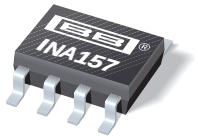
BURR-BROWN®



INA157

For most current data sheet and other product information, visit www.burr-brown.com

High-Speed, Precision DIFFERENCE AMPLIFIER

FEATURES

- DESIGNED FOR LOW COST
- LOW OFFSET VOLTAGE: ±500µV max
- LOW OFFSET DRIFT: ±2µV/°C
- LOW GAIN ERROR: ±0.05% max
- WIDE BANDWIDTH: 3MHz
- HIGH SLEW RATE: 14V/µs
- FAST SETTLING TIME: 3µs to 0.01%
- WIDE SUPPLY RANGE: ±4V to ±18V
- LOW QUIESCENT CURRENT: 2.4mA
- SO-8 SURFACE-MOUNT PACKAGE

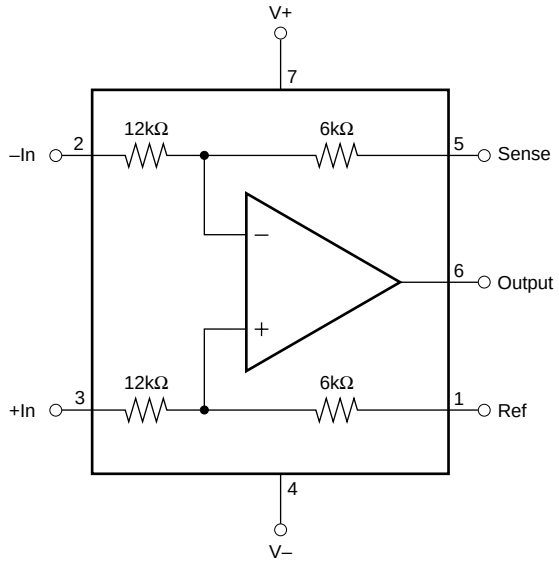
APPLICATIONS

- DIFFERENTIAL INPUT AMPLIFIER
- INSTRUMENTATION AMPLIFIER BUILDING BLOCK
- G = 1/2 AMPLIFIER
- G = 2 AMPLIFIER
- DIFFERENTIAL CURRENT RECEIVER
- VOLTAGE-CONTROLLED CURRENT SOURCE
- GROUND LOOP ELIMINATOR
- CURRENT SHUNT MONITOR

DESCRIPTION

The INA157 is a high slew rate, G = 1/2 or G = 2 difference amplifier consisting of a precision op amp with a precision resistor network. The on-chip resistors are laser trimmed for accurate gain and high common-mode rejection. Excellent TCR tracking of the resistors maintains gain accuracy and common-mode rejection over temperature. The input common-mode voltage range extends beyond the positive and negative supply rails. It operates on ±4V to ±18V supplies.

The difference amplifier is the foundation of many commonly used circuits. The INA157 provides this circuit function without using an expensive precision resistor network. The INA157 is available in a SO-8 surface-mount package and is specified for operation over the extended industrial temperature range, –40°C to +85°C.



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Twx: 910-952-1111 • Internet: http://www.burr-brown.com/ • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

PDS-1483B
Printed in U.S.A. March, 1999
SBOS105

SPECIFICATIONS: $V_S = \pm 15V$

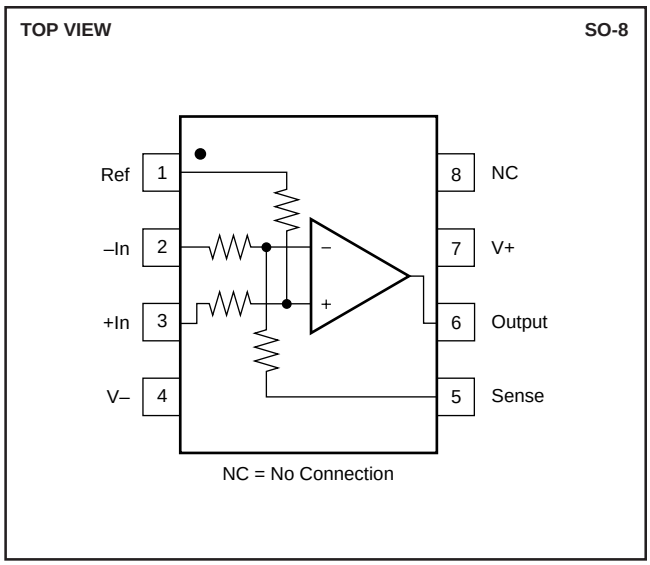
At T_A = +25°C, V_S = ±15V, R_L = 2kΩ connected to ground, and reference pin connected to ground, unless otherwise noted.

