Micropower Precision, Dual/Quad CMOS Rail-to-Rail Input/Output Amplifiers

FEATURES

- **Maximum Offset Voltage of 25μV (25°C)**
- **Maximum Offset Drift of 0.7μV/°C**
- **Maximum Input Bias:**
  1pA (25°C)
  50pA (≤85°C)
- Micropower: 54μA per Amp
- 95dB CMRR (Min)
- 100dB PSRR (Min)
- Input Noise Voltage Density: 16nV/√Hz
- Rail-to-Rail Inputs and Outputs
- 2.7V to 5.5V Operation Voltage
- LTC6078 Available in 8-Lead MSOP and 10-Lead DFN Packages; LTC6079 Available in 16-Lead SSOP and DFN Packages

APPLICATIONS

- Photodiode Amplifier
- High Impedance Sensor Amplifier
- Microvolt Accuracy Threshold Detection
- Instrumentation Amplifiers
- Battery Powered Applications

DESCRIPTION

The LTC®6078/LTC6079 are dual/quad, low offset, low noise operational amplifiers with low power consumption and rail-to-rail input/output swing.

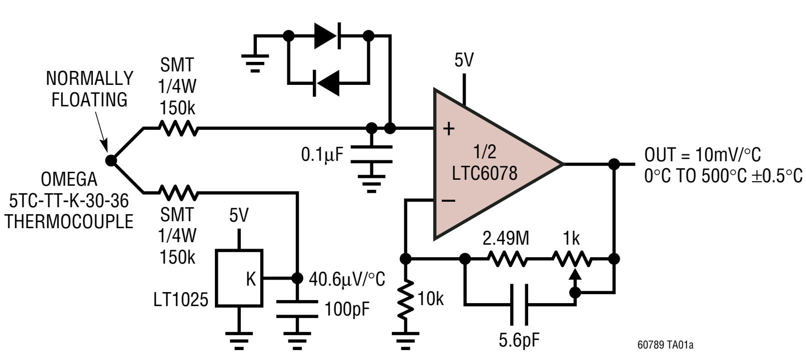
Input offset voltage is trimmed to less than 25μV and the CMOS inputs draw less than 50pA of bias current. The low offset drift, excellent CMRR, and high voltage gain make it a good choice for precision signal conditioning.

Each amplifier draws only 54μA current on a 3V supply. The micropower, rail-to-rail operation of the LTC6078/LTC6079 is well suited for portable instruments and single supply applications.

The LTC6078/LTC6079 are specified on power supply voltages of 3V and 5V from –40 to 125°C. The dual amplifier LTC6078 is available in 8-lead MSOP and 10-lead DFN packages. The quad amplifier LTC6079 is available in 16-lead SSOP and DFN packages.

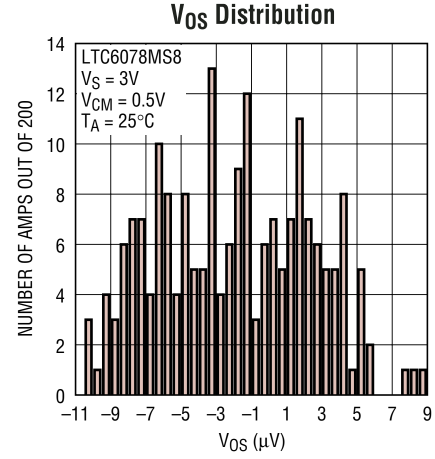
TYPICAL APPLICATION

Thermocouple Signal Conditioner



AMPLIFIER PROTECTED TO ±190V, ACCIDENTAL CONTACT

V_{OS} Distribution



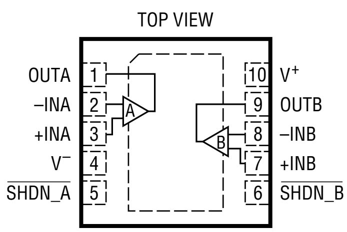
ABSOLUTE MAXIMUM RATINGS

(Note 1)

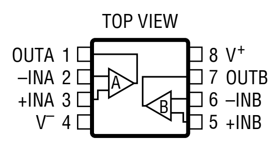
Total Supply Voltage (V^+ to V^-) 6V
Input Voltage .... V^- to V^+
Output Short Circuit Duration (Note 2) .... Indefinite
Operating Temperature Range (Note 3)
LTC6078C, LTC6079C .... –40°C to 85°C
LTC6078I, LTC6079I .... –40°C to 85°C
LTC6078H, LTC6079H .... –40°C to 125°C
(Not Available in DFN Package)

Specified Temperature Range (Note 4)
LTC6078C, LTC6079C .... 0°C to 70°C
LTC6078I, LTC6079I .... –40°C to 85°C
LTC6078H, LTC6079H .... –40°C to 125°C
Junction Temperature
DFN Packages .... 125°C
All Other Packages .... 150°C
Storage Temperature Range
DFN Packages .... –65°C to 125°C
All Other Packages .... –65°C to 150°C
Lead Temperature (Soldering, 10 Sec) .... 300°C

PACKAGE/ORDER INFORMATION



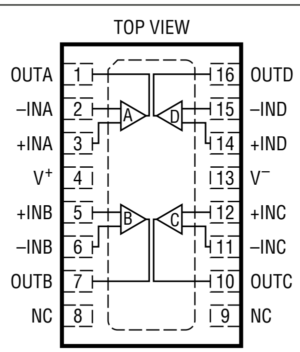
DD PACKAGE
10-LEAD (3mm × 3mm) PLASTIC DFN
T_{JMAX} = 125°C, θ_{JA} = 43°C/W
UNDERSIDE METAL CONNECTED TO V^-



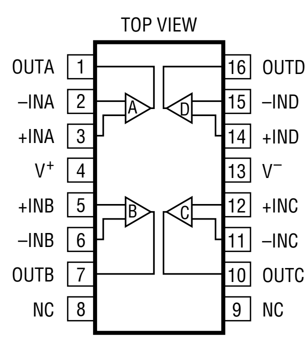
MS8 PACKAGE
8-LEAD PLASTIC MSOP
T_{JMAX} = 150°C, θ_{JA} = 200°C/W

ORDER PART NUMBER	DD PART MARKING*
LTC6078CDD LTC6078IDD	LBBB LBBB

ORDER PART NUMBER	MS8 PART MARKING*
LTC6078ACMS8 LTC6078CMS8 LTC6078AIMS8 LTC6078IMS8 LTC6078AHMS8 LTC6078HMS8	LTAJZ LTAJZ LTAJZ LTAJZ LTAJZ LTAJZ



DHC PACKAGE
16-LEAD (5mm × 3mm) PLASTIC DFN
T_{JMAX} = 125°C, θ_{JA} = 43°C/W
UNDERSIDE METAL CONNECTED TO V^-



GN PACKAGE
16-LEAD PLASTIC SSOP
T_{JMAX} = 150°C, θ_{JA} = 110°C/W

ORDER PART NUMBER	DHC PART MARKING*
LTC6079CDHC LTC6079IDHC	6079 6079

ORDER PART NUMBER	GN PART MARKING
LTC6079CGN LTC6079IGN LTC6079HGN	6079 6079I 6079H

Order Options Tape and Reel: Add #TR
Lead Free: Add #PBF Lead Free Tape and Reel: Add #TRPBF
Lead Free Part Marking: http://www.linear.com/leadfree/

Consult LTC Marketing for parts specified with wider operating temperature ranges.
*The temperature grades and parametric grades are identified by a label on the shipping container.

