HA-2404, HA-2405

40MHz, PRAM Four Channel Programmable Amplifiers

August 2002

Features

- **Programmability**
- **High Rate Slew 30V/μs**
- **Wide Gain Bandwidth 40MHz**
- **High Gain 150kV/V**
- **Low Offset Current 5nA**
- **High Input Impedance 30MΩ**
- **Single Capacitor Compensation**
- **DTL/TTL Compatible Inputs**

Applications

- **Thousands of Applications; Program**
  - **Signal Selection/Multiplexing**
  - **Operational Amplifier Gain**
  - **Oscillator Frequency**
  - **Filter Characteristics**
  - **Add-Subtract Functions**
  - **Integrator Characteristics**
  - **Comparator Levels**

Description

The HA-2404/05 comprise a series of four-channel programmable amplifiers providing a level of versatility unsurpassed by any other monolithic operational amplifier. Versatility is achieved by employing four input amplifier channels, any one (or none) of which may be electronically selected and connected to a single output stage through DTL/TTL compatible address inputs. The device formed by the output and the selected pair of inputs is an op amp which delivers excellent slew rate, gain bandwidth and power bandwidth performance. Other advantageous features for these dielectrically isolated amplifiers include high voltage gain and input impedance coupled with low input offset voltage and offset current. External compensation is not required on this device at closed loop gains greater than 10.

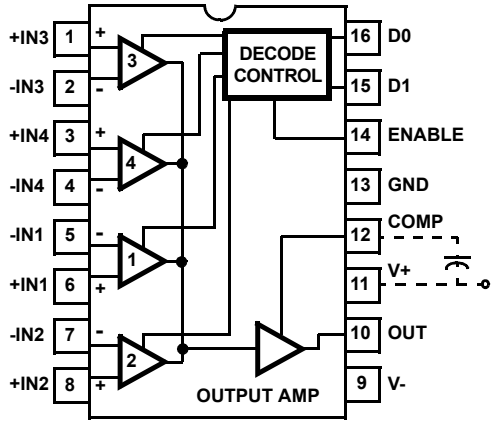
Each channel of the HA-2404/05 can be controlled and operated with suitable feedback networks in any of the standard op amp configurations. This specialization makes these amplifiers excellent components for multiplexing signal selection and mathematical function designs. With 30V/μs slew rate, 40MHz gain bandwidth and 30MΩ input impedance these devices are ideal building blocks for signal generators, active filters and data acquisition designs. Programmability, coupled with 4mV typical offset voltage and 5nA offset current, makes these amplifiers outstanding components for signal conditioning circuits.

During Disable Mode V_{OUT} goes to V-. For high output impedance during Disable, see HA2444.

For further design ideas, see Application Note AN514.

Pinout

HA-2404 (CERDIP)
HA-2405 (CERDIP, PDIP)
TOP VIEW)



TRUTH TABLE

D1	D0	EN	SELECTED CHANNEL	D1
L	L	H	1	L
L	H	H	2	L
H	L	H	3	H
H	H	H	4	H
X	X	L	None, V_{OUT} goes to V-	X

Ordering Information

PART NUMBER	TEMP. RANGE (^{O}C)	PACKAGE	PKG. NO.
HA1-2404-4	-25 to 85	16 Ld CERDIP	F16.3
HA1-2405-5	0 to 75	16 Ld CERDIP	F16.3
HA3-2405-5	0 to 75	16 Ld PDIP	E16.3

Absolute Maximum Ratings $T_A = 25^oC$

Voltage Between V+ and V- Terminals 45.0V
Differential Input Voltage . . . . . V_{SUPPLY}
Digital Input Voltage . . . . . -0.76V to +10.0V
Output Current . . . . . Short Circuit Protected, I_{SC} <±33mA)
Internal Power Dissipation (Note 1)

Operating Conditions

Temperature Range
HA-2404-4. . . . . -25^oC to 85^oC
HA-2405-5. . . . . 0^oC to 75^oC

Thermal Information

Thermal Resistance (Typical, Note 2)	θ_{JA} ($^oC/W$)	θ_{JC} ($^oC/W$)
PDIP Package	80	N/A
CERDIP Package	75	22

Maximum Junction Temperature (Ceramic Package) . . . . . 175^oC
Maximum Junction Temperature (Plastic Package) . . . . . 150^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 junction temperature below 175^oC for the ceramic package, and below 150^oC for the plastic packages.
2. θ_{JA} is measured with the component mounted on a low effective thermal conductivity test board in free air. See Tech Brief TB379 for details.

