# 8-Channel, High-Bandwidth, Analog Front-End

**Check for Samples: PGA5807A**

## FEATURES

- **8-Channel Complete AFE:**
  - **LNA, PGA, and LPF**
  - **Full-Channel Gain: 12 dB to 30 dB**
  - **Input-Referred Noise: 2.1 nV/$\sqrt{Hz}$**
- **LNA:**
  - **Gain: 12 dB**
  - **Fully Differential**
  - **Wide Input Common-Mode Support: 2.1 ± 200 mV**
  - **Maximum Linear Input Range: 500 $mV_{PP}$**
- **PGA Gain: 0 dB to 18 dB**
  - **With 3-dB Gain Steps**
  - **Programmable via Either Serial Interface or External Pins**
- **Maximum Total Channel Gain: 30 dB**
- **Programmable LPF:**
  - **Corner Frequency: 75 MHz, 60 MHz**
- **Power (Full-Chain):**
  - **60 mW per Channel**
- **Fast and Consistent Overload Recovery**
- **Small Package: 9-mm × 9-mm QFN-64**

## APPLICATIONS

- **Data Acquisition Front Ends**
- **Ultrasound Imaging**

## DESCRIPTION

The PGA5807A is an 8-channel, high-bandwidth, analog front-end (AFE). The device functions on a single 3.3-V analog supply. The device supports high-bandwidth input frequencies with a total power of 60 mW per channel. The PGA5807A consists of a low-noise amplifier (LNA), a programmable gain amplifier (PGA), and a programmable low-pass filter (LPF). The LNA has a fixed 12-dB gain (the differential amplifier supports both direct and capacitive input coupling) and supports a maximum linear input range of 500 $mV_{PP}$.

The device provides gain options from 0 dB to 18 dB, in 3-dB gain steps. This 18-dB PGA gain can be programmed using either the serial interface or external pins. The PGA5807A integrates an antialiasing filter in the form of an LPF to reduce noise. The device is available in a very small, 9-mm × 9-mm QFN-64 package and is specified for operation over the –40°C to +85°C temperature range.

This integrated circuit can be damaged by ESD. Texas Instruments 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.

## ORDERING INFORMATION(1)

| PRODUCT | PACKAGE-LEAD | PACKAGE DESIGNATOR |
|---|---|---|
| PGA5807A | QFN-64 | RGC |

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or visit the device product folder at www.ti.com.

## ABSOLUTE MAXIMUM RATINGS

Over operating free-air temperature range, unless otherwise noted.(1)

| | | VALUE | UNIT |
|---|---|---|---|
| Supply voltage range | AVDD | –0.3 to 3.9 | V |
| Voltage at analog input and digital input | | –0.3 to minimum (3.6, AVDD + 0.3) | V |
| Temperature range | Operating, $T_A$ | –40 to +85 | °C |
| | Storage, $T_{stg}$ | –55 to +150 | °C |
| Electrostatic discharge (ESD) ratings | Human body model (HBM) | 1 | kV |

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and 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.

## RECOMMENDED OPERATING CONDITIONS

| | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| AVDD | Analog voltage supply | 3.15 | | 3.6 | V |
| $T_A$ | Operating temperature | –40 | | +85 | °C |
| | Input common-mode voltage range | 1.9 | | 2.3 | V |

## THERMAL INFORMATION

| THERMAL METRIC(1) | | PGA5807 RGC (QFN) 64 PINS | UNITS |
|---|---|---|---|
| $\theta_{JA}$ | Junction-to-ambient thermal resistance | 22.8 | °C/W |
| $\theta_{JCtop}$ | Junction-to-case (top) thermal resistance | 6.9 | |
| $\theta_{JB}$ | Junction-to-board thermal resistance | 2.4 | |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 0.1 | |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 2.4 | |
| $\theta_{JCbot}$ | Junction-to-case (bottom) thermal resistance | 0.2 | |

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.

## ELECTRICAL CHARACTERISTICS

Typical values are at $T_A$ = +25°C, AVDD = 3.3 V, input dc-coupled with a 2.1-V common-mode voltage, LNA gain = 12 dB, PGA gain = 18 dB, total channel gain = 30 dB, bandwidth = high, and $V_{OUT}$ = –1 dBFS, unless otherwise specified. Minimum and maximum values are specified across the full temperature range of $T_{MIN}$ = –40°C to $T_{MAX}$ = +85°C with AVDD = 3.3 V.

