Dual/Quad Low Power Precision, Picoamp Input Op Amps

FEATURES

- Offset Voltage – Prime Grade: 60µV Max
- Offset Voltage – Low Cost Grade (Including Surface Mount Dual/Quad): 75µV Max
- Offset Voltage Drift: 0.5µV/°C Max
- Input Bias Current: 250pA Max
- 0.1Hz to 10Hz Noise: 0.3μV_{P-P}, 2.2pA_{P-P}
- Supply Current per Amplifier: 400µA Max
- CMRR: 120dB Min
- Voltage Gain: 1 Million Min
- Guaranteed Specs with ±1.0V Supplies
- Guaranteed Matching Specifications
- SO-8 Package – Standard Pinout
- LT1114 in Narrow Surface Mount Package

APPLICATIONS

- Picoampere/Microvolt Instrumentation
- Two and Three Op Amp Instrumentation Amplifers
- Thermocouple and Bridge Amplifiers
- Low Frequency Active Filters
- Photo Current Amplifiers
- Battery-Powered Systems

DESCRIPTION

The LT®1112 dual and LT1114 quad op amps achieve a new standard in combining low cost and outstanding precision specifications.

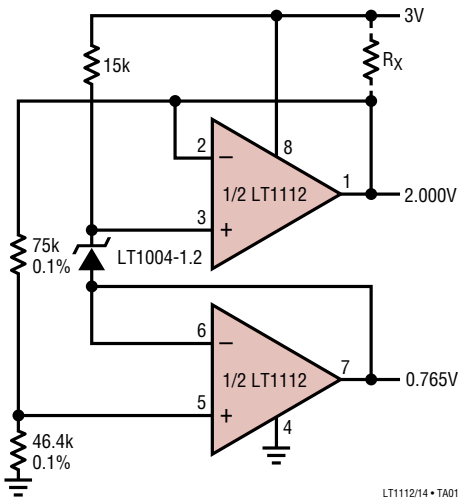
The performance of the selected prime grades matches or exceeds competitive devices. In the design of the LT1112/LT1114 however, particular emphasis has been placed on optimizing performance in the low cost plastic and SO packages. For example, the 75µV maximum offset voltage in these low cost packages is the lowest on any dual or quad non-chopper op amp.

The LT1112/LT1114 also provide a full set of matching specifications, facilitating their use in such matching dependent applications as two and three op amp instrumentation amplifiers.

Another set of specifications is furnished at ±1V supplies. This, combined with the low 320µA supply current per amplifier, allows the LT1112/LT1114 to be powered by two nearly discharged AA cells.

TYPICAL APPLICATION

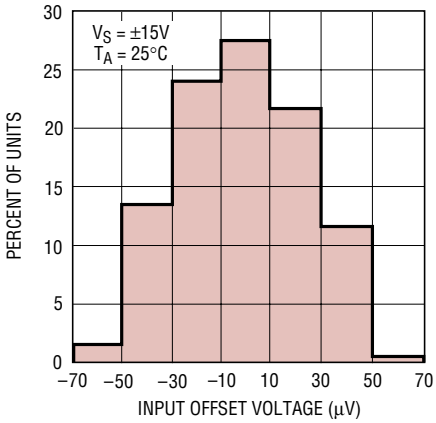
Dual Output, Buffered Reference (On Single 3V Supply)



TOTAL SUPPLY CURRENT = 700µA
2V REFERENCE: SOURCES 1.7mA, SINKS 5mA
OPTIONAL R_X = 300Ω INCREASES SOURCE CURRENT TO 5mA
0.765V REFERENCE: SOURCES 5mA, SINKS 0.5mA
TEMPERATURE COEFFICIENT LIMITED BY REFERENCE = 20ppm/°C
MINIMUM SUPPLY = 2.7V

LT1112/14 • TA01

Distribution of Input Offset Voltage (In All Packages)



LT1112/14 • TA02

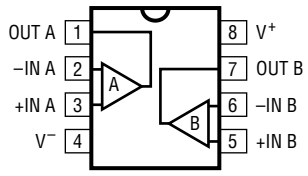
ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage ..... ±20V
Differential Input Current (Note 2) ..... ±10mA
Input Voltage (Equal to Supply Voltage) ..... ±20V
Output Short-Circuit Duration ..... Indefinite
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) ..... 300°C
Operating Temperature Range (Note 11)
LT1112AM/LT1112M
LT1114AM/LT1114M **(OBSOLETE)** ... –55°C to 125°C
LT1112AC/LT1112C/LT1112S8
LT1114AC/LT1114C/LT1114S ..... –40°C to 85°C
LT1112I/LT1114I ..... –40°C to 85°C
LT1112MPS8 ..... –55°C to 125°C

Specified Temperature Range (Note 12)
LT1112AM/LT1112M
LT1114AM/LT1114M **(OBSOLETE)** ... –55°C to 125°C
LT1112AC/LT1112C/LT1112S8
LT1114AC/LT1114C/LT1114S ..... –40°C to 85°C
LT1112I/LT1114I ..... –40°C to 85°C
LT1112MPS8 ..... –55°C to 125°C

PACKAGE/ORDER INFORMATION

TOP VIEW



N8 PACKAGE
8-LEAD PDIP
T_{JMAX} = 150°C, θ_{JA} = 130°C/W

ORDER PART NUMBER

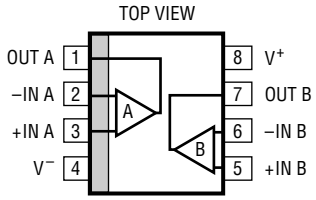
LT1112ACN8
LT1112CN8
LT1112IN8

J8 PACKAGE 8-LEAD CERDIP
T_{JMAX} = 160°C, θ_{JA} = 100°C/W

LT1112AMJ8
LT1112MJ8

OBSOLETE PACKAGE
Consider the N8 Package for Alternate Source

TOP VIEW



S8 PACKAGE
8-LEAD PLASTIC SO
T_{JMAX} = 150°C, θ_{JA} = 190°C/W

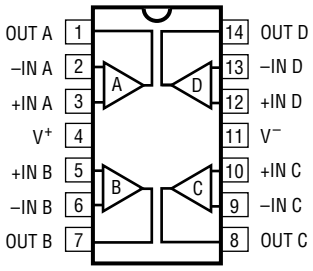
ORDER PART NUMBER

LT1112S8
LT1112IS8
LT1112MPS8

S8 PART MARKING

1112
1112I
1112MP

TOP VIEW



N PACKAGE
14-LEAD PDIP
T_{JMAX} = 150°C, θ_{JA} = 110°C/W

ORDER PART NUMBER

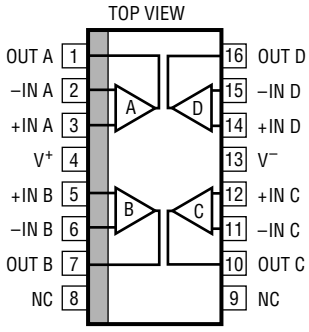
LT1114ACN
LT1114CN
LT1114IN

J PACKAGE 14-LEAD CERDIP
T_{JMAX} = 160°C, θ_{JA} = 80°C/W (J)

