Low-Noise, Low-Distortion
INSTRUMENTATION AMPLIFIER
Replacement for SSM2017

FEATURES

- **LOW NOISE: 1.3nV/$\sqrt{\text{Hz}}$ at 1kHz**
- **LOW THD+N: 0.004% at 1kHz, G = 100**
- **WIDE BANDWIDTH: 800kHz at G = 100**
- **WIDE SUPPLY RANGE: $\pm$4.5V to $\pm$18V**
- **HIGH CMR: > 100dB**
- **GAIN SET WITH EXTERNAL RESISTOR**
- **DIP-8 AND SOL-16 WIDEBODY PACKAGES**

APPLICATIONS

- **PROFESSIONAL MICROPHONE PREAMPS**
- **MOVING-COIL TRANSDUCER AMPLIFIERS**
- **DIFFERENTIAL RECEIVERS**
- **BRIDGE TRANSDUCER AMPLIFIERS**

DESCRIPTION

The INA217 is a low-noise, low-distortion, monolithic instrumentation amplifier. Current-feedback circuitry allows the INA217 to achieve wide bandwidth and excellent dynamic response over a wide range of gain. The INA217 is ideal for low-level audio signals such as balanced low-impedance microphones. Many industrial, instrumentation, and medical applications also benefit from its low noise and wide bandwidth.

Unique distortion cancellation circuitry reduces distortion to extremely low levels, even in high gain. The INA217 provides near-theoretical noise performance for 200Ω source impedance. The INA217 features differential input, low noise, and low distortion that provides superior performance in professional microphone amplifier applications.

The INA217 features wide supply voltage, excellent output voltage swing, and high output current drive making it an optimal candidate for use in high-level audio stages.

The INA217 is available in the same DIP-8 and SOL-16 wide body packages and pin outs as the SSM2017. For a smaller package, see the INA163 in SO-14 narrow. The INA217 is specified over the temperature range of –40°C to +85°C.

$$G = 1 + \frac{10k\Omega}{R_G}$$
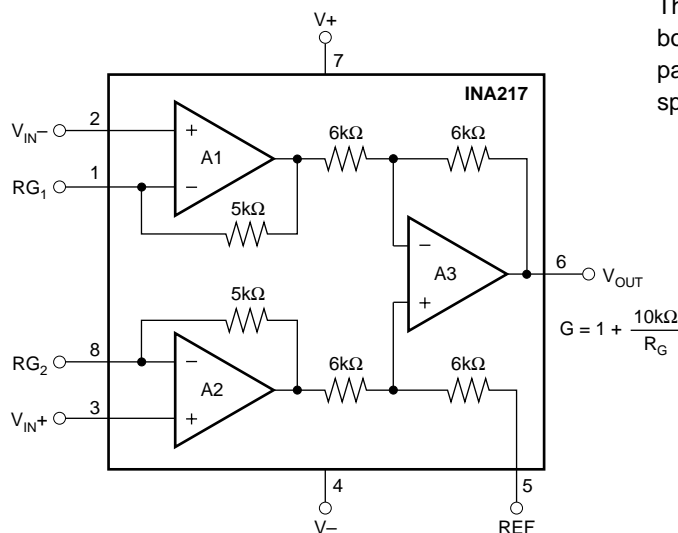
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ABSOLUTE MAXIMUM RATINGS[1]

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Supply Voltage, V+ to V– .................................................. ±18V
Signal Input Terminals, Voltage[2] ................. (V–) – 0.5V to (V+) + 0.5V
                        Current[2] ................................................. 10mA
Output Short-Circuit[3] ............................................... Continuous
Operating Temperature ................................. –55°C to +125°C
Storage Temperature ..................................... –55°C to +150°C
Junction Temperature ....................................................... +150°C
Lead Temperature (soldering, 10s) ............................. +300°C
```

NOTES: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. (2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current limited to 10mA or less. (3) Short-circuit to ground, one amplifier per package.

ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.
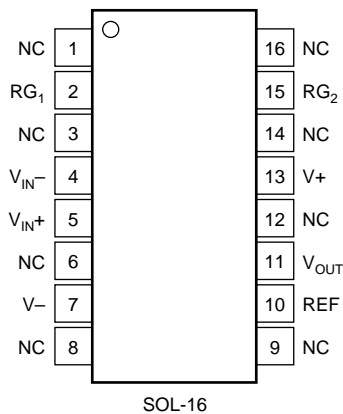
PACKAGE/ORDERING INFORMATION

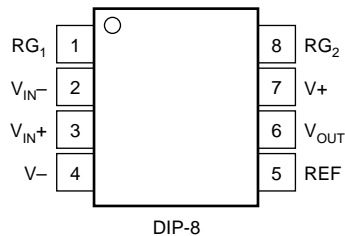| PRODUCT	PACKAGE-LEAD	PACKAGE DESIGNATOR[1]	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA, QUANTITY
INA217	SOL-16	DW	–40°C to +125°C	INA217	INA217AIDWT	Tape and Reel, 250
"	"	"	"	"	INA217AIDWR	Tape and Reel, 1000
INA217	DIP-8	P	–40°C to +125°C	INA217	INA217AIP	Rails, 50

NOTES: (1) For the most current specifications and package information, refer to our web site at www.ti.com.