PARAMETER	CONDITIONS	INA157U			INA157UA			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
OFFSET VOLTAGE[1]	RTO							
Initial[1]			±100	±500		✻	±1000	µV
vs Temperature			±2	±20		✻	✻	µV/°C
vs Power Supply	V_S = ±4V to ±18V		±5	±60		✻	✻	µV/V
vs Time			0.25			✻		µV/mo
INPUT IMPEDANCE[2]								
Differential			24			✻		kΩ
Common-Mode			18			✻		kΩ
INPUT VOLTAGE RANGE								
Common-Mode Voltage Range								
Positive	V_O = 0V	3(V+)–7.5	3(V+)–6		✻	✻		V
Negative	V_O = 0V	3(V–)+7.5	3(V–)+3		✻	✻		V
Common-Mode Rejection Ratio	V_{CM} = –37.5V to 37.5V, R_S = 0Ω	86	96		80	✻		dB
OUTPUT VOLTAGE NOISE[3]	RTO							
f = 0.1Hz to 10Hz			1.3			✻		µVp-p
f = 1kHz			26			✻		$nV/\sqrt{Hz}$
GAIN								
Initial			0.5			✻		V/V
Error	V_O = –10V to +10V		±0.01	±0.05		✻	±0.1	%
vs Temperature			±1	±10		✻	✻	ppm/°C
Nonlinearity	V_O = –10V to +10V		±0.0001	±0.001		✻	±0.002	% of FS
OUTPUT								
Voltage, Positive		(V+)–2	(V+)–1.8		✻	✻		V
Negative		(V–)+2	(V–)+1.6		✻	✻		V
Current Limit, Continuous to Common			±60			✻		mA
Capacitive Load (stable operation)			500			✻		pF
FREQUENCY RESPONSE								
Small-Signal Bandwidth	–3dB		4			✻		MHz
Slew Rate			14			✻		V/µs
Settling Time: 0.1%	10V Step, C_L = 100pF		2			✻		µs
0.01%	10V Step, C_L = 100pF		3			✻		µs
Overload Recovery Time	50% Overdrive		3			✻		µs
POWER SUPPLY								
Rated Voltage			±15			✻		V
Operating Voltage Range		±4		±18	✻		✻	V
Quiescent Current	I_O = 0mA		±2.4	±2.9		✻	✻	mA
TEMPERATURE RANGE								
Specified		–40		+85	✻		✻	°C
Operation		–55		+125	✻		✻	°C
Storage		–55		+125	✻		✻	°C
Thermal Resistance, Θ_{JA}								
SO-8 Surface-Mount			150			✻		°C/W

✻Specifications the same as INA157U.

NOTES: (1) Includes effects of amplifier's input bias and offset currents. (2) Internal resistors are ratio matched but have ±20% absolute value. (3) Includes effects of amplifier's input current noise and thermal noise contribution of resistor network.

PIN CONFIGURATION



ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage, V+ to V–	40V
Input Voltage Range	±80V
Output Short Circuit (to ground)	Continuous
Operating Temperature	–55°C to +125°C
Storage Temperature	–55°C to +125°C
Junction Temperature	+150°C
Lead Temperature (soldering, 10s)	+300°C

NOTE: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability.

ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Burr-Brown 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

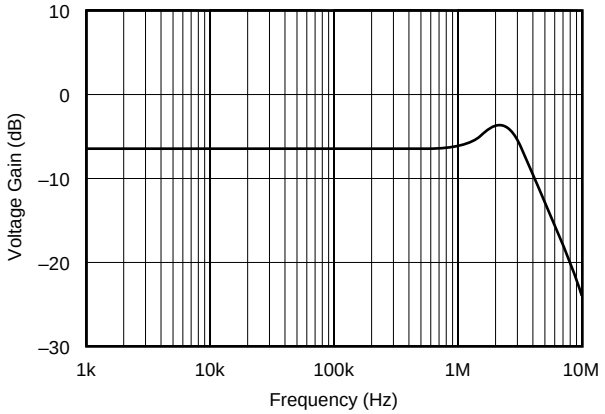
PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER[1]	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER[2]	TRANSPORT MEDIA
INA157U	SO-8 Surface-Mount	182	–40°C to +85°C	INA157U	INA157U	Rails
"	"	"	"	"	INA157U/2K5	Tape and Reel
INA157UA	SO-8 Surface-Mount	182	–40°C to +85°C	INA157UA	INA157UA	Rails
"	"	"	"	"	INA157UA/2K5	Tape and Reel

NOTES: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book. (2) Models with a slash (/) are available only in Tape and Reel in the quantities indicated (e.g., /2K5 indicates 2500 devices per reel). Ordering 2500 pieces of "INA157U/2K5" will get a single 2500-piece Tape and Reel. For detailed Tape and Reel mechanical information, refer to Appendix B of Burr-Brown IC Data Book.

