Data Sheet | April 1999 | File Number 2907.4

2.5MHz, Precision Operational Amplifier

The Intersil HA-5135 is a precision operational amplifier manufactured using a combination of key technological advancements to provide outstanding input characteristics.

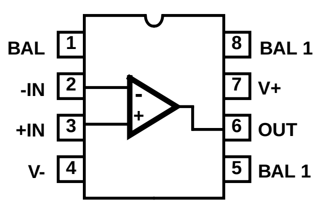
A Super Beta input stage is combined with laser trimming, dielectric isolation and matching techniques to produce 75μV (Maximum) input offset voltage and 0.4μV/^{o}C input offset voltage average drift. Other features enhanced by this process include 9nV/$\sqrt{Hz}$ (Typ) Input Noise Voltage, 1nA Input Bias Current and 140dB Open Loop Gain.

These features coupled with 120dB CMRR and PSRR make the HA-5135 an ideal device for precision DC instrumentation amplifiers. Excellent input characteristics in conjunction with 2.5MHz bandwidth and 0.8V/μs slew rate, make this amplifier extremely useful for precision integrator and biomedical amplifier designs. This amplifier is also well suited for precision data acquisition and for accurate threshold detector applications.

HA-5135 offers added features over the industry standard OP-07 in regards to bandwidth and slew rate specifications. For the military grade product, refer to the HA-5135/883 data sheet.

Pinout

HA-5135
(CERDIP)
TOP VIEW



NOTE: Both BAL 1 pins are connected together internally.

Features

- Low Offset Voltage . . . . 75μV (Max)
- Low Offset Voltage Drift . . . . 0.4μV/^{o}C
- Low Noise. . . . . 9nV/$\sqrt{Hz}$
- Open Loop Gain 140dB
- Unity Gain Bandwidth. 2.5MHz
- All Bipolar Construction

Applications

- High Gain Instrumentation
- Precision Data Acquisition
- Precision Integrators
- Biomedical Amplifiers
- Precision Threshold Detectors

Ordering Information

PART NUMBER	TEMP. RANGE (^{o}C)	PACKAGE	PKG. NO.
HA7-5135-5	0 to 75	8 Ld CERDIP	F8.3A

Absolute Maximum Ratings

Voltage Between V+ and V- Terminals 40V
Differential Input Voltage 7V
Output Short Circuit Duration. . . . . Indefinite

Operating Conditions

Temperature Ranges
HA-5135-5 . . . . 0^oC to 75^oC

Thermal Information

Thermal Resistance (Typical, Note 2)	θ_{JA} ($^oC/W$)	θ_{JC} ($^oC/W$)
CERDIP Package	135	50

Maximum Junction Temperature (Note 1) . . . . 175^oC
Maximum Storage Temperature Range . . . . -65^oC to 150^oC
Maximum Lead Temperature (Soldering 10s) . . . . 300^oC

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTES:

1. Maximum power dissipation, including output load, must be designed to maintain the maximum junction temperature below 175^oC.
2. θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

Electrical Specifications $V_{SUPPLY} = \pm15V$

PARAMETER	TEST CONDITIONS	TEMP. (^oC)	HA-5135-5 MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS						
Offset Voltage		25	-	10	75	µV
		Full	-	50	130	µV
Average Offset Voltage Drift		Full	-	0.4	1.3	µV/^oC
Bias Current		25	-	±1	±4	nA
		Full	-	-	±6	nA
Bias Current Average Drift		Full	-	0.02	0.04	nA/^oC
Offset Current		25	-	-	4	nA
		Full	-	-	5.5	nA
Offset Current Average Drift		Full	-	0.02	0.04	nA/^oC
Common Mode Range		Full	±12	-	-	V
Differential Input Resistance		25	20	30	-	MΩ
Input Noise Voltage (Note 3)	0.1Hz to 10Hz	25	-	-	0.6	μV_{P-P}
Input Noise Voltage Density (Note 3)	f = 10Hz	25	-	13.0	18.0	$nV/\sqrt{Hz}$
	f = 100Hz		-	10.0	13.0	$nV/\sqrt{Hz}$
	f = 1000Hz		-	9.0	11.0	$nV/\sqrt{Hz}$
Input Noise Current (Note 3)	0.1Hz to 10Hz	25	-	15	30	pA_{P-P}
Input Noise Current Density (Note 3)	f = 10Hz	25	-	0.4	0.8	$pA/\sqrt{Hz}$
	f = 100Hz		-	0.17	0.23	$pA/\sqrt{Hz}$
	f = 1000Hz		-	0.14	0.17	$pA/\sqrt{Hz}$
TRANSFER CHARACTERISTICS						
Large Signal Voltage Gain	$V_{OUT} = \pm10V$, $R_L = 2k\Omega$	25	120	140	-	dB
		Full	120	-	-	dB
Common Mode Rejection Ratio	$V_{CM} = \pm10V$	Full	106	120	-	dB
Closed Loop Bandwidth	$A_{VCL} = +1$	25	0.6	2.5	-	MHz
OUTPUT CHARACTERISTICS						
Output Voltage Swing	$R_L = 600\Omega$	25	±10	±12	-	V
		Full	±10	-	-	V

