

# INA20x オープン・ドレイン・コンパレータおよび基準電圧搭載の ハイサイド測定、電流シャント・モニタ

## 1 特長

- 完全な電流検出ソリューション
- 3つのゲイン・オプションを利用可能:
  - INA200: 20V/V
  - INA201: 50V/V
  - INA202: 100V/V
- 0.6Vの内部基準電圧
- 内蔵のオープン・ドレイン・コンパレータ
- コンパレータのラッチ機能
- 同相範囲: -16V~80V
- 高精度: 温度範囲にわたって最大誤差3.5%
- 帯域幅: 500kHz (INA200)
- 静止電流: 1800 $\mu$ A (最大値)
- パッケージ: SOIC-8、VSSOP-8

## 2 アプリケーション

- ノートブック・コンピュータ
- 携帯電話
- 通信機器
- オートモーティブ (車載)
- パワー・マネージメント
- バッテリー充電器
- 溶接機器

## 3 概要

INA200、INA201、INA202デバイスは、ハイサイドの電圧出力、電流シャント・モニタで、コンパレータが内蔵されています。INA20xデバイスは、-16V~80Vの範囲の同相電圧において、シャントの両端の電圧降下を検出できます。INA20xシリーズは20V/V、50V/V、100V/Vの3つの出力電圧スケールで、500kHzまでの帯域幅で利用可能です。

INA200、INA201、INA202デバイスにはオープン・ドレインのコンパレータと、0.6Vのスレッシュホールドを提供する内部基準電圧が組み込まれています。外部の分圧抵抗により、電流トリップ点を設定します。コンパレータにはラッチ機能があり、RESETピンをグラウンドに接続(またはオープンに保持)することで透過的にできます。

INA200、INA201、INA202デバイスは2.7V~18Vの単一電源で動作し、消費電流は最大1800 $\mu$ Aです。パッケージは、超小型のVSSOP-8とSOIC-8を選択できます。

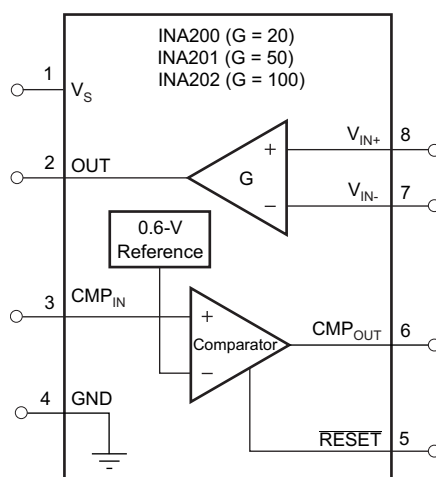
すべてのバージョンは、拡張動作温度範囲の-40°C~+125°Cで動作が規定されています。

### 製品情報<sup>(1)</sup>

| 型番     | パッケージ     | 本体サイズ(公称)     |
|--------|-----------|---------------|
| INA200 | SOIC (8)  | 4.90mm×3.91mm |
| INA201 | VSSOP (8) | 3.00mm×3.00mm |
| INA202 |           |               |

(1) 提供されているすべてのパッケージについては、データシートの末尾にある注文情報を参照してください。

### 概略回路図



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## 4 改訂履歴

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

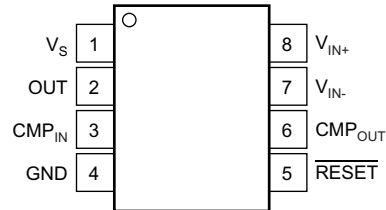
| Revision D (October 2015) から Revision E に変更   | Page |
|---|------|
| • Reformatted <i>Thermal Information</i> table note   | 4    |
| • Corrected typo in <i>Voltage Output</i> section in <i>Electrical Characteristics</i> table      | 6    |
| • 追加 text to <i>Comparator</i> subsection in <i>Feature Description</i> section                   | 14   |
| • 追加 <a href="#">図 31</a> to <i>Feature Description</i> section                                   | 18   |
| • 追加 <i>Output vs Supply Ramp Considerations</i> subsection in <i>Feature Description</i> section | 23   |
| • 追加 <a href="#">図 36</a> , <a href="#">図 37</a> , and <a href="#">図 38</a>                       | 23   |

| Revision C (October 2010) から Revision D に変更  | Page |
|--|------|
| • Added <i>ESD Ratings</i> table, <i>Thermal Information</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section | 4    |

| Revision B (October, 2007) から Revision C に変更 | Page |
|--|------|
| • 表紙の図を修正                                    | 1    |
| • データシートのタイトルを変更                             | 1    |
| • 現行の標準に合わせてドキュメントのフォーマットを更新                 | 1    |

## 5 Pin Configuration and Functions

**DGK and D Packages  
8-Pin VSSOP and SOIC  
Top View**



**Pin Functions**

| PIN                       |     | I/O           | DESCRIPTION                      |
|---------------------------|-----|---------------|----------------------------------|
| NAME                      | NO. |               |                                  |
| CMP <sub>IN</sub>         | 3   | Analog input  | Comparator input                 |
| CMP <sub>OUT</sub>        | 6   | Analog output | Comparator output                |
| GND                       | 4   | Analog        | Ground                           |
| OUT                       | 2   | Analog output | Output voltage                   |
| $\overline{\text{RESET}}$ | 5   | Analog input  | Comparator reset pin, active low |
| V <sub>IN-</sub>          | 7   | Analog input  | Connect to shunt low side        |
| V <sub>IN+</sub>          | 8   | Analog input  | Connect to shunt high side       |
| V <sub>S</sub>            | 1   | Analog        | Power supply                     |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|  |  | MIN       | MAX             | UNIT |
|--|--|-----------|-----------------|------|
| Supply voltage, $V_s$                                      |  | 2.7       | 18              | V    |
| Current-shunt monitor analog inputs, $V_{IN+}$ , $V_{IN-}$ | Differential ( $V_{IN+}$ ) – ( $V_{IN-}$ ) | –18       | 18              | V    |
|  | Common-mode <sup>(2)</sup>                 | –16       | 80              | V    |
| Comparator analog input and reset pins <sup>(2)</sup>      |  | GND – 0.3 | ( $V_s$ ) + 0.3 | V    |
| Analog output, OUT <sup>(2)</sup>                          |  | GND – 0.3 | ( $V_s$ ) + 0.3 | V    |
| Comparator output, OUT <sup>(2)</sup>                      |  | GND – 0.3 | 18              | V    |
| Input current into any pin <sup>(2)</sup>                  |  |           | 5               | mA   |
| Operating temperature                                      |  | –55       | 150             | °C   |
| Junction temperature                                       |  | –65       | 150             | °C   |
| Storage temperature, $T_{stg}$                             |  | –65       | 150             | °C   |

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) This voltage may exceed the ratings shown if the current at that pin is limited to 5 mA.

### 6.2 ESD Ratings

|                                     |  | VALUE | UNIT |
|-------------------------------------|--|-------|------|
| $V_{(ESD)}$ Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins <sup>(1)</sup>              | ±4000 | V    |
|                                     | Charged device model (CDM), per JEDEC specification JESD22-C101, all pins <sup>(2)</sup> | ±1000 |      |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

|          |                                | MIN | NOM | MAX | UNIT |
|----------|--------------------------------|-----|-----|-----|------|
| $V_{CM}$ | Common-mode input voltage      | –16 | 12  | 80  | V    |
| $V_s$    | Operating supply voltage       | 2.7 | 12  | 18  | V    |
| $T_A$    | Operating free-air temperature | –40 | 25  | 125 | °C   |

### 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> | INA20x                                       |            | UNIT  |      |
|-------------------------------|--|------------|-------|------|
|                               | D (SOIC)                                     | DGK (SOIC) |       |      |
|                               | 8 PINS                                       | 8 PINS     |       |      |
| $R_{\theta JA}$               | Junction-to-ambient thermal resistance       | 110.5      | 162.2 | °C/W |
| $R_{\theta JC(top)}$          | Junction-to-case (top) thermal resistance    | 50.4       | 37.7  | °C/W |
| $R_{\theta JB}$               | Junction-to-board thermal resistance         | 52.7       | 82.9  | °C/W |
| $\Psi_{JT}$                   | Junction-to-top characterization parameter   | 7.8        | 1.3   | °C/W |
| $\Psi_{JB}$                   | Junction-to-board characterization parameter | 51.9       | 81.4  | °C/W |

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

## 6.5 Electrical Characteristics: Current-Shunt Monitor

at  $T_A = 25^\circ\text{C}$ ,  $V_S = 12\text{ V}$ ,  $V_{CM} = 12\text{ V}$ ,  $V_{SENSE} = 100\text{ mV}$ ,  $R_L = 10\text{ k}\Omega$  to GND,  $R_{PULL-UP} = 5.1\text{ k}\Omega$  connected from  $CMP_{OUT}$  to  $V_S$ , and  $CMP_{IN} = \text{GND}$ , (unless otherwise noted)

| PARAMETER    |                                      | TEST CONDITIONS  | MIN | TYP       | MAX                          | UNIT                         |
|--------------|--------------------------------------|--|-----|-----------|------------------------------|------------------------------|
| <b>INPUT</b> |                                      |  |     |           |                              |                              |
| $V_{SENSE}$  | Full-scale sense input voltage       | $V_{SENSE} = V_{IN+} - V_{IN-}$  |     | 0.15      | $(V_S - 0.25) / \text{Gain}$ | V                            |
| $V_{CM}$     | Common-mode input range              | $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$   | -16 |           | 80                           | V                            |
| CMR          | Common-mode rejection                | $V_{IN+} = -16\text{ V}$ to $80\text{ V}$  | 80  | 100       |                              | dB                           |
|              |                                      | $V_{IN+} = 12\text{ V}$ to $80\text{ V}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$                          | 100 | 123       |                              | dB                           |
| $V_{OS}$     | Offset voltage, RTI <sup>(1)</sup>   | $T_A = 25^\circ\text{C}$   |     | $\pm 0.5$ | $\pm 2.5$                    | mV                           |
|              |                                      | $T_A = 25^\circ\text{C}$ to $125^\circ\text{C}$  |     |           | $\pm 3$                      | mV                           |
|              |                                      | $T_A = -40^\circ\text{C}$ to $25^\circ\text{C}$  |     |           | $\pm 3.5$                    | mV                           |
| $dV_{OS}/dT$ | Offset voltage, RTI, vs temperature  | $T_{MIN}$ to $T_{MAX}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$  |     | 5         |                              | $\mu\text{V}/^\circ\text{C}$ |
| PSR          | Offset voltage, RTI, vs power supply | $V_{OUT} = 2\text{ V}$ , $V_{IN+} = 18\text{ V}$ , $2.7\text{ V}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$ |     | 2.5       | 100                          | $\mu\text{V}/\text{V}$       |
| $I_B$        | Input bias current, $V_{IN-}$ pin    | $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$   |     | $\pm 9$   | $\pm 16$                     | $\mu\text{A}$                |

(1) Offset is extrapolated from measurements of the output at 20-mV and 100-mV  $V_{SENSE}$ .

