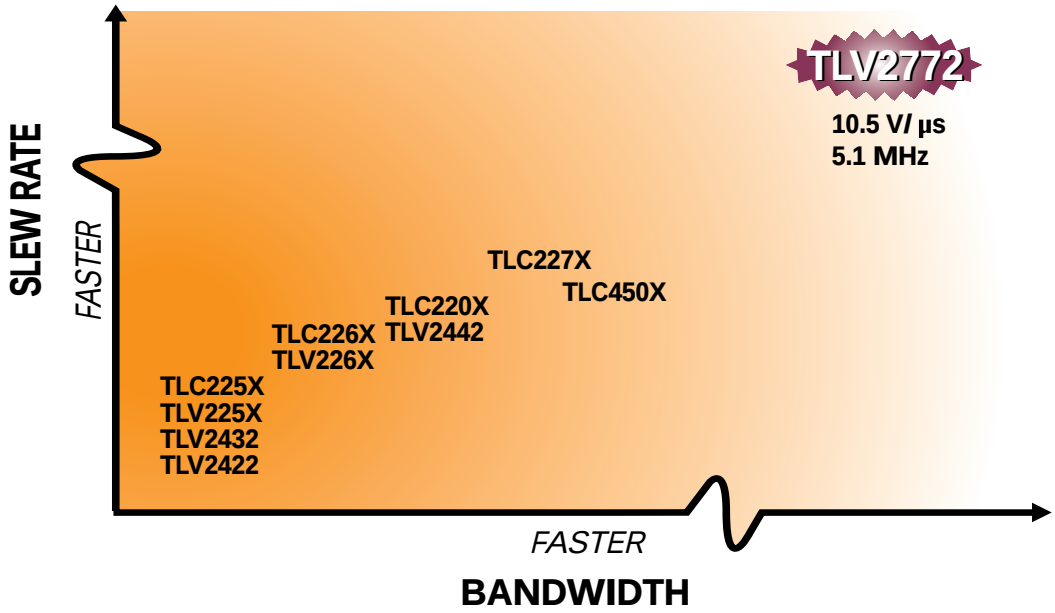
Texas Instruments

March 1998
Volume 1

Sine ON

OPERATIONAL AMPLIFIERS

Low Power, Rail-to-Rail Op Amps in SOT-23 Package - TLV2711/21/31



The TLV27x1 family of operation amplifiers reinforces TI's commitment to provide single supply, low voltage operational amplifiers. The TLV2711, TLV2721, and TLV2731 are a family of low voltage rail-to-rail op amps in the SOT-23 package. These products provide engineers with a choice of either high speed performance or micropower operation in battery powered and space-conscious applications.

(continued on page 2)

Inside:

Low Power, Rail-to-Rail Op Amps in SOT-23 Package - TLV2711/21/31

AT A GLANCE

- Superior performance over similar NSC devices
- Three power/ performance options
- Highest bandwidth 200 mHz
- Fastest slew rate: 1.25 V/ µs
- Micropower: I_{DD} = 25 µA (TLV2711)

(continued from cover)

The TLV2711 is a micropower device targeted at battery-powered systems where power consumption must be minimized. It has a maximum supply current of 25 µA (5 V). DC applications are also well served with an input offset voltage of 400 µV (typ) and a 3-V noise floor of 22 nV/$\sqrt{Hz}$ - one fifth of the nearest competitor's micropower SOT-23 op amps.

The TLV2731 has a bandwidth of 2 MHz and a slew rate of 1.6 V/µs for applications requiring better ac performance. It has a noise floor of 15 nV/$\sqrt{Hz}$ and can drive 600-Ω loads for telecom applications.

The TLV2721 offers a compromise between the micropower TLV2711 and the ac performance and output drive of the TLV2731. All three devices are rated for operation from 2.7 V to 10 V, and specified and characterized at both V_{DD} = 3 V and 5 V.

The SOT-23 package is one third the size of an SO-8 and lets designers place single amplifiers very near the signal source, minimizing noise pick-up from long PCB traces. Furthermore, amplifiers can be built into sensors or squeezed into tightly packed layouts.

TLV2711CDBV

➤ $0.64 in quantities of 1000

TLV2721CDBV

➤ $0.64 in quantities of 1000

TLV2731CDBV

➤ $0.64 in quantities of 1000

Available in ultra small SOT-23 packages

TLV27x1 vs. LMC71x1

	TLV2711	vs. LMC7111	TLV2721	TLV2731	vs. LMC7101
Bandwidth (kHz)	56	40	480	2000	600
Slew Rate (V/µs)	0.025	0.015	0.25	1.25	0.7
Supply Current (µA)	11	25	100	750	500
Voltage Noise (nV/$\sqrt{Hz}$)	22	110	20	16	37
Input offset Voltage (mV)	3.0	5.0	3.0	3.0	6.0
Price	$0.64	$0.84	$0.64	$0.64	$0.84

For technical support, call 972-644-5580

To order documentation, call 1-800-477-8924, ext.3233

Low Power, Rail-to-Rail Op Amps with Optimized Pinout in a SOT-23 Package - TLV2211/21/31

TLV2211CDBV
➤ $0.64 in quantities of 1000

TLV2221CDBV
➤ $0.64 in quantities of 1000

TLV2231CDBV
➤ $0.64 in quantities of 1000

Available in ultra small SOT-23 packages

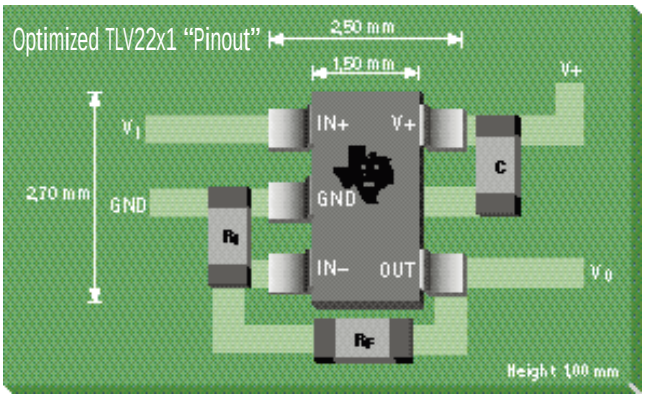
Now a single op amp is available in the space saving efficiency of the SOT-23 package from Texas Instruments. The TLV2211, TLV2221, and TLV2231 are low voltage rail-to-rail op amps, and one of the latest additions to a growing line of ultra-small "SOT-23" analog products. This new family of op amps lets designers trade power consumption and speed for the best performance in low voltage applications, and offer significantly improved output drive over earlier generations of rail-to-rail op amps.

