



# High-stability Isolated Error Amplifier

Preliminary  
Technical Data

## ADuM3190

### FEATURES

Stable Over Time and Temperature

- 0.5% initial accuracy

- 1% accuracy over the full temp range

For Type II or Type III compensation networks

Reference voltage 1.225V

Compatible with DOSA

Low power operation: <7 mA total

Wide Supply Voltage Range

- $V_{DD1}$  - 3V to 20V

- $V_{DD2}$  - 3V to 20V

Bandwidth - 400kHz

Isolation Voltage

- 2.5kVrms

Wide temperature range:

- 40°C to 125°C ambient operation

- 150°C maximum junction temperature

### APPLICATIONS

Linear Power Supplies

Inverters

UPS

DOSA Compatible Modules

Voltage Monitor

### GENERAL DESCRIPTION

The ADuM3190 is an isolated error amplifier based on Analog Devices, Inc. iCoupler® technology. The ADuM3190 is ideal for linear feedback power supplies with primary side controllers enabling improvements in transient response, power density and stability as compared to commonly used optocoupler and shunt regulator solutions.

Unlike optocoupler-based solutions, which have an uncertain current-transfer-ratio over lifetime and at high temperatures, the ADuM3190 transfer function does not change over lifetime and is stable over a wide temperature range of -40°C to 125°C.

Included is a wide band operational amplifier which can be used to set up a variety of commonly used power supply loop compensation techniques. The ADuM3190 is fast enough to allow a feedback loop to react to fast transient conditions and over current conditions. Also, included is a high accuracy 1.225V reference to compare with the supply output set point.

The ADuM3190 is packaged in a small QSOP-16 package for 2.5kVrms. The ADuM4190 is packaged in a wide body SO-16 package for reinforced 5kVrms isolation rating.

### FUNCTIONAL BLOCK DIAGRAM

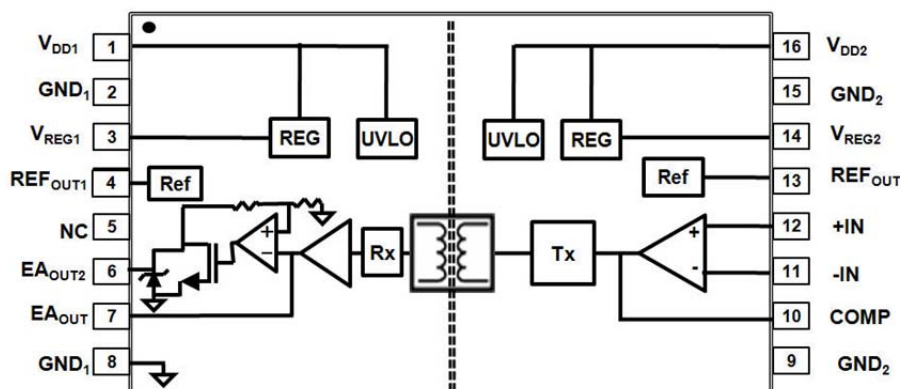


Figure 1. ADuM3190

<sup>1</sup> Protected by U.S. Patents 5,952,849, 6,873,065 and 7,075,329. Other patents pending.

Rev. Pr January 22, 2013

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# SPECIFICATIONS WITH $V_{DD1} = V_{DD2} = 3\text{ V TO }20\text{ V}$ , $T_A = -40\text{ TO }125^\circ\text{C}$

Table 1. All typical specifications are at  $T_A = 25^\circ\text{C}$ ,  $V_{DD1} = V_{DD2} = 5\text{V}$ .