LT1114AMJ
LT1114MJ

OBSOLETE PACKAGE
Consider the N Package for Alternate Source

TOP VIEW



S PACKAGE
16-LEAD PLASTIC SO (NARROW)
T_{JMAX} = 150°C, θ_{JA} = 150°C/W

ORDER PART NUMBER

LT1114S
LT1114IS

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

ELECTRICAL CHARACTERISTICS

V_S = ±15V, V_{CM} = 0V, T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS (Note 3)	LT1112AM/AC LT1114AM/AC MIN	LT1112AM/AC LT1114AM/AC TYP	LT1112AM/AC LT1114AM/AC MAX	LT1112M/C/I LT1114M/C/I MIN	LT1112M/C/I LT1114M/C/I TYP	LT1112M/C/I LT1114M/C/I MAX	UNITS
V_{OS}	Input Offset Voltage	 V_S = ±1.0V		20 40	60 110		25 45	75 130	µV µV
$\frac{\Delta V_{OS}}{\Delta Time}$	Long Term Input Offset Voltage Stability			0.3			0.3		µV/Mo
I_{OS}	Input Offset Current	 LT1114S/LT1114IS		50	180		60 75	230 330	pA pA
I_B	Input Bias Current	 LT1114S/LT1114IS		±70	±250		±80 ±100	±280 ±450	pA pA
e_n	Input Noise Voltage	0.1Hz to 10Hz (Note 10)		0.3	0.9		0.3	0.9	μV_{P-P}
	Input Noise Voltage Density	f_O = 10Hz (Note 10) f_O = 1000Hz (Note 10)		16 14	28 18		16 14	28 18	$nV/\sqrt{Hz}$ $nV/\sqrt{Hz}$
i_n	Input Noise Current	0.1Hz to 10Hz		2.2			2.2		pA_{P-P}
	Input Noise Current Density	f_O = 10Hz f_O = 1000Hz		0.030 0.008			0.030 0.008		$pA/\sqrt{Hz}$ $pA/\sqrt{Hz}$
V_{CM}	Input Voltage Range		±13.5	±14.3		±13.5	±14.3		V
CMRR	Common Mode Rejection Ratio	V_{CM} = ±13.5V	120	136		115	136		dB
PSRR	Power Supply Rejection Ratio	V_S = ±1.0V to ±20V	116	126		114	126		dB
	Minimum Supply Voltage	(Note 5)	±1.0			±1.0			V
R_{IN}	Input Resistance Differential Mode Common Mode	(Note 4)	20	50 800		15	40 700		MΩ GΩ
A_{VOL}	Large-Signal Voltage Gain	V_O = ±12V, R_L = 10kΩ V_O = ±10V, R_L = 2kΩ	1000 800	5000 1500		800 600	5000 1300		V/mV V/mV
V_{OUT}	Output Voltage Swing	R_L = 10kΩ R_L = 2kΩ	±13.0 ±11.0	±14.0 ±12.4		±13.0 ±11.0	±14.0 ±12.4		V V
SR	Slew Rate		0.16	0.30		0.16	0.30		V/µs
GBW	Gain-Bandwidth Product	f_O = 10kHz	450	750		450	750		kHz
I_S	Supply Current per Amplifier	 V_S = ±1.0V		350 320	400 370		350 320	450 420	µA µA
	Channel Separation	f_O = 10Hz		150			150		dB
ΔV_{OS}	Offset Voltage Match	(Note 6)		35	100		40	130	µV
ΔI_B^+	Noninverting Bias Current Match (Notes 6, 7)	 LT1114S/LT1114IS		100	450		100 120	500 680	pA pA
ΔCMRR	Common Mode Rejection Match	(Notes 6, 8)	117	136		113	136		dB
ΔPSRR	Power Supply Rejection Match	(Notes 6, 8)	114	130		112	130		dB

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range of –55°C ≤ T_A ≤ 125°C, otherwise specifications are at T_A = 25°C. V_S = ±15V, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS (Note 3)		LT1112AMJ8 LT1114AMJ MIN	LT1112AMJ8 LT1114AMJ TYP	LT1112AMJ8 LT1114AMJ MAX	LT1112MJ8/MPS8 LT1114MJ MIN	LT1112MJ8/MPS8 LT1114MJ TYP	LT1112MJ8/MPS8 LT1114MJ MAX	UNITS
V_{OS}	Input Offset Voltage		●		35	120		45	150	µV
		LT1112MPS8	●					45	160	µV
		V_S = ±1.2V	●		60	220		70	260	µV
$\frac{\Delta V_{OS}}{\Delta Temp}$	Average Input Offset Voltage Drift	(Note 9)	●		0.15	0.5		0.20	0.75	µV/°C
		LT1112MPS8	●					0.4	1.3	µV/°C
I_{OS}	Input Offset Current		●		80	400		100	500	pA
I_B	Input Bias Current		●		±150	±600		±170	±700	pA
V_{CM}	Input Voltage Range		●	±13.5	±14.1		±13.5	±14.1		V
CMRR	Common Mode Rejection Ratio	V_{CM} = ±13.5V	●	116	130		111	130		dB
PSRR	Power Supply Rejection Ratio	V_S = ±1.2V to ±20V	●	112	124		110	124		dB
A_{VOL}	Large-Signal Voltage Gain	V_O = ±12V, R_L = 10kΩ	●	500	2500		400	2500		V/mV
		V_O = ±10V, R_L = 2kΩ	●	200	600		170	500		V/mV
V_{OUT}	Output Voltage Swing	R_L = 10kΩ	●	±13.0	±13.85		±13.0	±13.85		V
SR	Slew Rate		●	0.12	0.22		0.12	0.22		V/µs
I_S	Supply Current per Amplifier		●		380	460		380	530	µA
ΔV_{OS}	Offset Voltage Match (Note 6)		●		55	200		70	240	µV
		LT1112MPS8	●					70	270	µV
	Offset Voltage Match Drift (Notes 6, 9)		●		0.2	0.7		0.3	1.0	µV/°C
		LT1112MPS8	●					0.5	1.9	µV/°C
ΔI_B^+	Noninverting Bias Current Match	(Notes 6, 7)	●		150	750		170	850	pA
ΔCMRR	Common Mode Rejection Ratio	(Notes 6, 8)	●	112	130		106	130		dB
ΔPSRR	Power Supply Rejection Ratio	(Notes 6, 8)	●	109	126		106	126		dB

The ● denotes the specifications which apply over the full operating temperature range of 0°C ≤ T_A ≤ 70°C, otherwise specifications are at T_A = 25°C. V_S = ±15V, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS (Note 3)		LT1112ACN8 LT1114ACN MIN	LT1112ACN8 LT1114ACN TYP	LT1112ACN8 LT1114ACN MAX	LT1112CN8/S8/IS8 LT1114CN/S/IS MIN	LT1112CN8/S8/IS8 LT1114CN/S/IS TYP	LT1112CN8/S8/IS8 LT1114CN/S/IS MAX	UNITS
V_{OS}	Input Offset Voltage	LT1112CN8	●		27	100		30	125	µV
		LT1112S8, LT1114CN/S	●		35	125		45	150	µV
		V_S = ±1.2V	●		50	175		65	210	µV
$\frac{\Delta V_{OS}}{\Delta Temp}$	Average Input Offset Voltage Drift (Note 9)	LT1112CN8	●		0.15	0.5		0.2	0.75	µV/°C
		LT1112S8, LT1114CN/S	●		0.3	1.1		0.4	1.3	µV/°C
I_{OS}	Input Offset Current		●		60	220		70	290	pA
		LT1114S	●					90	420	pA
I_B	Input Bias Current		●		±80	±300		±90	±350	pA
		LT1114S	●					±115	±550	pA
V_{CM}	Input Voltage Range		●	±13.5	±14.2		±13.5	±14.2		V
CMRR	Common Mode Rejection Ratio	V_{CM} = ±13.5V	●	118	133		113	133		dB
PSRR	Power Supply Rejection Ratio	V_S = ±1.2V to ±20V	●	114	125		112	125		dB
A_{VOL}	Large-Signal Voltage Gain	V_O = ±12V, R_L = 10kΩ	●	800	4000		650	4000		V/mV
		V_O = ±10V, R_L = 2kΩ	●	500	1300		400	1000		V/mV
V_{OUT}	Output Voltage Swing	R_L = 10kΩ	●	±13.0	±13.9		±13.0	±13.9		V
SR	Slew Rate		●	0.14	0.27		0.14	0.27		V/µs

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range of 0°C ≤ T_A ≤ 70°C, otherwise specifications are at T_A = 25°C. V_S = ±15V, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS (Note 3)		LT1112ACN8 LT1114ACN MIN	LT1112ACN8 LT1114ACN TYP	LT1112ACN8 LT1114ACN MAX	LT1112CN8/S8/IS8 LT1114CN/S/IS MIN	LT1112CN8/S8/IS8 LT1114CN/S/IS TYP	LT1112CN8/S8/IS8 LT1114CN/S/IS MAX	UNITS
I_S	Supply Current per Amplifier		●		370	440		370	500	µA
ΔV_{OS}	Offset Voltage Match (Note 6)	LT1112CN8 LT1112S8, LT1114CN/S	● ●		45 55	170 220		55 70	210 270	µV µV
	Offset Voltage Match Drift (Notes 6, 9)	LT1112N8 LT1112S8, LT1114CN/S	● ●		0.2 0.4	0.7 1.6		0.3 0.5	1.0 1.9	µV/°C µV/°C
ΔI_B^+	Noninverting Bias Current Match (Notes 6, 7)	 LT1114S	● ●		120	530		135 160	620 880	pA pA
ΔCMRR	Common Mode Rejection Ratio	(Notes 6, 8)	●	114	134		109	134		dB
ΔPSRR	Power Supply Rejection Ratio	(Notes 6, 8)	●	110	128		108	128		dB

The ● denotes the specifications which apply over the full operating temperature range of –40°C ≤ T_A ≤ 85°C, otherwise specifications are at T_A = 25°C. V_S = ±15V, unless otherwise noted. (Note 12)