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. Test conditions are V^+ = 3V, V^- = 0V, V_{CM} = 0.5V unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		C, I SUFFIXES MIN	C, I SUFFIXES TYP	C, I SUFFIXES MAX	H SUFFIX MIN	H SUFFIX TYP	H SUFFIX MAX	UNITS
V_{OS}	Offset Voltage (Note 5)	LTC6078MS8, LTC6078AMS8, LTC6079GN								
		V_{CM} = 0.5V, 2.5V			±7	±25		±7	±25	µV
		LTC6078DD, LTC6079DHC V_{CM} = 0.5V, 2.5V			±7	±30				µV
		LTC6078AMS8 V_{CM} = 0.5V	●		±20	±70		±25	±95	µV
		LTC6078MS8 V_{CM} = 0.5V	●		±25	±97		±30	±135	µV
		LTC6079GN V_{CM} = 0.5V	●		±30	±115		±35	±165	µV
		LTC6078DD V_{CM} = 0.5V	●		±30	±120				µV
		LTC6079DHC V_{CM} = 0.5V	●		±35	±150				µV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift (Note 5)	LTC6078AMS8	●		±0.2	±0.7		±0.2	±0.7	µV/°C
		LTC6078MS8	●			±1.1			±1.1	µV/°C
		LTC6078DD, LTC6079GN	●		±0.3	±1.4		±0.3	±1.4	µV/°C
		LTC6079DHC	●		±0.3	±1.8				µV/°C
I_B	Input Bias Current (Note 6)	V_{CM} = $V^+/2$			0.2	1		0.2	1	pA
		V_{CM} = $V^+/2$	●		10	50		150	350	pA
I_{OS}	Input Offset Current (Note 6)	V_{CM} = $V^+/2$			0.1			0.1		pA
		V_{CM} = $V^+/2$	●		0.5	25		10	100	pA
e_n	Input Noise Voltage	0.1Hz to 10Hz			1			1		$µV_{P-P}$
	Input Noise Voltage Density	f = 1kHz			18			18		$nV/\sqrt{Hz}$
		f = 10kHz			16			16		$nV/\sqrt{Hz}$
i_n	Input Noise Current Density (Note 8)				0.56			0.56		$fA/\sqrt{Hz}$
	Input Common Mode Range		●	V^-		V^+	V^-		V^+	V
C_{DIFF}	Differential Input Capacitance				10			10		pF
C_{CM}	Common Mode Input Capacitance				18			18		pF
CMRR	Common Mode Rejection Ratio	All Packages V_{CM} = 0V to 3V		95	110		95	110		dB
		LTC6078AMS8 V_{CM} = 0V to 3V	●	87	105		87	103		dB
		LTC6078AMS8 V_{CM} = 0V to 1.7V	●	91	103		91	103		dB
		LTC6078MS8 V_{CM} = 0V to 3V	●	85	102		85	100		dB
		LTC6078MS8 V_{CM} = 0V to 1.7V	●	89	102		89	102		dB
		LTC6079GN V_{CM} = 0V to 3V	●	84	102		84	100		dB
		LTC6079GN V_{CM} = 0V to 1.7V	●	88	102		88	102		dB
		LTC6078DD, LTC6079DHC V_{CM} = 0V to 3V	●	83	100					dB
		LTC6078DD, LTC6079DHC V_{CM} = 0V to 1.7V	●	87	102					dB
PSRR	Power Supply Rejection Ratio	V_S = 2.7V to 5.5V		100	120		100	120		dB
			●	97			97			dB
V_{OUT}	Output Voltage, High (Referred to V^+)	No Load			1			1		mV
		I_{SOURCE} = 0.2mA	●	35	15		40	15		mV
		I_{SOURCE} = 2mA	●	350	150		400	150		mV
	Output Voltage, Low (Referred to V^-)	No Load			1			1		mV
		I_{SINK} = 0.2mA	●		10	30		10	35	mV
		I_{SINK} = 2mA	●		100	300		100	350	mV
A_{VOL}	Large-Signal Voltage Gain	R_{LOAD} = 10k, 0.5V ≤ V_{OUT} ≤ 2.5V	●	115	130		110	125		dB
I_{SC}	Output Short-Circuit Current	Source	●	5	10		4	10		mA
		Sink	●	7	14		6	14		mA
SR	Slew Rate	A_V = 1			0.05			0.05		V/µs
GBW	Gain-Bandwidth Product (f_{TEST} = 10kHz)	R_L = 100k		420	750		420	750		kHz
			●	360			320			kHz
Φ_0	Phase Margin	R_L = 10k, C_L = 200pF			66			66		Deg
t_S	Settling Time 0.1%	A_V = 1, 1V Step			24			24		µs

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. Test conditions are V^+ = 3V, V^- = 0V, V_{CM} = 0.5V unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		C, I SUFFIXES			H SUFFIX			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
I_S	Supply Current (per Amplifier)	No Load			54	72		54	72	µA
			●			78			80	µA
	Shutdown Current (per Amplifier)	Shutdown, $V_{\overline{SHDN}}$ ≤ 0.8V, LTC6078DD	●		0.3	1				µA
V_S	Supply Voltage Range	Guaranteed by the PSRR Test	●	2.7		5.5	2.7		5.5	V
	Channel Separation	f_S = 10kHz, R_L = 10k			–110			–110		dB
	Shutdown Logic	$\overline{SHDN}$ High, LTC6078DD	●	2			2			V
		$\overline{SHDN}$ Low, LTC6078DD	●			0.8			0.8	V
t_{ON}	Turn on Time	$V_{\overline{SHDN}}$ = 0.8V to 2V, LTC6078DD			50			50		µs
t_{OFF}	Turn off Time	$V_{\overline{SHDN}}$ = 2V to 0.8V, LTC6078DD			2			2		µs
	Leakage of $\overline{SHDN}$ Pin	$V_{\overline{SHDN}}$ = 0V, LTC6078DD			0.6					µA

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. Test conditions are V^+ = 5V, V^- = 0V, V_{CM} = 0.5V unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		C, I SUFFIXES			H SUFFIX			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{OS}	Offset Voltage	LTC6078MS8, LTC6078AMS8, LTC6079GN V_{CM} = 0.5V			±10	±30		±10	±30	µV
		LTC6078DD, LTC6079DHC V_{CM} = 0.5V			±10	±35				µV
		LTC6078AMS8 V_{CM} = 0.5V	●		±20	±75		±25	±100	µV
		LTC6078MS8 V_{CM} = 0.5V	●		±25	±102		±30	±140	µV
		LTC6079GN V_{CM} = 0.5V	●		±30	±120		±35	±170	µV
		LTC6078DD V_{CM} = 0.5V	●		±30	±125				µV
		LTC6079DHC V_{CM} = 0.5V	●		±35	±155				µV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift (Note 7)	LTC6078AMS8	●		±0.2	±0.7		±0.2	±0.7	µV/°C
		LTC6078MS8	●			±1.1			±1.1	µV/°C
		LTC6078DD, LTC6079GN	●		±0.3	±1.4		±0.3	±1.4	µV/°C
		LTC6079DHC	●		±0.3	±1.8				µV/°C
I_B	Input Bias Current	V_{CM} = V^+/2			0.2	1		0.2	1	pA
		V_{CM} = V^+/2	●		10	50		150	350	pA
I_{OS}	Input Offset Current	V_{CM} = V^+/2			0.1			0.1		pA
		V_{CM} = V^+/2	●		0.5	25		10	100	pA
e_n	Input Noise Voltage	0.1Hz to 10Hz			1			1		μV_{P-P}
	Input Noise Voltage Density	f = 1kHz			18			18		$nV/\sqrt{Hz}$
		f = 10kHz			16			16		$nV/\sqrt{Hz}$
i_n	Input Noise Current Density (Note 8)				0.56			0.56		$fA/\sqrt{Hz}$
	Input Common Mode Range		●	V^-		V^+	V^-		V^+	V
C_{DIFF}	Differential Input Capacitance				10			10		pF
C_{CM}	Common Mode Input Capacitance				18			18		pF

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. Test conditions are V^+ = 5V, V^- = 0V, V_{CM} = 0.5V unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		C, I SUFFIXES MIN	C, I SUFFIXES TYP	C, I SUFFIXES MAX	H SUFFIX MIN	H SUFFIX TYP	H SUFFIX MAX	UNITS
CMRR	Common Mode Rejection Ratio	All Packages V_{CM} = 0V to 5V LTC6078AMS8 V_{CM} = 0V to 5V LTC6078AMS8 V_{CM} = 0V to 3.7V LTC6078MS8 V_{CM} = 0V to 5V LTC6078MS8 V_{CM} = 0V to 3.7V LTC6079GN V_{CM} = 0V to 5V LTC6079GN V_{CM} = 0V to 3.7V LTC6078DD, LTC6079DHC V_{CM} = 0V to 5V LTC6078DD, LTC6079DHC V_{CM} = 0V to 3.7V	 ● ● ● ● ● ● ● ●	91 90 94 88 90 86 90 86 90	105 105 105 100 105 100 105 100 105		91 90 94 88 90 86 90	105 105 105 100 105 100 105		dB dB dB dB dB dB dB dB dB
PSRR	Power Supply Rejection Ratio	V_S = 2.7V to 5.5V	 ●	100 97	120		 97	120		dB dB
V_{OUT}	Output Voltage, High (Referred to V^+)	No Load I_{SOURCE} = 0.5mA I_{SOURCE} = 5mA	 ● ●	 50 500	2 20 200		 55 550	2 20 200		mV mV mV
	Output Voltage, Low (Referred to V^-)	No Load I_{SINK} = 0.5mA I_{SINK} = 5mA	 ● ●		1 15 150	 40 400		1 15 150	 45 450	mV mV mV
A_{VOL}	Large-Signal Voltage Gain	R_{LOAD} = 10k, 0.5V ≤ V_{OUT} ≤ 4.5V	●	115	130		110	125		dB
I_{SC}	Output Short-Circuit Current	Source Sink	● ●	14 14	25 25		12 12	25 25		mA mA
SR	Slew Rate	A_V = 1			0.05			0.05		V/μs
GBW	Gain-Bandwidth Product (f_{TEST} = 10kHz)	R_L = 100k	 ●	420 360	750		420 320	750		kHz kHz
Φ_0	Phase Margin	R_L = 10k, C_L = 200pF			66			66		Deg
t_S	Settling Time 0.1%	A_V = 1, 1V Step			24			24		μs
I_S	Supply Current (per Amplifier)	No Load	 ●		55	74 82		55	74 84	μA μA
	Shutdown Current (per Amplifier)	Shutdown, $V_{\overline{SHDN}}$ ≤ 1.2V, LTC6078DD	●		1.5	5		1.5	5	μA
V_S	Supply Voltage Range	Guaranteed by the PSRR Test	●	2.7		5.5	2.7		5.5	V
	Channel Separation	f_S = 10kHz, R_L = 10k			–110			–110		dB
	Shutdown Logic	$\overline{SHDN}$ High, LTC6078DD $\overline{SHDN}$ Low, LTC6078DD	● ●	3.5		 1.2	3.5		 1.2	V V
t_{ON}	Turn on Time	$V_{\overline{SHDN}}$ = 1.2V to 3.5V, LTC6078DD			50			50		μs
t_{OFF}	Turn off Time	$V_{\overline{SHDN}}$ = 1.2V to 3.5V, LTC6078DD			2			2		μs
	Leakage of $\overline{SHDN}$ Pin	$V_{\overline{SHDN}}$ = 0V, LTC6078DD			0.6					μA

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted.