**Electrical Characteristics: Current-Shunt Monitor (continued)**

 at  $T_A = 25^\circ\text{C}$ ,  $V_S = 12\text{ V}$ ,  $V_{CM} = 12\text{ V}$ ,  $V_{SENSE} = 100\text{ mV}$ ,  $R_L = 10\text{ k}\Omega$  to GND,  $R_{PULL-UP} = 5.1\text{ k}\Omega$  connected from  $CMP_{OUT}$  to  $V_S$ , and  $CMP_{IN} = \text{GND}$ , (unless otherwise noted)

| PARAMETER  |                                    | TEST CONDITIONS   | MIN                      | TYP                    | MAX                   | UNIT                   |
|--|------------------------------------|---|--------------------------|------------------------|-----------------------|------------------------|
| <b>OUTPUT (<math>V_{SENSE} \geq 20\text{ mV}</math>)</b>               |                                    |   |                          |                        |                       |                        |
| G  | Gain                               | INA200  |                          | 20                     |                       | V/V                    |
|  |                                    | INA201  |                          | 50                     |                       | V/V                    |
|  |                                    | INA202  |                          | 100                    |                       | V/V                    |
|  | Gain error                         | $V_{SENSE} = 20\text{ mV to }100\text{ mV}$   |                          | $\pm 0.2\%$            | $\pm 1\%$             |                        |
|  |                                    | $V_{SENSE} = 20\text{ mV to }100\text{ mV}$ , $T_A = -40^\circ\text{C to }125^\circ\text{C}$        |                          |                        |                       | $\pm 2\%$              |
|  | Total output error <sup>(2)</sup>  | $V_{SENSE} = 120\text{ mV}$ , $V_S = 16\text{ V}$   |                          | $\pm 0.75\%$           | $\pm 2.2\%$           |                        |
|  |                                    | $V_{SENSE} = 120\text{ mV}$ , $V_S = 16\text{ V}$ , $T_A = -40^\circ\text{C to }125^\circ\text{C}$  |                          |                        |                       | $\pm 3.5\%$            |
|  | Nonlinearity error <sup>(3)</sup>  | $V_{SENSE} = 20\text{ mV to }100\text{ mV}$   |                          | $\pm 0.002\%$          |                       |                        |
| $R_O$  | Output impedance                   |   |                          | 1.5                    |                       | $\Omega$               |
|  | Maximum capacitive load            | No sustained oscillation  |                          | 10                     |                       | nF                     |
| <b>OUTPUT (<math>V_{SENSE} &lt; 20\text{ mV}</math>)<sup>(4)</sup></b> |                                    |   |                          |                        |                       |                        |
| Output   | INA200, INA201, INA202             | $-16\text{ V} \leq V_{CM} < 0\text{ V}$   |                          | 300                    |                       | mV                     |
|  | INA200                             | $0\text{ V} \leq V_{CM} \leq V_S$ , $V_S = 5\text{ V}$  |                          |                        | 0.4                   | V                      |
|  | INA201                             | $0\text{ V} \leq V_{CM} \leq V_S$ , $V_S = 5\text{ V}$  |                          |                        | 1                     | V                      |
|  | INA202                             | $0\text{ V} \leq V_{CM} \leq V_S$ , $V_S = 5\text{ V}$  |                          |                        | 2                     | V                      |
|  | INA200, INA201, INA202             | $V_S < V_{CM} \leq 80\text{ V}$   |                          | 300                    |                       | mV                     |
| <b>VOLTAGE OUTPUT<sup>(5)</sup></b>                                    |                                    |   |                          |                        |                       |                        |
|  | Output swing to the positive rail  | $V_{IN-} = 11\text{ V}$ , $V_{IN+} = 12\text{ V}$ , $T_A = -40^\circ\text{C to }125^\circ\text{C}$  |                          | $(V_S) - 0.15$         | $(V_S) - 0.25$        | V                      |
|  | Output swing to GND <sup>(6)</sup> | $V_{IN-} = 0\text{ V}$ , $V_{IN+} = -0.5\text{ V}$ , $T_A = -40^\circ\text{C to }125^\circ\text{C}$ |                          | $(\text{GND}) + 0.004$ | $(\text{GND}) + 0.05$ | V                      |
| <b>FREQUENCY RESPONSE</b>  |                                    |   |                          |                        |                       |                        |
| BW   | Bandwidth                          | INA200  | $C_{LOAD} = 5\text{ pF}$ | 500                    |                       | kHz                    |
|  |                                    | INA201  | $C_{LOAD} = 5\text{ pF}$ | 300                    |                       | kHz                    |
|  |                                    | INA202  | $C_{LOAD} = 5\text{ pF}$ | 200                    |                       | kHz                    |
|  | Phase margin                       | $C_{LOAD} < 10\text{ nF}$   |                          | 40                     |                       | $^\circ\text{C}$       |
| SR   | Slew rate                          |   |                          | 1                      |                       | V/ $\mu\text{s}$       |
|  | Settling time (1%)                 | $V_{SENSE} = 10\text{ mV}_{PP}$ to $100\text{ mV}_{PP}$ , $C_{LOAD} = 5\text{ pF}$                  |                          | 2                      |                       | $\mu\text{s}$          |
| <b>NOISE, RTI</b>  |                                    |   |                          |                        |                       |                        |
|  | Voltage noise density              |   |                          | 40                     |                       | nV/ $\sqrt{\text{Hz}}$ |

 (2) Total output error includes effects of gain error and  $V_{OS}$ .

(3) Linearity is best fit to a straight line.

 (4) For details on this region of operation, see [Accuracy Variations](#) section in [Device Functional Modes](#).

 (5) See [Figure 8](#).

(6) Specified by design.

## 6.6 Electrical Characteristics: Comparator

at  $T_A = 25^\circ\text{C}$ ,  $V_S = 12\text{ V}$ ,  $V_{CM} = 12\text{ V}$ ,  $V_{SENSE} = 100\text{ mV}$ ,  $R_L = 10\text{ k}\Omega$  to GND, and  $R_{PULL-UP} = 5.1\text{ k}\Omega$  connected from  $CMP_{OUT}$  to  $V_S$ , (unless otherwise noted)

| PARAMETER  | TEST CONDITIONS  | MIN                         | TYP    | MAX | UNIT             |
|--|--|-----------------------------|--------|-----|------------------|
| <b>OFFSET VOLTAGE</b>                                  |  |                             |        |     |                  |
| Threshold  | $T_A = 25^\circ\text{C}$   | 590                         | 608    | 620 | mV               |
|  | $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$   | 586                         |        | 625 | mV               |
| Hysteresis <sup>(1)</sup>                              | $T_A = -40^\circ\text{C}$ to $85^\circ\text{C}$  |                             | -8     |     | mV               |
| <b>INPUT BIAS CURRENT<sup>(2)</sup></b>                |  |                             |        |     |                  |
| Input bias current, $CMP_{in}$ PIN                     |  |                             | 0.005  | 10  | nA               |
| Input bias current, $CMP_{in}$ PIN, vs temperature     | $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$   |                             |        | 15  | nA               |
| <b>INPUT VOLTAGE RANGE</b>                             |  |                             |        |     |                  |
| Input voltage range, $CMP_{in}$ PIN                    |  | 0 V to $V_S - 1.5\text{ V}$ |        |     | V                |
| <b>OUTPUT (OPEN-DRAIN)</b>                             |  |                             |        |     |                  |
| Large-signal differential voltage gain                 | $CMP\ V_{OUT} 1\text{ V to }4\text{ V}$ ,<br>$R_L \geq 15\text{ k}\Omega$ connected to 5 V |                             | 200    |     | V/mV             |
| $I_{LKG}$ High-level leakage current <sup>(3)(4)</sup> | $V_{ID} = 0.4\text{ V}$ , $V_{OH} = V_S$   |                             | 0.0001 | 1   | $\mu\text{A}$    |
| $V_{OL}$ Low-level output voltage <sup>(3)</sup>       | $V_{ID} = -0.6\text{ V}$ , $I_{OL} = 2.35\text{ mA}$                                       |                             | 220    | 300 | mV               |
| <b>RESPONSE TIME</b>                                   |  |                             |        |     |                  |
| Response time <sup>(5)</sup>                           | $R_L$ to 5 V, $C_L = 15\text{ pF}$ , 100-mV Input Step with 5-mV overdrive                 |                             | 1.3    |     | $\mu\text{s}$    |
| <b>RESET</b>   |  |                             |        |     |                  |
| $\overline{\text{RESET}}$ threshold <sup>(6)</sup>     |  |                             | 1.1    |     | V                |
| Logic input impedance                                  |  |                             | 2      |     | $\text{M}\Omega$ |
| Minimum $\overline{\text{RESET}}$ pulse width          |  |                             | 1.5    |     | $\mu\text{s}$    |
| $\overline{\text{RESET}}$ propagation delay            |  |                             | 3      |     | $\mu\text{s}$    |

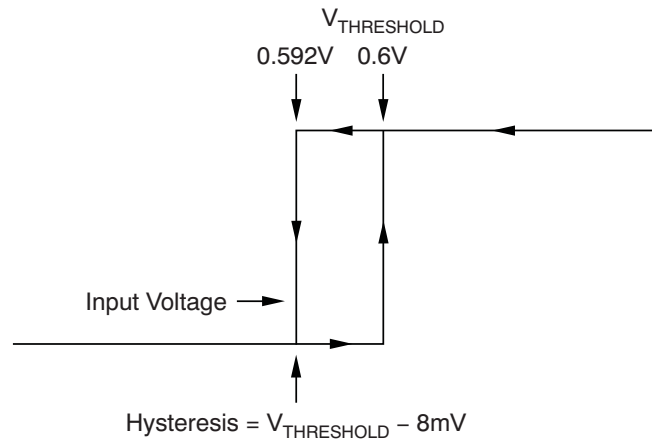
- (1) Hysteresis refers to the threshold (the threshold specification applies to a rising edge of a noninverting input) of a falling edge on the noninverting input of the comparator; refer to [Figure 1](#).
- (2) Specified by design.
- (3)  $V_{ID}$  refers to the differential voltage at the comparator inputs.
- (4) Open-drain output can be pulled to the range of 2.7 to 18 V, regardless of  $V_S$ .
- (5) The comparator response time specified is the interval between the input step function and the instant when the output crosses 1.4 V.
- (6) The  $\overline{\text{RESET}}$  input has an internal 2  $\text{M}\Omega$  (typical) pull-down. Leaving  $\overline{\text{RESET}}$  open results in a LOW state, with transparent comparator operation.

