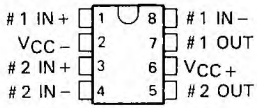
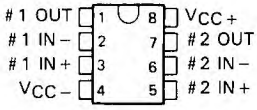
D3237, MAY 1988 – REVISED FEBRUARY 1989

- **Single-Supply Operation:**
  Input Voltage Range Extends to Ground
  Output Swings to Ground While Sinking Current
- **Input Offset Voltage . . . 150 μA Max at 25°C for LT1013AM, LT1013AC**
- **Offset Voltage Temperature Coefficient . . . 2 μV/°C Max for LT1013AM, LT1013AC**
- **Input Offset Current . . . 0.8 nA Max at 25°C for LT1013AM, LT1013AC**
- **High Gain . . . 1.5 V/μV Min (R_L = 600 Ω), 0.8 V/μV Min (R_L = 2 kΩ) for LT1013AM, LT1013AC**
- **Low Supply Current . . . 0.5 mA Max at 25°C for LT1013AM, LT1013AC**
- **Low Peak-To-Peak Noise Voltage . . . 0.55 μV Typ**
- **Low Current Noise . . . 0.07 pA/√Hz Typ**

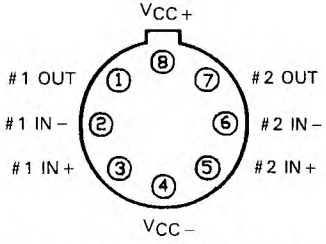
D PACKAGE
(TOP VIEW)



JG OR P PACKAGE
(TOP VIEW)



L PACKAGE
(TOP VIEW)



Pin 4 (L package) is in electrical contact with the case.

description

The LT1013 is a precision dual operational amplifier with an 8-pin industry-standard configuration. It features low offset voltage temperature coefficient, high gain, low supply current, and low noise.

The LT1013 can be operated from a single 5-V power supply; the common-mode input voltage range includes ground, and the output can also swing to within a few millivolts of ground. Crossover distortion, so apparent in previous single-supply designs, is eliminated. The LT1013 is fully specified for both dual ±15-V and single 5-V supplies.

The LT1013AM and LT1013M are characterized for operation over the full military temperature range of −55°C to 125°C. The LT1013AC, LT1013C, and LT1013D are characterized for operation from 0°C to 70°C.

AVAILABLE OPTIONS

T_A	V_{IO} MAX at 25°C	PACKAGE			
		SMALL OUTLINE (D)	CERAMIC DIP (JG)	METAL CAN (L)	PLASTIC DIP (P)
0°C to 70°C	150 μV		LT1013ACJG	LT1013ACL	
	300 μV		LT1013CJG	LT1013CL	LT1013CP
	800 μV	LT1013DD			LT1013DP
−55°C to 125°C	150 μV		LT1013AMJG	LT1013AML	
	[illegible] μV		LT1013MJG	LT1013ML	

The D package is available taped and reeled. Add the suffix R to the device type (e.g., LT1013DDR).

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC+} (see Note 1)	22 V
Supply voltage, V_{CC-}	−22 V
Differential input voltage	±30 V
Input voltage range, V_I	V_{CC-} −5 V to V_{CC+}
Duration of output short-circuit at (or below) 25°C	unlimited
Operating free-air temperature range: LT1013AM, LT1013M	−55°C to 125°C
LT1013AC, LT1013C, LT1013D	0°C to 70°C
Storage temperature range	−65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or P package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: JG or L package	300°C

NOTE 1: All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and V_{CC-}.

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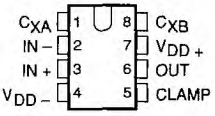
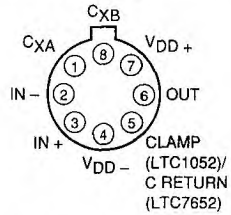
D3238, MAY 1988 – REVISED MARCH 1989

- **Input Offset Voltage . . . 5 μV Max at 25°C**
- **Temperature Coefficient of Input Offset Voltage . . . 0.01 μV/°C Typ**
- **Long-Term Drift of Input Offset Voltage . . . 100 nV/mo Typ**
- **Maximum Input Bias Current . . . 30 pA at 25°C**
- **Minimum Differential Voltage Amplification Over Full Temperature Range . . . 120 dB**
- **Minimum Common-Mode Rejection Ratio Over Full Temperature Range . . . 120 dB**
- **Minimum Supply Voltage Rejection Ratio Over Full Temperature Range . . . 120 dB**
- **Single-Supply Operation from 4.75 V to 16 V (Input Voltage Range Extends to Ground)**
- **External Capacitors Can Be Returned to V_{DD-} with No Noise Degradation**

LTC1022 . . . JG OR P PACKAGE
(TOP VIEW)



LTC1052, LTC7652 . . . L PACKAGE
(TOP VIEW)



Pin 4 (L package) is in electrical contact with the case.

description

The LTC1052 and LTC7652 are low-noise chopper-stabilized operational amplifiers manufactured using CMOS silicon-gate technology. The devices are well-suited for applications such as thermocouple amplifiers, strain-gauge amplifiers, low-level signal processing, and medical instrumentation.