Note 3: The LTC6078C/LTC6079C and LTC6078I/LTC6079I are guaranteed functional over the operating temperature range of –40°C to 85°C. The LTC6078H/LTC6079H are guaranteed functional over the operating temperature range of –40°C to 125°C.

Note 4: The LTC6078C/LTC6079C are guaranteed to meet specified performance from 0°C to 70°C. The LTC6078C/LTC6079C are designed, characterized and expected to meet specified performance from –40°C to 85°C but are not tested or QA sampled at these temperatures. The LTC6078I/LTC6079I are guaranteed to meet specified performance from –40°C to 85°C. The LTC6078H/LTC6079H are guaranteed to meet specified performance from –40°C to 125°C.

Note 5: V_{OS} and V_{OS} drift are 100% tested at 25°C and 125°C.

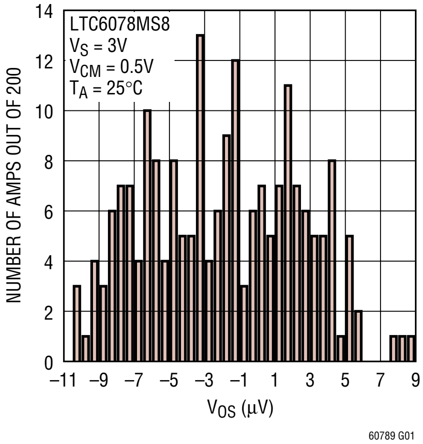
Note 6: I_B and I_{OS} are guaranteed by the V_S = 5V test.

Note 7: V_{OS} drift is guaranteed by the V_S = 3V test.

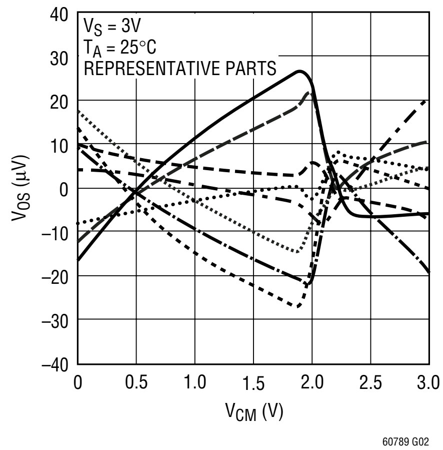
Note 8: Current noise is calculated from $i_n = \sqrt{2qI_B}$, where $q = 1.6 \cdot 10^{-19}$ coulomb.