| Parameter                        | Conditions                                                                     | Min   | Typ    | Max   | Unit                       |
|----------------------------------|--------------------------------------------------------------------------------|-------|--------|-------|----------------------------|
| Accuracy                         | $= (1.225\text{V} - EA_{OUT})/1.225\text{V}$ Refer to Figure 2                 |       |        |       |                            |
| Initial Error                    | at $25^\circ\text{C}$                                                          |       | 0.25%  | 0.5%  | V/V                        |
| Total Error                      | $-40^\circ$ to $125^\circ\text{C}$                                             |       | 0.5%   | 1%    | V/V                        |
| Op Amp                           |                                                                                |       |        |       |                            |
| Offset Error                     |                                                                                | -5    | +/-2.5 | 5     | mV                         |
| Open Loop Gain                   |                                                                                | 66    | 80     |       | dB                         |
| Input Common-mode Range          |                                                                                | 0.35  |        | 1.5   | V                          |
| Gain Bandwidth Product           |                                                                                |       | 10     |       | MHz                        |
| Common-mode rejection            |                                                                                |       | 72     |       | dB                         |
| Input Capacitance                |                                                                                |       | 2      |       | pF                         |
| Output Voltage Range             | COMP pin                                                                       | 0.2   |        | 2.7   | V                          |
| Input bias current               |                                                                                |       | 0.01   |       | $\mu\text{A}$              |
| Reference                        |                                                                                |       |        |       |                            |
| Output Voltage                   | at $25^\circ\text{C}$ , 0 to 1mA load, $C_{REFOUT} = 15\text{pF}$              | 1.220 | 1.225  | 1.230 | V                          |
|                                  | $-40^\circ$ to $125^\circ\text{C}$ , 0 to 1mA load, $C_{REFOUT} = 15\text{pF}$ | 1.215 | 1.225  | 1.235 | V                          |
| Output Current                   | $C_{REFOUT} = 15\text{pF}$                                                     | 2.0   |        |       | mA                         |
| UVLO                             |                                                                                |       |        |       |                            |
| Positive Going Threshold         |                                                                                |       | 2.8    |       | V                          |
| Negative Going Threshold         |                                                                                |       | 2.6    |       | V                          |
| $EA_{OUT}$ Impedance             | $V_{DD2} < \text{UVLO threshold}$ or $V_{DD1} < \text{UVLO threshold}$         |       | High Z |       | Ohms                       |
| OUTPUT CHARACTERISTICS           |                                                                                |       |        |       |                            |
| Output Gain                      | From Comp to $EA_{OUT}$ , DC, 0.3 to 2.4V                                      | 0.9   | 1.0    | 1.1   | V/V                        |
|                                  | From Comp to $EA_{OUT2}$ , DC, 0.4 to 5.0V                                     | 0.9   | 1.0    | 1.1   | V/V                        |
| Output -3dB Bandwidth            | From Comp to $EA_{OUT}$ , 0.3 to 2.4V, +/- 3mA                                 |       |        |       |                            |
|                                  | From Comp to $EA_{OUT2}$ , 0.4 to 5.0V, +/- 1mA                                |       |        |       |                            |
| A and S Grade                    |                                                                                | 50    | 100    |       | kHz                        |
| B and T Grade                    |                                                                                | 250   | 400    |       | kHz                        |
| Output Voltage, $EA_{OUT}$ Low   | +/- 3mA output                                                                 |       |        | 0.3   | V                          |
| Output Voltage, $EA_{OUT}$ High  | +/- 3mA output                                                                 | 2.4   | 2.5    |       | V                          |
| Output Voltage, $EA_{OUT2}$ Low  | $V_{DD1} = 4.5\text{V to }5.5\text{V}$ , +/- 1mA output                        |       | 0.2    | 0.4   | V                          |
| Output Voltage, $EA_{OUT2}$ High | $V_{DD1} = 4.5\text{V to }5.5\text{V}$ , +/- 1mA output                        | 4.8   | 4.9    |       | V                          |
| Output Voltage, $EA_{OUT2}$ Low  | $V_{DD1} = 10\text{ to }20\text{V}$ , +/- 1mA output                           |       | 0.2    | 0.4   | V                          |
| Output Voltage, $EA_{OUT2}$ High | $V_{DD1} = 10\text{ to }20\text{V}$ , +/- 1mA output                           | 5.0   | 5.4    |       | V                          |
| Output Voltage Noise             |                                                                                |       | TBD    |       | $\mu\text{V}_{\text{RMS}}$ |
| POWER SUPPLY                     |                                                                                |       |        |       |                            |
| Operating Range                  | $V_{DD1}$                                                                      | 3.0   |        | 20    | V                          |
| Operating Range                  | $V_{DD2}$                                                                      | 3.0   |        | 20    | V                          |
| Power Supply Rejection           | DC, $V_{DD1} = V_{DD2} = 3\text{V to }20\text{V}$                              | 60    |        |       | dB                         |
| Supply Current                   | $I_{DD1}$                                                                      |       | 0.9    | 1.8   | mA                         |
|                                  | $I_{DD2}$                                                                      |       | 3.0    | 5.0   | mA                         |