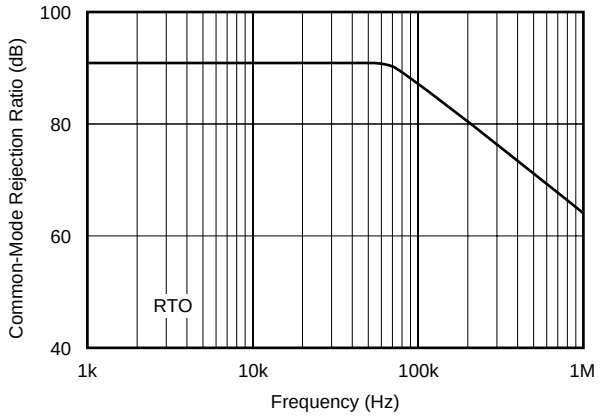
TYPICAL PERFORMANCE CURVES

At T_A = +25°C, V_S = ±15V, and G = 1/2, unless otherwise noted.

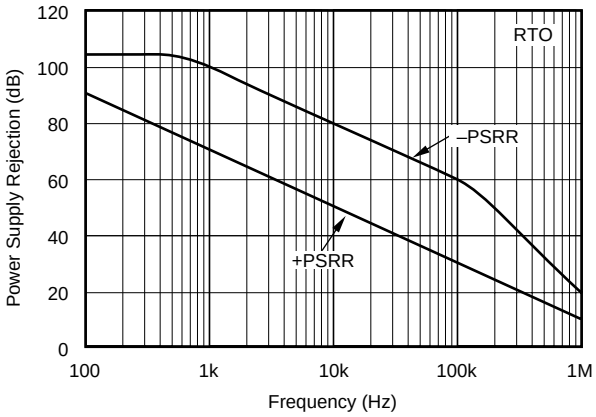
GAIN vs FREQUENCY



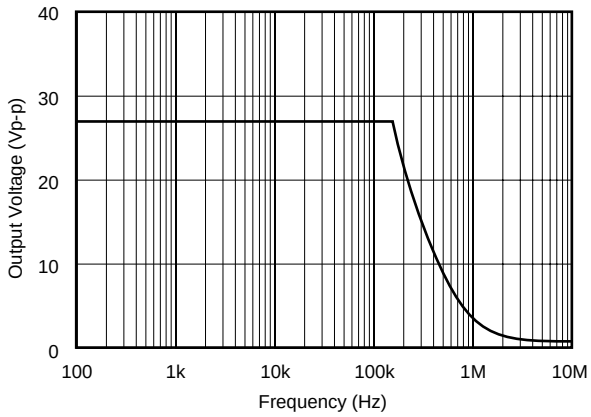
COMMON-MODE REJECTION RATIO vs FREQUENCY



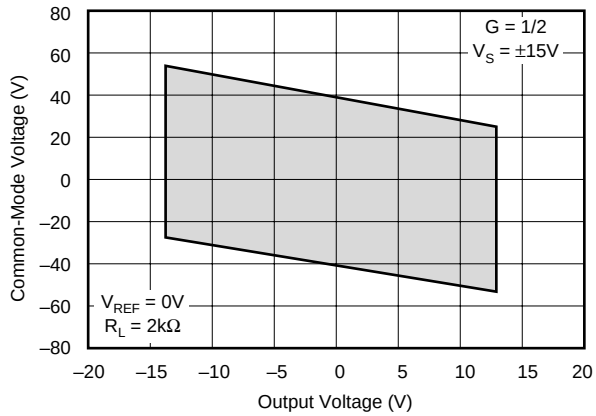
POWER SUPPLY REJECTION RATIO vs FREQUENCY



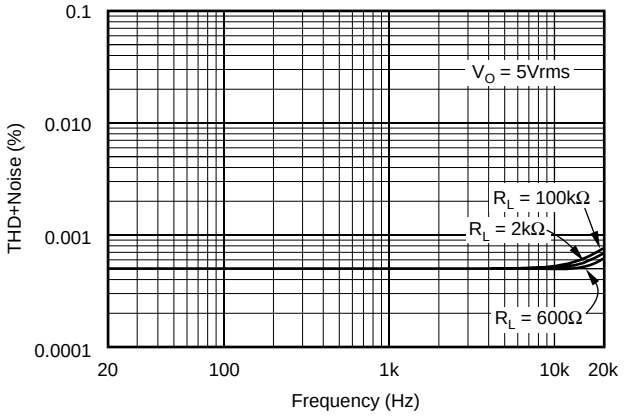
MAXIMUM OUTPUT VOLTAGE vs FREQUENCY



INPUT COMMON-MODE VOLTAGE
vs OUTPUT VOLTAGE



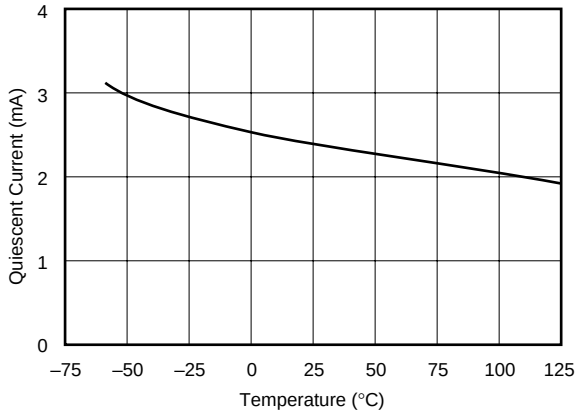
TOTAL HARMONIC DISTORTION + NOISE
vs FREQUENCY