TYPICAL PERFORMANCE CHARACTERISTICS

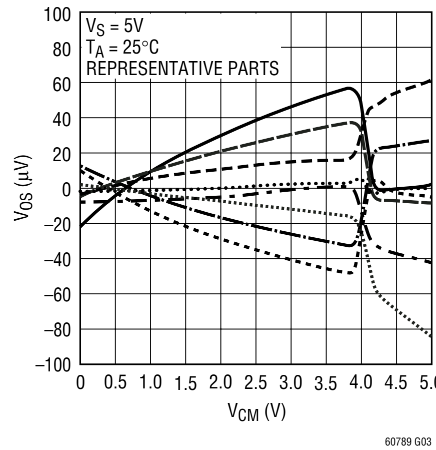
V_{OS} Distribution



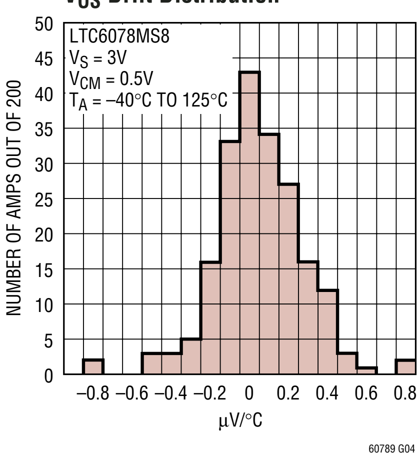
V_{OS} vs V_{CM}



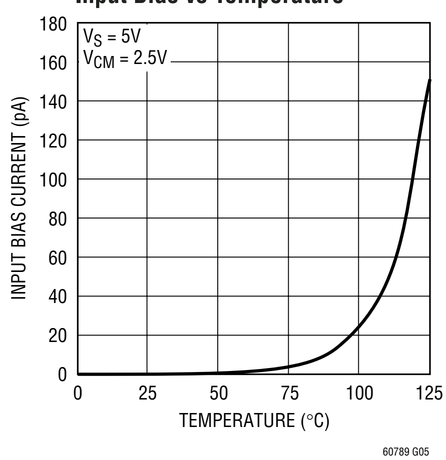
V_{OS} vs V_{CM}



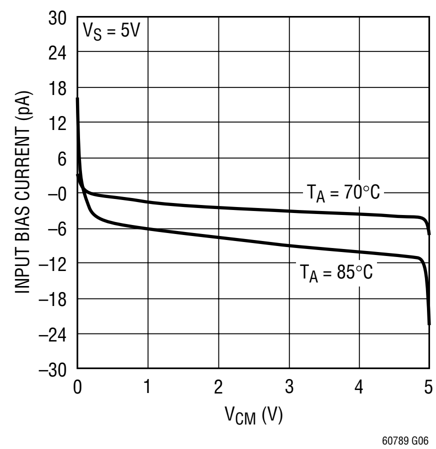
V_{OS} Drift Distribution



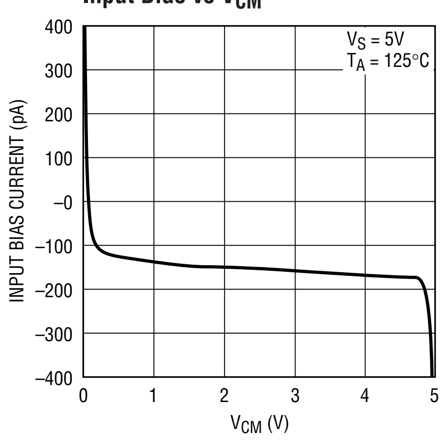
Input Bias vs Temperature



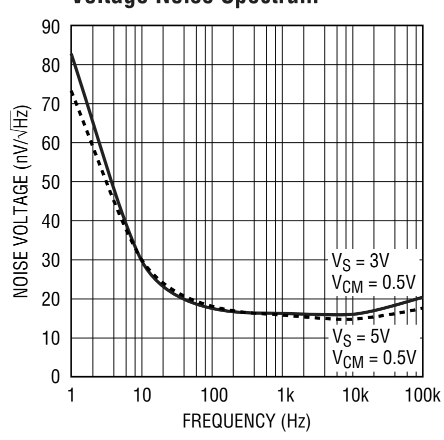
Input Bias vs V_{CM}



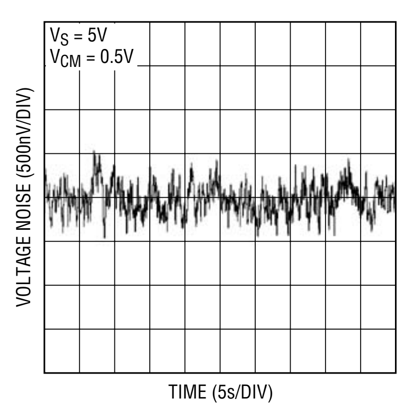
Input Bias vs V_{CM}



Voltage Noise Spectrum

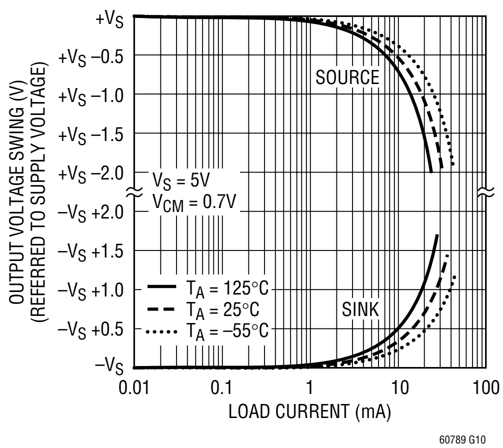


0.1Hz to 10Hz Output Voltage Noise

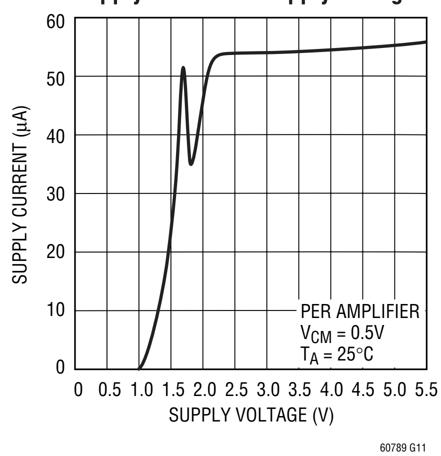


TYPICAL PERFORMANCE CHARACTERISTICS

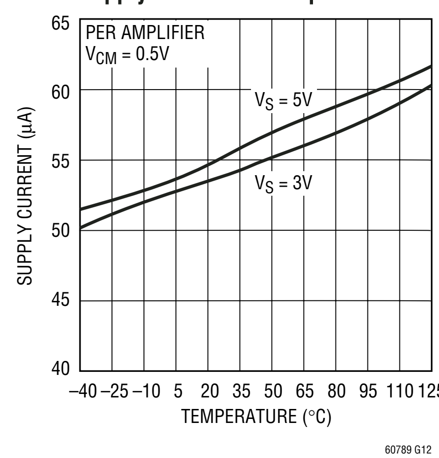
Output Voltage Swing vs Load Current



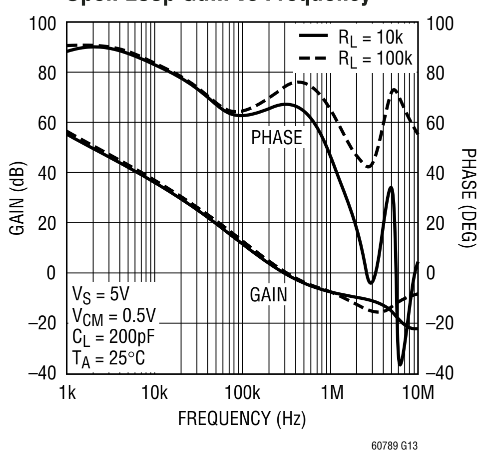
Supply Current vs Supply Voltage



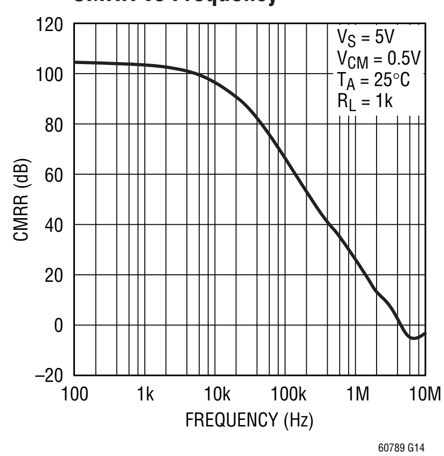
Supply Current vs Temperature



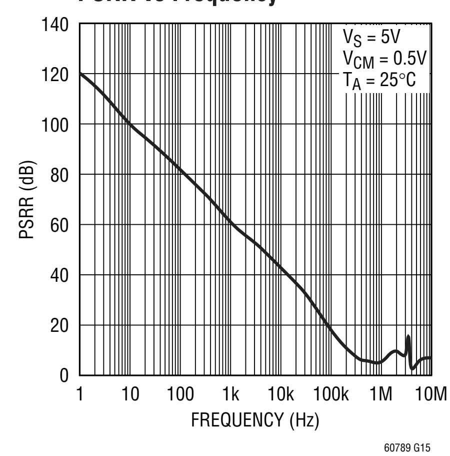
Open Loop Gain vs Frequency



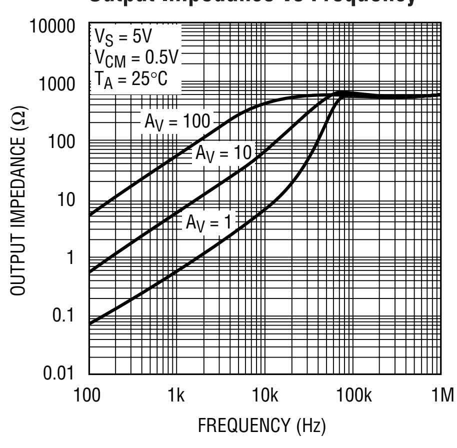
CMRR vs Frequency



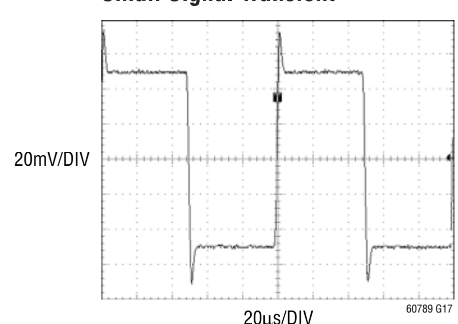
PSRR vs Frequency



Output Impedance vs Frequency

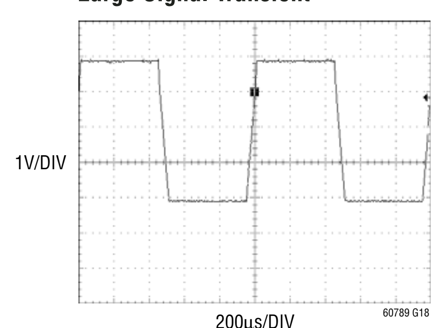


Small Signal Transient



$V_S = 5V$
$R_L = 10k$
$C_L = 100pF$

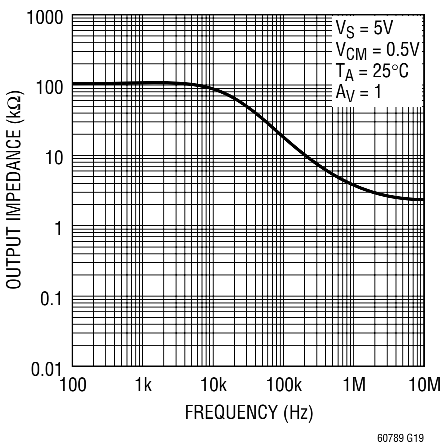
Large Signal Transient



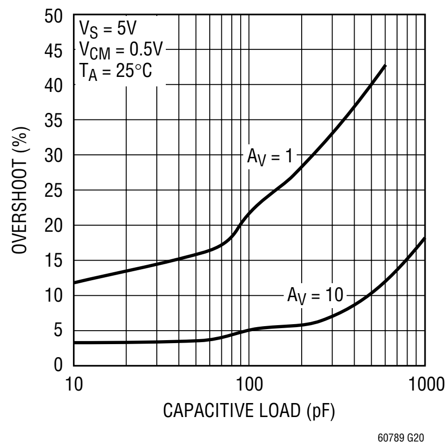
$V_S = 5V$
$R_L = 10k$
$C_L = 100pF$

TYPICAL PERFORMANCE CHARACTERISTICS

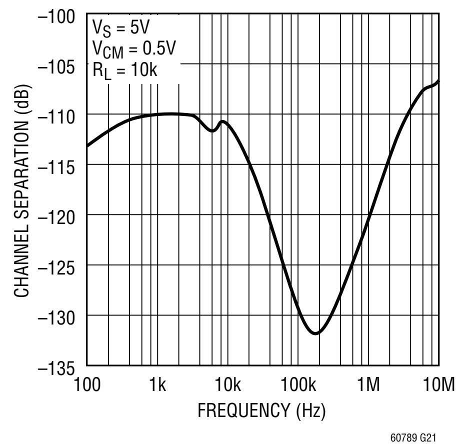
Disabled Output Impedence vs Frequency



Overshoot vs C_L



Channel Separation vs Frequency



PIN FUNCTIONS

OUT: Amplifier Output

–IN: Inverting Input

+IN: Noninverting Input

V+: Positive Supply

V–: Negative Supply

$\overline{\text{SHDN\_A}}$: Shutdown Pin of Amplifier A, active low and only valid for LTC6078DD. An internal current source pulls the pin to V^+ when floating.

$\overline{\text{SHDN\_B}}$: Shutdown Pin of Amplifier B, active low and only valid for LTC6078DD. An internal current source pulls the pin to V^+ when floating.

NC: Not internally connected.

Exposed Pad: Connected to V^-.

APPLICATIONS INFORMATION

Preserving Input Precision

Preserving input accuracy of the LTC6078/LTC6079 requires that the application circuit and PC board layout do not introduce errors comparable or greater than the 10μV typical offset of the amplifiers. Temperature differentials across the input connections can generate thermocouple voltages of 10's of microvolts so the connections to the input leads should be short, close together and away from heat dissipating components. Air current across the board can also generate temperature differentials.

The extremely low input bias currents (0.2pA typical) allow high accuracy to be maintained with high impedance sources and feedback resistors. Leakage currents on the PC board can be higher than the input bias current. For example, 10GΩ of leakage between a 5V supply lead and an input lead will generate 500pA! Surround the input leads with a guard ring driven to the same potential as the input common mode to avoid excessive leakage in high impedance applications.

Input Clamps

Large differential voltages across the inputs over very long time periods can impact the precisely trimmed input offset voltage of the LTC6078/LTC6079. As an example, a 2V differential voltage between the inputs over a period of 100 hours can shift the input offset voltage by tens of microvolts. If the amplifier is to be subjected to large differential input voltages, adding back-to-back diodes between the two inputs will minimize this shift and retain the DC precision. If necessary, current-limiting series resistors can be added in front of the diodes, as shown in Figure 1. These diodes are not necessary for normal closed loop applications.

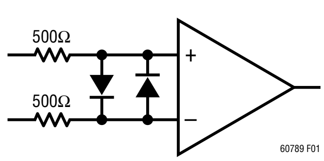


Figure 1. Op Amp with Input Voltage Clamp

Capacitive Load

LTC6078/LTC6079 can drive capactive load up to 200pF in unity gain. The capacitive load driving capability increases as the amplifier is used in higher gain configurations. A small series resistance between the ouput and the load further increases the amount of capacitance the amplifier can drive.

$\overline{\text{SHDN}}$ Pins

Pins 5 and 6 are used for power shutdown on the LTC6078 in the DD package. If they are floating, internal current sources pull Pins 5 and 6 to V+ and the amplifiers operate normally. In shutdown, the amplifier output is high impedance, and each amplifier draws less than 2μA current.

When the chip is turned on, the supply current per amplifier is about 35μA larger than its normal values for 50μs.