ADuM3190

Preliminary  
Technical Data

| Parameter | Conditions | Min | Typ | Max | Unit |
|-----------|------------|-----|-----|-----|------|
|-----------|------------|-----|-----|-----|------|

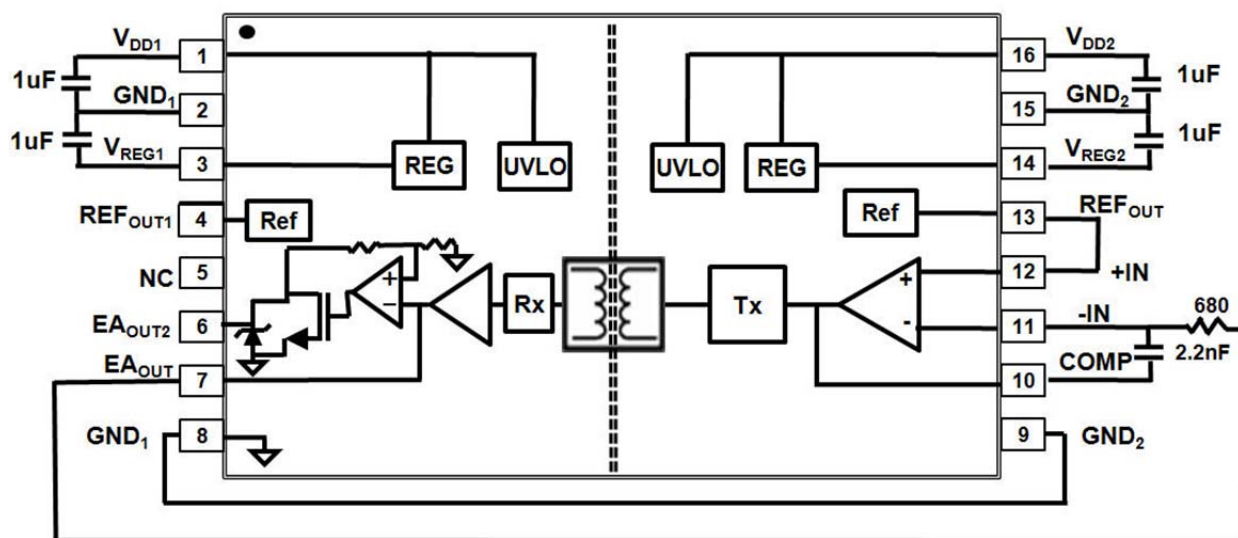


Figure 2. ADuM3190 Test Circuit 1

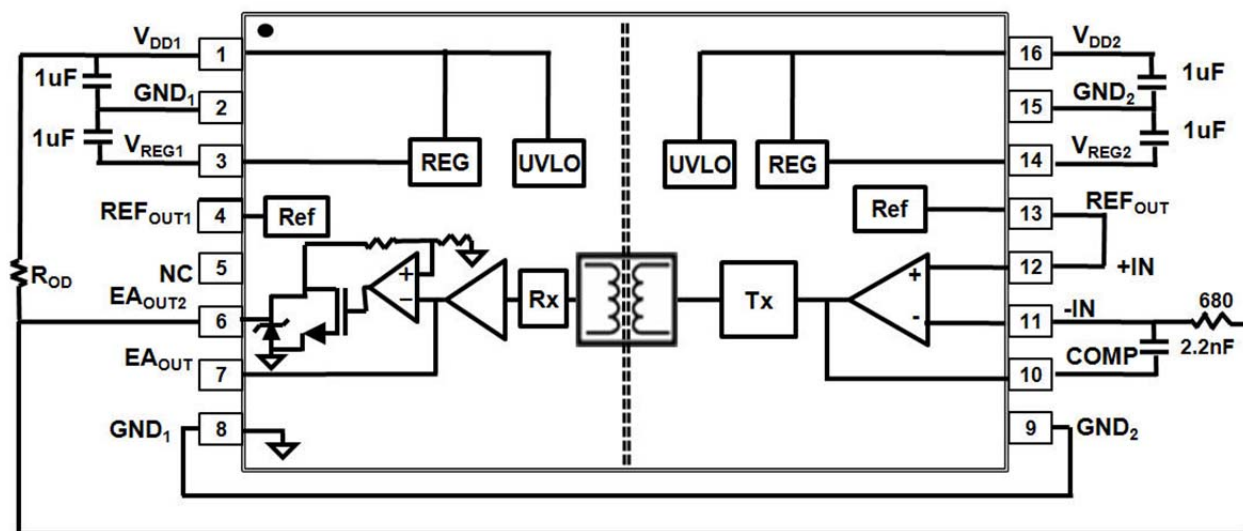


Figure 3. ADuM3190 Test Circuit 2

## PACKAGE CHARACTERISTICS

Table 2.