Electrical Specifications $V_{SUPPLY} = \pm15V$ **(Continued)**

PARAMETER	TEST CONDITIONS	TEMP. (^oC)	HA-5135-5			UNITS
			MIN	TYP	MAX	
Full Power Bandwidth (Note 4)	$R_L = 2k\Omega$	25	8	10	-	kHz
Output Current	$V_{OUT} = 10V$	25	±15	±20	-	mA
Output Resistance	Note 5	25	-	45	-	Ω
TRANSIENT RESPONSE (Note 6)						
Rise Time		25	-	340	-	ns
Slew Rate		25	0.5	0.8	-	V/µs
Settling Time (Note 7)		25	-	11	-	µs
POWER SUPPLY CHARACTERISTICS						
Supply Current		Full	-	1.0	1.7	mA
Power Supply Rejection Ratio	$V_S = \pm5V$ to $\pm20V$	Full	94	130	-	dB

NOTES:

3. Not tested. 90% of units meet or exceed these specifications.
4. Full power bandwidth guaranteed based on slew rate measurement using: $FPBW = \frac{\text{Slew Rate}}{2\pi V_{PEAK}}$.
5. Output resistance measured under open loop conditions (f = 100Hz).
6. Refer to test circuits section of the data sheet.
7. Settling time is measured to 0.1% of final value for a 10V output step and $A_V = -1$.

Test Circuits and Waveforms

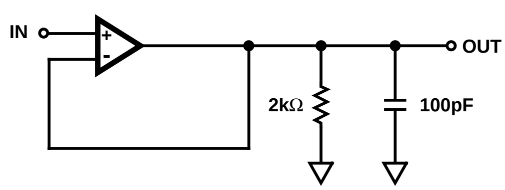
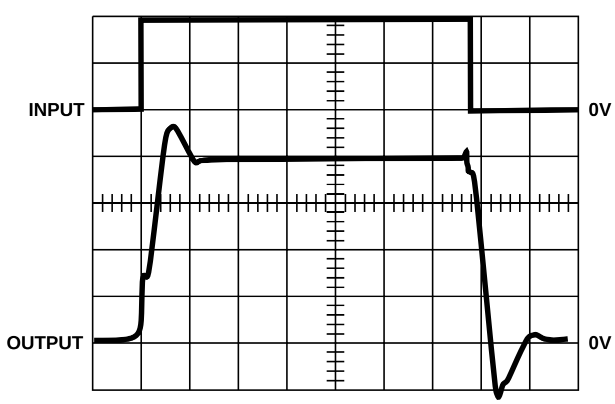
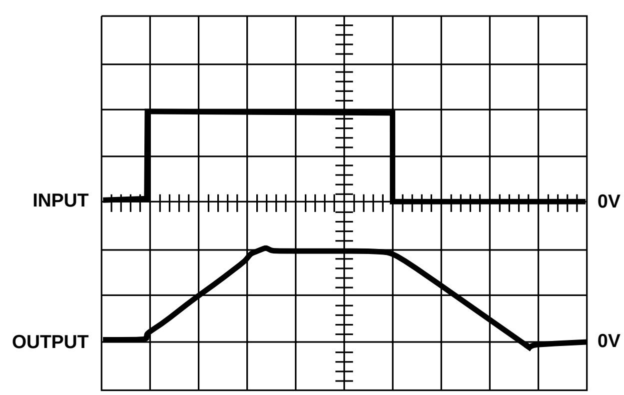


FIGURE 1. SLEW RATE AND TRANSIENT RESPONSE TEST CIRCUIT



Vertical Scale: Input = 50mV/Div. Output = 100mV/Div.
Horizontal Scale: 1µs/Div.

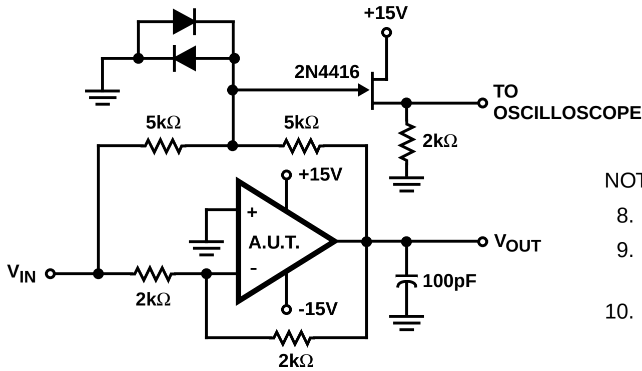
SMALL SIGNAL RESPONSE



Vertical Scale: 5V/Div.
Horizontal Scale: 5µs/Div.

