

Radiation Hardened, Ultra High Speed Current Feedback Amplifier

August 1996

Features

- Electrically Screened to SMD 5962F9467602VPA
- MIL-PRF-38535 Class V Compliant
- Low Distortion (HD3, 30MHz) -84dBc (Typ)
- Wide -3dB Bandwidth 850MHz (Typ)
- Very High Slew Rate 2300V/ μ s (Typ)
- Fast Settling (0.1%) 11ns (Typ)
- Excellent Gain Flatness (to 50MHz) 0.05dB (Typ)
- High Output Current 65mA (Typ)
- Fast Overdrive Recovery <10ns (Typ)
- Total Gamma Dose 300K RAD (Si)
- Latch Up None (DI Technology)

Applications

- Video Switching and Routing
- Pulse and Video Amplifiers
- Wideband Amplifiers
- RF/IF Signal Processing
- Flash A/D Driver
- Imaging Systems

Description

The HS-1100RH is a radiation hardened high speed, wideband, fast settling current feedback amplifier. Built with Harris' proprietary, complementary bipolar UHF-1 (DI bonded wafer) process, it is the fastest monolithic amplifier available from any semiconductor manufacturer. These devices are QML approved and are processed and screened in full compliance with MIL-PRF-38535.

The HS-1100RH's wide bandwidth, fast settling characteristic, and low output impedance make this amplifier ideal for driving fast A/D converters.

Component and composite video systems will also benefit from this amplifier's performance, as indicated by the excellent gain flatness, and 0.03%/0.05 Deg. Differential Gain/Phase specifications (RL = 75 Ω).

Detailed electrical specifications are contained in SMD 5962F9467602VPA, available on the Harris Website or AnswerFAX systems (document #946760)

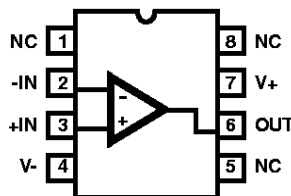
A Cross Reference Table is available on the Harris Website for conversion of Harris Part Numbers to SMDs. The address is (http://www.semi.harris.com/datasheets/smd/smd_xref.html). SMD numbers must be used to order Radiation Hardened Products.

Ordering Information

PART NUMBER	TEMP. RANGE ($^{\circ}$ C)	PACKAGE	PKG. NO.
5962F9467602VPA	-55 to 125	8 Ld CERDIP	GDIP1-T8
HFA1100IJ (Sample)	-40 to 85	8 Ld CERDIP	F8.3A
HFA11XXEVAL	Evaluation Board		

Pinout

HS-1100RH
MIL-STD-1835, GDIP1-T8
(CERDIP)
TOP VIEW



Typical Applications

Optimum Feedback Resistor

The enclosed plots of inverting and non-inverting frequency response illustrate the performance of the HS-1100RH in various gains. Although the bandwidth dependency on closed loop gain isn't as severe as that of a voltage feedback amplifier, there can be an appreciable decrease in bandwidth at higher gains. This decrease may be minimized by taking advantage of the current feedback amplifier's unique relationship between bandwidth and R_F . All current feedback amplifiers require a feedback resistor, even for unity gain applications, and R_F , in conjunction with the internal compensation capacitor, sets the dominant pole of the frequency response. Thus, the amplifier's bandwidth is inversely proportional to R_F . The HS-1100RH design is optimized for a 510Ω R_F at a gain of +1. Decreasing R_F in a unity gain application decreases stability, resulting in excessive peaking and overshoot. At higher gains the amplifier is more stable, so R_F can be decreased in a trade-off of stability for bandwidth.

The table below lists recommended R_F values for various gains, and the expected bandwidth.

GAIN (ACL)	R_F (Ω)	BANDWIDTH (MHz)
-1	430	580
+1	510	850
+2	360	670
+5	150	520
+10	180	240
+19	270	125

PC Board Layout

The frequency response of this amplifier depends greatly on the amount of care taken in designing the PC board. **The use of low inductance components such as chip resistors and chip capacitors is strongly recommended, while a solid ground plane is a must!**

Attention should be given to decoupling the power supplies. A large value (10μF) tantalum in parallel with a small value (0.1μF) chip capacitor works well in most cases.

Terminated microstrip signal lines are recommended at the input and output of the device. Capacitance directly on the output must be minimized, or isolated as discussed in the next section.

Care must also be taken to minimize the capacitance to ground seen by the amplifier's inverting input (-IN). The larger this capacitance, the worse the gain peaking, resulting in pulse overshoot and possible instability. To this end, it is recommended that the ground plane be removed under traces connected to -IN, and connections to -IN should be kept as short as possible.

An example of a good high frequency layout is the Evaluation Board shown in Figure 2.

Driving Capacitive Loads

Capacitive loads, such as an A/D input, or an improperly terminated transmission line will degrade the amplifier's phase margin resulting in frequency response peaking and possible oscillations. In most cases, the oscillation can be avoided by placing a resistor (R_S) in series with the output prior to the capacitance.

Figure 1 details starting points for the selection of this resistor. The points on the curve indicate the R_S and CL combinations for the optimum bandwidth, stability, and settling time, but experimental fine tuning is recommended. Picking a point above or to the right of the curve yields an overdamped response, while points below or left of the curve indicate areas of underdamped performance.

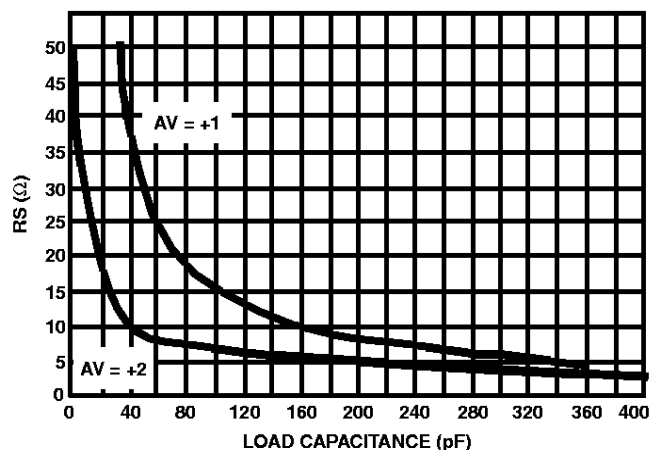


FIGURE 1. RECOMMENDED SERIES OUTPUT RESISTOR vs LOAD CAPACITANCE

R_S and CL form a low pass network at the output, thus limiting system bandwidth well below the amplifier bandwidth of 850MHz. By decreasing R_S as CL increases (as illustrated in the curves), the maximum bandwidth is obtained without sacrificing stability. Even so, bandwidth does decrease as you move to the right along the curve. For example, at $AV = +1$, $R_S = 50\Omega$, $CL = 30pF$, the overall bandwidth is limited to 300MHz, and bandwidth drops to 100MHz at $AV = +1$, $R_S = 5\Omega$, $CL = 340pF$.

