

# INA133 INA2133

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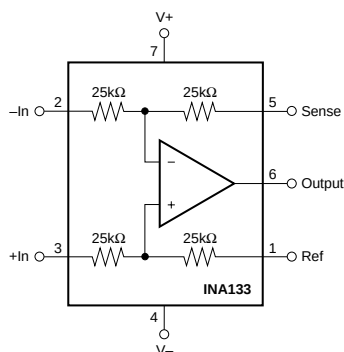
## High-Speed, Precision DIFFERENCE AMPLIFIERS

### FEATURES

- DESIGNED FOR LOW COST
- SINGLE, DUAL VERSIONS
- LOW OFFSET VOLTAGE DRIFT:  $\pm 450\mu\text{V}$  max,  $\pm 5\mu\text{V}/^\circ\text{C}$  max
- LOW GAIN ERROR: 0.05% max
- WIDE BANDWIDTH: 1.5MHz
- HIGH SLEW RATE:  $5\text{V}/\mu\text{s}$
- FAST SETTLING TIME:  $5.5\mu\text{s}$  to 0.01%
- LOW QUIESCENT CURRENT:  $950\mu\text{A}$
- WIDE SUPPLY RANGE:  $\pm 2.25\text{V}$  to  $\pm 18\text{V}$
- SO-8 and SO-14 PACKAGES

### DESCRIPTION

The INA133 and INA2133 are high slew rate, unity-gain difference amplifiers 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. They operate over a wide supply range,  $\pm 2.25\text{V}$  to  $\pm 18\text{V}$  ( $+4.5\text{V}$  to  $+36\text{V}$  single supply), and input common-mode voltage range extends beyond the positive and negative supply rails.

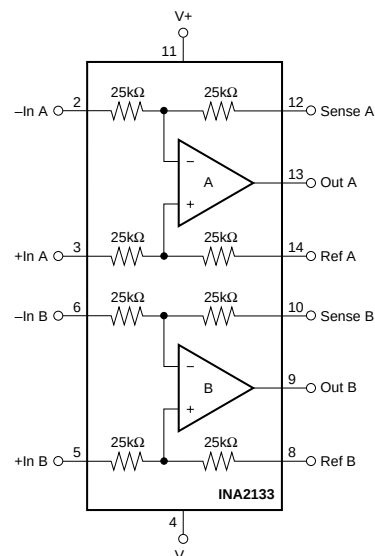


### APPLICATIONS

- DIFFERENTIAL INPUT AMPLIFIER BUILDING BLOCK
- DIFF IN/DIFF OUT AMPLIFIER
- UNITY-GAIN INVERTING AMPLIFIER
- GAIN =  $+1/2$  OR  $G = +2$  AMPLIFIER
- SUMMING AMPLIFIER
- SYNCHRONOUS DEMODULATOR
- CURRENT/DIFFERENTIAL LINE RECEIVER
- VOLTAGE-CONTROLLED CURRENT SOURCE
- BATTERY POWERED SYSTEMS
- LOW COST AUTOMOTIVE

The differential amplifier is the foundation of many commonly used circuits. The low cost INA133 and INA2133 provide this precision circuit function without using an expensive precision network.

The single version, INA133, package is the SO-8 surface mount. The dual version, INA2133, package is the SO-14 surface mount. Both are specified for operation over the extended industrial temperature range,  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$ . Operation is from  $-55^\circ\text{C}$  to  $+125^\circ\text{C}$ .



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# SPECIFICATIONS: $V_S = \pm 15V$

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 15V$ ,  $R_L = 10k\Omega$  connected to ground, and reference pin connected to ground, unless otherwise noted.

| PARAMETER                                                                                                                                                    | CONDITIONS                                                                                                                                      | INA133U<br>INA2133U        |                                                                     |                                       | INA133UA<br>INA2133UA                   |                            |                               | UNITS                                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|---------------------------------------------------------------------|---------------------------------------|-----------------------------------------|----------------------------|-------------------------------|------------------------------------------------------------------------------------------------------|
|                                                                                                                                                              |                                                                                                                                                 | MIN                        | TYP                                                                 | MAX                                   | MIN                                     | TYP                        | MAX                           |                                                                                                      |
| <b>OFFSET VOLTAGE<sup>(1)</sup></b><br>Initial <sup>(1)</sup><br>vs Temperature<br>vs Power Supply<br>vs Time<br>Channel Separation (dual)                   | RTO<br>$V_{CM} = 0V$<br>$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$<br>$V_S = \pm 2.25V$ to $\pm 18V$<br>dc                                |                            | $\pm 150$<br>$\pm 2$<br>$\pm 10$<br>0.3<br>120                      | $\pm 450$<br>$\pm 5$<br>$\pm 30$      | See Typical Curve<br>*<br>900<br>*<br>* |                            |                               | $\mu V$<br>$\mu V/^\circ\text{C}$<br>$\mu V/V$<br>$\mu V/\sqrt{m\text{O}}$<br>dB                     |
| <b>INPUT IMPEDANCE<sup>(2)</sup></b><br>Differential<br>Common-Mode                                                                                          | $V_{CM} = 0V$                                                                                                                                   |                            | 50<br>25                                                            |                                       |                                         | *<br>*                     |                               | k $\Omega$<br>k $\Omega$                                                                             |
| <b>INPUT VOLTAGE RANGE</b><br>Common-Mode Voltage Range<br>Positive<br>Negative<br>Common-Mode Rejection Ratio                                               | $V_O = 0V$<br>$V_O = 0V$<br>$V_{CM} = -27V$ to $+27V$ , $R_S = 0\Omega$                                                                         | 2(V+) -3<br>2(V-) +3<br>80 | 2(V+) -2<br>2(V-) +2<br>90                                          |                                       | *<br>*<br>74                            | *<br>*<br>*                |                               | V<br>V<br>dB                                                                                         |
| <b>OUTPUT VOLTAGE NOISE<sup>(3)</sup></b><br>f = 0.1Hz to 10Hz<br>f = 10Hz<br>f = 100Hz<br>f = 1kHz                                                          | RTO                                                                                                                                             |                            | 2<br>80<br>60<br>57                                                 |                                       |                                         | *<br>*<br>*<br>*           |                               | $\mu Vp-p$<br>nV/ $\sqrt{\text{Hz}}$<br>nV/ $\sqrt{\text{Hz}}$<br>nV/ $\sqrt{\text{Hz}}$             |
| <b>GAIN</b><br>Initial<br>Error<br>vs Temperature<br>Nonlinearity                                                                                            | $V_O = -14V$ to $+13.5V$<br>$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$<br>$V_O = -14V$ to $+13.5V$                                        |                            | 1<br>$\pm 0.02$<br>$\pm 1$<br>$\pm 0.0001$                          | $\pm 0.05$<br>$\pm 10$<br>$\pm 0.001$ |                                         | *<br>*<br>*<br>*           | $\pm 0.1$<br>*<br>$\pm 0.002$ | V/V<br>%<br>ppm/ $^\circ\text{C}$<br>% of FS                                                         |
| <b>OUTPUT</b><br>Voltage Output<br>Positive<br>Negative<br>Positive<br>Negative<br>Current Limit, Continuous-to-Common<br>Capacitive Load (stable operation) | Gain Error < 0.1%<br>$R_L = 10k\Omega$ to Ground<br>$R_L = 10k\Omega$ to Ground<br>$R_L = 100k\Omega$ to Ground<br>$R_L = 100k\Omega$ to Ground | (V+) -1.5<br>(V-) +1       | (V+) -1.3<br>(V-) +0.8<br>(V+) -0.8<br>(V-) +0.3<br>-25/+32<br>1000 |                                       | *<br>*                                  | *<br>*<br>*<br>*<br>*<br>* |                               | V<br>V<br>V<br>V<br>mA<br>pF                                                                         |
| <b>FREQUENCY RESPONSE</b><br>Small-Signal Bandwidth<br>Slew Rate<br>Settling Time: 0.1%<br>0.01%<br>Overload Recovery Time                                   | -3dB<br>10V Step, $C_L = 100pF$<br>10V Step, $C_L = 100pF$<br>50% Overdrive                                                                     |                            | 1.5<br>5<br>4<br>5.5<br>4                                           |                                       |                                         | *<br>*<br>*<br>*<br>*      |                               | MHz<br>V/ $\mu s$<br>$\mu s$<br>$\mu s$<br>$\mu s$                                                   |
| <b>POWER SUPPLY</b><br>Rated Voltage<br>Operating Voltage Range<br>Dual Supplies<br>Single Supply<br>Quiescent Current (per amplifier)                       | $I_O = 0$                                                                                                                                       | $\pm 2.25$<br>+4.5         | $\pm 15$<br><br>$\pm 0.95$                                          | $\pm 18$<br>+36<br>$\pm 1.2$          | *<br>*                                  | *<br>*                     | *<br>*                        | V<br>V<br>V<br>mA                                                                                    |
| <b>TEMPERATURE RANGE</b><br>Specification<br>Operation<br>Storage<br>Thermal Resistance<br>SO-8 Surface Mount<br>SO-14 Surface Mount                         | $\theta_{JA}$                                                                                                                                   | -40<br>-55<br>-55          |                                                                     | +85<br>+125<br>+125                   | *<br>*<br>*                             |                            | *<br>*<br>*                   | $^\circ\text{C}$<br>$^\circ\text{C}$<br>$^\circ\text{C}$<br>$^\circ\text{C/W}$<br>$^\circ\text{C/W}$ |

\* Specifications the same as INA133U, INA2133U.

NOTES: (1) Includes the effects of amplifier's input bias and offset currents. (2) 25k $\Omega$  resistors are ratio matched but have  $\pm 20\%$  absolute value. (3) Includes effects of amplifier's input current noise and thermal noise contribution of resistor network.