LARGE SIGNAL RESPONSE

Test Circuits and Waveforms (Continued)

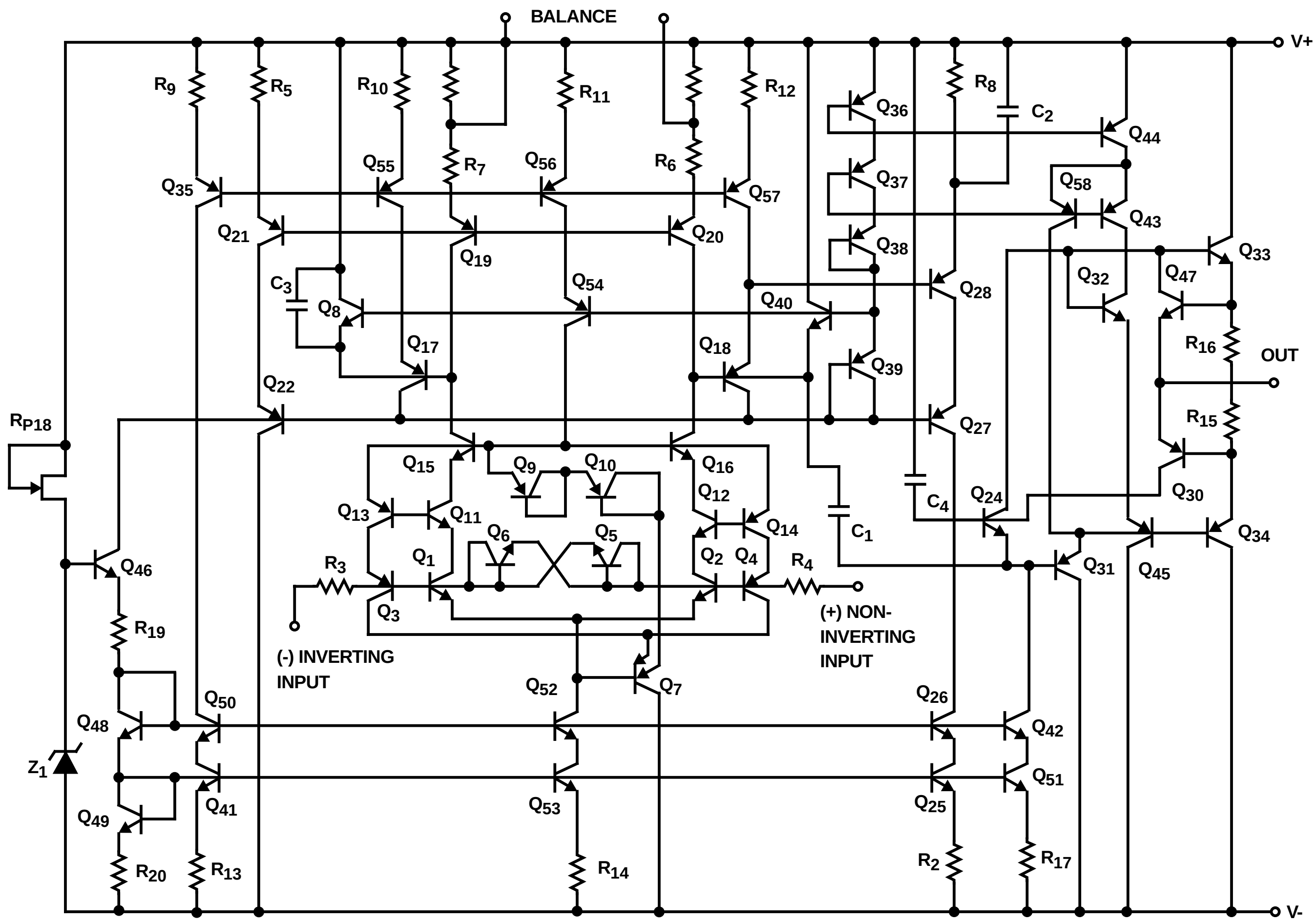


NOTES:

8. A_V = -1.
9. Feedback and summing resistors should be 0.1% matched.
10. Clipping diodes are optional. HP5082-2810 recommended.

FIGURE 2. SETTLING TIME CIRCUIT

Schematic Diagram



Application Information

Power Supply Decoupling

Although not absolutely necessary, it is recommended that all power supply lines be decoupled with 0.01µF ceramic capacitors to ground. Decoupling capacitors should be located as near to the amplifier terminals as possible.

Considerations For Prototyping:

The following list of recommendations are suggested for prototyping.

1. Resolving low level signals requires minimizing leakage currents caused by external circuitry. Use of quality insulating materials, thorough cleaning of insulating surfaces and implementation of moisture barriers when required is suggested.
2. Error voltages generated by thermocouples formed between dissimilar metals in the presence of temperature gradients should be minimized. Isolation of low level circuity from heat generating components is recommended.
3. Shielded cable input leads, guard rings and shield drivers are recommended for the most critical applications.

