



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"> MONOLITHIC CONSTRUCTION EXCELLENT TEMPERATURE STABILITY LOW NOISE 100 μV_{RMS} WIDE INPUT RANGE 14V TO 20V 	<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"> EXTERNAL VOLTAGE REFERENCE FOR DATA CONVERTERS (D/A OR A/D) COMPARATOR REFERENCE VOLTAGE REGULATOR REFERENCE 	<p>HA-1600/02/05 is packaged in a 14 pin DIP. HA-1600-2 is guaranteed to provide ± 1 LSB accuracy from -55°C to +125°C while the HA-1602-2 offers guaranteed accuracy to ± 2 LSB* over the military temperature range. HA-1605-5 is specified to maintain better than ± 1 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	
POWER INPUT CHARA.'S											
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
REGULATED OUTPUT CHARA.'S											
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		μVRMS
Line Regulation $V_{IN} = 14.5\text{V}$ to 17.5V	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			± 1.35			± 2.7			± 3.25	ppm/°C
Output Voltage Error, Total (Note 3)	Full			± 1 LSB			± 2 LSB			± 1 LSB	
TURN-ON CHARACTERISTICS											
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 40Ω 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.

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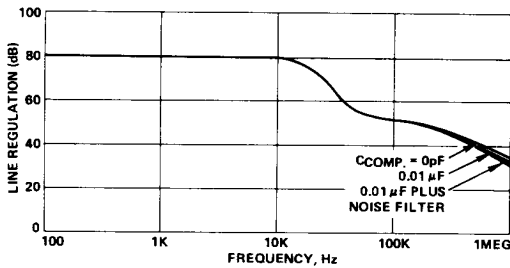
DEFINITIONS

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) = $[(\Delta V_O/10V) \times 100] / \Delta I_L$.

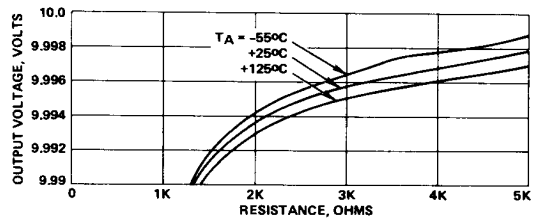
PERFORMANCE CURVES

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

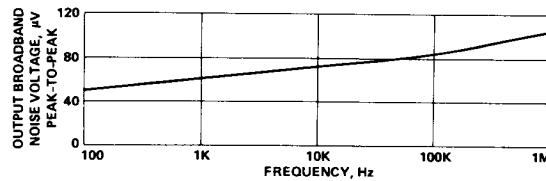
LINE REGULATION VS. FREQUENCY

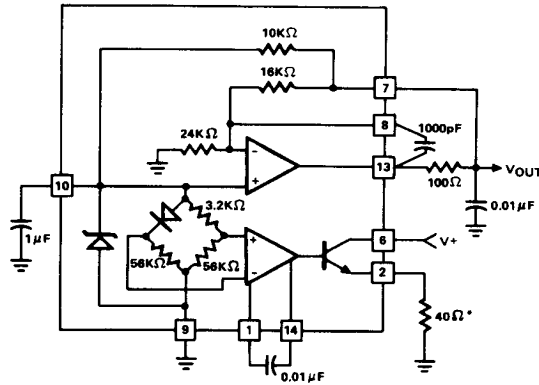


OUTPUT VOLTAGE VS. LOAD RESISTANCE



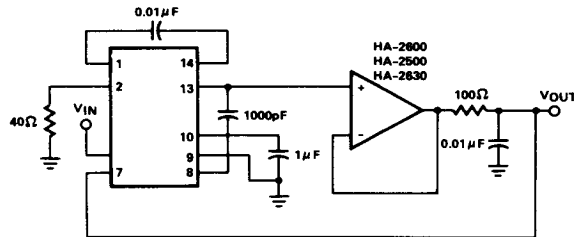
OUTPUT BROADBAND NOISE VOLTAGE VS. FREQUENCY (CCOMP. = 0.01 μF)





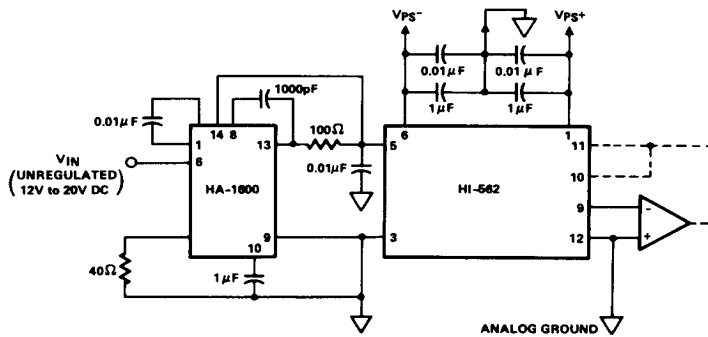
*Current limiting resistor - See note 2.

FUNCTIONAL DIAGRAM/SUGGESTED HOOK-UP



BOOSTING OUTPUT CURRENT

In this circuit an operational amplifier is tied in the feedback loop of HA-1600. Output current capability can be increased from 2mA to several hundred milliamps if required. The errors of the op amp are nullified by HA-1600.



12 BIT D/A CONVERTER USING HA-1600