SYMBOL	PARAMETER	CONDITIONS (Note 3)		LT1112ACN8 LT1114ACN MIN	LT1112ACN8 LT1114ACN TYP	LT1112ACN8 LT1114ACN MAX	LT1112CN8/IN8/S8/IS8 LT1114CN/S/IS MIN	LT1112CN8/IN8/S8/IS8 LT1114CN/S/IS TYP	LT1112CN8/IN8/S8/IS8 LT1114CN/S/IS MAX	UNITS
V_{OS}	Input Offset Voltage	LT1112CN8/IN8 LT1112S8/IS8, LT1114CN/S/IS V_S = ±1.2V	● ● ●		30 40 55	110 135 200		35 45 60	135 160 240	µV µV µV
$\frac{\Delta V_{OS}}{\Delta Temp}$	Average Input Offset Voltage Drift	LT1112CN8/IN8 LT1112S8/IS8, LT1114CN/S/IS	● ●		0.15 0.30	0.50 1.10		0.20 0.40	0.75 1.30	µV/°C µV/°C
I_{OS}	Input Offset Current	 LT1114S/IS	● ●		70	330		85 110	400 600	pA pA
I_B	Input Bias Current	 LT1114S/IS	● ●		±110	±500		±120 ±150	±550 ±800	pA pA
V_{CM}	Input Voltage Range		●	±13.5	±14.1		±13.5	±14.1		V
CMRR	Common Mode Rejection Ratio	V_{CM} = ±13.5V	●	117	132		112	132		dB
PSRR	Power Supply Rejection Ratio	V_S = ±1.2V to ±20V	●	113	125		111	125		dB
A_{VOL}	Large-Signal Voltage Gain	V_O = ±12V, R_L = 10kΩ V_O = ±10V, R_L = 2kΩ	● ●	700 400	3300 1100		600 300	3300 900		V/mV V/mV
V_{OUT}	Output Voltage Swing	R_L = 10kΩ	●	±13.0	±13.85		±13.0	±13.85		V
SR	Slew Rate		●	0.13	0.24		0.13	0.24		V/µs
I_S	Supply Current per Amplifier		●		370	450		370	510	µA
ΔV_{OS}	Offset Voltage Match (Note 6)	LT1112CN8/IN8 LT1112S8/IS8, LT1114CN/S/IS	● ●		50 60	180 230		60 70	225 270	µV µV
	Offset Voltage Match Drift (Notes 6)	LT1112CN8/IN8 LT1112S8/IS8, LT1114CN/S/IS	● ●		0.2 0.4	0.7 1.6		0.3 0.5	1.0 1.9	µV/°C µV/°C
ΔI_B^+	Noninverting Bias Current Match (Notes 6, 7)	 LT1114S/IS	● ●		140	660		155 190	770 1300	pA pA
ΔCMRR	Common Mode Rejection Ratio	(Notes 6, 8)	●	113	133		109	133		dB
ΔPSRR	Power Supply Rejection Ratio	(Notes 6, 8)	●	110	127		107	127		dB

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: Differential input voltages greater than 1V will cause excessive current to flow through the input protection diodes unless limiting resistance is used.

Note 3: Typical parameters are defined as the 60% yield of parameter distributions of individual amplifiers; i.e., out of 100 LT1114s (or 100 LT1112s) typically 240 op amps (or 120) will be better than the indicated specification.

Note 4: This parameter is guaranteed by design and is not tested.

ELECTRICAL CHARACTERISTICS

Note 5: Offset voltage, supply current and power supply rejection ratio are measured at the minimum supply voltage.

Note 6: Matching parameters are the difference between amplifiers A and D and between B and C on the LT1114; between the two amplifiers on the LT1112.

Note 7: This parameter is the difference between two noninverting input bias currents.

Note 8: ΔCMRR and ΔPSRR are defined as follows: (1) CMRR and PSRR are measured in μV/V on the individual amplifiers. (2) The difference is calculated between the matching sides in μV/V. (3) The result is converted to dB.

Note 9: This parameter is not 100% tested.

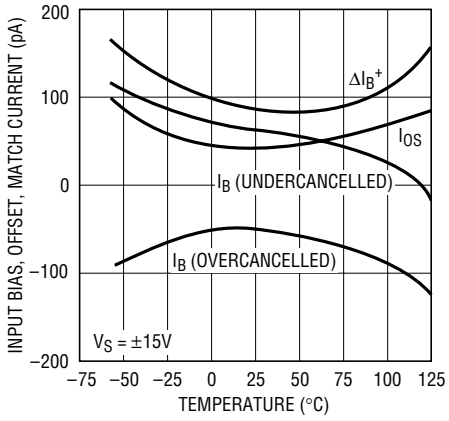
Note 10: These parameters are not tested. More than 99% of the op amps tested during product characterization have passed the maximum limits. 100% passed at 1kHz.

Note 11: The LT1112AC/LT1112C/LT1112S8/LT1112I and LT1114AC/LT1114C/LT1114S/LT1114I are guaranteed functional over the temperature range of –40°C to 85°C.

Note 12: The LT1112AC/LT1112C/LT1112S8/LT1114AC/LT1114C/LT1114S are guaranteed to meet specified performance from 0°C to 70°C and 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 LT1112I/LT1114I are guaranteed to meet specified performance from –40°C to 85°C.

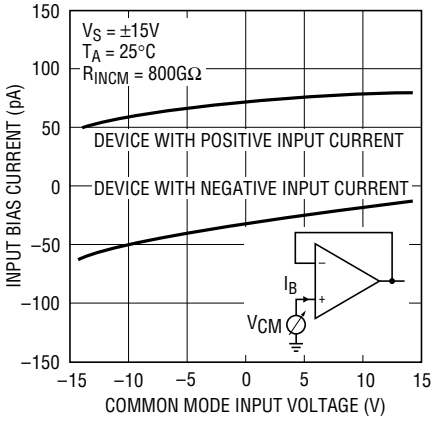
TYPICAL PERFORMANCE CHARACTERISTICS

Input Bias and Offset Current, Noninverting Bias Current Match vs Temperature



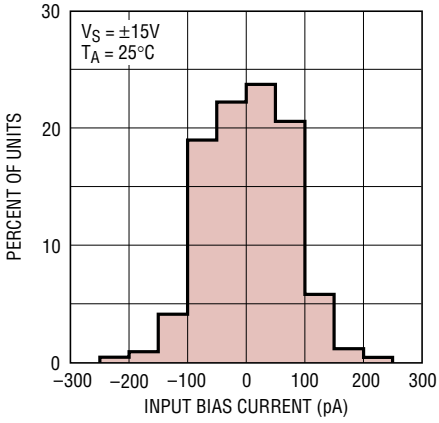
LT1112/14 • TPC01

Input Bias Current Over Common Mode Range



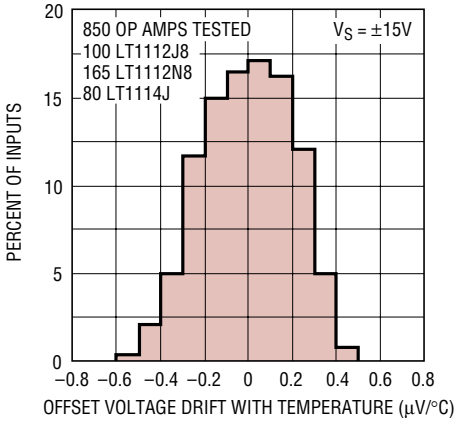
LT1112/14 • TPC02

Distribution of Input Bias Current (In All Packages Except LT1114S)



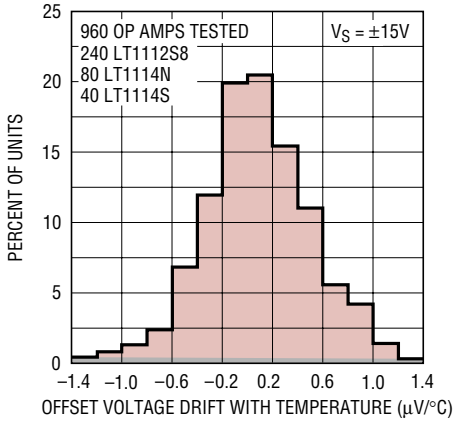
LT1112/14 • TPC03

Drift with Temperature LT1112N8/J8, LT1114J



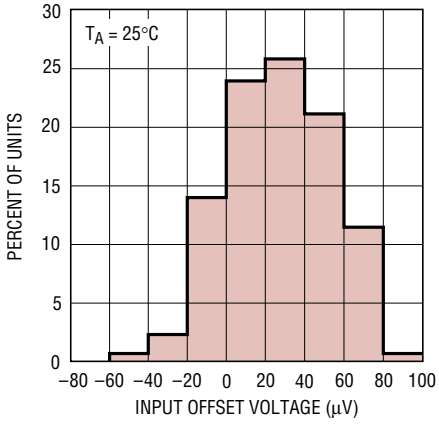
LT1112/14 • TPC04

Drift with Temperature LT1112S8, LT1114N/S



LT1112/14 • TPC05

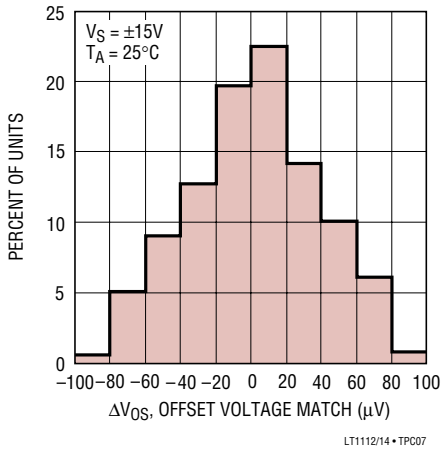
Distribution of Offset Voltage at V_S = ±1.0V (In All Packages)