PIN CONFIGURATIONS

Top View

SOL-16

NC 1 — 16 NC
RG₁ 2 — 15 RG₂
NC 3 — 14 NC
V_IN– 4 — 13 V+
V_IN+ 5 — 12 NC
NC 6 — 11 V_OUT
V– 7 — 10 REF
NC 8 — 9 NC

DIP-8

RG₁ 1 — 8 RG₂
V_IN– 2 — 7 V+
V_IN+ 3 — 6 V_OUT
V– 4 — 5 REF

NC = No Internal Connection

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ELECTRICAL CHARACTERISTICS: $V_S = \pm15V$

Boldface limits apply over the specified temperature range, $T_A = -40°C$ to $+85°C$.

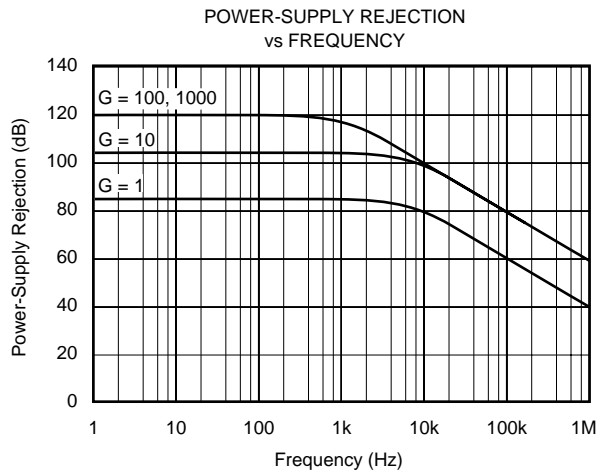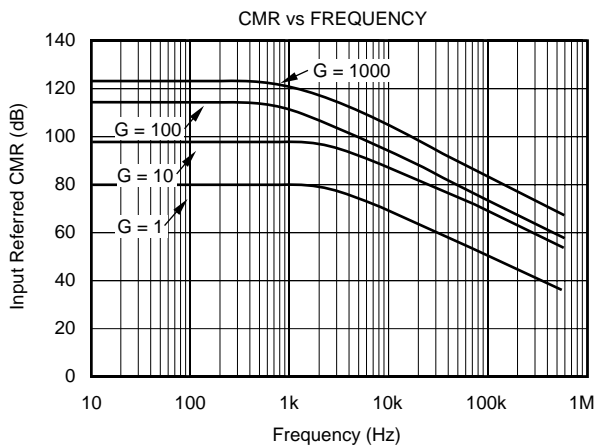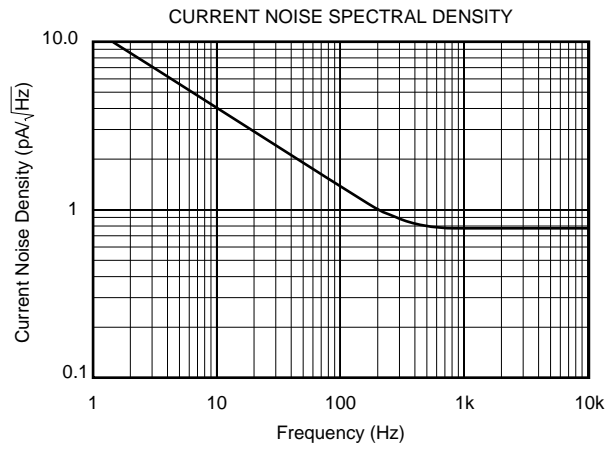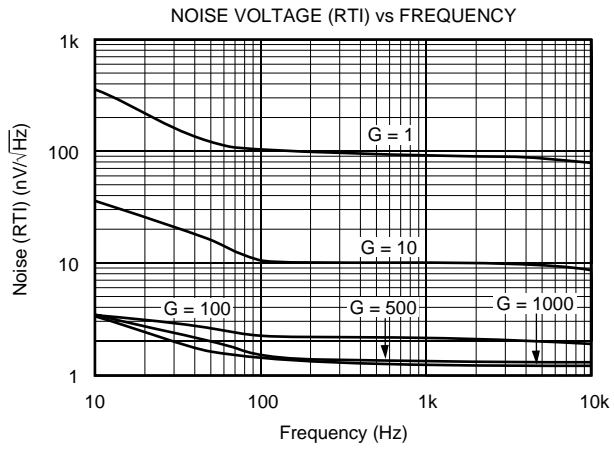$T_A = +25°C$, $R_L = 2k\Omega$, $V_S = \pm15V$, unless otherwise noted.