## 6.7 Electrical Characteristics: General

at  $T_A = 25^\circ\text{C}$ ,  $V_S = 12\text{ V}$ ,  $V_{CM} = 12\text{ V}$ ,  $V_{SENSE} = 100\text{ mV}$ ,  $R_L = 10\text{ k}\Omega$  to GND,  $R_{PULL-UP} = 5.1\text{ k}\Omega$  connected from  $CMP_{OUT}$  to  $V_S$ , and  $CMP_{IN} = 1\text{ V}$ , unless otherwise noted.

| PARAMETER  | TEST CONDITIONS  | MIN | TYP  | MAX  | UNIT                      |
|--|--|-----|------|------|---------------------------|
| <b>POWER SUPPLY</b>                                |  |     |      |      |                           |
| $V_S$ Operating power supply                       | $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$                             | 2.7 |      | 18   | V                         |
| $I_Q$ Quiescent current                            | $V_{OUT} = 2\text{ V}$   |     | 1350 | 1800 | $\mu\text{A}$             |
|  | $V_{SENSE} = 0\text{ mV}$ , $T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$ |     |      | 1850 | $\mu\text{A}$             |
| Comparator power-on reset threshold <sup>(1)</sup> |  |     | 1.5  |      | V                         |
| <b>TEMPERATURE</b>                                 |  |     |      |      |                           |
| Specified temperature                              |  | -40 |      | 125  | $^\circ\text{C}$          |
| Operating temperature                              |  | -55 |      | 150  | $^\circ\text{C}$          |
| Storage temperature                                |  | -65 |      | 150  | $^\circ\text{C}$          |
| $\theta_{JA}$ Thermal resistance                   | VSSOP-8 Surface-Mount  |     | 200  |      | $^\circ\text{C}/\text{W}$ |
|  | SOIC-8   |     | 150  |      | $^\circ\text{C}/\text{W}$ |

- (1) The INA200, INA201, and INA202 are designed to power-up with the comparator in a defined reset state as long as  $\overline{\text{RESET}}$  is open or grounded. The comparator is in reset as long as the power supply is below the voltage shown here. The comparator assumes a state based on the comparator input above this supply voltage. If  $\overline{\text{RESET}}$  is high at power-up, the comparator output comes up high and requires a reset to assume a low state, if appropriate.



**图 1. Typical Comparator Hysteresis**



### 6.8 Typical Characteristics

at  $T_A = 25^\circ\text{C}$ ,  $V_S = 12\text{ V}$ ,  $V_{IN+} = 12\text{ V}$ , and  $V_{SENSE} = 100\text{ mV}$ , (unless otherwise noted)

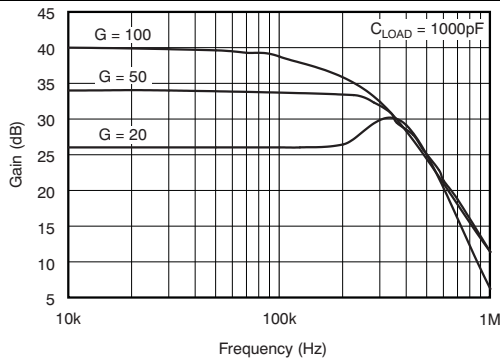


图 2. Gain vs Frequency

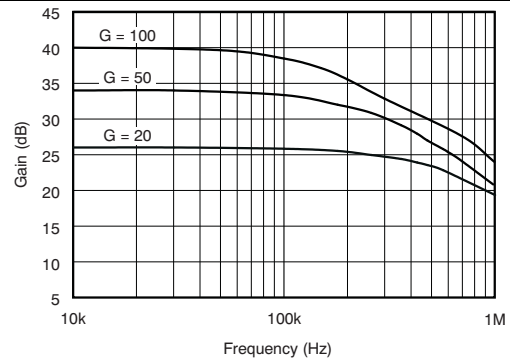


图 3. Gain vs Frequency

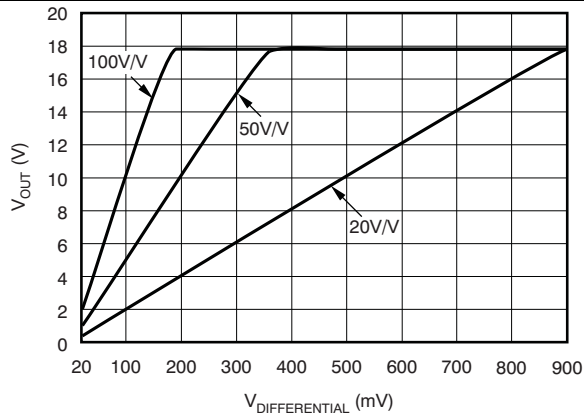


图 4. Gain Plot

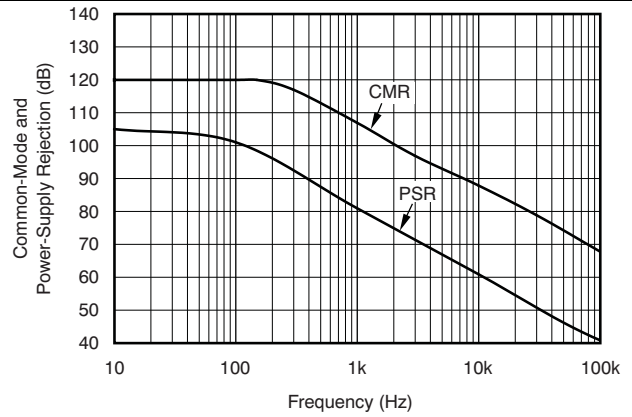


图 5. Common-Mode and Power-Supply Rejection vs Frequency

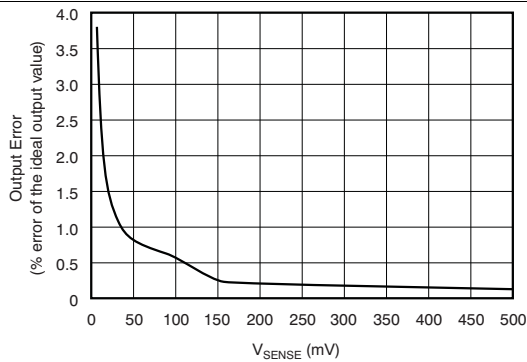


图 6. Output Error vs  $V_{SENSE}$

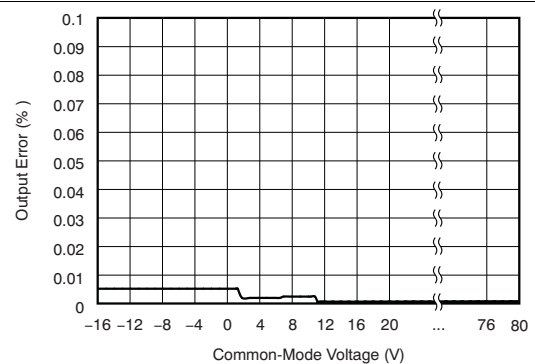
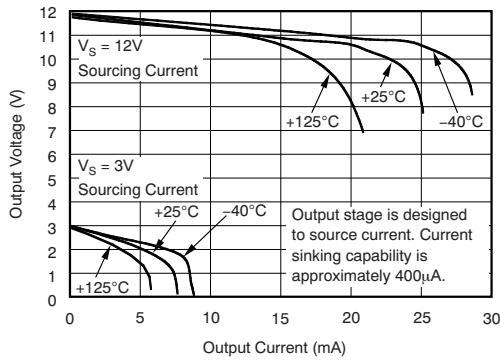


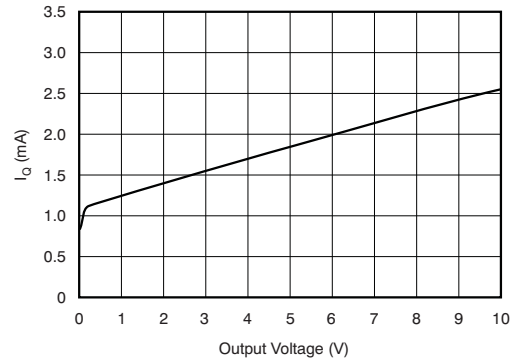
图 7. Output Error vs Common-Mode Voltage

**Typical Characteristics (continued)**

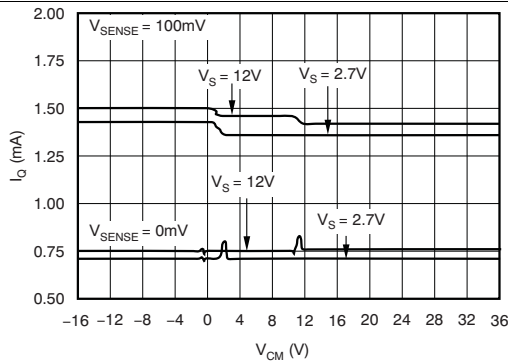
at  $T_A = 25^\circ\text{C}$ ,  $V_S = 12\text{ V}$ ,  $V_{IN+} = 12\text{ V}$ , and  $V_{SENSE} = 100\text{ mV}$ , (unless otherwise noted)



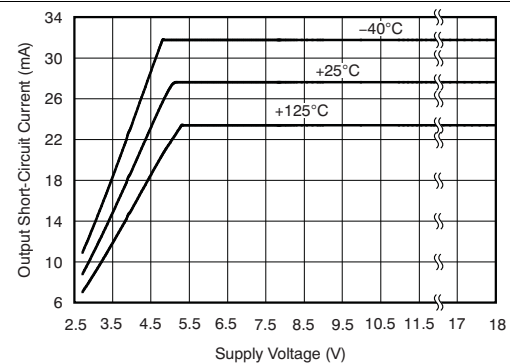
**Fig 8. Positive Output Voltage Swing vs Output Current**



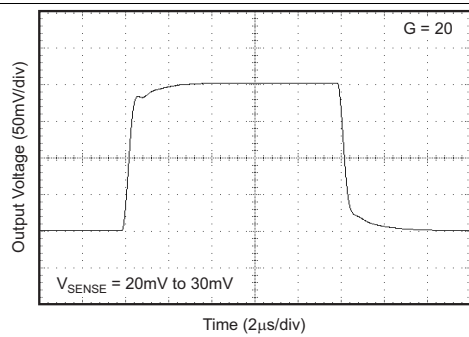
**Fig 9. Quiescent Current vs Output Voltage**



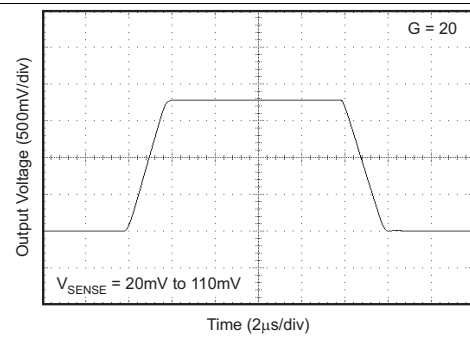
**Fig 10. Quiescent Current vs Common-Mode Voltage**