The TLV2211 is a single micropower op amp for battery-powered dc applications where power consumption is critical. Quiescent current at 3 V is only 11 µA (typ); at 5 V, it's just 13 µA! And it's the lowest noise SOT-23 micropower op amp available with a 3-V noise floor of 22 nV/√Hz - a fifth of the nearest competitor's micropower SOT-23 op amps.

The TLV2231 has 2-MHz bandwidth and 1.6-V/µs slew rate (V_{DD} = 5 V) for applications requiring better ac response. Yet it still consumes just 850 µA (typ) supply current. The TLV2231 can drive 600-Ω loads, and has the lowest noise floor of the three devices: 15 nV/√Hz.

The TLV2221 offers designers a compromise between the ac performance and output drive of the TLV2231 and the micropower TLV2211. All three op amps are rated for operation from 2.7 V to 10 V, and fully specified and characterized at both V_{DD} equal to 3 V and 5 V.

The ultra-small SOT-23 package lets designers place single amplifiers very near the signal source, minimizing noise pick-up from long PCB traces. Furthermore, amplifiers can be built right into sensors or squeezed into tightly packed layouts. The pinout is optimized for signal isolation, component placement, and PCB layout (see illustration).



- **Inputs are separated by GND to prevent coupling or leakage paths**
- **OUT and IN - pins are at the same end of the package for closing the feedback loop**
- **Decoupling capacitor and gain-setting resistors are easily placed**

AT A GLANCE

- Ultra-small SOT-23 packaging
- Optimized pinout
- Very low noise: 22 nV/√Hz (TLV2211)
- Very low power consumption: I_{DD} = 11 µA; typ (TLV2211)

Read Sine-On online and download datasheets at: www.ti.com/sc/sine-on

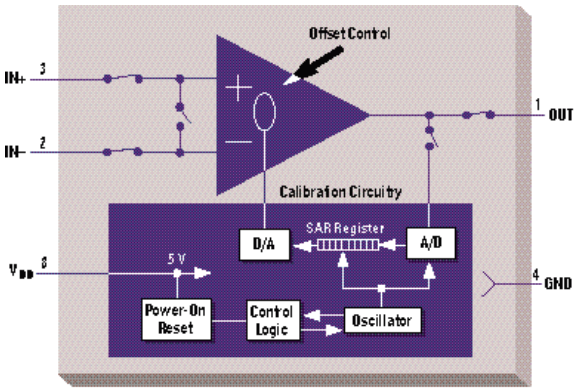
Self-Cal Op amps: V_{IO} = 50 µV max - TLC4501A & TLC4502A

AT A GLANCE

- No external calibration components required
- Standard package, standard product
- Rail-to-Rail output voltage swing
- High output drive capability (± 50 mA)
- 300 ms typical calibration time
- 5-V single-supply operation

The TLC4501 and TLC4502 are single and dual, self-calibrating, precision, operational amplifiers. They achieve precision by automatically nulling their input offset voltage during power up. During the calibration procedure, the operational amplifier is removed from the signal path and both inputs are tied to GND. The offset cancellation uses a current-mode digital-to-analog converter (D/A), whose full-scale current allows for an adjustment of approximately ±5 mV to the input offset voltage. The digital code producing the cancellation current is stored in the successive-approximation register (SAR). This self-calibrating procedure typically requires 300 ms to complete and is repeatable to within ±3 µV on successive calibrations.

These amplifiers offer significant advantages over chopper-stabilized and precision bipolar amplifier solutions. The designer does not have to worry about noise and frequency limitations created by the continual chopping frequency of chopper-stabilized amplifiers. After calibration, the calibration circuitry drops out of the signal path, becoming transparent to the user. Also, choppers are normally only single channel devices requiring external storage capacitors for proper use. The Self-Cal amps use a standard single or dual op amp pinout, require no external components, and can be used as a performance upgrade in standard designs.



Channel one of the TLC4502

The high input impedence make the TLC4501 and TLC4502 excellent alternatives to laser-trimmed bipolar amplifiers. The low input impedance of bipolar amps cause excess loading of the input signal when interfacing with high impedance sensors. The TLC4501 and TLC4502 offer the designer a unique combination of DC and AC performance that makes these Self-Cal amplifiers a good choice for a wide range of amplifier applications.

- Rail-to-rail output swing ideal for interfacing with ADCs
- 5-V single-supply operation for battery-powered applications
- High output drive for 100-Ω loads
- 4.7-MHz bandwidth and 2.5-V/µs slew rate for AC applications

