BURR - BROWN®

INA154

High-Speed, Precision DIFFERENCE AMPLIFIER (G = 1)

FEATURES

- DESIGNED FOR LOW COST
- LOW OFFSET VOLTAGE: ±750μV 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

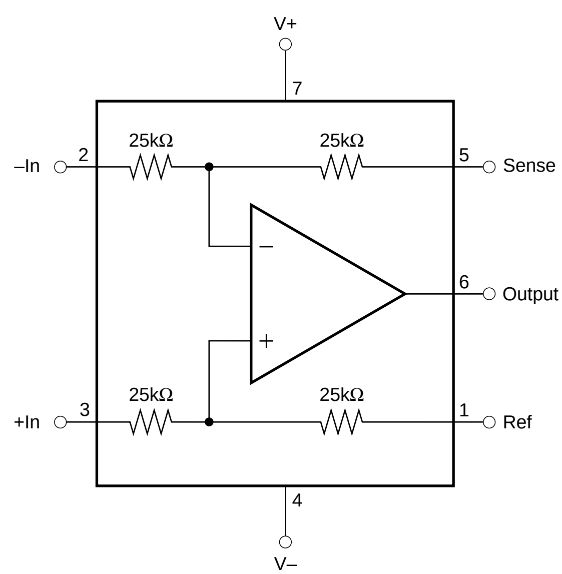
APPLICATIONS

- DIFFERENTIAL INPUT AMPLIFIER
- INSTRUMENTATION AMPLIFIER BUILDING BLOCK
- UNITY-GAIN INVERTING AMPLIFIER
- SUMMING AMPLIFIER
- DIFFERENTIAL CURRENT RECEIVER
- VOLTAGE-CONTROLLED CURRENT SOURCE
- SYNCHRONOUS DEMODULATOR

DESCRIPTION

The INA154 is a high slew rate, unity-gain 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 INA154 provides this circuit function without using an expensive precision resistor network. The INA154 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

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SBOS104

SPECIFICATIONS: $V_S = \pm15V$

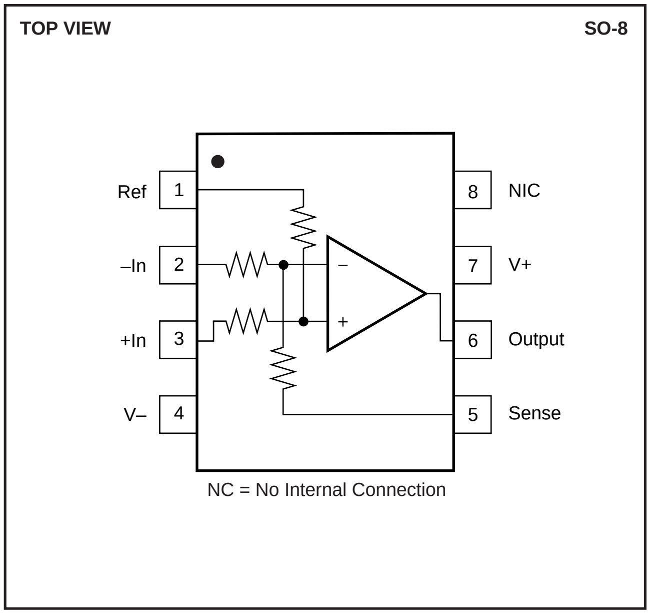
At $T_A = +25°C$, $V_S = \pm15V$, $R_L = 2k\Omega$ connected to ground, and reference pin connected to ground, unless otherwise noted.

		INA154U			INA154UA			
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
OFFSET VOLTAGE(1)	RTO							
Initial			±100	±750		✻	±1500	µV
vs Temperature			±2	±20		✻	✻	µV/°C
vs Power Supply	V_S = ±4V to ±18V		±5	±60		✻	✻	µV/V
vs Time			0.5			✻		µV/mo
INPUT IMPEDANCE(2)								
Differential			50			✻		kΩ
Common-Mode			50			✻		kΩ
INPUT VOLTAGE RANGE								
Common-Mode Voltage Range								
Positive	V_O = 0V	2(V+) – 5	2(V+) – 4		✻	✻		V
Negative	V_O = 0V	2(V–) + 5	2(V–) + 2		✻	✻		V
Common-Mode Rejection Ratio	V_{CM} = –25V to 25V, R_S = 0Ω	80	90		74	✻		dB
OUTPUT VOLTAGE NOISE(3)	RTO							
f = 0.1Hz to 10Hz			2.6			✻		µVp-p
f = 1kHz			52			✻		$nV/\sqrt{Hz}$
GAIN								
Initial			1			✻		V/V
Error	V_O = –13V to +13V		±0.02	±0.05		✻	±0.1	%
vs Temperature			±1	±10		✻	✻	ppm/°C
Nonlinearity	V_O = –13V to +13V		±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		3.1			✻		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 INA154U.

NOTES: (1) Includes effects of amplifier's input bias and offset currents. (2) 25kΩ 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.