PARAMETER	CONDITIONS	INA217 MIN	INA217 TYP	INA217 MAX	UNITS
GAIN EQUATION			$G = 1 + 10k/R_G$		
Range			1 to 10000		V/V
Gain Error, G = 1			±0.1	±0.25	%
G = 10			±0.2	±0.7	%
G = 100			±0.2		%
G = 1000			±0.5		%
Gain Temp Drift Coefficient, G = 1			**±3**	**±10**	**ppm/°C**
G > 10			**±40**	**±100**	**ppm/°C**
Nonlinearity, G = 1			±0.0003		% of FS
G = 100			±0.0006		% of FS
INPUT STAGE NOISE					
Voltage Noise	$R_{SOURCE} = 0\Omega$				
f_O = 1kHz			1.3		nV/√Hz
f_O = 100Hz			1.5		nV/√Hz
f_O = 10Hz			3.5		nV/√Hz
Current Noise					
f_O = 1kHz			0.8		pA/√Hz
OUTPUT STAGE NOISE					
Voltage Noise, f_O = 1kHz			90		nV/√Hz
INPUT OFFSET VOLTAGE					
Input Offset Voltage	$V_{CM} = V_{OUT} = 0V$		50 + 2000/G	250 + 5000/G	µV
vs Temperature	$T_A = T_{MIN}$ to T_{MAX}		**1 + 20/G**		**µV/°C**
vs Power Supply	$V_S = \pm4.5V$ to $\pm18V$		1 + 50/G	3 + 200/G	µV/V
INPUT VOLTAGE RANGE					
Common-Mode Voltage Range	$V_{IN}+ - V_{IN}- = 0V$	(V+) − 4	(V+) − 3		V
	$V_{IN}+ - V_{IN}- = 0V$	(V−) + 4	(V−) + 3		V
Common-Mode Rejection, G = 1	$V_{CM} = \pm11V$, $R_{SRC} = 0\Omega$	70	80		dB
G = 100		100	116		dB
INPUT BIAS CURRENT					
Initial Bias Current			2	12	µA
vs Temperature			**10**		**nA/°C**
Initial Offset Current			0.1	1	µA
vs Temperature			**0.5**		**nA/°C**
INPUT IMPEDANCE					
	Differential		60‖2		MΩ‖pF
	Common-Mode		60‖2		MΩ‖pF
DYNAMIC RESPONSE					
Bandwidth, Small Signal, −3dB, G = 1			3.4		MHz
G = 100			800		kHz
Slew Rate			15		V/µs
THD+Noise, f = 1kHz	G = 100		0.004		%
Settling Time, 0.1%	G = 100, 10V Step		2		µs
0.01%	G = 100, 10V Step		3.5		µs
Overload Recovery	50% Overdrive		1		µs
OUTPUT					
Voltage	R_L to GND	(V+) − 2	(V+) − 1.8		V
		(V−) + 2	(V−) + 1.8		V
Load Capacitance Stability			1000		pF
Short-Circuit Current	Continuous-to-Common		±60		mA
POWER SUPPLY					
Rated Voltage			±15		V
Voltage Range		±4.5		±18	V
Current, Quiescent	I_O = 0mA		±10	±12	mA
TEMPERATURE RANGE					
Specification		−40		+85	°C
Operating		−40		+125	°C
DIP-8	θ_{JA}		85		°C
SOL-16			90		°C

NOTE: (1) Gain accuracy is a function of external R_G.

TYPICAL CHARACTERISTICS

At T_A = +25°C, V_S = ±15V, R_L = 2kΩ, unless otherwise noted.

GAIN vs FREQUENCY

Gain (dB) vs Frequency (Hz), curves for G = 1000, G = 100, G = 10, G = 1

THD+N vs FREQUENCY

THD+N (%) vs Frequency (Hz), curves for G = 1000, G = 100, G = 10, G = 1
V_O = 7Vrms, R_L = 10kΩ

NOISE VOLTAGE (RTI) vs FREQUENCY

Noise (RTI) (nV/√Hz) vs Frequency (Hz), curves for G = 1, G = 10, G = 100, G = 500, G = 1000

CURRENT NOISE SPECTRAL DENSITY

Current Noise Density (pA/√Hz) vs Frequency (Hz)

CMR vs FREQUENCY

Input Referred CMR (dB) vs Frequency (Hz), curves for G = 1000, G = 100, G = 10, G = 1

POWER-SUPPLY REJECTION vs FREQUENCY

Power-Supply Rejection (dB) vs Frequency (Hz), curves for G = 100, 1000, G = 10, G = 1

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TYPICAL CHARACTERISTICS (Cont.)

At T_A = +25°C, V_S = ±15V, R_L = 2kΩ, unless otherwise noted.