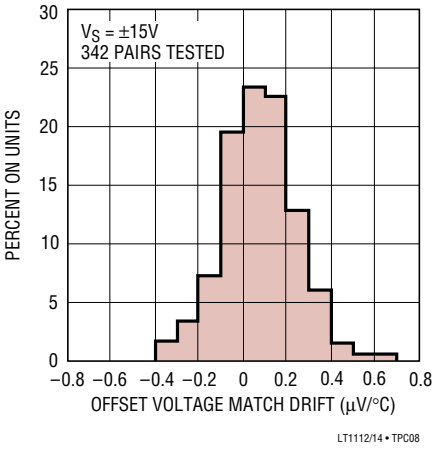
LT1112/14 • TPC06

TYPICAL PERFORMANCE CHARACTERISTICS

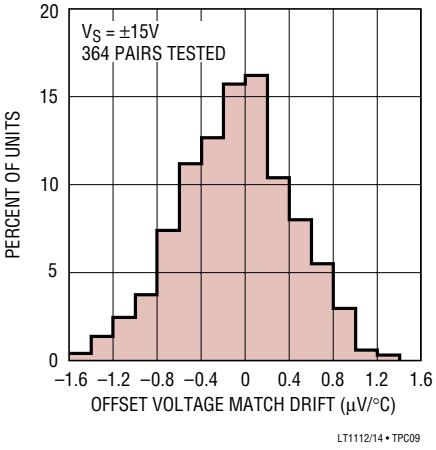
Distribution of Offset Voltage Match



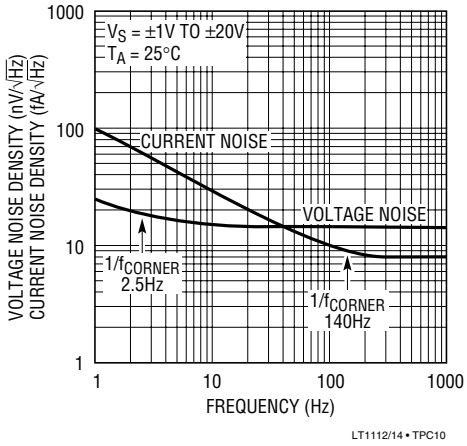
Distribution of Offset Voltage Match Drift (LT1112J8, LT1112N8, LT1114J Packages)



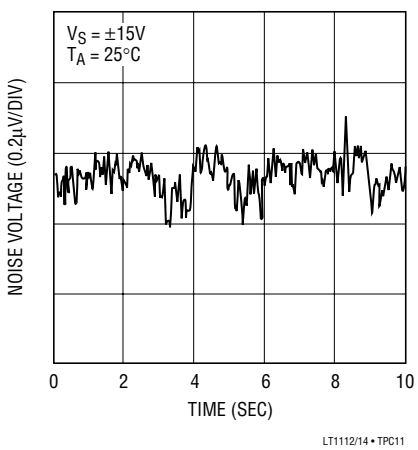
Distribution of Offset Voltage Match Drift (LT1112S8, LT1114N, LT1114S Packages)