Evaluation Board

The performance of the HS-1100RH may be evaluated using the HFA11XXEVAL Evaluation Board.

The layout and schematic of the board are shown in Figure 2. To order evaluation boards, please contact your local sales office.

HS-1100RH

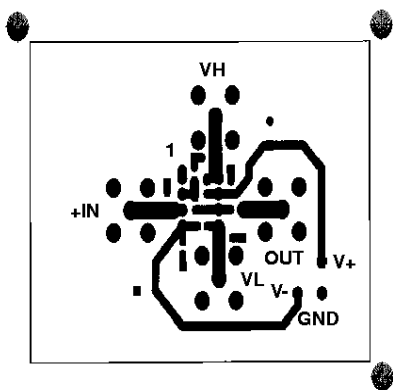


FIGURE 2A. TOP LAYOUT

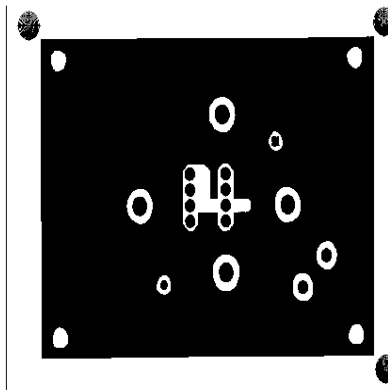


FIGURE 2B. BOTTOM LAYOUT

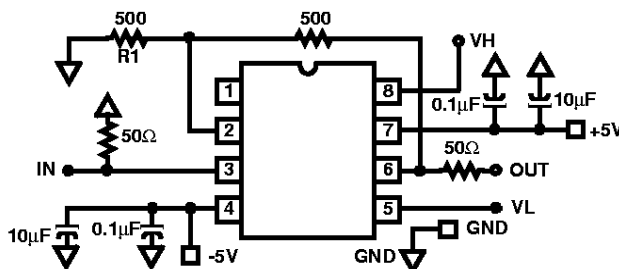


FIGURE 2C. SCHEMATIC

FIGURE 2. EVALUATION BOARD SCHEMATIC AND LAYOUT

Typical Performance Characteristics

Device Characterized at: VSUPPLY = ±5V, RF = 360Ω, AV = +2V/V, RL = 100Ω, Unless Otherwise Specified

PARAMETERS	CONDITIONS	TEMPERATURE	TYPICAL	UNITS
Input Offset Voltage (Note 1)	VCM = 0V	+25°C	2	mV
Average Offset Voltage Drift	Versus Temperature	Full	10	μV/°C
VIO CMRR	ΔVCM = ±2V	+25°C	46	dB
VIO PSRR	ΔVS = ±1.25V	+25°C	50	dB
+Input Current (Note 1)	VCM = 0V	+25°C	25	μA
Average +Input Current Drift	Versus Temperature	Full	40	nA/°C
- Input Current (Note 1)	VCM = 0V	+25°C	12	μA
Average -Input Current Drift	Versus Temperature	Full	40	nA/°C
+Input Resistance	ΔVCM = ±2V	+25°C	50	kΩ
- Input Resistance		+25°C	16	Ω
Input Capacitance		+25°C	2.2	pF
Input Noise Voltage (Note 1)	f = 100kHz	+25°C	4	nV/√Hz
+Input Noise Current (Note 1)	f = 100kHz	+25°C	18	pA/√Hz
-Input Noise Current (Note 1)	f = 100kHz	+25°C	21	pA/√Hz
Input Common Mode Range		Full	±3.0	V
Open Loop Transimpedance	AV = -1	+25°C	500	kΩ

HS-1100RH

Typical Performance Characteristics (Continued)

Device Characterized at: VSUPPLY = ±5V, RF = 360Ω, AV = +2V/V, RL = 100Ω, Unless Otherwise Specified

PARAMETERS	CONDITIONS	TEMPERATURE	TYPICAL	UNITS
Output Voltage	AV = -1, RL = 100Ω	+25°C	±3.3	V
	AV = -1, RL = 100Ω	Full	±3.0	V
Output Current (Note 1)	AV = -1, RL = 50Ω	+25°C to +125°C	±65	mA
	AV = -1, RL = 50Ω	-55°C to 0°C	±50	mA
DC Closed Loop Output Resistance		+25°C	0.1	Ω
Quiescent Supply Current (Note 1)	RL = Open	Full	24	mA
-3dB Bandwidth (Note 1)	AV = -1, RF = 430Ω, VOUT = 200mVP-P	+25°C	580	MHz
	AV = +1, RF = 510Ω, VOUT = 200mVP-P	+25°C	850	MHz
	AV = +2, RF = 360Ω, VOUT = 200mVP-P	+25°C	670	MHz
Slew Rate	AV = +1, RF = 510Ω, VOUT = 5VP-P	+25°C	1500	V/μs
	AV = +2, VOUT = 5VP-P	+25°C	2300	V/μs
Full Power Bandwidth	VOUT = 5VP-P	+25°C	220	MHz
Gain Flatness (Note 1)	To 30MHz, RF = 510Ω	+25°C	±0.014	dB
	To 50MHz, RF = 510Ω	+25°C	±0.05	dB
	To 100MHz, RF = 510Ω	+25°C	±0.14	dB
Linear Phase Deviation (Note 1)	To 100MHz, RF = 510Ω	+25°C	±0.6	Degrees
2nd Harmonic Distortion (Note 1)	30MHz, VOUT = 2VP-P	+25°C	-55	dBc
	50MHz, VOUT = 2VP-P	+25°C	-49	dBc
	100MHz, VOUT = 2VP-P	+25°C	-44	dBc
3rd Harmonic Distortion (Note 1)	30MHz, VOUT = 2VP-P	+25°C	-84	dBc
	50MHz, VOUT = 2VP-P	+25°C	-70	dBc
	100MHz, VOUT = 2VP-P	+25°C	-57	dBc
3rd Order Intercept (Note 1)	100MHz, RF = 510Ω	+25°C	30	dBm
1dB Compression	100MHz, RF = 510Ω	+25°C	20	dBm
Reverse Isolation (S12)	40MHz, RF = 510Ω	+25°C	-70	dB
	100MHz, RF = 510Ω	+25°C	-60	dB
	600MHz, RF = 510Ω	+25°C	-32	dB
Rise and Fall Time	VOUT = 0.5VP-P	+25°C	500	ps
	VOUT = 2VP-P	+25°C	800	ps
Overshoot (Note 1)	VOUT = 0.5VP-P, Input tR/tF = 550ps	+25°C	11	%
Settling Time (Note 1)	To 0.1%, VOUT = 2V to 0V, RF = 510Ω	+25°C	11	ns
	To 0.05%, VOUT = 2V to 0V, RF = 510Ω	+25°C	19	ns
	To 0.02%, VOUT = 2V to 0V, RF = 510Ω	+25°C	34	ns
Differential Gain	AV = +2, RL = 75Ω, NTSC	+25°C	0.03	%
Differential Phase	AV = +2, RL = 75Ω, NTSC	+25°C	0.05	Degrees
Overdrive Recovery Time	RF = 510Ω, VIN = 5VP-P	+25°C	7.5	ns

