HARRIS

HA-5004

August 1991

100MHz Current Feedback Amplifier

Features

- Slew Rate 1200V/μs
- Output Current ..... ±100mA
- Drives ..... ±9V into 100Ω
- V_{SUPPLY} ..... ±5V to ±18V
- Thermal Overload Protection and Output Flag
- Bandwidth Nearly Independent of Gain
- Output Enable/Disable

Applications

- Unity Gain Video/Wideband Buffer
- Video Gain Block
- High Speed Peak Detector
- Fiber Optic Transmitters
- Zero Insertion Loss Transmission Line Drivers
- Current to Voltage Converter
- Radar Systems

Description

The HA-5004 current feedback amplifier is a video/wideband amplifier optimized for low gain applications. The design is based on current-mode feedback which allows the amplifier to achieve higher closed loop bandwidth than voltage-mode feedback operational amplifiers. Since feedback is employed, the HA-5004 can offer better gain accuracy and lower distortion than open loop buffers. Unlike conventional op amps, the bandwidth and rise time of the HA-5004 are nearly independent of closed loop gain. The 100MHz bandwidth at unity gain reduces to only 65MHz at a gain of 10. The HA-5004 may be used in place of a conventional op amp with a significant improvement in speed power product.

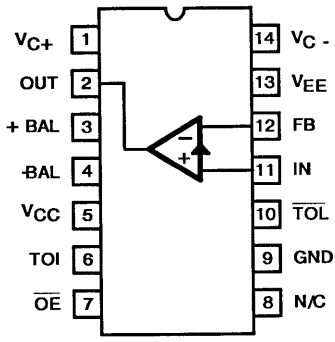
Several features have been designed in for added value. A thermal overload feature protects the part against excessive junction temperature by shutting down the output. If this feature is not needed, it can be inhibited via a TTL input (TOI). A TTL chip enable/disable ($\overline{OE}$) input is also provided; when the chip is disabled its output is high impedance. Finally, an open collector output flag ($\overline{TOL}$) is provided to indicate the status of the chip. The status flag goes low to indicate when the chip is disabled due to either the internal Thermal Overload shutdown or the external disable.

In order to maximize bandwidth and output drive capacity, internal current limiting is not provided. However, current limiting may be applied via the V_C+ and V_C- pins which provide power separately to the output stage.

The HA-5004 is available in a 14-pin Ceramic DIP and is specified for operation from 0°C to +75°C (HA1-5004-5) and -40°C to +85°C (HA1-5004-9). For Military grade product refer to the HA-5004/883 data sheet.

Pinouts

HA1-5004 (CERAMIC DIP)
TOP VIEW



INPUTS		TEMP	$\overline{TOL}$ OUTPUT (OPEN COLLECTOR)	OPERATION
$\overline{OE}$	TOI	T_J		
0	0	Normal	1	Normal
0	0	High*	0	Auto Shutdown, Hi-Z OUT
0	1	X	1	Normal
1	X	X	0	Manual Shutdown, Hi-Z OUT

*>180°C Typical

CAUTION: These devices are sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.

File Number 2923

OPERATIONAL

HA 5004

Absolute Maximum Ratings (Note 1)

Supply Voltage ..... ±20V
Differential Input Voltage 5V
Common Mode Input Voltage ..... $\pm V_{SUPPLY}$
Output Current ..... ±120mA

Operating Temperature Range

HA-5004-9 ..... $-40^oC \leq T_A \leq +85^oC$
HA-5004-5 ..... $0^oC \leq T_A \leq +75^oC$
Storage Temperature ..... $-65^oC \leq T_A \leq +150^oC$
Maximum Junction Temperature ..... $+175^oC$

Electrical Specifications $V_{CC} = V_{C+} = +15V$, $V_{EE} = V_{C-} = -15V$, $R_S = 50\Omega$, $R_L = 100\Omega$, $A_V = +1$, $R_F = 250\Omega$, $\overline{OE} = 0.8V$, TOI = 0.8V or 2.0V Unless Otherwise Specified.