Large Capacitive Loads

When driving large capacitive loads (>500pF), a small value resistor (≈50Ω) should be connected in series with the output and inside the feedback loop.

Offset Voltage Adjustment (See Figure 3)

A 20kΩ balance potentiometer is recommended if offset nulling is required. However, other potentiometer values such as 10kΩ, 50kΩ and 100kΩ may be used. The minimum adjustment range for given values is ±2mV. V_{OS} TC of the amplifier is optimized at minimal V_{OS}. Tested Offset Adjustment is $|V_{OS}$ + 1mV$|$ minimum referred to output.

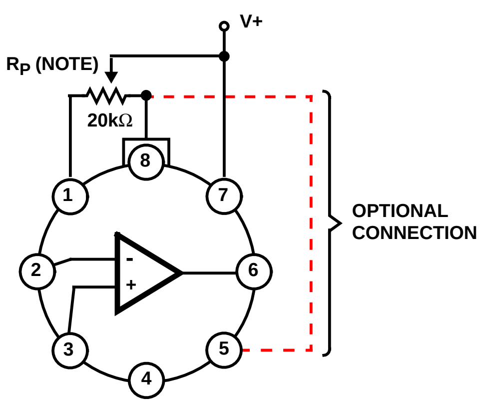


FIGURE 3. OFFSET NULLING CONNECTIONS

Saturation Recovery

Input and output saturation recovery time is negligible in most applications. However, care should be exercised to avoid exceeding the absolute maximum ratings of the device.

Differential Input Voltages

Inputs are shunted with back-to-back diodes for overvoltage protection. In applications where differential input voltages in excess of 1V are applied between the inputs, the use of limiting resistors at the inputs is recommended.

Typical Applications

The excellent input and gain characteristics of HA-5135 are well suited for precision integrator applications. Accurate integration over seven decades of frequency using HA-5135, virtually nullifies the need for more expensive chopper-type amplifiers.

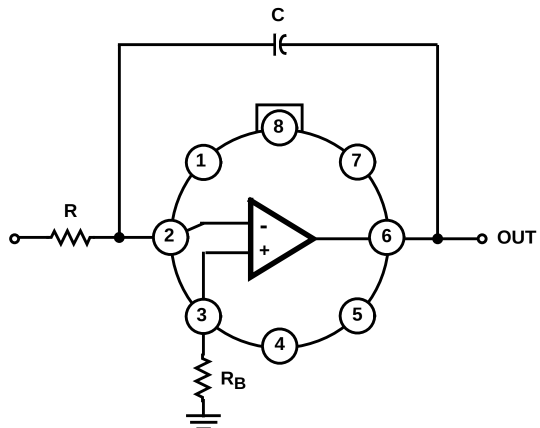


FIGURE 4. PRECISION INTEGRATOR

Low V_{OS} coupled with high open loop Gain, high CMRR and high PSRR make HA-5135 ideally suited for precision detector applications, such as the zero crossing detector shown in Figure 5.

