HARRIS SEMICONDUCTOR PRODUCTS DIVISION
A DIVISION OF HARRIS CORPORATION

HA-2900/04/05

Chopper Stabilized Operational Amplifier

2

FEATURES

- OFFSET VOLTAGE DRIFT — 0.2 μV/°C
- OFFSET CURRENT DRIFT — 1pA/°C
- OPEN LOOP GAIN — 5×10^8
- BANDWIDTH — 3MHz
- SLEW RATE — 2.5V/μs
- TRUE DIFFERENTIAL INPUTS

APPLICATIONS

- HIGH-GAIN DC INSTRUMENTATION
- HIGH-ACCURACY WEIGHING EQUIPMENT
- BIOMEDICAL AMPLIFIERS
- PRECISION INTEGRATORS AND TIMERS

DESCRIPTION

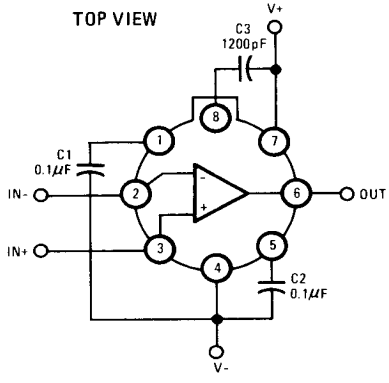
HA-2900/2904/2905 are monolithic chopper-stabilized operational amplifiers that employ dielectric isolation achieving superior offset drift, extremely low input currents and excellent AC performance. Input drift is characterized by offset voltage drift of 0.2 μV/°C and offset current drift of 1pA/°C. Initial offset voltage is only 20 μV while offset current is 50pA. These input specifications make HA-2900/2904/2905 ideally suited to high accuracy applications such as high-gain DC instrumentation, and precision integration. The amplifiers can be used to replace other op amps in designs where much lower errors are required without external adjustments. 3MHz gain-bandwidth product makes HA-2900/2904/2905 valuable for processing wide band signals as well as for low frequency measurements.

In addition to offering high-accuracy performance, these "choppers" also offer versatility by virtue of their symmetrical, differential inputs which permit operation in any op amp configuration – inverting, non-inverting or balanced. These devices require only three external capacitors for proper operation.

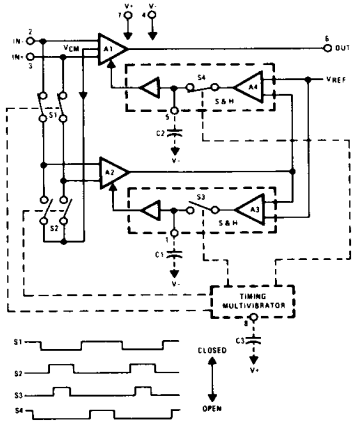
HA-2900 is guaranteed over -55°C to +125°C; HA-2904 operates from -25°C to +85°C; HA-2905 operates from 0°C to +75°C. All devices are available in a hermetically sealed metal can.

PINOUT AND SUGGESTED HOOKUP

TO-99 **Package Code 2E**



FUNCTIONAL DIAGRAM



CAUTION: These devices are sensitive to electrostatic discharge. Users should follow IC Handling Procedures specified on pg. 1-4.

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V- Terminals	42.0V	Operating Temperature Range	$-55^{o}C \leq T_A \leq +125^{o}C$ (HA-2900)
Differential Input Voltage (Note 1)	±15V		$-25^{o}C \leq T_A \leq +85^{o}C$ (HA-2904)
Output Current/Full Short Circuit Protection		Storage Temperature Range	$0^{o}C \leq T_A \leq +75^{o}C$ (HA-2905)
Internal Power Dissipation	300mW*		$-65^{o}C \leq T_A \leq +150^{o}C$

*Derate by 6.6mW/^{o}C above +105^{o}C

ELECTRICAL CHARACTERISTICS

Test Conditions: C1 = C2 = 0.1μF, C3 = 1200pF, V_{Supply} = ±15.0V unless otherwise specified.