TLC4501CD

➤ $0.89 in quantities of 1000

TLC4502CD

➤ $1.28 in quantities of 1000

Available in 8-pin SOIC

For technical support, call 972-644-5580

To order documentation, call 1-800-477-8924, ext.3233

Wide Input Voltage Range with Rail-to-Rail, High Output Drive

TLV2422CD

➤ $0.80 in quantities of 1000

TLV2432CD

➤ $0.80 in quantities of 1000

TLV2442CD

➤ $0.80 in quantities of 1000

Available in 8-pin SOIC and TSSOP

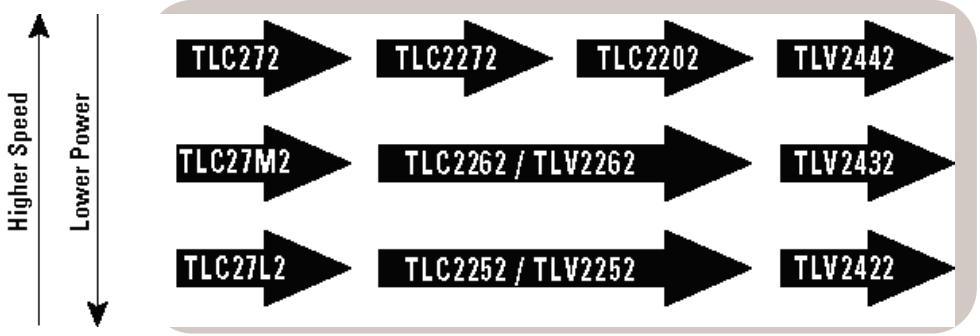
Texas Instruments (TI) is enhancing its line of single-supply operational amplifier solutions with a new family of wide input range, rail-to-rail output operational amplifiers. The rail-to-rail output performance makes these devices perfect for interfacing with analog-to-digital (ADC) converters, and are ideal in applications such as cellular phones, notebook computers, modems and PCMCIA cards.

These devices, designated the TLV2422, TLV2432 and the TLV2442 display up to three times less noise voltage than current market amplifiers. The TLV2422 and TLV2432 have low supply current for minimal battery consumption, 50 µA and 195 µA respectively. The TLV2442 offers better AC performance for higher-speed applications. The extended input common mode range, high input impedence, and low noise, make these amplifiers suitable for a broad variety of applications. This includes small-signal conditioning and high-impedance piezoelectric sensors. The high drive output which is capable of driving 600-Ω loads also makes this family suitable for telecom applications.

The TLV2442 and TLV2432 are the high speed and low power members of the family. However, if power consumption must be an absolute minimum choose the TLV2422 which is a micropower, rail-to-rail, dual version. The device consumes 50 µA (typ) of supply current per channel and has a supply voltage range from 2.7 V to 10 V, fully characterized at 3 V and 5 V.

The TLV2422 has low input bias current (I_{IB} = 1 pA) for interfacing to high impedance sensors. Precision DC applications are also well served with

(continued on next page)



AT A GLANCE

- Upgrade for the TLC22xx
- Extended input voltage: 0 V to 4.5 V
- High output drive: 600 Ω
- Low noise: 16 nV/√Hz (TLV2442)

Read Sine-On online and download datasheets at: www.ti.com/sc/sine-on

Wide Input Voltage Range with Rail-to-Rail High Output Drive

(continued from page 5)

an input offset voltage of 300 µV (typ) and a 5-V noise level of only 18 nV/√Hz. This noise level is the lowest in industry for micropower CMOS op amps.

All three products feature a wide input and output voltage range and can drive 600-Ω loads. The input common mode range includes the negative rail and swings to within 0.25 V of the positive rail. The output provides full rail-to-rail performance and increased output drive.

Very Low Power, Rail-to-Rail, Op Amps - TLV2262/4 & TLV2252/4

AT A GLANCE

- Very low power: I_{DD} = 35 µA/channel (TLV225x)
- Low noise: 12 nV/√Hz (TLV226x)
- Fully characterized for both 3-V and 5-V operation

Consider the TLV2262/4 and TLV2252/4 for data acquisition systems, operating at 3-V. These low voltage op amps are tested and characterized for guaranteed operation from a single 3-V supply. Like their 5-V cousins these op amps combine rail-to-rail output swing with very low power consumption. They are both offered in TSSOP packaging for applications where board space is critical.

These op amps exhibit high input impedance and low noise, making them excellent choices for small-signal conditioning for high-impedance sources. Because of the low power dissipation levels combined with 3-V operation, these devices also work well in hand-held monitoring and remote-sensing applications.

Other applications include:

- Piezoelectric transducers
- Remote pressure sensors
- Temperature control
- Active voltage-resistive (VR) sensors
- Accelerometers
- Hand-held metering

TLV2252/4ID

➤ $1.00/1.46 in quantities of 1000

TLV2262/4ID

➤ $0.94/1.46 in quantities of 1000

Available in 8 and 14-pin SOIC and TSSOP

For technical support, call 972-644-5580

To order documentation, call 1-800-477-8924, ext.3233

Highest Precision, Lowest Noise, Rail-to-Rail CMOS Op Amps - TLC2201/2

TLC2201CD
➤ $2.27 in quantities of 1000

TLC2202CD
➤ $2.76 in quantities of 1000

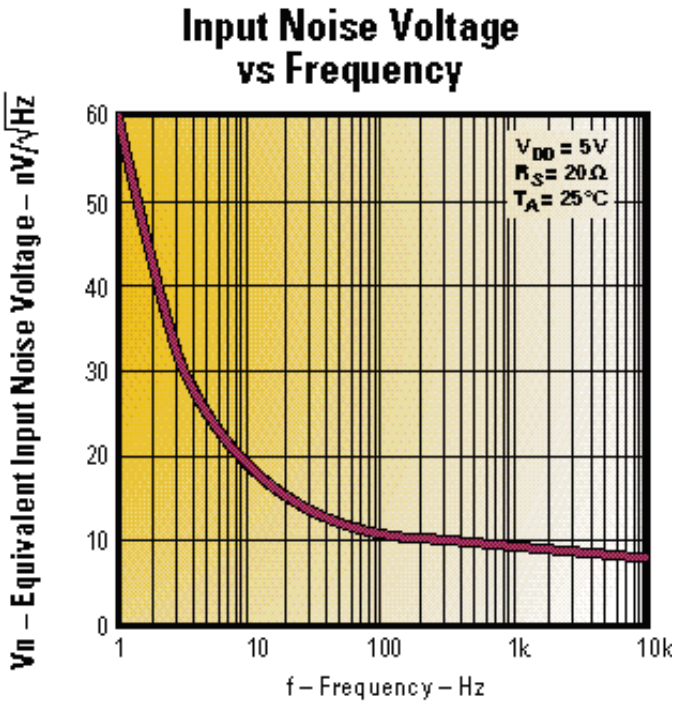
Available in 8-pin SOIC

If the design requires top performance, consider the TLC2201 single or TLC2202 dual op amp. These devices are the highest precision CMOS amplifiers in the industry. They combine excellent dc and noise performance with a common-mode input voltage range that includes the negative rail. A maximum value of 200-µV input offset voltage (V_{IO}), places these devices in a category that bridges the gap between bipolar and CMOS technologies. They provide the precision of bipolar technology, with the high input impedance of CMOS. As the plot illustrates, V_N reaches 8 nV/√Hz at 1 kHz. Their low noise floor and low V_{IO} make these op-amps ideal upgrades for the TLC27x and TLC227x.