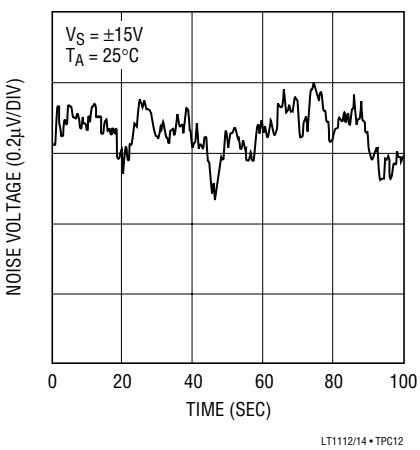
Noise Spectrum



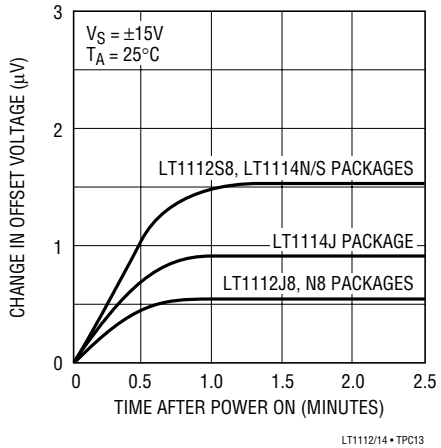
0.1Hz to 10Hz Noise



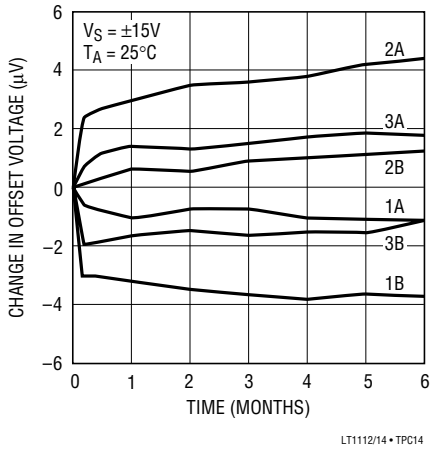
0.01Hz to 1Hz Noise



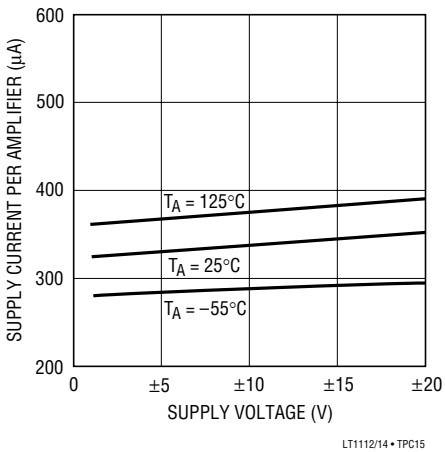
Warm-Up Drift



Long Term Stability of Three Representative Units

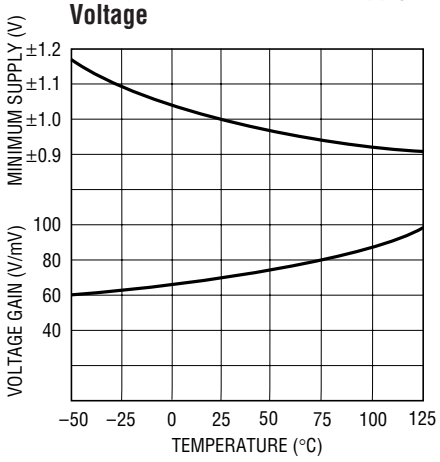


Supply Current per Amplifier vs Supply Voltage



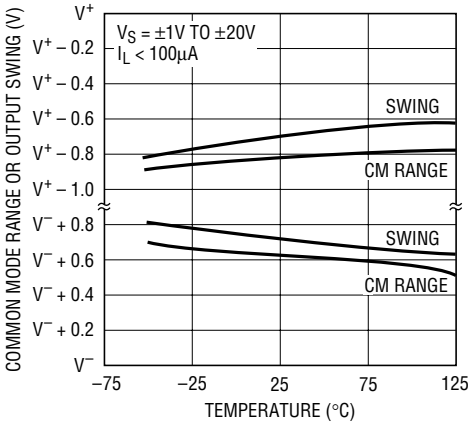
TYPICAL PERFORMANCE CHARACTERISTICS

Minimum Supply Voltage vs Temp Voltage Gain at Minimum Supply Voltage



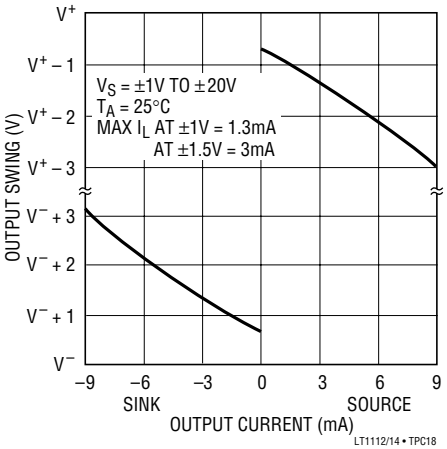
LT1112/14 • TPC16

Common Mode Range and Voltage Swing with Respect to Supply Voltages



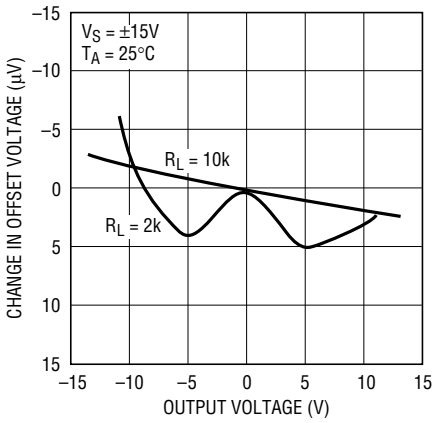
LT1112/14 • TPC17

Output Voltage Swing vs Load Current



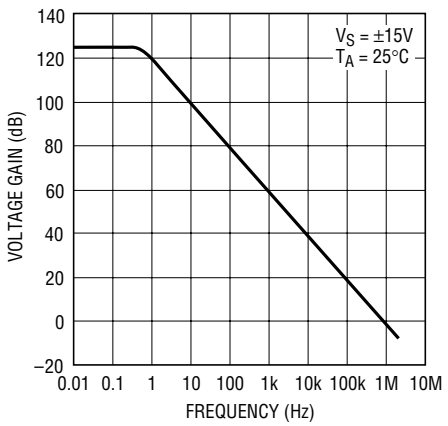
LT1112/14 • TPC18

Voltage Gain



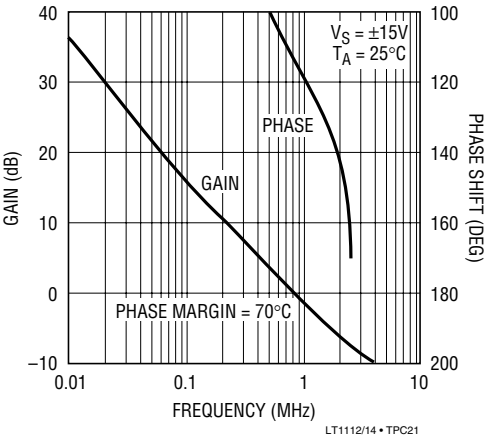
LT1112/14 • TPC19

Voltage Gain vs Frequency



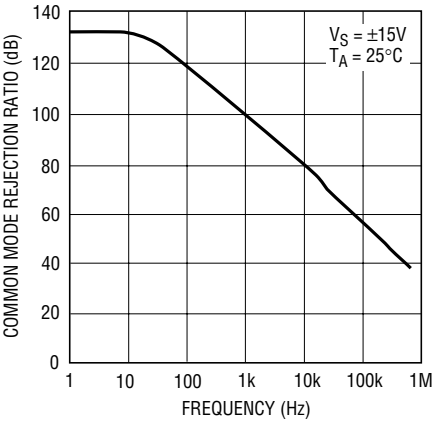
LT1112/14 • TPC20

Gain, Phase Shift vs Frequency



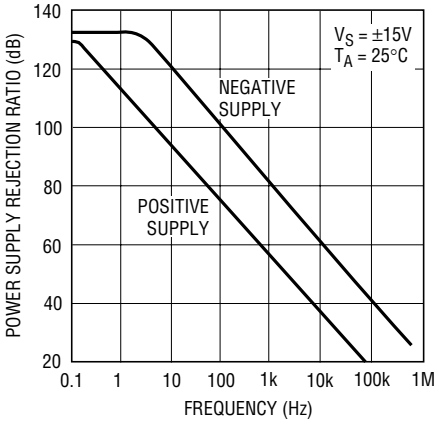
LT1112/14 • TPC21

Common Mode Rejection vs Frequency



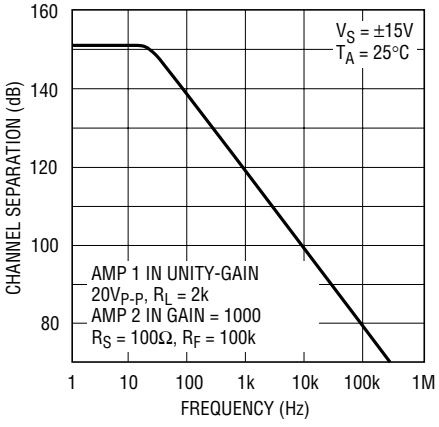
LT1112/14 • TPC22

Power Supply Rejection vs Frequency



LT1112/14 • TPC23

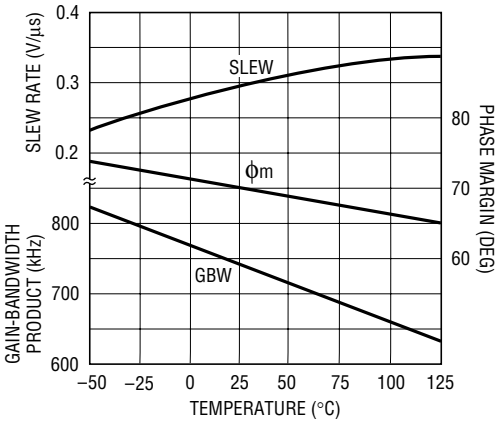
Channel Separation vs Frequency



LT1112/14 • TPC24

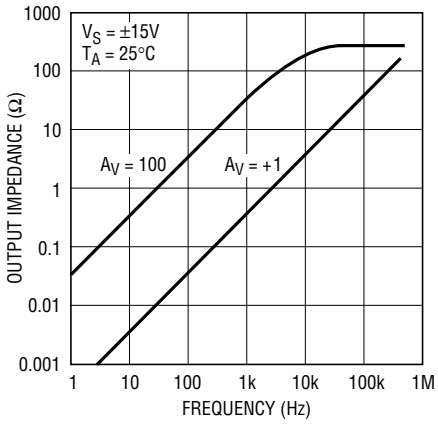
TYPICAL PERFORMANCE CHARACTERISTICS

Slew Rate, Gain-Bandwidth Product and Phase Margin vs Temperature



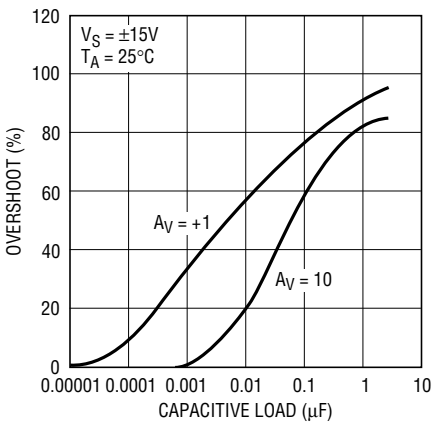
LT1112/14 • TPC25

Closed-Loop Output Impedance



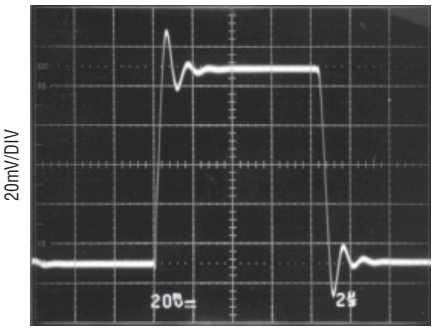
LT1112/14 • TPC26

Capacitive Loading Handling



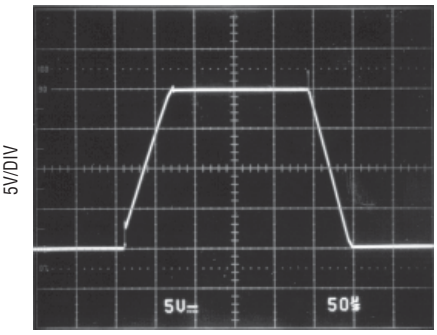
LT1112/14 • TPC27

Small-Signal Transient Response



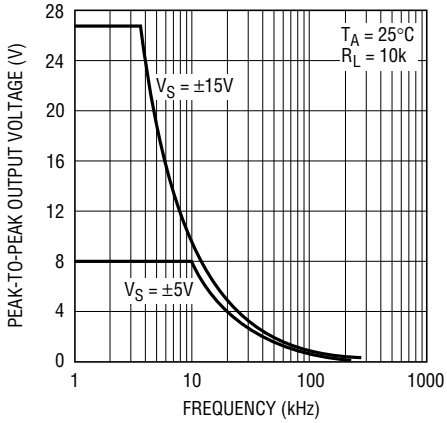
A_V = +1
C_L = 500pF
V_S = ±15V

Large-Signal Transient Response



A_V = +1
R_F = 10k
C_F = 100pF
V_S = ±15V

Undistorted Output Voltage vs Frequency



LT1112/14 • TPC30

APPLICATIONS INFORMATION

The LT1112 dual and LT1114 quad in the plastic and ceramic DIP packages are pin compatible to and directly replace such precision op amps as the OP-200, OP-297, AD706 duals and OP-400, OP-497, AD704 quads with improved price/performance.