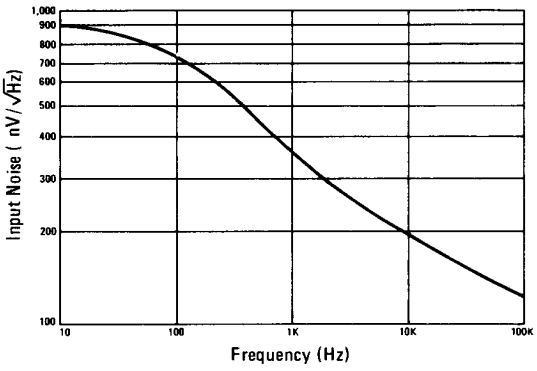
		HA-2900 -55^{o}C to +125^{o}C			HA-2904 -25^{o}C to +85^{o}C			HA-2905 0^{o}C to +75^{o}C			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS											
Offset Voltage	+25^{o}C		20	60		20			20		μV
	Full			100			50			80	μV
Offset Voltage Average Drift	Full		0.3	0.6		0.2	0.4		0.2	0.4	μV/^{o}C
Bias Current	+25^{o}C		150	1,000		150			150		pA
	Full			1,500			1,000			1,000	pA
Offset Current	+25^{o}C		50	500		50			50		pA
	Full			800			500			500	pA
Offset Current Average Drift	Full		1	4		1	3		1		pA/^{o}C
Input Resistance	+25^{o}C		100			100			100		MΩ
Input Capacitance	+25^{o}C		10			10			10		pF
Common Mode Range	Full	±10			±10			±10			V
TRANSFER CHARACTERISTICS											
Large Signal Voltage Gain (Note 2, 5)	+25^{o}C		5x10^{8}			5 x 10^{8}			5 x 10^{8}		V/V
	Full	10^{6}			10^{6}			10^{6}			V/V
Chopper Frequency	+25^{o}C		750			750			750		Hz
Common Mode Rejection Ratio (Note 3)	+25^{o}C	120	160		120	160		120	160		dB
	Full	110									
Gain Bandwidth Product (Note 4)	+25^{o}C		3			3			3		MHz
OUTPUT CHARACTERISTICS											
Output Voltage Swing (Note 2)	Full	±10	±12		±10	±12		±10	±12		V
Output Current	+25^{o}C	±10			±10			±7			mA
Output Resistance	Full		200			200			200		Ω
Full Power Bandwidth (Note 5)	+25^{o}C		40			40			40		kHz
TRANSIENT RESPONSE (NOTES 2, 8, and 9)											
Rise Time (Note 6)	+25^{o}C		200			200			200		ns
Overshoot (Note 6)	+25^{o}C		20			20			20		%
Slew Rate (Note 10)	+25^{o}C		2.5			2.5			2.5		V/μs
POWER SUPPLY CHARACTERISTICS											
Supply Current	+25^{o}C		3.5	5.0		3.5	5.0		3.5	5.0	mA
Supply Voltage Range	Full	±12		±20	±10		±20	±12		±20	V
Power Supply Rejection Ratio (Note 7)	+25^{o}C	120	160		120	160		120	160		dB
	Full	110									

NOTES:
1. Input terminals should be protected against static discharge during handling and installation. Input voltage should never exceed supply voltages.
2. R_L = 2K
3. V_{CM} = ±5.0V
4. A_V = 10
5. V_O = ±10V
6. V_O = ±200mV
7. ΔV_S = ±5V
8. C_L = 50pF
9. A_V = +1. See transient response test circuits and waveforms, page 4.
10. V_{OUT} = ±5V

