

1319/1323/1332 HIGH PERFORMANCE OPERATIONAL AMPLIFIERS

These bipolar amplifiers are solutions to problems which cannot be solved with the typical 741. Each has had one or more specifications optimized to provide such capabilities as low drift, high output voltage swing, high speed, etc.

To simplify selection of the best amplifier for a particular application, Table 1 lists the optimized specifications and recommended amplifier for each.

SPECIFICATIONS	RECOMMENDED DEVICES	VALUE		UNITS
		Guar.	Typical	
Untrimmed Initial Offset Voltage	1319-01	2	0.7	mV
Offset Voltage vs Temp	1319-01	15	3	$\pm \mu\text{V}/^\circ\text{C}$
Initial Offset Current	1319-01 1323	5	2 2.5	$\pm \text{nA}$
Offset Current vs Temp	1319 & 1319-01		30	$\pm \mu\text{A}/^\circ\text{C}$
Open Loop Gain	1323	106	120	dB
Max p-p Output Frequency	1323 & 1332		25	kHz
Slew Rate	1323 1332	10	20 5	V/ μsec
$\pm V_{\text{CC}}$ Range LOW	1323		5.5 to 20	
$\pm V_{\text{CC}}$ Range HIGH	1332	10 to 40	9 to 44	Volts
Quiescent Current	1323	80		μA
Output Swing Voltage/Current	1332 $V_{\text{CC}} = \pm 40 \text{ V}$ 1323 $V_{\text{CC}} = \pm 15$	35/10 12/10	13/20	V/mA
Operating Temp. Range	1319-01		-55 $^\circ\text{C}$ +125 $^\circ\text{C}$	

Table 1.

These true differential operational amplifiers are all pin-for-pin with the standard 741 (including 10 k Ω optional trimpot connection) except the 1323 which is 741 pin compatible when no external trim is required. If an initial offset of less than $\pm 3 \text{ mV}$ is required, the 1323 is trimmed with a 1 M Ω potentiometer between pins 1 and 8 with the wiper to $+V_{\text{CC}}$. It should also be noted that pin 4 ($-V_{\text{CC}}$) of the 1323 is connected to the case (see outline and base drawing).

All amplifiers have smooth 6 dB/octave roll off providing stable operation at all values of gain, even when connected as a unity gain follower.

All devices have a low initial offset voltage, the worst case (1332) being 6 mV. The quiescent power supply current of the 1323 is guaranteed to be less than 80 microamps. However, it can drive ± 10 volts into a 500 ohm load at 20 kHz. It thus can provide a battery powered precision power amplifier (approximately 200 mV out). When operating at high power out, quiescent current increases as a function of differential input voltage as shown in Figure 3. Its high stable gain and common mode rejection also make it ideal for battery powered instrumentation amplifiers.



FEATURES

- Low Drift (1319) $2 \mu\text{V}/^\circ\text{C}$
- Low Initial E_{OS} (1319 & 1323) $< 1 \text{ mV}$
- Low Bias Current (1323) 5 nA
- Low Offset Current TC (1319) 2 nA
- Low Quiescent Current (1323) $80 \mu\text{A}$
- High Gain (1322) 120 dB
- High Full Power Frequency (1332) 25 kHz
- High Slew Rate (1323) $20 \text{ V}/\mu\text{sec}$
- High $\pm V_{\text{CC}}$ Range (1332) to $\pm 40 \text{ V}$
- High Output Current (1323) $\pm 20 \text{ mA}$
- High Temperature Operation (1319-01) to 125°C

Model 1332

The 1332, operating with a ± 40 V power supply, can drive ± 35 V into $2.7 \text{ k}\Omega$ at 25 kHz . See Figures 5 and 6. Under maximum load conditions, the output can be short circuited to common without danger, as the output is limited by a chip temperature sensing circuit.

If it is desired to decrease bandwidth, capacity may be added between pin 8 and common. Figure 7 shows the effect of this capacity.