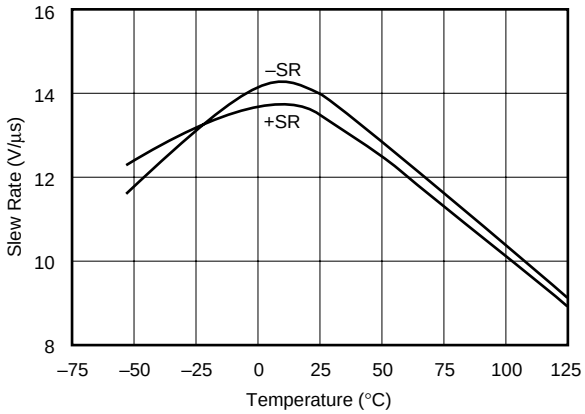
TYPICAL PERFORMANCE CURVES (CONT)

At T_A = +25°C, V_S = ±15V, and G = 1/2, unless otherwise noted.

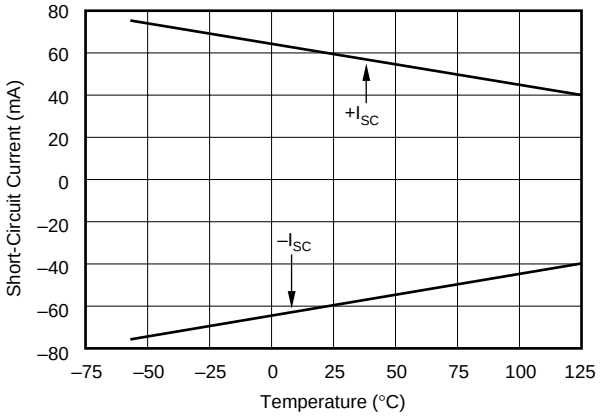
QUIESCENT CURRENT vs TEMPERATURE



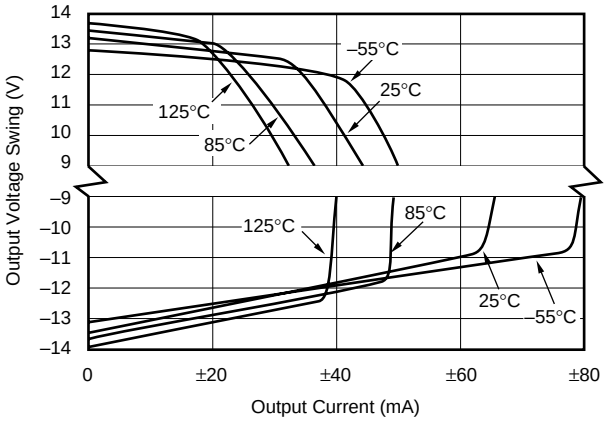
SLEW RATE vs TEMPERATURE



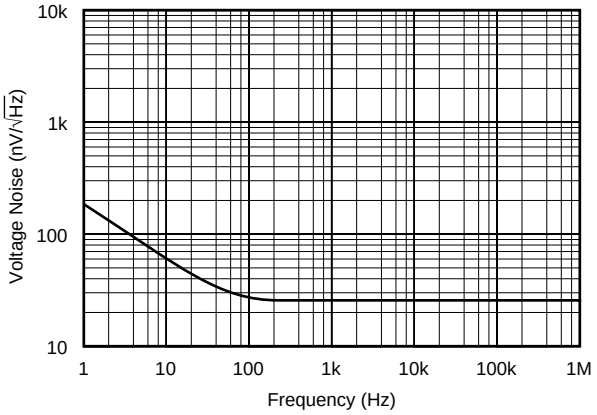
SHORT-CIRCUIT CURRENT vs TEMPERATURE



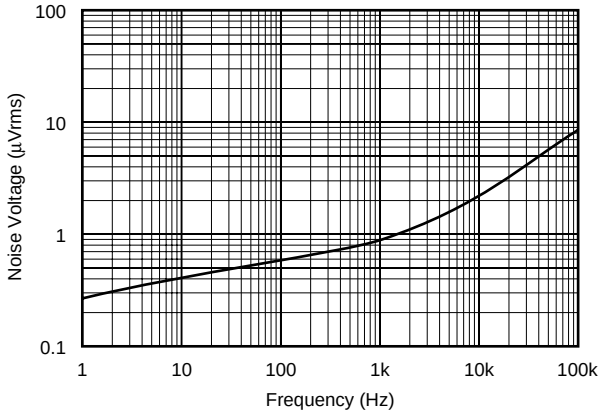
OUTPUT VOLTAGE SWING vs OUTPUT CURRENT



OUTPUT VOLTAGE NOISE SPECTRAL DENSITY vs FREQUENCY



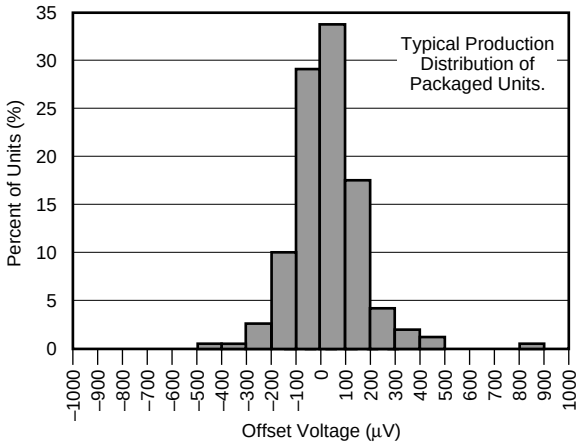
OUTPUT NOISE VOLTAGE vs NOISE BANDWIDTH



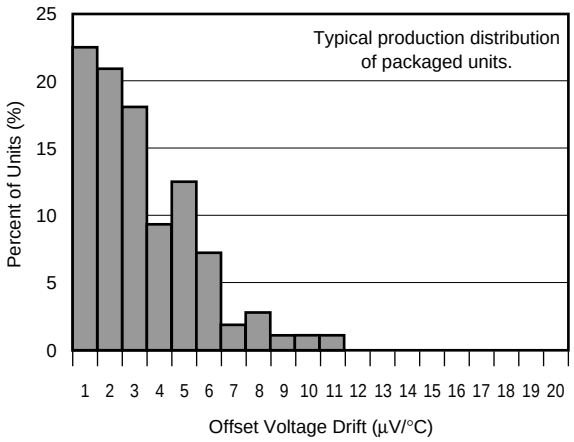
TYPICAL PERFORMANCE CURVES (CONT)

At T_A = +25°C, V_S = ±15V, and G = 1/2, unless otherwise noted.

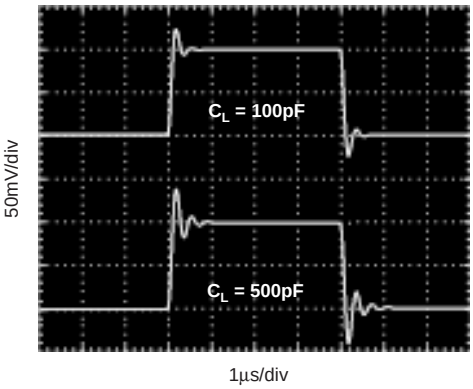