Electrical Specifications

Test Conditions: V_{SUPPLY} = ±15V, Unless Otherwise Specified. Digital Inputs: V_{IL} = +0.5V, V_{IH} = +2.4. Limits apply to each of the four channels, when addressed

PARAMETER	TEST CONDITIONS	TEMP. (^oC)	HA-2404			HA-2405			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
INPUT CHARACTERISTICS									
Offset Voltage		25	-	4	9	-	4	9	mV
		Full	-	-	11	-	-	11	mV
Bias Current (Note 8)		25	-	50	200	-	50	250	nA
		Full	-	-	400	-	-	500	nA
Offset Current (Note 8)		25	-	5	50	-	5	50	nA
		Full	-	-	100	-	-	100	nA
Input Resistance (Note 8)		25	-	30	-	-	30	-	MΩ
Common Mode Range		Full	±9.0	-	-	±9.0	-	-	V
TRANSFER CHARACTERISTICS									
Large Signal Voltage Gain	R_L = 2kΩ	25	50	150	-	50	150	-	kV/V
	V_{OUT} = $20V_{P-P}$	Full	25	-	-	25	-	-	kV/V
Common Mode Rejection Ratio	V_{CM} = ±5V	Full	80	100	-	74	100	-	dB
Gain Bandwidth (Notes 3, 9)		25	20	40	-	20	40	-	MHz
Gain Bandwidth (Notes 4, 9)		25	4	8	-	4	8	-	MHz
Minimum Stable Gain	(C_{COMP} = 0)		10	-	-	10	-	-	V/V
OUTPUT CHARACTERISTICS									
Output Voltage Swing	R_L = 2kΩ	Full	±10.0	±12.0	-	±10.0	±12.0	-	V
Output Current		25	10	20	-	10	20	-	mA
Full Power Bandwidth (Notes 3, 10)	V_{OUT} = $20V_{P-P}$	25	640	950	-	640	950	-	kHz
Full Power Bandwidth (Notes 4, 10)	V_{OUT} = $20V_{P-P}$	25	200	250	-	200	250	-	kHz
TRANSIENT RESPONSE (Note 11)									
Rise Time (Note 4)	V_{OUT} = $200mV_{PEAK}$	25	-	20	45	-	20	50	ns
Overshoot (Note 4)	V_{OUT} = $200mV_{PEAK}$	25	-	25	40	-	25	40	%
Slew Rate (Note 3)	V_{OUT} = $10V_{P-P}$	25	20	30	-	20	30	-	V/µs
Slew Rate (Notes 4, 9)	V_{OUT} = $10V_{P-P}$	25	6	8	-	6	8	-	V/µs
Settling Time (Notes 4, 5, 9)	V_{OUT} = $10V_{P-P}$	25	-	1.5	2.5	-	1.5	2.5	µs

Electrical Specifications Test Conditions: $V_{SUPPLY} = \pm 15V$, Unless Otherwise Specified. Digital Inputs: $V_{IL} = +0.5V$, $V_{IH} = +2.4$. Limits apply to each of the four channels, when addressed **(Continued)**

