

## PRELIMINARY

## Ultra-Low Offset Voltage Operational Amplifier

### Features

- Low Offset Voltage ..... 25 $\mu$ V Max.
- Low Offset Voltage Drift ..... 0.3 $\mu$ V/ $^{\circ}$ C Max.
- High Voltage Gain ..... 134dB Min.
- High CMRR ..... 120dB Min.
- High PSRR ..... 3 $\mu$ V/V Max.
- Low Noise ..... 9nV/ $\sqrt{\text{Hz}}$  Typ.
- Low Power Consumption ..... 51mW Max.

### Applications

- High Gain Instrumentation Amplifiers
- Precision Control Systems
- Precision Integrators
- High Resolution Data Converters
- Precision Threshold Detectors
- Low Level Transducer Amplifiers

### Description

The HA-5177 is a monolithic, all bipolar, precision operational amplifier, utilizing Harris dielectric isolation and advance processing techniques. This design features a combination of precision input characteristics, wide bandwidth (1.4MHz) and high speed (0.8 V/ $\mu$ s).

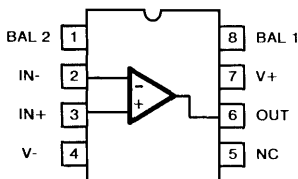
The HA-5177 uses advanced matching techniques and laser trimming to produce low offset voltage (25 $\mu$ V) and low offset voltage drift (0.3 $\mu$ V/ $^{\circ}$ C). This design also features low voltage noise (9.0nV/ $\sqrt{\text{Hz}}$ ), low current noise (0.12pA/ $\sqrt{\text{Hz}}$ ), nanoamp input currents, and 120dB minimum gain.

These outstanding features along with high CMRR (140dB) and high PSRR (135dB) make this unity gain stable amplifier ideal for high resolution data acquisition systems, precision integrators, and low level transducer amplifiers.

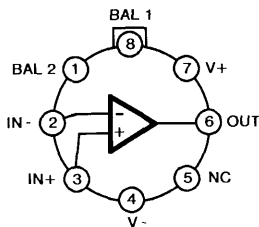
The HA-5177 can be used as a direct replacement for the OP05, OP07, and OP77 while offering higher bandwidth and slew rate. The HA-5177 is packaged in a 8 pin (TO-99) Metal Can and Ceramic 8 pin Mini-DIP and is pin compatible with many existing op amps. See the HA-5177/883 data sheet for military grade parts and LCC package.

### Pinouts

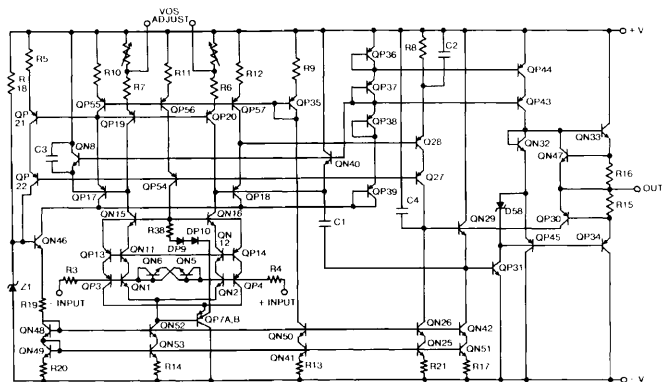
HA7-5177 (CERAMIC MINI-DIP)  
TOP VIEW



HA2-5177 (TO-8 METAL CAN)  
TOP VIEW



### Schematic



# Specifications HA-5177

HA-5177

## Absolute Maximum Ratings (Note 1)

$T_A = +25^\circ\text{C}$ Unless Otherwise Specified	
Voltage Between V+ and V- Terminals	40V
Differential Input Voltage	$\pm 15\text{V}$
Output Current	Short Circuit Protected
Power Dissipation	500mW
Maximum Junction Temperature	$+175^\circ\text{C}$

## Operating Temperature Ranges

HA-5177A/5177-2	$-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$
HA-5177A/5177-5	$0^\circ\text{C} \leq T_A \leq +75^\circ\text{C}$
Storage Temperature Range:	$-65^\circ\text{C} \leq T_A \leq +150^\circ\text{C}$

