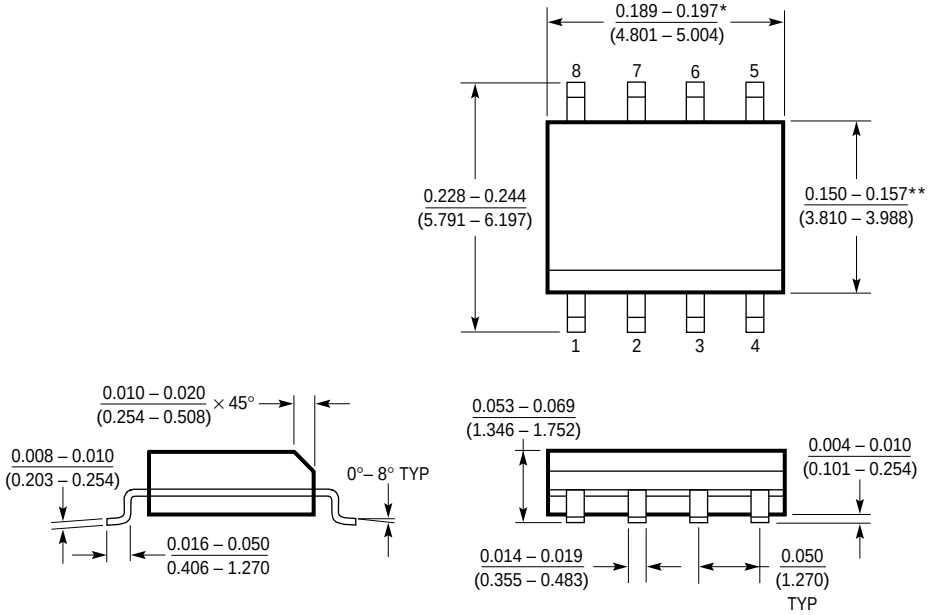
MS8 Package
8-Lead Plastic MSOP
(LTC DWG # 05-08-1660)



* 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

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

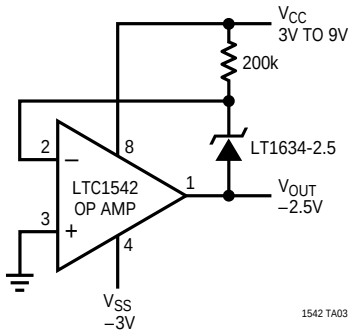


*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

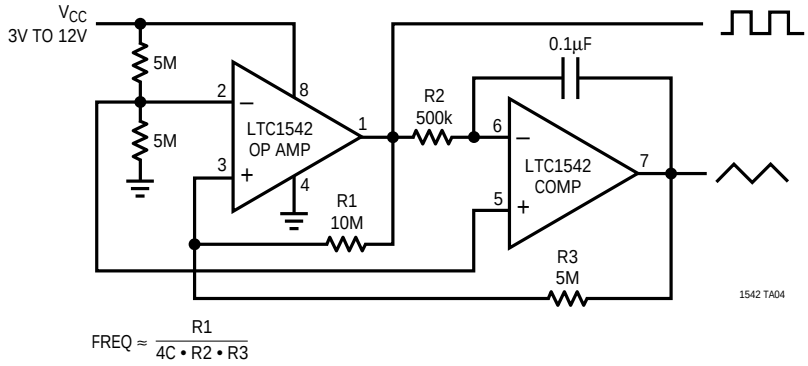
**DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

TYPICAL APPLICATIONS

Negative Reference



Single Supply Function Generator



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT®1078/LT1079	Dual/Quad Micropower, Single Supply Precision Op Amps	70µV, V_{OS} Max and 0.4µV/°C Drift, 200kHz GBW, 0.07V/µs Slew Rate, Input/Output Common Mode Includes Ground
LT1178/LT1179	Dual/Quad 17µA Max, Single Supply Precision Op Amps	70µV, V_{OS} Max and 2.5µV/°C Drift Max, 85kHz GBW, 0.04V/µs Slew Rate, Input/Output Common Mode Includes Ground
LT1490/LT1491	Dual/Quad Micropower Rail-to-Rail Input and Output Op Amps	Single Supply Input Range: –0.4V to 44V, Micropower 50µA Amplifier, Rail-to-Rail Input and Output, 200kHz GBW
LT1635	Micropower Rail-to-Rail Op Amp and Reference	130µA of Supply Current, 1.3mV V_{OS} Max
LT2078/LT2079	Dual/Quad Micropower, Single Supply Precision Op Amps	SO-8 and 14-Lead Standard Pinout, 70µV V_{OS} Max, 200kHz GBW
LT2178/LT2179	Dual/Quad 17µA Max, Single Supply Precision Op Amps	SO-8 and 14-Lead Standard Pinout, 70µV V_{OS} Max, 85kHz GBW
LTC1541	Micropower Op Amp, Comparator and Reference	Internal 1.2V ± 0.8% Reference with Comparator and Op Amp

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