The LT1112 in the S8 surface mount package has the standard pin configuration, i.e., the same configuration as the plastic and ceramic DIP packages.

The LT1114 quad is offered in the narrow 16-pin surface mount package. All competitors are in the wide 16-pin package which occupies 1.8 times the area of the narrow package. The wide package is also 1.8 times thicker than the narrow package.

The inputs of the LT1112/1114 are protected with back-to-back diodes. In the voltage follower configuration, when the input is driven by a fast large-signal pulse (>1V), the input protection diodes effectively short the output to the input during slewing, and a current, limited only by the output short-circuit protection, will flow through the diodes.

The use of a feedback resistor is recommended because this resistor keeps the current below the short-circuit limit, resulting in faster recovery and settling of the output.

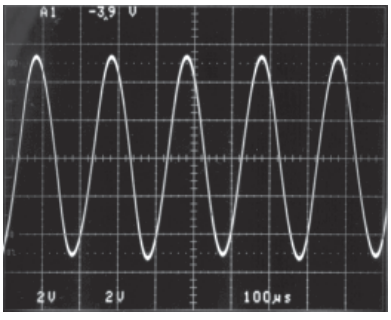
The input voltage of the LT1112/1114 should never exceed the supply voltages by more than a diode drop. However, the example below shows that as the input voltage exceeds the common mode range, the LT1112's output clips cleanly, without any glitches or phase reversal. The OP-297 exhibits phase reversal. The photos also illustrate that both the input and output ranges of the LT1112 are within 800mV of the supplies. The effect of input and output overdrive on the other amplifiers in the LT1112 or LT1114 packages is negligible, as each amplifier is biased independently.

Advantages of Matched Dual and Quad Op Amps

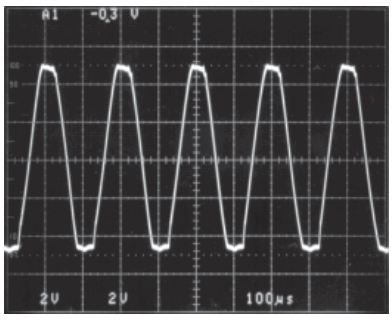
In many applications the performance of a system depends on the matching between two operational amplifiers rather than the individual characteristics of the two op amps. Two or three op amp instrumentation amplifiers, tracking voltage references and low drift active filters are some of the circuits requiring matching between two op amps.

The well-known triple op amp configuration illustrates these concepts. Output offset is a function of the difference between the offsets of the two halves of the LT1112. This error cancellation principle holds for a considerable number of input referred parameters in addition to offset voltage and its drift with temperature. Input bias current will be the average of the two noninverting input currents (I_B^+). The difference between these two currents (ΔI_B^+) is the offset current of the instrumentation amplifier. Common mode and power supply rejections will be dependent only on the match between the two amplifiers (assuming perfect resistor matching).

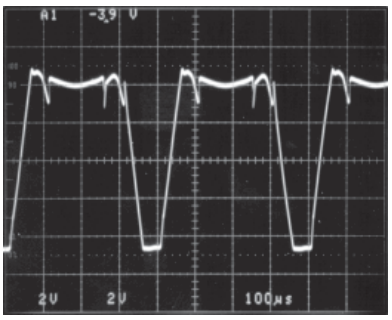
Voltage Follower with Input Exceeding the Common Mode Range (V_S = ±5V)



INPUT: ±5.2V Sine Wave



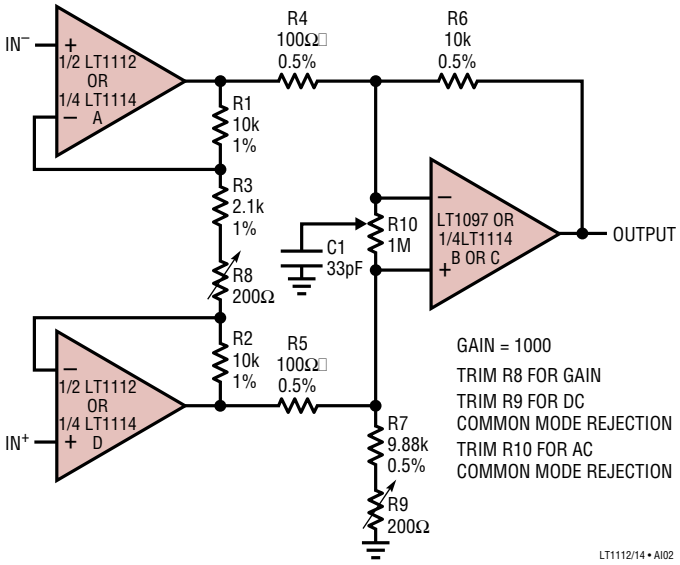
LT1112 Output



OP-297 Output

APPLICATIONS INFORMATION

Three Op Amp Instrumentation Amplifier



The concepts of common mode and power supply rejection ratio match (ΔCMRR and ΔPSRR) are best demonstrated with a numerical example:

Assume $CMRR_A = +1\mu V/V$ or 120dB,
and $CMRR_B = +0.75\mu V/V$ or 122.5dB,
then ΔCMRR = 0.25μV/V or 132dB;
if $CMRR_B = -0.75\mu V/V$ which is still 122.5dB,
then ΔCMRR = 1.75μV/V or 115dB.

Clearly the LT1112/LT1114, by specifying and guaranteeing all of these matching parameters, can significantly improve the performance of matching-dependent circuits.

Typical performance of the instrumentation amplifier:

Input offset voltage = 35μV
Offset voltage drift = 0.3μV/°C
Input bias current = 80pA
Input offset current = 100pA
Input resistance = 800GΩ
Input noise = $0.42\mu V_{P-P}$

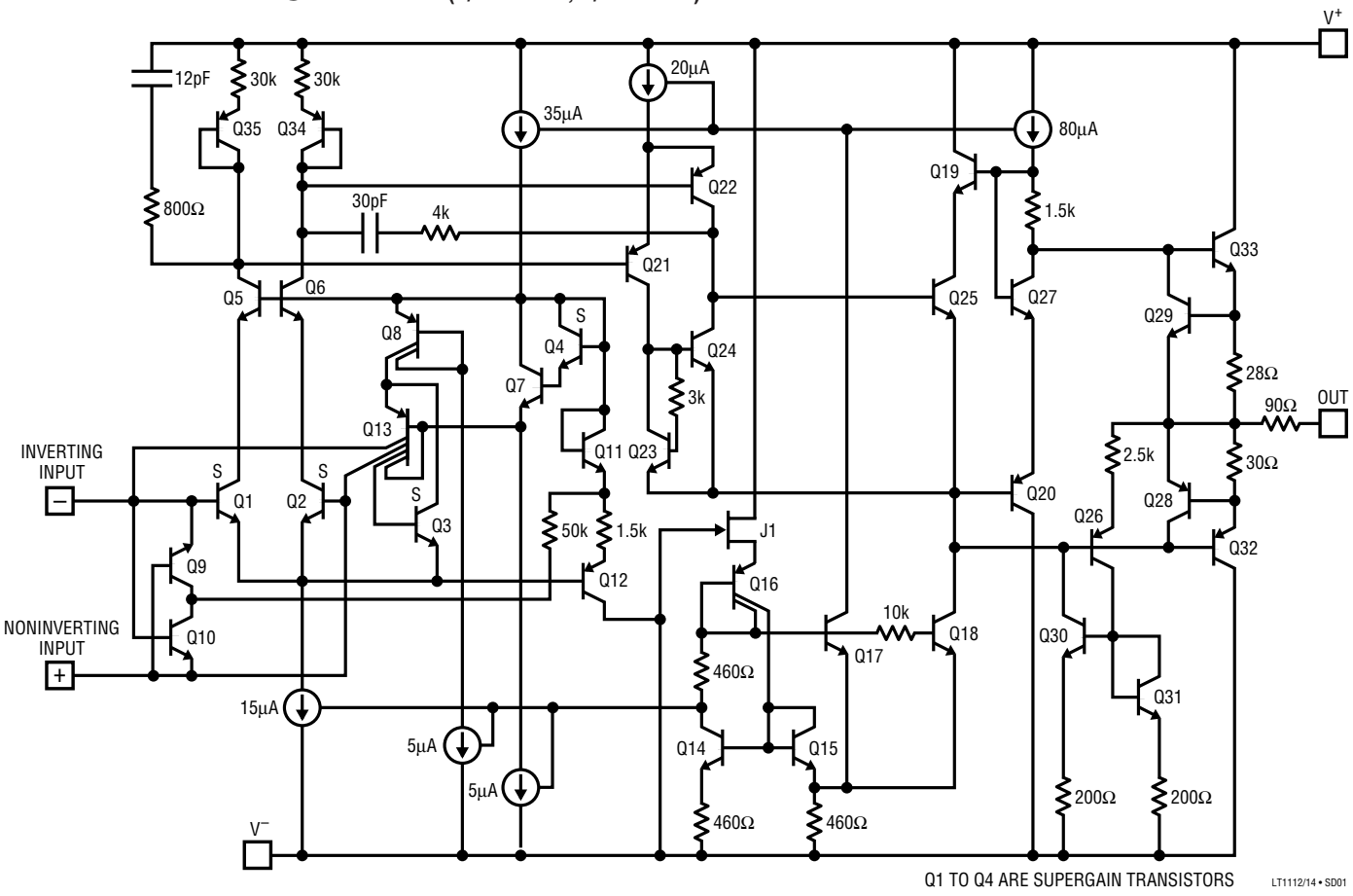
When the instrumentation amplifier is used with high impedance sources, the LT1114 is recommended because its CMRR vs frequency performance is better than the LT1112's. For example, with two matched 1MΩ source resistors, CMRR at 100Hz is 100dB with the LT1114, 76dB with the LT1112.

