TELEDYNE PHILBRICK

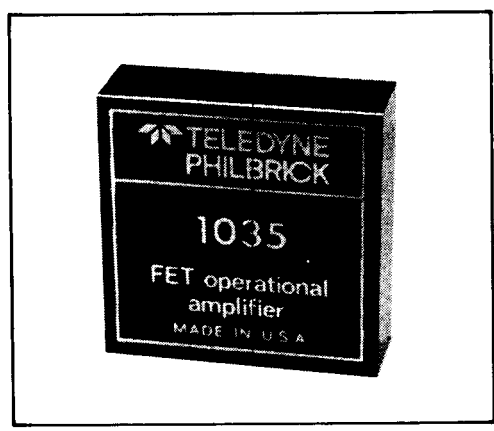
Low Bias Low Drift FET Op Amps

1035

The 1035 and 1035-02 JFET op amps use state-of-the-art components and design techniques to obtain bias currents approaching those of a varactor (TP Model 1702) but with lower offset TC, noise, and cost. Designed for precision pH measurement, the bandwidth of these op amps makes possible many high performance amplifier designs. These miniature modules combine a dual, internally boot-strapped, JFET front end with a wideband monolithic operational amplifier and several trimming resistors for maximum simplicity and reliability. Mechanically, these modules are designed to minimize leakage currents to input pins and to maintain performance under adverse environmental conditions. To optimize system performance, precautions must be taken to minimize current leakage paths around the amplifier's inputs. For instance, it is quite possible to have a $10^{13}\Omega$ conduction path from the 15V supply terminal to one of the inputs. This will permit 1.5 pA of leakage current to flow, which is 30 times the actual bias current of the 1035-02. Other sources of leakage include switches, pc boards, connectors, wire, and sockets. Leakage problems are multiplied in humid environments unless precautions are taken in the installation of the device. We recommend the use of a socket with teflon inserts (Philbrick model 6123) and that all wiring going to the inputs be well insulated. The 1035 employs input protection to the supply voltages, and output short circuit protection to power common. For detailed information on designing subpicoamp circuits, please request Applications Bulletin AN-3.

Applications Information

The design of the 1035 was optimized for use in precision pH meters. The basic pH measuring circuit is shown in Figure A. A 1035-02 in this circuit will provide a max pH error of ±0.001 pH over a ±5°C temperature range and ±0.01 pH over a ±20°C temperature range (from 25°C). Circuit and 1035 zero offset may be zeroed with R_t, and gain error with Rg. Three similar applications requiring both low I_b and low $E_{os}TC$ are long term integrators, and "long hold" peak detectors and sample/holds. A simplified sample/hold schematic is shown in Figure B. A 1035 should "grab" a 10V input step to 0.1% in $<5\mu$sec and hold it to that accuracy for at least 12 hours. Figure C illustrates differential current measurement.



FEATURES

- Low Bias Current
  1035 150fA Max
  1035-02 50fA Max
- 120dB Open Loop Gain
- $10^{13}\Omega$ Input Resistance
- 50kHz Full Power Bandwidth
- Low Flicker Noise 3μVp-p
- Condensation Resistant Input Terminals

APPLICATIONS

- pH Measurement
- Electrometers
- Chromatography
- Spectroscopy
- Photo Current Measurement
- Long Term Integrators
- Long Hold, Low Droop S/H's and Peak Detectors

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SPECIFICATIONS @ +25°C, V_{CC} = ±15 V, unless otherwise indicated

		Typical	Guaranteed
OUTPUT RANGE			
Voltage		±12 V	±10 V
Current		±10 mA	±5 mA
VOLTAGE GAIN (dc Open Loop)			
Rated Load		120 dB	100 dB
FREQUENCY RESPONSE			
Small Signal (Unity Gain Bandwidth)		300 kHz	---
Large Signal: Full Output (Undistorted)		50 kHz	---
Slew Rate		0.3 V/μsec	---
Settling Time to 0.1%		30 μsec	---
to 0.01%		40 μsec	---
Overload Recovery Time (30 V Step)		10 μsec	---
Stable Capacitive Load		---	1000 pF
INPUT VOLTAGE RANGE			
Common Mode (dc Linear Operation)		③	±10 V
Common Mode Fault, Abs. Max.		---	$\pm V_{CC}$
Common Mode Rejection Ratio		80 dB ④	---
Common Mode Impedance		$10^{13}\Omega$, 1 pF	---
Differential Impedance		$10^{13}\Omega$, 1 pF	---
INPUT VOLTAGE OFFSET			
Initial (No External Trim) ①	1035	0.5 mV	2 mV
	1035-02	0.5 mV	1 mV
ΔE_{OS} vs Temp			
(Avg. 0°C to +70°C)	1035	---	50 μV/°C
	1035-02	---	50 μV/°C
Power Supply Rejection Ratio		100 dB	---
INPUT BIAS CURRENT			
Initial (untrimmed)	1035	---	150 fA
	1035-02	---	50 fA
ΔI_b vs Temp (Avg. 0°C to +70°C)		doubles every 10°C	
NOISE (referred to input) ②			
Flicker (0.016 to 1.6 Hz)			
Voltage (peak-to-peak)		3 μV	---
Midband (1.6 Hz to 160 Hz)			
Voltage (rms)		2 μV	---
Wideband (160 Hz to 16 kHz)			
Voltage (rms)		5 μV	---
POWER REQUIREMENTS			
Voltage Range		±8 to ±20 V	±12 to ±18 V
Quiescent Current		---	±3 mA
TEMPERATURE RANGE			
Operation		-25 to +85°C	0 to +70°
Storage			-55 to +125°C
RECOMMENDED POWER SUPPLIES		TP 2301	