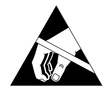
PIN CONFIGURATION



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.

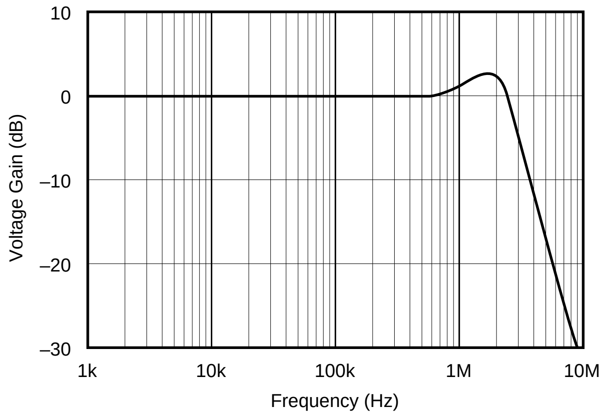
PACKAGE/ORDERING INFORMATION

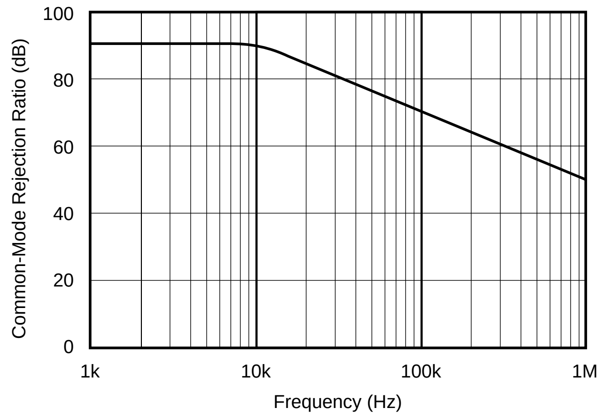
PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER(1)	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER(2)	TRANSPORT MEDIA
INA154U	SO-8 Surface-Mount	182	–40°C to +85°C	INA154U	INA154U	Rails
"	"	"	"	"	INA154U/2K5	Tape and Reel
INA154UA	SO-8 Surface-Mount	182	–40°C to +85°C	INA154UA	INA154UA	Rails
"	"	"	"	"	INA154UA/2K5	Tape and Reel

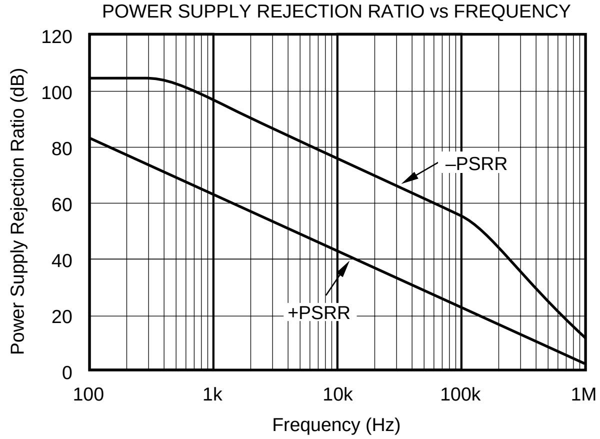
NOTES: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book. (2) Models with a slash (/) are available only in Tape and Reel in the quantities indicated (e.g., /2K5 indicates 2500 devices per reel). Ordering 2500 pieces of “INA154U/2K5” 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.

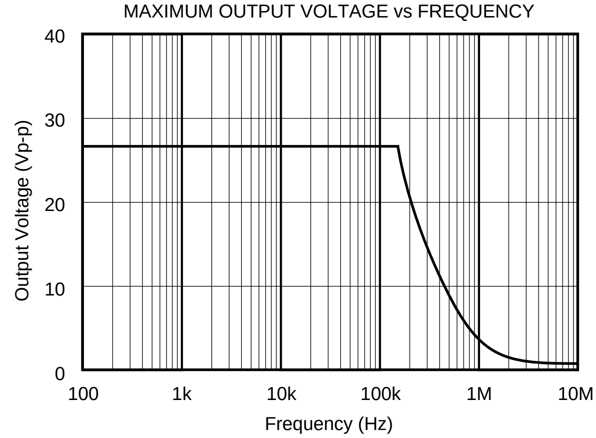
TYPICAL PERFORMANCE CURVES

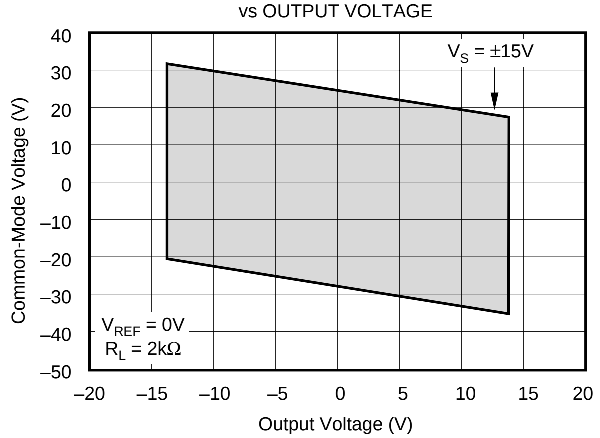
At T_A = +25°C and V_S = ±15V, unless otherwise noted.