OFFSET VOLTAGE
PRODUCTION DISTRIBUTION



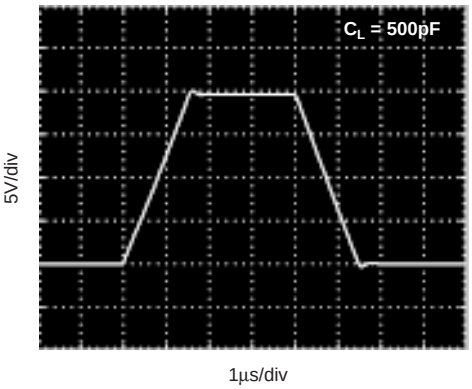
OFFSET VOLTAGE DRIFT
PRODUCTION DISTRIBUTION



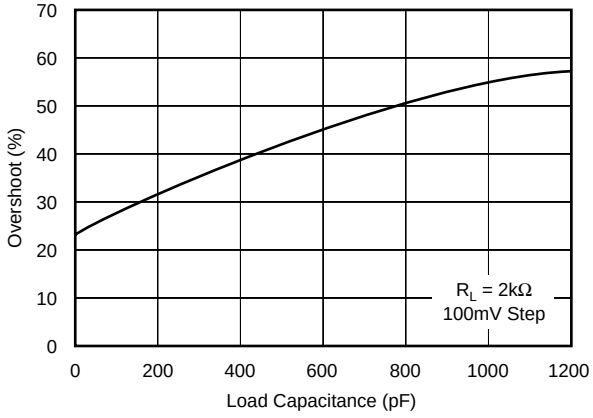
SMALL-SIGNAL STEP RESPONSE



LARGE-SIGNAL STEP RESPONSE



SMALL-SIGNAL OVERSHOOT
vs LOAD CAPACITANCE



APPLICATIONS INFORMATION

The INA157 is a difference amplifier suitable for a wide range of general-purpose applications. Figure 1 shows the basic G = 1/2 configuration. The input and feedback resistors can be reversed to achieve G = 2, as shown in Figure 2. For applications requiring G = 1, the INA154 is recommended.

Decoupling capacitors are strongly recommended for applications with noisy or high impedance power supplies. The capacitors should be placed close to the device pins as shown in Figure 1.