| PARAMETER | | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| | Input-referred noise | | f = 25 MHz, total channel gain = 30 dB | | 2.1 | | nV/√Hz |
| | Noise figure | | $R_S$ = 100 Ω, differential | | 6.4 | | dB |
| | Maximum linear input voltage | | Total channel gain = 12 dB, differential | | 500 | | $mV_{PP}$ |
| | Maximum linear output swing | | | | 2 | | $V_{PP}$ |
| $G_{LNA}$ | LNA gain | | | | 12 | | dB |
| | Maximum channel gain | | | 29 | 30 | 31 | dB |
| | PGA gain range | | | 0 | | 18 | dB |
| | Gain step | | | | 3 | | dB |
| | Total output-referred noise | | Total channel gain = 30 dB | | 450 | | µV |
| | Input resistance | | | | 5 | | kΩ |
| $C_i$ | Input capacitance | | | | 3 | | pF |
| | LPF –3-dB cutoff frequency | | | | 75 | | MHz |
| | Gain matching | | Across devices, $T_A$ = +25°C | –1 | | 1 | dB |
| | | | Across channels in the same device | | ±0.25 | | dB |
| $V_{ICR}$ | Input common-mode voltage range | | | 1.9 | | 2.3 | V |
| | Output offset | | | –50 | | 50 | mV |
| $V_{OCR}$ | Output common-mode voltage | | | | 950 | | mV |
| HD2 | Harmonic distortion | Second | f = 25 MHz, $V_{OUT}$ = –1 dBFS | | –55 | | dBc |
| HD3 | | Third | f = 25 MHz, $V_{OUT}$ = –1 dBFS | | –50 | | dBc |
| THD | | Total | f = 25 MHz, $V_{OUT}$ = –1 dBFS | | –48 | | dBc |
| IMD3 | Intermodulation distortion | | $f_1$ = 25 MHz at –7 dBFS, $f_2$ = 25 MHz, 1 MHz at –7 dBFS, for all PGA gains | | –45 | | dBc |
| | Fundamental crosstalk | | f = 25 MHz, $V_{OUT}$ = –1 dBFS | | –50 | | dBc |
| $P_D$ | Power dissipation | Total, per channel | | | 60 | 69 | mW/ch |
| | | Power-down mode | Partial power-down | | 4.2 | | mW/ch |
| | | | Complete power-down | | | 2.5 | mW/ch |
| | AVDD current (3.3 V) | | | | 145 | | mA |
| | Settling time for overload recovery | | For 12-dB higher signal than linear input | | –30 | | ns |
| | Power-up response time | | Partial power-down | | 1 | | µs |
| | | | Full power-down | | 1 | | ms |
| PSRR | Power-supply rejection ratio | | f = 10 kHz, gain = 30 dB | | –40 | | dBc |
| | | | f = 10 kHz, gain = 12 dB | | –38 | | dBc |