OUTPUT VOLTAGE SWING vs OUTPUT CURRENT
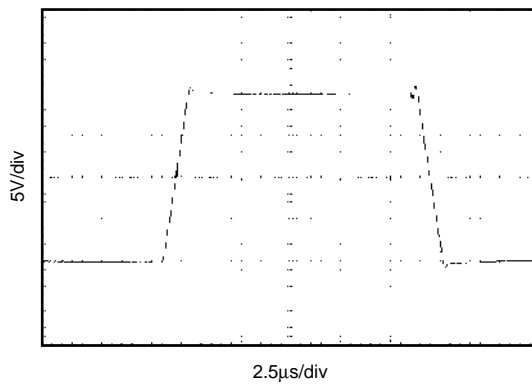
SETTLING TIME vs GAIN
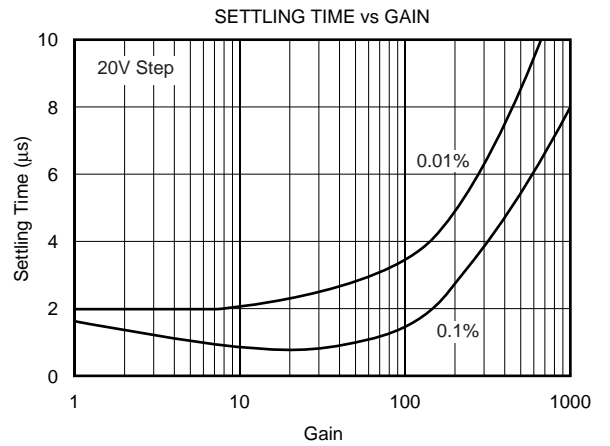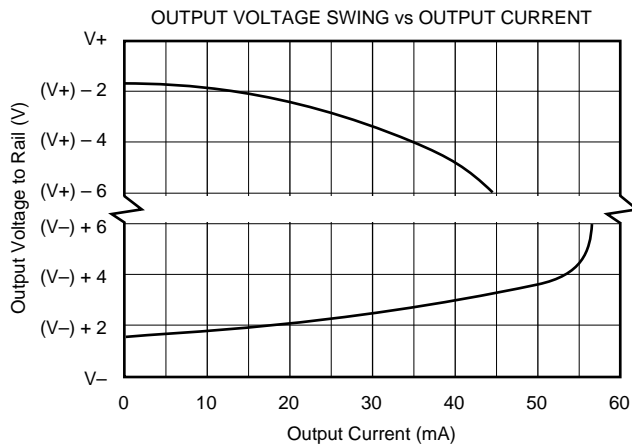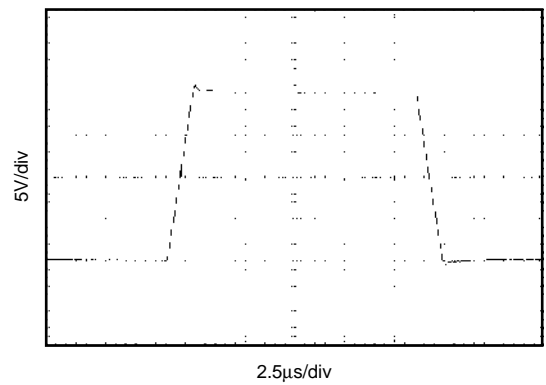
SMALL-SIGNAL TRANSIENT RESPONSE
(G = 1)
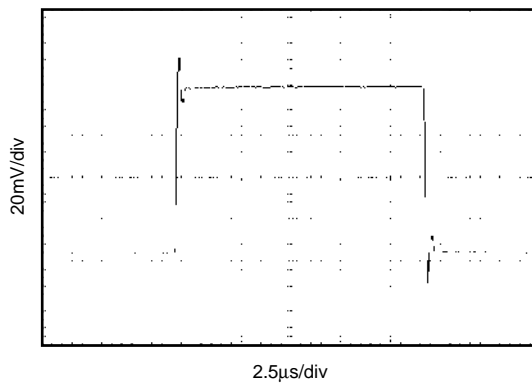
SMALL-SIGNAL TRANSIENT RESPONSE
(G = 100)
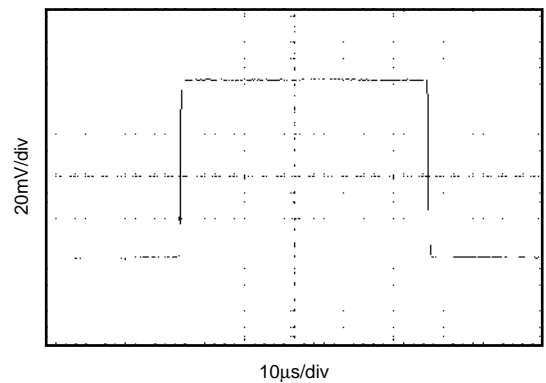
LARGE-SIGNAL TRANSIENT RESPONSE
(G = 1)

LARGE-SIGNAL TRANSIENT RESPONSE
(G = 100)

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APPLICATIONS INFORMATION

Figure 1 shows the basic connections required for operation. Power supplies should be bypassed with 0.1μF tantalum capacitors near the device pins. The output Reference (pin 5) should be a low-impedance connection. Resistance of a few ohms in series with this connection will degrade the common-mode rejection of the INA217.

GAIN-SET RESISTOR

Gain is set with an external resistor, R_G, as shown in Figure 1. The two internal 5kΩ feedback resistors are laser-trimmed to 5kΩ within approximately ±0.2%. The gain equation for the INA217 is:

$$G = 1 + \frac{10,000}{R_G}$$

The temperature coefficient of the internal 5kΩ resistors is approximately ±25ppm/°C. Accuracy and TCR of the external R_G will also contribute to gain error and temperature drift. These effects can be inferred from the gain equation. Make a short, direct connection to the gain set resistor, R_G. Avoid running output signals near these sensitive input nodes.

NOISE PERFORMANCE

The INA217 provides very low-noise with low-source impedance. Its 1.3nV/√Hz voltage noise delivers near-theoretical noise performance with a source impedance of 200Ω. The input stage design used to achieve this low noise, results in relatively high input bias current and input bias current noise. As a result, the INA217 may not provide the best noise performance with a source impedance greater than 10kΩ. For source impedance greater than 10kΩ, other instrumentation amplifiers may provide improved noise performance.

INPUT CONSIDERATIONS

Very low source impedance (less than 10Ω) can cause the INA217 to oscillate. This depends on circuit layout, signal source, and input cable characteristics. An input network consisting of a small inductor and resistor, as shown in Figure 2, can greatly reduce any tendency to oscillate. This is especially useful if a variety of input sources are to be connected to the INA217. Although not shown in other figures, this network can be used as needed with all applications shown.