As shown in Figure 1, the output is referred to the reference terminal (pin 1). A voltage applied to this pin will be summed with the output signal. The differential input signal is connected to pins 2 and 3. The source impedances connected to the inputs must be nearly equal to assure good common-mode rejection. A 5Ω mismatch in source impedance will degrade the common-mode rejection of a typical device to approximately 77dB (RTO). If the source has a known impedance mismatch, an additional resistor in series with the opposite input can be used to preserve good common-mode rejection.

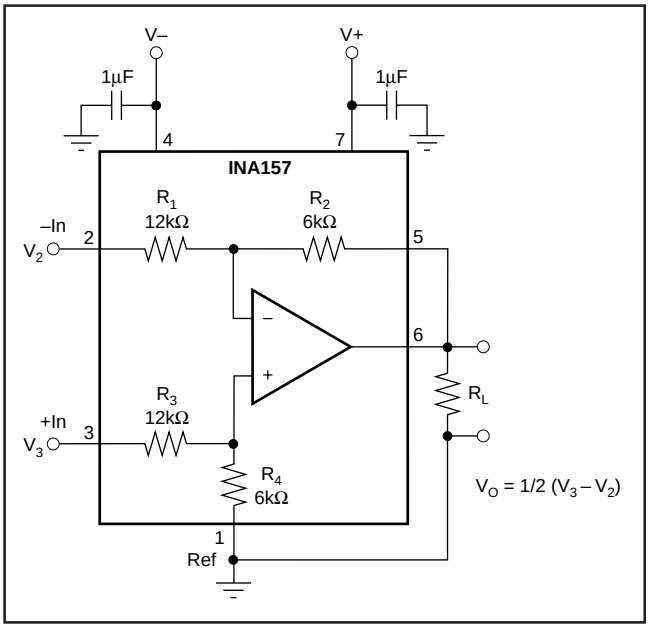


FIGURE 1. G = 1/2 Differential Amplifier (basic power supply and signal connections).

OPERATING VOLTAGE

The INA157 operates from ±4V to ±18V supplies with excellent performance. Most behavior remains unchanged throughout the full operating voltage range. Parameters which vary significantly with operating voltage are shown in the Typical Performance Curves.

INPUT VOLTAGE RANGE

The INA157 can accurately measure differential signals that are above the positive or negative power supply rail. In a gain of 1/2, the linear common-mode range extends from 3•(V+) – 7.5V to 3•(V–) +7.5V. See the Typical Performance Curve, "Input Common-Mode Range vs Output Voltage."

OFFSET VOLTAGE TRIM

The INA157 is laser trimmed for low offset voltage and drift. Most applications require no external offset adjustment. Figure 3 shows an optional circuit for trimming the output offset voltage. The output is referred to the output reference terminal (pin 1), which is normally grounded. A voltage applied to the Ref terminal will be summed with the output signal. This can be used to null offset voltage as shown in Figure 3. The source impedance of a signal applied to the Ref terminal should be less than 10Ω to maintain good common-mode rejection.

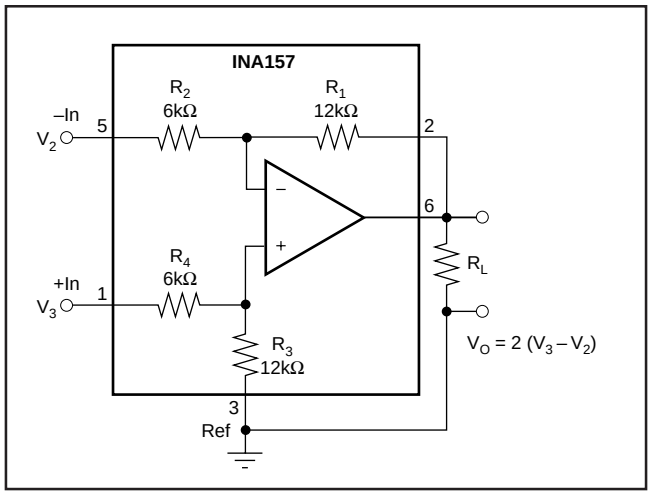


FIGURE 2. G = 2 Differential Amplifier.

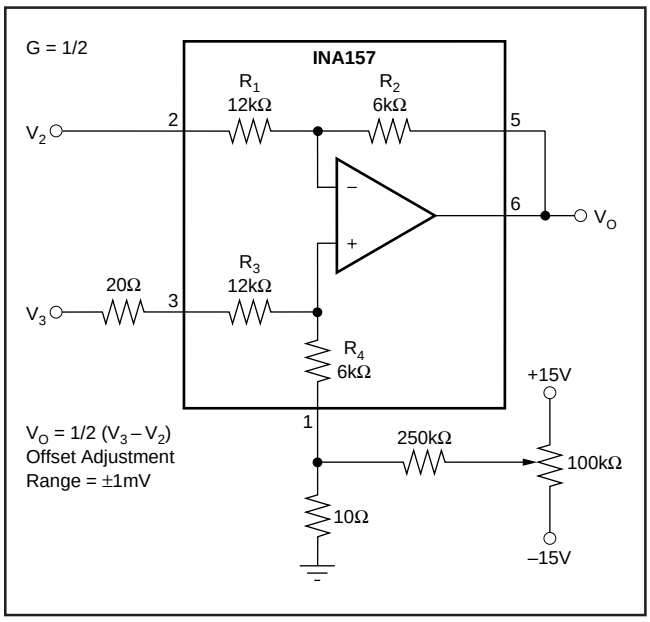


FIGURE 3. Offset Adjustment.