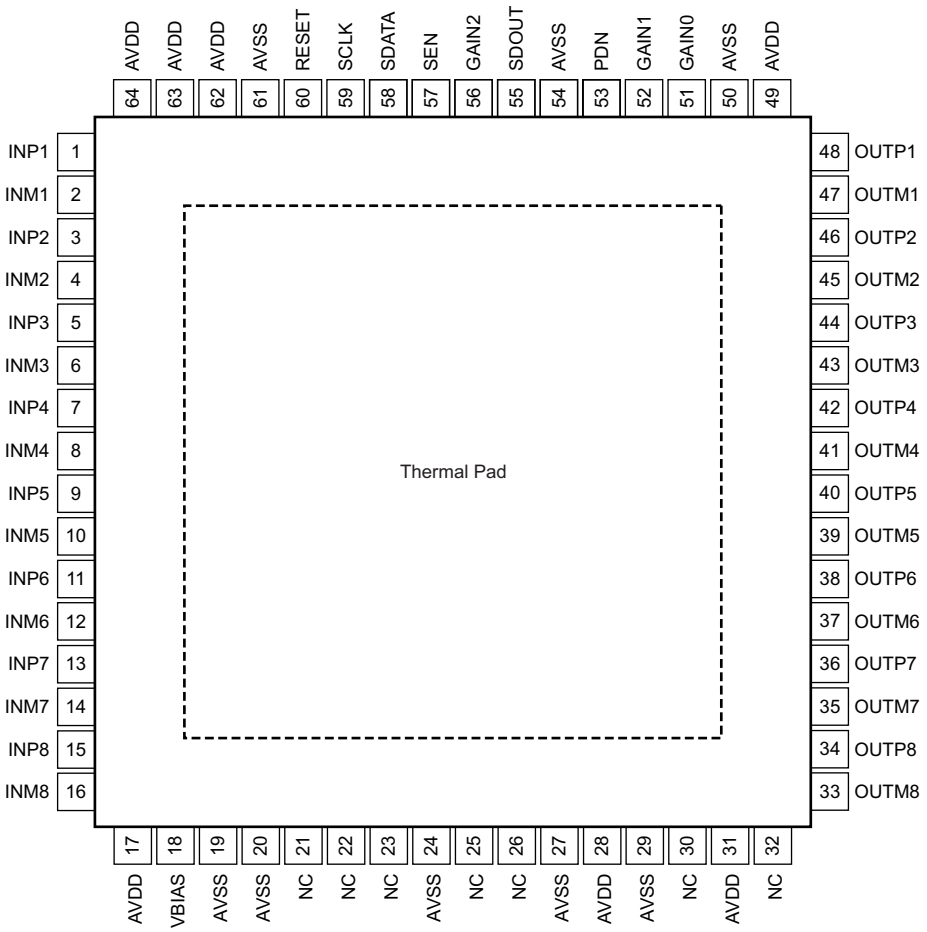
## DIGITAL CHARACTERISTICS

Typical values are at $T_A$ = +25°C and AVDD = 3.3 V, unless otherwise specified. Minimum and maximum values are specified across the full temperature range of $T_{MIN}$ = –40°C to $T_{MAX}$ = +85°C.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **DIGITAL INPUTS/OUTPUTS** | | | | | | |
| $V_{IH}$ | Logic high input voltage | | 2 | | | V |
| $V_{IL}$ | Logic low input voltage | | 0 | | | V |
| $I_{IH}$ | Logic high input current | | | 200 | | µA |
| $I_{IL}$ | Logic low input current | | | 200 | | µA |
| $C_i$ | Input capacitance | | | 5 | | pF |
| $V_{OH}$ | Logic high output voltage | SDOUT pin | | AVDD | | V |
| $V_{OL}$ | Logic low output voltage | SDOUT pin | | 0 | | V |