PARAMETER	TEST CONDITIONS	TEMP. (^oC)	HA-2404			HA-2405			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
CHANNEL SELECT CHARACTERISTICS									
Digital Input Current	$V_{IN} = 0V$	Full	-	1	1.5	-	1	1.5	mA
Digital Input Current	$V_{IN} = +5.0V$	Full	-	5	-	-	5	-	nA
Output Delay (Notes 6, 9)		25	-	100	250	-	100	250	ns
Crosstalk (Note 7)		25	-80	-110	-	-74	-110	-	dB
POWER SUPPLY CHARACTERISTICS									
Supply Current		25	-	4.8	6.0	-	4.8	6.0	mA
Power Supply Rejection Ratio	$V_S = \pm 10V$ to $\pm 20V$	Full	74	90	-	74	90	-	dB

NOTES:

3. $A_V = +10$, $C_{COMP} = 0$, $R_L = 2k\Omega$, $C_L = 50pF$.
4. $A_V = +1$, $C_{COMP} = 15pF$, $R_L = 2k\Omega$, $C_L = 50pF$.
5. To 0.1% of final value.
6. To 10% of final value; output then slews at normal rate to final value.
7. Unselected input to output; $V_{IN} = \pm 10V_{DC}$.
8. Unselected channels have approximately the same input parameters.
9. Guaranteed by design.
10. Full Power Bandwidth based on slew rate measurement using: $FPBW = \frac{SR}{2\pi V_{PEAK}}$; $V_{PEAK} = 5V$.
11. See Figure 13 for test circuit.