NOTE:

1. See Typical Performance Curves for more information.

HS-1100RH

Typical Performance Curves $V_{SUPPLY} = \pm 5V$, $R_F = 510\Omega$, $R_L = 100\Omega$, $T_A = +25^\circ C$, Unless Otherwise Specified

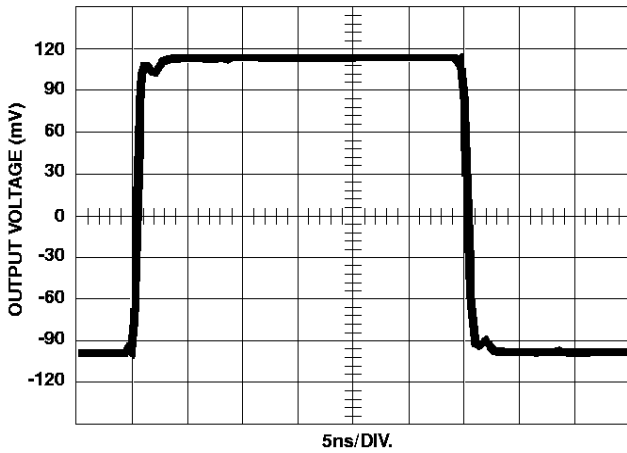


FIGURE 3. SMALL SIGNAL PULSE RESPONSE ($AV = +2$)

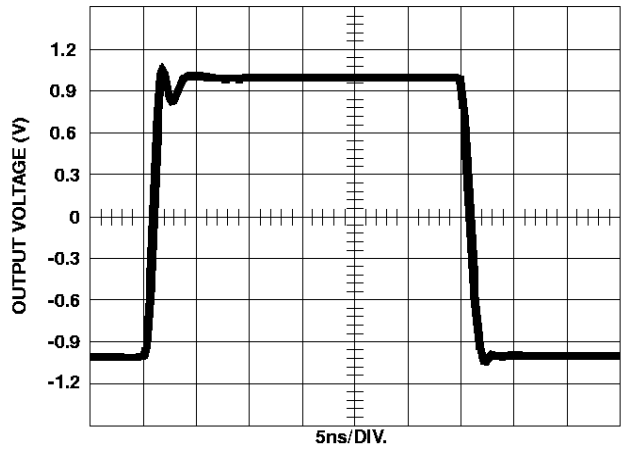


FIGURE 4. LARGE SIGNAL PULSE RESPONSE ($AV = +2$)

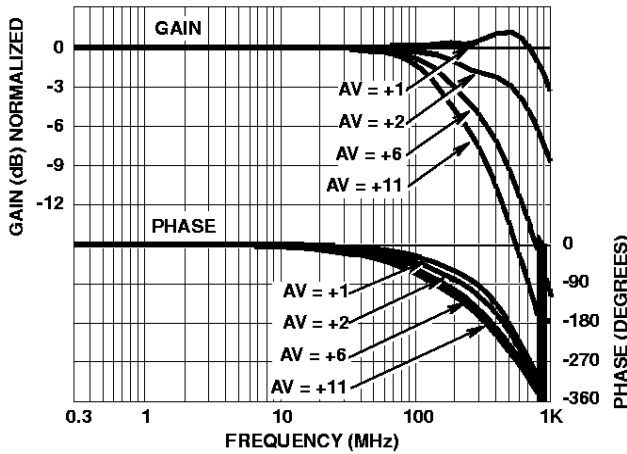


FIGURE 5. NON-INVERTING FREQUENCY RESPONSE ($V_{OUT} = 200mVP-P$)

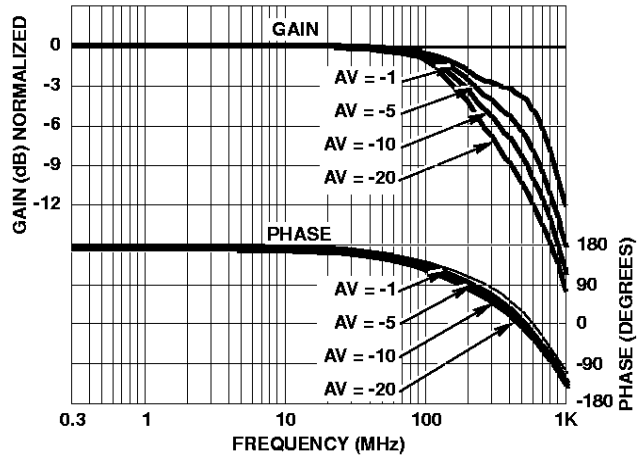


FIGURE 6. INVERTING FREQUENCY RESPONSE ($V_{OUT} = 200mVP-P$)