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# SPECIFICATIONS: $V_S = \pm 5V$

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 5V$ ,  $R_L = 10\text{k}\Omega$  connected to ground, and reference pin connected to ground, unless otherwise noted.

| PARAMETER                                                                                                                              | CONDITIONS                                                                                                                                                                  | INA133U<br>INA2133U              |                                                  |                              | INA133UA<br>INA2133UA |     |                          | UNITS                             |
|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|--------------------------------------------------|------------------------------|-----------------------|-----|--------------------------|-----------------------------------|
|                                                                                                                                        |                                                                                                                                                                             | MIN                              | TYP                                              | MAX                          | MIN                   | TYP | MAX                      |                                   |
| <b>OFFSET VOLTAGE<sup>(1)</sup></b><br>Initial <sup>(1)</sup><br>vs Temperature                                                        | RTO<br>$V_{CM} = 0V$                                                                                                                                                        |                                  | $\pm 300$<br>$\pm 2$                             | $\pm 750$                    |                       | *   | $\pm 1500$               | $\mu V$<br>$\mu V/^\circ\text{C}$ |
| <b>INPUT VOLTAGE RANGE</b><br>Common-Mode Voltage Range<br>Positive<br>Negative<br>Common-Mode Rejection Ratio                         | $V_O = 0V$<br>$V_O = 0V$<br>$V_{CM} = -7V$ to $+7V$ , $R_S = 0\Omega$                                                                                                       | $2(V+) - 3$<br>$2(V-) + 3$<br>80 | $2(V+) - 2$<br>$2(V-) + 2$<br>90                 |                              | *                     | *   |                          | V<br>V<br>dB                      |
| <b>GAIN</b><br>Initial<br>Gain Error<br>Nonlinearity                                                                                   | $V_O = -4V$ to $3.5V$<br>$V_O = -4V$ to $3.5V$                                                                                                                              |                                  | 1<br>$\pm 0.02$<br>$\pm 0.0001$                  | $\pm 0.05$<br>$\pm 0.001$    |                       | *   | $\pm 0.1$<br>$\pm 0.002$ | V/V<br>%<br>% of FS               |
| <b>OUTPUT</b><br>Voltage Output<br>Positive<br>Negative<br>Positive<br>Negative                                                        | Gain Error < 0.1%<br>$R_L = 10\text{k}\Omega$ to Ground<br>$R_L = 10\text{k}\Omega$ to Ground<br>$R_L = 100\text{k}\Omega$ to Ground<br>$R_L = 100\text{k}\Omega$ to Ground | (V+) -1.5<br>(V-) +1             | (V+) -1.3<br>(V-) +0.8<br>(V+) -0.8<br>(V-) +0.3 |                              | *                     | *   |                          | V<br>V<br>V<br>V                  |
| <b>POWER SUPPLY</b><br>Rated Voltage<br>Operating Voltage Range<br>Dual Supplies<br>Single Supply<br>Quiescent Current (per amplifier) | $I_O = 0$                                                                                                                                                                   | $\pm 2.25$<br>+4.5               | $\pm 15$                                         | $\pm 18$<br>+36<br>$\pm 1.2$ | *                     | *   | *                        | V<br>V<br>V<br>mA                 |

\* Specifications the same as INA133U, INA2133U.

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

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

|                                                       |                                             |
|-------------------------------------------------------|---------------------------------------------|
| Supply Voltage, $V_+$ to $V_-$ .....                  | 36V                                         |
| Input Voltage Range .....                             | $2 \cdot V_S$                               |
| Output Short-Circuit (to ground) <sup>(2)</sup> ..... | Continuous                                  |
| Operating Temperature .....                           | $-55^\circ\text{C}$ to $+125^\circ\text{C}$ |
| Storage Temperature .....                             | $-55^\circ\text{C}$ to $+125^\circ\text{C}$ |
| Junction Temperature .....                            | $+150^\circ\text{C}$                        |
| Lead Temperature (soldering, 10s) .....               | $+300^\circ\text{C}$                        |

NOTES: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. (2) One channel per package.



## 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.

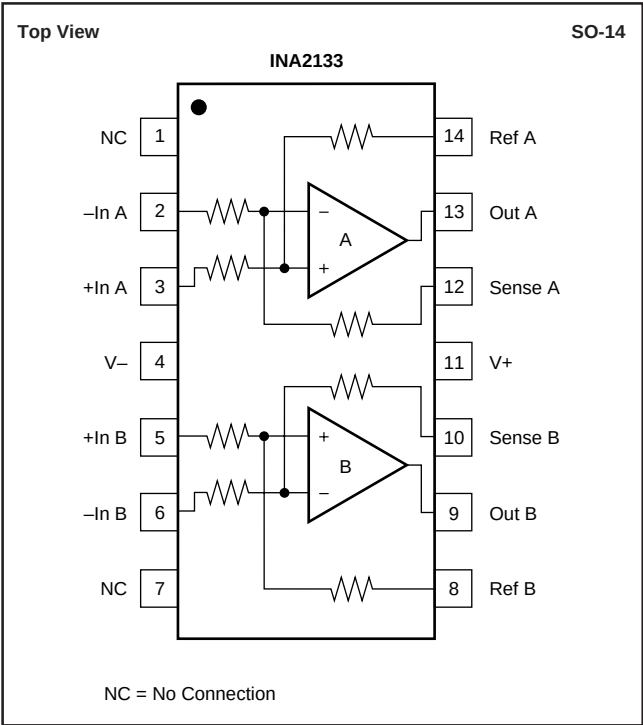
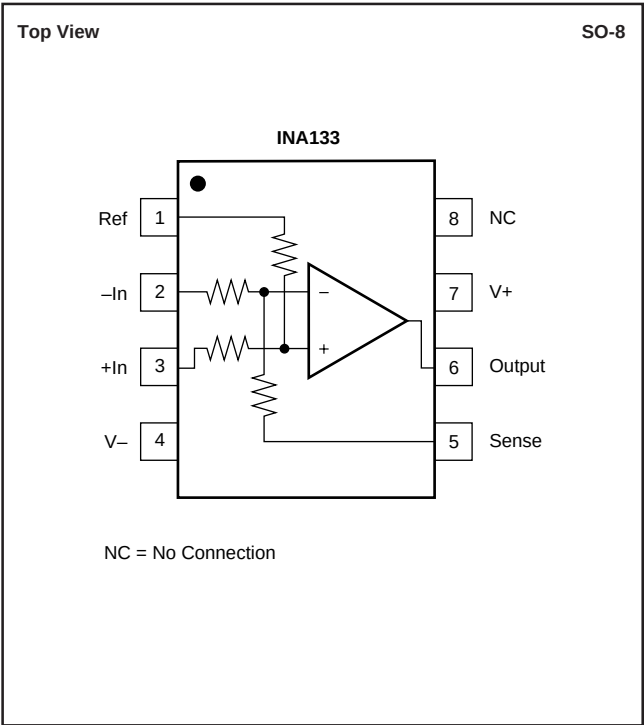
ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## PACKAGE/ORDERING INFORMATION

| PRODUCT       | PACKAGE             | PACKAGE DRAWING NUMBER <sup>(1)</sup> | SPECIFIED TEMPERATURE RANGE                | PACKAGE MARKING | ORDERING NUMBER <sup>(2)</sup> | TRANSPORT MEDIA |
|---------------|---------------------|---------------------------------------|--------------------------------------------|-----------------|--------------------------------|-----------------|
| <b>Single</b> |                     |                                       |                                            |                 |                                |                 |
| INA133U       | SO-8 Surface Mount  | 182                                   | $-40^\circ\text{C}$ to $+85^\circ\text{C}$ | INA133U         | INA133U                        | Rails           |
| "             | "                   | "                                     | "                                          | "               | INA133U/2K5                    | Tape and Reel   |
| INA133UA      | SO-8 Surface Mount  | 182                                   | $-40^\circ\text{C}$ to $+85^\circ\text{C}$ | INA133UA        | INA133UA                       | Rails           |
| "             | "                   | "                                     | "                                          | "               | INA133UA/2K5                   | Tape and Reel   |
| <b>Dual</b>   |                     |                                       |                                            |                 |                                |                 |
| INA2133U      | SO-14 Surface Mount | 235                                   | $-40^\circ\text{C}$ to $+85^\circ\text{C}$ | INA2133U        | INA2133U                       | Rails           |
| "             | "                   | "                                     | "                                          | "               | INA2133U/2K5                   | Tape and Reel   |
| INA2133UA     | SO-14 Surface Mount | 235                                   | $-40^\circ\text{C}$ to $+85^\circ\text{C}$ | INA2133UA       | INA2133UA                      | Rails           |
| "             | "                   | "                                     | "                                          | "               | INA2133UA/2K5                  | Tape and Reel   |

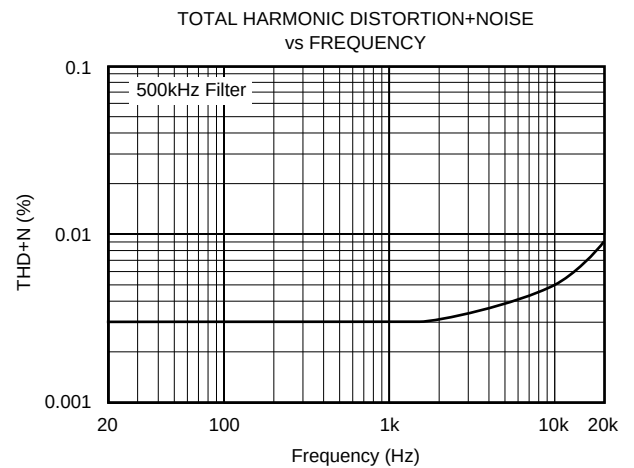
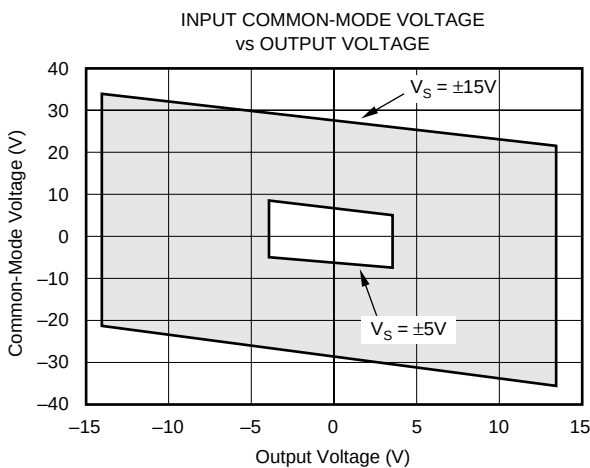
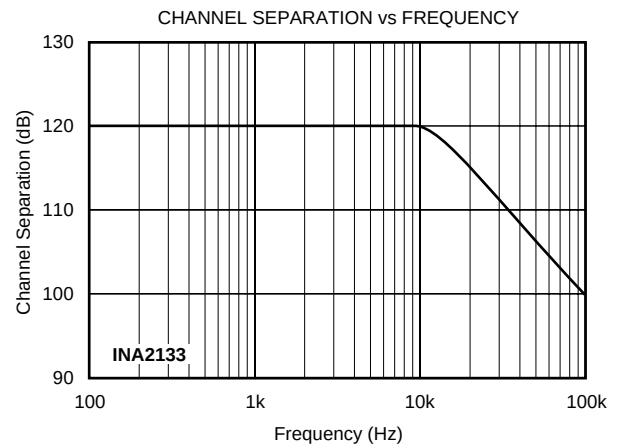
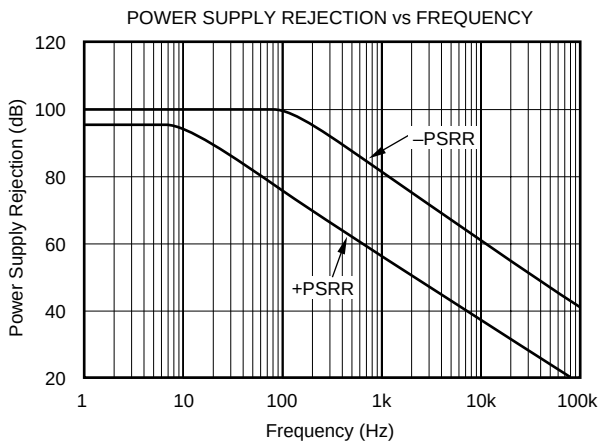
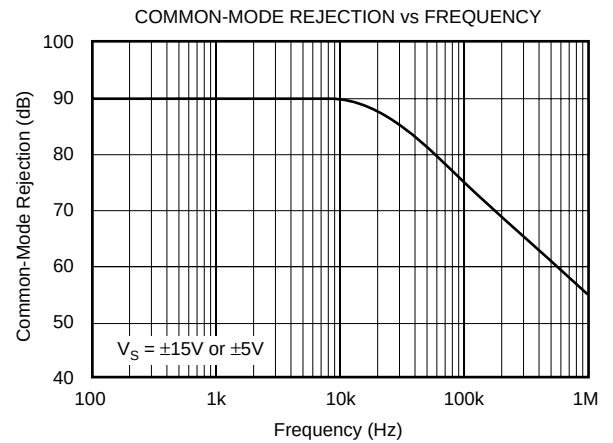
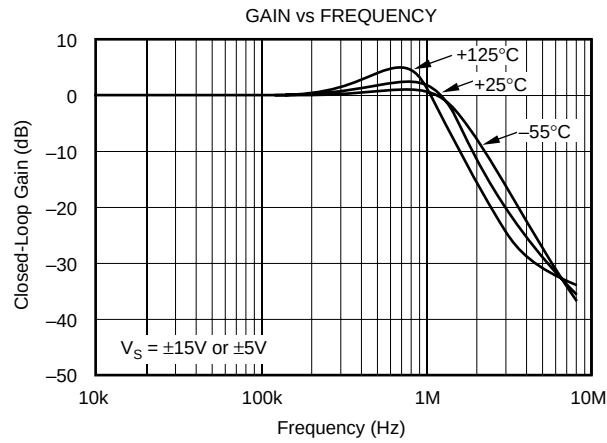
NOTES: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book. (2) Models with a slash (/) are available only in Tape and Reel in the quantities indicated (e.g., /2K5 indicates 2500 devices per reel). Ordering 2500 pieces of "INA133UA/2K5" 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.