This difference is explained by the fact that capacitance between adjacent pins on an IC package is about 0.25pF (including package, socket and PC board trace capacitances).

On the dual op amp package, positive input A is next to the V^- pin (AC ground), while positive input B has no AC ground pin adjacent to it, resulting in a 0.25pF input capacitance mismatch. At 100Hz, 0.25pF represents a $6.4 \cdot 10^9$ input impedance mismatch, which is only 76dB higher than the 1MΩ source resistors.

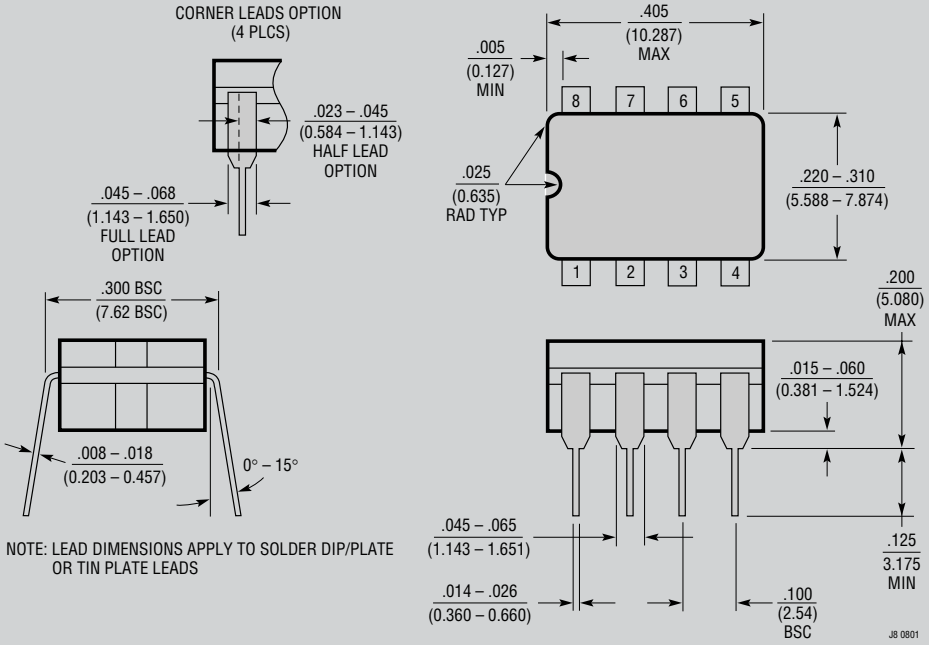
On the quad package, all four inputs are adjacent to a power supply terminal—therefore, there is no mismatch.

SCHEMATIC DIAGRAM (1/2 LT1112, 1/4 LT1114)

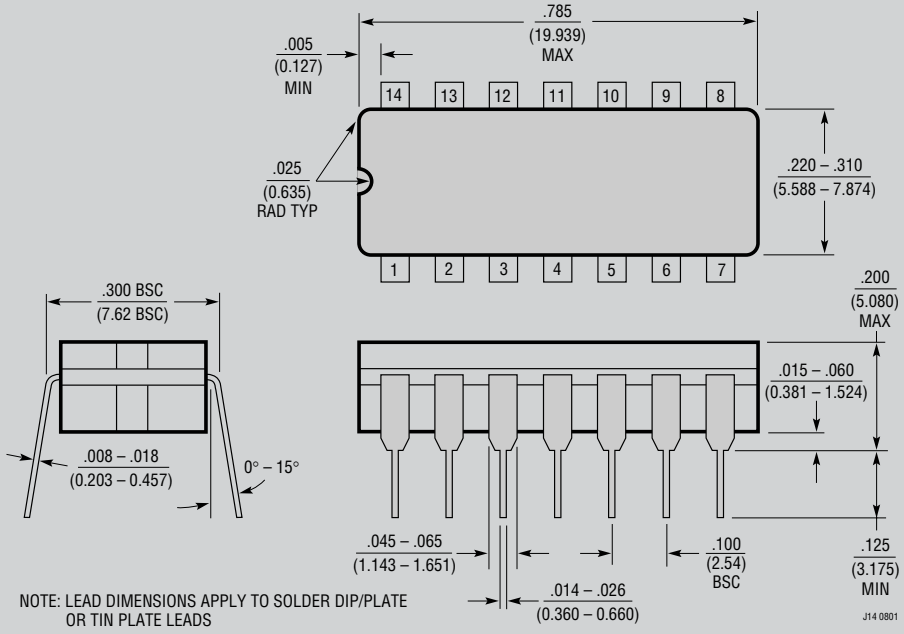


PACKAGE DESCRIPTION

J8 Package
8-Lead CERDIP (Narrow .300 Inch, Hermetic)
(Reference LTC DWG # 05-08-1110)



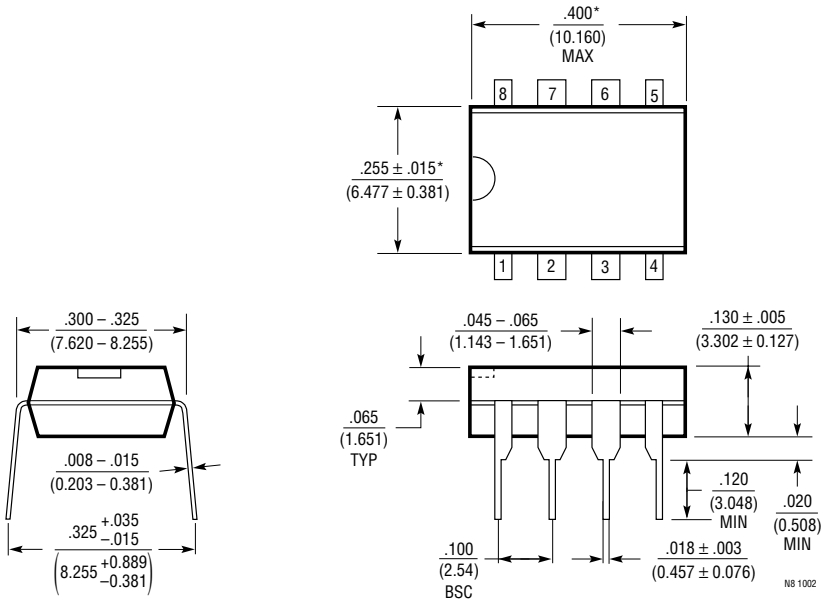
J Package
14-Lead CERDIP (Narrow .300 Inch, Hermetic)
(Reference LTC DWG # 05-08-1110)



