National Semiconductor

LH0042
Low Cost FET Op Amp

General Description

The LH0042 is a FET input operational amplifier with very high input impedance and low input currents with no compromise in noise, common mode rejection ratio, open loop gain, or slew rate. The LH0042 is internally compensated and is free of latch-up.

The LH0042 is specified for operation over the −55°C to +125°C military temperature range. The LH0042C is specified for operation over the −25°C to +85°C temperature range.

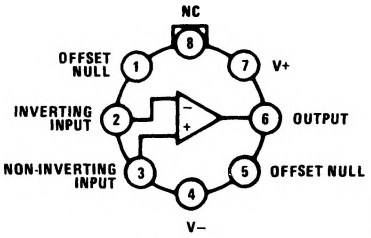
The LH0042 op amp is intended to fulfill a wide variety of applications for process control, medical instrumentation, and other systems requiring very low input currents. The LH0042 provides low cost high performance for such applications as electrometer and photocell amplification, picoammeters, and high input impedance buffers.

Features

- High open loop gain—100 dB typ
- Internal compensation
- Pin compatible with standard IC op amps (TO-99 package)

Connection Diagram

Metal Can Package



TL/K/5557-3

Top View

Order Number LH0042H-MIL, LH0042H or LH0042CH
See NS Package Number H08D

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	±22V
Power Dissipation (see Graph)	500 mW
Input Voltage (Note 1)	±15V
Differential Input Voltage (Note 2)	±30V
Voltage Between Offset Null and V^-	±0.5V
Short Circuit Duration	Continuous
Operating Temperature Range	
LH0022, LH0042, LH0052	−55°C to +125°C
LH0022C, LH0042C, LH0052C	−25°C to +85°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	300°C

DC Electrical Characteristics for LH0022/LH0022C (Note 3) $T_A = T_J$(Max)

Parameter	Conditions	Limits						Units
		LH0022			LH0022C			
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	$R_S \leq 100\ k\Omega$, $T_A = 25°C$ $V_S = \pm 15V$		2.0	4.0		3.5	6.0	mV
	$R_S \leq 100\ k\Omega$, $V_S = \pm 15V$			5.0			7.0	mV
Temperature Coefficient of Input Offset Voltage	$R_S \leq 100\ k\Omega$		10			15		µV/°C
Offset Voltage Drift with Time			3			4		µV/week
Input Offset Current	$T_A = 25°C$ (Note 4)		0.2	2.0		1.0	5.0	pA
				2.0			0.5	nA
Temperature Coefficient of Input Offset Current		Doubles Every 10°C			Doubles Every 10°C			
Offset Current Drift with Time			0.1			0.1		pA/week
Input Bias Current	$T_A = 25°C$ (Note 4)		5	10		10	25	pA
				10			2.5	nA
Temperature Coefficient of Input Bias Current		Doubles Every 10°C			Doubles Every 10°C			
Differential Input Resistance			10^{12}			10^{12}		Ω
Common Mode Input Resistance			10^{12}			10^{12}		Ω
Input Capacitance			4.0			4.0		pF
Input Voltage Range	$V_S = \pm 15V$	±12	±13.5		±12	±13.5		V
Common Mode Rejection Ratio	$R_S \leq 10\ k\Omega$, $V_{IN} = \pm 10V$	74	90		70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10\ k\Omega$, $\pm 5V \leq V_S \leq \pm 15V$	74	90		70	90		dB
Large Signal Voltage Gain	$R_L = 2\ k\Omega$, $V_{OUT} = \pm 10V$ $T_A = 25°C$, $V_S = \pm 15V$	75	100		75	100		V/mV
	$R_L = 2\ k\Omega$, $V_{OUT} = \pm 10V$ $V_S = \pm 15V$	30			30			V/mV
Output Voltage Swing	$R_L = 1\ k\Omega$, $T_A = 25°C$ $V_S = \pm 15V$	±10	±12.5		±10	±12		V
	$R_L = 2\ k\Omega$, $V_S = \pm 15V$	±10			±10			V
Output Current Swing	$V_{OUT} = \pm 10V$, $T_A = 25°C$	±10	±15		±10	±15		mA
Output Resistance			75			75		Ω
Output Short Circuit Current			25			25		mA
Supply Current	$V_S = \pm 15V$		2.0	2.5		2.4	2.8	mA
Power Consumption	$V_S = \pm 15V$			75			85	mW

