



**HARRIS**  
SEMICONDUCTOR  
PRODUCTS DIVISION  
A DIVISION OF HARRIS CORPORATION

# HA-1600/02/05

**+10V Precision  
Voltage Reference**

4

FEATURES	DESCRIPTION
<ul style="list-style-type: none"> <li>MONOLITHIC CONSTRUCTION</li> <li>EXCELLENT TEMPERATURE STABILITY</li> <li>LOW NOISE <span style="float: right;">100 <math>\mu</math>V<sub>RMS</sub></span></li> <li>WIDE INPUT RANGE <span style="float: right;">14V TO 20V</span></li> </ul>	<p>HA-1600/02/05 is a monolithic, temperature regulated, +10V precision voltage reference featuring load regulation accuracies to 1 LSB (12 Bit system) over its operating temperature range. This guaranteed accuracy specification is achieved by employing a high gain differential amplifier to sense and regulate the chip temperature.</p> <p>To enhance accuracy and provide fast warm-up and minimum power drain these devices are thermally isolated from the package. Advanced laser trimming techniques are used to ensure a precision +10V output.</p> <p>In operation, HA-1600/02/05 will accept an unregulated DC input voltage ranging from +14V to +20V and provide a low noise, extremely accurate +10V DC output at load currents up to 2mA. For higher output currents an external amplifier may be connected inside the feedback loop of HA-1600/02/05.</p>
APPLICATIONS	<p>The outstanding accuracy of these voltage references make them ideal selections for applications requiring maximum precision and minimum drift, such as the external voltage reference for a 12 Bit D/A converter.</p>
<ul style="list-style-type: none"> <li>EXTERNAL VOLTAGE REFERENCE FOR DATA CONVERTERS (D/A OR A/D)</li> <li>COMPARATOR REFERENCE</li> <li>VOLTAGE REGULATOR REFERENCE</li> </ul>	<p>HA-1600/02/05 is packaged in a 14 pin DIP. HA-1600-2 is guaranteed to provide <math>\pm 1</math> LSB accuracy from -55°C to +125°C while the HA-1602-2 offers guaranteed accuracy to <math>\pm 2</math> LSB* over the military temperature range. HA-1605-5 is specified to maintain better than <math>\pm 1</math> LSB* accuracy from 0°C to +75°C.</p> <p>* Relative to 12 Bit resolution 1 LSB equals one part in 4096 or 2.44mV for a +10V output.</p>
PINOUT	SCHEMATIC
<p style="text-align: center;">Package Code 4T</p> <p style="text-align: center;">TOP VIEW</p>	

# SPECIFICATIONS

## ABSOLUTE MAXIMUM RATINGS (Referred to Ground - Note 1)

Storage Temp. Range	$-65^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$	Operating Temperature Range:	HA-1600-2	$-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$
Input Voltage	35V	HA-1602-2	$-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$	
Power Dissipation	800mW	HA-1605-5	$0^{\circ}\text{C} \leq T_A \leq 75^{\circ}\text{C}$	