Schematic Diagram

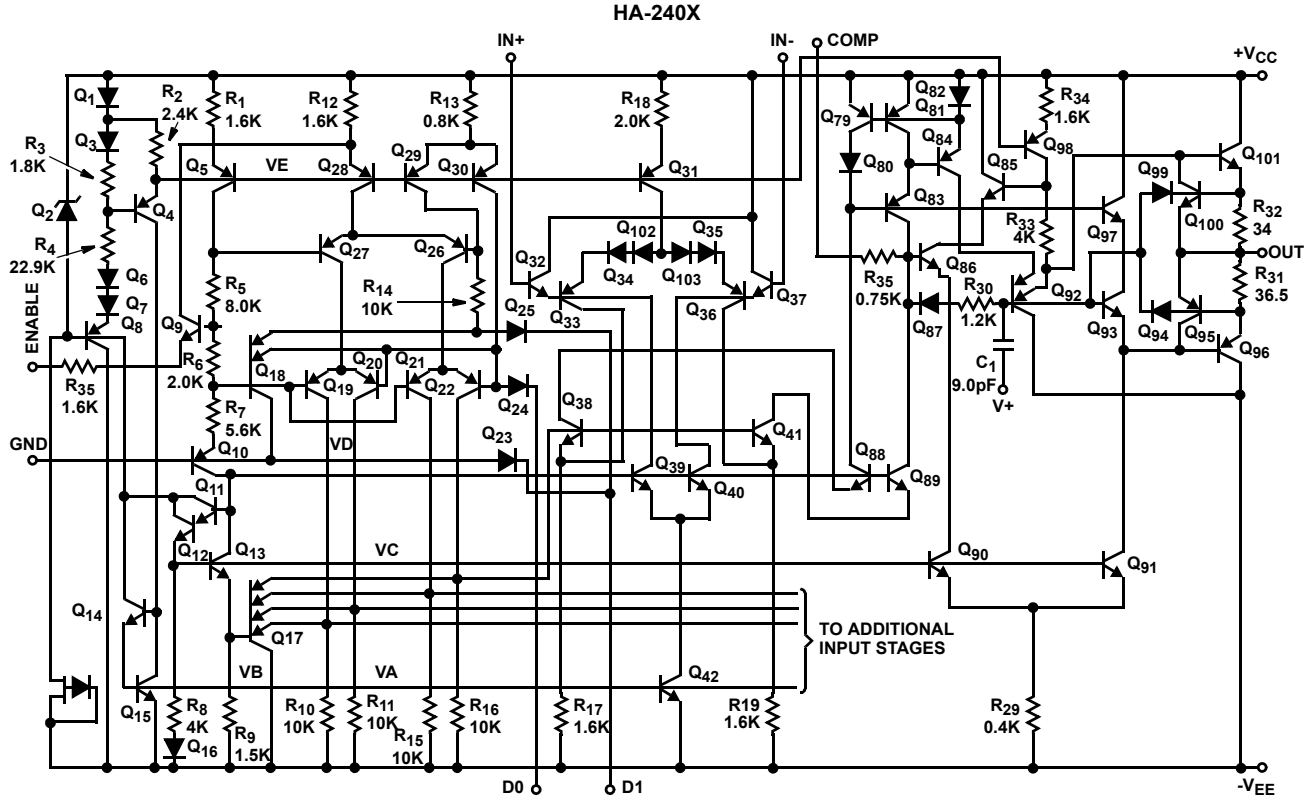


Diagram Includes: One Input Stage, Decode Control, Bias Network, and Output Stage

Typical Applications

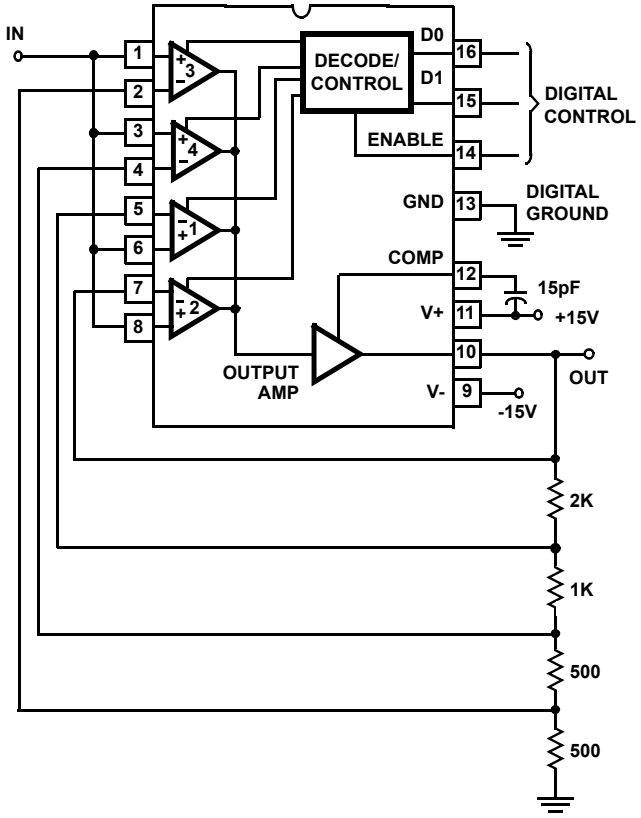
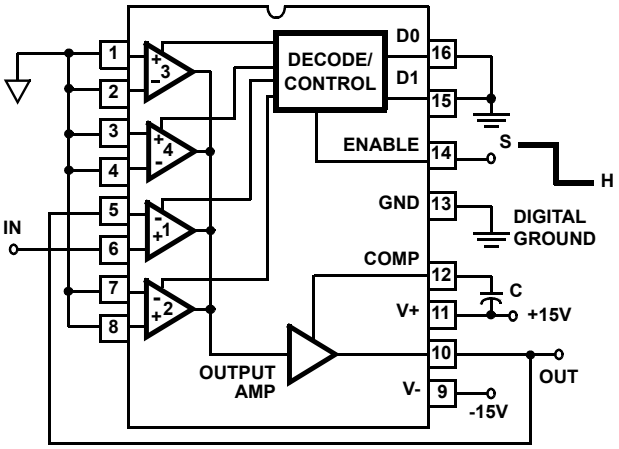


FIGURE 1. HA-240X AMPLIFIER, NONINVERTING PROGRAMMABLE GAIN



Sample Charging Rate $= \frac{I_1}{C} V/s$

Hold Drift Rate $= \frac{I_2}{C} V/s$

Switch Pedestal Error $= \frac{Q}{C} V$

$I_1 \approx 150 \times 10^{-6} A$

$I_2 \approx 200 \times 10^{-9} A$ at 25^oC

$\approx 600 \times 10^{-9} A$ at -55^oC

$\approx 100 \times 10^{-9} A$ at 125^oC

$Q \approx 2 \times 10^{-12} C$

FIGURE 2. HA-240X SAMPLE AND HOLD

For more examples, see Intersil Application Note AN514.