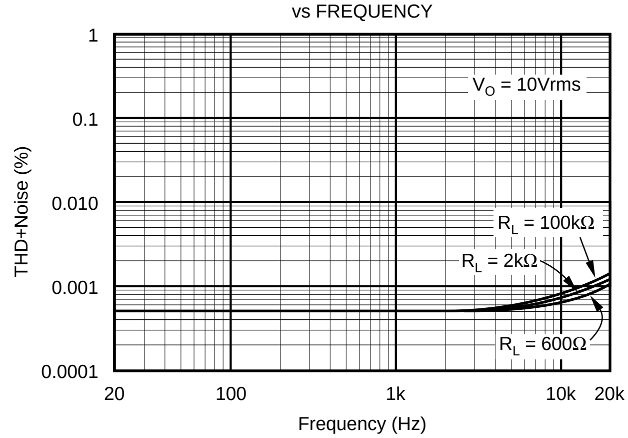






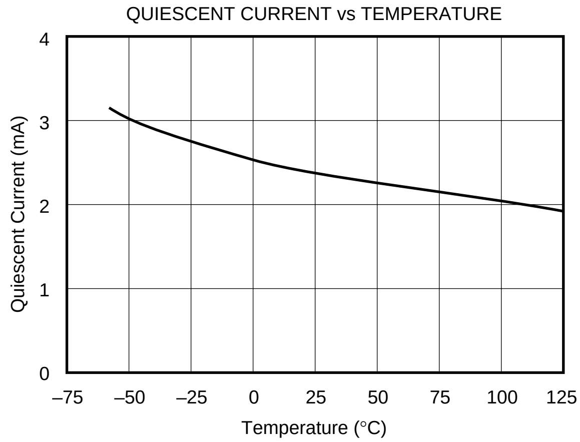


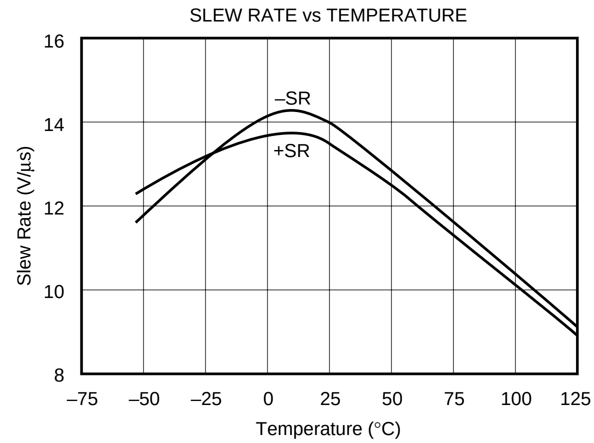


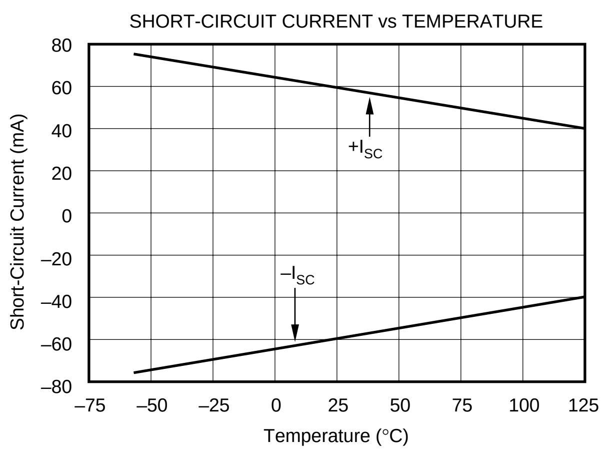


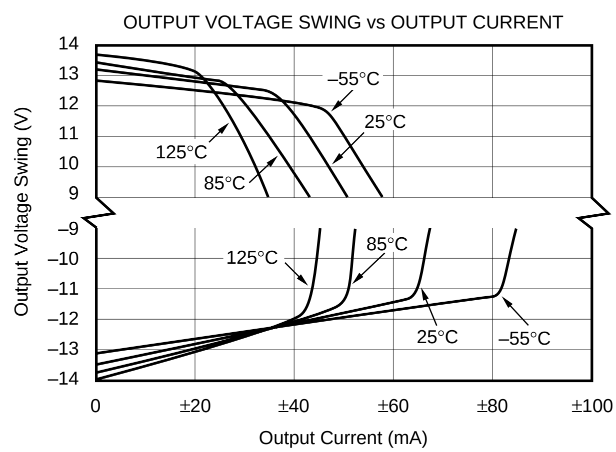
TYPICAL PERFORMANCE CURVES (CONT)