PARAMETER		TEMP	HA-5004-5, -9 MIN	HA-5004-5, -9 TYP	HA-5004-5, -9 MAX	UNITS
INPUT CHARACTERISTICS						
Offset Voltage		+25°C	-	1	5	mV
		Full	-	-	20	mV
Average Offset Voltage Drift		Full	-	10	-	µV/°C
Bias Current (+Input Only) (Note 2)		+25°C	-	2	5	µA
		Full	-	-	20	µA
Input Resistance (+Input Only) (Note 2)		+25°C	-	3	-	MΩ
Input Capacitance		+25°C	-	3	-	pF
Common Mode Range		Full	±10	-	-	V
DISTORTION AND NOISE						
Total Harmonic Distortion $2V_{p-p}$, 200kHz	$A_{VCL} = +1$		-	-72	-	dBc
	$A_{VCL} = +2$		-	-70	-	dBc
	$A_{VCL} = +5$		-	-68	-	dBc
Input Noise Voltage 10Hz to 1MHz		+25°C	-	15	-	μV_{p-p}
Input Noise Voltage Density (Note 3)	$f_O = 10kHz$	+25°C	-	2.2	-	$nV/\sqrt{Hz}$
	$f_O = 100kHz$	+25°C	-	2.2	-	$nV/\sqrt{Hz}$
Input Noise Current Density (Note 3)	$f_O = 10kHz$	+25°C	-	6	-	$pA/\sqrt{Hz}$
	$f_O = 100kHz$	+25°C	-	4	-	$pA/\sqrt{Hz}$
DIGITAL I/O CHARACTERISTICS						
Logic Inputs (OE and TOI)	V_{IH}	Full	2.0	-	-	V
	V_{IL}	Full	-	-	0.8	V
	I_{IH} @ $V_I = 2.4V$	Full	-	-	1	µA
	I_{IL} @ $V_I = 0.4V$	Full	-	-	10	µA
Logic Output (TOL) (Open Collector)	V_{OL} @ 800µA	Full	-	0.05	0.4	V
TRANSFER CHARACTERISTICS						
DC Gain Error	Small Signal (±100mV)	+25°C	-	0.25	0.43	%
		Full	-	0.25	0.75	%
	Large Signal (±10V) (R_L = 1K)	+25°C	-	0.25	0.43	%
		Full	-	0.25	0.75	%
DC Voltage Gain (Note 4)		+25°C	233	400	-	V/V
		Full	133	400	-	V/V
DC Transimpedance (Note 5)		+25°C	-	100	-	V/mA
		Full	33	100	-	V/mA
-3dB Bandwidth $A_V = +1$ (Note 6)		+25°C	-	100	-	MHz
Gain Flatness	DC to 5MHz	+25°C	-	0.03	-	dB
	DC to 10MHz	+25°C	-	0.05	-	dB
Differential Gain (Notes 6, 7, 8) 3.58MHz	$A_{VCL} = +1$	+25°C	-	0.035	-	%
	$A_{VCL} = +2$	+25°C	-	0.058	-	%
Differential Gain (Notes 6, 7, 8) 4.43MHz	$A_{VCL} = +1$	+25°C	-	0.035	-	%
	$A_{VCL} = +2$	+25°C	-	0.058	-	%
Differential Phase (Note 6, 7) 3.58MHz	$A_{VCL} = +1$	+25°C	-	0.15	-	Degree
	$A_{VCL} = +2$	+25°C	-	0.23	-	Degree
Differential Phase (Note 6, 7) 4.43MHz	$A_{VCL} = +1$	+25°C	-	0.17	-	Degree
	$A_{VCL} = +2$	+25°C	-	0.24	-	Degree
Common Mode Rejection Ratio (Note 9)		Full	-	58	-	dB
Minimum Stable Gain		Full	1	-	-	V/V