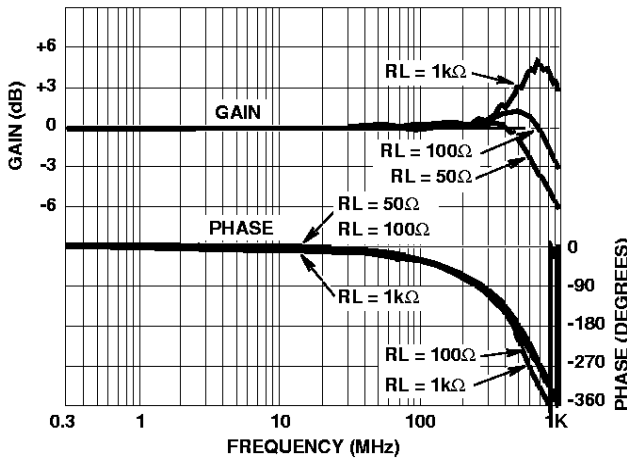


FIGURE 7. FREQUENCY RESPONSE FOR VARIOUS LOAD RESISTORS ($AV = +1$, $V_{OUT} = 200mVP-P$)

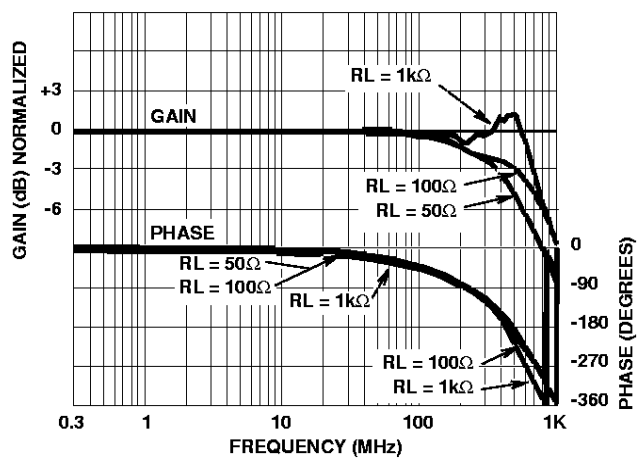


FIGURE 8. FREQUENCY RESPONSE FOR VARIOUS LOAD RESISTORS ($AV = +2$, $V_{OUT} = 200mVP-P$)

HS-1100RH

Typical Performance Curves $V_{SUPPLY} = \pm 5V$, $R_F = 510\Omega$, $R_L = 100\Omega$, $T_A = +25^\circ C$, Unless Otherwise Specified (Continued)

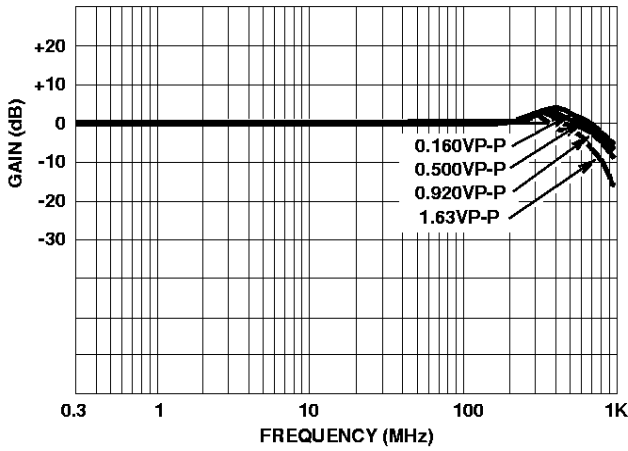


FIGURE 9. FREQUENCY RESPONSE FOR VARIOUS OUTPUT VOLTAGES ($A_V = +1$)

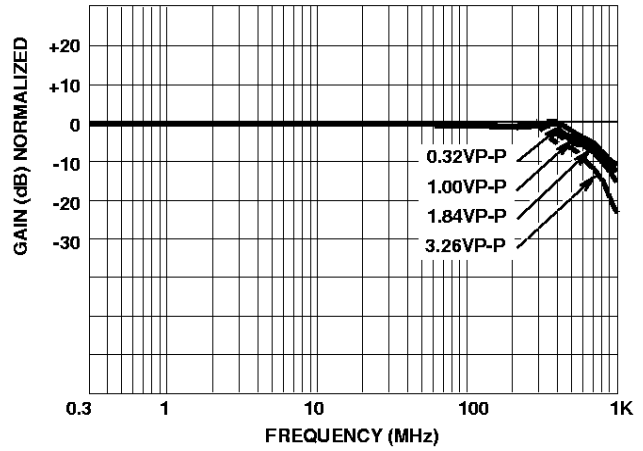


FIGURE 10. FREQUENCY RESPONSE FOR VARIOUS OUTPUT VOLTAGES ($A_V = +2$)

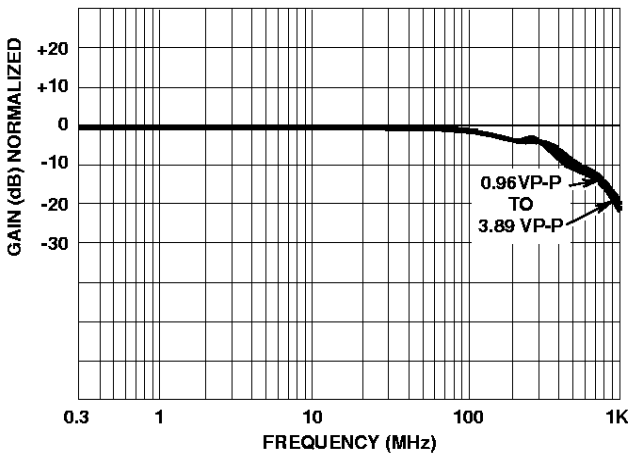


FIGURE 11. FREQUENCY RESPONSE FOR VARIOUS OUTPUT VOLTAGES ($A_V = +6$)

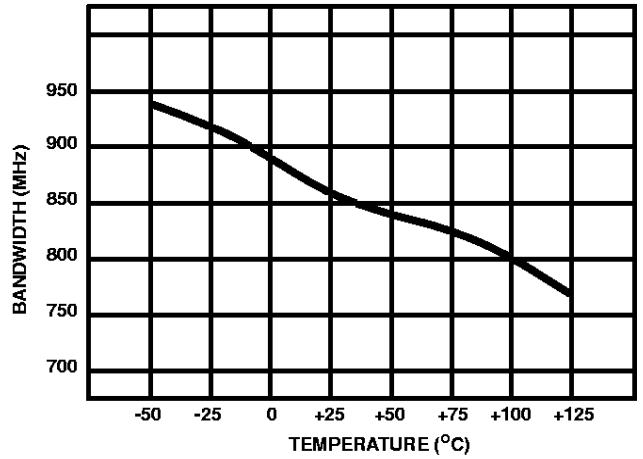


FIGURE 12. -3dB BANDWIDTH vs TEMPERATURE ($A_V = +1$)