Typical Performance Curves

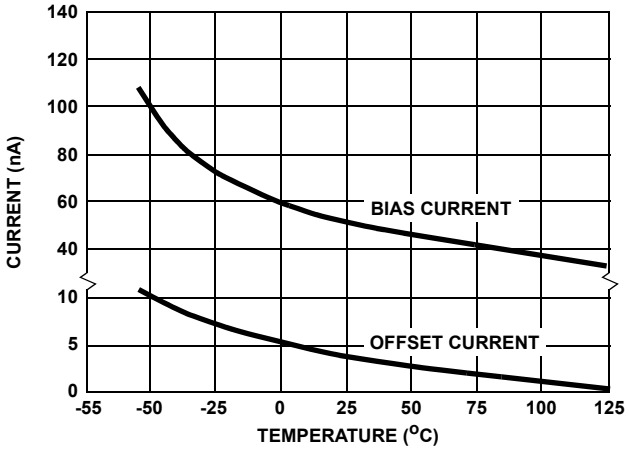


FIGURE 3. INPUT BIAS CURRENT AND OFFSET CURRENT vs TEMPERATURE

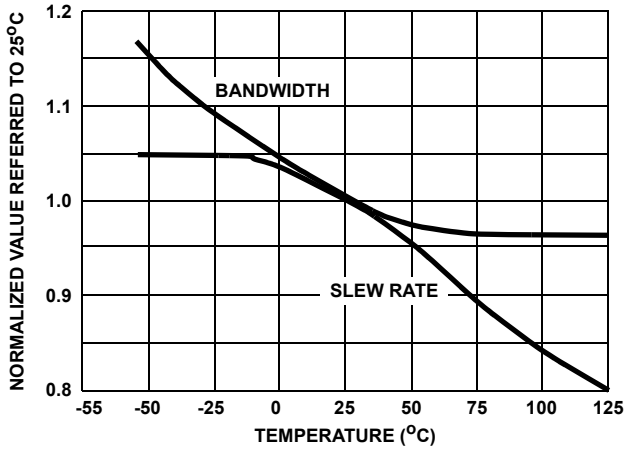


FIGURE 4. NORMALIZED AC PARAMETERS vs TEMPERATURE

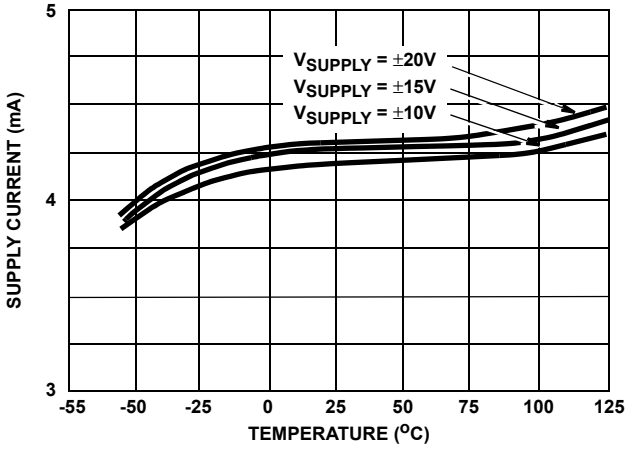


FIGURE 5. POWER SUPPLY CURRENT vs TEMPERATURE

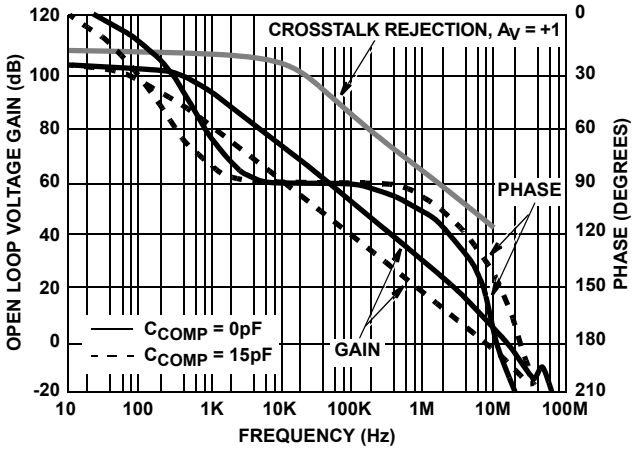


FIGURE 6. OPEN LOOP FREQUENCY AND PHASE RESPONSE

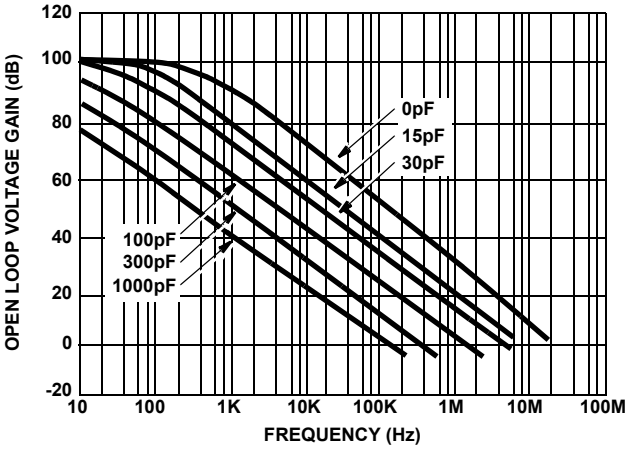


FIGURE 7. FREQUENCY RESPONSE vs C_{COMP}

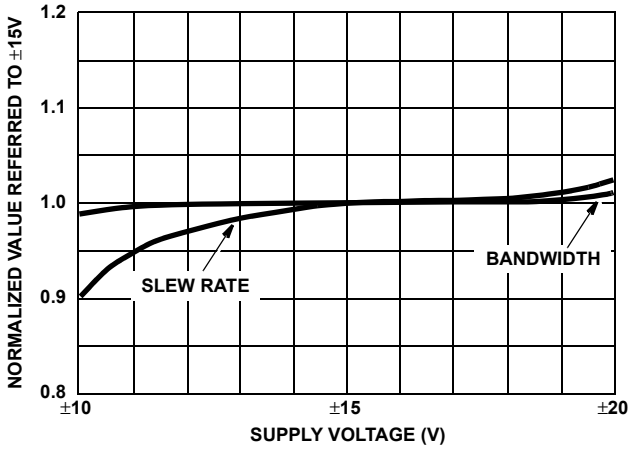


FIGURE 8. NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE

Typical Performance Curves (Continued)