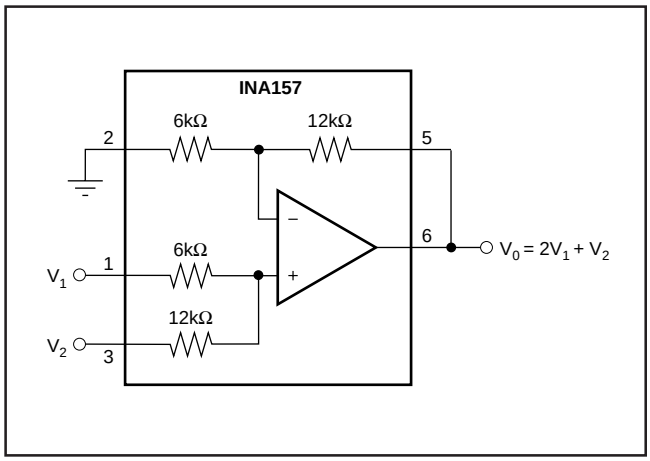
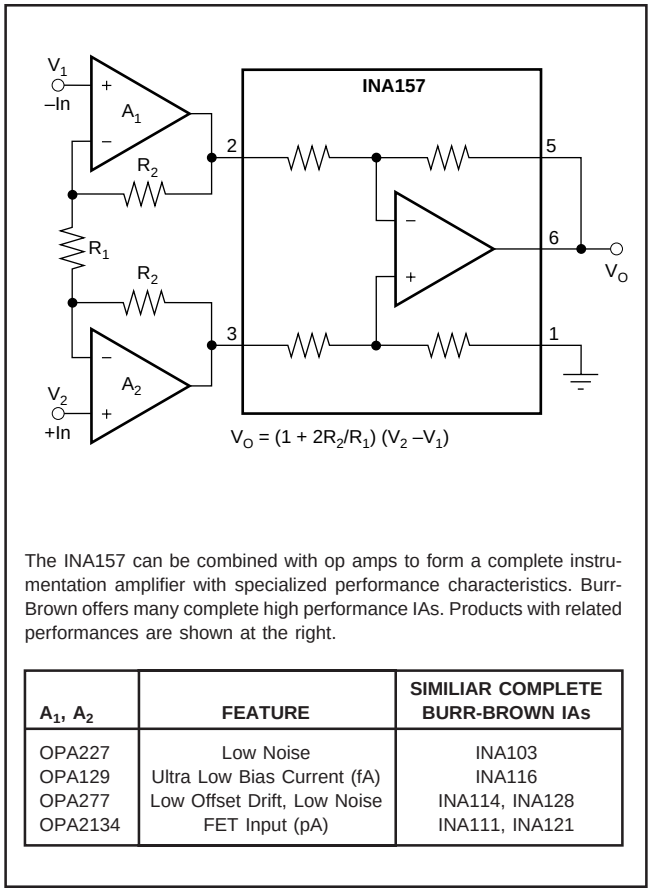


FIGURE 4. Precision Summing Amplifier.



The INA157 can be combined with op amps to form a complete instrumentation amplifier with specialized performance characteristics. Burr-Brown offers many complete high performance IAs. Products with related performances are shown at the right.

A_1, A_2	FEATURE	SIMILIAR COMPLETE BURR-BROWN IAs
OPA227	Low Noise	INA103
OPA129	Ultra Low Bias Current (fA)	INA116
OPA277	Low Offset Drift, Low Noise	INA114, INA128
OPA2134	FET Input (pA)	INA111, INA121

FIGURE 5. Precision Instrumentation Amplifier.

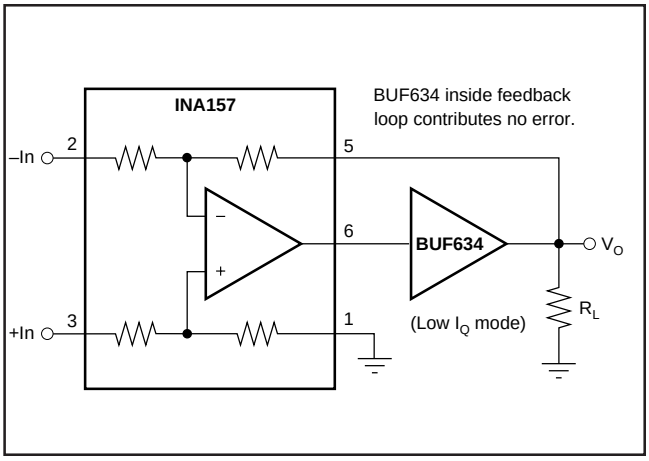


FIGURE 6. Boosting Output Current.