DC Electrical Characteristics for LH0042/LH0042C (Note 3)

Parameter	Conditions	Limits						Units
		LH0042			LH0042C			
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	$R_S \leq 100\ k\Omega$		5.0	20		6.0	20	mV
Temperature Coefficient of Input Offset Voltage	$R_S \leq 100\ k\Omega$		10			15		$\mu V/°C$
Offset Voltage Drift with Time			7.0			10		μV/week
Input Offset Current	$T_A = 25°C$ (Note 4)		1.0	5.0		2.0	10	pA
Input Bias Current	$T_A = 25°C$ (Note 4)		10	25		15	50	pA
Temperature Coefficient of Input Bias Current		Doubles Every 10°C			Doubles Every 10°C			
Differential Input Resistance			10^{12}			10^{12}		Ω
Common Mode Input Resistance			10^{12}			10^{12}		Ω
Input Capacitance			4.0			4.0		pF
Input Voltage Range		±12	±13.5		±12	±13.5		V
Common Mode Rejection Ratio	$R_S \leq 10\ k\Omega$, $V_{IN} = \pm 10V$	70	86		70	80		dB
Supply Voltage Rejection Ratio	$R_S \leq 10\ k\Omega$, $\pm 5V \leq V_S \leq \pm 15V$	70	86		70	86		dB
Large Signal Voltage Gain	$R_S \leq 2\ k\Omega$, $V_{OUT} = \pm 10V$, $T_A = 25°C$	50	100		25	100		V/mV
	$R_S \leq 2\ k\Omega$, $V_{OUT} = \pm 10V$	30			25			V/mV
Output Voltage Swing	$R_L = 1\ k\Omega$, $T_A = 25°C$	±10	±12.5		±10	±12		V
	$R_L = 2\ k\Omega$	±10			±10			V
Output Current Swing	$V_{OUT} = \pm 10V$	±10	±15		±10	±15		mA
Output Resistance			75			75		Ω
Output Short Circuit Current			20			20		mA
Supply Current	$V_S = \pm 15V$		2.5	3.5		2.8	4.0	mA
Power Consumption	$V_S = \pm 15V$			105			120	mW

DC Electrical Characteristics for LH0052/LH0052C (Note 3) (Continued)

Parameter	Conditions	Limits						Units
		LH0052			LH0052C			
		Min	Typ	Max	Min	Typ	Max	
Input Bias Current	T_A = 25°C (Note 4)		0.5	2.5		1.0	5.0	pA
				2.5			0.5	nA
Temperature Coefficient of Input Bias Current		Doubles Every 10°C			Doubles Every 10°C			
Differential Input Resistance			10^{12}			10^{12}		Ω
Common Mode Input Resistance			10^{12}			10^{12}		Ω
Input Capacitance			4.0			4.0		pF
Input Voltage Range	V_S = ±15V	±12	±13.5		±12	±13.5		V
Common Mode Rejection Ratio	$R_S \leq 10\ k\Omega$, V_{IN} = ±10V	74	90		70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10\ k\Omega$, $\pm 5V \leq V_S \leq \pm 15V$	74	90		70	90		dB
Large Signal Voltage Gain	R_L = 2 kΩ, V_{OUT} = ±10V V_S = ±15V, T_A = 25°C	75	100		75	100		V/mV
	R_L = 2 kΩ, V_{OUT} = ±10V V_S = ±15V	30			30			V/mV
Output Voltage Swing	R_L = 1 kΩ, T_A = 25°C V_S = ±15V	±10	±12.5		±10	±12		V
	R_L = 2 kΩ, V_S = ±15V	±10			±10			V
Output Current Swing	V_{OUT} = ±10V, T_A = 25°C	±10	±15		±10	±15		mA
Output Resistance			75			75		Ω
Output Short Circuit Current			25			25		mA
Supply Current	V_S = ±15V		3.0	3.5		3.0	3.8	mA
Power Consumption	V_S = ±15V			105			114	mW

AC Electrical Characteristics for all amplifiers (T_A = 25°C, V_S = ±15V)