PIN CONFIGURATIONS



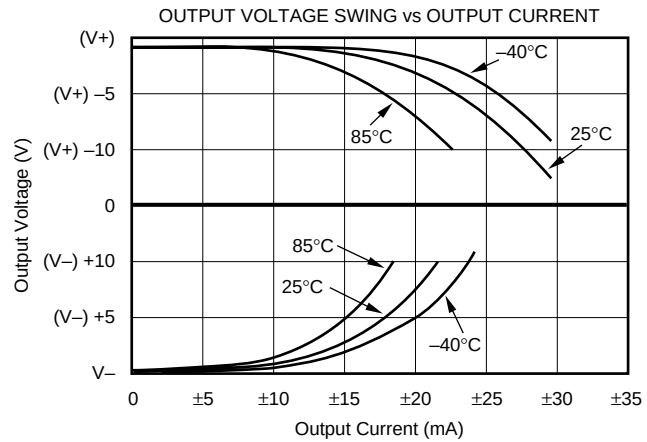
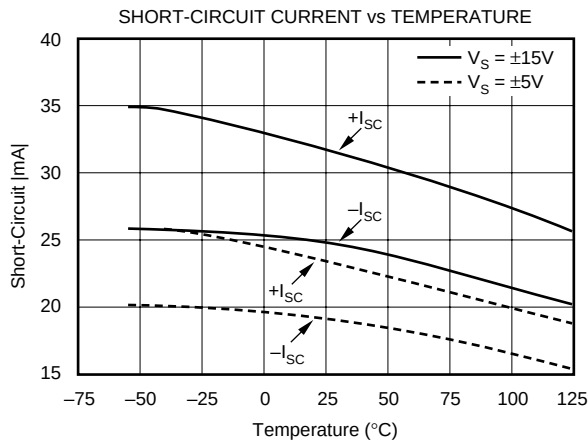
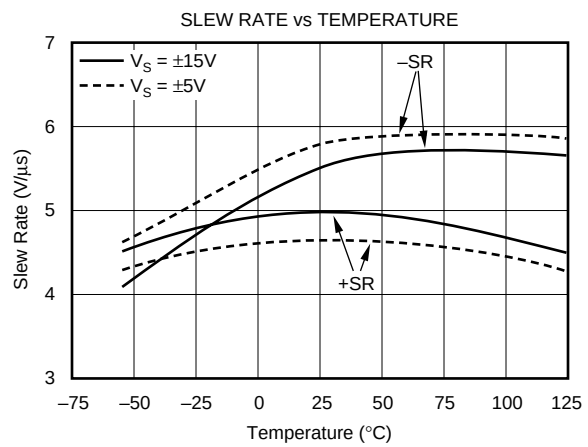
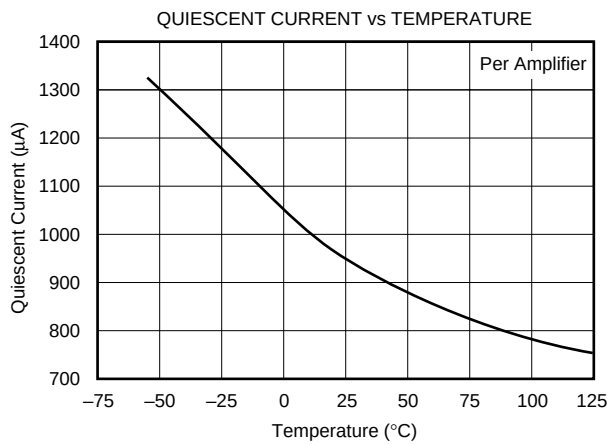
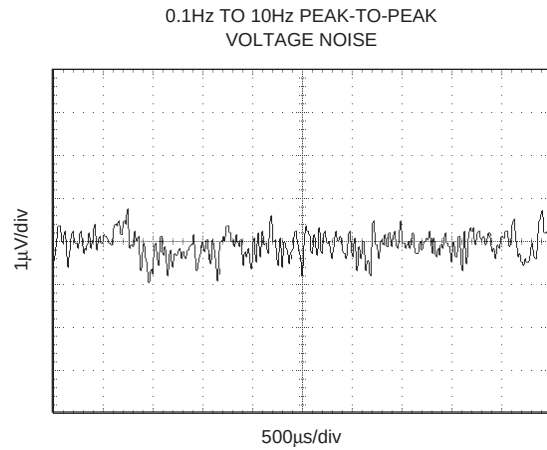
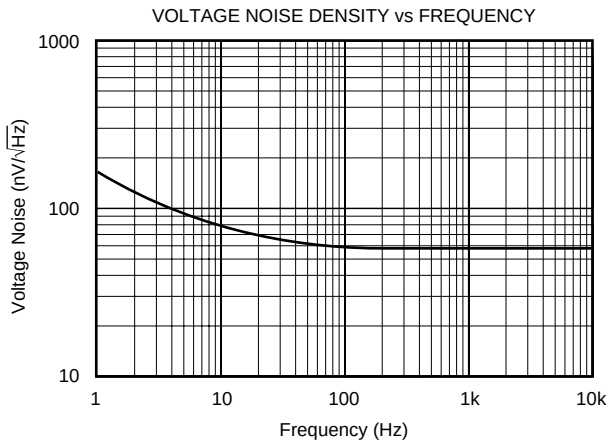
# TYPICAL PERFORMANCE CURVES

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 15\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to ground, and reference pin connected to ground, unless otherwise noted.



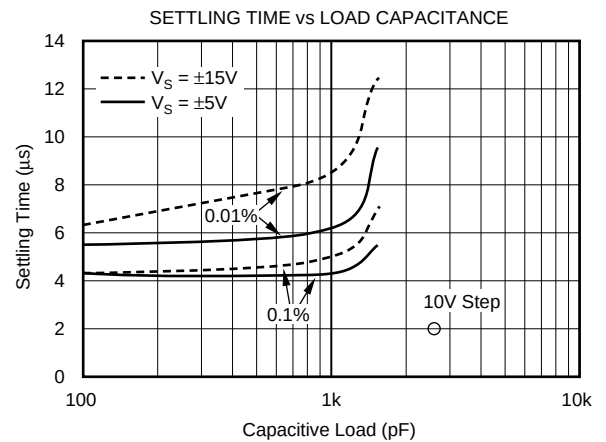
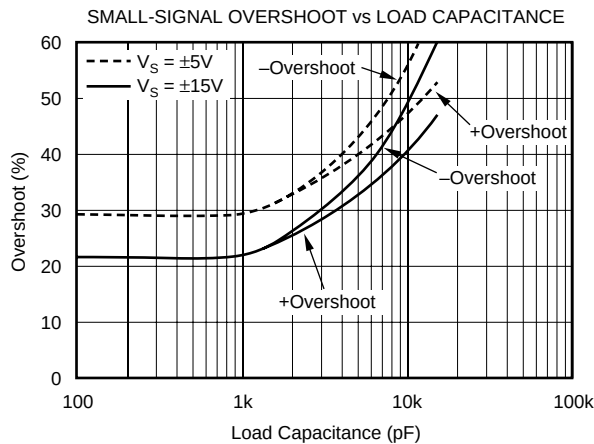
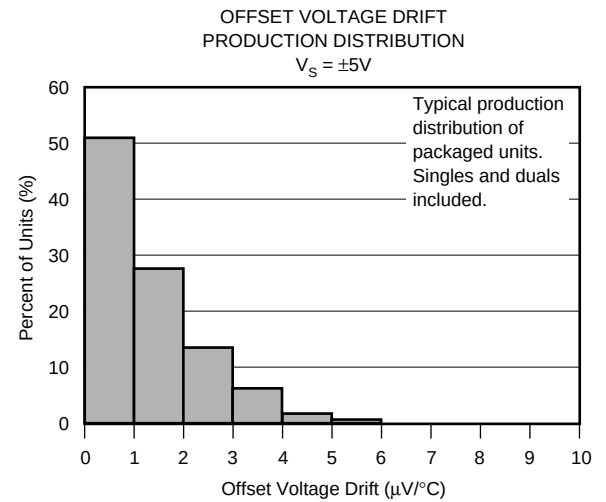
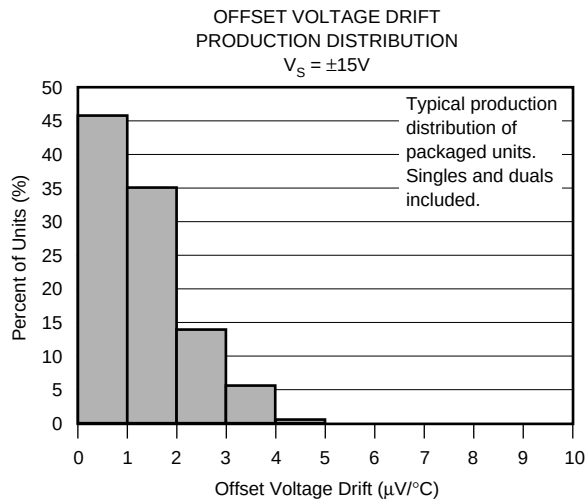
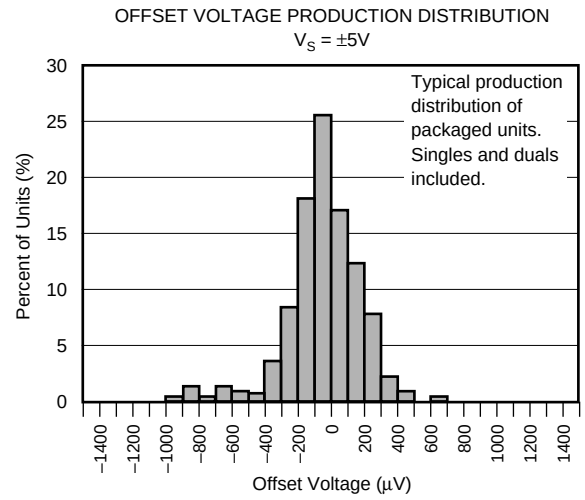
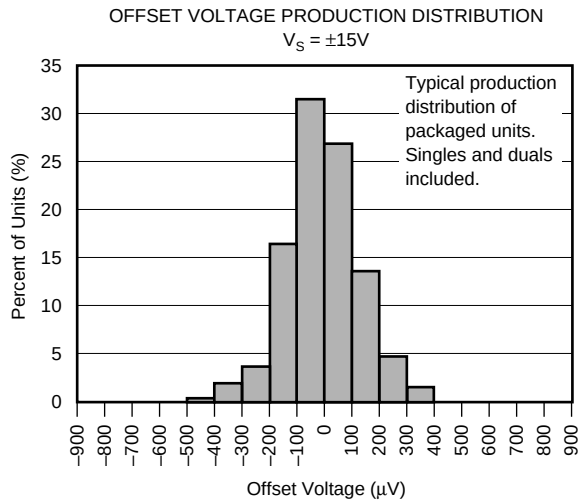
# TYPICAL PERFORMANCE CURVES (CONT)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 15\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to ground, and reference pin connected to ground, unless otherwise noted.