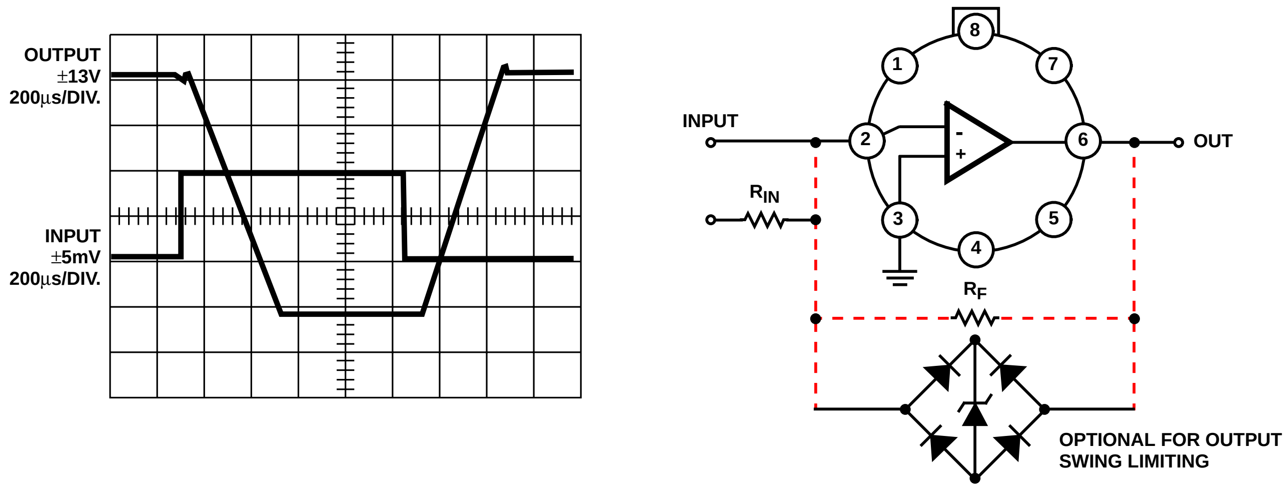


FIGURE 5. ZERO CROSSING DETECTOR

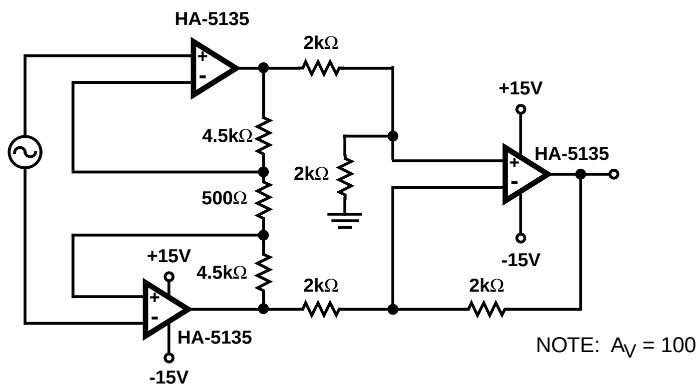


FIGURE 6. PRECISION INSTRUMENTATION AMPLIFIER

Typical Performance Curves

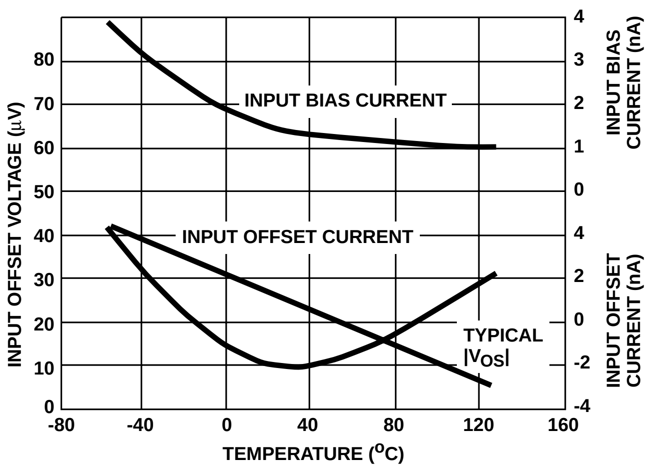


FIGURE 7. INPUT OFFSET VOLTAGE, INPUT BIAS AND OFFSET CURRENT vs TEMPERATURE

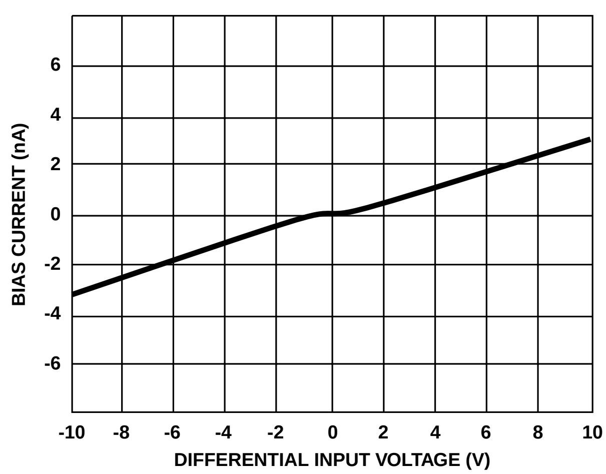


FIGURE 8. INPUT BIAS CURRENT vs DIFFERENTIAL INPUT VOLTAGE

Typical Performance Curves (Continued)