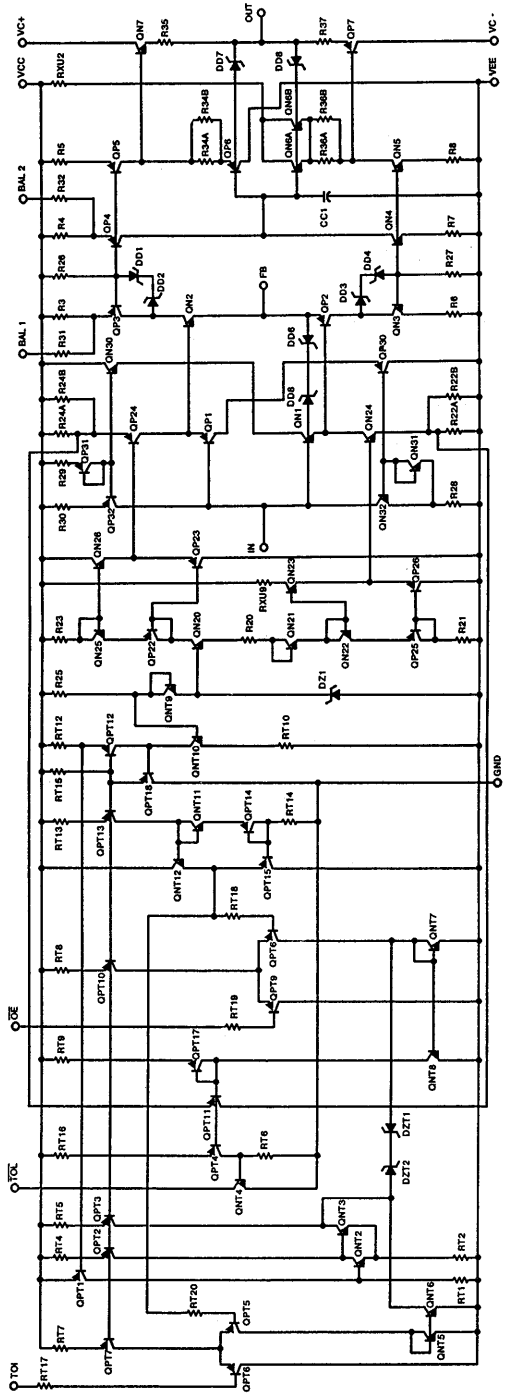
Electrical Specifications (Continued) $V_{CC} = V_{C+} = +15V$, $V_{EE} = V_{C-} = -15V$, $R_S = 50\Omega$, $R_L = 100\Omega$, $A_V = +1$, $R_F = 250\Omega$, $\overline{OE} = 0.8V$, TOI = 0.8V or 2.0V Unless Otherwise Specified.

PARAMETER		TEMP	HA-5004-5, -9 MIN	HA-5004-5, -9 TYP	HA-5004-5, -9 MAX	UNITS
OUTPUT CHARACTERISTICS						
Output Voltage Swing	($R_L = 100\Omega$)	+25°C	±9.0	±9.5	-	V
	($R_L = 1k\Omega$)	+25°C	±11.5	±11.8	-	V
	($R_L = 100\Omega$)	Full	±8.0	±9.5	-	V
	($R_L = 1k\Omega$)	Full	±10.5	±11.8	-	V
Full Power Bandwidth ($A_V = +1$) (Note 10)		+25°C	-	100	-	MHz
Output Resistance, Open Loop		+25°C	-	5	-	Ω
Output Current		+25°C	±90	±100	-	mA
		Full	±80	±100	-	mA
Output Enable time (Hi Z to ±2V)		Full	-	100	-	ns
Output Disable time (±2V to Hi Z)		Full	-	3	-	µs
Output Leakage (Disabled)		Full	-	-	1	µA
TRANSIENT RESPONSE						
Rise Time/Fall Time		+25°C	-	6.3	-	ns
Propagation Delay (10V Step)		+25°C	-	7	-	ns
Slew Rate		+25°C	-	1200	-	V/µs
Settling Time (0.1%, 10V Step)		+25°C	-	50	-	ns
Overshoot		+25°C	-	10	-	%
POWER SUPPLY CHARACTERISTICS						
Supply Current	(Enabled)	+25°C	-	12	16	mA
		Full	-	-	22	mA
	(Disabled)	+25°C	-	7	-	mA
Power Supply Rejecton Ratio		Full	50	60	-	dB

NOTES:

1. Absolute maximum ratings are limiting values, applied individually, beyond which the serviceability of the circuit may be impaired. Functional operation under any of these conditions is not necessarily implied.
2. Inverting (FB) input is a low impedance point; Bias Current, Offset Current, and Input Resistance are not specified for this terminal.
3. See typical performance curves.
4. DC Voltage Gain $= \frac{1}{\text{Gain Error}}$
5. DC Transimpedance $= \frac{R_F}{\text{Gain Error}}$, $R_F = 250\Omega$
6. $V_{IN} = 300mVp\text{-}p$
7. $V_{OFFSET} = 1.0V$
8. Differential Gain (dB) = 0.0869 Differential Gain (%)
9. $V_{CM} = \pm 10V$
10. Full power bandwidth guaranteed by equation: Full Power Bandwidth $= \frac{\text{Slew Rate}}{2\pi V_{peak}}$, $V_{peak} = 2V$