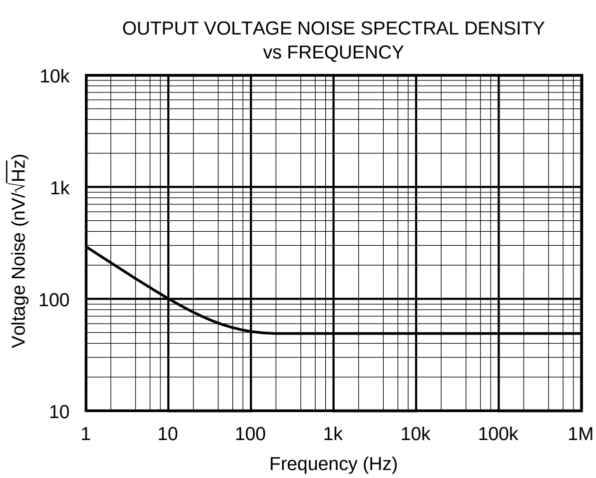
At T_A = +25°C, and V_S = ±15V, unless otherwise noted.

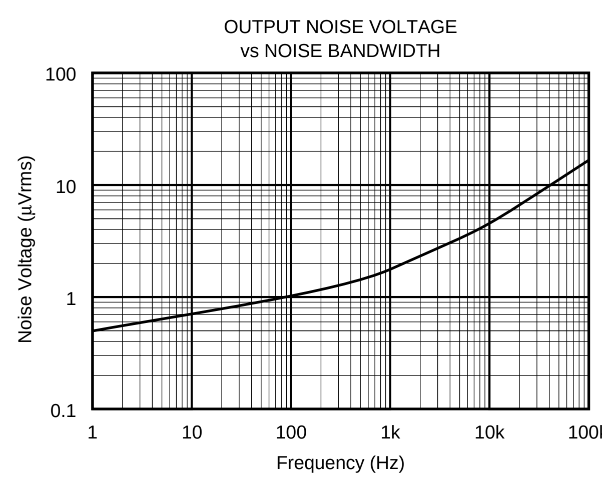






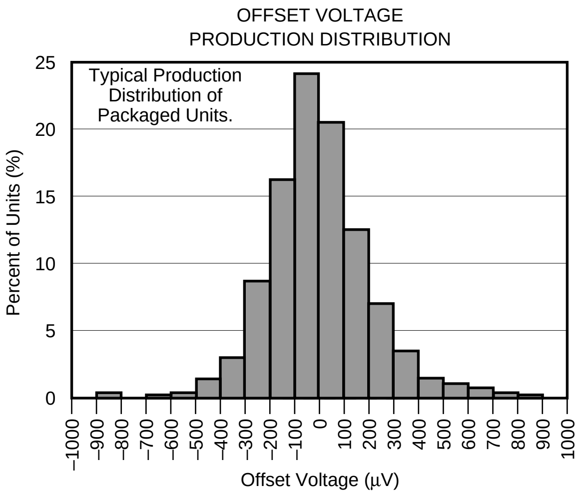


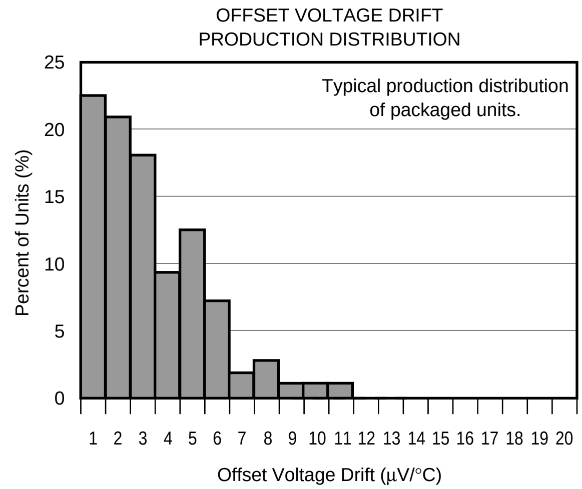


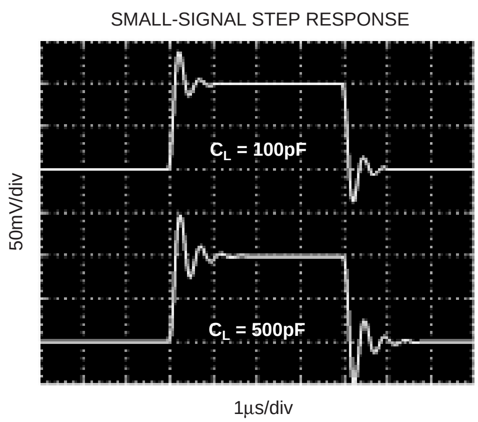


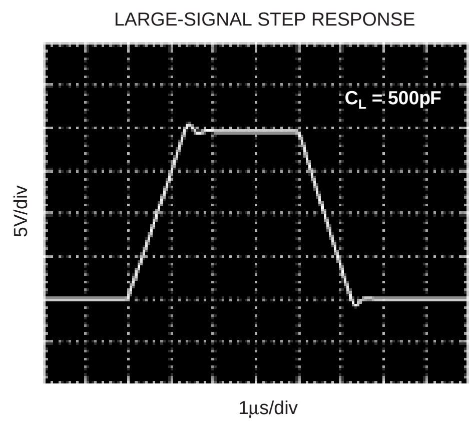
TYPICAL PERFORMANCE CURVES (CONT)