**Fig 11. Output Short-Circuit Current vs Supply Voltage**



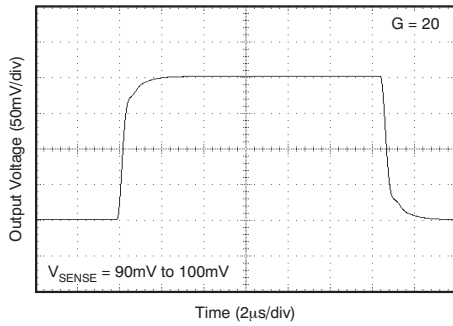
**Fig 12. Step Response**



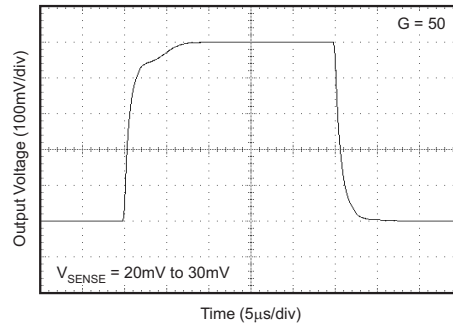
**Fig 13. Step Response**

**Typical Characteristics (continued)**

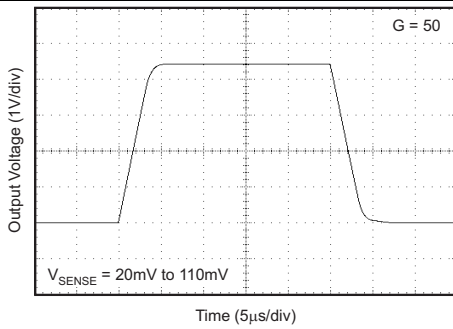
at  $T_A = 25^\circ\text{C}$ ,  $V_S = 12\text{ V}$ ,  $V_{IN+} = 12\text{ V}$ , and  $V_{SENSE} = 100\text{ mV}$ , (unless otherwise noted)



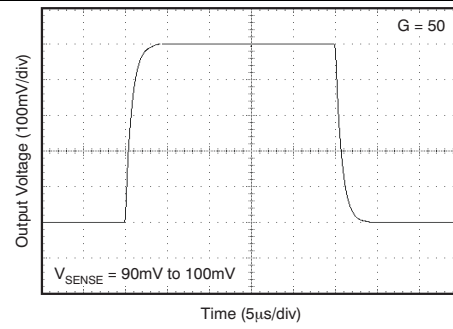
**14. Step Response**



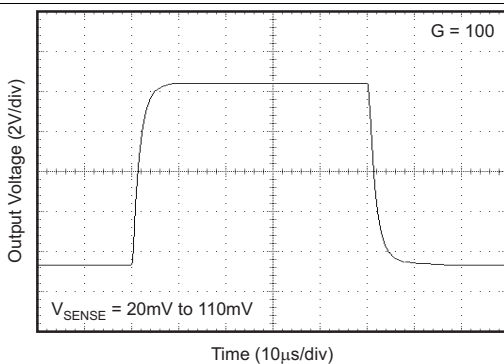
**15. Step Response**



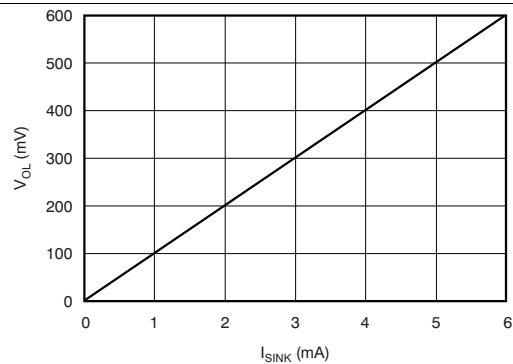
**16. Step Response**



**17. Step Response**



**18. Step Response**



**19. Comparator  $V_{OL}$  vs  $I_{SINK}$**

### Typical Characteristics (continued)

at  $T_A = 25^\circ\text{C}$ ,  $V_S = 12\text{ V}$ ,  $V_{IN+} = 12\text{ V}$ , and  $V_{SENSE} = 100\text{ mV}$ , (unless otherwise noted)

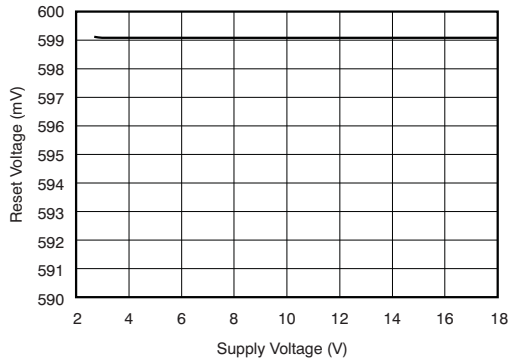


Figure 20. Comparator Trip Point vs Supply Voltage

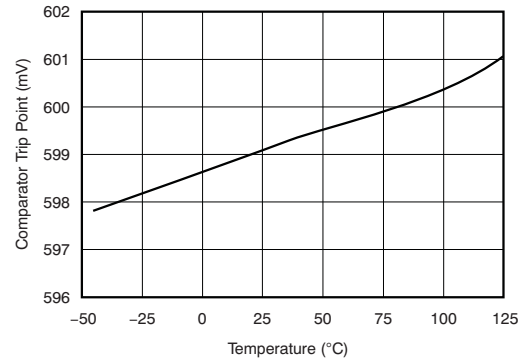


Figure 21. Comparator Trip Point vs Temperature

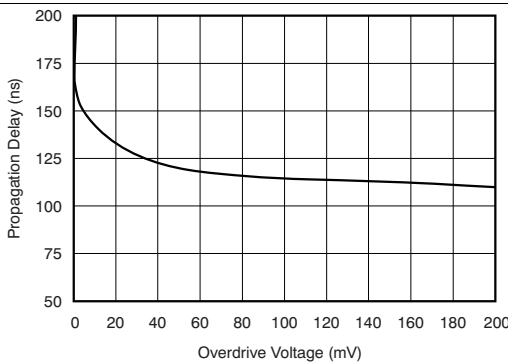


Figure 22. Comparator Propagation Delay vs Overdrive Voltage

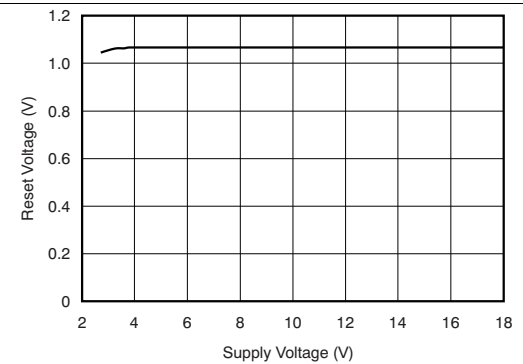


Figure 23. Comparator Reset Voltage vs Supply Voltage

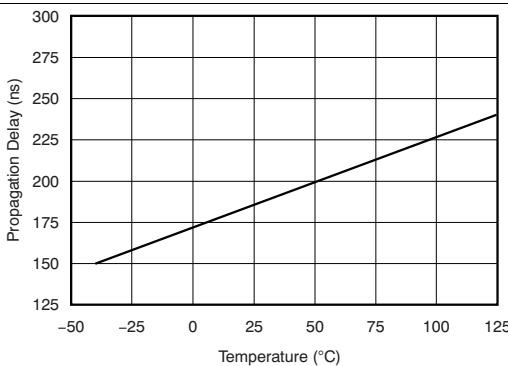


Figure 24. Comparator Propagation Delay vs Temperature

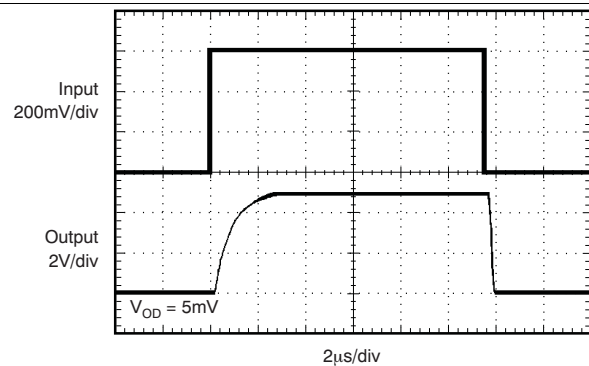


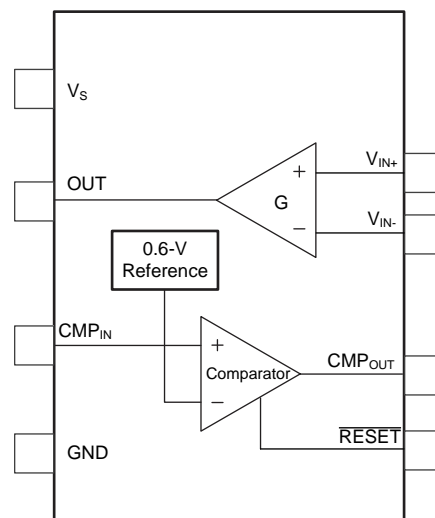
Figure 25. Comparator Propagation Delay

## 7 Detailed Description

### 7.1 Overview


The INA200, INA201, and INA202 devices are high-side current-shunt monitors with voltage output. The INA20x devices can sense drops across shunts at common-mode voltages from  $-16\text{ V}$  to  $80\text{ V}$ . The INA200–INA202 devices are available with three output voltage scales:  $20\text{ V/V}$ ,  $50\text{ V/V}$ , and  $100\text{ V/V}$ , with up to  $500\text{-kHz}$  bandwidth. The INA200, INA201, and INA202 devices incorporate an open-drain comparator and internal reference providing a  $0.6\text{-V}$  threshold. External dividers set the current trip point. The comparator includes a latching capability, that can be made transparent by grounding (or leaving open) the RESET pin. The INA200, INA201, and INA202 devices operate from a single  $2.7$  to  $18\text{-V}$  supply, drawing a maximum of  $1800\text{ }\mu\text{A}$  of supply current. Package options include the very small MSOP-8 and the SO-8. All versions are specified over the extended operating temperature range of  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

### 7.2 Functional Block Diagram

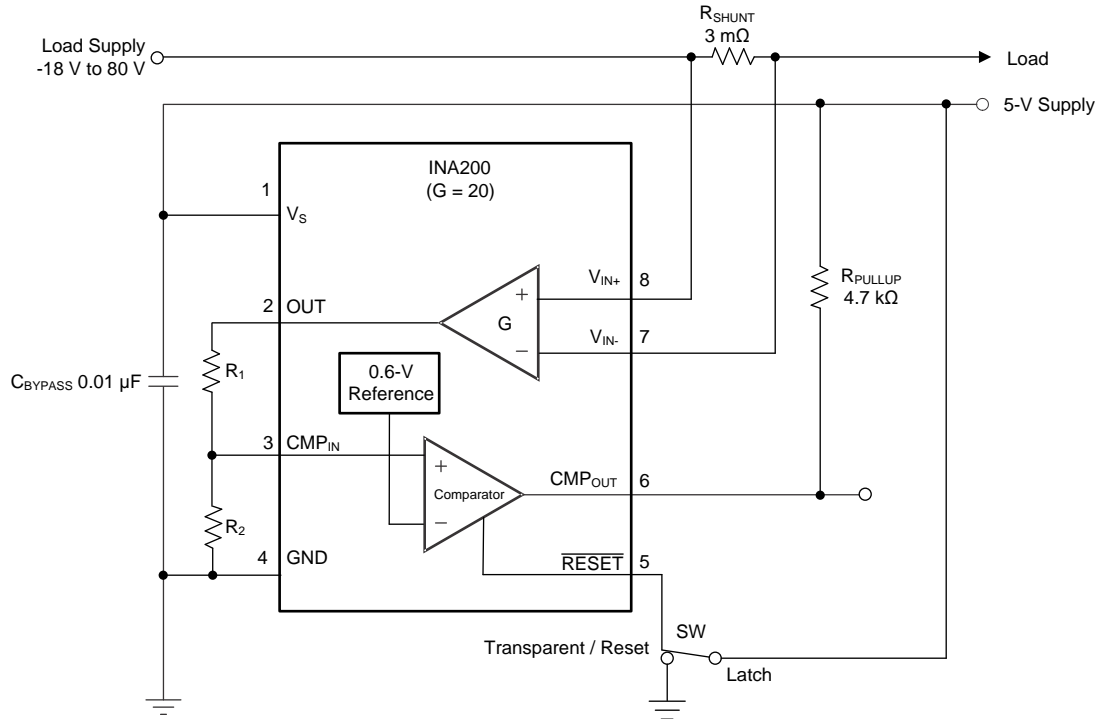


### 7.3 Feature Description

#### 7.3.1 Basic Connections

 **26** shows the basic connections of the INA20x devices. The input pins ( $V_{IN+}$  and  $V_{IN-}$ ) must be connected as closely as possible with Kelvin connections to the shunt resistor to minimize any resistance in series with the shunt resistance.