AVAILABLE OPTIONS

T_A	PACKAGE		
	CERAMIC DIP (JG)	METAL CAN (L)	PLASTIC DIP (P)
–40°C to 85°C	LTC1052CJG	LTC1052CL LTC7652CL	LTC1052CP
–55°C to 125°C	LTC1052MJG	LTC1052ML	LTC1052MP

Chopper stabilization constantly corrects input offset voltage errors, including both errors in the initial input offset voltage and errors in input offset voltage due to time, temperature, and common-mode input voltage. The chopper circuitry is internal and completely transparent to the user. Only two external capacitors are required to alternately sample and hold the offset correction voltage and the amplified input signal.

Low-frequency (1/f) noise is also improved by the chopping technique. Instead of noise increasing continuously at a rate of 3 dB/octave, the internal chopping causes noise to decrease at low frequencies. Picoampere input currents further enhance the performance of these devices.

The M-suffix devices are characterized for operation over the full military temperature range of –55°C to 125°C. The C-suffix devices are characterized for operation from –40°C to 85°C.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{DD+} (see Notes 1 and 2) . . . . . 8 V
Supply voltage, V_{DD-} (see Notes 1 and 2) . . . . . −8 V
Input voltage range, V_I (any input, see Note 1) . . . . . ±16 V
Duration of short-circuit current at (or below) 25°C (see Note 2) . . . . . unlimited
Operating free-air temperature, T_A: M-suffix . . . . . −55°C to 125°C
C-suffix . . . . . −40°C to 85°C
Storage temperature range . . . . . −65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG or L package . . . . . 300°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: P package . . . . . 260°C

NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between V_{DD+} and V_{DD-}.
2. Connecting any terminal to voltages greater than V_{DD+} or less than V_{DD-} may cause destructive latch-up. No sources operating from external supplies should be applied prior to device power-up.
3. The output may be shorted to either supply.

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electrical characteristics at specified free-air temperature, $V_{DD\pm}$ = ±5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	LTC1052M			LTC [illegible]		LTC7652C	UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C		0.5	5		0.5	5	μV
α_{VIO}	Temperature coefficient of input offset voltage		Full range		0.01	0.05		0.01	0.05	μV/°C
	Long-term drift of input offset voltage		25°C		100			100		nV/mo
I_{IO}	Input offset current		25°C		5	30		5	30	pA
			Full range			2000			350	
I_{IB}	Input bias current		25°C		1	30		1	30	pA
			Full range			1000			175	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	Full range	−5 to 2.7			−5 to 2.7			V
V_{OM}	Maximum peak output voltage swing	R_L = 100 kΩ, See Note 4	25°C		4.95			4.95		V
		R_L = 10 kΩ, See Note 4	Full range	4.7			4.7			
A_{VD}	Large-signal differential voltage amplification	V_O = ±4 V, R_L = 10 kΩ	25°C	120	150		120	150		dB
			Full range	120			120			
f_{ch}	Internal chopping frequency		25°C		330			330		Hz
	On-state clamp current	R_L = 100 kΩ	25°C		100			100		μA
			Full range	25			25			
	Off-state clamp current	V_O = −4 V to 4 V	25°C		10	100		10	100	pA
			Fi · · e			2			1	nA
CMRR	Common-mode rejection ratio	V_O = 0, V_{IC} = V_{ICR} min, R_S = 50 Ω	·	120	140		120	140		dB
			Fi · · e	120			120			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}$ / ΔV_{IO})	$V_{CC\pm}$ = ±2.375 V to ±8 V, V_O = 0, R_S = 50 Ω		120	150		120	150		dB
			Full range	120			120			
I_{DD}	Supply current	V_O = 0, No load	25°C		1.7	2		1.7	2	mA
			Full range			3			3	

†Full range is −55°C to 125°C for the LTC1052M and −40°C to 85°C for the LTC1052C and LTC7652C.
NOTE 4: Output clamp is not connected.

operating characteristics, $V_{DD\pm}$ = ±5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SR	Slew rate	R_L = [illegible], C_L = 50 pF		4		V/μs
V_{NPP}	Peak-to-peak equivalent input noise voltage	R_S = 100 Ω to 10 Hz		1.5		μV
		R_S = 100 Ω to 1 Hz		0.5		
I_n	Input noise current (see Note 5)	f = 10 Hz		0.6		fA/√Hz
GBP	Gain bandwidth product			1.2		MHz

NOTE 5: Equivalent input noise current is calculated as follows: $I_n = (2q \times I_{IB})^{1/2}$, where $q = 1.6 \times 10^{-19}$.