| Parameter                                                 | Symbol           | Min | Typ              | Max | Unit | Test Conditions                                                      |
|-----------------------------------------------------------|------------------|-----|------------------|-----|------|----------------------------------------------------------------------|
| Resistance (Input-to-Output) <sup>1</sup>                 | R <sub>I-O</sub> |     | 10 <sup>13</sup> |     | Ω    | f = 1 MHz<br><br>Thermocouple located at center of package underside |
| Capacitance (Input-to-Output) <sup>1</sup>                | C <sub>I-O</sub> |     | 2.2              |     | pF   |                                                                      |
| Input Capacitance <sup>2</sup>                            | C <sub>I</sub>   |     | 4.0              |     | pF   |                                                                      |
| IC Junction-to-Ambient Thermal Resistance<br>16-Lead QSOP | θ <sub>JA</sub>  |     | 76               |     | °C/W |                                                                      |

<sup>1</sup> The device is considered a 2-terminal device; Pin 1 through Pin 8 are shorted together, and Pin 9 through Pin 16 are shorted together.

<sup>2</sup> Input capacitance is from any input data pin to ground.

## REGULATORY INFORMATION

The ADuM3190 will be approved by the organizations listed in Table 3. See Table 3 and the section for recommended maximum working voltages for specific cross-isolation waveforms and insulation levels.

Table 3.

| UL (pending)                                                     | CSA (pending)                                                                                       | VDE (pending)                                                                    |
|------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Recognized Under 1577 Component Recognition Program <sup>1</sup> | Approved under CSA Component Acceptance Notice #5A                                                  | Certified according to DIN V VDE V 0884-10 (VDE V 0884-10): 2006-12 <sup>2</sup> |
| Single Protection,<br>2500Vrms isolation Voltage QSOP-16         | Basic insulation per CSA 60950-1-03 and IEC 60950-1, 400 V rms (565 V peak) maximum working voltage | Reinforced insulation, 560 V peak                                                |
| File E214400                                                     | File 205078                                                                                         | File 2471900-4880-0001                                                           |

<sup>1</sup> In accordance with UL1577, each ADuM3190 is proof tested by applying an insulation test voltage ≥1200 V rms for 1 sec (current leakage detection limit = 5 μA).

<sup>2</sup> In accordance with DIN V VDE V 0884-10, each ADuM3190 is proof tested by applying an insulation test voltage ≥525 V peak for 1 second (partial discharge detection limit = 5 pC). The asterisk (\*) marked on the component designates DIN V VDE V 0884-10 approval.

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## INSULATION AND SAFETY-RELATED SPECIFICATIONS

Table 4. ADuM3190.

| Parameter                                        | Symbol | Value    | Unit  | Conditions                                                                           |
|--------------------------------------------------|--------|----------|-------|--------------------------------------------------------------------------------------|
| Rated Dielectric Insulation Voltage              |        | 2500     | V rms | 1-minute duration                                                                    |
| Minimum External Air Gap (Clearance)             | L(l01) | 3.8 min  | mm    | Measured from input terminals to output terminals, shortest distance through air     |
| Minimum External Tracking (Creepage)             | L(l02) | 3.8 min  | mm    | Measured from input terminals to output terminals, shortest distance path along body |
| Minimum Internal Gap (Internal Clearance)        |        | 0.017min | mm    | Insulation distance through insulation                                               |
| Tracking Resistance (Comparative Tracking Index) | CTI    | >400     | V     | DIN IEC 112/VDE 0303 Part 1                                                          |
| Isolation Group                                  |        | II       |       | Material Group (DIN VDE 0110, 1/89, Table 1)                                         |

Table 5. Maximum Continuous Working Voltage<sup>1</sup>

| Parameter                     | Max  | Unit   | Constraint               |
|-------------------------------|------|--------|--------------------------|
| AC Voltage, Bipolar Waveform  | 560  | V peak | 50-year minimum lifetime |
| AC Voltage, Unipolar Waveform | 1131 | V peak | 50-year minimum lifetime |
| DC Voltage                    | 1131 | V peak | 50-year minimum lifetime |

<sup>1</sup> Refers to continuous voltage magnitude imposed across the isolation barrier. See the Applications section for more details.