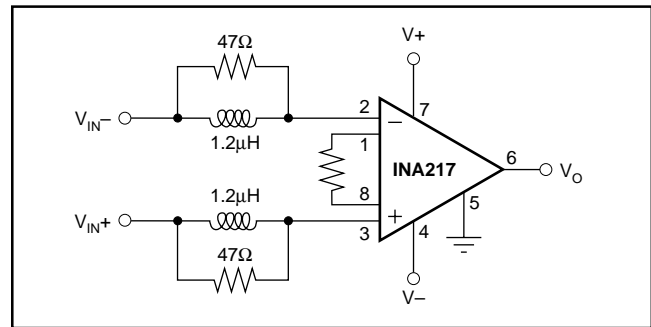

FIGURE 2. Input Stabilization Network.

FIGURE 1. Basic Circuit Connections.

GAIN		R_G
(V/V)	(dB)	(Ω)
1	0	NC[1]
2	6	10000
5	14	2500
10	20	1111
20	26	526
50	34	204
100	40	101
200	46	50
500	54	20
1000	60	10
2000	66	5

NOTE: (1) NC = No Connection.

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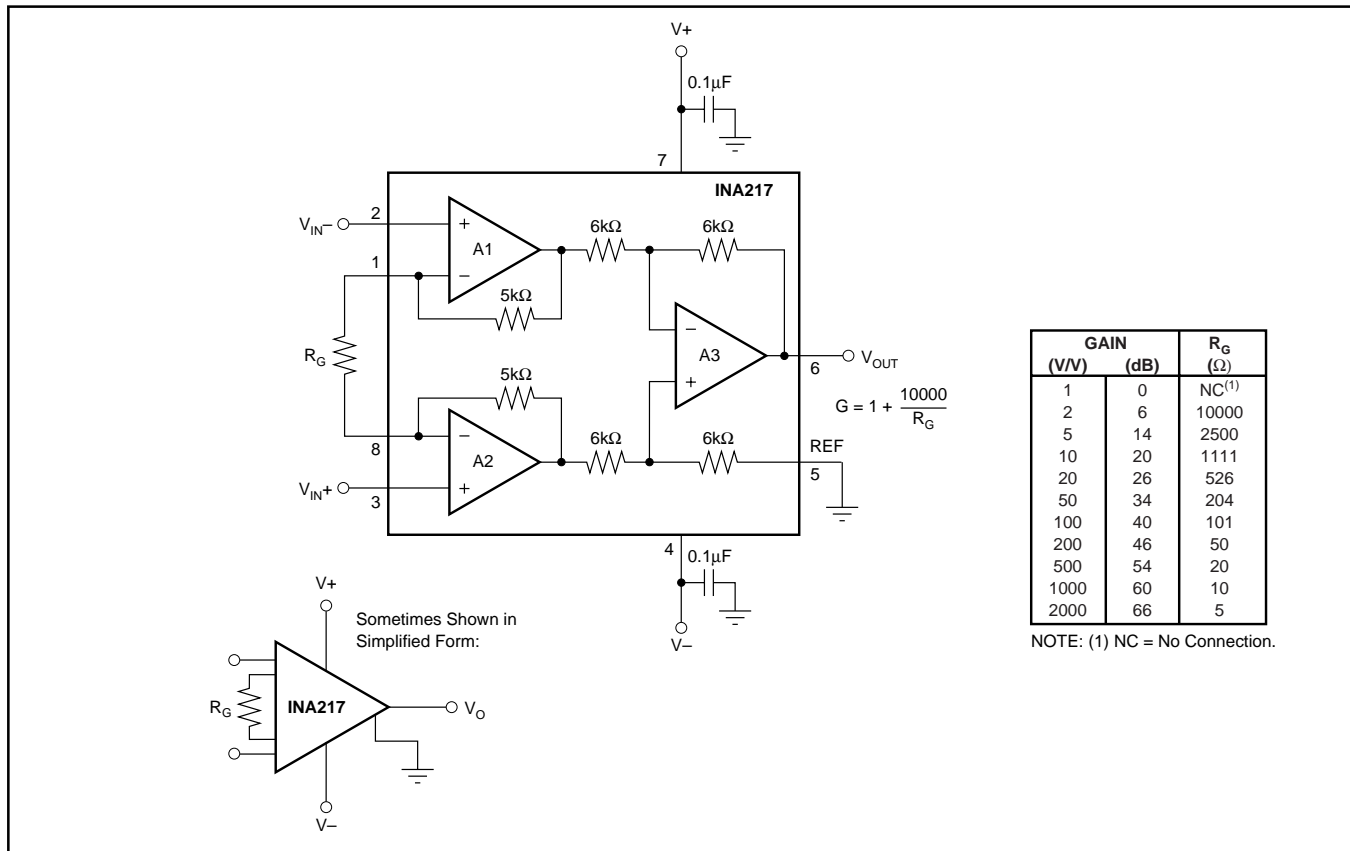
OFFSET VOLTAGE TRIM

A variable voltage applied to pin 5, as shown in Figure 3, can be used to adjust the output offset voltage. A voltage applied to pin 5 is summed with the output signal. An op amp connected as a buffer is used to provide a low impedance at pin 5 to assure good common-mode rejection.