Model 1319

The 1319 has better dc input and drift specifications than the 741. The 1319 and 1319-01 are identical except for operating temperature range, E_{OS} , and $E_{OS} \text{ TC}$. All devices are capable of $\pm 10 \text{ mA}$ output at $\pm 12 \text{ V}$.

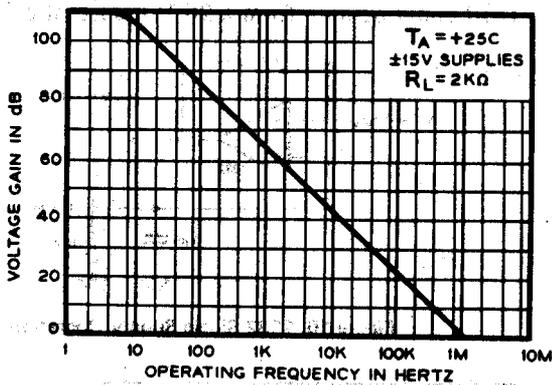


Figure 1. Voltage Gain vs Frequency for Model 1319

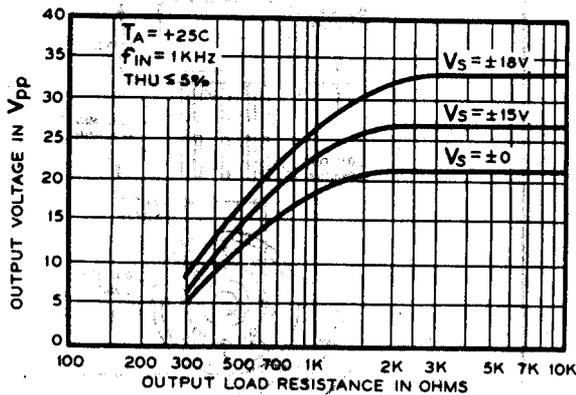


Figure 2. Output Voltage Swing vs Load Resistance Model 1319

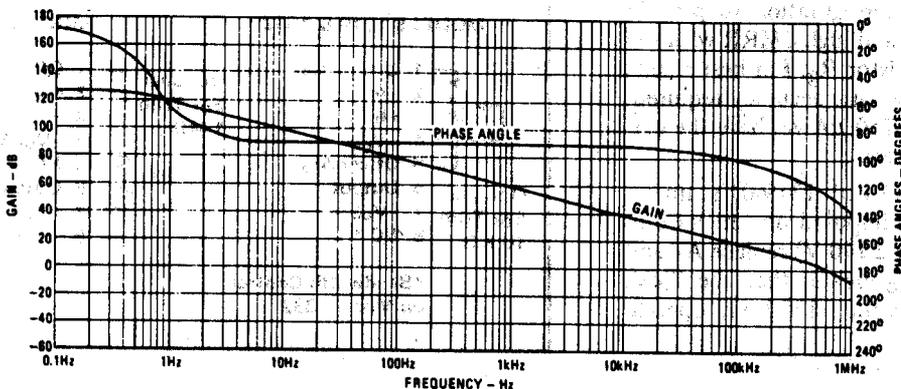


Figure 4. Phase-Frequency for Model 1323

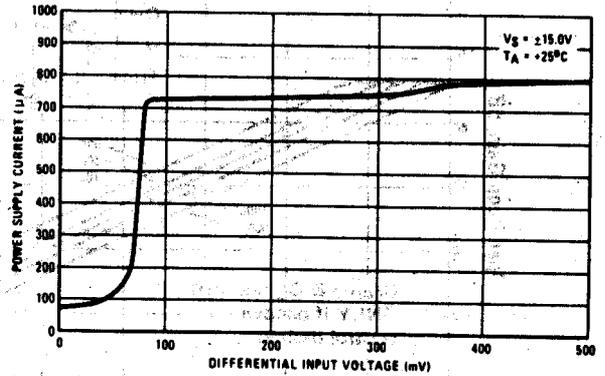


Figure 3. Supply Current vs Diff. Input Voltage for Model 1323

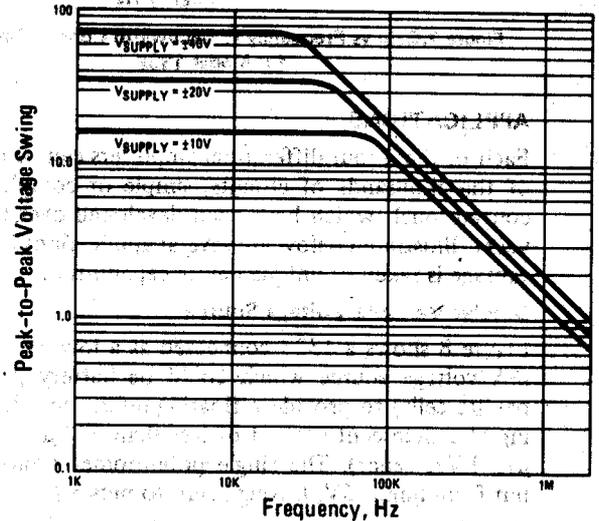


Figure 5. Output Voltage Swing vs Frequency at 25°C Model 1332

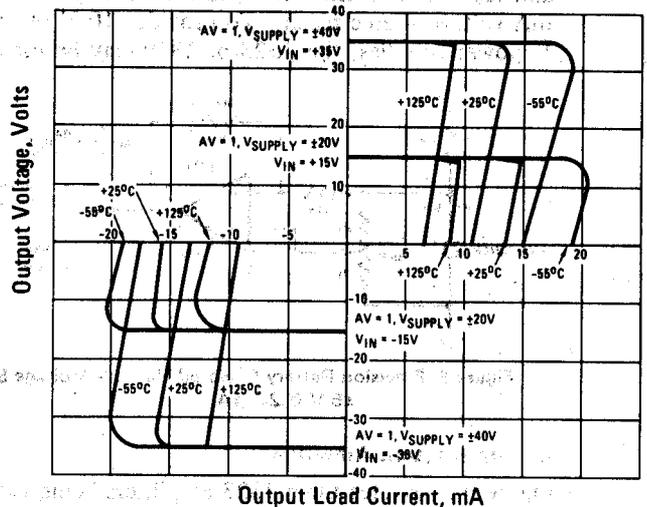


Figure 6. Output Current Characteristic of Model 1332

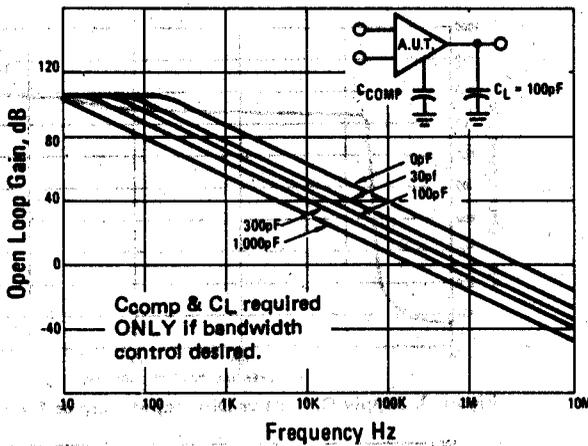


Figure 7. Gain vs Frequency vs Bandwidth Control Pin Capacity for Model 1332

APPLICATIONS

Each of these four differential amplifiers can be used in any of the thousands of circuits, simple or complex, cute or conventional, which have been developed over the past 30 years. Illustrated below are several applications in which advantage is taken of unique device capabilities.

Bipolar Variable Voltage Source

Figure 8 shows a 1323 connected as a low cost ± 5 V @ 20 mA voltage source which could be battery powered (10 penlite cells) to provide a floating reference voltage operating at a quiescent current of less than 500 μ A (using a 250 μ A, LVA zener). The single potentiometer varies the output from minus 5V, through zero to plus 5V.

If a 1332 is substituted for the 1323, V_{CC} changed to ± 40 V and resistors and zener changed accordingly, a ± 35 V @ 10 mA voltage source results. To provide ± 10 V out with ± 15 V power supplies, the 1323 or 1319 may be used.