OBSOLETE PACKAGES

PACKAGE DESCRIPTION

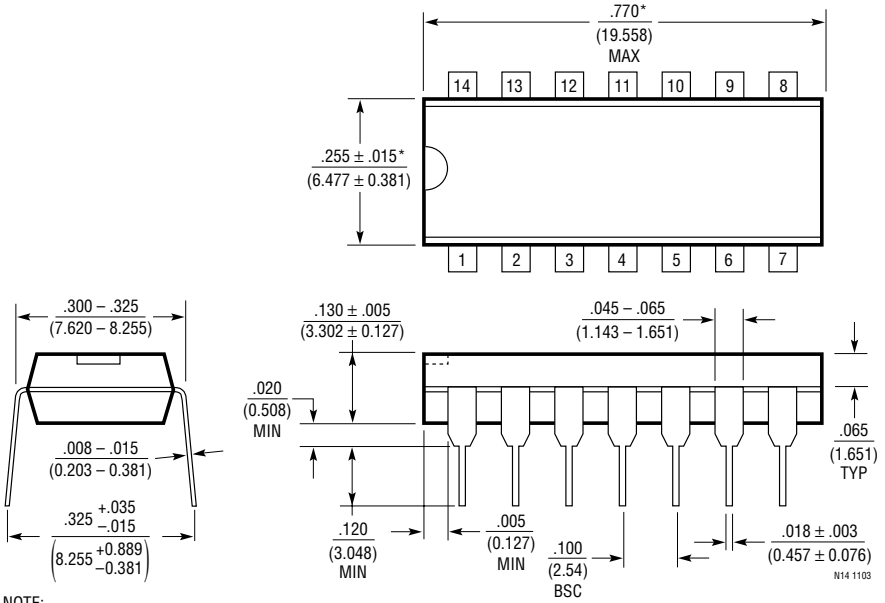
N8 Package
8-Lead PDIP (Narrow .300 Inch)
(Reference LTC DWG # 05-08-1510)



NOTE:
1. DIMENSIONS ARE INCHES / MILLIMETERS

*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 INCH (0.254mm)

N Package
14-Lead PDIP (Narrow .300 Inch)
(Reference LTC DWG # 05-08-1510)

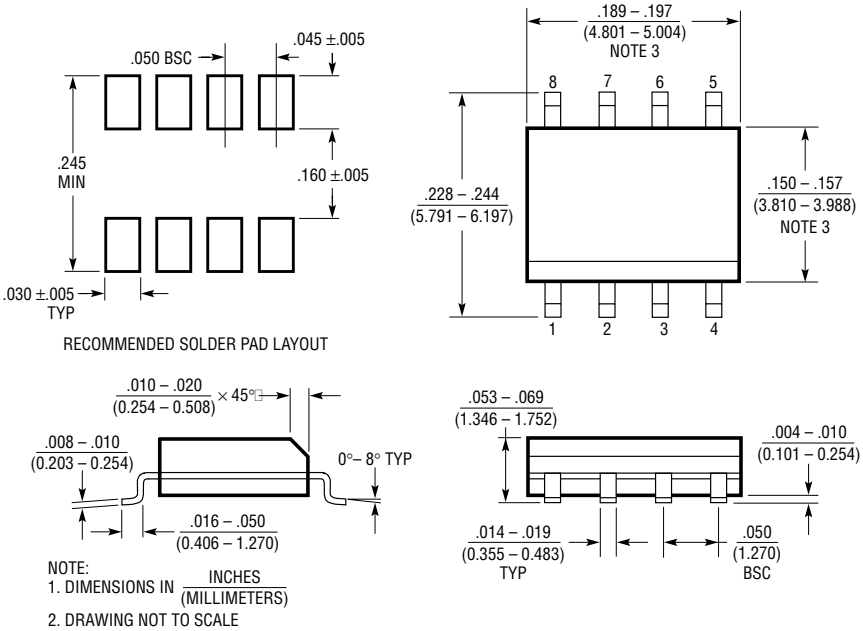


NOTE:
1. DIMENSIONS ARE INCHES / MILLIMETERS

*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 INCH (0.254mm)

PACKAGE DESCRIPTION

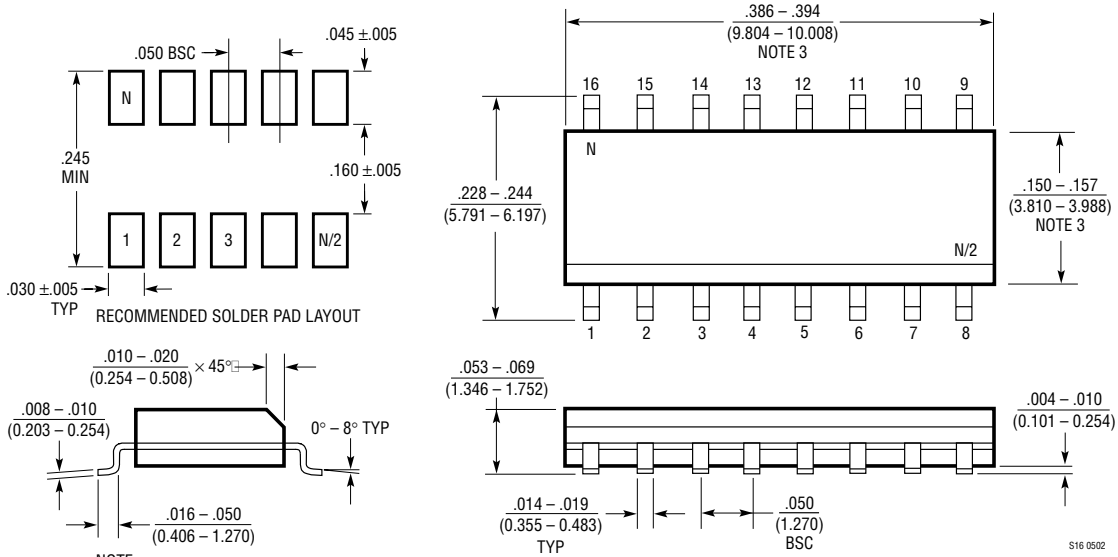
S8 Package
8-Lead Plastic Small Outline (Narrow .150 Inch)
(Reference LTC DWG # 05-08-1610)



NOTE:
1. DIMENSIONS IN $\frac{\text{INCHES}}{(\text{MILLIMETERS})}$
2. DRAWING NOT TO SCALE
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)

S08 0303

S Package
16-Lead Plastic Small Outline (Narrow .150 Inch)
(Reference LTC DWG # 05-08-1610)

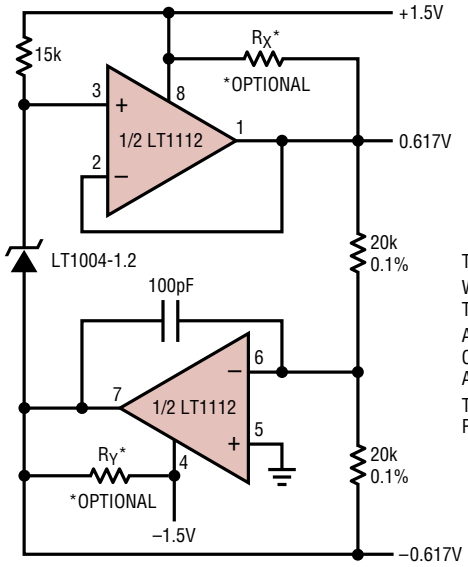


NOTE:
1. DIMENSIONS IN $\frac{\text{INCHES}}{(\text{MILLIMETERS})}$
2. DRAWING NOT TO SCALE
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)

S16 0502

TYPICAL APPLICATION

Dual Buffered ±0.617V Reference Powered by Two AA Batteries



TOTAL SUPPLY CURRENT = 700µA
WORKS WITH BATTERIES DISCHARGED TO ±1.3V
AT ±1.5V: MAXIMUM LOAD CURRENT = 800µA; CAN BE INCREASED WITH OPTIONAL R_X, R_Y; AT $R_X = R_Y = 750\Omega$ LOAD CURRENT = 2mA
TEMPERATURE COEFFICIENT LIMITED BY REFERENCE = 20ppm/°C

LT1112/14 • TA03

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1880	Rail-to-Rail Output, Picoamp Input Precision Op Amp	SOT-23
LT1881/LT1882	Dual/Quad Rail-to-Rail Output, Picoamp Input Precision Op Amp	C_{LOAD} Up to 1000pF
LT1884/LT1885	Dual/Quad Rail-to-Rail Output, Picoamp Input Precision Op Amp	9.5nV/√Hz Input Noise
LT6011/LT6012	Dual/Quad Rail-to-Rail Output, Picoamp Input Precision Op Amp	135µA Supply Current, 14nV/√Hz

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