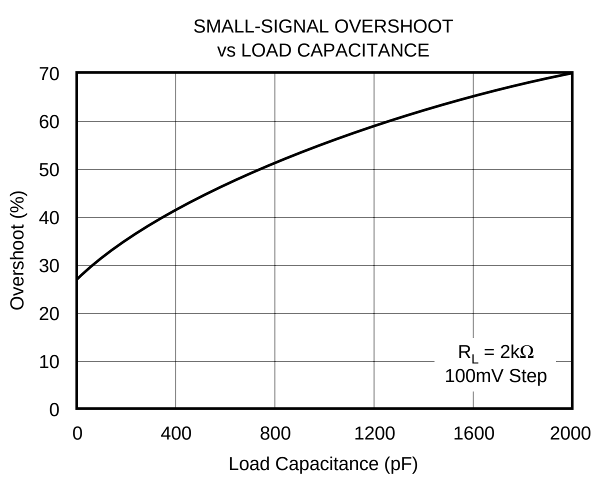
At T_A = +25°C, and V_S = ±15V, unless otherwise noted.











APPLICATIONS INFORMATION

Figure 1 shows the basic connections required for operation of the INA154. Decoupling capacitors are strongly recommended in 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 output signal. The differential input signal is connected to pins 2 and 3. The source impedances connected to the pinouts 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 80dB (a 10Ω mismatch degrades CMR to 74dB). 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.

Do not interchange pins 1 and 3 or pins 2 and 5, even though nominal resistor values are equal. The resistors are laser trimmed for precise resistor ratios to achieve accurate gain and highest CMR. Interchanging these pins would not provide specified performance.

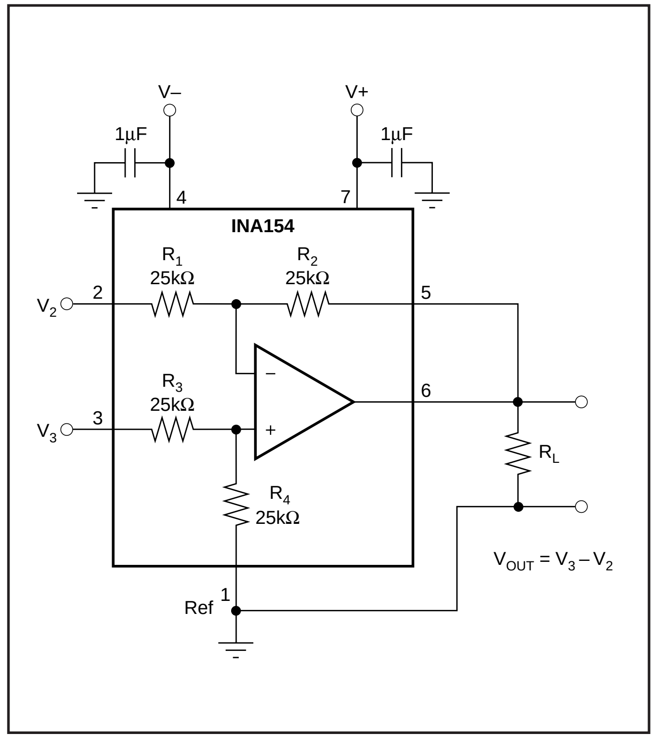


FIGURE 1. Basic Power Supply and Signal Connections.

OPERATING VOLTAGE

The INA154 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 INA154 can accurately measure differential signals that are beyond the positive or negative power supply rails. The linear common-mode range extends from 2•(V+) – 5V to 2•(V–) +5V. See the Typical Performance Curve, "Input Common-Mode Range vs Output Voltage."

OFFSET VOLTAGE TRIM

The INA154 is laser trimmed for low offset voltage and drift. Most applications require no external offset adjustment. Figure 2 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 2. The source impedance of a signal applied to the Ref terminal should be less than 10Ω to maintain good common-mode rejection.