## PIN CONFIGURATION

**RGC PACKAGE**
**QFN-64**
**(TOP VIEW)**



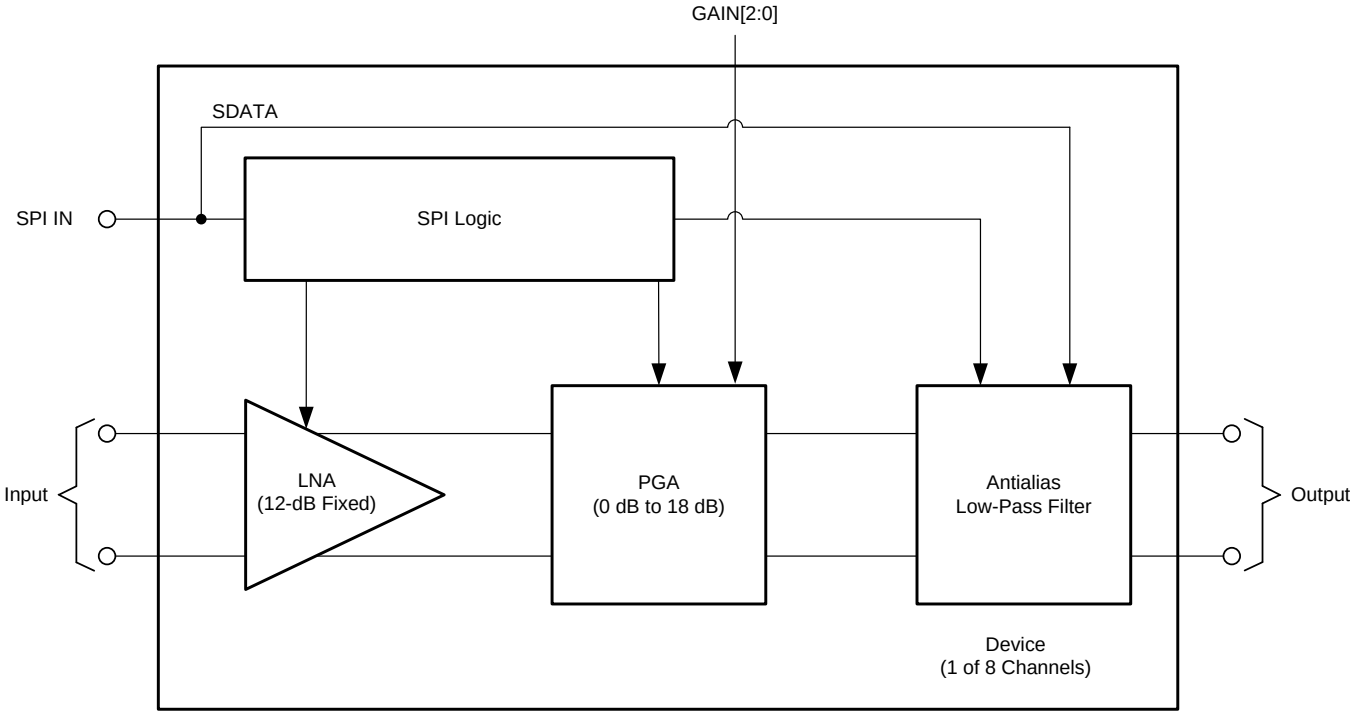
## Table 1. PIN FUNCTIONS

| NAME | NO. | FUNCTION | DESCRIPTION | |
|---|---|---|---|---|
| AVDD | 17, 28, 31, 49, 62-64 | Supply | Analog supply pin, 3.3 V | |
| AVSS | 19, 20, 24, 27, 29, 50, 54, 61 | Ground | Analog ground | |
| GAIN0 | 51 | Digital input | When RESET is high, this pin is used to program the PGA gain. Refer to Table 2 for more details. Note: Use 3.3-V logic. | |
| GAIN1 | 52 | Digital input | When RESET is high, this pin is used to program the PGA gain. Refer to Table 2 for more details. Note: Use 3.3-V logic. | |
| GAIN2 | 56 | Digital input | When RESET is high, this pin is used to program the PGA gain. Refer to Table 2 for more details. Note: Use 3.3-V logic. | |
| INM1 | 2 | Input | Complimentary analog input for channel 1 | The dc input common-mode can be 2.1 V ± 200 mV. |
| INP1 | 1 | Input | Analog input for channel 1 | |
| INM2 | 4 | Input | Complimentary analog input for channel 2 | |
| INP2 | 3 | Input | Analog input for channel 2 | |
| INM3 | 6 | Input | Complimentary analog input for channel 3 | |
| INP3 | 5 | Input | Analog input for channel 3 | |
| INM4 | 8 | Input | Complimentary analog input for channel 4 | |
| INP4 | 7 | Input | Analog input for channel 4 | |
| INM5 | 10 | Input | Complimentary analog input for channel 5 | |
| INP5 | 9 | Input | Analog input for channel 5 | |
| INM6 | 12 | Input | Complimentary analog input for channel 6 | |
| INP6 | 11 | Input | Analog input for channel 6 | |
| INM7 | 14 | Input | Complimentary analog input for channel 7 | |
| INP7 | 13 | Input | Analog input for channel 7 | |
| INM8 | 16 | Input | Complimentary analog input for channel 8 | |
| INP8 | 15 | Input | Analog input for channel 8 | |
| NC | 21-23, 25, 26, 30, 32 | — | Unused pins; do not connect | |