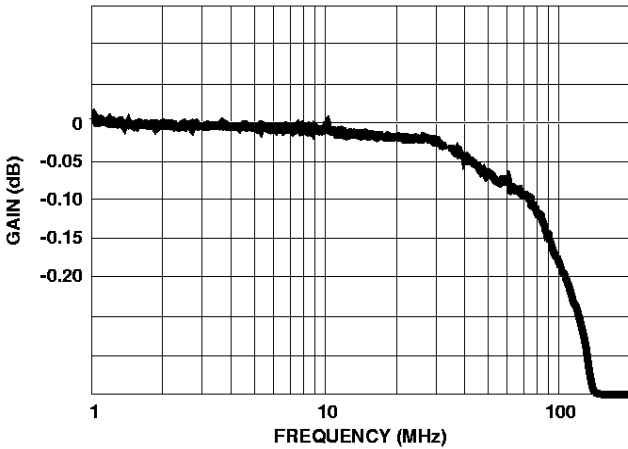


FIGURE 13. GAIN FLATNESS ($A_V = +2$)

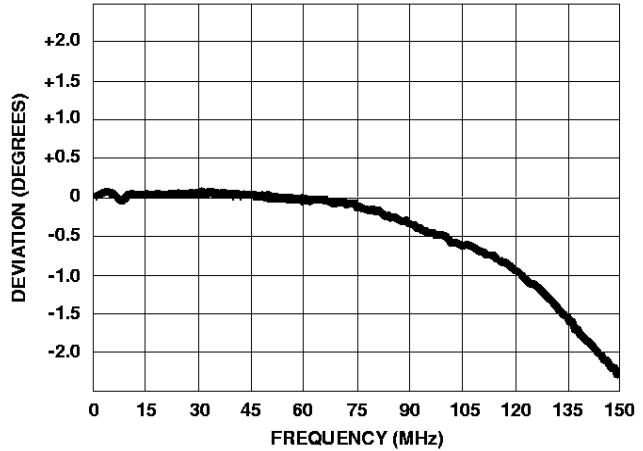


FIGURE 14. DEVIATION FROM LINEAR PHASE ($A_V = +2$)

HS-1100RH

Typical Performance Curves $V_{SUPPLY} = \pm 5V$, $R_F = 510\Omega$, $R_L = 100\Omega$, $T_A = +25^\circ C$, Unless Otherwise Specified (Continued)

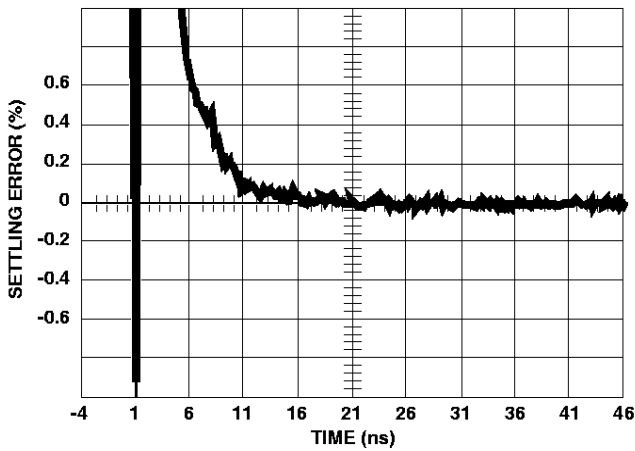


FIGURE 15. SETTLING RESPONSE ($A_V = +2$, $V_{OUT} = 2V$)

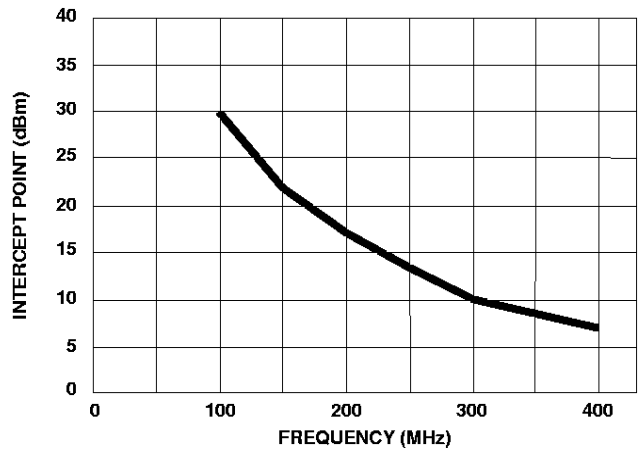


FIGURE 16. 3RD ORDER INTERMODULATION INTERCEPT (2-TONE)