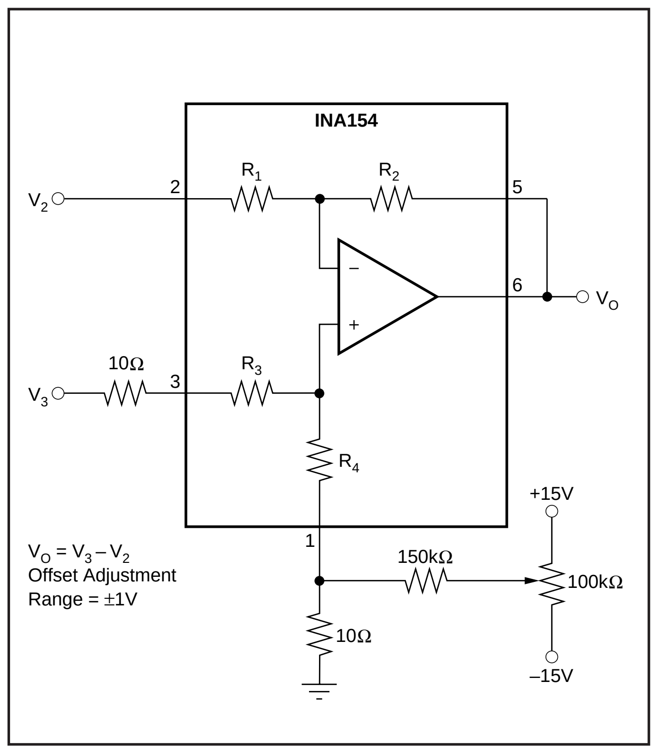


FIGURE 2. Offset Adjustment.

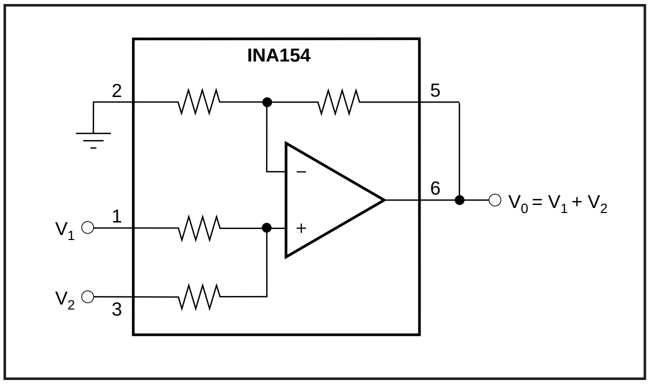
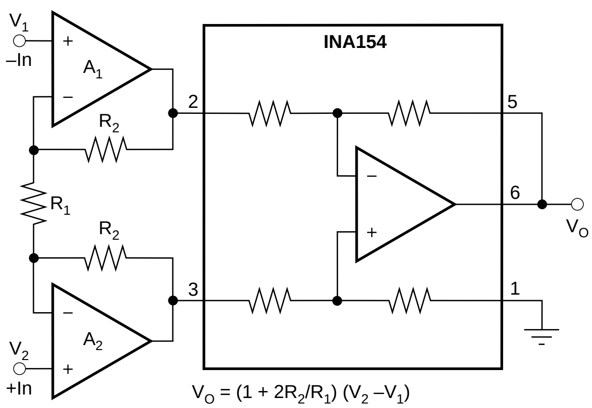


FIGURE 3. Precision Summing Amplifier.



The INA154 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 4. Precision Instrumentation Amplifier.

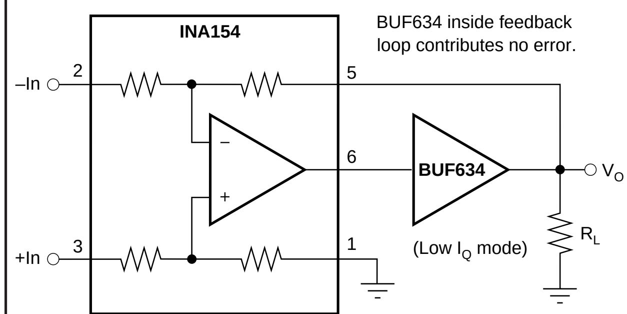


FIGURE 5. Boosting Output Current.

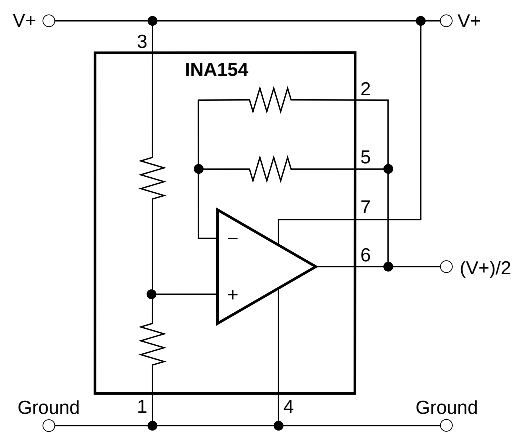


FIGURE 6. Pseudoground Generator.

