# ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage	±20V
Differential Input Voltage	.±40V
Input Voltage	. ±20V

**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/

# PACKAGE/ORDER INFORMATION



Consult LTC Marketing for parts specified with wider operating temperature ranges.



# **ELECTRICAL CHARACTERISTICS** $V_{S} = \pm 15V$ , $V_{CM} = 0V$ , $T_{A} = 25^{\circ}C$ , Gain = 10 or 100, unless otherwise noted.

			LT1102AM/AC			L			
SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
G <sub>E</sub>	Gain Error	$V_0 = \pm 10V, R_L = 50k \text{ or } 2k$		0.010	0.050		0.012	0.070	%
G <sub>NL</sub>	Gain Nonlinearity	G = 100, R <sub>L</sub> = 50k		3	14		4	18	ppm
		$G = 100, R_L = 2k$		8	20		8	25	ppm
		G = 10, RL = 50k or 2k		7	16		7	30	ppm
V <sub>OS</sub>	Input Offset Voltage			180	600		200	900	μV
l <sub>os</sub>	Input Offset Current			3	40		4	60	рА
I <sub>B</sub>	Input Bias Current			±3	±40		$\pm 4$	±60	рА
	Input Resistance Common Mode Differential Mode	V <sub>CM</sub> = -11V to 8V V <sub>CM</sub> = 8V to 11V		10 <sup>12</sup> 10 <sup>11</sup> 10 <sup>12</sup>			10 <sup>12</sup> 10 <sup>11</sup> 10 <sup>12</sup>		Ω Ω Ω
e <sub>n</sub>	Input Noise Voltage	0.1Hz to 10Hz		2.8			2.8		μνρ-ρ
	Input Noise Voltage Density	$f_0 = 10$ Hz $f_0 = 1000$ Hz (Note 2)		37 19	30		37 20		nV/√Hz nV/√Hz
	Input Noise Current Density	f <sub>0</sub> = 1000Hz, 10Hz (Note 3)		1.5	4		2	5	fA/√Hz
	Input Voltage Range		±10.5	±11.5		±10.5	±11.5		V
CMRR	Common Mode Rejection Ratio	1k Source Imbalance, $V_{CM} = \pm 10.5V$	84	98		82	97		dB
PSRR	Power Supply Rejection Ratio	$V_{\rm S}$ = ±9V to ±18V	88	102		86	101		dB
Is	Supply Current			3.3	5.0		3.4	5.6	mA
V <sub>0</sub>	Maximum Output Voltage Swing	$R_{L} = 50k$ $R_{L} = 2k$	±13.0 ±12.0	±13.5 ±13.0		±13.0 ±12.0	±13.5 ±13.0		V V
BW	Bandwidth	G = 100 (Note 4) G = 10 (Note 4)	120 2.0	220 3.5		100 1.7	220 3.5		kHz MHz
SR	Slew Rate	$ \begin{array}{l} G = 100,  V_{IN} = \pm 0.13 V,  V_0 = \pm 5 V \\ G = 10,  V_{IN} = \pm 1 V,  V_0 = \pm 5 V \end{array} $	12 21	17 30		10 18	17 30		V/µs V/µs
	Overdrive Recovery	50% Overdrive (Note 5)		400			400		ns
	Settling Time	$V_0 = 20V \text{ Step (Note 4)} \\ G = 10 \text{ to } 0.05\% \\ G = 10 \text{ to } 0.01\% \\ G = 100 \text{ to } 0.05\% \\ G = 100 \text{ to } 0.01\% \\ \end{cases}$		1.8 3.0 7 9	4.0 6.5 13 18		1.8 3.0 7 9	4.0 6.5 13 18	μs μs μs



# $\label{eq:constraint} \begin{array}{l} \textbf{ELECTRICAL CHARACTERISTICS} \\ -40^\circ C \leq T_A \leq 85^\circ C \mbox{ for } I \mbox{ grades, unless otherwise noted.} \end{array}$

 $V_S$  = ±15V,  $V_{CM}$  = 0V, Gain = 10 or 100,  $-55^\circ C \leq T_A \leq 125^\circ C$  for AM/M grades,