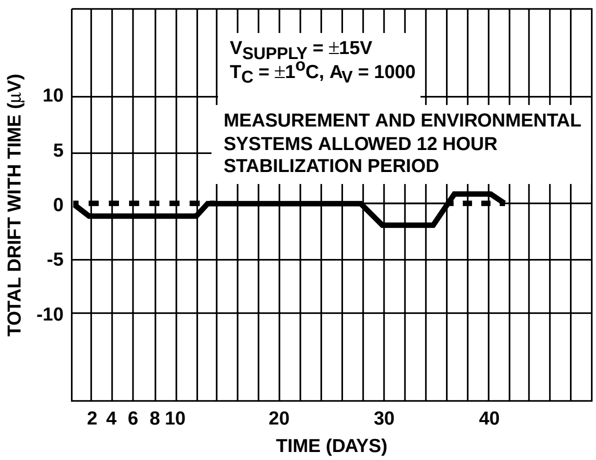


FIGURE 9. HA-5135 OFFSET VOLTAGE STABILITY vs TIME

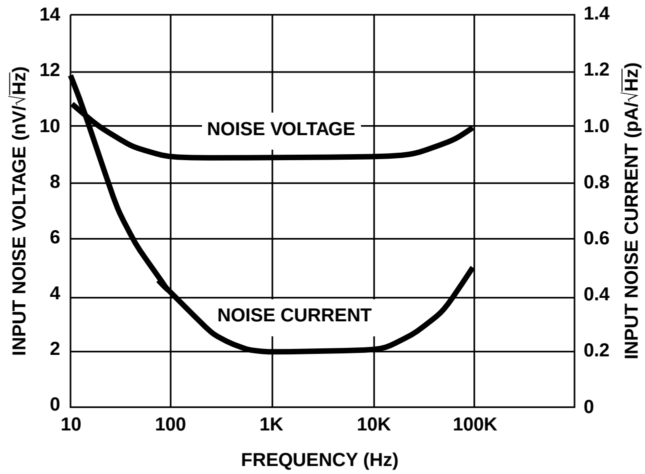


FIGURE 10. INPUT NOISE vs FREQUENCY

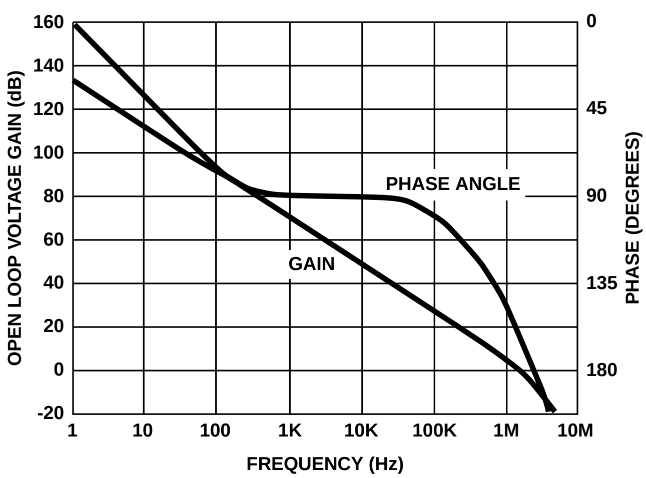


FIGURE 11. OPEN LOOP FREQUENCY RESPONSE

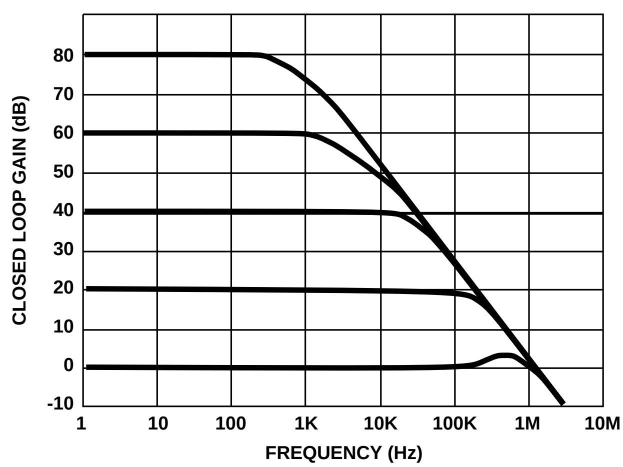


FIGURE 12. CLOSED LOOP FREQUENCY RESPONSE

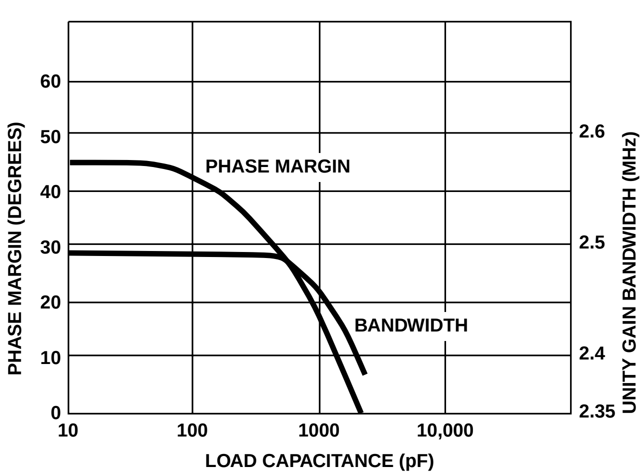


FIGURE 13. SMALL SIGNAL BANDWIDTH AND PHASE MARGIN vs LOAD CAPACITANCE

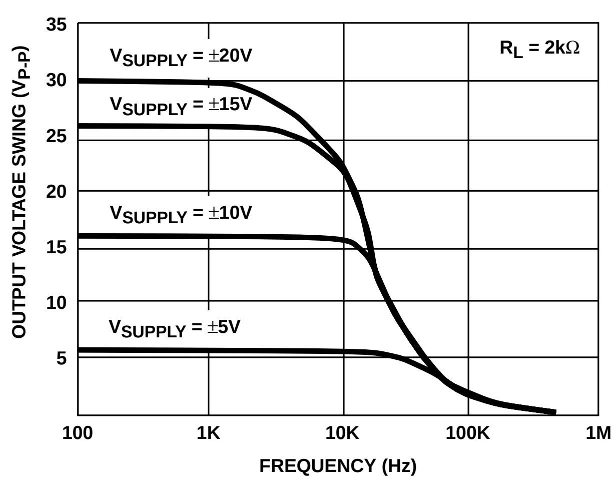


FIGURE 14. OUTPUT VOLTAGE SWING vs FREQUENCY

Typical Performance Curves (Continued)