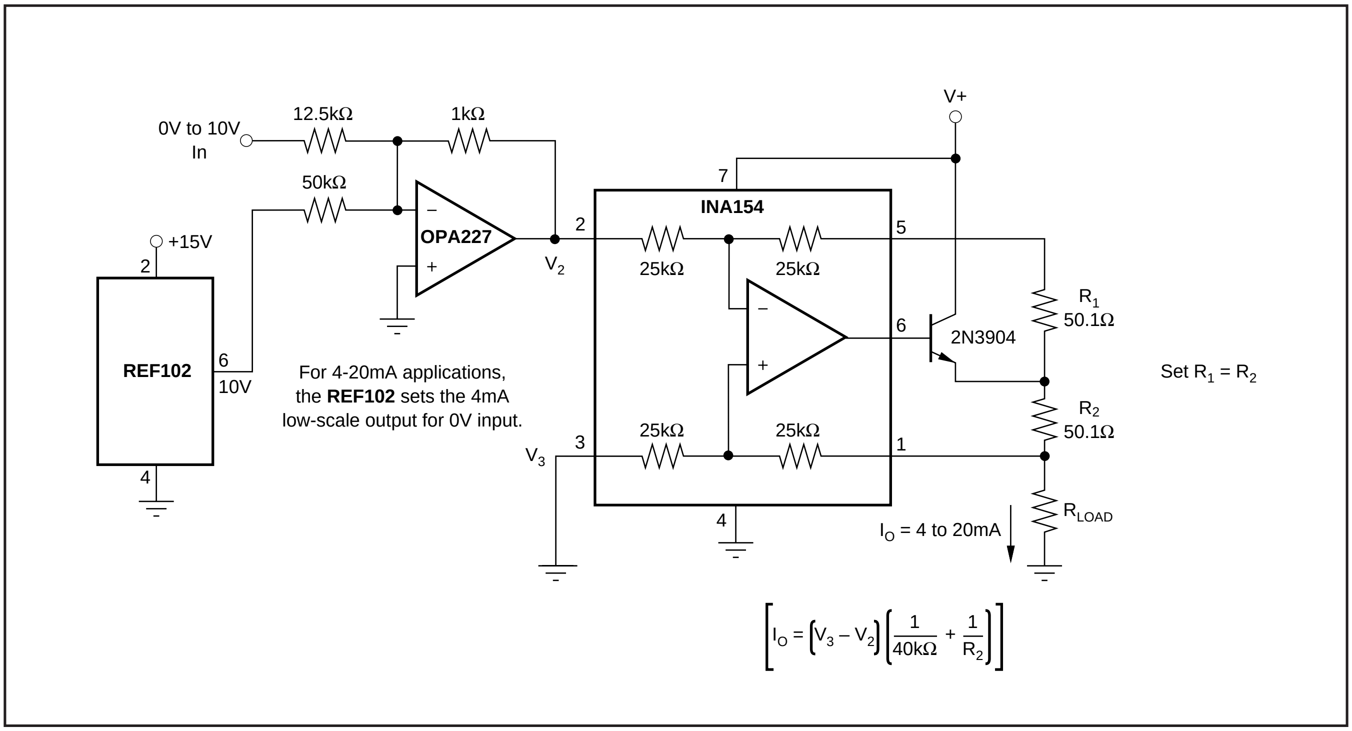


FIGURE 7. Precision Voltage-to-Current Conversion.

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
- Precision Unity-Gain Inverting Amplifier
- ±10V Precision Voltage Reference
- ±5V Precision Voltage Reference
- Precision Unity-Gain Buffer
- Precision Average Value Amplifier
- Precision G = 2 Amplifier (see INA157)
- Precision G = 1/2 Amplifier (see INA157)
- 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 Buff-ered Differential Inputs and Gain
- Digitally Controlled Gain of ±1 Amplifier

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
INA154U	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	Call TI	Level-3-260C-168 HR	-40 to 85	INA 154U
INA154U.A	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	Call TI	Level-3-260C-168 HR	-40 to 85	INA 154U
INA154U/2K5	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	Call TI	Level-3-260C-168 HR	-40 to 85	INA 154U
INA154U/2K5.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	Call TI	Level-3-260C-168 HR	-40 to 85	INA 154U
INA154UA	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	Call TI	Level-3-260C-168 HR	-40 to 85	INA 154U A
INA154UA.A	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	Call TI	Level-3-260C-168 HR	-40 to 85	INA 154U A

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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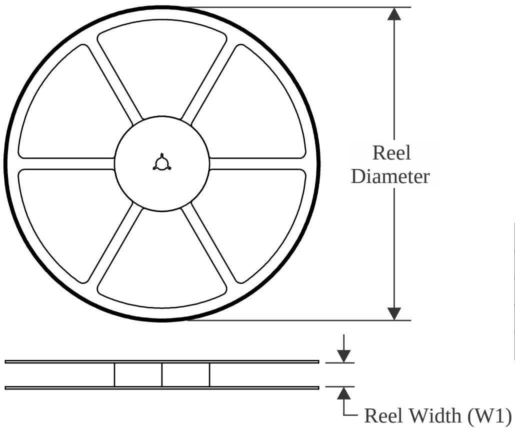
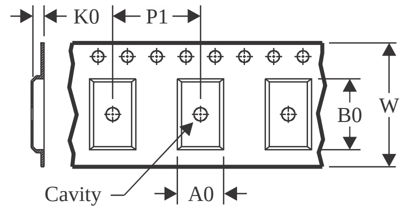
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