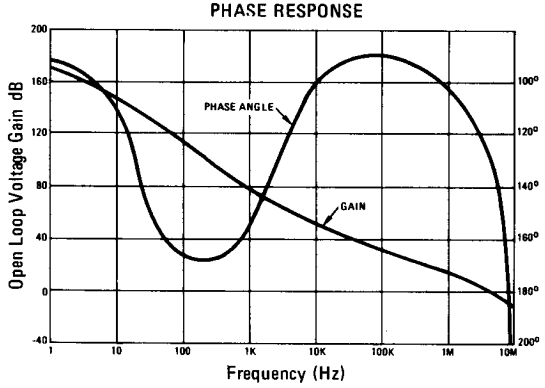
*100% Tested For DASH 8

V+ = V- = 15VDC, T_A = 25°C UNLESS OTHERWISE STATED

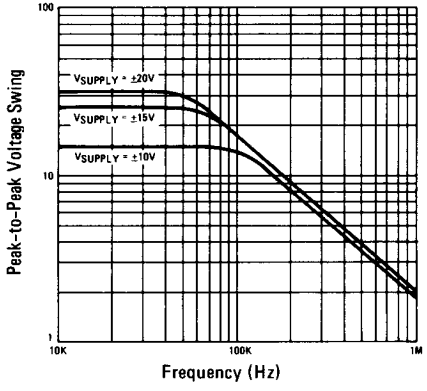
INPUT VOLTAGE NOISE



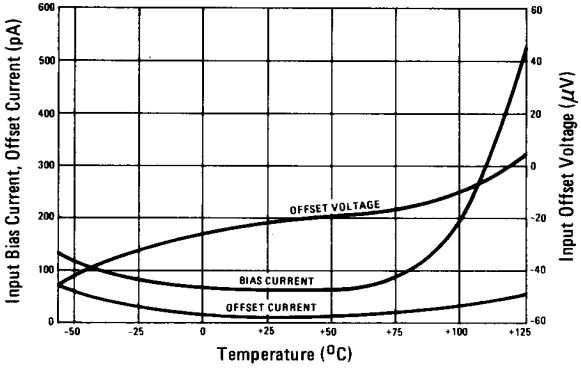
OPEN LOOP FREQUENCY AND PHASE RESPONSE



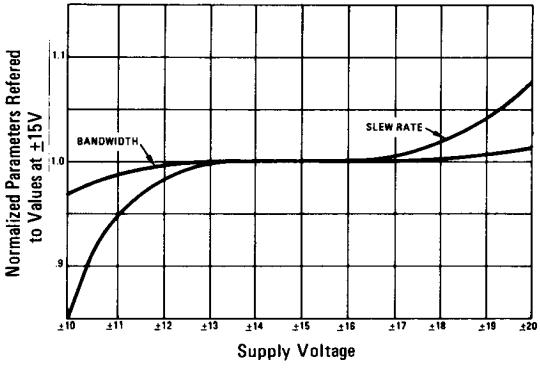
OUTPUT VOLTAGE SWING vs. FREQUENCY



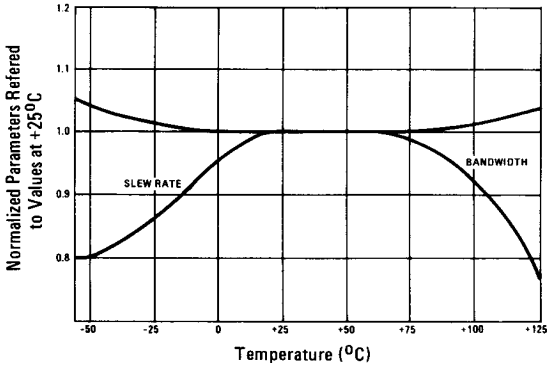
TYPICAL INPUT CHARACTERISTICS vs. TEMPERATURE



NORMALIZED A.C. PARAMETERS vs. SUPPLY VOLTAGE

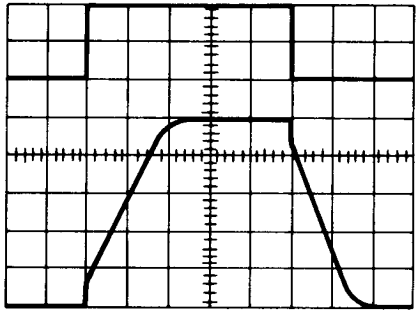


NORMALIZED A.C. PARAMETERS vs. TEMPERATURE



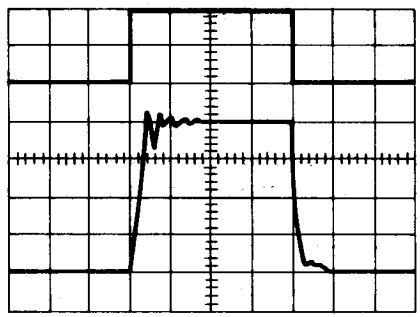
PERFORMANCE CURVES (continued)

VOLTAGE FOLLOWER SLEWING WAVEFORM



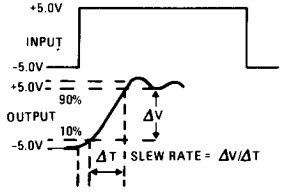
Upper Trace: Input: 5V/Div.
Lower Trace: Output; 2V/Div.
Horizontal: 2μS/Div.

VOLTAGE FOLLOWER TRANSIENT RESPONSE WAVEFORM

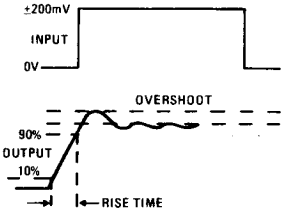


Upper Trace: Input; 100mV/Div.
Lower Trace: Output; 50mV/Div.
Horizontal: 500ns/Div.

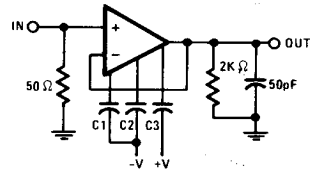
SLEW RATE



TRANSIENT RESPONSE



SLEW RATE AND TRANSIENT RESPONSE



NOTE: Measured on both positive and negative transitions.

APPLICATION TIPS

(1) Device inputs should be protected against exceeding either supply voltage from static discharge or inadvertent connection, particularly when wired directly to a connector or instrument panel.

(2) External capacitors C1, C2, and C3 should have good temperature stability, low leakage, and low dielectric absorption. Polystyrene (below +85°C), teflon types or polycarbonate are recommended. C3 could also be silver mica.

(3) Particular care must be exercised in system layout and material and component selection to realize the full performance potential of the HA-2900/2904/2905. External sources of drift error may include the thermocouple and electrochemical EMF's generated at junctions of dissimilar metals, leakage across insulating materials, static charges created by moving air, and improper grounding and shielding practices.

(4) Chopper noise is present chiefly as a common mode input current signal, and may be minimized by matching the impedances at the two inputs. Random noise may be reduced at the expense of bandwidth using active or passive filtering.

(5) Input frequencies near the chopper frequency (750Hz) or its harmonics may result in small components of difference frequency in the output. This effect should be checked in the individual application, and if objectionable, a low pass filter may be added in series with the input.

(6) When operating at closed loop gains between 70 dB and 140 dB, compensation networks may be required, because of open loop phase shift in this gain region. In most cases, a capacitor placed in parallel with the feedback resistor to yield a gain-bandwidth product < 2MHz will be sufficient.