The TLC2201/2 are ideal for high-impedance, low-level signal conditioning applications in either single-supply or split-supply configurations.

- PIN diode interface
- Bar-code scanners
- Instrumentation
- Modems

Whatever the application, if performance is a must, the TLC220x family of operational amplifiers are the best choice.



AT A GLANCE

- Industries highest precision CMOS op amp: V_{IO} = 200 µV max
- Low noise: 8 nV/√Hz
- Upgrade for the TLC227x
- Fully specified for both single supply and split supply

Read Sine-On online and download datasheets at: www.ti.com/sc/sine-on

1.4-V, Micropower, High Precision Op Amps - TLC1078/79

AT A GLANCE

- V_{DD} = 1.4 V min
- High precision: V_{IO} = 450 µV max (TLC1078)
- Micropower: I_{DD} = 10 µA/channel

The TLC1078 and TLC1079 are ideal for designs needing ultra-low input offset voltage and power consumption. Both devices are characterized at 3 and 5 V, but will operate down to 1.4 V. In addition, they exhibit high gain, 110-kHz bandwidth, 32-V/ms slew rate, and consume just 10 µA/channel of supply current. They combine the low voltage advantages of the TLC25L2/4 and the precision of the TLC27L7/9.

Battery-operated systems are well served by a common-mode input to the negative rail, and output swing to the negative rail.

Since this device is functionally compatible as well as pin compatible with the TLC27L2 and TLC27L7, the TLC1078 easily upgrades existing designs that can benefit from its improved performance. Likewise, TLC1079 makes a great upgrade from the TLC27L4 and TLC27L9.

TLC1078/9CD

➤ $2.88/4.20 in quantities of 1000

Available in 8-pin SOIC

Very Low Noise, CMOS Rail-to-Rail Op Amps - TLC2272/4, TLC2262/4, & TLC2252/4

AT A GLANCE

- TLC2272/4: Upgrade for the TLC27x
  - · V_N = 9 nV/$\sqrt{Hz}$
  - · SR = 3.6 V/µs
  - · BW = 2.18 MHz
- TLC2262/4
  - · V_N = 12 nV/$\sqrt{Hz}$
  - · SR = 0.55 V/µs
  - · BW = 0.71 MHz
- TLC2252/4
  - · V_N = 19 nV/$\sqrt{Hz}$
  - · SR = 0.12 V/µs
  - · BW = 0.2 MHz

The TLC227x, TLC226x, and TLC225x op amps have the lowest noise floor of any CMOS amplifier in the industry. This family provides a full range of power vs. ac performance options. Furthermore, all three subfamilies include rail-to-rail output swing, low noise, high precision, high input impedance, and are available in the ultra thin TSSOP packaging.

The TLC2262 and TLC2264 are designed for any battery-powered equipment like personal digital assistance (PDAs), notebook computers, cellular phones, or hand held instrumentation. The TLC226x is also very stable device. It will drive 500 pF with no additional components. This allows the conditioning of the signal near the source while still being able to drive cables or other capacitive loads.

Completing this family of low noise rail-to-rail op-amps is the TLC2252 and TLC2254 with 35 µA per channel (typ) and rail-to-rail output swing the TLC225x's are great for remote sensing and portable applications. These op-amps are the lowest noise micropower CMOS amplifiers available. Their noise floor of only 19 nV/$\sqrt{Hz}$ (at 1 kHz) and a maximum offset voltage of 850 µV reduce the error floor of low bandwidth DC circuits.

TLC2272/4CD

➤ $0.78/1.18 in quantities of 1000

TLC2262/4CD

➤ $0.78/1.18 in quantities of 1000

TLC2252/4CD

➤ $0.82/1.18 in quantities of 1000

Available in 8 and 14-pin SOIC and TSSOP

For technical support, call 972-644-5580

To order documentation, call 1-800-477-8924, ext.3233

1.4-V Op Amps - TLC251/2/4, TLC25M2/4, & TLC25L2/4

TLC251CD
➤ $0.80 in quantities of 1000

TLC252/4CD
➤ $1.31/2.14 in quantities of 1000

TLC25M2/4CD
➤ $1.31/2.14 in quantities of 1000

TLC25L2/4CD
➤ $1.31/2.14 in quantities of 1000

Available in 8 and 14-pin SOIC and TSSOP

This series of op amps is ideally suited for battery-powered or energy-conserving applications because the input common-mode range extends to the negative rail and the power consumption is extremely low. Other features include:

- Operation down to a 1.4-V supply
- Excellent noise characteristics
- Very high input impedance
- Low input offset and bias currents
- Complete family of singles, duals, and quads
- Bias-select pin for optimum performance/power levels (TLC251)

AT A GLANCE

- Wide range of supply voltages: 1.4 V - 16 V
- Single-supply operation
- Low I_{DD}: 12.5 µA/channel (TLC25L2/4)
- Internal ESD protection circuit

General Purpose, Single Supply, 3-V Op Amps - TLV23xx

TLV2341ID
➤ $0.48 in quantities of 1000

TLV2342/4ID
➤ $0.78/1.15 in quantities of 1000

TLV2322/4ID
➤ $0.78/1.15 in quantities of 1000

TLV2332/4ID
➤ $0.78/1.15 in quantities of 1000

Available in 8 and 14-pin SOIC and TSSOP

This family of operational amplifiers is specifically designed for use in low-voltage single-supply applications. The TLV2341 is fully characterized at 3 and 5 V, but can operate over a voltage range of 2 V to 8 V. It also offers a bias-select feature that allows the user to select one of three bias levels. The tradeoffs between bias levels involve ac performance and power dissipation.