Product Previews

5

- Excellent Input Offset Voltage Stability with Temperature . . . 2 μV/°C Typ
- Long-Term Drift of Input Offset Voltage . . . 0.005 μV/mo Typ
- High Slew Rate . . . 0.9 V/μs Typ
- High Unity-Gain Bandwidth . . . 2 MHz Typ
- Low Supply Current . . . 200 μA/Amplifier
- Phase-Reversal Protection
- Stable Supply Current with Temperature . . . 0.08 μA/°C Typ
- Full Electrical Parameters Specified at $V_{CC\pm}$ = ±15 V and V_{CC} = 5 V to GND
- Common-Mode Input Voltage Range Includes the Negative Rail

description

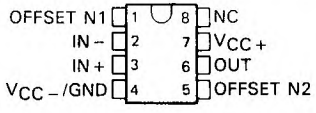
The TLE2021, TLE2022, and TLE2024 are high-precision, high-speed, low-power operational amplifiers using Texas Instruments patent-pending Excalibur process. Available in standard-pinout single, dual, and quad configurations, these devices offer improved slew rate and unity-gain bandwidth performance over the popular OP21, OP22I, and OP42I. A wide variety of packaging options is available, including small-outline (SO) and chip carrier versions for high-density systems applications.

The complementary bipolar Excalibur process uses isolated vertical P-N-P transistors that yield dramatic improvement in gain-bandwidth product and slew rate compared to similar devices. The addition of a patent-pending bias circuit in conjunction with this process results in unsurpassed parameter stability with both time and temperature. This means that a "precision" device remains a precision device even with extreme changes in temperature and over years of use.

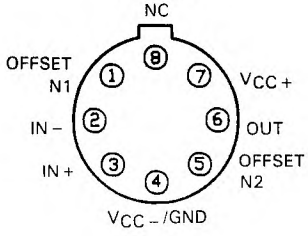
The combination of excellent dc performance with a common-mode input voltage range that includes the negative rail makes these devices an ideal choice for low-level signal conditioning applications in either single-supply or split-supply configurations. Additionally, these devices offer phase-reversal protection circuitry that eliminates an unexpected change in output states when one of the inputs goes below the negative supply rail.

The M-suffix devices are characterized for operation over the full military temperature range of −55°C to 125°C. The I-suffix devices are characterized for operation from −40°C to 85°C, and the C-suffix devices are characterized for operation from 0°C to 70°C.

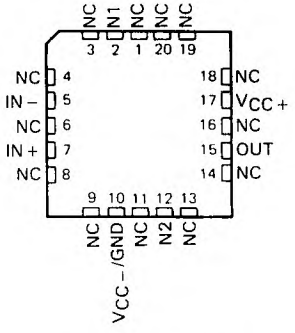
TLE2021 . . . D, JG, OR P PACKAGE
(TOP VIEW)



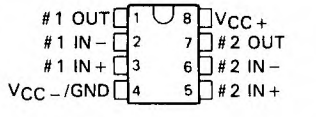
TLE2021 . . . L PACKAGE
(TOP VIEW)



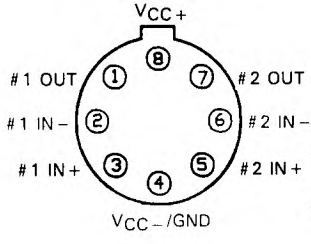
TLE2021 . . . FK PACKAGE
(TOP VIEW)



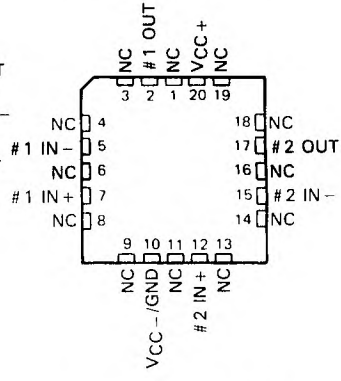
TLE2022 . . . D, JG, OR P PACKAGE
(TOP VIEW)



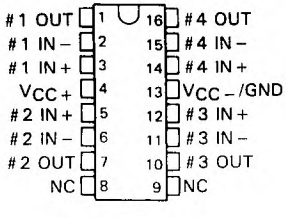
TLE2022 . . . L PACKAGE
(TOP VIEW)



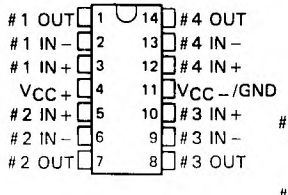
TLE2022 . . . FK PACKAGE
(TOP VIEW)



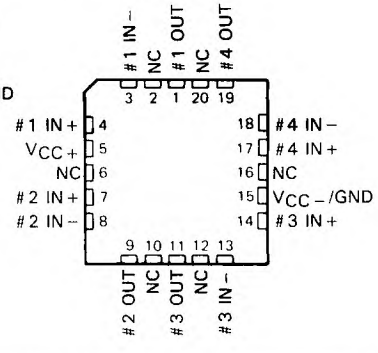
TLE2024 . . . DW PACKAGE
(TOP VIEW)



TLE2024 . . . J OR N PACKAGE
(TOP VIEW)



TLE2024 . . . FK PACKAGE
(TOP VIEW)



NC—No internal connection

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