Rail-to-Rail Input

The input stage of LTC6078/LTC6079 combines both PMOS and NMOS differential pairs, extending its input common mode voltage range to both positive and negative supply voltages. At high input common mode range, the NMOS pair is on. At low common mode range, the PMOS pair is on. The transition happens when the common voltage is between 1.3V and 0.9V below the positive supply.

Thermal Hysteresis

Figure 2 shows the input offset hysteresis of LTC6078MS8 for 3 thermal cycles from –45°C to 90°C. The typical offset shift after the 3 cycles is only 1μV.

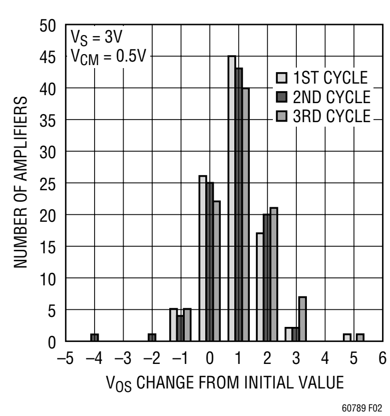


Figure 2. V_{OS} Thermal Hysteresis of LTC6078MS8

APPLICATIONS INFORMATION

PC Board Layout

Mechanical stress on a PC board and soldering-induced stress can cause the V_{OS} and V_{OS} drift to shift. The DD and DHC packages are more sensitive to stress. A simple way to reduce the stress-related shifts is to mount the IC near the short edge of the PC board, or in a corner. The board edge acts as a stress boundary, or a region where the flexure of the board is minimum. The package should always be mounted so that the leads absorb the stress and not the package. The package is generally aligned with the leads paralled to the long side of the PC board.

The most effective technique to relieve the PC board stress is to cut slots in the board around the op amp. These slots can be cut on three sides of the IC and the leads can exit on the fourth side. Figure 3 shows the layout of a LTC6078DD with slots at three sides.

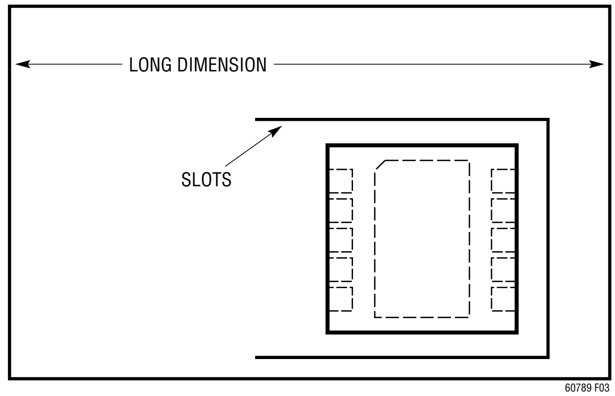
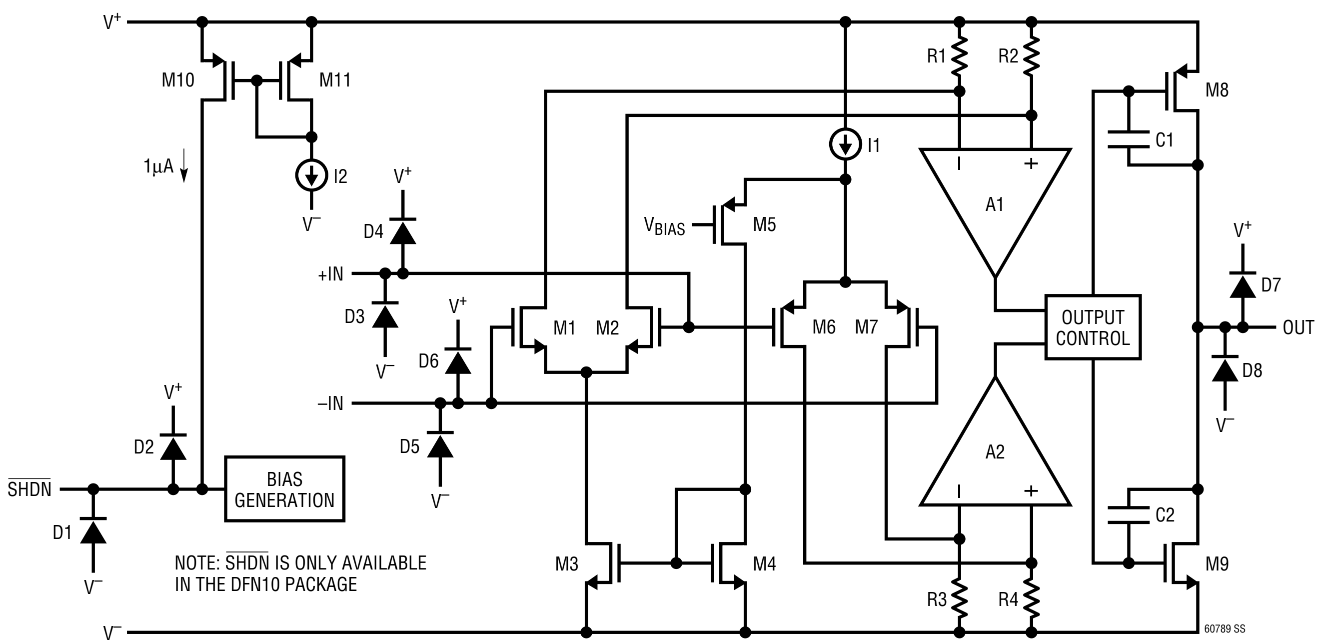


Figure 3. Vertical Orientation of LTC6078DD with Slots

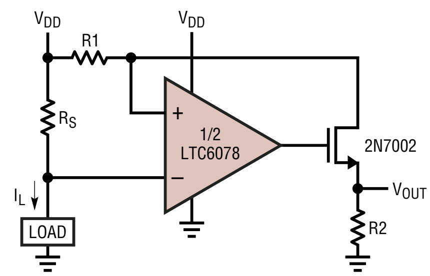
SIMPLIFIED SCHEMATIC



Simplified Schematic of the Amplifier

TYPICAL APPLICATIONS

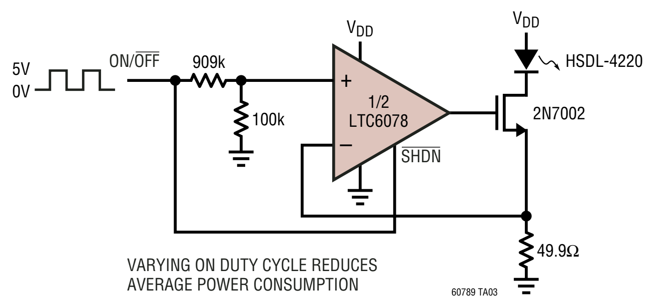
2.7V High Side Current Sense



$V_{OUT} = I_L \cdot \frac{R2}{R1} \cdot R_S - V_{OS} \cdot \frac{R2}{R1}$

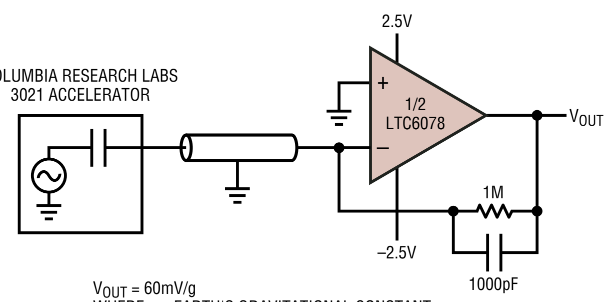
$0V \le V_{OUT} \le V_{DD} - V_{GS,\ MOSFET}$