If the design requires a low power dual or quad version of the TLV2341, use the TLV2332 or TLV2334. These devices are designed to provide a combination of low power and good ac performance. Each amplifier is fully functional down to a minimum supply voltage of 2 V, is fully characterized, tested, and specified at both 3 V and 5 V power supplies. From a 3-V power supply, the amplifier's typical slew rate is 0.38 V/µs and its bandwidth is 300 kHz, offering a level of ac performance greater than that of many other devices operating at comparable power levels.

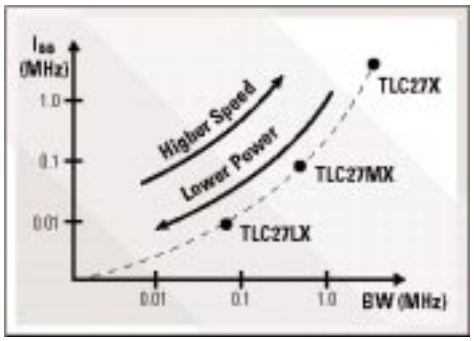
For ultra low-power system designs, TI offers the dual TLV2322 and quad TLV2324. These amplifiers are specifically targeted for use in very low-power, portable, battery-driven applications with the maximum supply current per amplifier specified at only 27 µA over its full temperature range of –40°C to 85°C.

AT A GLANCE

- Three speed/power options
- High input impedance 10^{12} Ω
- Fully characterized at 3 V and 5 V

Read Sine-On online and download datasheets at: www.ti.com/sc/sine-on

General Purpose, Single Supply Op Amps - TLC271/2/4, TLC27M2/4, & TLC27L2/4



AT A GLANCE

- High input impedance $10^{12}\ \Omega$
- Low bias currents 40 pA max.
- Precision grades available

The TLC27x family of op amps are excellent upgrades and offer superior performance over earlier single-supply bipolar amplifiers (e.g. LM358 and LM324). These CMOS amplifiers provide wider bandwidth, faster slew rate, and higher input impedance ($10^{12}\ \Omega$). The improved ac performance, combined with a range of input offset voltage grades, makes this series of op amps suitable for many applications. In addition, the TLC271 features a bias-select mode that allows the user to select the best combination of power dissipation and ac performance that suits the application.

If power consumption must be minimized, consider the micropower TLC27L2 (dual) and TLC27L4 (quad) op amps. These op amps consume only 17 µA per channel of supply current.

This family is available in the plastic dual-in-line (PDIP), small outline integrated circuit (SOIC), and thin small shrink outline (TSSOP) packages. All singles and duals are provided in an 8-pin package. The quads are placed in a 14-pin package.

TLC271CD
➤ $0.36 in quantities of 1000

TLC272/4CD
➤ $0.59/0.97 in quantities of 1000

TLC27M2/4CD
➤ $0.59/0.97 in quantities of 1000

TLC27L2/4CD
➤ $0.59/0.97 in quantities of 1000

Available in 8 and 14-pin SOIC and TSSOP

Improved Precision, Single Supply Op Amps - TLC277/9, TLC27M7/M9, & TLC27L7/L9

AT A GLANCE

- High precision: V_{IO} = 500 µV (TLC277)
- Micropower: I_{DD} = 10 µA/channel (TLC27L7/9)
- Available in extended temperature ranges (-55°C to 125°C)
- ESD protection circuitry

This family of op amps has lower input offset voltage (i.e. higher precision) than earlier TLC27Lx and TLC27Mx op amps with the same convenient power options. Many features associated with bipolar technology are available in LinCMOS operational amplifiers, without the power penalties of bipolar technology. The TLC277/9, TLC27M7/M9, and TLC27L7/L9 exhibit low voltage single-supply operation and ultra-low power consumption.

- **Remote and inaccessible battery-powered applications**
- **Transducer interfacing**
- **Analog calculations**
- **Amplifier blocks**
- **Active filters**
- **Signal buffering**

These advantages, in combination with a common-mode input voltage and good common-mode and supply voltage rejection, make these devices excellent choices for upgrading existing designs.