| OUTM1 | 47 | Output | Complimentary output pin for channel 1 | The common-mode voltage is 0.95 V. |
| OUTP1 | 48 | Output | Output pin for channel 1 | |
| OUTM2 | 45 | Output | Complimentary output pin for channel 2 | |
| OUTP2 | 46 | Output | Output pin for channel 2 | |
| OUTM3 | 43 | Output | Complimentary output pin for channel 3 | |
| OUTP3 | 44 | Output | Output pin for channel 3 | |
| OUTM4 | 41 | Output | Complimentary output pin for channel 4 | |
| OUTP4 | 42 | Output | Output pin for channel 4 | |
| OUTM5 | 39 | Output | Complimentary output pin for channel 5 | |
| OUTP5 | 40 | Output | Output pin for channel 5 | |
| OUTM6 | 37 | Output | Complimentary output pin for channel 6 | |
| OUTP6 | 38 | Output | Output pin for channel 6 | |
| OUTM7 | 35 | Output | Complimentary output pin for channel 7 | |
| OUTP7 | 36 | Output | Output pin for channel 7 | |
| OUTM8 | 33 | Output | Complimentary output pin for channel 8 | |
| OUTP8 | 34 | Output | Output pin for channel 8 | |
| PDN | 53 | Digital input | Partial power-down control pin for the entire device with an internal 20-kΩ pull-down resistor; active high. Note: Use 3.3-V logic. | |
| RESET | 60 | Digital input | Logic hardware reset pin. Note: Use 3.3-V logic. | |
| SCLK | 59 | Digital input | Serial interface clock pin with an internal 20-kΩ pull-down resistor. Note: Use 3.3-V logic. | |
| SDATA | 58 | Digital input | Serial interface data input with an internal 20-kΩ pull-down resistor. When RESET is high, the corner frequency for the antialias filter can be programmed to a lower frequency (60 MHz) by setting this pin high. Note: Use 3.3-V logic. | |
| SDOUT | 55 | Digital output | Serial interface readout pin | |
| SEN | 57 | Digital input | Serial interface enabled for channels 1 to 8 with an internal 20-kΩ pull-up resistor; active low. Note: Use 3.3-V logic. | |
| VBIAS | 18 | Decap | Bias voltage; bypass to ground with a 1-µF capacitor or greater | |