Power-supply bypass capacitors are required for stability. Applications with noisy or high-impedance power supplies may require additional decoupling capacitors to reject power-supply noise. Connect bypass capacitors close to the device pins.



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**☒ 26. INA200 Basic Connections**

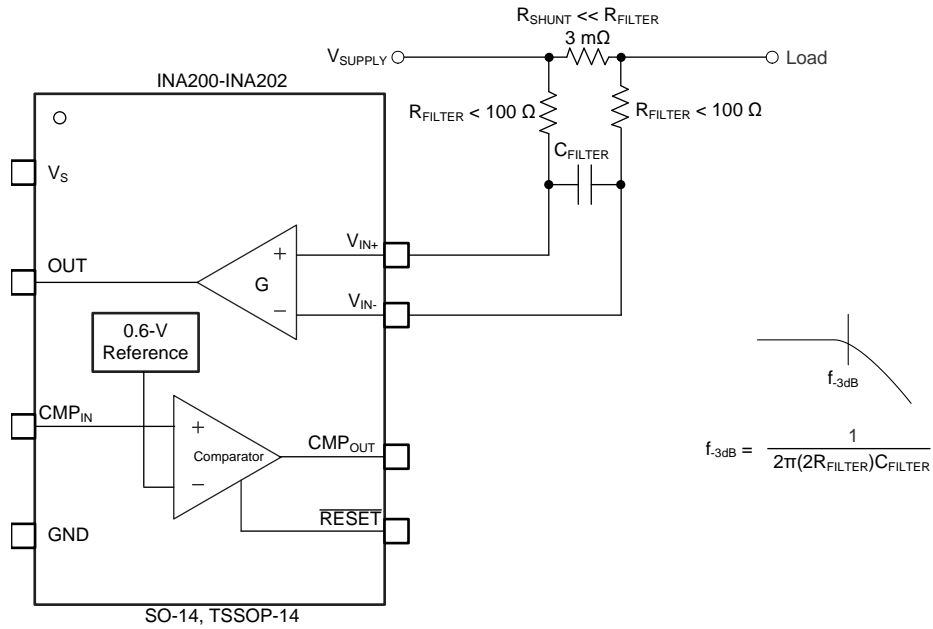
### 7.3.2 Selecting $R_S$

The selected value for the shunt resistor,  $R_S$ , depends on the application and is a compromise between small-signal accuracy and maximum permissible voltage loss in the measurement line. High values of  $R_S$  provide better accuracy at lower currents by minimizing the effects of offset, while low values of  $R_S$  minimize voltage loss in the supply line. For most applications, using an  $R_S$  value that provides a full-scale shunt voltage range of 50 mV to 100 mV results in the best performance. Maximum input voltage for accurate measurements is 500 mV, but output voltage is limited by supply.

### 7.3.3 Comparator

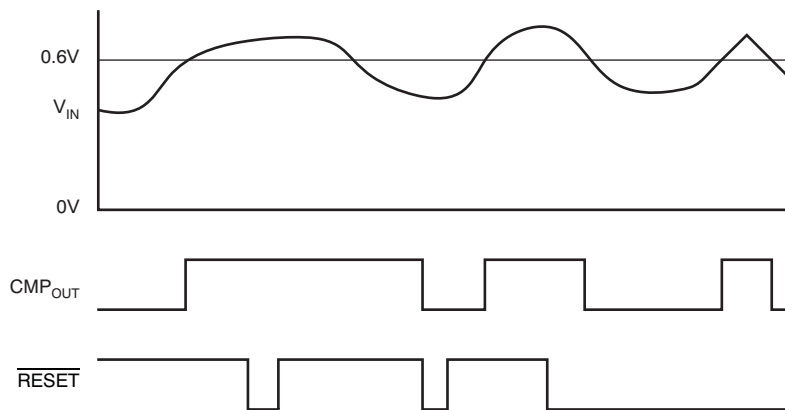
The INA200, INA201, and INA202 devices incorporate an open-drain comparator. This comparator typically has 2 mV of offset and a 1.3- $\mu$ s (typical) response time. The output of the comparator latches and is reset through the  $\overline{\text{RESET}}$  pin; see [☒ 28](#).

When  $V_S$  and  $\overline{\text{RESET}}$  are different, TI recommends adding a low-pass filter (LPF) on the  $\overline{\text{RESET}}$  pin to avoid comparator behavior inconsistent with the data sheet. For instance, with a 12-V supply and a 3.3-V  $\overline{\text{RESET}}$ , a rise time of 400 ns is appropriate. Similarly, with an 18-V supply and a 2.7-V  $\overline{\text{RESET}}$ , a 1- $\mu$ s rise time is appropriate; see [☒ 31](#).

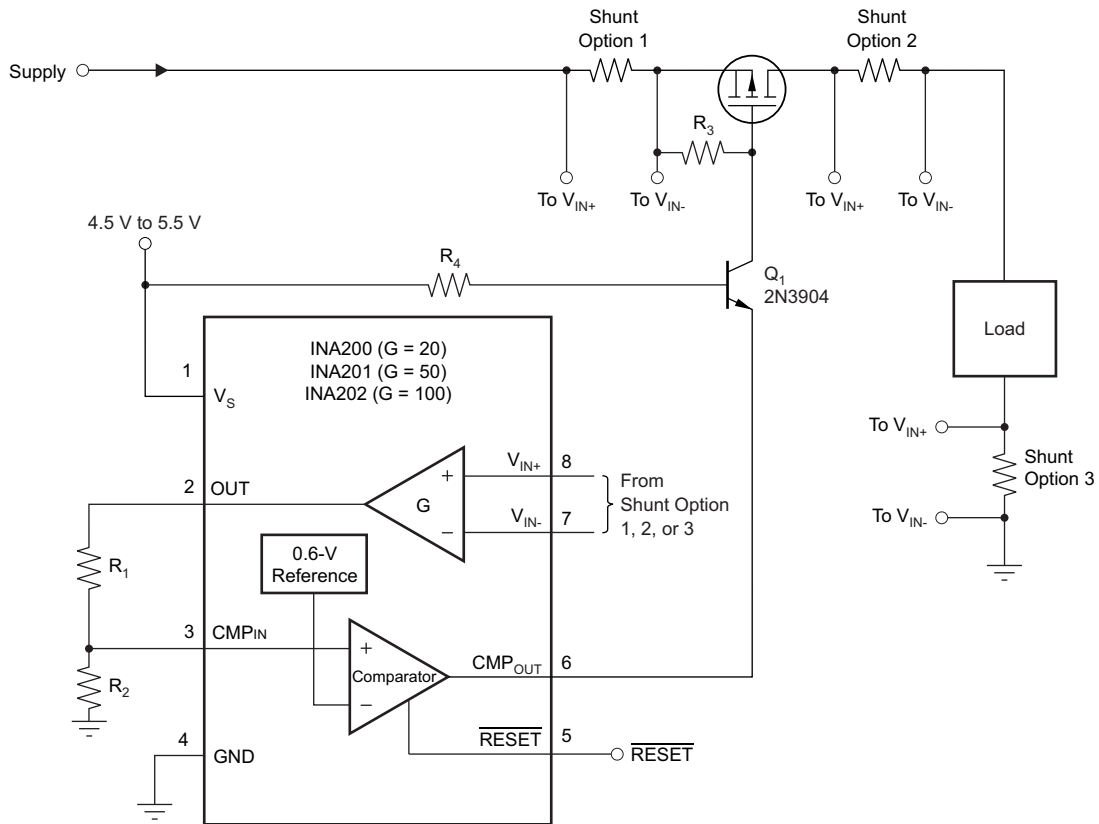


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**Figure 27. Input Filter (Gain Error: 1.5% to 2.8%)**



**Figure 28. Comparator Latching Capability**

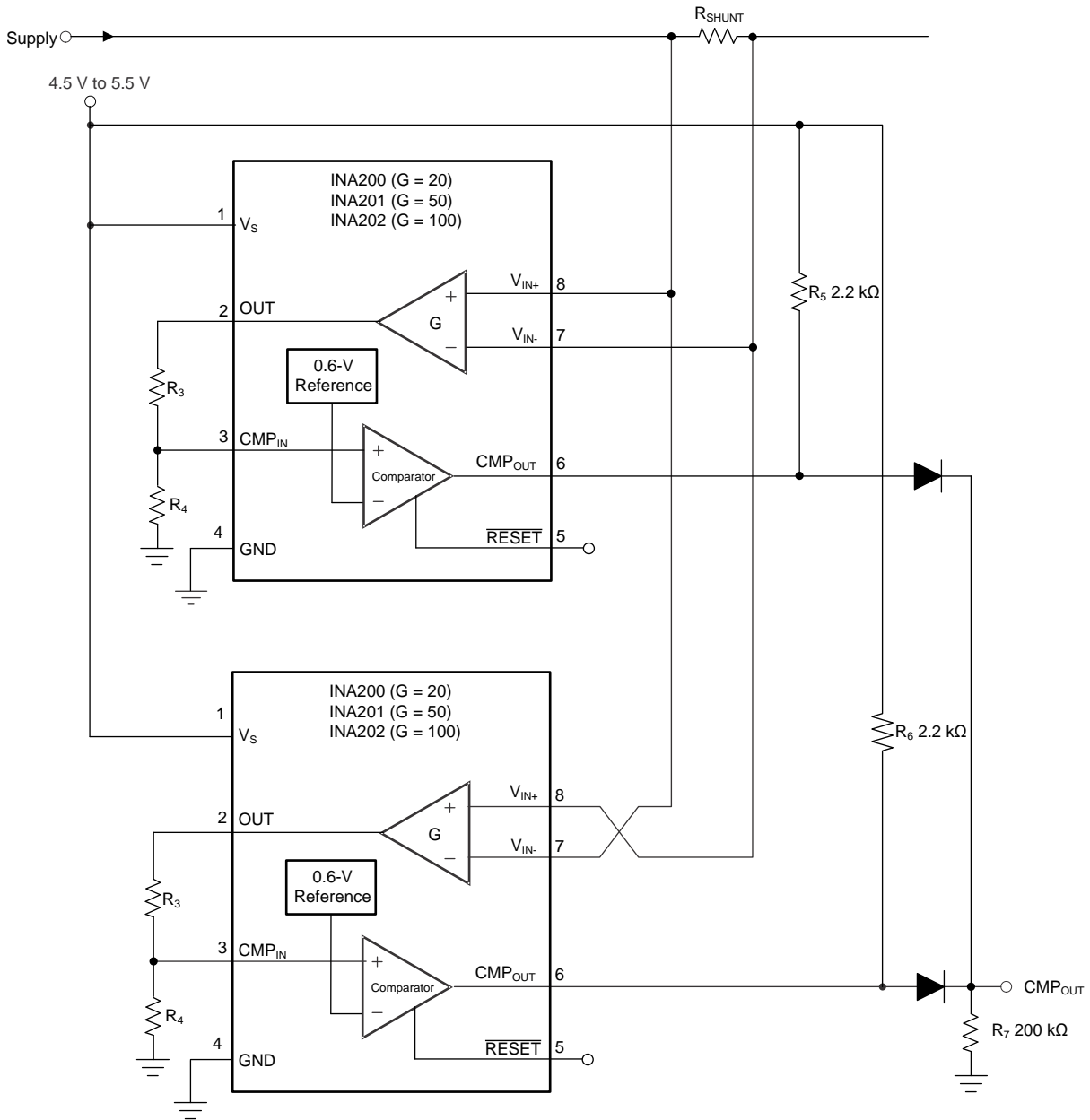


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- (1) Q1 cascodes the comparator output to drive a high-side FET (the 2N3904 shown is good up to 60 V). The shunt can be located in any one of the three locations shown. The latching capability must be used in shutdown applications to prevent oscillation at the trip point.