TLC277/9CD
➤ $0.97/1.68 in quantities of 1000

TLC27M7/9CD
➤ $1.18/2.02 in quantities of 1000

TLC27L7/9CD
➤ $1.23/2.02 in quantities of 1000

Available in 8 and 14-pin SOIC and TSSOP

For technical support, call 972-644-5580

To order documentation, call 1-800-477-8924, ext.3233

Texas Instruments Operational Amplifier Selection Guide

Device Name	V_{DD} Min	V_{DD} Max	V_{IO} max (max) (mV)	I_{IB} (pA) (typ)	CMRR (dB) (typ)	I_{DD} / I_{CC} per channel (µA) (max)	I_{DD} / I_{CC} per channel (µA) (typ)	Slew Rate (V/µs) (typ)	Vn (nV/√Hz) (typ)	GBW (MHz) (typ)	Military
TLC1078	1.4	16	0.45	0.6	95	0.017	0.01	0.032	68	0.085	BOTH
TLC1079	1.4	16	0.85	0.6	95	0.017	0.01	0.032	68	0.085	NO
TLC2201	4.6	16	0.5	1	110	1.5	1	2.5	8	1.8	NO
TLC2202	4.6	16	1	1	110	1.3	0.85	2.5	8	1.9	BOTH
TLC2252	4.4	16	1.5	1	83	0.0625	0.035	0.12	19	0.2	BOTH
TLC2254	4.4	16	1.5	1	83	0.0625	0.035	0.12	19	0.2	BOTH
TLC252	1.4	16	10	0.6	80	1.6	0.7	3.6	3.6	1.7	NO
TLC254	1.4	16	10	0.6	80	1.8	0.775	3.6	25	1.7	NO
TLC25L2	1.4	16	10	0.6	94	0.017	0.01	0.03	68	0.085	NO
TLC25L4	1.4	16	10	0.6	94	0.017	0.01	0.03	70	0.085	NO
TLC25M2	1.4	16	10	0.6	91	0.28	0.105	0.43	32	0.525	NO
TLC25M4	1.4	16	10	0.6	91	0.28	0.105	0.43	32	0.525	NO
TLC2262	4.4	16	2.5	1	83	0.25	0.2	0.55	12	0.82	NO
TLC2264	4.4	16	2.5	1	83	0.25	0.2	0.55	12	0.82	NO
TLC2272	4.4	16	2.5	1	75	1.5	1.1	3.6	9	2.18	BOTH
TLC2274	4.4	16	2.5	1	75	1.5	1.1	3.6	9	2.18	NO
TLC274	3	16	10	0.6	80	1.6	0.675	3.6	25	1.7	NO
TLC274x2	3	16	10	0.6	80	1.6	0.675	3.6	25	1.7	NO
TLC277	3	16	0.5	0.6	80	1.6	0.7	3.6	25	1.7	NO
TLC279	3	16	0.9	0.6	80	1.6	0.675	3.6	25	1.7	BOTH
TLC27L2	3	16	10	0.6	94	0.017	0.01	0.03	68	0.085	BOTH
TLC27L4	3	16	10	0.6	94	0.017	0.01	0.03	70	0.085	NO
TLC27L7	3	16	0.5	0.6	94	0.017	0.01	0.03	68	0.085	NO
TLC27L9	3	16	0.9	0.6	94	0.017	0.01	0.03	70	0.085	NO

Con't next page

Texas Instruments Operational Amplifier Selection Guide (con't)

Device Name	V_{DD} Min	V_{DD} Max	V_{IO} max (max) (mV)	I_{IB} (pA) (typ)	CMRR (dB) (typ)	I_{DD} / I_{CC} per channel (µA) (max)	I_{DD} / I_{CC} per channel (µA) (typ)	Slew Rate (V/µs) (typ)	Vn (nV/√Hz) (typ)	GBW (MHz) (typ)	Military
TLC27M2	3	16	10	0.6	91	0.28	0.105	0.43	32	0.525	NO
TLC27M4	3	16	10	0.6	91	0.28	0.105	0.43	32	0.525	NO
TLC27M7	3	16	0.5	0.6	91	0.28	0.105	0.43	32	0.525	NO
TLC27M9	3	16	0.9	0.6	91	0.28	0.105	0.43	32	0.525	NO
TLC4501	4	6	0.05	1	100	3.5	2.5	2.5	12	4.7	NO
TLC4502	4	6	0.05	1	100	3.5	2.5	2.5	12	4.7	BOTH
TLV2211	2.7	10	3	1	83	0.025	0.013	0.025	22	0.065	NO
TLV2221	2.7	10	3	1	85	0.150	0.110	0.18	19	2	NO
TLV2231	2.7	10	3	1	70	1.200	0.850	1.6	15	0.51	NO
TLV2252	2.7	8	1.5	1	75	0.0625	0.034	0.1	19	0.187	BOTH
TLV2254	2.7	8	1.5	1	75	0.0625	0.034	0.1	19	0.187	BOTH
TLV2262	2.7	8	2.5	1	75	0.25	0.2	0.55	12	0.67	NO
TLV2264	2.7	8	2.5	1	75	0.25	0.2	0.55	12	0.67	BOTH
TLV2322	2	8	9	0.6	88	0.017	0.006	0.02	68	0.027	NO
TLV2324	2	8	10	0.6	88	0.017	0.006	0.02	68	0.027	NO
TLV2332	2	8	9	0.6	92	0.25	0.08	0.38	32	0.3	NO
TLV2334	2	8	10	0.6	92	0.25	0.08	0.38	32	0.3	NO
TLV2342	2	8	9	0.6	78	1.5	0.325	2.1	25	0.79	NO
TLV2344	2	8	10	0.6	78	1.5	0.325	2.1	25	0.79	NO
TLV2422	2.7	10	2	1	8.3	0.050	0.075	0.02	23	0.046	BOTH
TLV2432	2.7	10	2	1	83	0.125	0.098	0.25	22	0.5	BOTH
TLV2442	2.7	10	2	1	75	0.725	1.1	1.3	18	1.75	BOTH
TLV2711	2.7	10	3	1	83	0.025	0.013	0.025	21	0.065	NO
TLV2721	2.7	10	3	1	85	0.150	0.110	0.18	19	0.51	NO
TLV2731	2.7	10	3	1	70	1.300	0.85	1.6	15	2	NO