## Electrical Specifications $V_+ = +15\text{V}, V_- = -15\text{V}$

PARAMETER	TEMP	HA-5177A			HA-5177			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
<b>INPUT CHARACTERISTICS</b>								
Offset Voltage	$+25^\circ\text{C}$	-	10	25	-	20	60	$\mu\text{V}$
	Full	-	25	60	-	40	100	$\mu\text{V}$
Average Offset Voltage Drift	Full	-	0.1	0.3	-	0.2	0.6	$\mu\text{V}/^\circ\text{C}$
Bias Current	$+25^\circ\text{C}$	-	1.2	2	-	1.2	6	nA
	Full	-	2.4	4	-	2.4	8	nA
Bias Current Average Drift	Full	-	2.4	4	-	2.4	6	$\text{nA}/^\circ\text{C}$
Offset Current	$+25^\circ\text{C}$	-	0.6	2	-	0.6	6	nA
	Full	-	1.0	4	-	1.0	8	nA
Offset Current Average Drift	Full	-	1.5	25	-	1.5	50	$\text{pA}/^\circ\text{C}$
Common Mode Range	Full	$\pm 12$	-	-	$\pm 12$	-	-	V
Differential Input Resistance	$+25^\circ\text{C}$	-	47	-	-	47	-	$\text{M}\Omega$
Input Noise Voltage 0.1Hz to 10Hz	$+25^\circ\text{C}$	-	0.35	0.6	-	0.35	0.6	$\mu\text{V}_{\text{p-p}}$
Input Noise Voltage Density (Note 2)	$+25^\circ\text{C}$	-	-	-	-	-	-	$\text{nV}/\sqrt{\text{Hz}}$
$f_0 = 10\text{Hz}$		-	5.5	8	-	13	18	
$f_0 = 100\text{Hz}$		-	4.5	5.6	-	10	13	
$f_0 = 1000\text{Hz}$		-	3.8	4.5	-	9	11	
Input Noise Current 0.1Hz to 10Hz	$+25^\circ\text{C}$	-	14	30	-	14	45	$\text{pA}_{\text{p-p}}$
Input Noise Current Density (Note 2)	$+25^\circ\text{C}$	-	-	-	-	-	-	$\text{pA}/\sqrt{\text{Hz}}$
$f_0 = 10\text{Hz}$		-	1.1	4	-	7.1	10	
$f_0 = 100\text{Hz}$		-	0.55	2.3	-	3.3	5	
$f_0 = 1000\text{Hz}$		-	0.32	1	-	1.2	2	
<b>TRANSFER CHARACTERISTICS</b>								
Large Signal Voltage Gain (Note 3)	$+25^\circ\text{C}$	134	150	-	126	150	-	dB
	Full	126	140	-	120	140	-	dB
Common Mode Rejection Ratio (Note 4)	Full	120	140	-	110	140	-	dB
Closed Loop Bandwidth ( $A_{\text{VCL}} = +1$ )	$+25^\circ\text{C}$	-	1.4	-	-	1.4	-	MHz
<b>OUTPUT CHARACTERISTICS</b>								
Output Voltage Swing (Note 5)	$+25^\circ\text{C}$	$\pm 12$	$\pm 13$	-	$\pm 12$	$\pm 13$	-	V
	Full	$\pm 12$	$\pm 12.5$	-	$\pm 12$	$\pm 12.5$	-	V
Full Power Bandwidth (Note 6)	$+25^\circ\text{C}$	8	10	-	8	10	-	kHz
Output Current (Note 7)	$+25^\circ\text{C}$	15	20	-	15	20	-	mA
Output Resistance	$+25^\circ\text{C}$	-	60	-	-	60	-	$\Omega$
<b>TRANSIENT RESPONSE</b>								
Rise Time	$+25^\circ\text{C}$	-	310	420	-	310	420	ns
Slew Rate	$+25^\circ\text{C}$	0.5	0.8	-	0.5	0.8	-	$\text{V}/\mu\text{s}$
Settling Time (Note 9)	$+25^\circ\text{C}$	-	14	-	-	14	-	$\mu\text{s}$
Overshoot	$+25^\circ\text{C}$	-	10	40	-	10	40	%
<b>POWER SUPPLY CHARACTERISTICS</b>								
Supply Current	Full	-	1.2	1.7	-	1.2	1.7	mA
Power Supply Rejection Ratio (Note 10)	Full	110	135	-	110	135	-	dB