# TYPICAL PERFORMANCE CURVES (CONT)

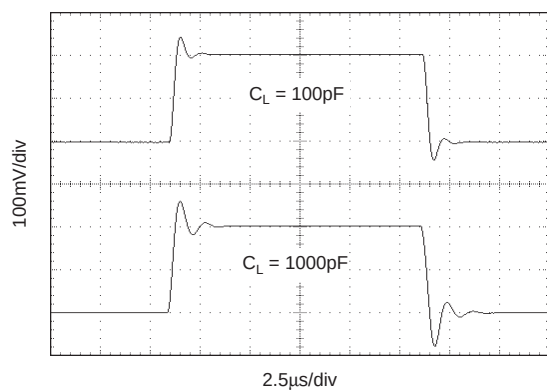
At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 15\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to ground, and reference pin connected to ground, unless otherwise noted.



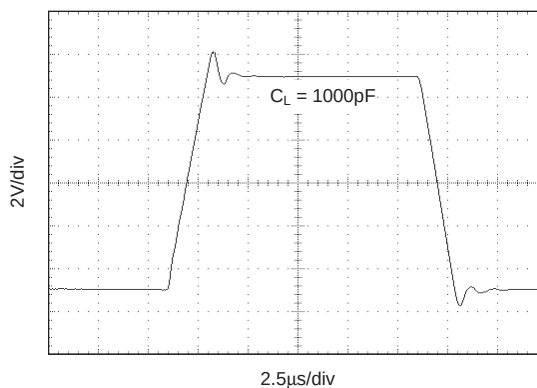
# TYPICAL PERFORMANCE CURVES (CONT)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 15\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to ground, and reference pin connected to ground, unless otherwise noted.

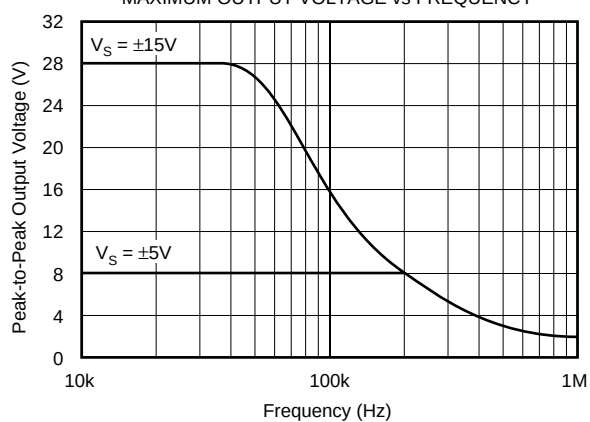
SMALL-SIGNAL STEP RESPONSE



LARGE-SIGNAL STEP RESPONSE



MAXIMUM OUTPUT VOLTAGE vs FREQUENCY





# APPLICATIONS INFORMATION

The INA133 and INA2133 are high-speed difference amplifiers suitable for a wide range of general purpose applications. Figure 1 shows the basic connections required for operation of the INA133. 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. All circuitry is completely independent in the dual version assuring lowest crosstalk and normal behavior when one amplifier is overdriven or short-circuited.

As shown in Figure 1, 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  $5\Omega$  mismatch in source impedance will degrade the common-mode rejection of a typical device to approximately 80dB (a  $10\Omega$  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.

The INA133's internal resistors are accurately ratio trimmed to match. That is,  $R_1$  is trimmed to match  $R_2$  and  $R_3$  is trimmed to match  $R_4$ . However, the absolute values may not be equal ( $R_1 + R_2$  may be slightly different than  $R_3 + R_4$ ). Thus, large series resistors on the input (greater than  $250\Omega$ ), even if well matched, will degrade common-mode rejection.

Circuit board layout constraints might suggest possible variations in connections of the internal resistors. For instance, it appears that pins 1 and 3 could be interchanged. However, because of the ratio trimming technique used (see paragraph above) CMRR will be degraded. If pins 1 and 3 are inter-

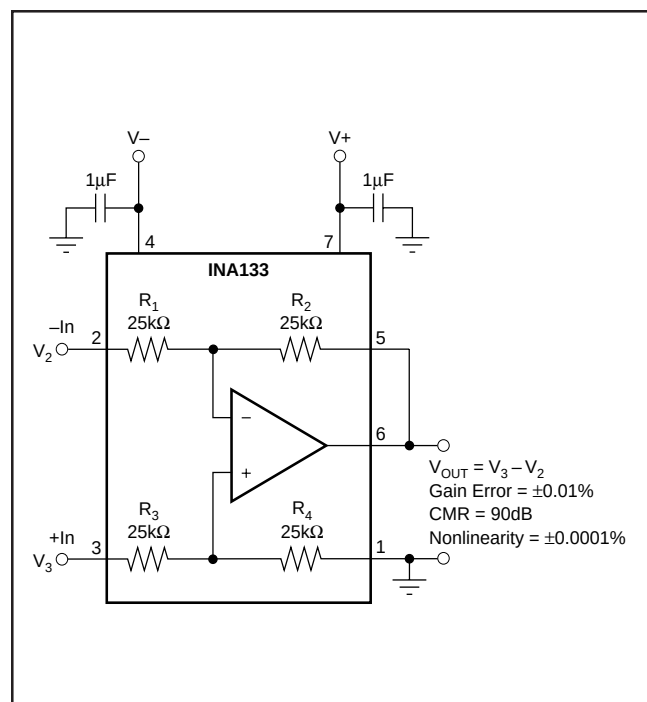


FIGURE 1. Precision Difference Amplifier (Basic Power Supply and Signal Connections).

changed, pins 2 and 5 must also be interchanged to maintain proper ratio matching.

## OPERATING VOLTAGE

The INA133 and INA2133 operate from single (+4.5V to +36V) or dual ( $\pm 2.25V$  to  $\pm 18V$ ) supplies with excellent performance. Specifications are production tested with  $\pm 5V$  and  $\pm 15V$  supplies. 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

The INA133 and INA2133 can accurately measure differential signals that are above and below the supply rails. Linear common-mode range extends from  $2 \cdot (V^+) - 3V$  to  $2 \cdot (V^-) + 3V$  (nearly twice the supplies). See the typical performance curve, "Input Common-Mode Voltage vs Output Voltage."

## OFFSET VOLTAGE TRIM

The INA133 and INA2133 are 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  $10\Omega$  to maintain good common-mode rejection.

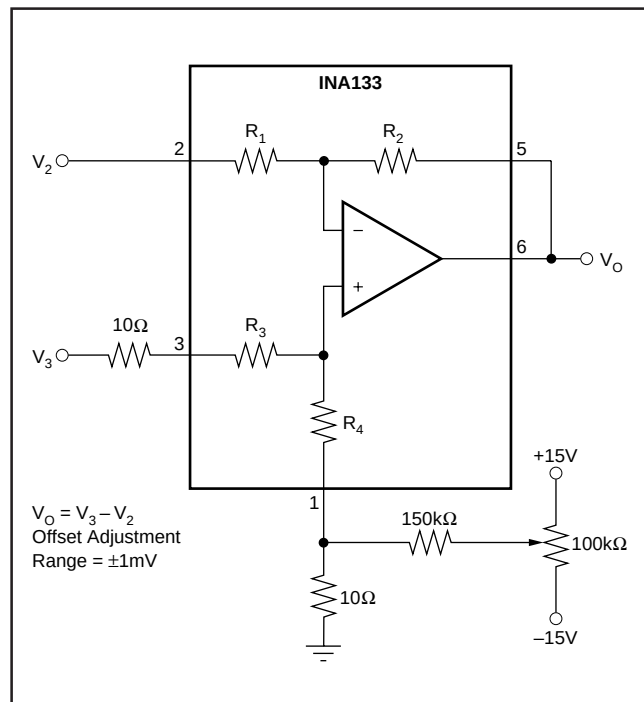
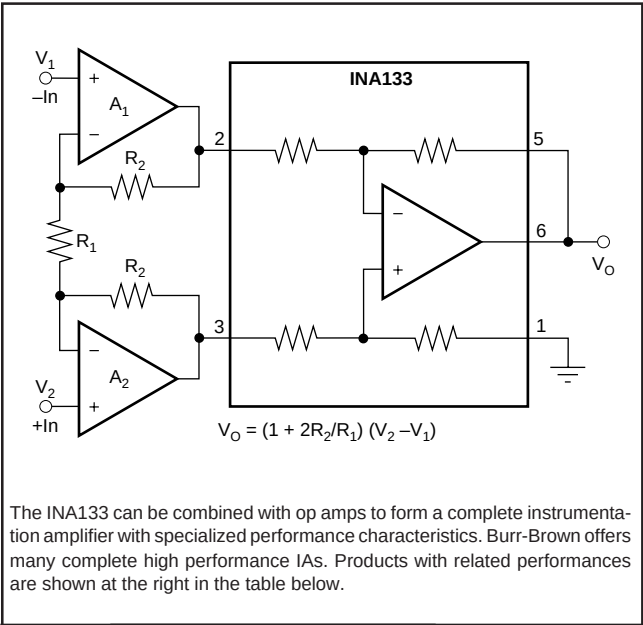


FIGURE 2. Offset Adjustment.

# TYPICAL APPLICATIONS



| A <sub>1</sub> , A <sub>2</sub> | FEATURE                             | SIMILAR COMPLETE BURR-BROWN IA |
|---------------------------------|-------------------------------------|--------------------------------|
| OPA2227                         | Low Noise                           | INA103                         |
| OPA129                          | Ultra Low Bias Current (fA)         | INA116                         |
| OPA2277                         | Low Offset Drift, Low Noise         | INA114, INA128                 |
| OPA2130                         | Low Power, FET-Input (pA)           | INA121                         |
| OPA2234                         | Single Supply, Precision, Low Power | INA122, INA118                 |
| OPA2237                         | Single Supply, Low Power, MSOP-8    | INA122, INA126                 |

FIGURE 3. Precision Instrumentation Amplifier.