Texas Instruments Operational Amplifier Cross Reference

Competitor Part No.	TI Part No.	Competitor Name	Replacement Type
AD820	TLC2201	Analog Devices	P
AD822	TLC2202	Analog Devices	P
AD822	TLC2272	Analog Devices	P
AD822	TLC277	Analog Devices	P
AD822	TLC27M7	Analog Devices	P
AD824	TLC2274	Analog Devices	P
AD824	TLC279	Analog Devices	P
AD824	TLC27M9	Analog Devices	P
AD882	TLC2272	Analog Devices	Q
CA324	TLC274	Harris	P
CA324	TLC27M4	Harris	P
CA358	TLC272	Harris	P
CA358	TLC27M2	Harris	P
CA5130	TLC2262	Harris	Q
CA5160	TLC2262	Harris	Q
CA5260	TLC2262	Harris	P
CA5420	TLC2274	Harris	P
ICL7621	TLC272	ICL (Phillips)	P
ICL7621	TLC272	Maxim	P
ICL7621	TLC272	Harris	P
ICL7641	TLC272	ICL (Phillips)	P
ICL7641	TLC272	Maxim	P
ICL7641	TLC272	Harris	P
ICL7641	TLC274	ICL (Phillips)	P
ICL7641	TLC274	Maxim	P
ICL7642	TLC272	Maxim	P
ICL7642	TLC272	Harris	P
LM324	TLC274	National Semiconductor	P
LM358	TLC272	National Semiconductor	P
LM358	TLC274	National Semiconductor	P
LM358	TLC27M4	National Semiconductor	P
LM7301	TLV2231	National Semiconductor	P
LMC6022	TLC2252	National Semiconductor	P
LMC6022	TLC27L2	National Semiconductor	P
LMC6022	TLC27M2	National Semiconductor	P
LMC6024	TLC2254	National Semiconductor	P
LMC6024	TLC27L4	National Semiconductor	P
LMC6024	TLC27M4	National Semiconductor	P
LMC6032	TLC2262	National Semiconductor	P
LMC6032	TLC2272	National Semiconductor	P
LMC6032	TLC272	National Semiconductor	P
LMC6032	TLC27M2	National Semiconductor	P
LMC6034	TLC2264	National Semiconductor	P
LMC6034	TLC2274	National Semiconductor	P
LMC6034	TLC274	National Semiconductor	P
LMC6034	TLC27M4	National Semiconductor	P
LMC6035	TLV2442	National Semiconductor	P
LMC6042	TLC2252	National Semiconductor	P
LMC6044	TLC2254	National Semiconductor	P
LMC6062	TLC1078	National Semiconductor	P
LMC6062	TLC2252	National Semiconductor	P
LMC6062	TLC27L7	National Semiconductor	P
LMC6064	TLC1079	National Semiconductor	P
LMC6064	TLC2254	National Semiconductor	P
LMC6064	TLC27L9	National Semiconductor	P
LMC6081	TLC2201	National Semiconductor	P
LMC6082	TLC2262	National Semiconductor	P
LMC6082	TLC2264	National Semiconductor	P
LMC6082	TLC2272	National Semiconductor	P
LMC6082	TLC277	National Semiconductor	P
LMC6082	TLC27M7	National Semiconductor	P
LMC6084	TLC2264	National Semiconductor	P
LMC6084	TLC2274	National Semiconductor	P
LMC6084	TLC279	National Semiconductor	P
LMC6084	TLC27M9	National Semiconductor	P
LMC6462	TLC27L7	National Semiconductor	P
LMC6462	TLV2322	National Semiconductor	P
LMC6464A	TLC27L9	National Semiconductor	P
LMC6464A	TLV2324	National Semiconductor	P
LMC6482	TLC2272	National Semiconductor	P
LMC6482	TLC272	National Semiconductor	P
LMC6482	TLC277	National Semiconductor	P
LMC6484	TLC2274	National Semiconductor	P
LMC6484	TLC279	National Semiconductor	P
LMC6492A	TLC2272	National Semiconductor	P
LMC6494	TLC274	National Semiconductor	P

Con't next page

Replacement Type Key:

F= The device is an exact equivalent in functionality and parametrics to the competitor's device.

P= The device has the same functionality and pinout to the competitor's device, but is not an exact equivalent.

Q= The device has the same functionality as the competitor's device, but is not pin-for-pin and/or parametrically equivalent.

S= The device has similar functionality but is not functionally equivalent to the competitor's device.

Texas Instruments Operational Amplifier Cross Reference (con't)

Competitor Part No.	TI Part No.	Competitor Name	Replacement Type
LMC6494A	TLC2274	National Semiconductor	P
LMC6572	TLC2254	National Semiconductor	Q
LMC6572	TLC2262	National Semiconductor	P
LMC6572	TLV2252	National Semiconductor	P
LMC6572	TLV2262	National Semiconductor	P
LMC6572A	TLC2252	National Semiconductor	P
LMC6574	TLC27M4	National Semiconductor	P
LMC6574	TLV2254	National Semiconductor	P
LMC6574	TLV2264	National Semiconductor	P
LMC6574	TLV2324	National Semiconductor	P
LMC6582A	TLV2262	National Semiconductor	P
LMC6584A	TLV2264	National Semiconductor	P
LMC660	TLC2264	National Semiconductor	P
LMC660	TLC2274	National Semiconductor	P
LMC662	TLV2432	National Semiconductor	P
LMC662	TLV2442	National Semiconductor	P
LMC6684A	TLC2274	National Semiconductor	Q
LMC7101	TLV2721	National Semiconductor	P
LMC7101	TLV2731	National Semiconductor	P
LMC7111	TLV2711	National Semiconductor	P
LP324	TLC274	National Semiconductor	P
LP324	TLV2322	National Semiconductor	Q
LPC660	TLC2254	National Semiconductor	P
LPC660	TLC2264	National Semiconductor	P
LPC660	TLC27L4	National Semiconductor	P
LPC660	TLC27M4	National Semiconductor	P
LPC662	TLC2252	National Semiconductor	P
LPC662	TLC2262	National Semiconductor	P
LPC662	TLV2252	National Semiconductor	P
LS404	TLC274	SGS-Thomson	P
LT1013	TLC27M7	Linear Technology	P
LT1014	TLC27M9	Linear Technology	P
LT1077	TLC27L7	Linear Technology	P
LT1078	TLC1078	Linear Technology	P
LT1078	TLC27L7	Linear Technology	P
LT1079	TLC1079	Linear Technology	P
LT1079	TLC27L9	Linear Technology	P
LT1112	TLC2262	Linear Technology	P
LT1178	TLC1078	Linear Technology	P
LT1178	TLC27L7	Linear Technology	P
LT1179	TLC1079	Linear Technology	P
LT1179	TLC27L9	Linear Technology	P
LT1413	TLC1078	Linear Technology	P
LT1413	TLC277	Linear Technology	P
MAX402	TLC2272	Maxim	Q
MAX406	TLC2252	Maxim	Q
MAX407	TLC2252	Maxim	Q
MAX407	TLC2262	Maxim	Q
MAX407	TLV2252	Maxim	Q
MAX409	TLC2252	Maxim	Q
MAX409	TLC2254	Maxim	Q
MAX417	TLC2252	Maxim	Q
MAX417	TLV2252	Maxim	Q
MAX418	TLC2254	Maxim	Q
MAX419	TLC2254	Maxim	Q
MAX419	TLC27L4	Maxim	Q
MAX478	TLC2252	Maxim	P
MAX478	TLV2252	Maxim	P
MAX479	TLC2252	Maxim	P
MAX479	TLC2254	Maxim	P
MAX479	TLV2254	Maxim	P
MAX494	TLC2252	Maxim	Q
MAX494	TLC2262	Maxim	Q
MAX494	TLV2432	Maxim	P
MAX494	TLV2442	Maxim	P
MAX495	TLC2254	Maxim	Q
MC33172	TLC272	Motorola	P
MC33172	TLC27M2	Motorola	P
MC33174	TLC274	Motorola	P
MC33174	TLC27M4	Motorola	P
MC33182	TLC27M2	Motorola	P
MC33184	TLC27M4	Motorola	P
MC33202	TLC2272	Motorola	P
MC33202	TLC272	Motorola	P
MC33204	TLC2274	Motorola	P
MC33204	TLC274	Motorola	P