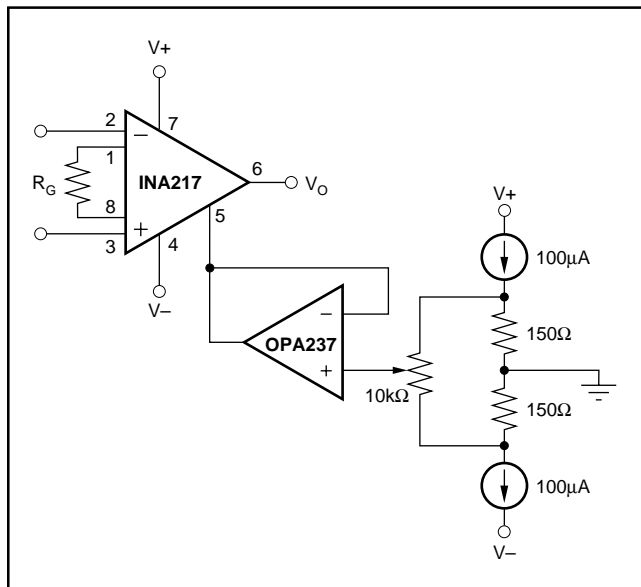

FIGURE 3. Offset Voltage Adjustment Circuit.

MICROPHONE AMPLIFIER

Figure 4 shows a typical circuit for a professional microphone input amplifier. R_1 and R_2 provide a current path for conventional 48V phantom power source for a remotely located microphone. An optional switch allows phantom power to be disabled. C_1 and C_2 block the phantom power voltage from the INA217 input circuitry. Non-polarized capacitors should be used for C_1 and C_2 if phantom power is to be disabled. For additional input protection against ESD and hot-plugging, four IN4148 diodes may be connected from the input to supply lines.

R_4 and R_5 provide a path for input bias current of the INA217. Input offset current (typically 100nA) creates a DC differential input voltage that will produce an output offset voltage. This is generally the dominant source of output offset voltage in this application. With a maximum gain