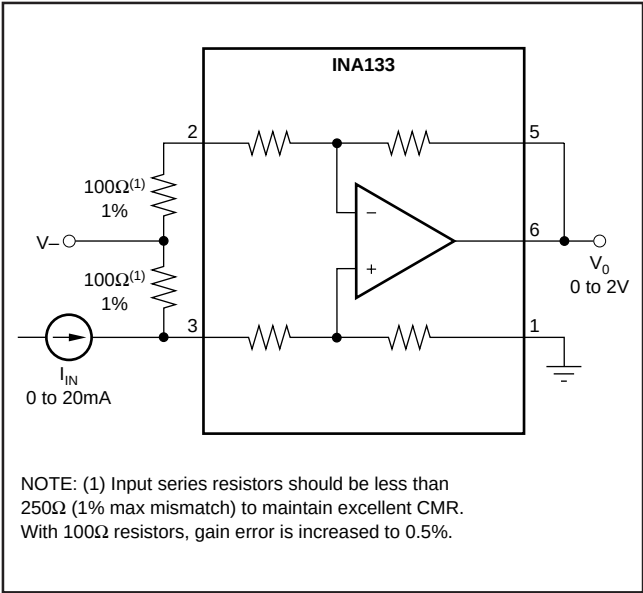


FIGURE 4. Current Receiver with Compliance to Rails.

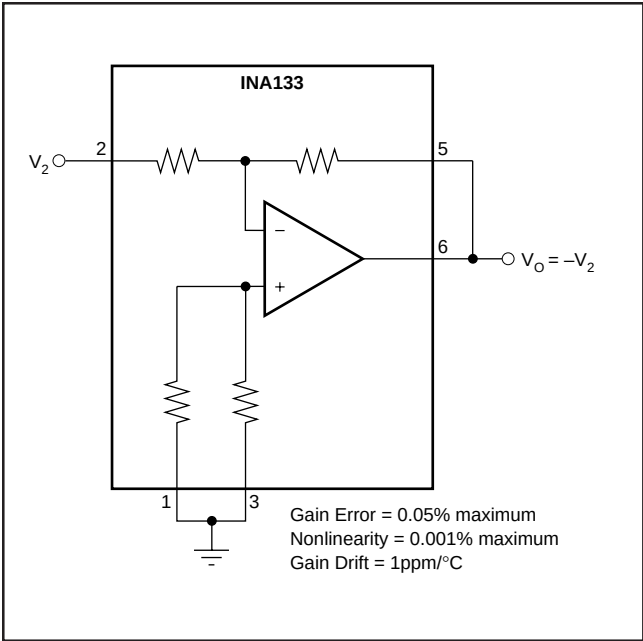
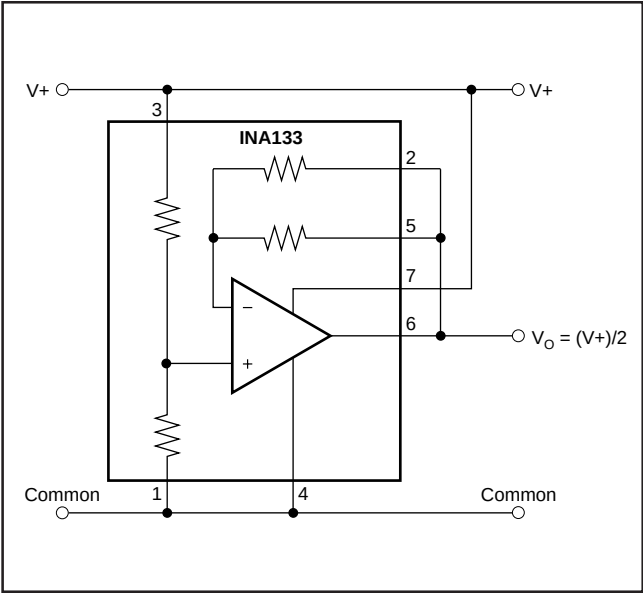


FIGURE 6. Precision Unity-Gain Inverting Amplifier.

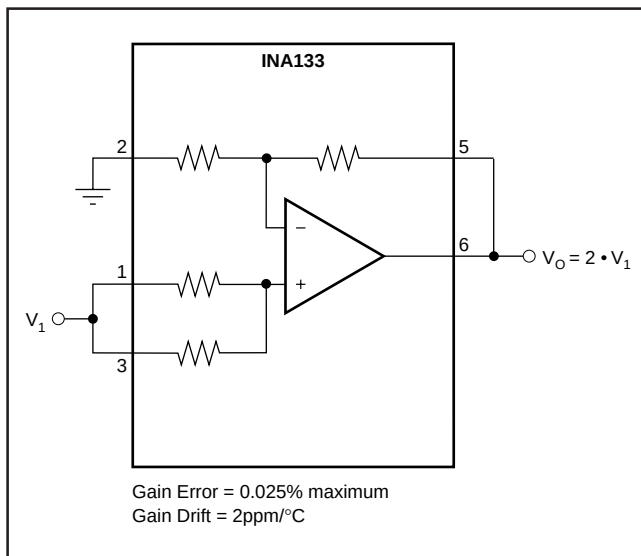


FIGURE 7. Precision Gain = 2 Amplifier.

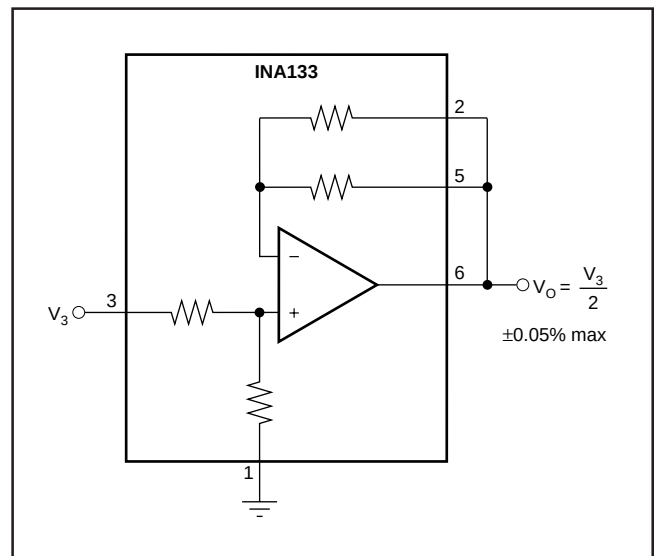


FIGURE 8. Precision Gain = 1/2 Amplifier.

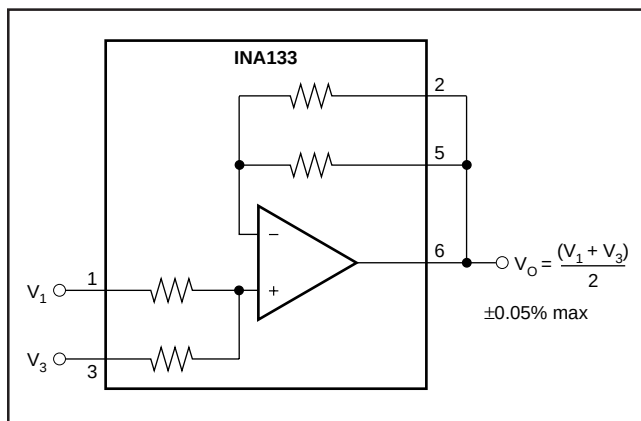


FIGURE 9. Precision Average Value Amplifier.

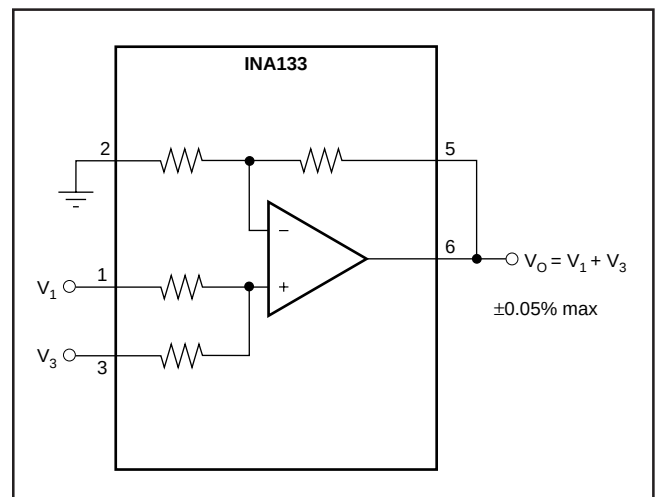


FIGURE 10. Precision Summing Amplifier.

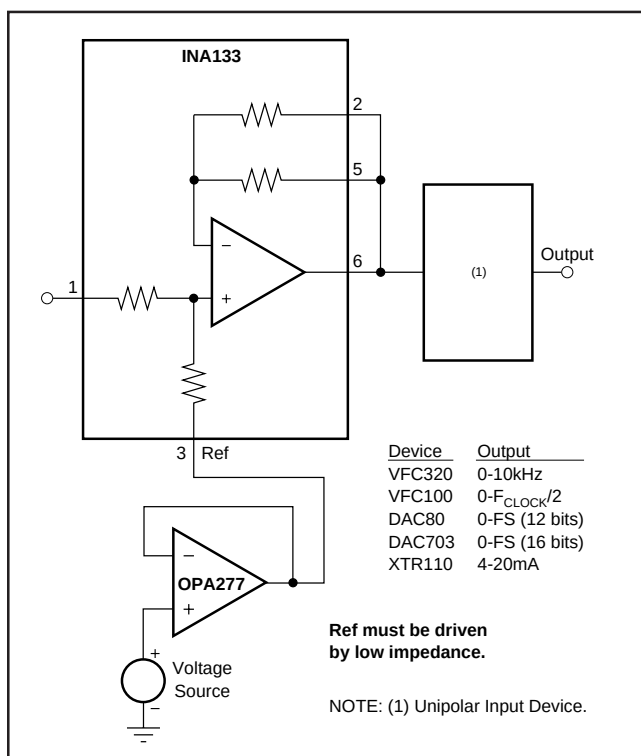


FIGURE 11. Precision Bipolar Offsetting.

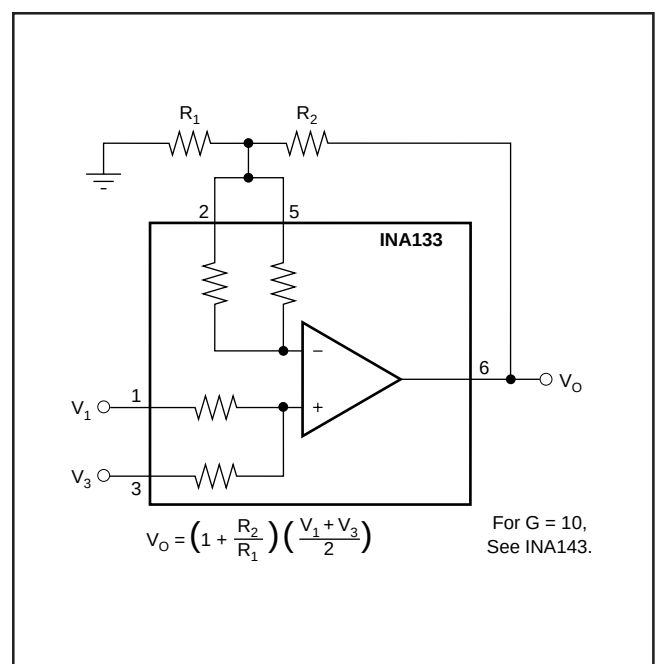


FIGURE 12. Precision Summing Amplifier with Gain.