**Table 2. PGA Gain Control**

| GAIN[2:0] | PGA_GAIN (dB) |
|---|---|
| 000 | 18 |
| 001 | 15 |
| 010 | 12 |
| 011 | 9 |
| 100 | 6 |
| 101 | 3 |
| 110 | 0 |

## FUNCTIONAL BLOCK DIAGRAM



## TYPICAL CHARACTERISTICS

At $T_A$ = +25°C, AVDD = 3.3 V, input dc-coupled with 2.1-V input common-mode, LNA gain = 12 dB, PGA gain = 18 dB, total channel gain = 30 dB, GAIN[2:0] = 000, $f_{IN}$ = 5 MHz, default LPF filter corner, and $V_{OUT}$ = –1 dBFS, unless otherwise noted.

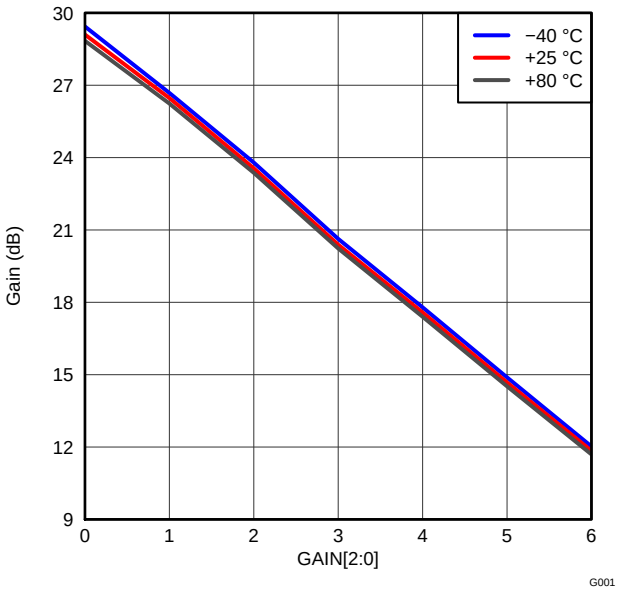



**Figure 1. GAIN vs GAIN[2:0] ACROSS TEMPERATURE**

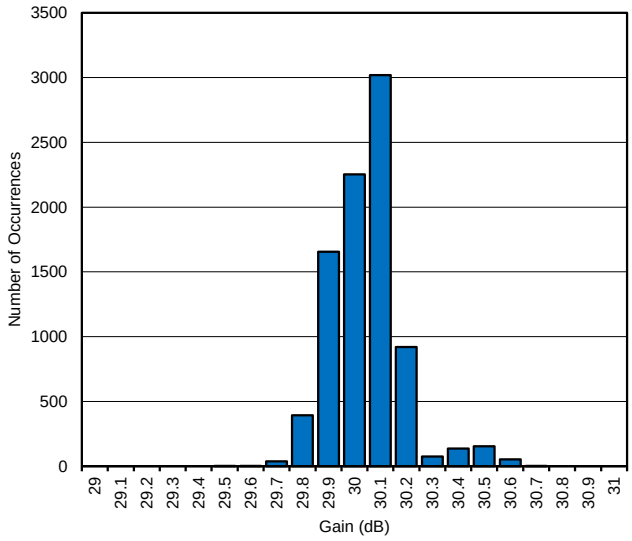



**Figure 2. GAIN-MATCHING HISTOGRAM (Gain = 30 dB)**

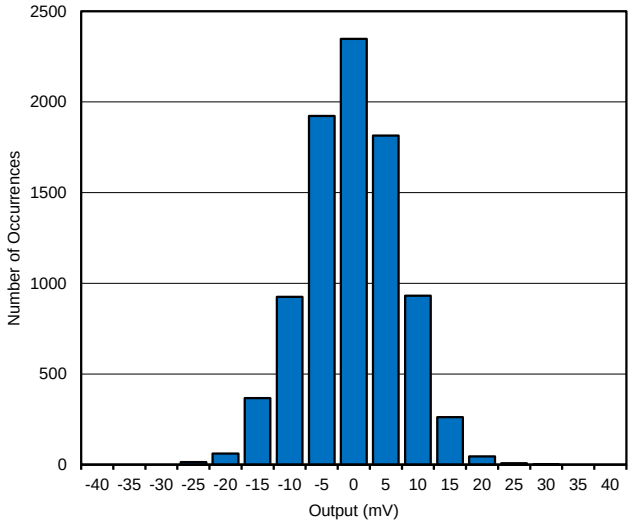



**Figure 3. OUTPUT OFFSET HISTOGRAM (Gain = 30 dB)**

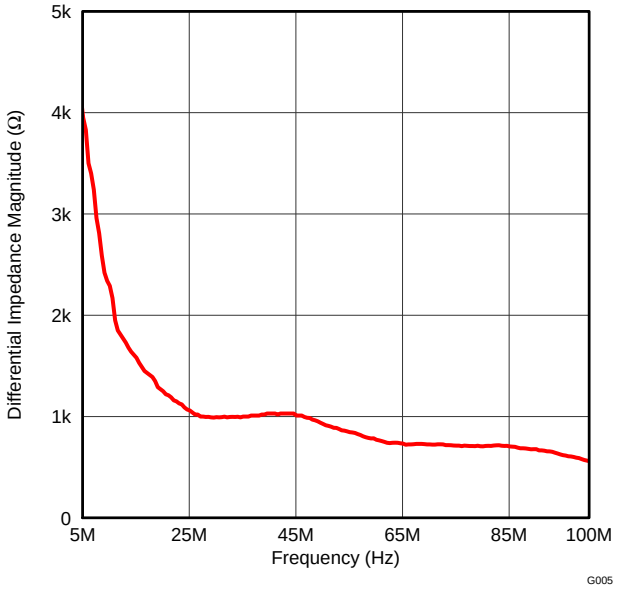



**Figure 4. INPUT IMPEDANCE MAGNITUDE**

## TYPICAL CHARACTERISTICS (continued)

At $T_A$ = +25°C, AVDD = 3.3 V, input dc-coupled with 2.1-V input common-mode, LNA gain = 12 dB, PGA gain = 18 dB, total channel gain = 30 dB, GAIN[2:0] = 000, $f_{IN}$ = 5 MHz, default LPF filter corner, and $V_{OUT}$ = –1 dBFS, unless otherwise noted.