### NOTES:

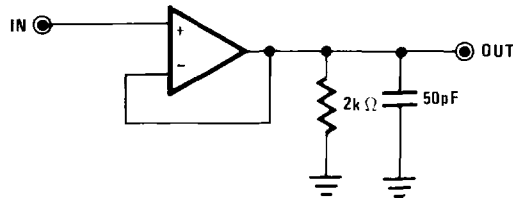
1. Absolute maximum ratings are limiting values, applied individually beyond which the serviceability of the circuit may be impaired. Functional operability under any of these conditions is not necessarily implied.
2. Sample Tested.
3.  $V_{\text{OUT}} = \pm 10\text{V}, R_L = 2\text{k}\Omega$
4.  $\Delta V_{\text{CM}} = \pm 10\text{V D.C.}$
5.  $R_L = 2\text{K}$
6. Full power bandwidth guaranteed based on slew rate measurement using  $\text{FPBW} = \frac{\text{Slew Rate}}{2\pi V_{\text{PEAK}}} V_{\text{PEAK}} = 10\text{V}$ .
7.  $V_{\text{OUT}} = \pm 10$ .
8. Refer to test circuits section of the data sheet.
9. Settling time is measured to 0.1% of final value for a 10V output step and  $A_V = -1$ .
10.  $\Delta V_{\text{SUPPLY}} = \pm 10\text{V D.C. to } \pm 20\text{V D.C.}$

2

OP AMPS & COMPARATORS

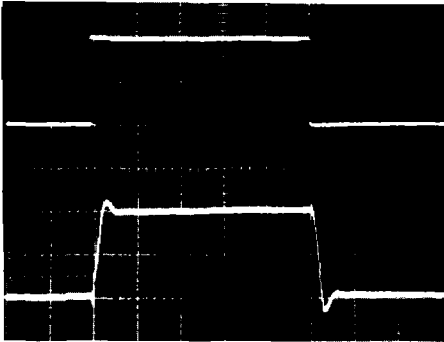
**Test Circuits**

**SLEW RATE AND TRANSIENT RESPONSE TEST CIRCUIT**



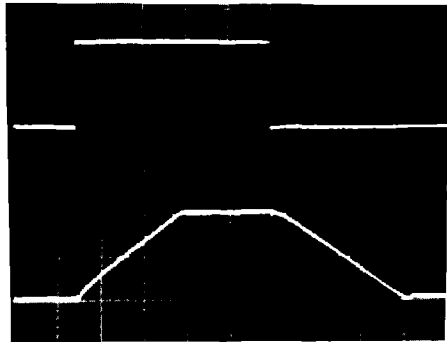
**SMALL SIGNAL RESPONSE**

Vertical Scale: (Volts: 100mV/Div.)  
Horizontal Scale: (Time: 2μs/Div.)

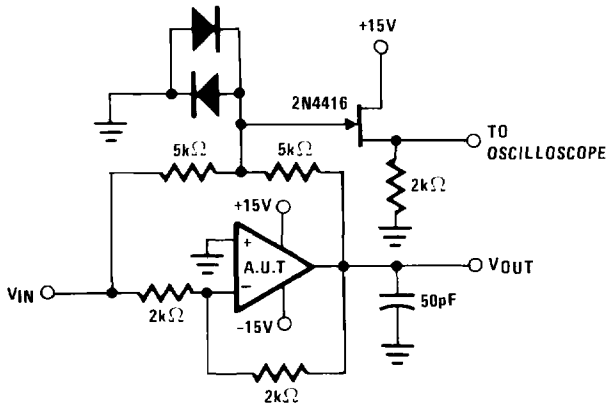


**LARGE SIGNAL RESPONSE**

Vertical Scale: (Volts: 5V/Div.)  
Horizontal Scale: (Time: 5μs/Div.)



**SETTLING TIME CIRCUIT**



- $A_V = -1$
- Feedback and summing resistors should be 0.1% matched.
- Clipping diodes are optional. HP5082-2810 recommended.