## RECOMMENDED OPERATING CONDITIONS

Table 6.

| Parameter                        | Symbol                                 | Min | Max  | Unit |
|----------------------------------|----------------------------------------|-----|------|------|
| Operating Temperature            | T <sub>A</sub>                         |     |      |      |
| ADuM3190A/ADuM3190B              |                                        | -40 | +85  | °C   |
| ADuM3190S/ADuM3190T              |                                        | -40 | +125 | °C   |
| Supply Voltages <sup>1</sup>     | V <sub>DD1</sub> ,<br>V <sub>DD2</sub> | 3.0 | 20   | V    |
| Input Signal Rise and Fall Times |                                        |     | 1.0  | ms   |

## ABSOLUTE MAXIMUM RATINGS

$T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 7.

| Parameter                                                                                                              | Rating                                      |
|------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| Storage Temperature ( $T_{ST}$ ) Range                                                                                 | $-65^\circ\text{C}$ to $+150^\circ\text{C}$ |
| Ambient Operating Temperature ( $T_A$ ) Range                                                                          | $-40^\circ\text{C}$ to $+125^\circ\text{C}$ |
| Junction Temperature                                                                                                   | $-40^\circ\text{C}$ to $+150^\circ\text{C}$ |
| Supply Voltages ( $V_{DD1}$ , $V_{DD2}$ ) <sup>1</sup>                                                                 | $-0.5\text{ V}$ to $+24\text{ V}$           |
| Supply Voltages ( $V_{REG1}$ , $V_{REG2}$ ) <sup>1</sup>                                                               | $-0.5\text{ V}$ to $+5.5\text{ V}$          |
| Input Voltages (+IN, -IN)                                                                                              | $-0.5\text{ V}$ to $V_{DD2} + 0.5\text{ V}$ |
| Output Voltages (REF <sub>OUT1</sub> , Comp)                                                                           | $-0.5\text{ V}$ to $V_{DD1} + 0.5\text{ V}$ |
| Output Voltages (REF <sub>OUT1</sub> , EA <sub>OUT1</sub> , EA <sub>OUT2</sub> ) Average Output Current per Output Pin | $-11\text{ mA}$ to $+11\text{ mA}$          |

Common-Mode Transients<sup>4</sup>

$-100\text{ kV}/\mu\text{s}$  to  $+100\text{ kV}/\mu\text{s}$

<sup>1</sup> All voltages are relative to their respective ground.

<sup>2</sup>  $V_{DD1}$  and  $V_{DD2}$  refer to the supply voltages on the input and output sides of a given channel, respectively. See the Applications section.

<sup>3</sup> See Regulatory Information for maximum rated current values for various temperatures.

<sup>4</sup> Refers to common-mode transients across the insulation barrier. Common-mode transients exceeding the absolute maximum ratings may cause latch-up or permanent damage.

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

<sup>1</sup> All voltages are relative to their respective ground. See the Applications section for information on immunity to external magnetic fields.

## ESD CAUTION



### ESD (electrostatic discharge) sensitive device.

Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.



## PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

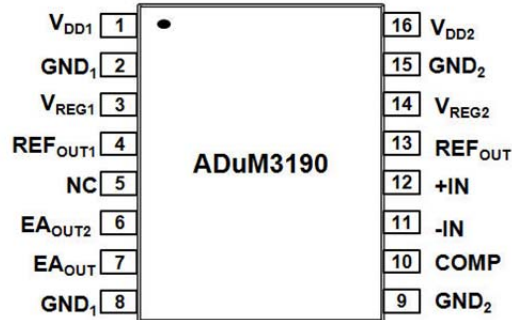
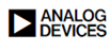