Low Average Power IR LED Driver



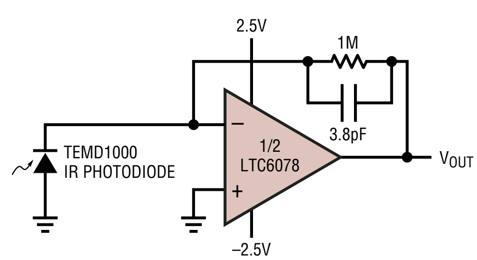
VARYING ON DUTY CYCLE REDUCES
AVERAGE POWER CONSUMPTION

Accelerometer Signal Conditioner



V_{OUT} = 60mV/g
WHERE g = EARTH'S GRAVITATIONAL CONSTANT

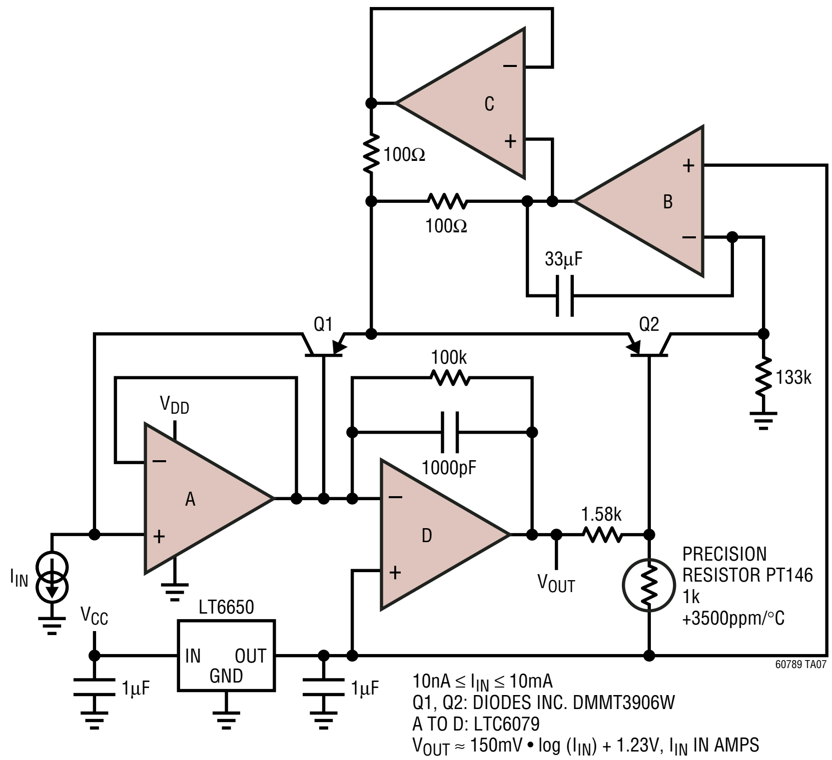
Photodiode Amplifier



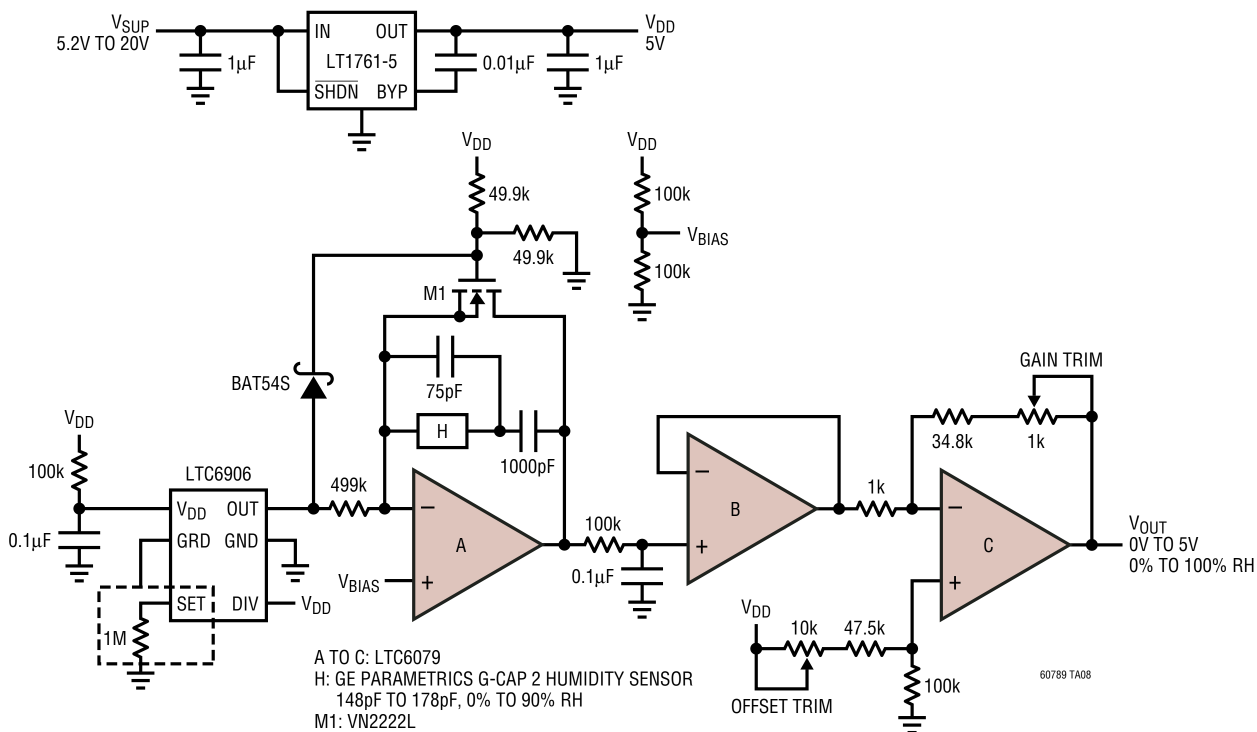
AT 870nm (IR),
V_{OUT} = 600mV/μW RECEIVED POWER