			LT1102AM			LT1102M/I			
SYMBOL	PARAMETER	CONDITIONS	MIN	ТҮР	MAX	MIN	TYP	MAX	UNITS
G <sub>E</sub>	Gain Error	$ \begin{array}{l} G = 100,  V_0 = \pm 10V,  R_L = 50k \; or \; 2k \\ G = 10,  V_0 = \pm 10V,  R_L = 50k \; or \; 2k \end{array} $		0.10 0.05	0.25 0.12		0.10 0.06	0.30 0.15	%
TCG <sub>E</sub>	Gain Error Drift (Note 6)	$ \begin{array}{l} G = 100,  R_L = 50k \; \text{or} \; 2k \\ G = 10,  R_L = 50k \; \text{or} \; 2k \end{array} $		9 5	20 10		10 6	25 14	ppm/°C ppm/°C
G <sub>NL</sub>	Gain Nonlinearity	$    \begin{array}{l} G = 100, \ R_L = 50k \\ G = 100, \ R_L = 2k \\ G = 10, \ R_L = 50k \ or \ 2k \end{array} $		20 28 9	70 85 20		24 32 9	90 110 24	ppm ppm ppm
V <sub>OS</sub>	Input Offset Voltage			300	1400		400	2000	μV
$\Delta V_{0S}/\Delta T$	Input Offset Voltage Drift	(Note 6)		2	8		3	12	μV/°C
l <sub>OS</sub>	Input Offset Current			0.3	4		0.4	6	nA
I <sub>B</sub>	Input Bias Current			±2	±10		±2.5	±15	nA
CMRR	Common Mode Rejection Ratio	V <sub>CM</sub> = ±10.3V	82	97		80	96		dB
PSRR	Power Supply Rejection Ratio	$V_{S} = \pm 10V$ to $\pm 17V$	88	100		84	99		dB
Is	Supply Current	T <sub>A</sub> = 125°C		2.5			2.5		mA
V <sub>0</sub>	Maximal Output Voltage Swing	$R_{L} = 50k$ $R_{L} = 2k$	±12.5 ±12.0	±13.2 ±12.6		±12.5 ±12.0	±13.2 ±12.6		V V

#### $V_S$ = ±15V, $V_{CM}$ = 0V, Gain = 10 or 100, $0^\circ C \leq T_A \leq 70^\circ C,$ unless otherwise noted.

			LT1102AC			LT1102C			1	
SYMBOL	PARAMETER	CONDITIONS	MIN	ТҮР	MAX	MIN	ТҮР	MAX	UNITS	
G <sub>E</sub>	Gain Error	$ \begin{array}{l} G = 100,  V_0 = \pm 10V,  R_L = 50k \text{ or } 2k \\ G = 10,  V_0 = \pm 10V,  R_L = 50k \text{ or } 2k \end{array} $		0.04 0.03	0.11 0.09		0.05 0.04	0.14 0.12	% %	
TCG <sub>E</sub>	Gain Error Drift (Note 6)	G = 100, $R_L = 50k$ or 2k G = 10, $R_L = 50k$ or 2k		8 5	18 10		9 6	22 14	ppm/°C ppm/°C	
G <sub>NL</sub>	Gain Nonlinearity			8 11 8	30 36 18		9 12 8	40 48 22	ppm ppm ppm	
V <sub>OS</sub>	Input Offset Voltage			230	1000		280	1400	μV	
$\Delta V_{0S}/\Delta T$	Input Offset Voltage Drift	(Note 6)		2	8		3	12	μV/°C	
I <sub>OS</sub>	Input Offset Current			10	150		15	220	pА	
$\Delta I_{0S} / \Delta T$	Input Offset Current Drift	(Note 6)		0.5	3		0.5	4	pA/°C	
I <sub>B</sub>	Input Bias Current			±40	±300		±50	±400	pА	
$\Delta I_{B} / \Delta T$	Input Bias Current Drift	(Note 6)		1	4		1	6	pA/°C	
CMRR	Common Mode Rejection Ratio	V <sub>CM</sub> = ±10.3V	83	98		81	97		dB	
PSRR	Power Supply Rejection Ratio	$V_{\rm S} = \pm 10$ V to $\pm 17$ V	87	101		85	100		dB	
I <sub>S</sub>	Supply Current	T <sub>A</sub> = 70°C		2.8			2.9		mA	
V <sub>0</sub>	Maximum Output Voltage Swing	$R_{L} = 50k$ $R_{L} = 2k$	±12.8 ±12.0	±13.4 ±12.8		±12.8 ±12.0	±13.4 ±12.8		V V	



# **ELECTRICAL CHARACTERISTICS**

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: This parameter is tested on a sample basis only.

Note 3: Current noise is calculated from the formula:

 $i_n = (2qI_B)^{1/2}$ 

where  $q = 1.6 \cdot 10^{-19}$  coulomb. The noise of source resistors up to  $1G\Omega$ swamps the contribution of current noise.