Figure 4. ADuM3190 Pin Configuration

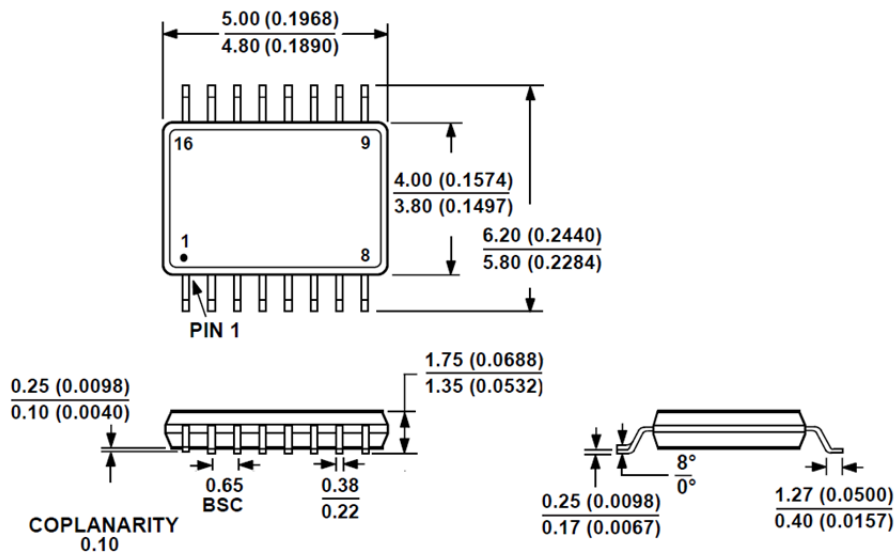
Table 8. ADuM3190 / ADuM4190 Pin Functional Descriptions

| Pin No. | Mnemonic            | Description                                                                                                 |
|---------|---------------------|-------------------------------------------------------------------------------------------------------------|
| 1       | V <sub>DD1</sub>    | Supply Voltage for Side 1 (3.0V to 20 V)                                                                    |
| 2       | GND <sub>1</sub>    | Ground Reference for Side 1                                                                                 |
| 3       | V <sub>REG1</sub>   | Internal Supply Voltage for Side 1. Connect a 1uF capacitor between V <sub>DD1</sub> and GND <sub>1</sub> . |
| 4       | REF <sub>OUT1</sub> | Reference Output Voltage for Side 1, maximum C <sub>REFOUT1</sub> = 15pF.                                   |
| 5       | NC                  | No Connection, connect to GND <sub>1</sub> , do not leave floating.                                         |
| 6       | EA <sub>OUT2</sub>  | Isolated Output Voltage, Open Drain Output, select pull-up resistor for up to 1mA current.                  |
| 7       | EA <sub>OUT</sub>   | Isolated Output Voltage                                                                                     |
| 8       | GND <sub>1</sub>    | Ground Reference for Side 1                                                                                 |
| 9       | GND <sub>2</sub>    | Ground Reference for Side 2                                                                                 |
| 10      | COMP                | Output of the Op Amp. Loop compensation network may be connected between COMP and -IN pins.                 |
| 11      | -IN                 | Inverting Op Amp input. Connection for the power supply set point and compensation network.                 |
| 12      | +IN                 | Non-Inverting Op Amp input. May be used as reference Input.                                                 |
| 13      | REF <sub>OUT</sub>  | Reference Output Voltage for Side 2, maximum C <sub>REFOUT</sub> = 15pF.                                    |
| 14      | V <sub>REG2</sub>   | Internal Supply Voltage for Side 2. Connect a 1uF capacitor between V <sub>DD2</sub> and GND <sub>2</sub> . |
| 15      | GND <sub>2</sub>    | Ground Reference for Side 2                                                                                 |
| 16      | V <sub>DD2</sub>    | Supply Voltage for Side 2 (3.0V to 20 V)                                                                    |

## OUTLINE DIMENSIONS

16-Lead Shrink Small Outline Package [QSOP]  
(RQ-16)

Dimensions shown in millimeters and (inches)



COMPLIANT TO JEDEC STANDARDS MO-137-AB

Figure 5. 16-lead Standard Package [QSOP], (RQ-16)  
Dimensions shown in millimeters and (inches)

## ORDERING GUIDE

| Model        | Temperature Range | Bandwidth (typical) | Package Description | Package Option |
|--------------|-------------------|---------------------|---------------------|----------------|
| ADuM3190ARQZ | -40°C to +85°C    | 100kHz              | 16-Lead QSOP        | RQ-16          |
| ADuM3190BRQZ | -40°C to +85°C    | 400kHz              | 16-Lead QSOP        | RQ-16          |
| ADuM3190SRQZ | -40°C to +125°C   | 100kHz              | 16-Lead QSOP        | RQ-16          |
| ADuM3190TRQZ | -40°C to +125°C   | 400kHz              | 16-Lead QSOP        | RQ-16          |