Con't next page

Replacement Type Key:

F= The device is an exact equivalent in functionality and parametrics to the competitor's device.

P= The device has the same functionality and pinout to the competitor's device, but is not an exact equivalent.

Q= The device has the same functionality as the competitor's device, but is not pin-for-pin and/or parametrically equivalent.

S= The device has similar functionality but is not functionally equivalent to the competitor's device.

Low Voltage Single Supply Op Amp Cross Reference (con't)

Competitor Part No.	TI Part No.	Competitor Name	Replacement Type
MC33206	TLC2272	Motorola	Q
MC33207	TLC2274	Motorola	Q
MC33502	TLV2442	Motorola	P
MC3403	TLC274	Motorola	P
MC3458	TLC272	Motorola	P
MXL1178	TLC1078	Maxim	P
MXL1178	TLC27L7	Maxim	P
MXL1179	TLC1079	Maxim	P
MXL1179	TLC27L9	Maxim	P
NJU7032	TLC2272	New Japan Radio	P
NJU7034	TLC2274	New Japan Radio	P
NJU7074	TLC2274	New Japan Radio	P
OP191	TLV2211	Analog Devices	P
OP191	TLV2221	Analog Devices	P
OP193	TLV2211	Analog Devices	P
OP193	TLV2221	Analog Devices	P
OP196	TLV2211	Analog Devices	P
OP196	TLV2221	Analog Devices	P
OP213	TLC277	Analog Devices	P
OP220	TLC2252	Analog Devices	Q
OP221	TLC2252	Analog Devices	P
OP221	TLC27M2	Analog Devices	P
OP283	TLC2272	Analog Devices	P
OP284	TLC2272	Analog Devices	Q
OP290	TLC1078	Analog Devices	P
OP290	TLC27L7	Analog Devices	P
OP290	TLV2252	Analog Devices	P
OP291	TLC27M7	Analog Devices	P
OP291	TLV2262	Analog Devices	P
OP291	TLV2432	Analog Devices	P
OP291	TLV2442	Analog Devices	P
OP292	TLC277	Analog Devices	P
OP293	TLC2254	Analog Devices	P
OP294	TLC277	Analog Devices	P
OP295	TLC27L7	Analog Devices	P
OP295	TLV2252	Analog Devices	P
OP295	TLV2262	Analog Devices	P
OP295	TLV2432	Analog Devices	P
OP295	TLV2442	Analog Devices	P
OP296	TLC2262	Analog Devices	P
OP413	TLC279	Analog Devices	P
OP420	TLC2264	Analog Devices	P
OP421	TLC2264	Analog Devices	P
OP421	TLC27M4	Analog Devices	P
OP484	TLC2274	Analog Devices	P
OP490	TLC1079	Analog Devices	P
OP490	TLC27L9	Analog Devices	P
OP491	TLC27M9	Analog Devices	P
OP492	TLC279	Analog Devices	P
OP493	TLC2254	Analog Devices	P
OP495	TLC27L9	Analog Devices	P
OP496	TLC2264	Analog Devices	P
OPA1013	TLC2262	Analog Devices	P
OPA1013	TLC2262	Burr Brown	P
OPA1013	TLC27M7	Analog Devices	P
OPA1013	TLC27M7	Burr Brown	P
OPA111	TLC2201	Burr Brown	P
OPA211	TLC2202	Burr Brown	P
TCA0372	TLC272	Motorola	P
TS272	TLC272	SGS-Thomson	F
TS274	TLC274	SGS-Thomson	F
TS27L2	TLC27L2	SGS-Thomson	F
TS27L4	TLC27L4	SGS-Thomson	F
TS27M2	TLC27M2	SGS-Thomson	F
TS27M4	TLC27M4	SGS-Thomson	F
TS3V902	TLC2272	SGS-Thomson	Q
TS3V904	TLC2274	SGS-Thomson	Q
TS3V912	TLC2272	SGS-Thomson	P
TS3V914	TLC2274	SGS-Thomson	P
TS902	TLC2272	SGS-Thomson	Q
TS904	TLC2274	SGS-Thomson	Q
TS912	TLC2262	SGS-Thomson	P
TS912	TLC2272	SGS-Thomson	P
TS912	TLC272	SGS-Thomson	P
TS912	TLV2262	SGS-Thomson	P
TS914	TLC2274	SGS-Thomson	P

Replacement Type Key:

F= The device is an exact equivalent in functionality and parametrics to the competitor's device.

P= The device has the same functionality and pinout to the competitor's device, but is not an exact equivalent.

Q= The device has the same functionality as the competitor's device, but is not pin-for-pin and/or parametrically equivalent.

S= The device has similar functionality but is not functionally equivalent to the competitor's device.

Read Sine-On online and download datasheets at: www.ti.com/sc/sine-on