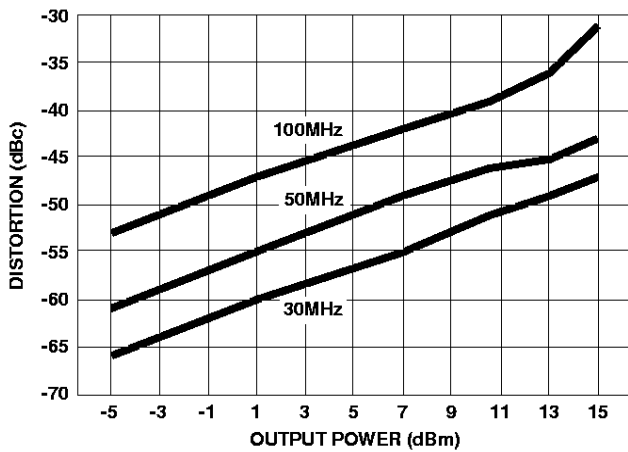


FIGURE 17. 2ND HARMONIC DISTORTION vs POUT

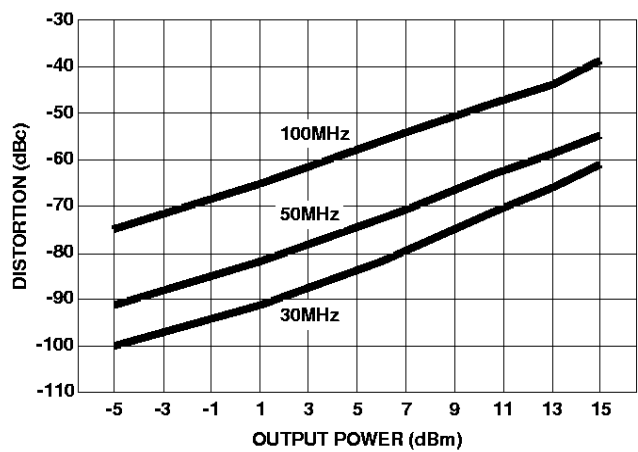


FIGURE 18. 3RD HARMONIC DISTORTION vs POUT

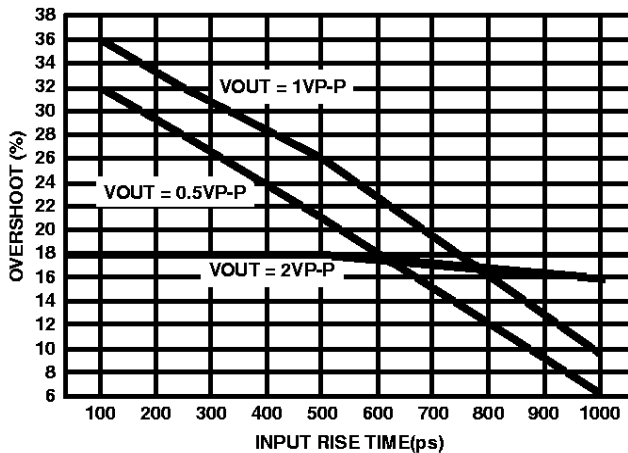


FIGURE 19. OVERSHOOT vs INPUT RISE TIME ($A_V = +1$)

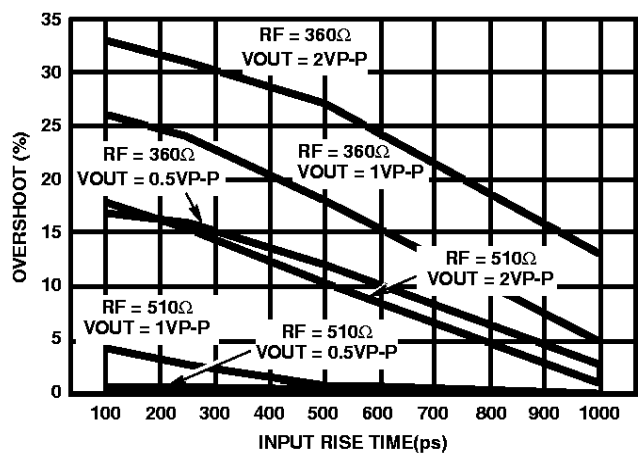


FIGURE 20. OVERSHOOT vs INPUT RISE TIME ($A_V = +2$)

HS-1100RH

Typical Performance Curves $V_{SUPPLY} = \pm 5V$, $R_F = 510\Omega$, $R_L = 100\Omega$, $T_A = +25^\circ C$, Unless Otherwise Specified (Continued)

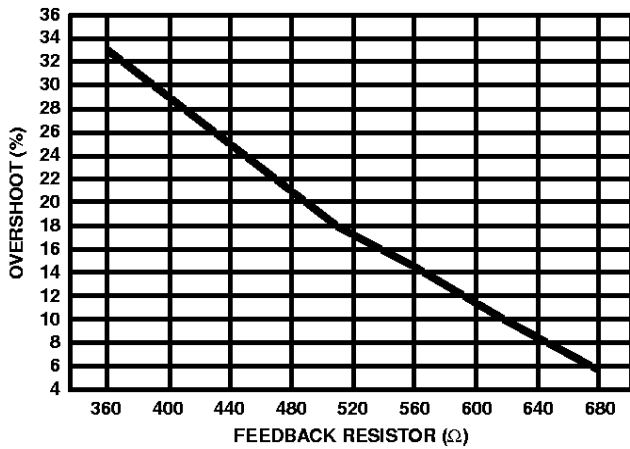


FIGURE 21. OVERSHOOT vs FEEDBACK RESISTOR ($A_V = +2$, $t_R = 200ps$, $V_{OUT} = 2VP-P$)