TYPICAL APPLICATIONS

6 Decade Current Log Amplifier

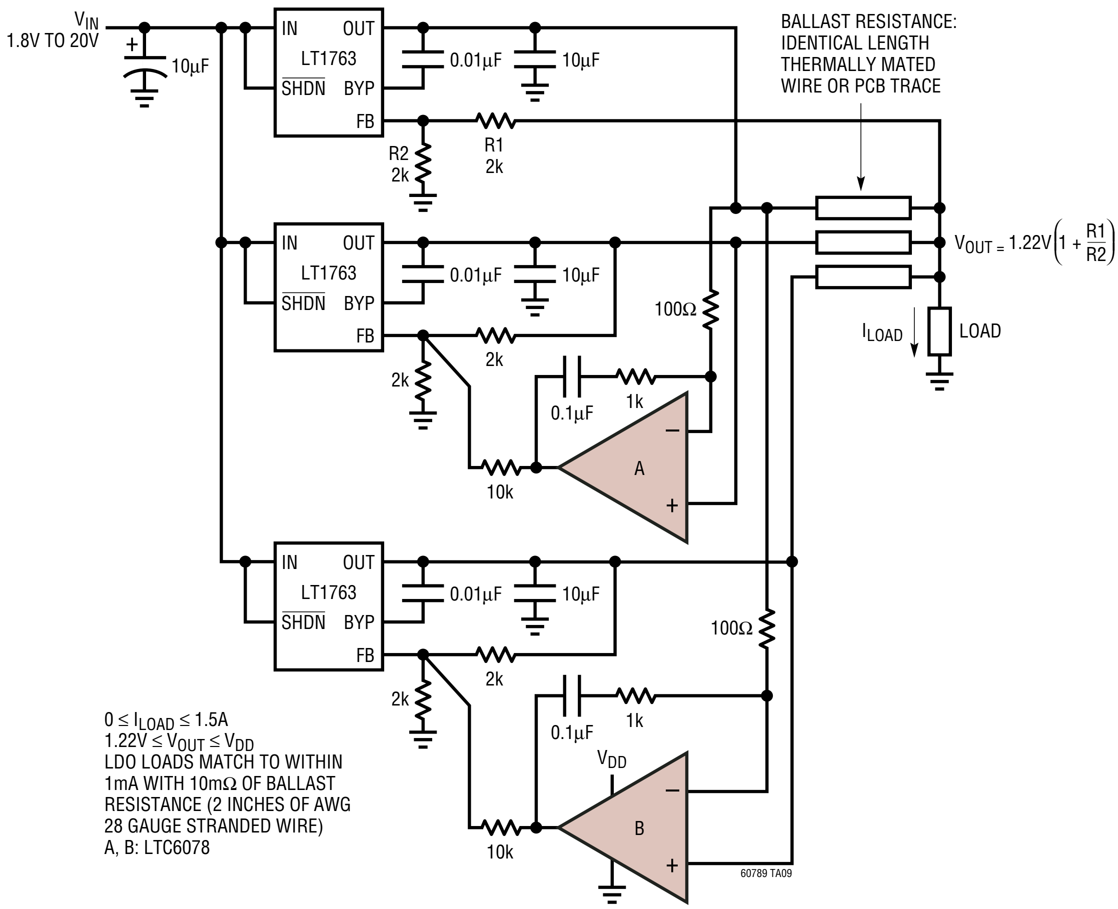


Humidity Sensor Signal Conditioner

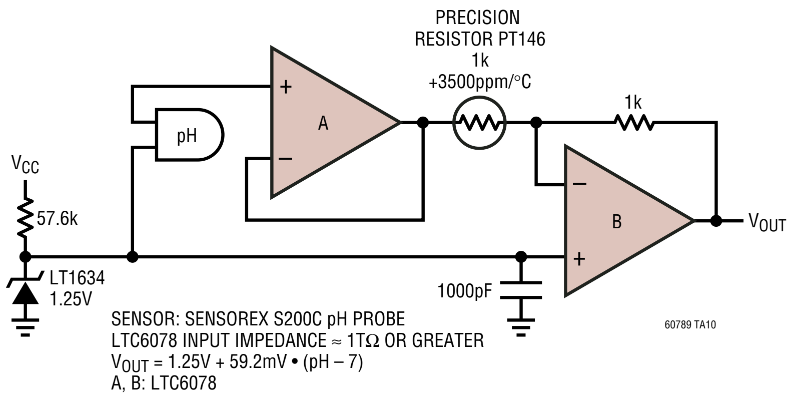


TYPICAL APPLICATIONS

LDO Load Balancing

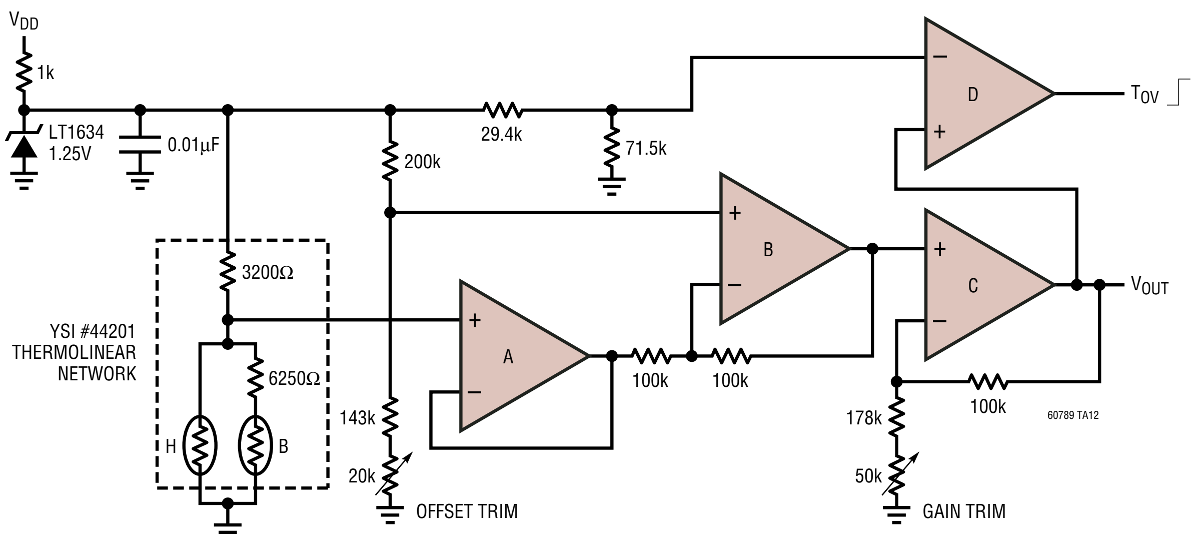


pH Probe Amplifier



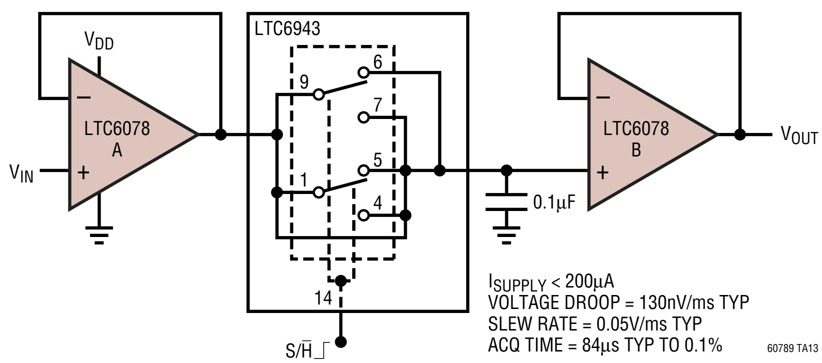
TYPICAL APPLICATIONS

Thermistor Amplifier with Overtemperature Alarm



A TO D: LTC6079, V_{DD} = 2.7V TO 5.5V, V_{SS} = GND
V_{OUT} = 0 → 1V FOR 0°C TO 100°C, LINEAR
T_{OV} → HIGH WHEN T ≥ 90°C

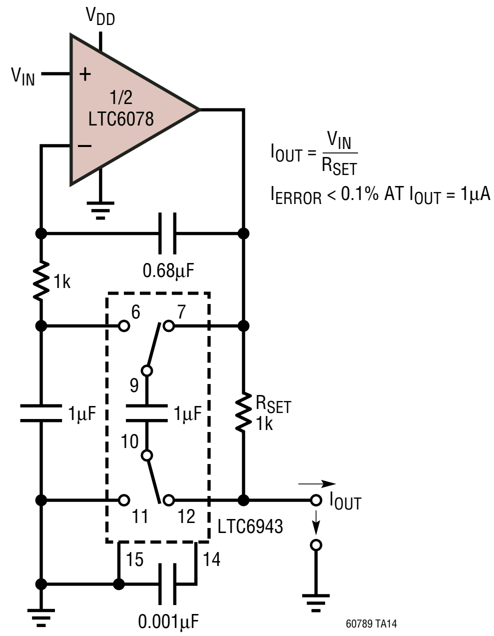
Precision Sample-and-Hold



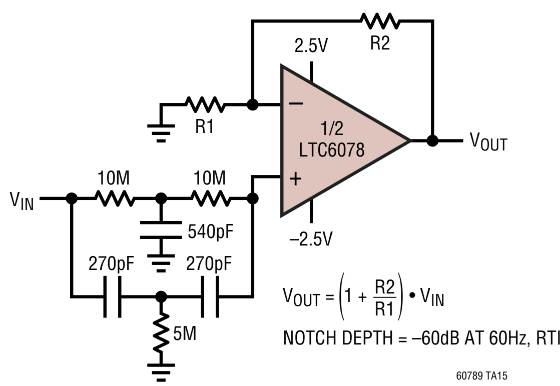
I_{SUPPLY} < 200µA
VOLTAGE DROOP = 130nV/ms TYP
SLEW RATE = 0.05V/ms TYP
ACQ TIME = 84µs TYP TO 0.1%

TYPICAL APPLICATIONS

Precision Voltage-Controlled Current Source

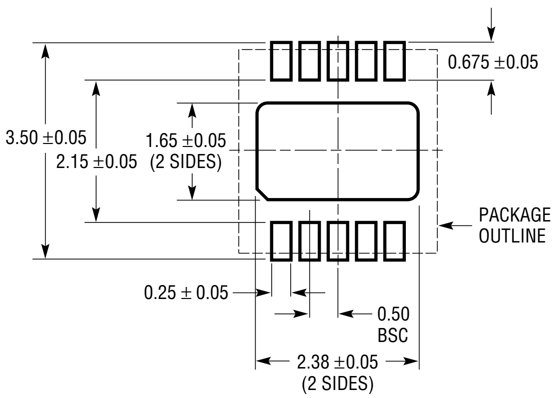


60Hz Notch

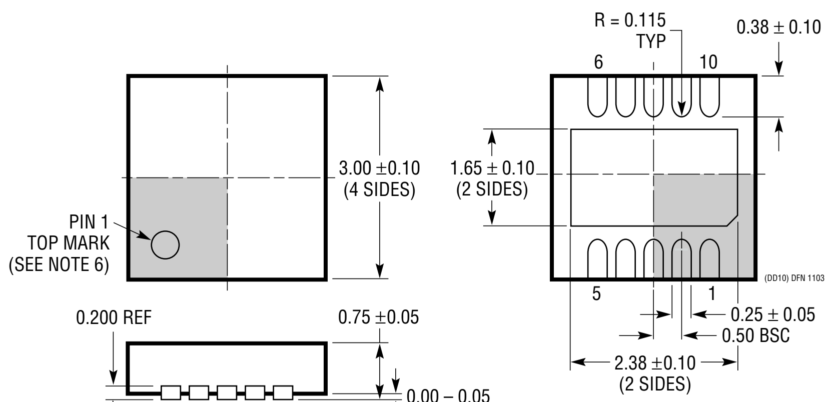


PACKAGE DESCRIPTION

DD Package
10-Lead Plastic DFN (3mm × 3mm)
(Reference LTC DWG # 05-08-1699)