Parameter	Conditions	Limits						Units
		LH0022/42/52			LH0022C/42C/52C			
		Min	Typ	Max	Min	Typ	Max	
Slew Rate	Voltage Follower	1.5	3.0		1.0	3.0		V/μs
Large Signal Bandwidth	Voltage Follower		40			40		kHz
Small Signal Bandwidth			1.0			1.0		MHz
Rise Time			0.3	1.5		0.3	1.5	μs
Overshoot			10	30		15	40	%
Settling Time (0.1%)	ΔV_{IN} = 10V		4.5			4.5		μs
Overload Recovery			4.0			4.0		μs

AC Electrical Characteristics for all amplifiers (T_A = 25°C, V_S = ±15V) (Continued)

Parameter	Conditions	Limits						Units
		LH0042			LH0042C			
		Min	Typ	Max	Min	Typ	Max	
Input Noise Voltage	R_S = 10 kΩ, f_o = 10 Hz		150			150		nV/√Hz
	R_S = 10 kΩ, f_o = 100 Hz		55			55		nV/√Hz
	R_S = 10 kΩ, f_o = 1 kHz		35			35		nV/√Hz
	R_S = 10 kΩ, f_o = 10 kHz		30			30		nV/√Hz
	BW = 10 Hz to 10kHz, R_S = 10 kΩ		12			12		μVrms

Note 1: For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

Note 2: Rating applies for minimum source resistance of 10 kΩ, for source resistances less than 10 kΩ, maximum differential input voltage is ±5V.

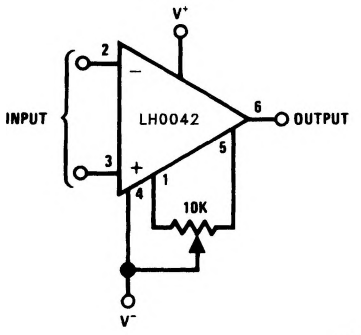
Note 3: Unless otherwise specified, these specifications apply for $\pm 5V \leq V_S \leq \pm 20V$ and $-55°C \leq T_A \leq +125°C$ for the LH0042 and $-25°C \leq T_A \leq +85°C$ for the LH0042C. Typical values are given for T_A = 25°C.

Note 4: Input currents are a strong function of temperature. Due to high speed testing they are specified at a junction temperature T_j = 25°C. Self heating will cause an increase in current in manual tests. 25°C spec is guaranteed by testing at 125°C.

Note 5: See RETS0042X for the LH0042H military specifications.

Auxiliary Circuits (Shown for TO-99 pin out)

Offset Null



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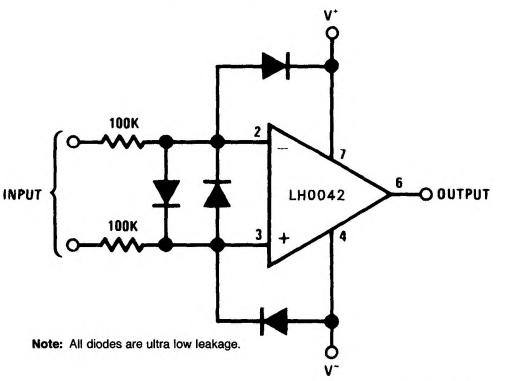
Protecting Inputs from ±150V Transients



Note: All diodes are ultra low leakage.

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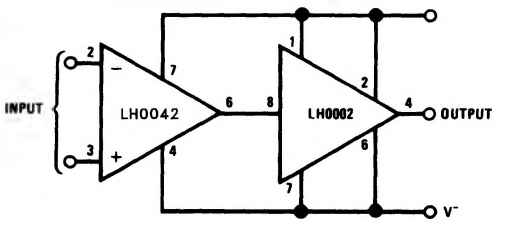
Boosting Output Drive to ±100 mA