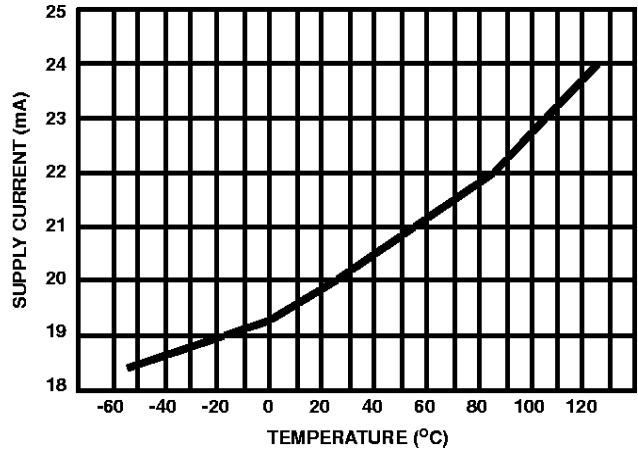


FIGURE 22. SUPPLY CURRENT vs TEMPERATURE

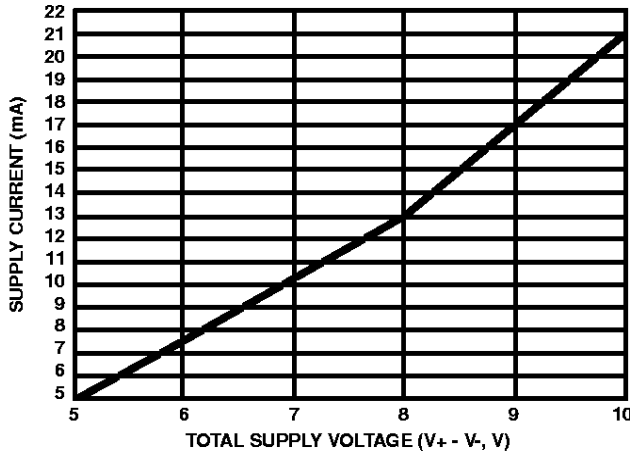


FIGURE 23. SUPPLY CURRENT vs SUPPLY VOLTAGE

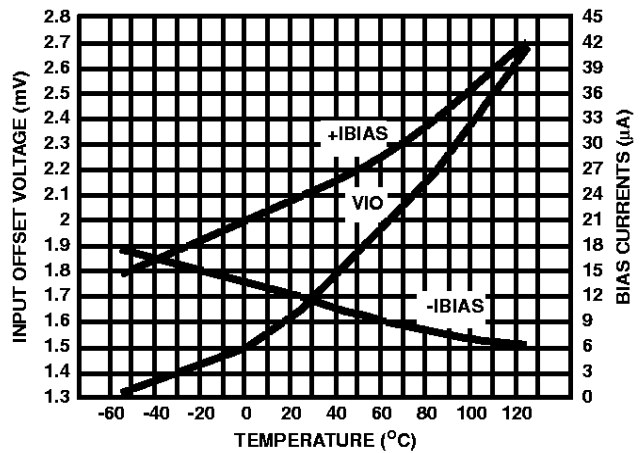


FIGURE 24. V_{IO} AND BIAS CURRENTS vs TEMPERATURE

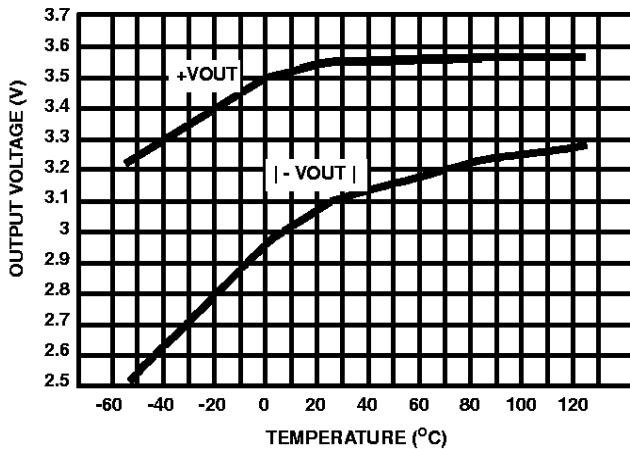


FIGURE 25. OUTPUT VOLTAGE vs TEMPERATURE ($A_V = -1$, $R_L = 50\Omega$)

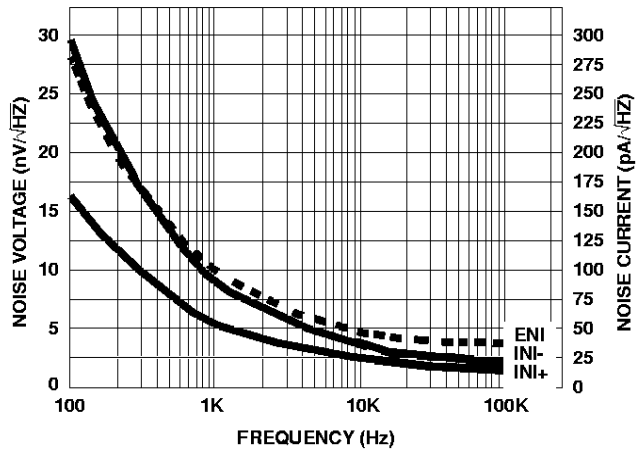
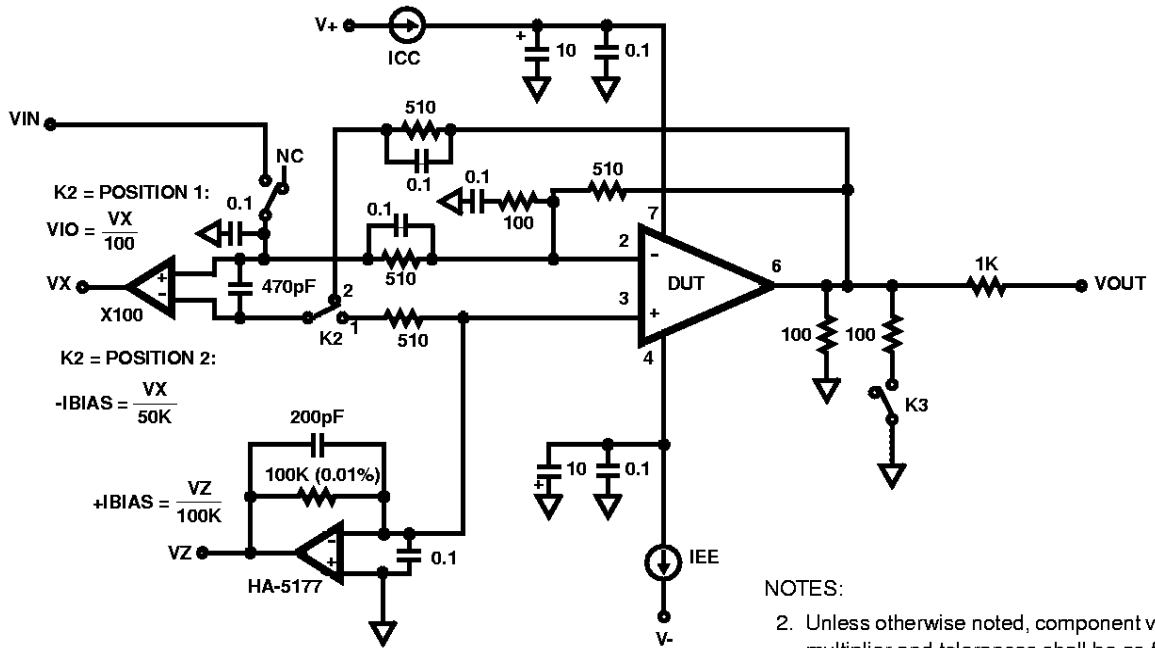


FIGURE 26. INPUT NOISE vs FREQUENCY

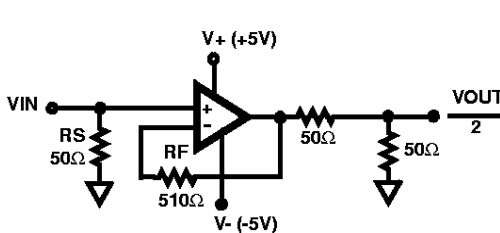
Test Circuit



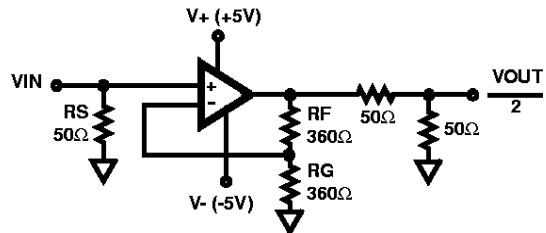
- NOTES:
2. Unless otherwise noted, component value multiplier and tolerances shall be as follows:
Resistors, $\Omega \pm 1\%$.
Capacitors, $\mu\text{F} \pm 10\%$
 3. Chip Components Recommended