**图 29. High-Side Switch Overcurrent Shutdown**

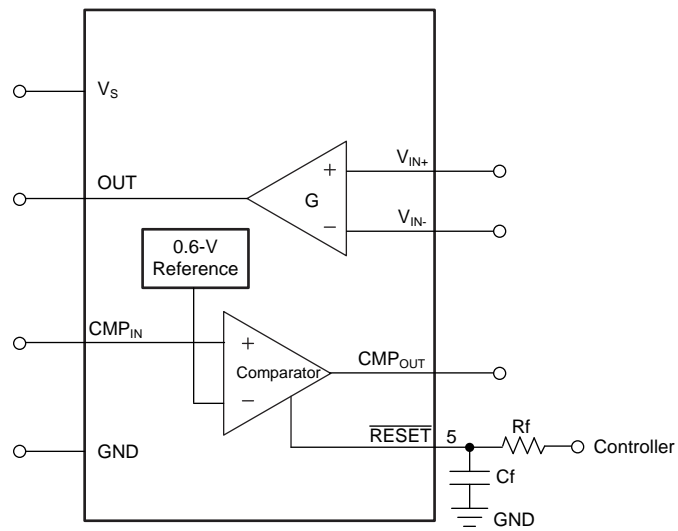




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(1) It is possible to set different limits for each direction.

**30. Bidirectional Overcurrent Comparator**



**31. Filter on  $\overline{\text{RESET}}$  Pin**

## 7.4 Device Functional Modes

### 7.4.1 Input Filtering

An obvious and straightforward location for filtering is at the output of the INA20x series; however, this location negates the advantage of the low output impedance of the internal buffer. The only other option for filtering is at the input pins of the INA20x devices, which is complicated by the internal  $5\text{ k}\Omega + 30\%$  input impedance. This is shown in [Figure 27](#). Using the lowest possible resistor values minimizes the initial shift in gain and effects of tolerance. The effect on initial gain is shown in [Equation 1](#):

$$\text{Gain Error \%} = 100 - \left[ 100 \times \frac{5\text{k}\Omega}{5\text{k}\Omega + R_{\text{FILT}}} \right] \quad (1)$$

Total effect on gain error can be calculated by replacing the  $5\text{-k}\Omega$  term with  $5\text{ k}\Omega - 30\%$ , (or  $3.5\text{ k}\Omega$ ) or  $5\text{ k}\Omega + 30\%$  (or  $6.5\text{ k}\Omega$ ). The tolerance extremes of  $R_{\text{FILT}}$  can be inserted into the equation. If a pair of  $100\text{-}\Omega$   $1\%$  resistors are used on the inputs, the initial gain error equals  $1.96\%$ . Worst-case tolerance conditions always occur at the lower excursion of the internal  $5\text{-k}\Omega$  resistor ( $3.5\text{ k}\Omega$ ), and the higher excursion of  $R_{\text{FILT}} - 3\%$  in this case.

The specified accuracy of the INA20x devices must then be combined in addition to these tolerances. While this discussion treated accuracy worst-case conditions by combining the extremes of the resistor values, it is appropriate to use geometric mean or root sum square calculations to total the effects of accuracy variations.

### 7.4.2 Accuracy Variations as a Result of $V_{\text{SENSE}}$ and Common-Mode Voltage

The accuracy of the INA200, INA201, and INA202 current shunt monitors is a function of two main variables:  $V_{\text{SENSE}}$  ( $V_{\text{IN+}} - V_{\text{IN-}}$ ), common-mode voltage, ( $V_{\text{CM}}$ ), relative to the supply voltage ( $V_{\text{S}}$ ).  $V_{\text{CM}}$  is expressed as  $(V_{\text{IN+}} + V_{\text{IN-}}) / 2$ ; however, in practice,  $V_{\text{CM}}$  is seen as the voltage at  $V_{\text{IN+}}$  because the voltage drop across  $V_{\text{SENSE}}$  is typically small.

This section addresses the accuracy of these specific operating regions:

- Normal Case 1:  $V_{\text{SENSE}} \geq 20\text{ mV}$ ,  $V_{\text{CM}} \geq V_{\text{S}}$
- Normal Case 2:  $V_{\text{SENSE}} \geq 20\text{ mV}$ ,  $V_{\text{CM}} < V_{\text{S}}$
- Low  $V_{\text{SENSE}}$  Case 1:  $V_{\text{SENSE}} < 20\text{ mV}$ ,  $-16\text{ V} \leq V_{\text{CM}} < 0$
- Low  $V_{\text{SENSE}}$  Case 2:  $V_{\text{SENSE}} < 20\text{ mV}$ ,  $0\text{ V} \leq V_{\text{CM}} \leq V_{\text{S}}$
- Low  $V_{\text{SENSE}}$  Case 3:  $V_{\text{SENSE}} < 20\text{ mV}$ ,  $V_{\text{S}} < V_{\text{CM}} \leq 80\text{ V}$

#### 7.4.2.1 Normal Case 1: $V_{\text{SENSE}} \geq 20\text{ mV}$ , $V_{\text{CM}} \geq V_{\text{S}}$

This region of operation provides the highest accuracy. Here, the input offset voltage is characterized and measured using a two-step method. First, the gain is determined by [Equation 2](#).

$$G = \frac{V_{\text{OUT1}} - V_{\text{OUT2}}}{100\text{mV} - 20\text{mV}}$$

where

- $V_{\text{OUT1}}$  = output voltage with  $V_{\text{SENSE}} = 100\text{ mV}$
  - $V_{\text{OUT2}}$  = output voltage with  $V_{\text{SENSE}} = 20\text{ mV}$
- (2)

Then the offset voltage is measured at  $V_{\text{SENSE}} = 100\text{ mV}$ , and referred to the input (RTI) of the current shunt monitor, as shown in [Electrical Characteristics: Current-Shunt Monitor](#).

$$V_{\text{OSRTI}} (\text{Referred-To-Input}) = \left[ \frac{V_{\text{OUT1}}}{G} \right] - 100\text{mV} \quad (3)$$

In the [Typical Characteristics](#), [Figure 7](#) shows the highest accuracy for the this region of operation. In this plot,  $V_{\text{S}} = 12\text{ V}$ . For  $V_{\text{CM}} \geq 12\text{ V}$ , the output error is at the minimum value. This case creates the  $V_{\text{SENSE}} \geq 20\text{-mV}$  output specifications in [Electrical Characteristics: Current-Shunt Monitor](#).

## Device Functional Modes (continued)

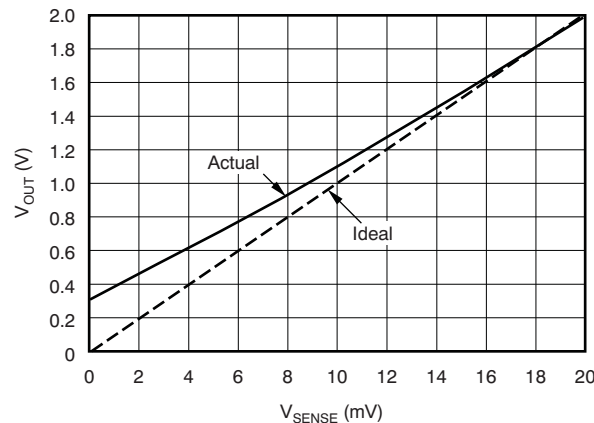
### 7.4.2.2 Normal Case 2: $V_{SENSE} \geq 20\text{ mV}$ , $V_{CM} < V_S$

This region of operation is less accurate than normal case 1 as a result of the common-mode operating area in which the part functions, as shown in the [Figure 7](#) curve ([Figure 7](#)). As noted, for this graph  $V_S = 12\text{ V}$ ; for  $V_{CM} < 12\text{ V}$ , the output error increases as  $V_{CM}$  decreases to less than  $12\text{ V}$ , with a typical maximum error of  $0.005\%$  at the most negative  $V_{CM} = -16\text{ V}$ .

### 7.4.2.3 Low $V_{SENSE}$ Case 1: $V_{SENSE} < 20\text{ mV}$ , $-16\text{ V} \leq V_{CM} < 0$ and Low $V_{SENSE}$ Case 3: $V_{SENSE} < 20\text{ mV}$ , $V_S < V_{CM} \leq 80\text{ V}$

Although the INA200 family of devices are not designed for accurate operation in these regions, some applications are exposed to these conditions. For example, when monitoring power supplies that are switched on and off while  $V_S$  is still applied to the INA20x devices, it is important to know what the behavior of the devices is in these regions.

As  $V_{SENSE}$  approaches  $0\text{ mV}$ , in these  $V_{CM}$  regions, the accuracy of the device output degrades. A larger-than-normal offset can appear at the current shunt monitor output with a typical maximum value of  $V_{OUT} = 300\text{ mV}$  for  $V_{SENSE} = 0\text{ mV}$ . As  $V_{SENSE}$  approaches  $20\text{ mV}$ ,  $V_{OUT}$  returns to the expected output value with accuracy as shown in [Electrical Characteristics: Current-Shunt Monitor](#). [Figure 32](#) shows this effect using the INA202 (gain = 100).