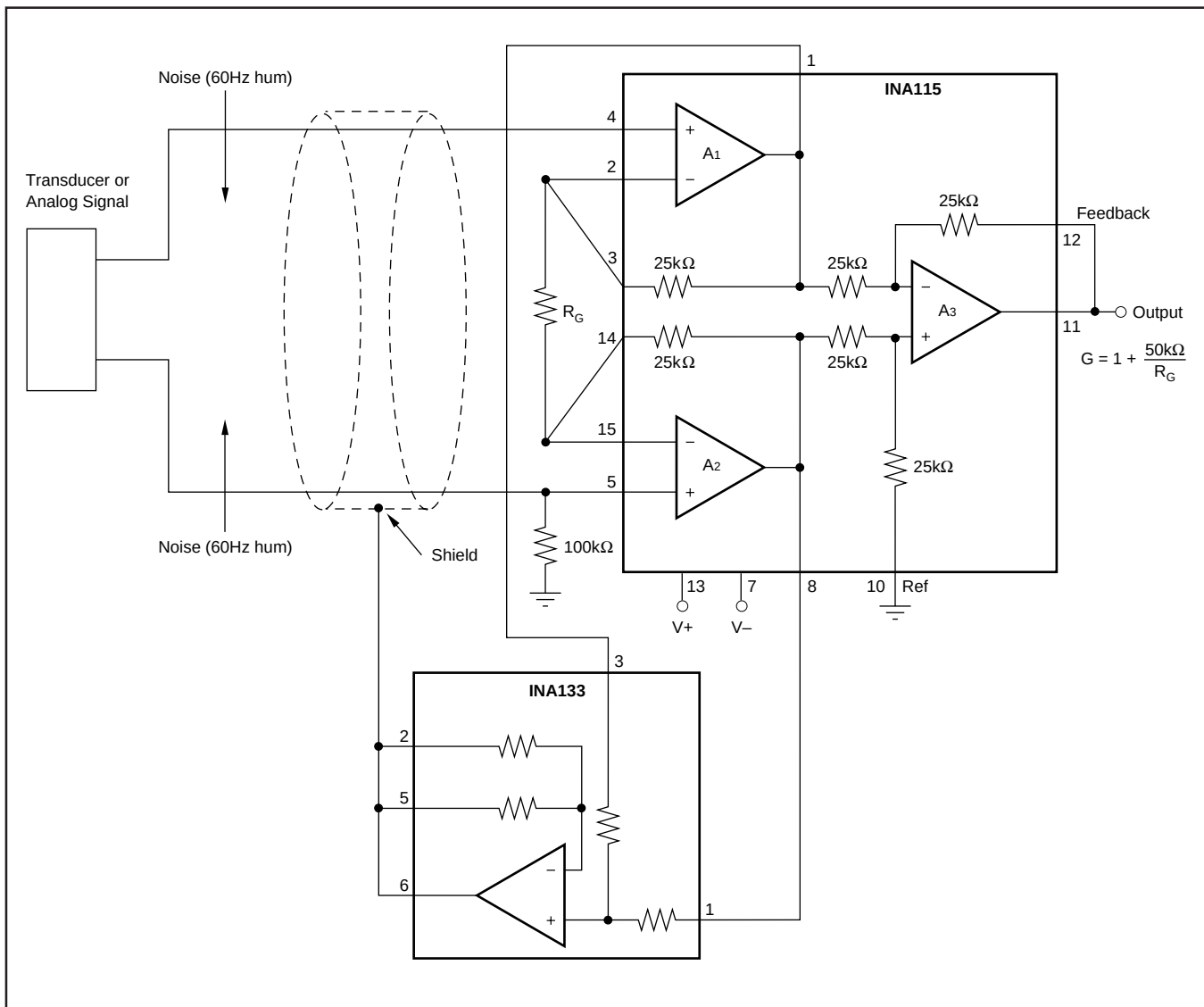


FIGURE 13. Instrumentation Amplifier Guard Drive Generator.

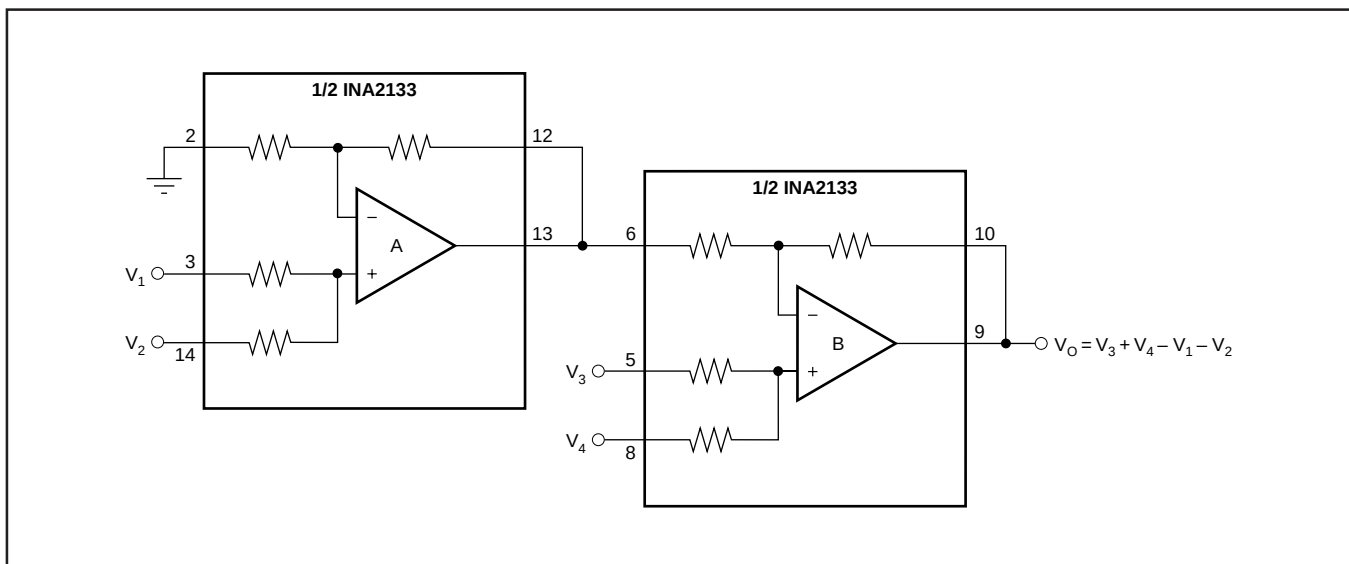


FIGURE 14. Precision Summing Instrumentation Amplifier.

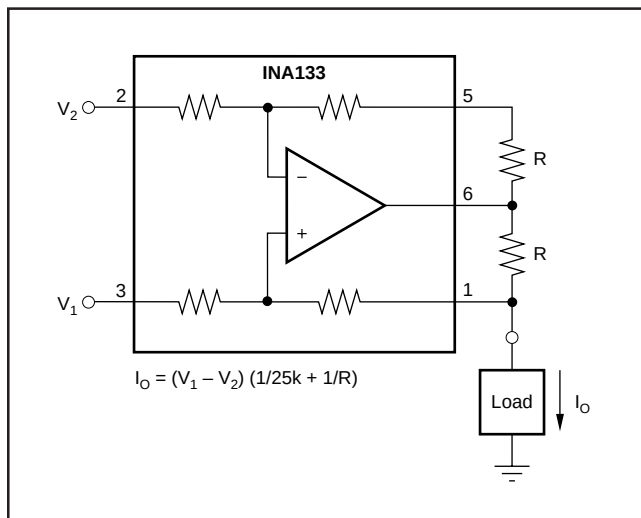


FIGURE 15. Precision Voltage-to-Current Converter with Differential Inputs.

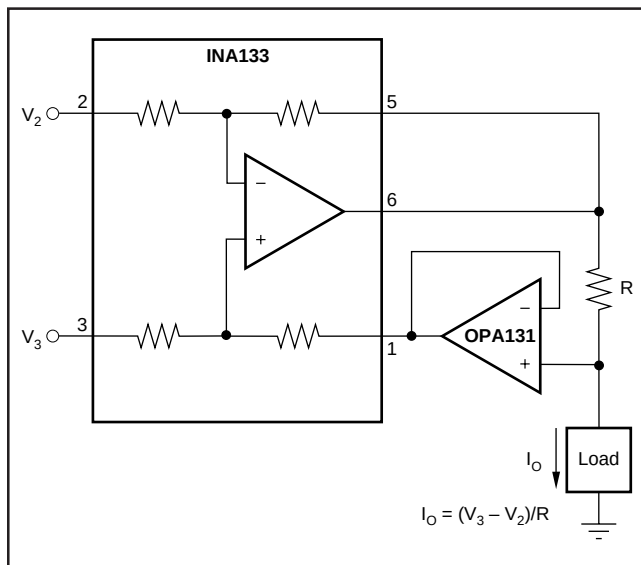


FIGURE 16. Differential Input Voltage-to-Current Converter for Low  $I_{OUT}$ .

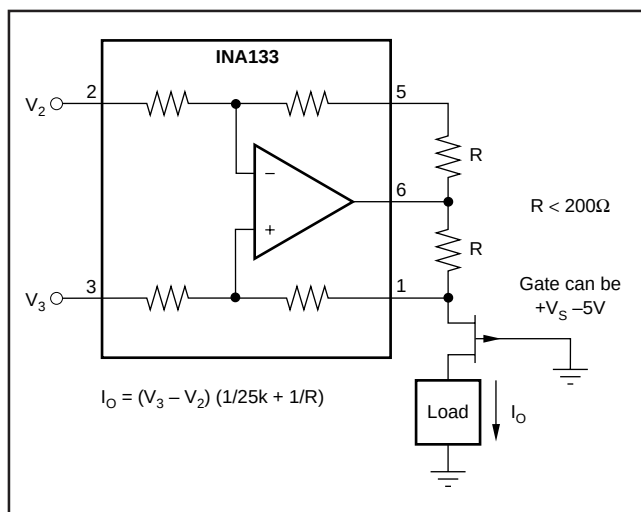


FIGURE 17. Isolating Current Source.