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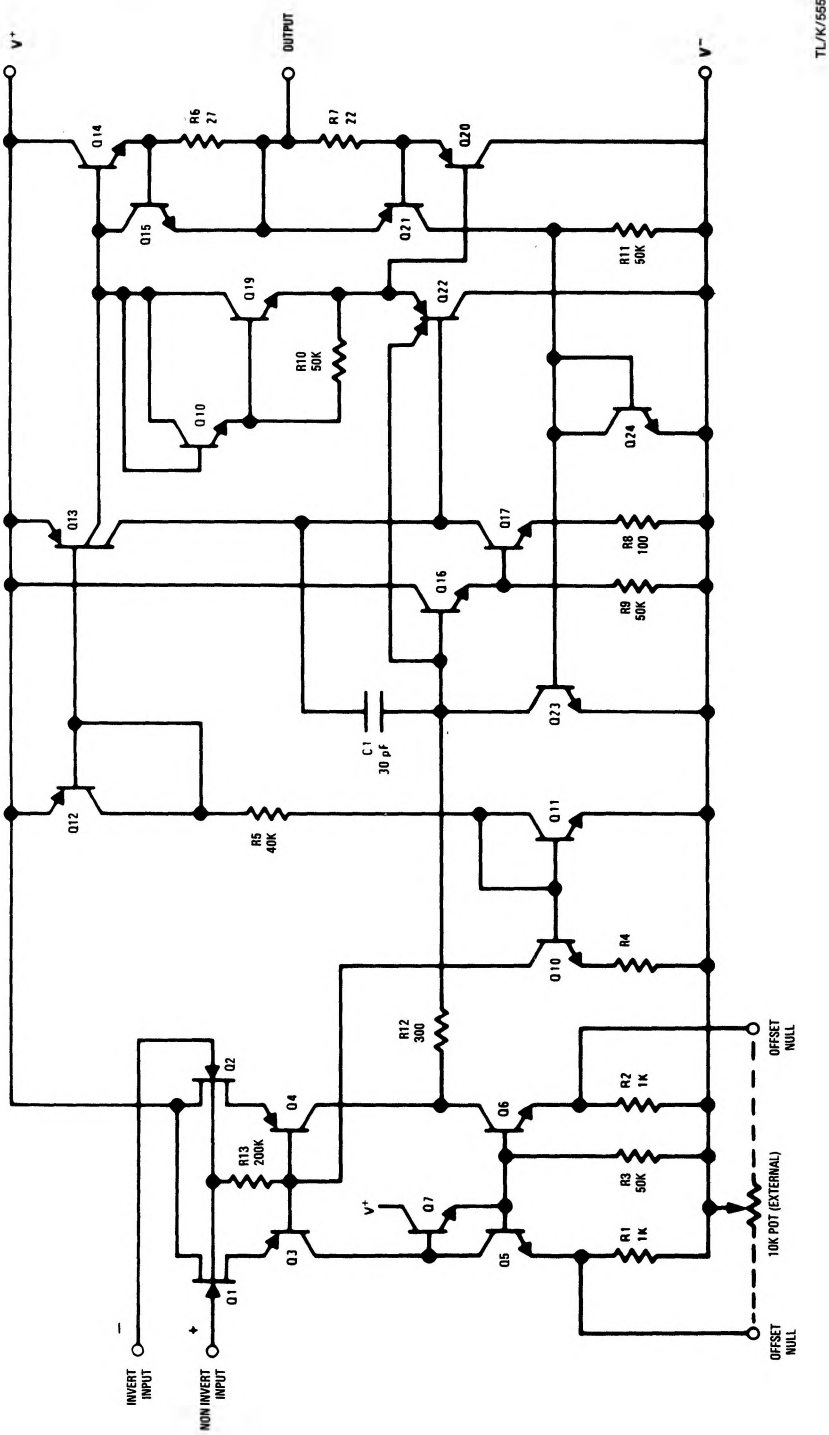
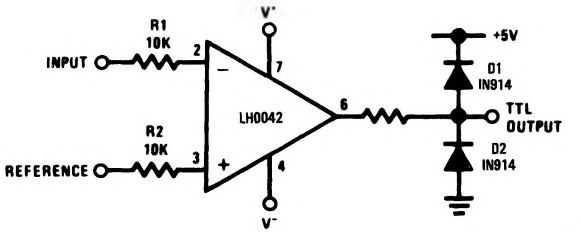
Schematic Diagram



Typical Applications

Precision Voltage Comparator



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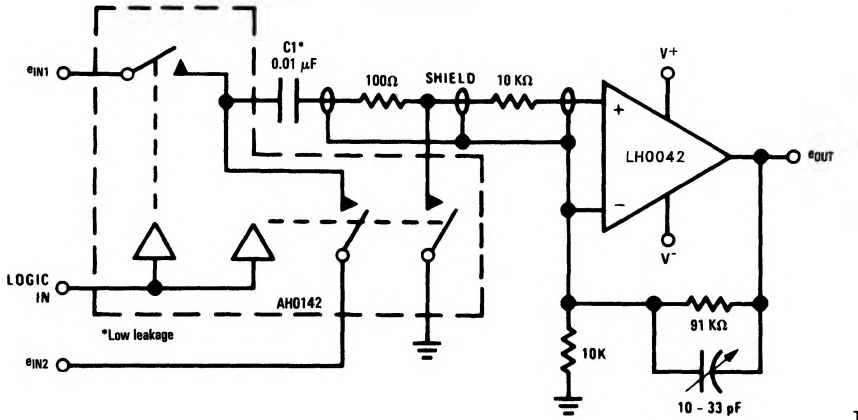
Subtractor for Automatic Test Gear