## ELECTRICAL CHARACTERISTICS (Note 2,5) $V_{IN} = +15\text{V}$ , $I_L = 0\text{mA}$ , unless otherwise specified.

PARAMETER	TEMP	HA-1600-2 -55°C to +125°C			HA-1602-2 -55°C to +125°C			HA-1605-5 0°C to +75°C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
<b>POWER INPUT CHARA.'S</b>											
$V_{IN}$ , Input Voltage Range	25°C	14	15	20	14	15	20	14	15	20	Volts
$I_Q$ , Quiescent Current	-55°C		80	130		80	130				mA
	25°C		50	80		50	80	15	50	80	mA
	+125°C		10	20		10	20				mA
<b>REGULATED OUTPUT CHARA.'S</b>											
Output Voltage ( $V_O$ )	25°C	9.995	10.000	10.005	9.995	10.000	10.005	9.995	10.000	10.005	Volts
Output Load Current ( $I_L$ )	25°C	2			2			2			mA
Output Noise Voltage ( $E_N$ ) (0.1Hz to 1MHz)			200			200			200		$\mu\text{VRMS}$
Line Regulation $V_{IN} = 14.5\text{V}$ to $17.5\text{V}$	Full		0.001	0.002		0.001	0.002		0.001	0.002	%/V
Load Reg., $R_L = \text{Open}$ to $5\text{K}\Omega$	Full		0.001	0.002		0.001	0.002		0.001	0.002	%/mA
Output Voltage Temperature Coefficient, $R_L = \text{Open}$	Full			$\pm 1.35$			$\pm 2.7$			$\pm 3.25$	ppm/°C
Output Voltage Error, Total (Note 3)	Full			$\pm 1$ LSB			$\pm 2$ LSB			$\pm 1$ LSB	
<b>TURN-ON CHARACTERISTICS</b>											
Turn-on Current (Note 4)	-55°C		120			120					mA
	+25°C		100			100		100			mA
	+125°C		20			20					mA
Warm-up Time	-55°C		180			180					sec
	+25°C		60			60		60			sec
	+125°C		30			30					sec

### NOTES:

- Absolute maximum ratings are limiting values beyond which the serviceability of the circuit may be impaired. Functional operation under any of these conditions is not necessarily implied.
- The specified electrical characteristics apply to suggested hook-up only. The  $40\Omega$  heater current limiter is mandatory.
- Specifications relative to 12 bit accuracy.
- The maximum current drawn from the input supply that is required to heat the chip to its operating temperature at the specified conditions.
- Low leakage capacitors are strongly recommended for noise control and other functions. Leaky capacitors can contribute to both accuracy and TC errors.

4

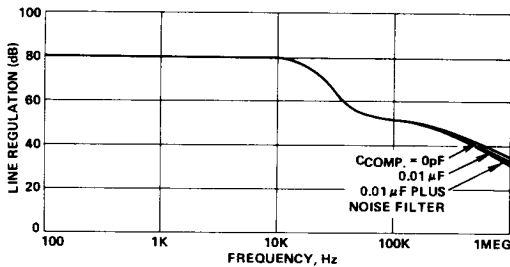
## DEFINITIONS

1. Output Noise Voltage: The peak-to-peak output noise voltage in a specified frequency band.
2. Quiescent Current,  $I_Q$ : The current required from the supply to operate the device at no load condition after the device is warmed up.
3. Output Voltage Temperature Coefficient,  $T_C$ : The ratio of the output voltage change with temperature to the specified temperature range expressed in ppm/°C;  $T_C$  (0°C to 75°C) =  $(\Delta V_O/10V)/75^\circ\text{C}$ .
4. Line Regulation: The ratio of the change in output voltage to the change in line voltage producing it; line regulation (%/V) =  $[(\Delta V_O/10V) \times 100] / \Delta V_{IN}$ .
5. Load Regulation: The ratio of the change in output voltage to the change in load current producing it; load regulation (%/mA) =  $[(\Delta V_O/10V) \times 100] / \Delta I_L$ .

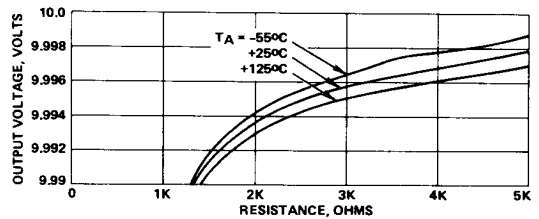
## PERFORMANCE CURVES

$V_{IN} = +15V$ ,  $R_L = \infty$ ,  $T_A = +25^\circ\text{C}$  Unless otherwise specified.

### LINE REGULATION VS. FREQUENCY



### OUTPUT VOLTAGE VS. LOAD RESISTANCE



### OUTPUT BROADBAND NOISE VOLTAGE VS. FREQUENCY (CCOMP. = 0.01 μF)