① E_{OS} can be brought to zero with external trim pot or varied ±100 mV for circuit trim.
② Current noise is typically 15 fA p-p (0.016 to 1.6Hz)
③ $+V_{CC}$ -5V and $-V_{CC}$ +5V
④ At ±5VCMV

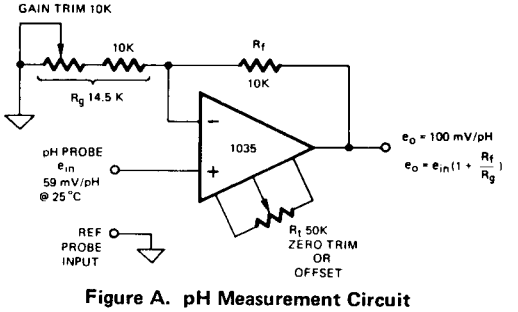


Figure A. pH Measurement Circuit

To minimize current errors, use a 6123 socket or encircle the plus and minus input terminals with a foil guard ring. Connect the socket or guard to common for Inverters or I-to-V's; connect the socket or guard to the output for Unity Gain Followers.

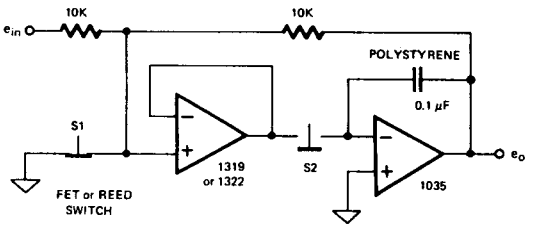


Figure B. Integrating Sample & Hold (Shown in Hold)

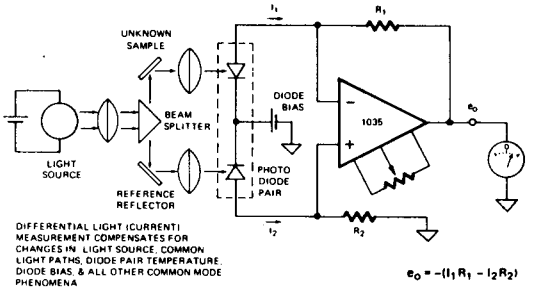
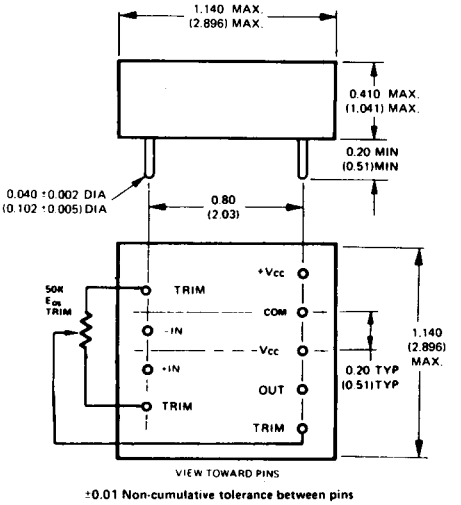
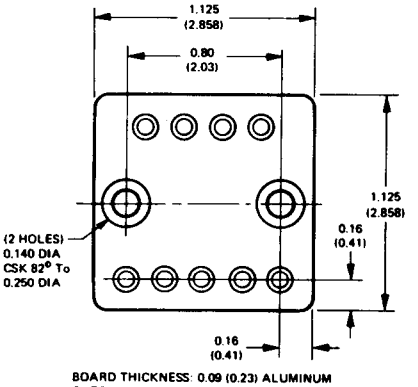


Figure C. Differential Reflectometer



±0.01 Non-cumulative tolerance between pins
±0.02 Tolerance from case edge to center of pins
DIMENSIONS IN PARENTHESES ARE EXPRESSED IN CENTIMETERS

Optional Socket: Model 6123 Aluminum Socket with Teflon Inserts



BOARD THICKNESS: 0.09 (0.23) ALUMINUM
OVERALL HEIGHT: 0.50 (1.27)

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