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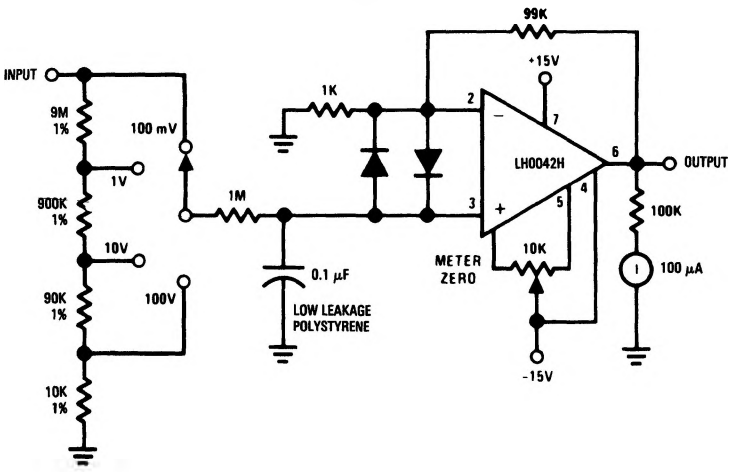
$e_{OUT} = 10 \times (e_{IN1} - e_{IN2})$

Sensitive Low Cost "VTVM"



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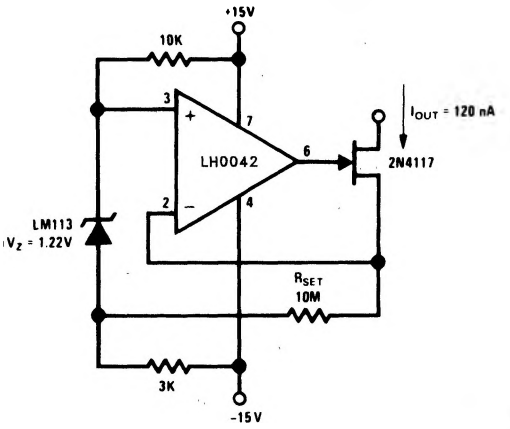
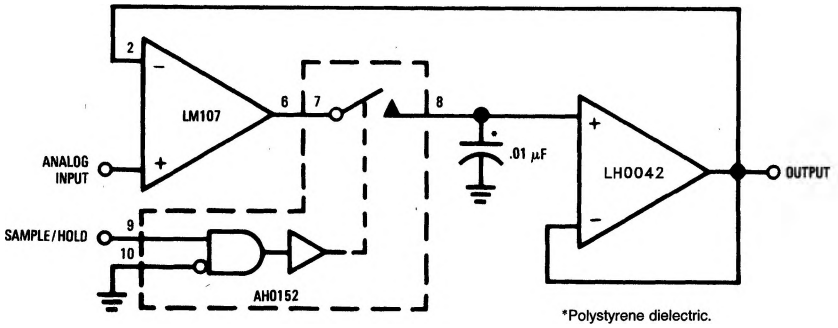
Typical Applications (Continued)

Ultra Low Level Current Source



TL/K/5777–13

Sample and Hold



*Polystyrene dielectric.

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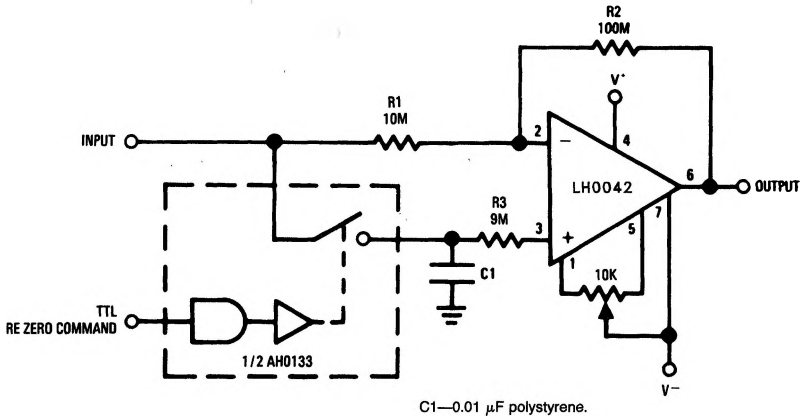
Re-Zeroing Amplifier



C1—0.01 μF polystyrene.