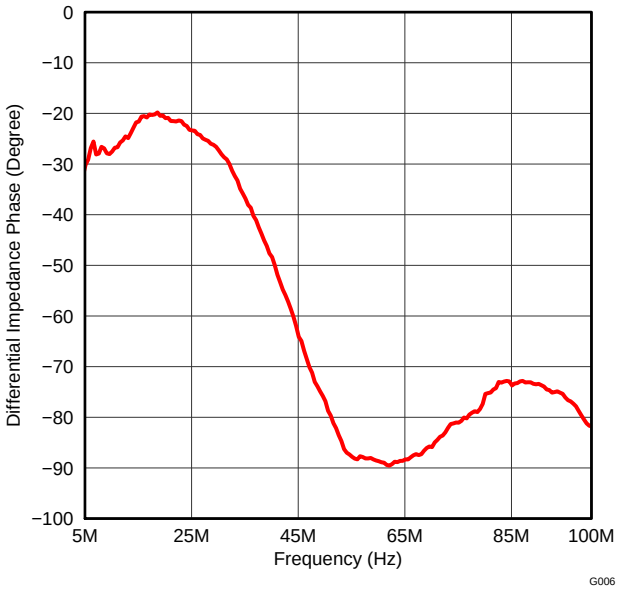



**Figure 5. INPUT IMPEDANCE PHASE**

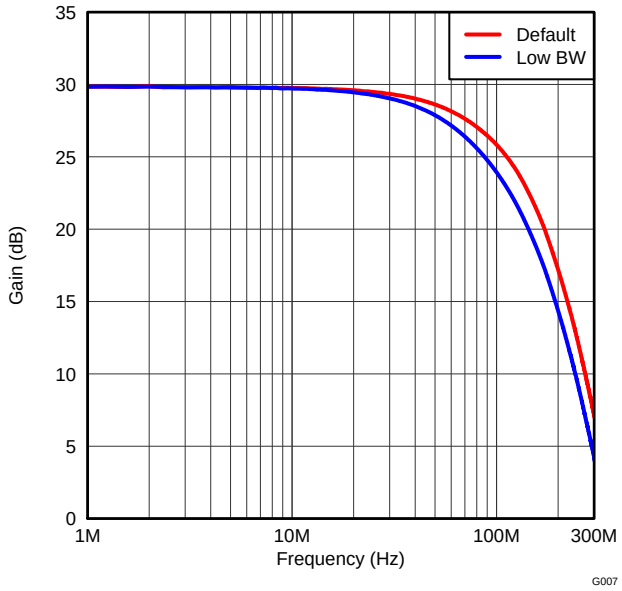



**Figure 6. LOW-PASS FILTER RESPONSE**

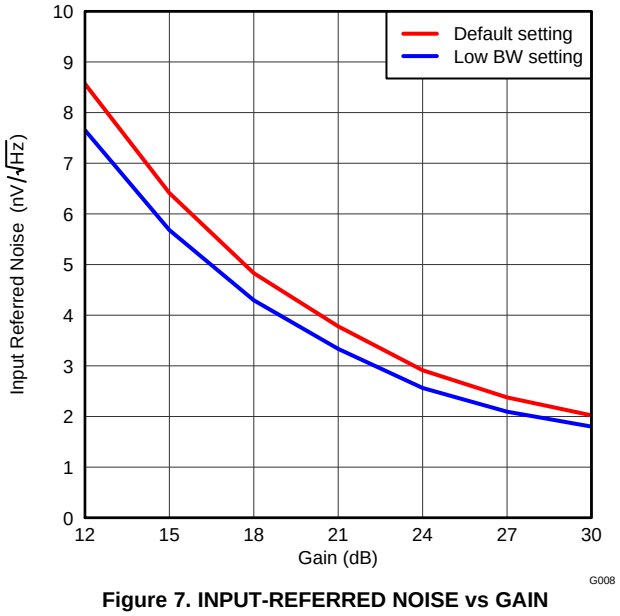



**Figure 7. INPUT-REFERRED NOISE vs GAIN**

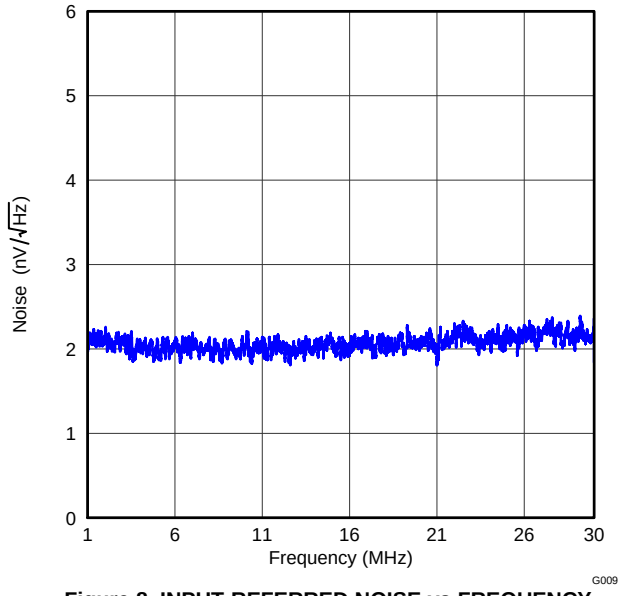



**Figure 8. INPUT-REFERRED NOISE vs FREQUENCY (Gain = 30 dB)**

## TYPICAL CHARACTERISTICS (continued)

At $T_A$ = +25°C, AVDD = 3.3 V, input dc-coupled with 2.1-V input common-mode, LNA gain = 12 dB, PGA gain = 18 dB, total channel gain = 30 dB, GAIN[2:0] = 000, $f_{IN}$ = 5 MHz, default LPF filter corner, and $V_{OUT}$ = –1 dBFS, unless otherwise noted.