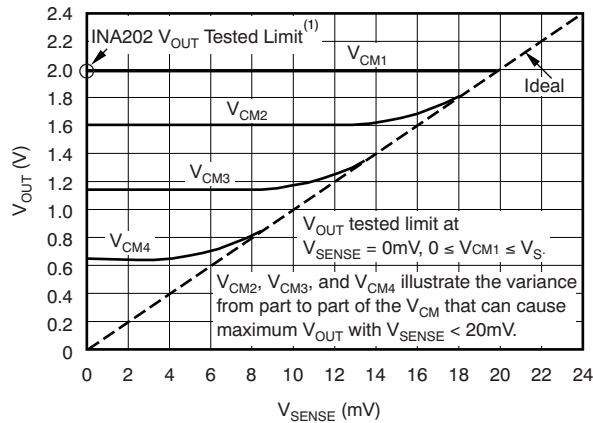


**Figure 32. Example For Low  $V_{SENSE}$  Cases 1 and 3 (INA202, Gain = 100)**

### 7.4.2.4 Low $V_{SENSE}$ Case 2: $V_{SENSE} < 20\text{ mV}$ , $0\text{ V} \leq V_{CM} \leq V_S$

This region of operation is the least accurate for the INA20x family. To achieve the wide input common-mode voltage range, these devices use two op amp front ends in parallel. One op amp front end operates in the positive input common-mode voltage range, and the other in the negative input region. For this case, neither of these two internal amplifiers dominates and overall loop gain is low. Within this region,  $V_{OUT}$  approaches voltages close to linear operation levels for normal case 2. This deviation from linear operation becomes greatest the closer  $V_{SENSE}$  approaches  $0\text{ V}$ . Within this region, as  $V_{SENSE}$  approaches  $20\text{ mV}$ , device operation is closer to that is described in normal case 2. [Figure 33](#) shows this behavior for the INA202. The  $V_{OUT}$  maximum peak for this case is tested by maintaining a constant  $V_S$ , setting  $V_{SENSE}$  equal to  $0\text{ mV}$  and sweeping  $V_{CM}$  from  $0\text{ V}$  to  $V_S$ . The exact  $V_{CM}$  at which  $V_{OUT}$  peaks during this test varies from device to device, but the  $V_{OUT}$  maximum peak is tested to be less than the specified  $V_{OUT}$  tested limit.

**Device Functional Modes (continued)**



NOTE: (1) INA200  $V_{OUT}$  Tested Limit = 0.4V. INA201  $V_{OUT}$  Tested Limit = 1V.

**33. Example For Low  $V_{SENSE}$  Case 2 (INA202, Gain = 100)**

**7.4.3 Transient Protection**

The –16 to 80 V common-mode range of the INA20x devices is ideal for withstanding automotive fault conditions ranging from 12-V battery reversal up to 80-V transients, since no additional protective components are required up to those levels. In the event that the INA20x devices are exposed to transients on the inputs in excess of their ratings, then external transient absorption with semiconductor transient absorbers (such as Zeners) are required. TI does not recommend using MOVs or VDRs, except when they are used in addition to a semiconductor transient absorber. Select the transient absorber so the absorber does not allow the INA20x devices to be exposed to transients greater than 80 V (that is, allow for transient absorber tolerance and additional voltage due to transient absorber dynamic impedance). Despite the use of internal Zener-type ESD protection, the INA20x devices do not lend themselves to using external resistors in series with the inputs since the internal gain resistors can vary up to  $\pm 30\%$ . (If gain accuracy is not important, then resistors can be added in series with the INA200, INA201, and INA202 inputs with two equal resistors on each input.)

**7.4.4 Output Voltage Range**

The output of the INA20x devices is accurate within the output voltage swing range set by the power supply pin ( $V_S$ .) This performance is best illustrated when using the INA202 (a gain of 100 version), where a 100-mV full-scale input from the shunt resistor requires an output voltage swing of 10 V, and a power-supply voltage sufficient to achieve 10 V on the output.

## 8 Application and Implementation

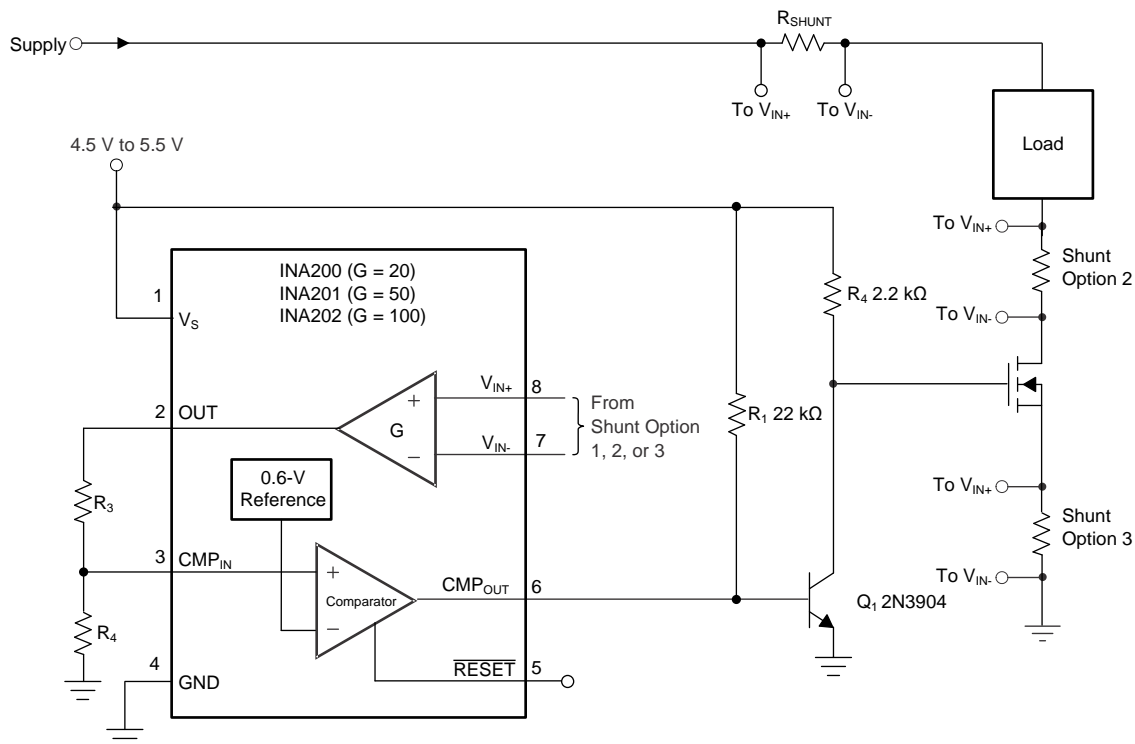
### 注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 8.1 Application Information

The INA20x series is designed to enable simple configuration for detecting overcurrent conditions and current monitoring in an application. This device is individually targeted towards overcurrent detection of a single threshold. However, this device can pair with additional devices and circuitry to create more complex monitoring functional blocks.

### 8.2 Typical Application



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(1) In this case, Q1 inverts the comparator output.

**图 34. Low-Side Switch Overcurrent Shutdown**

#### 8.2.1 Design Requirements

The device measures current through a resistive shunt with current flowing in one direction that enables detection of an overcurrent event only when the differential input voltage exceeds the threshold limit. When the current reaches the set limit of the divider  $R_1 / R_2$ , the output of  $CMP_{OUT}$  transitions high, which turns Q1 on, pulls the gate of the pass-FET low, and turns off the flow off current.

## Typical Application (continued)

### 8.2.2 Detailed Design Procedure

Figure 34 shows the basic connections of the device. The input terminals (IN+ and IN –) must be connected as closely as possible to the current-sensing resistor to minimize any resistance in series with the shunt resistance. Additional resistance between the current-sensing resistor and input terminals results in errors in the measurement. When input current flows through this external input resistance, the voltage developed across the shunt resistor differs from the voltage reaching the input terminals.

Use the gain of the INA20x and shunt value to calculate the OUT voltage for the desired trip current. Configure R1 and R2 so that the current trip point is equal to the 0.6-V reference voltage.

### 8.2.3 Application Curve

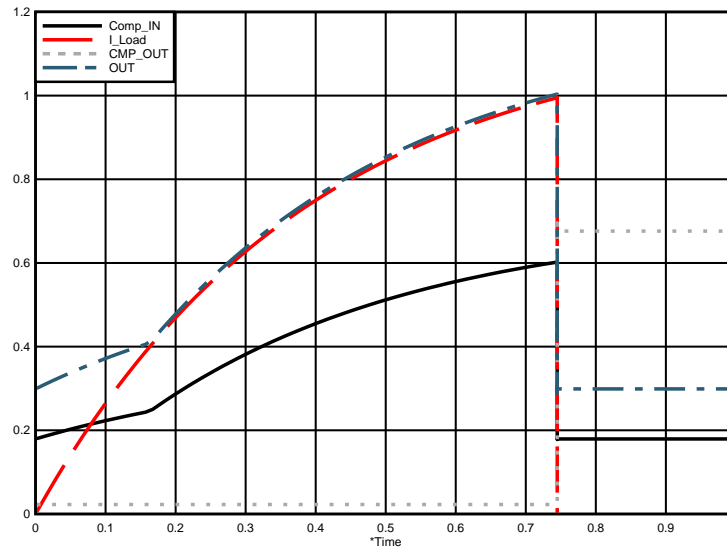


Figure 35. Low-Side Switch Overcurrent Shutdown Response

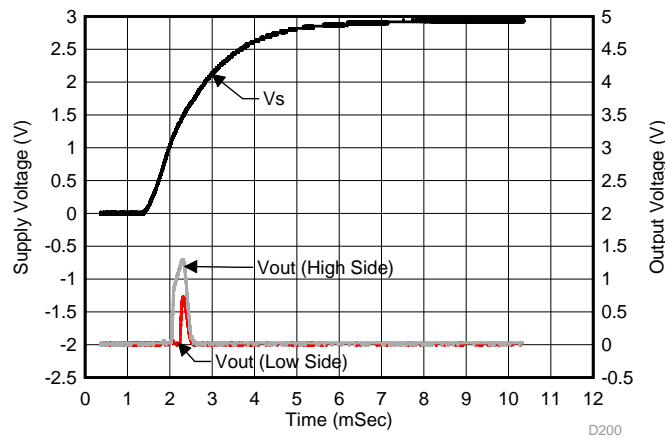
## 9 Power Supply Recommendations

The input circuitry of the INA20x devices can accurately measure beyond the power-supply voltage,  $V_s$ . For example, the  $V_s$  power supply is 5 V, whereas the load power-supply voltage is up to 80 V. However, the output voltage range of the OUT pin is limited by the voltages on the power supply pin.

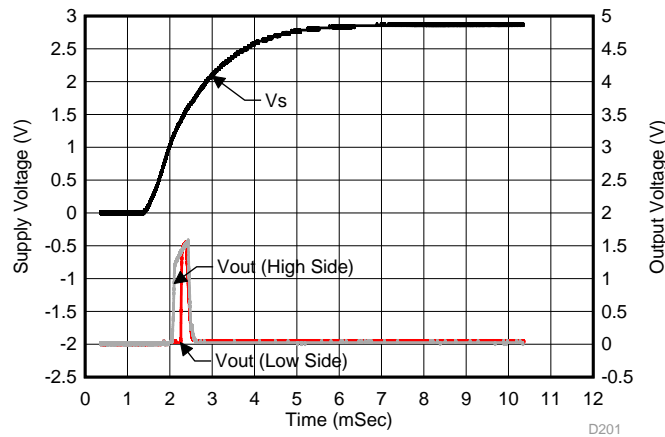
### 9.1 Output vs Supply Ramp Considerations

Figure 36, Figure 37, and Figure 38 show the typical output voltages for high and low-side configurations with the given ramp supply voltage. These fluctuations on the output during power-up may require a controller to incorporate a blanking time to disregard the artifacts.