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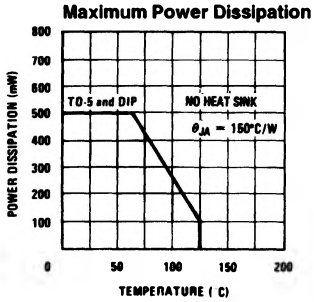
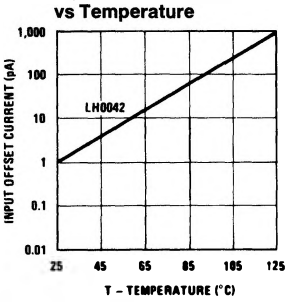
Typical Performance Characteristics

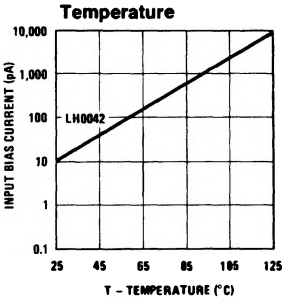
Maximum Power Dissipation



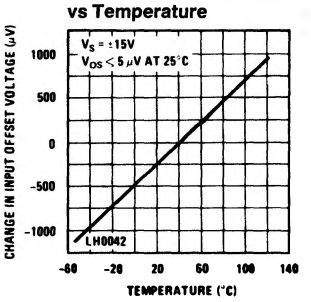
Input Offset Current vs Temperature



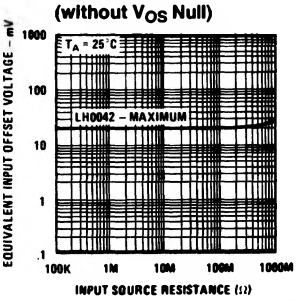
Input Bias Current vs Temperature



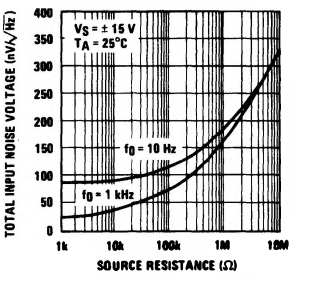
Input Offset Voltage vs Temperature



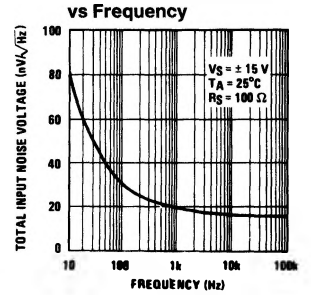
Offset Error (without V_{OS} Null)



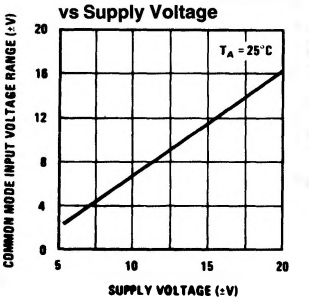
Total Input Noise Voltage* vs Source Resistance



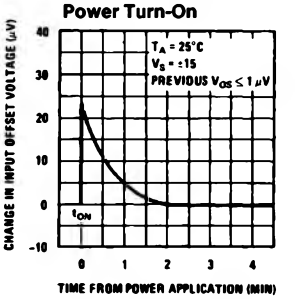
Total Input Noise Voltage* vs Frequency



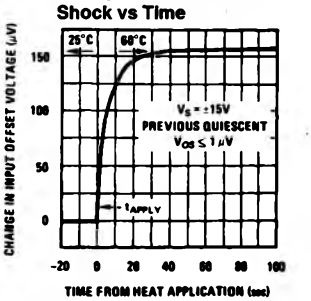
Common Mode Input Voltage vs Supply Voltage