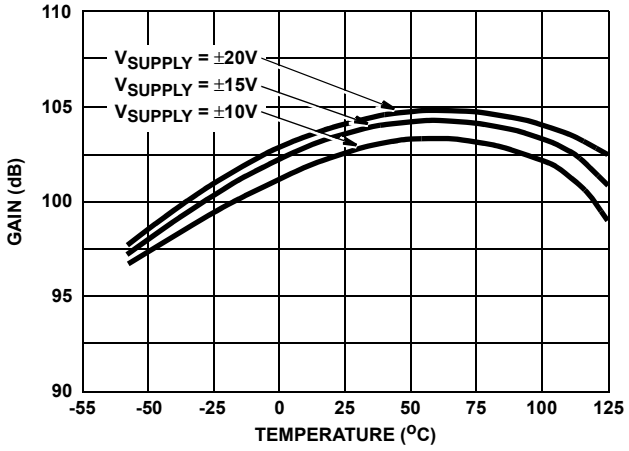


FIGURE 9. OPEN LOOP VOLTAGE GAIN vs TEMPERATURE

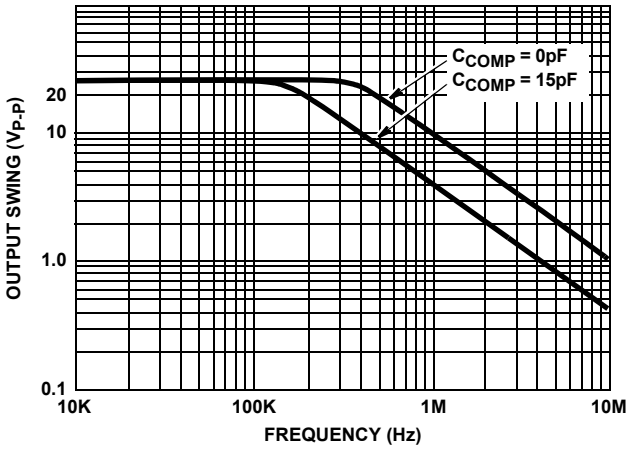


FIGURE 10. OUTPUT VOLTAGE SWING vs FREQUENCY

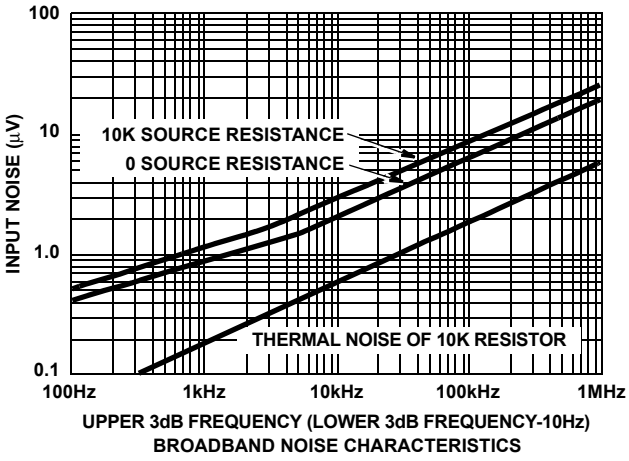


FIGURE 11. EQUIVALENT INPUT NOISE vs BANDWIDTH

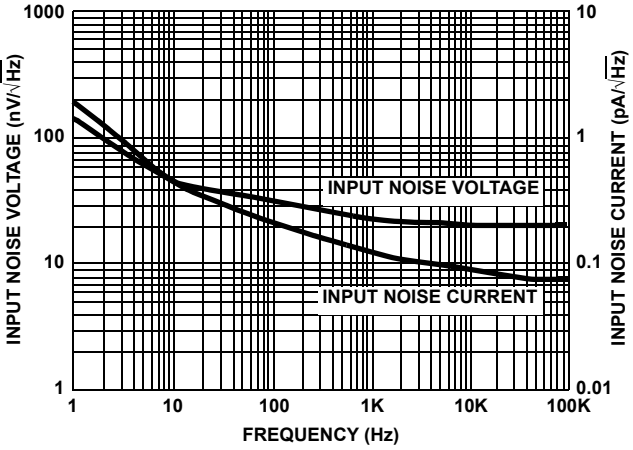


FIGURE 12. INPUT NOISE vs FREQUENCY

Typical Performance Curves (Continued)

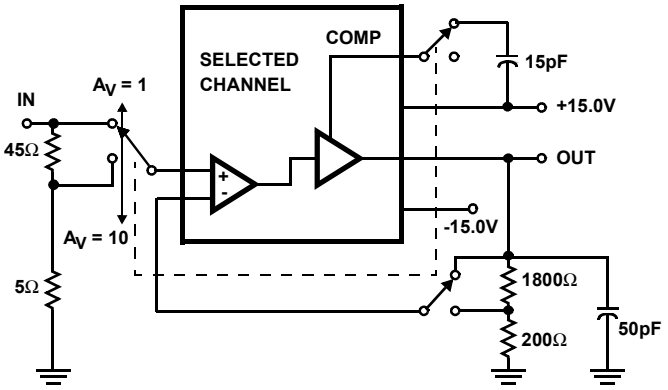


FIGURE 13. SLEW RATE AND TRANSIENT RESPONSE