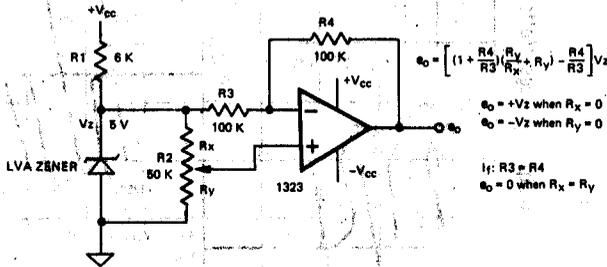


Figure 8. Precision Battery-Powered Variable Voltage Source ± 5 V @ 20 mA

Instrumentation Amplifier

Figure 9 illustrates three 1323 amplifiers being used in the classic Instrumentation amplifier configuration to provide high differential input impedance and high CMRR with the capability to set gain with one resistor R_g . For best results the $R3R4$ pairs are matched to the basic accuracy required. This amplifier will draw less than 250 μ A yet have the current and speed to drive galvanometers.

For lowest drift, replace A1 and A2 with 1319-01's and A3 with a 1319. If the input signal is imposed on a high Common Mode voltage (between ± 15 and ± 40 V) replace A1 and A2 with 1332's operating at $\pm V_{CC}$ greater than the CMV. For high voltage out, replace A3 with a 1332 and operate with voltage gain.

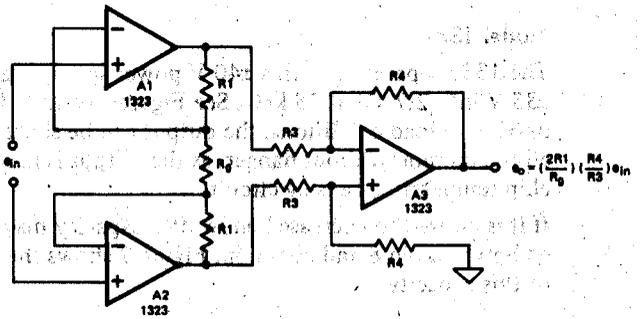


Figure 9. Micropower (<250 μ A) Instrumentation Amplifier

Single Supply Operation

Figure 10 shows a 1332 operating as an inverter from a single supply. This will allow a 1332 to operate from 48 V aircraft or vessel power, or the 1321 could operate from a single 6 V battery and the 1323 from a 12 V battery. The 1319 could operate from a 26 V industrial control supply.

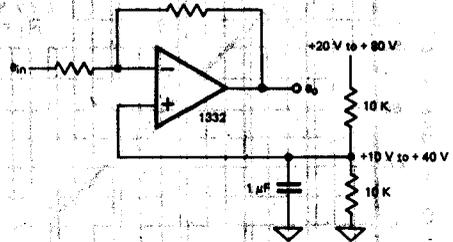


Figure 10. 1332 Single Supply Operation

TO-99

MODELS 1319 & 1332

- 1 Offset Adj.
- 2 -In
- 3 +In
- 4 -V_{CC}
- 5 Offset Adj.
- 6 Output
- 7 +V_{CC}
- 8 NC *

Optional
E_{os} Trim
10 K Ω

MODEL 1323

- 1 Offset Adj.
- 2 -In
- 3 +In
- 4 -V_{CC} & Case
- 5 NC
- 6 Output
- 7 +V_{CC}
- 8 Offset Adj.