RECOMMENDED SOLDER PAD PITCH AND DIMENSIONS

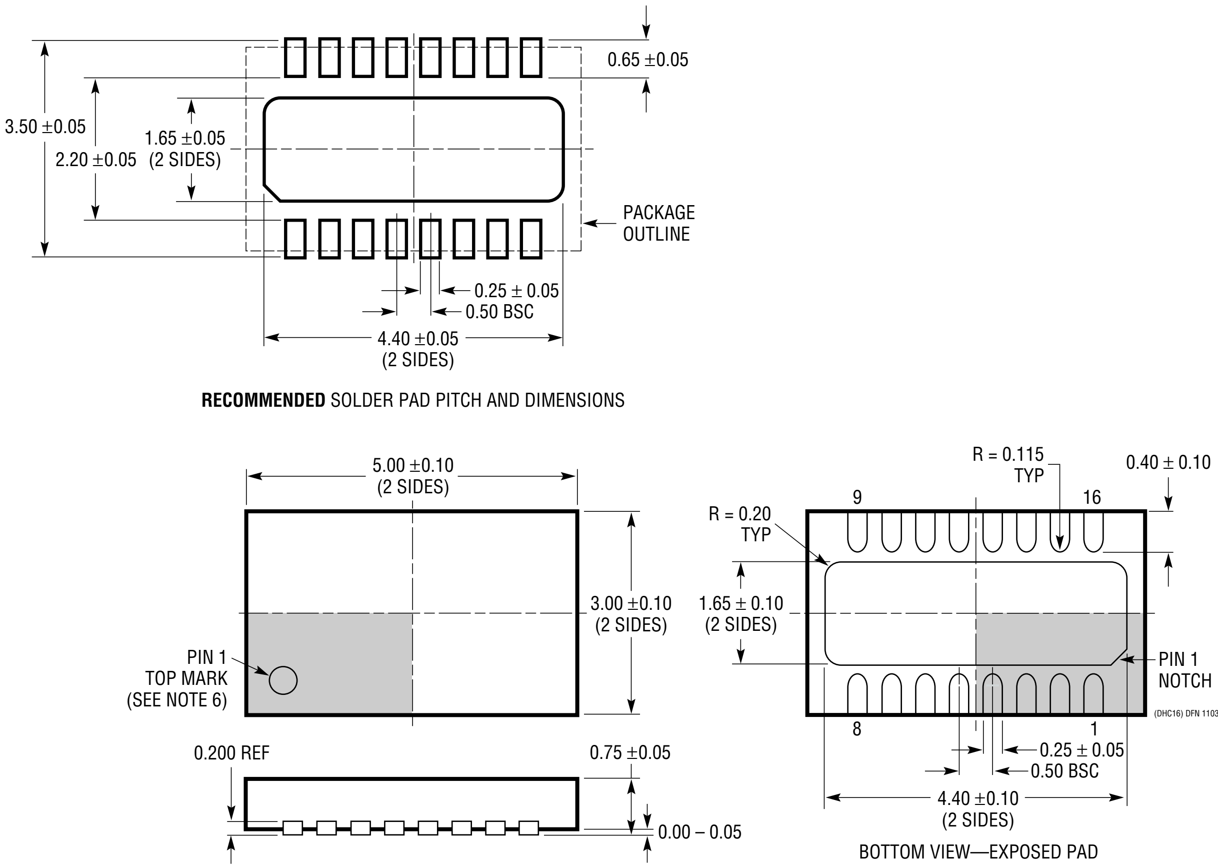


BOTTOM VIEW—EXPOSED PAD

NOTE:
1. DRAWING TO BE MADE A JEDEC PACKAGE OUTLINE M0-229 VARIATION OF (WEED-2). CHECK THE LTC WEBSITE DATA SHEET FOR CURRENT STATUS OF VARIATION ASSIGNMENT
2. DRAWING NOT TO SCALE
3. ALL DIMENSIONS ARE IN MILLIMETERS
4. DIMENSIONS OF EXPOSED PAD ON BOTTOM OF PACKAGE DO NOT INCLUDE MOLD FLASH. MOLD FLASH, IF PRESENT, SHALL NOT EXCEED 0.15mm ON ANY SIDE
5. EXPOSED PAD SHALL BE SOLDER PLATED
6. SHADED AREA IS ONLY A REFERENCE FOR PIN 1 LOCATION ON THE TOP AND BOTTOM OF PACKAGE

PACKAGE DESCRIPTION

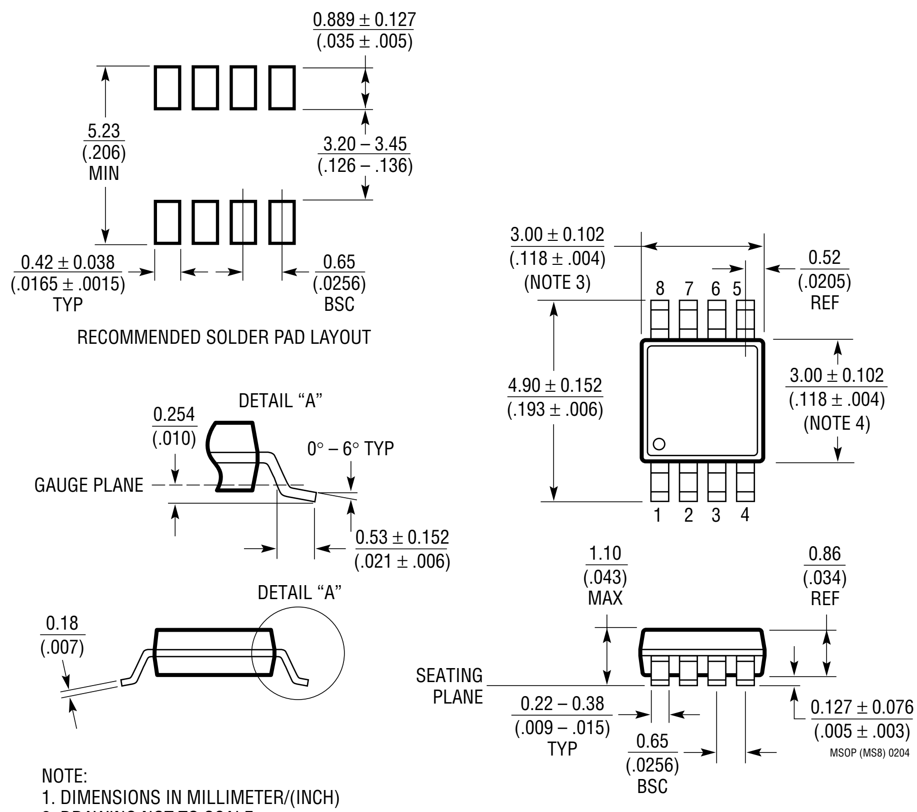
DHC Package
16-Lead Plastic DFN (5mm × 3mm)
(Reference LTC DWG # 05-08-1706)



NOTE:
1. DRAWING PROPOSED TO BE MADE VARIATION OF VERSION (WJED-1) IN JEDEC PACKAGE OUTLINE MO-229
2. DRAWING NOT TO SCALE
3. ALL DIMENSIONS ARE IN MILLIMETERS
4. DIMENSIONS OF EXPOSED PAD ON BOTTOM OF PACKAGE DO NOT INCLUDE MOLD FLASH. MOLD FLASH, IF PRESENT, SHALL NOT EXCEED 0.15mm ON ANY SIDE
5. EXPOSED PAD SHALL BE SOLDER PLATED
6. SHADED AREA IS ONLY A REFERENCE FOR PIN 1 LOCATION ON THE TOP AND BOTTOM OF PACKAGE

PACKAGE DESCRIPTION

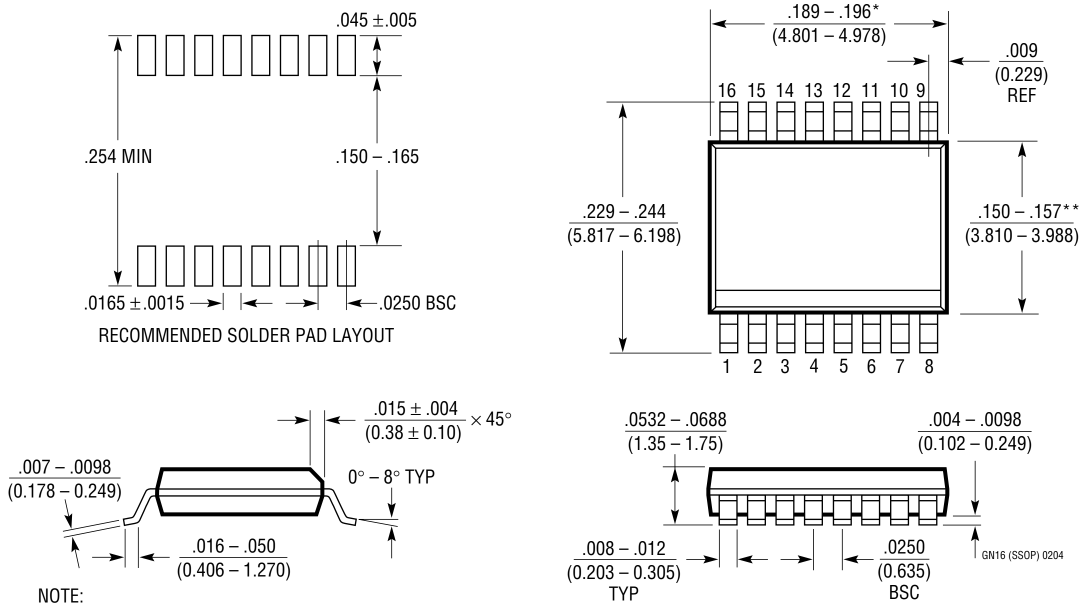
MS8 Package
8-Lead Plastic MSOP
(Reference LTC DWG # 05-08-1660)



NOTE:
1. DIMENSIONS IN MILLIMETER/(INCH)
2. DRAWING NOT TO SCALE
3. DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
4. DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
5. LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.102mm (.004") MAX

PACKAGE DESCRIPTION

GN Package
16-Lead Plastic SSOP (Narrow .150 Inch)
(Reference LTC DWG # 05-08-1641)



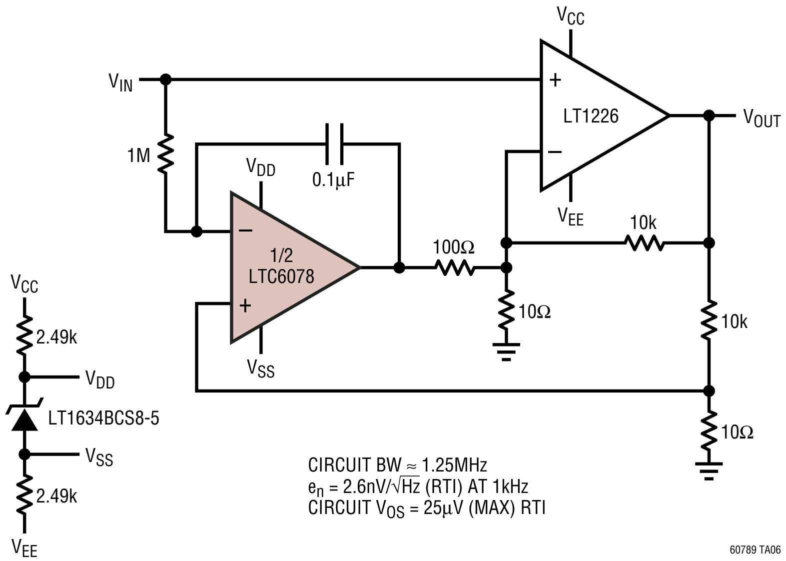
NOTE:
1. CONTROLLING DIMENSION: INCHES
2. DIMENSIONS ARE IN $\frac{\text{INCHES}}{\text{(MILLIMETERS)}}$
3. DRAWING NOT TO SCALE

*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 APPLICATION

DC Accurate Composite Amplifier, Gain of 1000



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC2051/LTC2052	Dual/Quad Zero-Drift Op Amps	3µV V_{OS}, 30nV/°C V_{OS} Drift
LT6011/LT6012	Dual/Quad Precision Op Amps	60µV V_{OS}, I_B = 300pA, I_S = 135µA

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