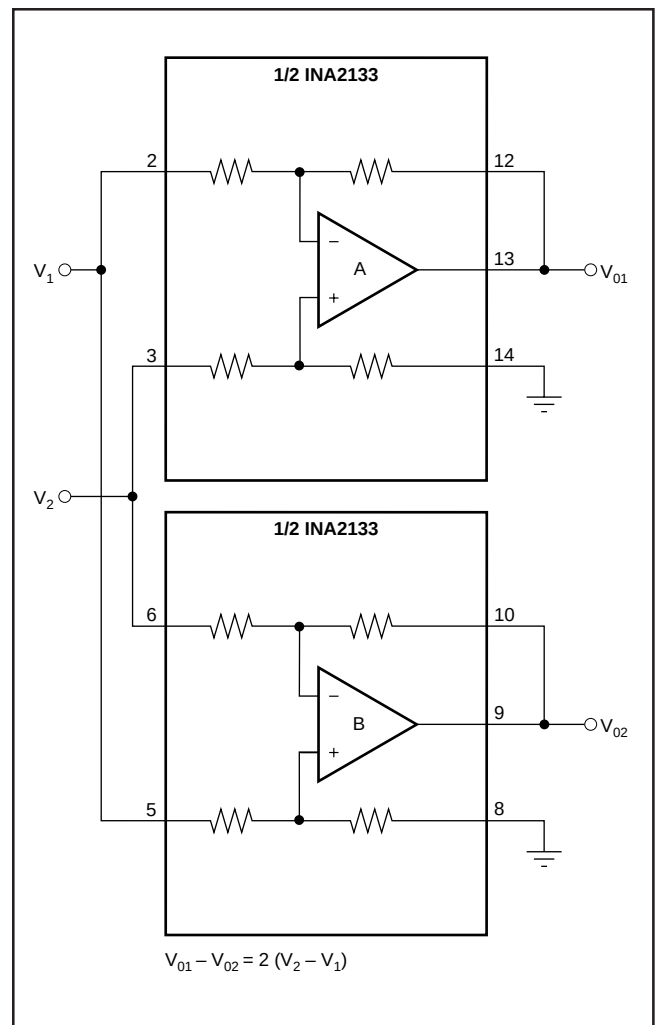


FIGURE 18. Differential Output Difference Amplifier.

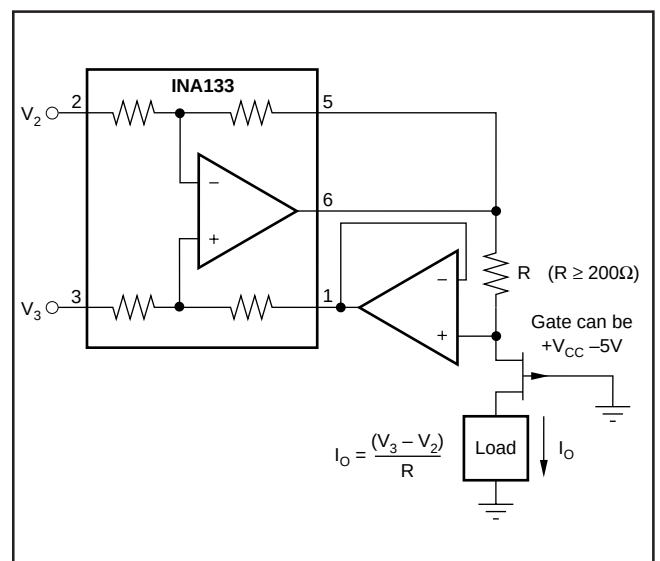


FIGURE 19. Isolating Current Source with Buffering Amplifier for Greater Accuracy.

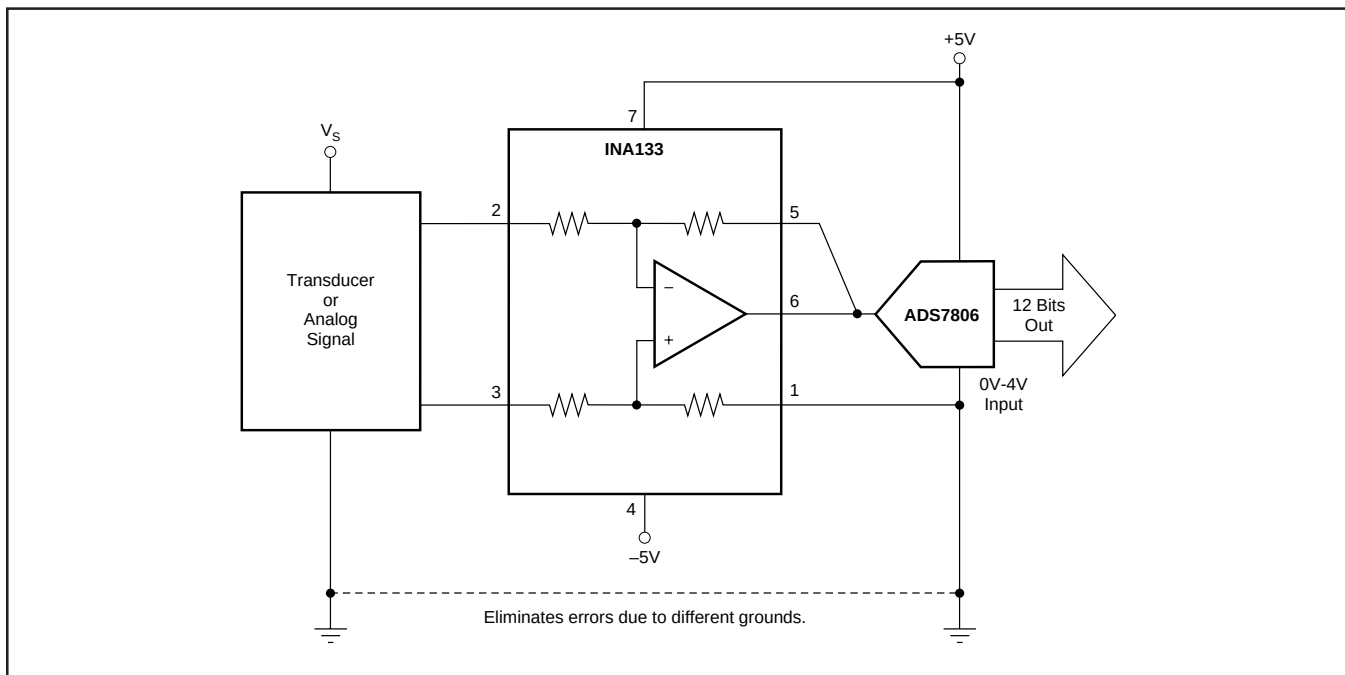


FIGURE 20. Differential Input Data Acquisition.

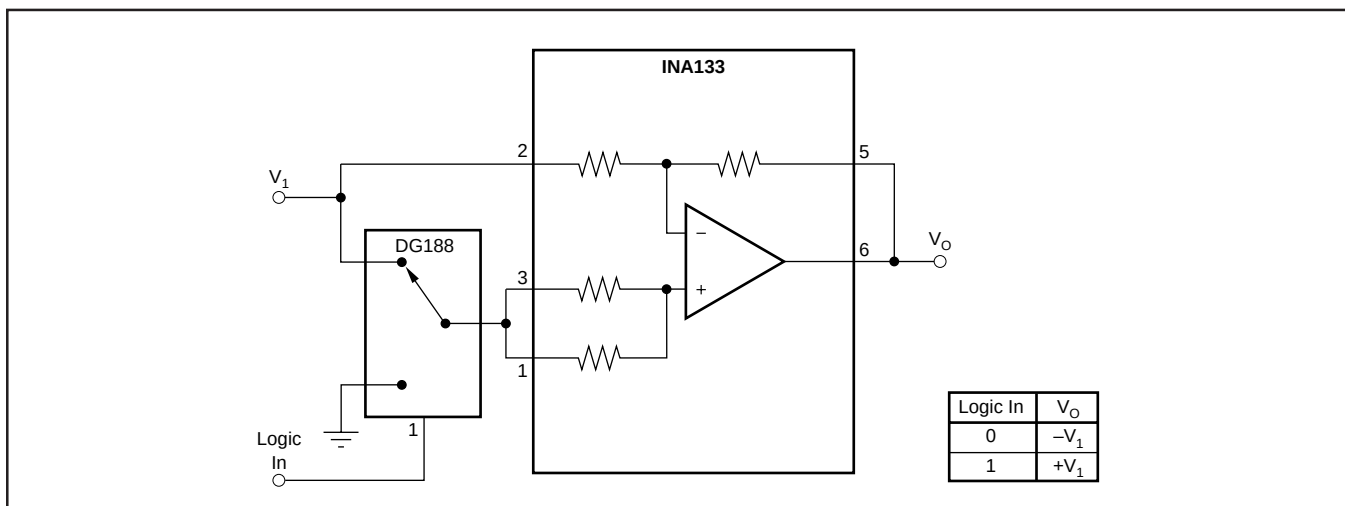


FIGURE 21. Digitally Controlled Gain of  $\pm 1$  Amplifier.

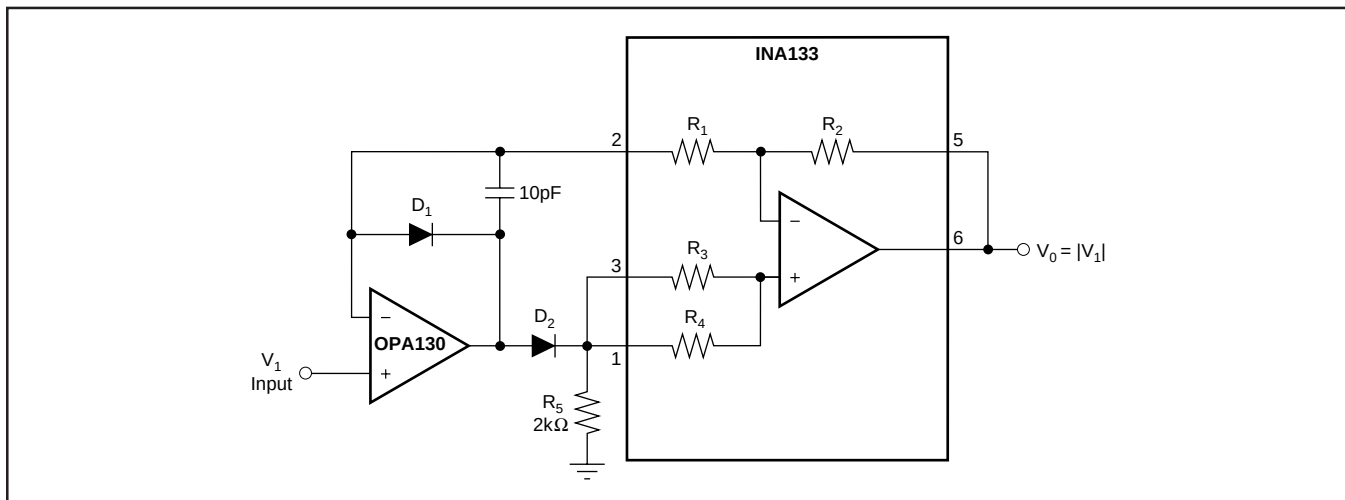


FIGURE 22. Precision Absolute Value Buffer.

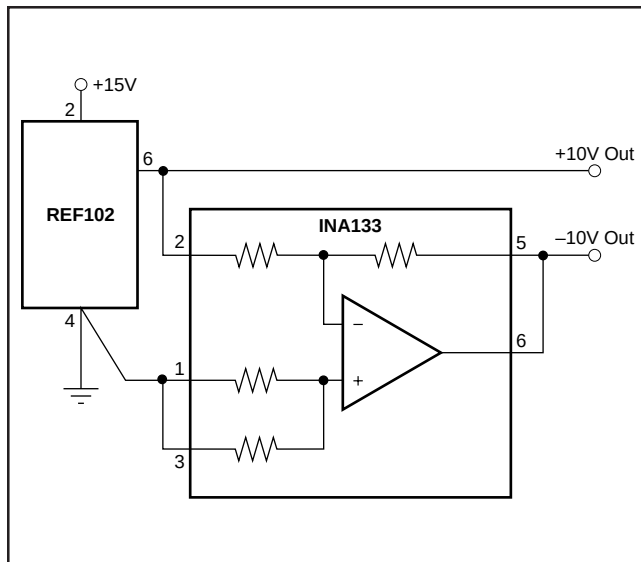


FIGURE 23. ±10V Precision Voltage Reference.