Schematic


VC+
VCC
BAL 2
BAL 1
OE
TOL
TOH
OUT
FB
IN
VC-
VEE
GND
QN7
R35
R37
QP7
DD7
DD8
RXU2
R34B
R36B
QN6B
R5
QP5
R34A
QP6
QN6A
R36A
QN5
R8
R32
CC1
R4
QP4
QN4
R7
R26
DD1
DD2
DD4
R27
R3
QP3
QN2
QP2
DD3
QN3
R6
R31
QN30
DD6
QP30
R24B
R22B
R24A
QP24
QP1
DD5
QN1
QN24
R22A
QN31
R29
DD31
R28
R30
QP32
QN32
QN26
QP23
QN23
QP26
RXU8
R23
QN25
QP22
QN20
R20
QN21
QN22
QP25
R21
R25
QN19
DZ1
RT12
QPT12
QNT10
RT10
RT15
QPT16
QNT11
QPT14
RT14
RT13
QPT13
QNT12
QPT15
RT18
RT8
QPT8
QNT7
QPT10
QPT9
RT19
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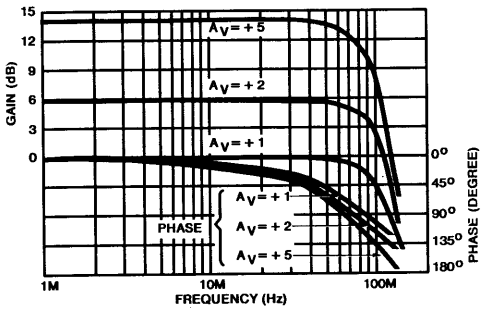
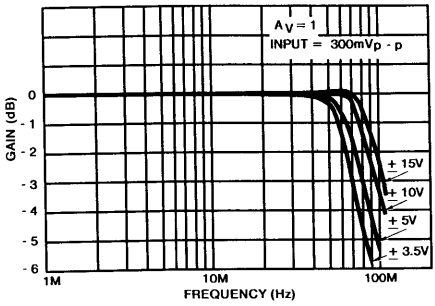
QPT17
QNT8
RT16
QPT11
QPT7
RT6
DZT1
DZT2
QNT4
RT5
QPT3
QNT3
RT4
QPT2
QNT2
RT2
QPT1
RT20
QPT5
QNT6
RT1
RT7
QPT4
QNT5
RT17
QPT6

Typical Performance Curves $V_{SUPPLY} = \pm 15V$, $T_A = 25^oC$, Unless Otherwise Specified.

GAIN AND PHASE vs. FREQUENCY

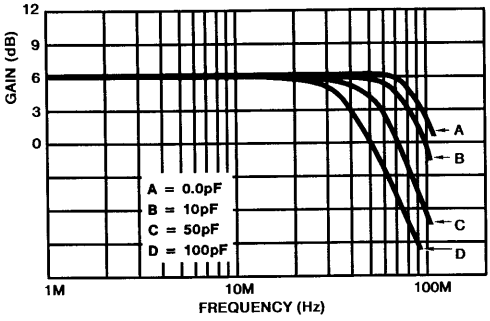


FREQUENCY RESPONSE vs. SUPPLY VOLTAGE



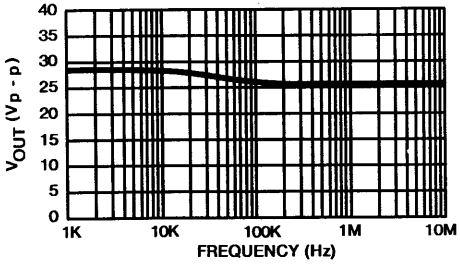
FREQUENCY RESPONSE vs. C_L

$V_{CC} = \pm 15V$, $A_V = +2$, $R_L = 1k\Omega$, Input = 10mV

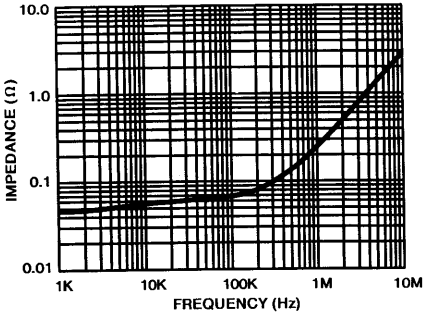


MAX. UNDISTORTED SINEWAVE OUTPUT vs. FREQUENCY

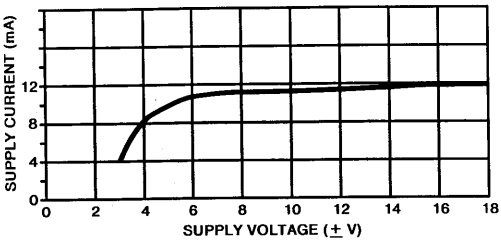
$V_{CC} = \pm 15V$, $A_V = +1$, Sinewave Input