The difference amplifier is a highly versatile building block that is useful in a wide variety of applications. See the INA105 data sheet for additional applications ideas, including:

- Current Receiver with Compliance to Rails
- ±10V Precision Voltage Reference
- ±5V Precision Voltage Reference
- Precision Average Value Amplifier
- Precision Bipolar Offsetting
- Precision Summing Amplifier with Gain
- Instrumentation Amplifier Guard Drive Generator
- Precision Summing Instrumentation Amplifier
- Precision Absolute Value Buffer
- Precision Voltage-to-Current Converter with Differential Inputs
- Differential Input Voltage-to-Current Converter for Low I_{OUT}
- Isolating Current Source
- Differential Output Difference Amplifier
- Isolating Current Source with Buffering Amplifier for Greater Accuracy
- Window Comparator with Window Span and Window Center Inputs
- Precision Voltage-Controlled Current Source with Buffered Differential Inputs and Gain
- Digitally Controlled Gain of ±1 Amplifier

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
INA157U	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA157U/2K5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA157U/2K5E4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA157UA	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA157UA/2K5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA157UA/2K5G4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA157UAG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA157UG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR

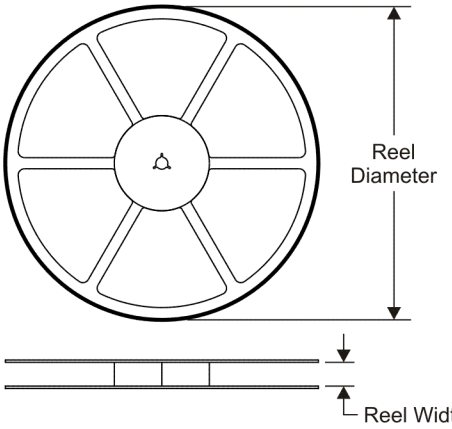
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

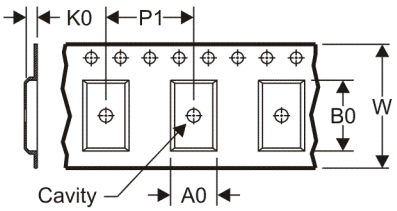
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

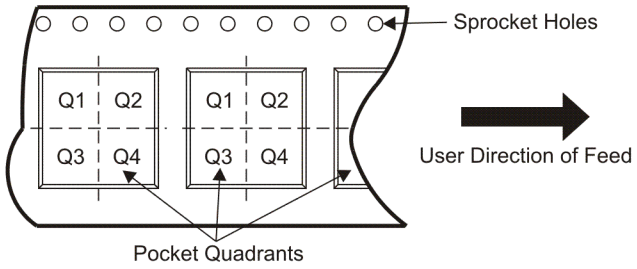


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

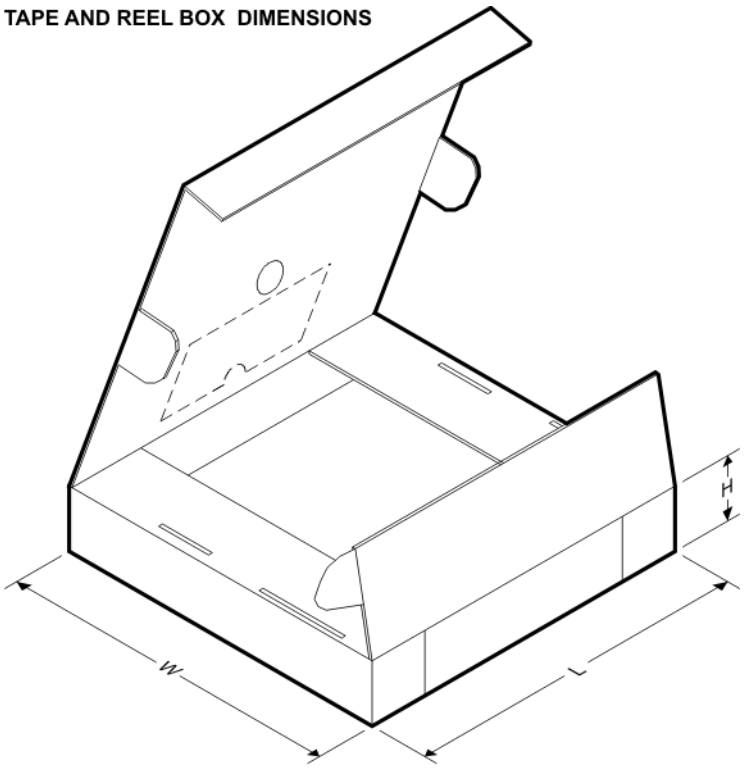
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
INA157U/2K5	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
INA157UA/2K5	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
INA157U/2K5	SOIC	D	8	2500	346.0	346.0	29.0
INA157UA/2K5	SOIC	D	8	2500	346.0	346.0	29.0

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