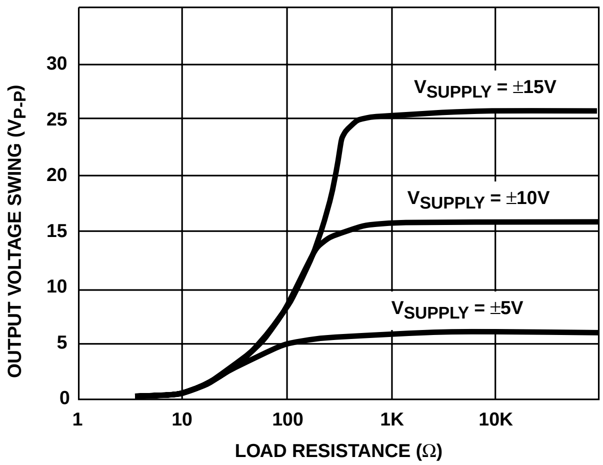


FIGURE 15. MAXIMUM OUTPUT VOLTAGE SWING vs LOAD RESISTANCE

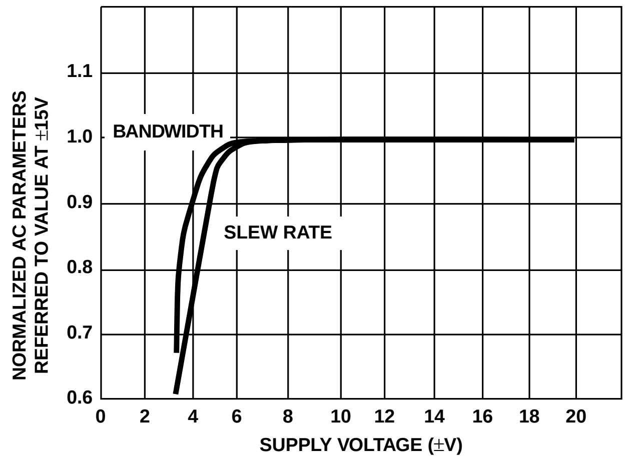


FIGURE 16. NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE

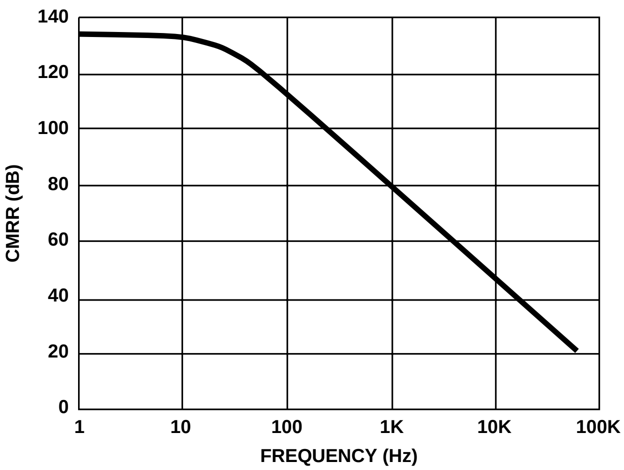


FIGURE 17. CMRR vs FREQUENCY

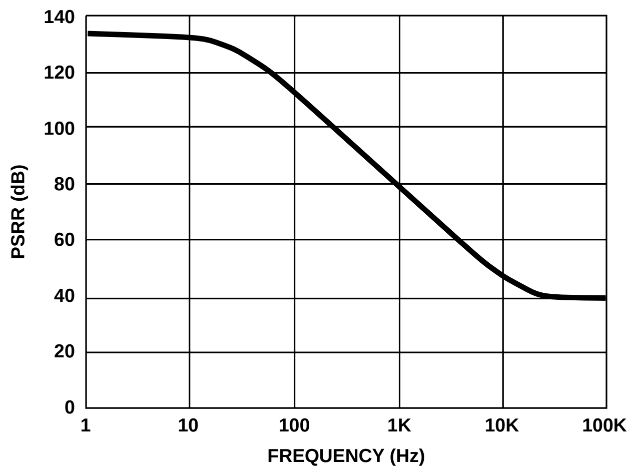


FIGURE 18. PSRR vs FREQUENCY

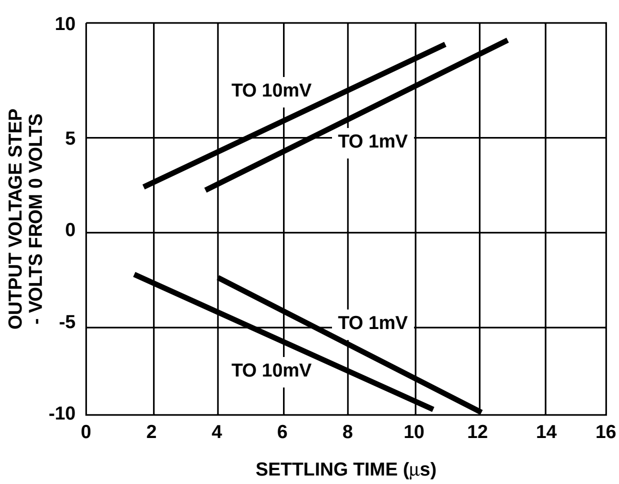


FIGURE 19. SETTLING TIME FOR VARIOUS OUTPUT STEP VOLTAGES

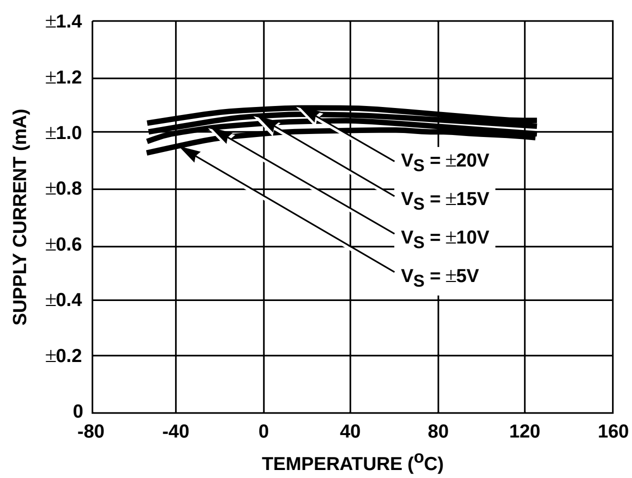


FIGURE 20. POWER SUPPLY CURRENT vs TEMPERATURE