Stabilization Time of Input Offset Voltage from Power Turn-On



Change in Input Offset Voltage Due to Thermal Shock vs Time



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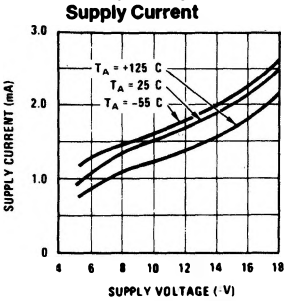
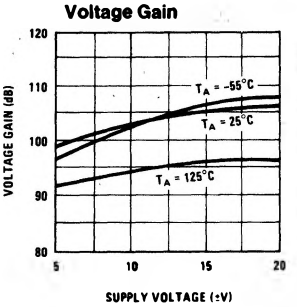
*Noise voltage includes contribution from source resistance.

Typical Performance Characteristics (Continued)

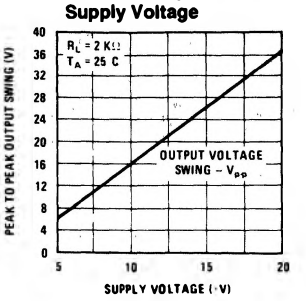
Supply Voltage vs Supply Current



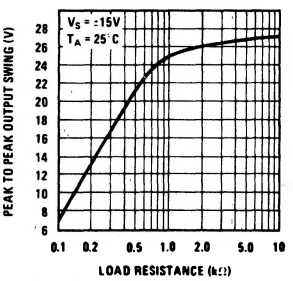
Voltage Gain



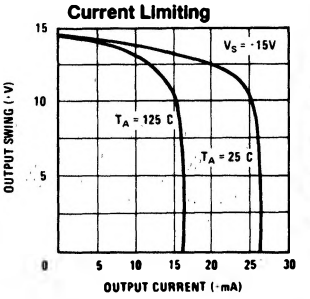
Output Swing vs Supply Voltage



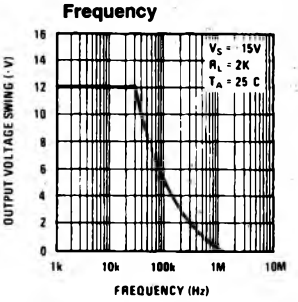
Output Voltage Swing vs Load Resistance



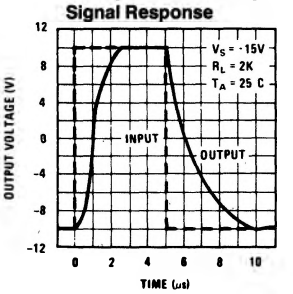
Current Limiting



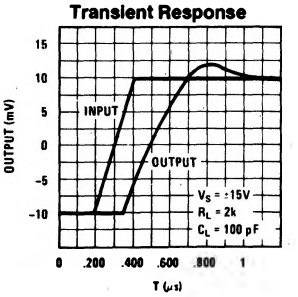
Output Voltage Swing vs Frequency



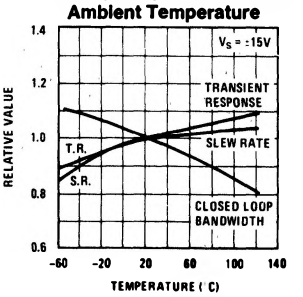
Voltage Follower Large Signal Response



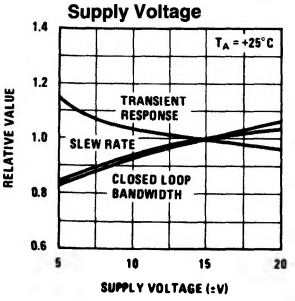
Transient Response



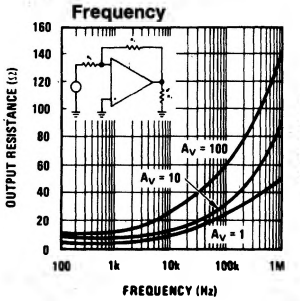
Frequency Characteristics vs Ambient Temperature



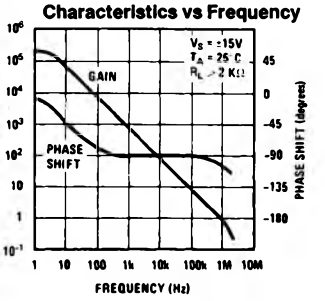
Frequency Characteristics vs Supply Voltage



Output Resistance vs Frequency



Open Loop Transfer Characteristics vs Frequency



TL/K/5557–19