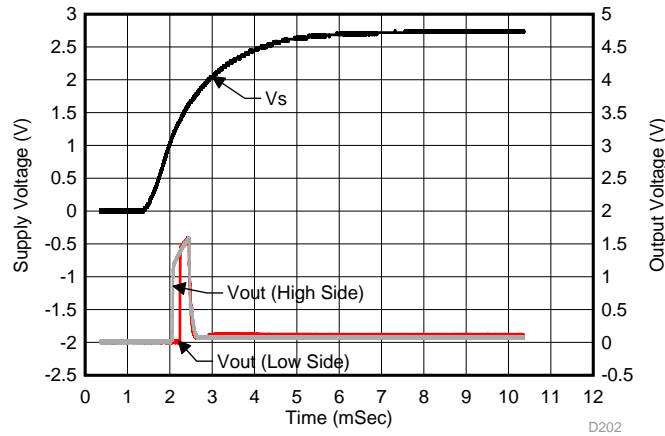
**Output vs Supply Ramp Considerations (continued)**



**36. Analog Output vs Supply Ramp (INA200)**



**37. Analog Output vs Supply Ramp (INA201)**



**38. Analog Output vs Supply Ramp (INA202)**

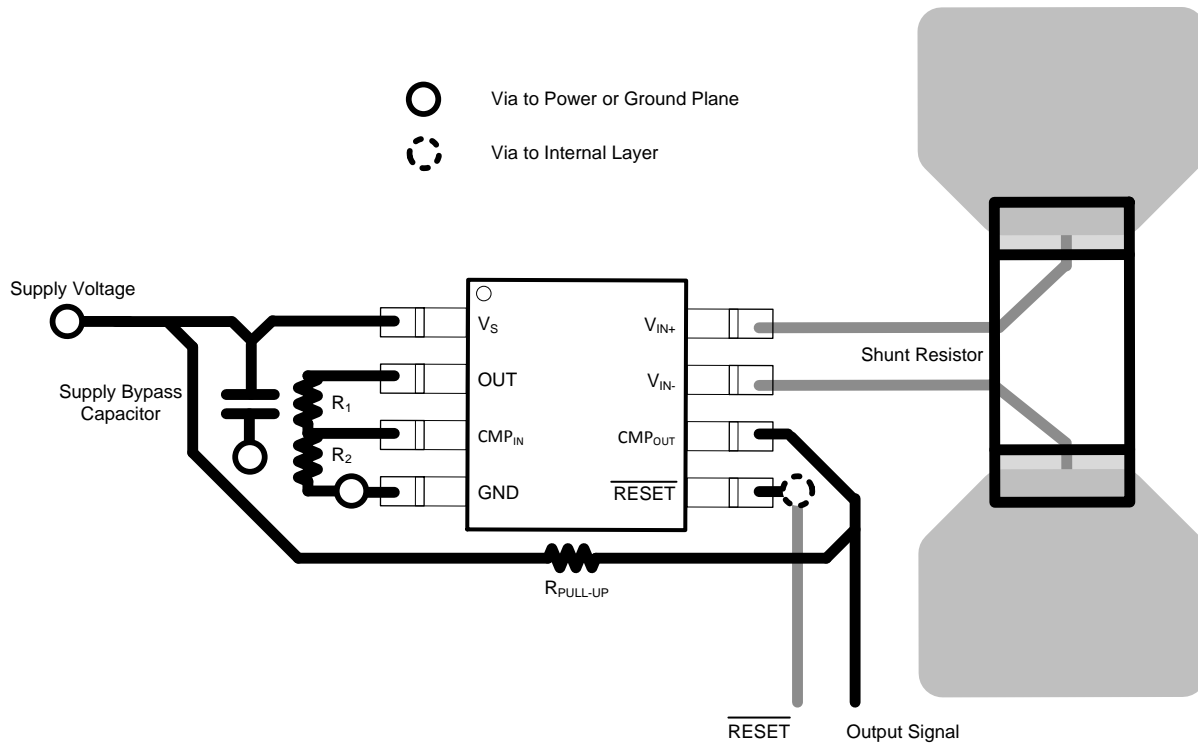


## 10 Layout

### 10.1 Layout Guidelines

- Connect the input pins to the sensing resistor using a Kelvin or 4-wire connection. This connection technique ensures that only the current-sensing resistor impedance is detected between the input pins. Poor routing of the current-sensing resistor commonly results in additional resistance present between the input pins. Given the very-low-ohmic value of the current resistor, any additional high-current carrying impedance causes significant measurement errors.
- The power-supply bypass capacitor must be placed as close as possible to the supply and ground pins. The recommended value of this bypass capacitor is 0.1  $\mu\text{F}$ . Additional decoupling capacitance can be added to compensate for noisy or high-impedance power supplies.

### 10.2 Layout Example



☒ 39. INA20x Layout Example

## 11 デバイスおよびドキュメントのサポート

### 11.1 関連リンク

次の表に、クイック・アクセス・リンクを示します。カテゴリには、技術資料、サポートおよびコミュニティ・リソース、ツールとソフトウェア、およびサンプル注文またはご購入へのクイック・アクセスが含まれます。

表 1. 関連リンク

| 製品     | プロダクト・フォルダ              | ご注文はこちら                 | 技術資料                    | ツールとソフトウェア              | サポートとコミュニティ             |
|--------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| INA200 | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> |
| INA201 | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> |
| INA202 | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> |

### 11.2 コミュニティ・リソース

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

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**設計サポート** *TIの設計サポート* 役に立つE2Eフォーラムや、設計サポート・ツールをすばやく見つけることができます。技術サポート用の連絡先情報も参照できます。

### 11.3 商標

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### 11.5 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 12 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。

## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|---------|
| INA200AID        | LIFEBUY       | SOIC         | D               | 8    | 75          | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 125   | INA<br>200A             |         |
| INA200AIDGKR     | ACTIVE        | VSSOP        | DGK             | 8    | 2500        | RoHS & Green    | NIPDAUAG                             | Level-2-260C-1 YEAR  | -40 to 125   | BQH                     | Samples |
| INA200AIDGKT     | LIFEBUY       | VSSOP        | DGK             | 8    | 250         | RoHS & Green    | NIPDAUAG                             | Level-2-260C-1 YEAR  | -40 to 125   | BQH                     |         |
| INA200AIDR       | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 125   | INA<br>200A             | Samples |
| INA201AID        | LIFEBUY       | SOIC         | D               | 8    | 75          | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 125   | INA<br>201A             |         |
| INA201AIDGKR     | ACTIVE        | VSSOP        | DGK             | 8    | 2500        | RoHS & Green    | Call TI   NIPDAUAG<br>  NIPDAU       | Level-2-260C-1 YEAR  | -40 to 125   | BQJ                     | Samples |
| INA201AIDGKT     | LIFEBUY       | VSSOP        | DGK             | 8    | 250         | RoHS & Green    | Call TI   NIPDAUAG<br>  NIPDAU       | Level-2-260C-1 YEAR  | -40 to 125   | BQJ                     |         |
| INA201AIDR       | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 125   | INA<br>201A             | Samples |
| INA202AID        | LIFEBUY       | SOIC         | D               | 8    | 75          | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 125   | INA<br>202A             |         |
| INA202AIDGKR     | ACTIVE        | VSSOP        | DGK             | 8    | 2500        | RoHS & Green    | Call TI                              | Level-2-260C-1 YEAR  | -40 to 125   | BQL                     | Samples |
| INA202AIDGKT     | LIFEBUY       | VSSOP        | DGK             | 8    | 250         | RoHS & Green    | Call TI   NIPDAUAG                   | Level-2-260C-1 YEAR  | -40 to 125   | BQL                     |         |
| INA202AIDR       | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 125   | INA<br>202A             | Samples |

(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.

**OBSELETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices 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.

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**OTHER QUALIFIED VERSIONS OF INA200, INA201, INA202 :**

- Automotive : [INA200-Q1](#), [INA201-Q1](#), [INA202-Q1](#)

**NOTE: Qualified Version Definitions:**

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

**TAPE AND REEL INFORMATION**

**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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| INA200AIDGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| INA200AIDGKT | VSSOP        | DGK             | 8    | 250  | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| INA200AIDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| INA201AIDGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| INA201AIDGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| INA201AIDGKT | VSSOP        | DGK             | 8    | 250  | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| INA201AIDGKT | VSSOP        | DGK             | 8    | 250  | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| INA201AIDGKT | VSSOP        | DGK             | 8    | 250  | 180.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| INA201AIDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| INA202AIDGKT | VSSOP        | DGK             | 8    | 250  | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| INA202AIDR   | 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) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| INA200AIDGKR | VSSOP        | DGK             | 8    | 2500 | 366.0       | 364.0      | 50.0        |
| INA200AIDGKT | VSSOP        | DGK             | 8    | 250  | 366.0       | 364.0      | 50.0        |
| INA200AIDR   | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| INA201AIDGKR | VSSOP        | DGK             | 8    | 2500 | 353.0       | 353.0      | 32.0        |
| INA201AIDGKR | VSSOP        | DGK             | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| INA201AIDGKT | VSSOP        | DGK             | 8    | 250  | 353.0       | 353.0      | 32.0        |
| INA201AIDGKT | VSSOP        | DGK             | 8    | 250  | 366.0       | 364.0      | 50.0        |
| INA201AIDGKT | VSSOP        | DGK             | 8    | 250  | 210.0       | 185.0      | 35.0        |
| INA201AIDR   | SOIC         | D               | 8    | 2500 | 356.0       | 356.0      | 35.0        |
| INA202AIDGKT | VSSOP        | DGK             | 8    | 250  | 366.0       | 364.0      | 50.0        |
| INA202AIDR   | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |

**TUBE**


\*All dimensions are nominal

| Device    | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|-----------|--------------|--------------|------|-----|--------|--------|--------|--------|
| INA200AID | D            | SOIC         | 8    | 75  | 506.6  | 8      | 3940   | 4.32   |
| INA201AID | D            | SOIC         | 8    | 75  | 506.6  | 8      | 3940   | 4.32   |
| INA202AID | D            | SOIC         | 8    | 75  | 506.6  | 8      | 3940   | 4.32   |



D0008A

# PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

### NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed  $.006$  [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.



# EXAMPLE BOARD LAYOUT

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE  
BASED ON .005 INCH [0.125 MM] THICK STENCIL  
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

# DGK0008A



# PACKAGE OUTLINE

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



**NOTES:**

PowerPAD is a trademark of Texas Instruments.

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187.

# EXAMPLE BOARD LAYOUT

DGK0008A

™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 15X



4214862/A 04/2023

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
8. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.
9. Size of metal pad may vary due to creepage requirement.

# EXAMPLE STENCIL DESIGN

DGK0008A

<sup>TM</sup> VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
SCALE: 15X

4214862/A 04/2023

NOTES: (continued)

11. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
12. Board assembly site may have different recommendations for stencil design.

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