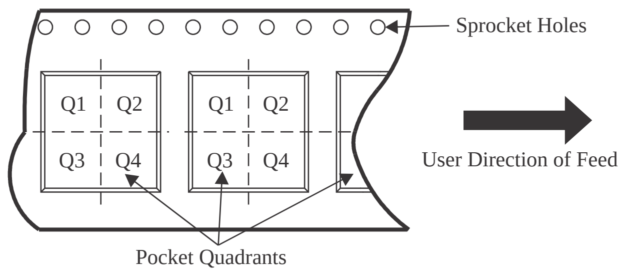


TAPE DIMENSIONS



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

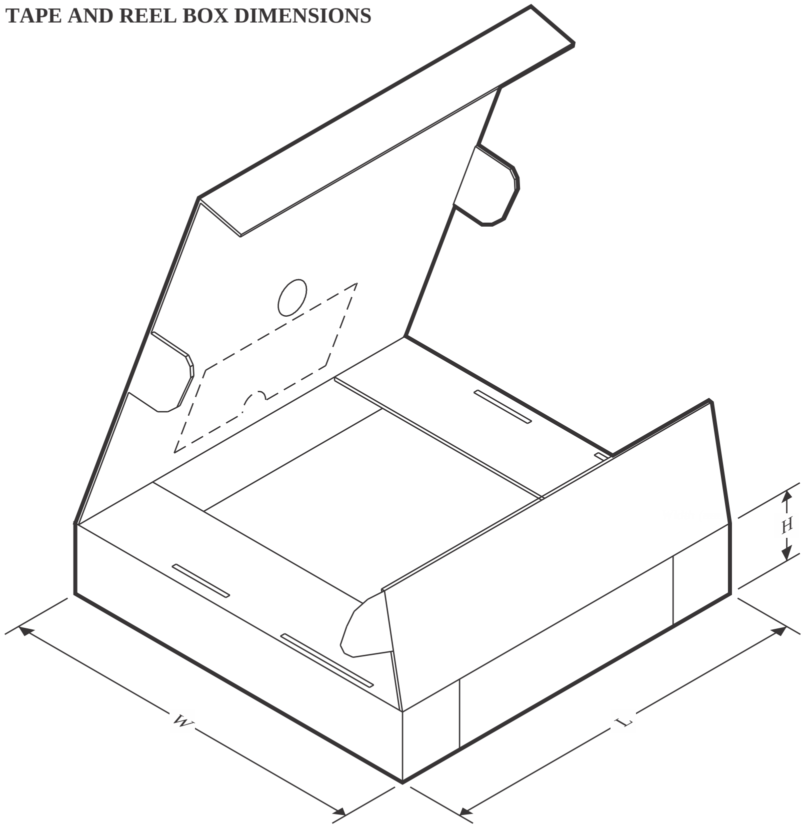
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
INA154U/2K5	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

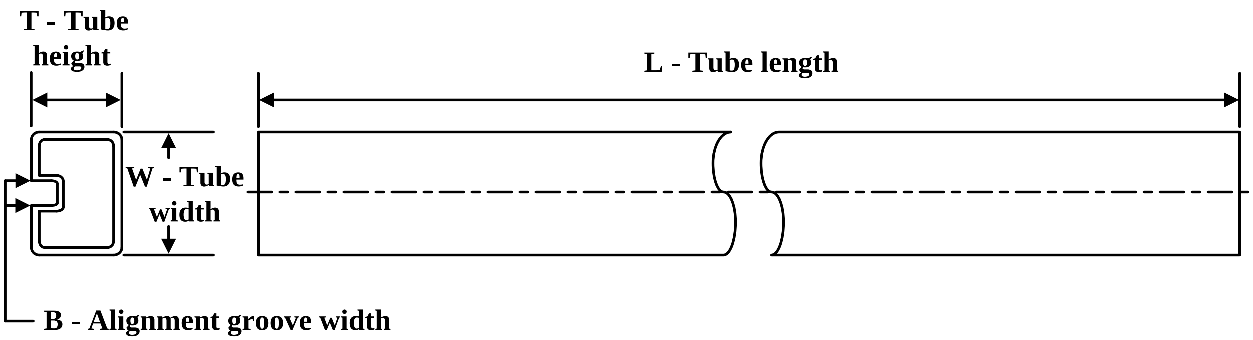
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
INA154U/2K5	SOIC	D	8	2500	353.0	353.0	32.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
INA154U	D	SOIC	8	75	506.6	8	3940	4.32
INA154U.A	D	SOIC	8	75	506.6	8	3940	4.32
INA154UA	D	SOIC	8	75	506.6	8	3940	4.32
INA154UA.A	D	SOIC	8	75	506.6	8	3940	4.32