Test Waveforms

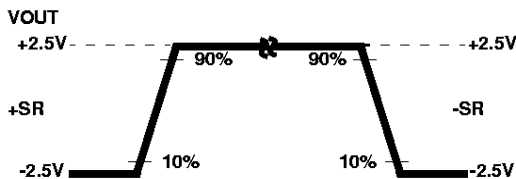
SIMPLIFIED TEST CIRCUIT FOR LARGE AND SMALL SIGNAL PULSE RESPONSE



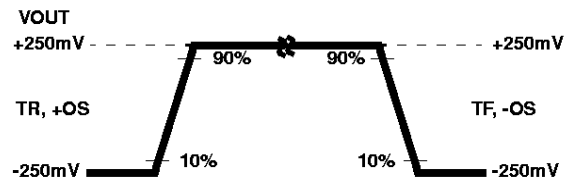
AV = +1 TEST CIRCUIT



AV = +2 TEST CIRCUIT



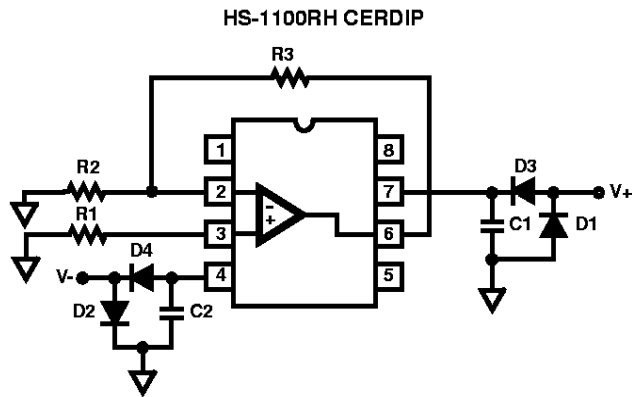
LARGE SIGNAL WAVEFORM



SMALL SIGNAL WAVEFORM

HS-1100RH

Burn-In Circuit



NOTES:

R1 = R2 = $1k\Omega$, $\pm 5\%$ (Per Socket).

R3 = $10k\Omega$, $\pm 5\%$ (Per Socket).

C1 = C2 = $0.01\mu F$ (Per Socket) or $0.1\mu F$ (Per Row) Min.

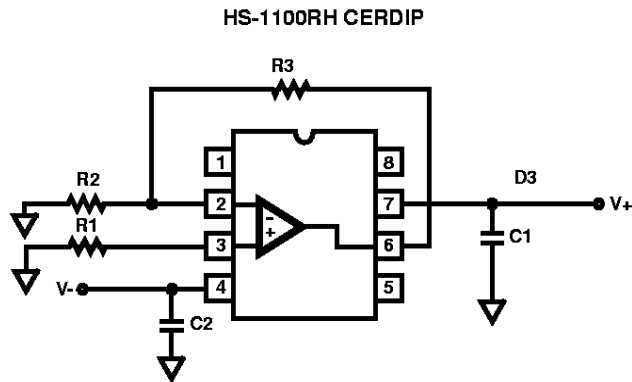
D1 = D2 = 1N4002 or Equivalent (Per Board).

D3 = D4 = 1N4002 or Equivalent (Per Socket).

V+ = $+5.5V \pm 0.5V$.

V- = $-5.5V \pm 0.5V$.

Irradiation Circuit



NOTES:

R1 = R2 = $1k\Omega$, $\pm 5\%$.

R3 = $10k\Omega$, $\pm 5\%$.

C1 = C2 = $0.1\mu F$.

V+ = $+5.5V \pm 0.5V$.

V- = $-5.5V \pm 0.5V$.

HS-1100RH

Die Characteristics

DIE DIMENSIONS:

63 mils x 44 mils x 19 mils ± 1 mil
(1600 μ m x 1130 μ m x 483 μ m $\pm 25.4\mu$ m)

METALLIZATION:

Type: Metal 1: AlCu(2%)/TiW
Thickness: Metal 1: 8k \AA $\pm 0.4\text{k}\text{\AA}$

Type: Metal 2: AlCu (2%)
Thickness: Metal 2: 16k \AA $\pm 0.8\text{k}\text{\AA}$

GLASSIVATION:

Type: Nitride
Thickness: 4k \AA $\pm 0.5\text{k}\text{\AA}$

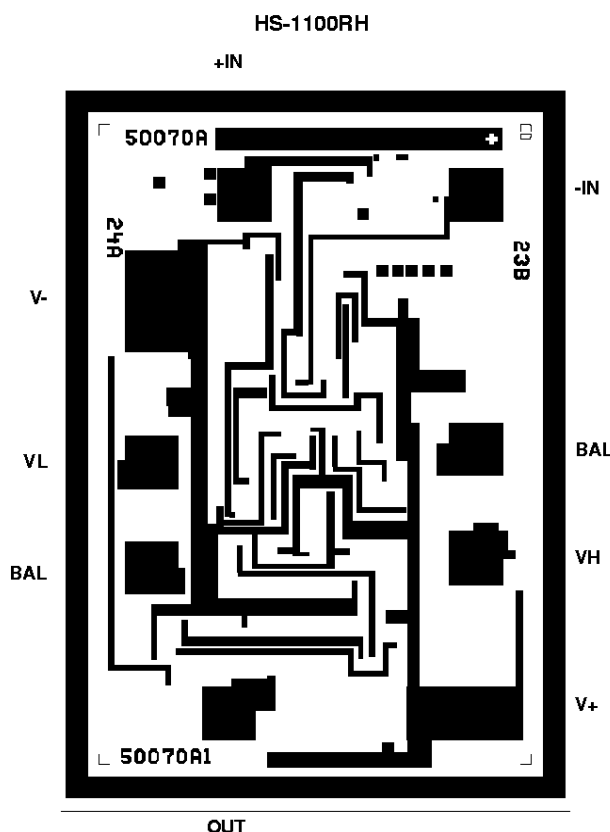
WORST CASE CURRENT DENSITY:

1.6 x 10⁵ A/cm²

TRANSISTOR COUNT: 52

SUBSTRATE POTENTIAL (Powered Up): Floating

Metallization Mask Layout



All Harris Semiconductor products are manufactured, assembled and tested under **ISO9000** quality systems certification.

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