Die Characteristics

DIE DIMENSIONS:

72 mils x 103 mils x 19 mils
(1840μm x 2620μm x 483μm)

METALLIZATION:

Type: Al, 1% Cu
Thickness: 16kÅ ±2kÅ

SUBSTRATE POTENTIAL (POWERED UP):

V-

PASSIVATION:

Type: Nitride (Si_3N_4) over Silox (SiO_2, 5% Phos.)
Silox Thickness: 12kÅ ±2kÅ
Nitride Thickness: 3.5kÅ ±1.5kÅ

TRANSISTOR COUNT:

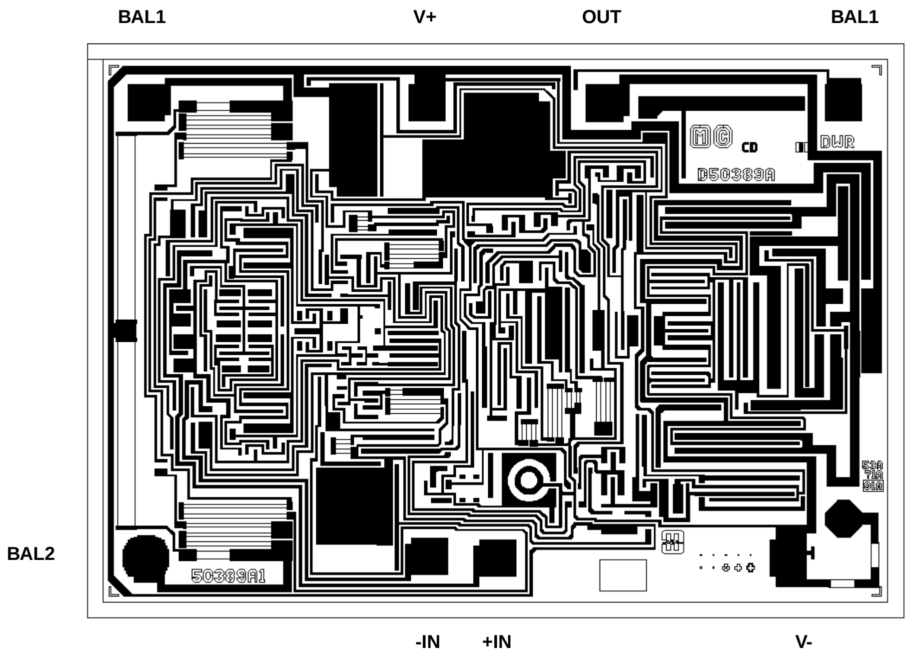
71

PROCESS:

Bipolar Dielectric Isolation

Metallization Mask Layout

HA-5135



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