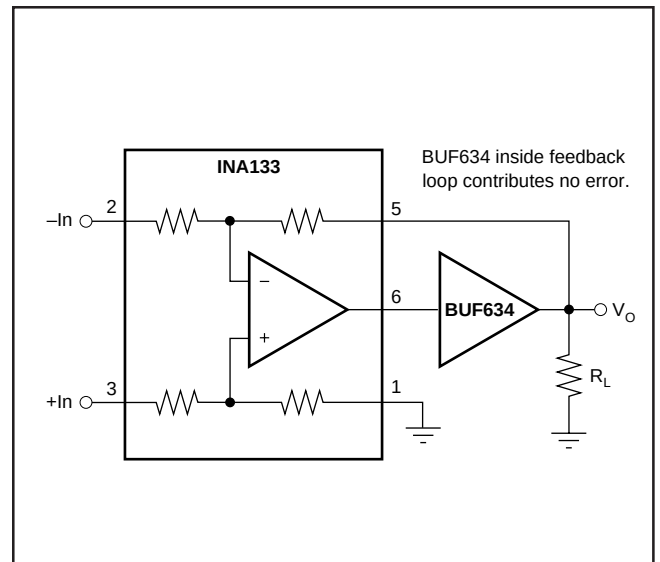


FIGURE 24. High Output Current Precision Difference Amplifier.

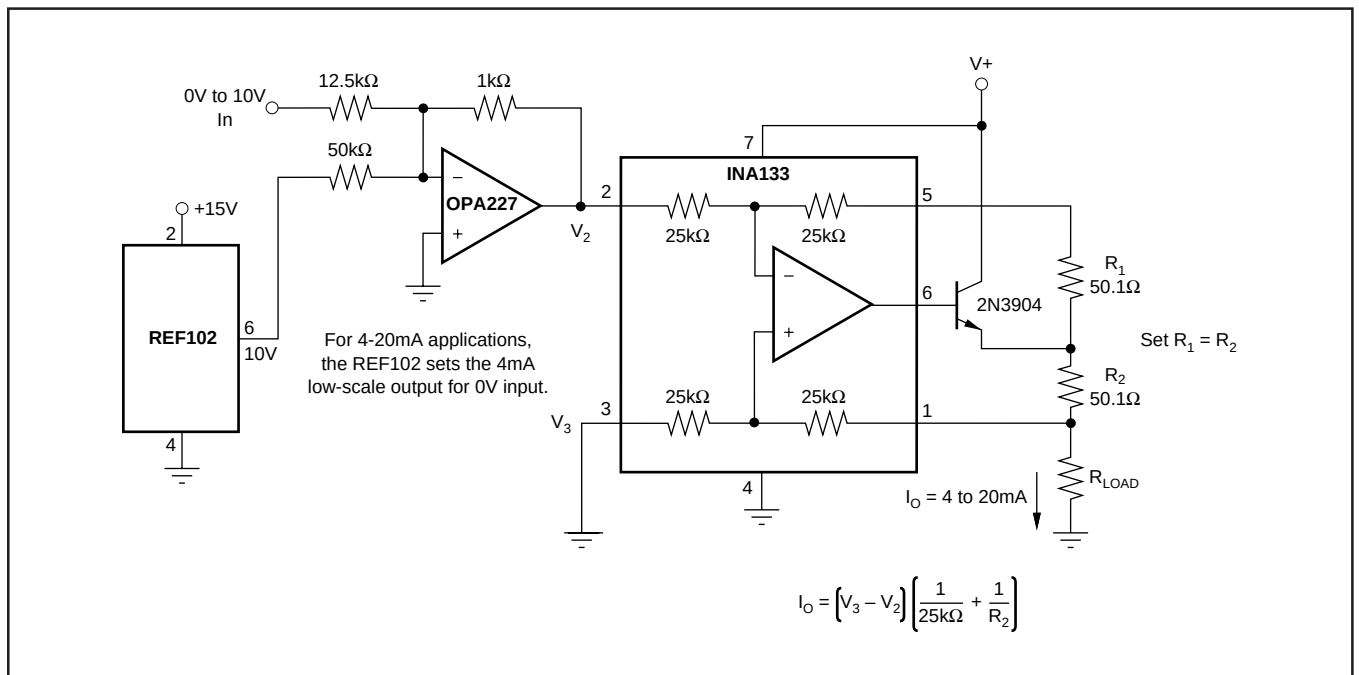


FIGURE 25. Precision Voltage-to-Current Conversion.

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| INA133U          | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| INA133U/2K5      | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| INA133U/2K5E4    | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| INA133UA         | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | Call TI          | Level-3-260C-168 HR          |
| INA133UA/2K5     | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| INA133UA/2K5E4   | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| INA133UAE4       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | Call TI          | Level-3-260C-168 HR          |
| INA133UE4        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| INA2133U         | ACTIVE                | SOIC         | D               | 14   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| INA2133U/2K5E4   | OBSOLETE              | SOIC         | D               | 14   |             | TBD                     | Call TI          | Call TI                      |
| INA2133UA        | ACTIVE                | SOIC         | D               | 14   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| INA2133UA/2K5E4  | OBSOLETE              | SOIC         | D               | 14   |             | TBD                     | Call TI          | Call TI                      |
| INA2133UAE4      | ACTIVE                | SOIC         | D               | 14   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| INA2133UAG4      | ACTIVE                | SOIC         | D               | 14   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| INA2133UE4       | ACTIVE                | SOIC         | D               | 14   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| INA2133UG4       | ACTIVE                | SOIC         | D               | 14   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |

<sup>(1)</sup> 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.

<sup>(2)</sup> 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.

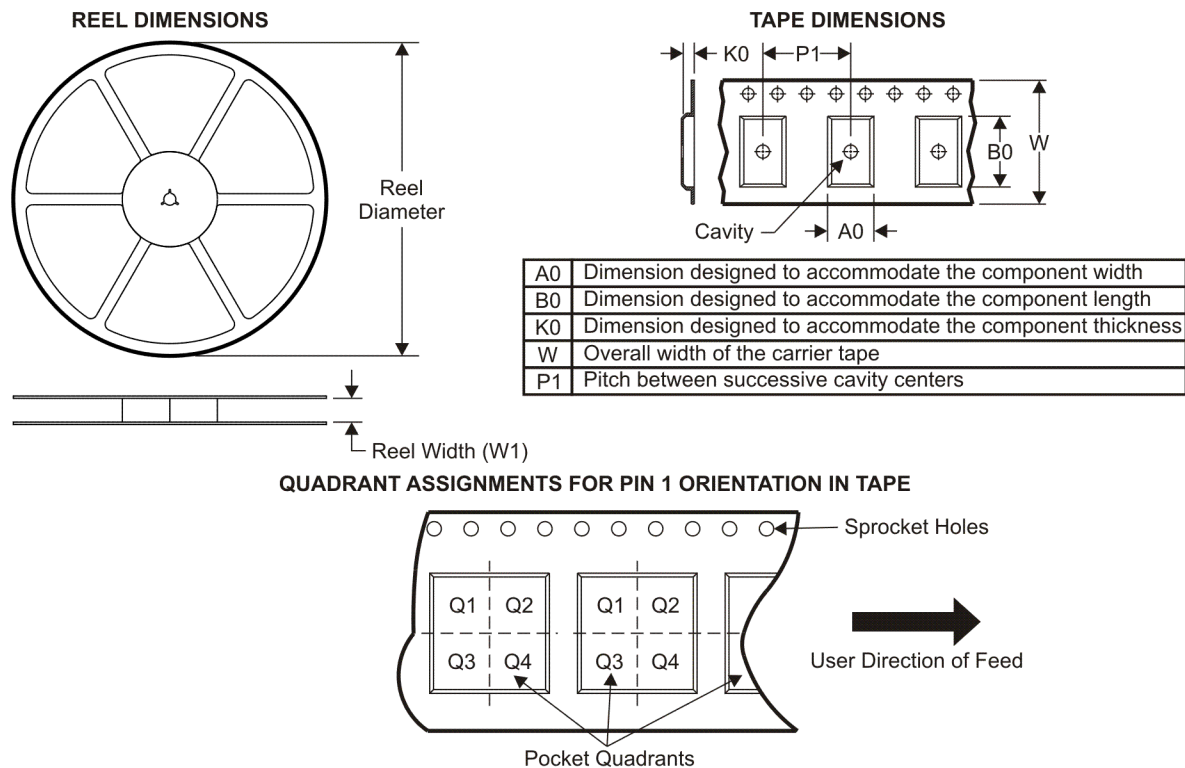
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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



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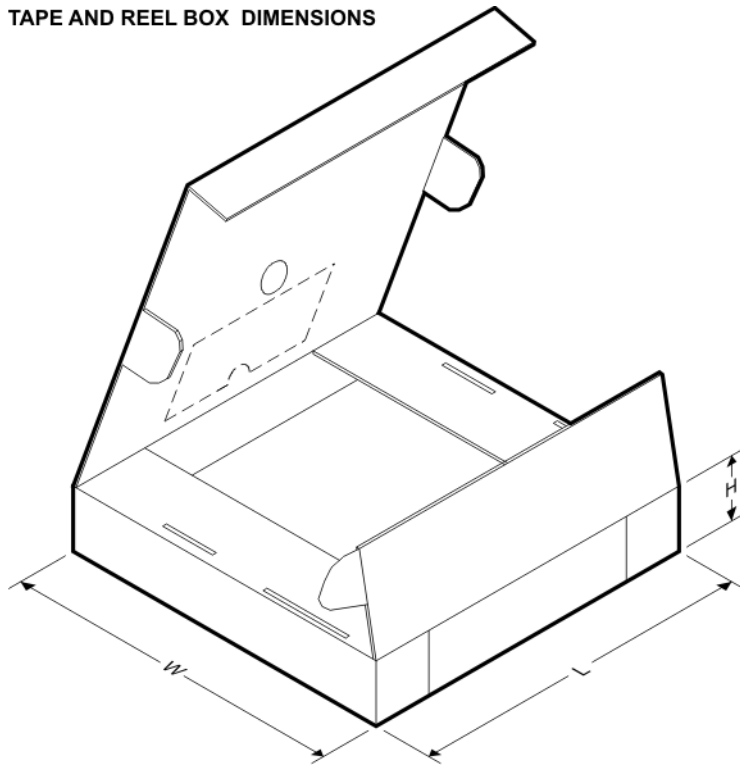
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**TAPE AND REEL INFORMATION**


\*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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| INA133U/2K5  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| INA133UA/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) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| INA133U/2K5  | SOIC         | D               | 8    | 2500 | 346.0       | 346.0      | 29.0        |
| INA133UA/2K5 | SOIC         | D               | 8    | 2500 | 346.0       | 346.0      | 29.0        |

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| DLP® Products               | <a href="http://www.dlp.com">www.dlp.com</a>                       |
| DSP                         | <a href="http://dsp.ti.com">dsp.ti.com</a>                         |
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