Note 4: This parameter is not tested. It is guaranteed by design and by inference from the slew rate measurement.

Note 5: Overdrive recovery is defined as the time delay from the removal of an input overdrive to the output's return from saturation to linear operation.

50% overdrive equals  $V_{IN} = \pm 2V$  (G = 10) or  $V_{IN} = \pm 200 \text{mV}$  (G = 100). Note 6: This parameter is not tested. It is guaranteed by design and by inference from other tests.

### TYPICAL PERFORMANCE CHARACTERISTICS



Small Signal Response, G = 100 (Input = 5mV Pulse)







Settling Time, G = 10 (Input From – 10V to 10V)







Settling Time, G = 10 (Input From 10V to -10V)



Settling Time, G = 100 (Input From 10V to -10V)



LT1102 • TPC07



# **TYPICAL PERFORMANCE CHARACTERISTICS**



1102fb



### TYPICAL PERFORMANCE CHARACTERISTICS









LT1102 • TPC18







# APPLICATIONS INFORMATION

In the two op amp instrumentation amplifier configuration, the first amplifier is basically in unity gain, and the second amplifier provides all the voltage gain. In the LT1102, the second amplifier is decompensated for gain of 10 stability, therefore high slew rate and bandwidth are achieved. Common mode rejection versus frequency is also optimized in the G = 10 mode, because the bandwidths of the two op amps are similar. When G = 100, this statement is no longer true; however, by connecting an 18pF capacitor between pins 1 and 2, a common mode AC gain is created to cancel the inherent roll-off. From 200Hz to 30kHz, CMRR versus frequency is improved by an order of magnitude.

#### Input Protection

Instrumentation amplifiers are often used in harsh environments where overload conditions can occur. The LT1102 employs FET input transistors, consequently the differential input voltage can be  $\pm 30V$  (with  $\pm 15V$ supplies,  $\pm 36V$  with  $\pm 18V$  supplies). Some competitive instrumentation amplifiers have NPN inputs which are protected by back-to-back diodes. When the differential input Voltage exceeds  $\pm 13V$  on these competitive devices, input current increases to milliampere level; more than  $\pm 10V$  differential voltage can cause permanent damage.

When the LT1102 inputs are pulled below the negative supply or above the positive supply, the inputs will clamp a diode voltage below or above the supplies. No damage will occur if the input current is limited to 20mA.



#### Gains Between 10 and 100

Gains between 10 and 100 can be achieved by connecting two equal resistors  $(= R_X)$  between pins 1 and 2 and pins 7 and 8.

Gain = 10 + 
$$\frac{R_{\chi}}{R + R_{\chi}/90}$$

The nominal value of R is  $1.84k\Omega$ . The usefulness of this method is limited by the fact that R is not controlled to better than  $\pm 10\%$  absolute accuracy in production. However, on any specific unit, 90R can be measured between Pins 1 and 2.



### **APPLICATIONS INFORMATION**



Gain = 20, 110, or 200 Instrumentation Amplifiers



800kHz SIGNALS CAN BE MULTIPLEXED WITH LT1102 IN G = 10 LT1102 • AI03

#### Voltage Programmable Current Source is Simple and Precise



#### **Dynamic Response of the Current Source**



LT1102 • AI05



### TYPICAL APPLICATIONS



**Basic Connections** 



**Offset Nulling** 







#### PACKAGE DESCRIPTION





Information furnished by Linear Technology Corporation is believed to be accurate and reliable. However, no responsibility is assumed for its use. Linear Technology Corporation makes no representation that the interconnection of its circuits as described herein will not infringe on existing patent rights.

### PACKAGE DESCRIPTION

8-Lead PDIP (Narrow .300 Inch) (Reference LTC DWG # 05-08-1510) .400\* (10.160)MAX 7 6 8 5  $.255 \pm .015*$  $(\overline{6.477 \pm 0.381})$ 2 1 3 4  $.130\pm.005$ .300 – .325 .045 - .065  $(\overline{1.143} - 1.651)$  $(\overline{3.302 \pm 0.127})$ (7.620 - 8.255) .065 (1.651) .008 – .015 TYP Å .120 (0.203 - 0.381).020 (3.048) .325 <sup>+.035</sup> -.015 MIN (0.508)MIN .100  $.018 \pm .003$ (8.255<sup>+0.889</sup>\_-0.381) (2.54)  $(0.457 \pm 0.076)$ N8 1002 BSC

**N8 Package** 

NOTE:

NOTE: 1. DIMENSIONS ARE <u>INCHES</u> \*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 INCH (0.254mm)