Optional
E_{os} Trim
1 M Ω

*Bandwidth Control on Model 1332

	1319		1323		1332	
	Typical	Guaranteed	Typical	Guaranteed	Typical	Guaranteed
OUTPUT RANGE						
Voltage	±13 V	±10 V	±13 V	±12 V	—	±35 V ⊙
Current	±10 mA	±5 mA	±20 mA	±10 mA	±12 mA	±10 mA
VOLTAGE GAIN (dc Open Loop)						
Rated Load	110 dB	94 dB	128 dB	108 dB	106 dB	100 dB
FREQUENCY-TIME-RESPONSE						
Small Signal (Unity Gain, Open Loop)	1 MHz	—	1 MHz	—	4 MHz	—
Max Sine Power Out (3 to 5% distortion)	10 kHz	8 kHz	25 kHz	—	25 kHz	—
Slew Rate	0.6 V/μsec	—	20 V/μsec	10 V/μsec	5 V/μsec	—
Settling Time to 0.1% (Step Input)	—	—	10 μsec	—	—	—
INPUT VOLTAGE RANGE						
Common Mode (dc Linear Operation)	±15 V	±12 V	±12 V	±11 V	—	±35 V
Common Mode Rejection	±V _{cc}	—	±V _{cc}	—	±V _{cc}	—
Differential (between inputs)	+V _{cc} - (-V _{cc})	24 V	+V _{cc} - (-V _{cc})	—	+V _{cc} - (-V _{cc})	—
Common Mode Rejection Ratio	100 dB	80 dB	106 dB	80 dB	100 dB	74 dB
INPUT OFFSET VOLTAGE						
Initial (without external trim)	±1 mV	±5 mV	±1 mV	±5 mV	±2 mV	±6 mV
Initial (1319-01)	±0.7 mV	±2 mV	—	—	—	—
Zero Adjustment (optional)	—	10 kΩ pot	—	1 MΩ pot	—	10 kΩ pot
Vs. Temperature (Avg. 0 to +70°C)	±5 μV/°C	±25 μV/°C	±30 μV/°C	—	±15 μV/°C	±20 μV/°C
Vs. Temperature (Avg. -55 to +125°C)	—	—	—	—	—	—
1319-01	±3 μV/°C	±15 μV/°C	—	—	—	—
Vs. Power Supply	10 μV/V	100 μV/V	10 μV/V	100 μV/V	30 μV/V	200 μV/V
INPUT BIAS CURRENT						
Initial	70 nA	250 nA	5 nA	40 nA	—	30 nA
Initial (1319-01)	30 nA	50 nA	—	—	—	—
Vs. Temperature (Average)	—	—	—	—	—	0.4 nA/°C
Offset (Tracking)	3 nA	50 nA	2.5 nA	—	—	—
Offset (Tracking) (1319-01)	2 nA	5 nA	—	—	—	—
Offset Current	—	—	—	—	—	—
Offset vs. Temperature (Avg. 0 to +70°C)	±30 pA/°C	—	0.5 nA/°C	—	—	30 nA
Offset vs. Temperature (Avg. -55 to +125°C)	—	—	—	—	—	—
1319-01	±30 pA/°C	—	—	—	—	—
INPUT IMPEDANCE						
Differential	2 MΩ	0.5 MΩ	2 MΩ	200 kΩ	200 MΩ	—
Common Mode	1000 MΩ	—	—	—	1000 MΩ	—
NOISE (Referred to Input)						
Wideband (10 Hz to 10 kHz)	1 μV rms	—	10 μV rms	—	—	—
Flicker (0.01 Hz to 1.6 Hz)	1 μV p-p	—	—	—	—	—
Midband (1.6 Hz to 160 Hz)	1.5 μV rms	—	—	—	—	—
Highband (160 Hz to 16 kHz)	2 μV rms	—	—	—	—	—
POWER REQUIREMENTS						
Voltage Range	±8 to ±22 V	±12 to ±18	±5.5 to ±20	±12 to ±18	—	±10 to ±40
Current: Quiescent	—	±3 mA	—	±80 μA ⊙	3.2 mA	4.5 mA
TEMPERATURE RANGE						
Operating	—	0 to +70°C	—	0 to +70°C	—	0 to +75°C
Operating (1319-01)	—	-55 to +125°C	—	—	—	—
Storage	—	-65 to +150°C	—	-65 to +150°C	—	-65 to +150°C

⊙ When inputs are less than 5 mV apart. When inputs are more than 50 mV apart, quiescent current is ±3 mA Typical.

⊙ @V_{cc} = ±40 V

The input circuits of these units are protected to ±V_{cc}. Output circuits are short-circuit protected to ground.

Recommended Power Supply: Models 1319 & 1323 — Teledyne Philbrick Model 2211
Model 1332 — Teledyne Philbrick Model 2216

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