of 1000 (60dB), the output offset voltage can be several volts. This may be entirely acceptable if the output is AC-coupled into the subsequent stage. An alternate technique is shown in Figure 4. An inexpensive FET-input op amp in a feedback loop drives the DC output voltage to 0V. A2 is not in the audio signal path and does not affect signal quality.

Gain is set with a variable resistor, R_7, in series with R_6. R_6 determines the maximum gain. The total resistance, $R_6 + R_7$, determines the lowest gain. A special reverse-log taper potentiometer for R_7 can be used to create a linear change (in dB) with rotation.
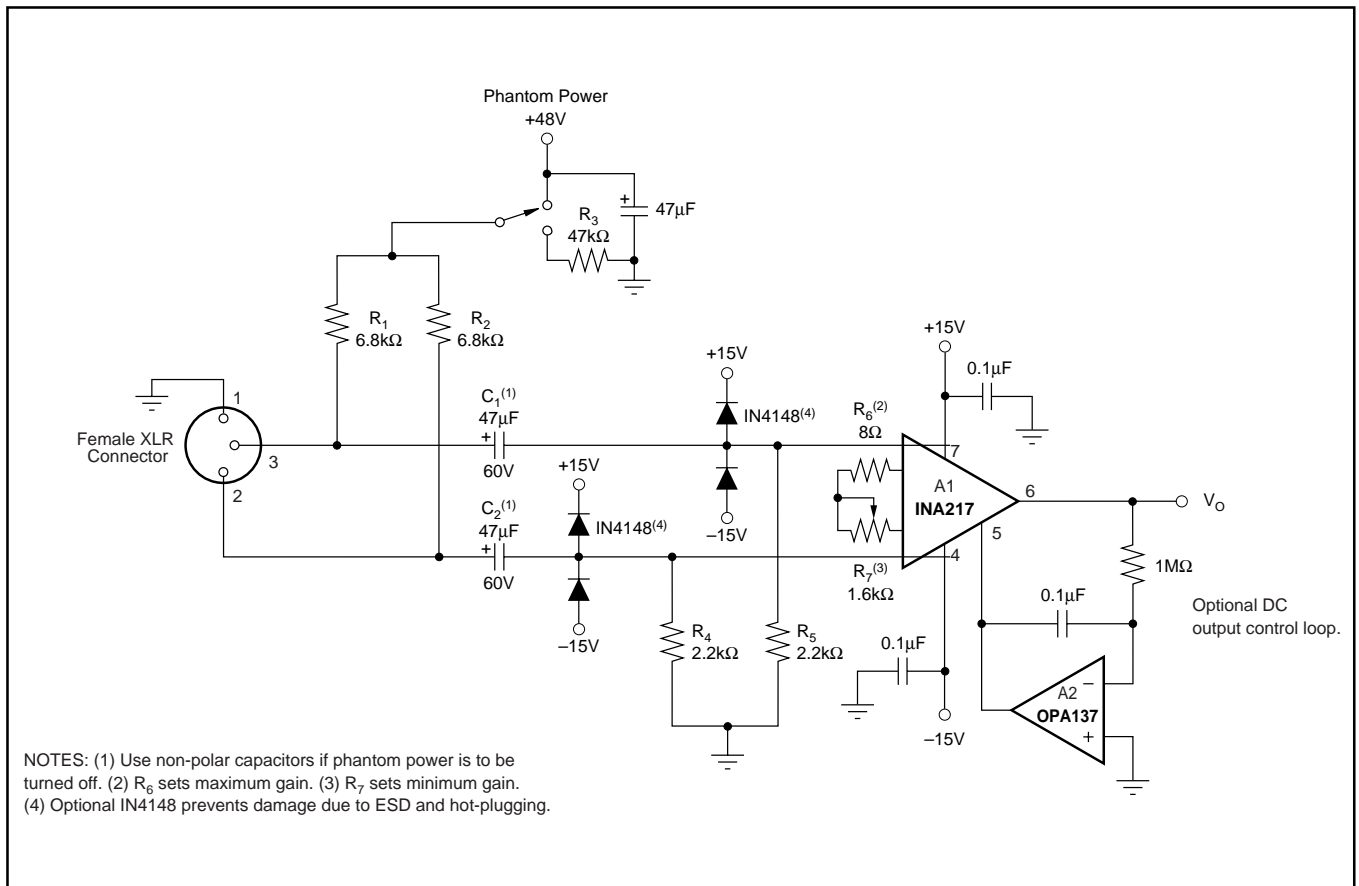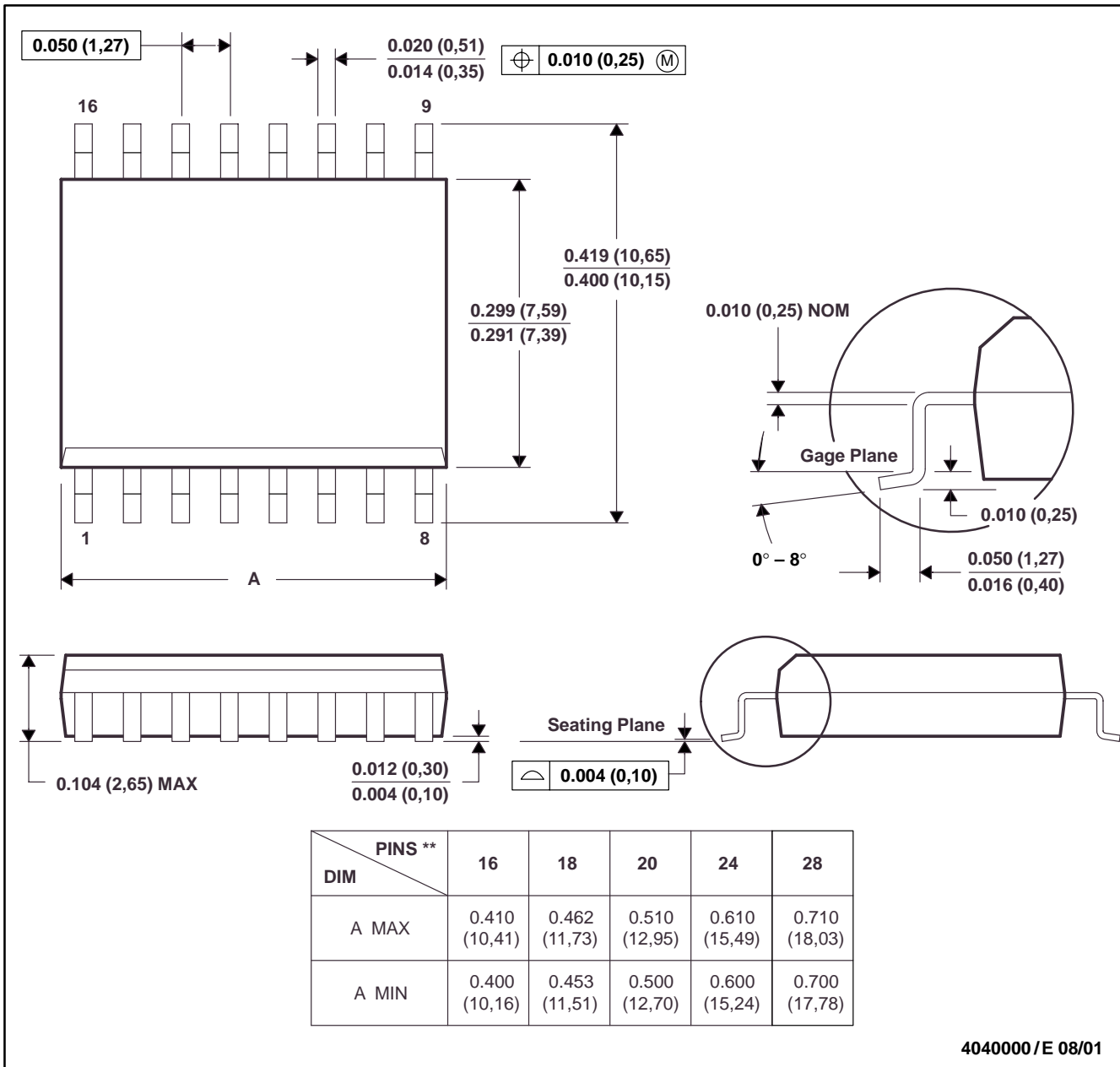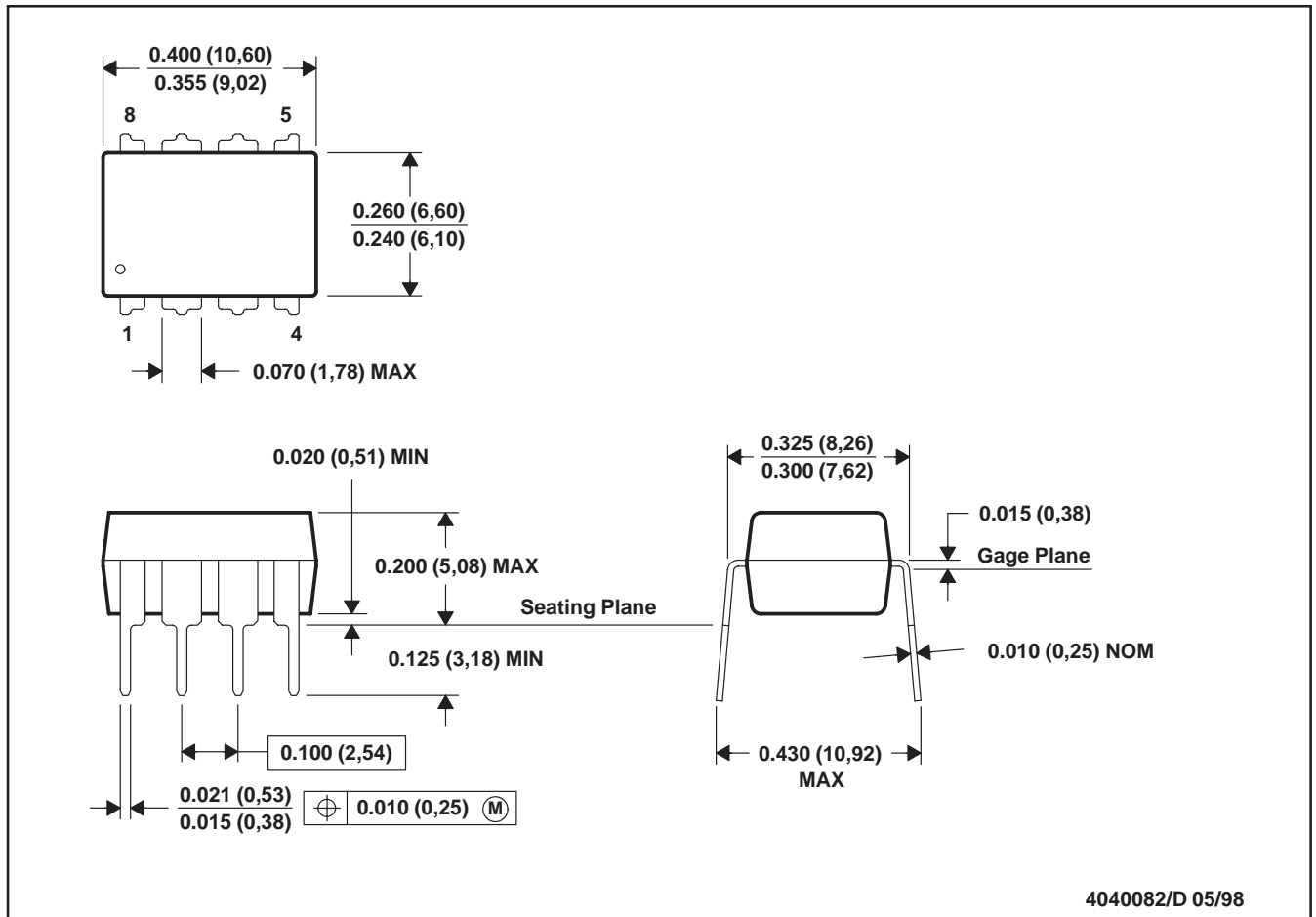

FIGURE 4. Phantom-Powered Microphone Preamplifier.

DW (R-PDSO-G**)   **PLASTIC SMALL-OUTLINE PACKAGE**

16 PINS SHOWN

0.050 (1,27)

0.020 (0,51)
0.014 (0,35)

⊕ | 0.010 (0,25) | Ⓜ

16   9

0.419 (10,65)
0.400 (10,15)

0.299 (7,59)
0.291 (7,39)

0.010 (0,25) NOM

Gage Plane

0.010 (0,25)

1   8

0° – 8°

0.050 (1,27)
0.016 (0,40)

A

0.104 (2,65) MAX

0.012 (0,30)
0.004 (0,10)

△ | 0.004 (0,10)

Seating Plane

PINS ** DIM	16	18	20	24	28
A MAX	0.410 (10,41)	0.462 (11,73)	0.510 (12,95)	0.610 (15,49)	0.710 (18,03)
A MIN	0.400 (10,16)	0.453 (11,51)	0.500 (12,70)	0.600 (15,24)	0.700 (17,78)

4040000 / E 08/01

NOTES: A. All linear dimensions are in inches (millimeters).
      B. This drawing is subject to change without notice.
      C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
      D. Falls within JEDEC MS-013

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P (R-PDIP-T8)   **PLASTIC DUAL-IN-LINE**

4040082/D 05/98

NOTES: A. All linear dimensions are in inches (millimeters).
        B. This drawing is subject to change without notice.
        C. Falls within JEDEC MS-001

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