CLOSED LOOP OUTPUT IMPEDANCE vs. FREQUENCY



SUPPLY CURRENT vs. SUPPLY VOLTAGE



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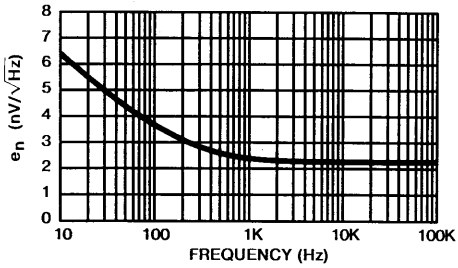
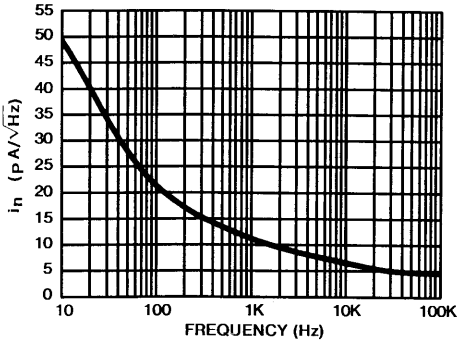
Typical Performance Curves (Continued) $V_{SUPPLY} = \pm15V$, $T_A = 25^oC$, Unless Otherwise Specified.

VOLTAGE NOISE vs. FREQUENCY
$V_{CC} = \pm15V$

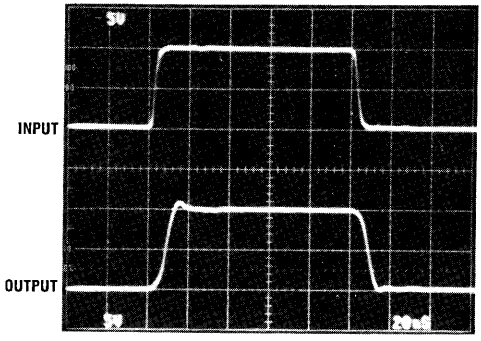


CURRENT NOISE vs. FREQUENCY
$V_{CC} = \pm15V$



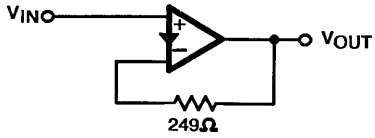
Switching Waveforms

LARGE SIGNAL RESPONSE, $A_V = +1$
Vertical Scale: 5V/Div.
Horizontal Scale: 20ns/Div.

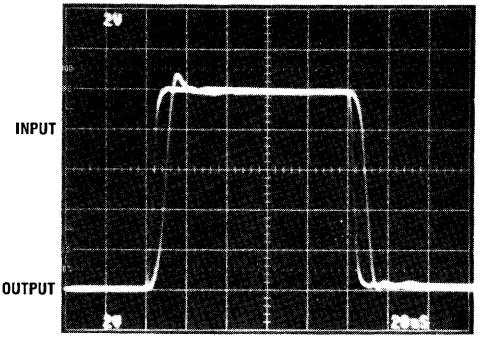


$A_V = +1$, $V_{SUPPLY} = \pm15V$

TEST CIRCUIT

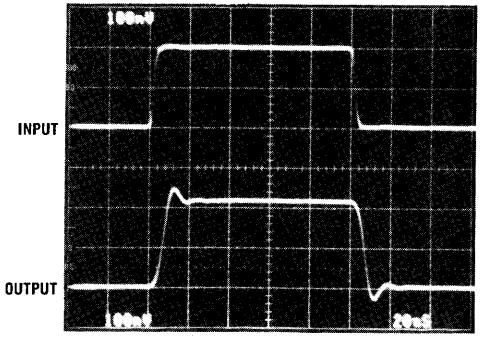


PROPAGATION DELAY
Vertical Scale: 2V/Div.
Horizontal Scale: 20ns/Div.



$A_V = +1$, $V_{SUPPLY} = \pm15V$

SMALL SIGNAL RESPONSE
Vertical Scale: 100mV/Div.
Horizontal Scale: 20ns/Div.



$A_V = +1$, $V_{SUPPLY} = \pm15V$