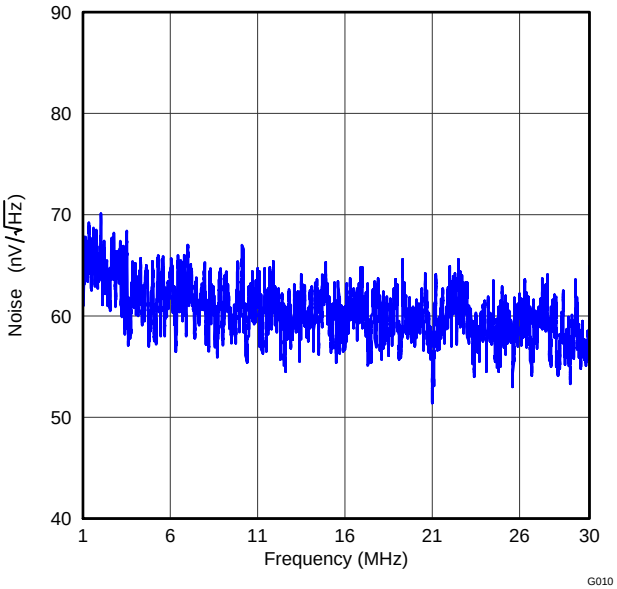



**Figure 9. OUTPUT-REFERRED NOISE vs FREQUENCY (Gain = 30 dB)**

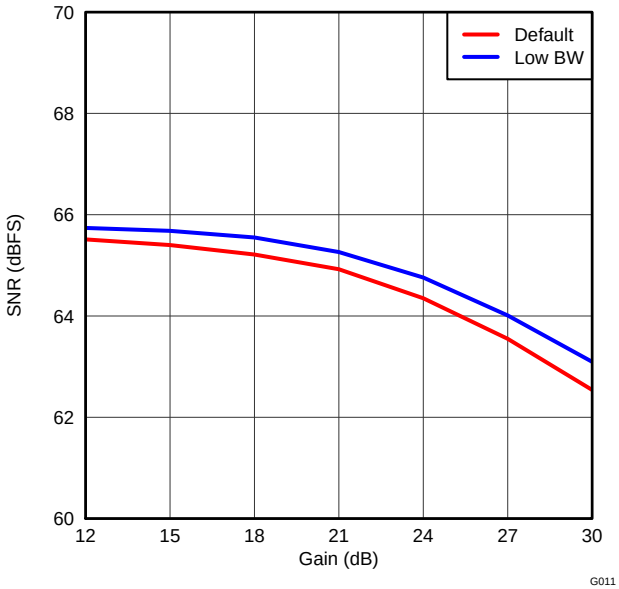



**Figure 10. SIGNAL-TO-NOISE RATIO vs GAIN ACROSS BANDWIDTH MODE**

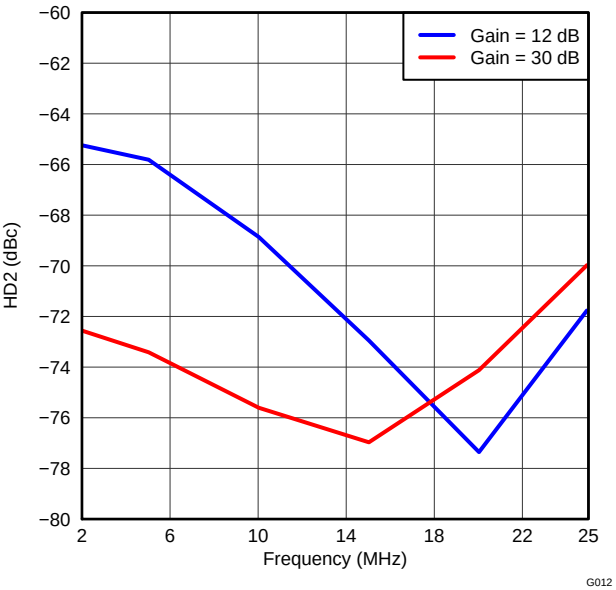



**Figure 11. SECOND-HARMONIC DISTORTION vs FREQUENCY**

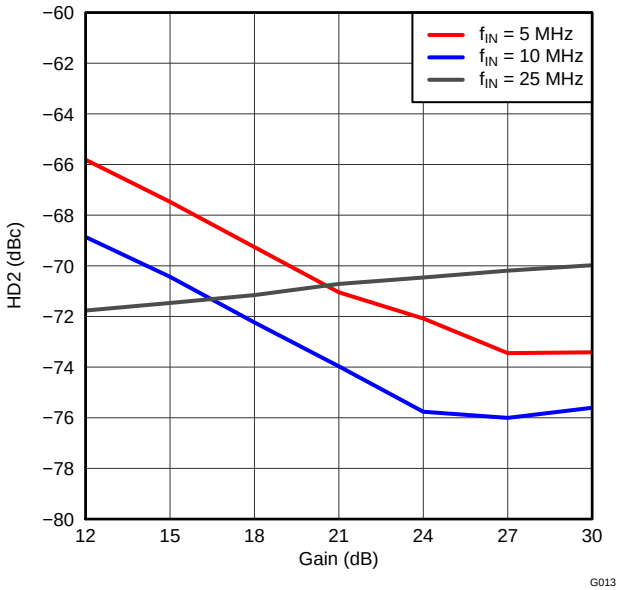



**Figure 12. SECOND-HARMONIC DISTORTION vs GAIN**

## TYPICAL CHARACTERISTICS (continued)

At $T_A$ = +25°C, AVDD = 3.3 V, input dc-coupled with 2.1-V input common-mode, LNA gain = 12 dB, PGA gain = 18 dB, total channel gain = 30 dB, GAIN[2:0] = 000, $f_{IN}$ = 5 MHz, default LPF filter corner, and $V_{OUT}$ = –1 dBFS, unless otherwise noted.

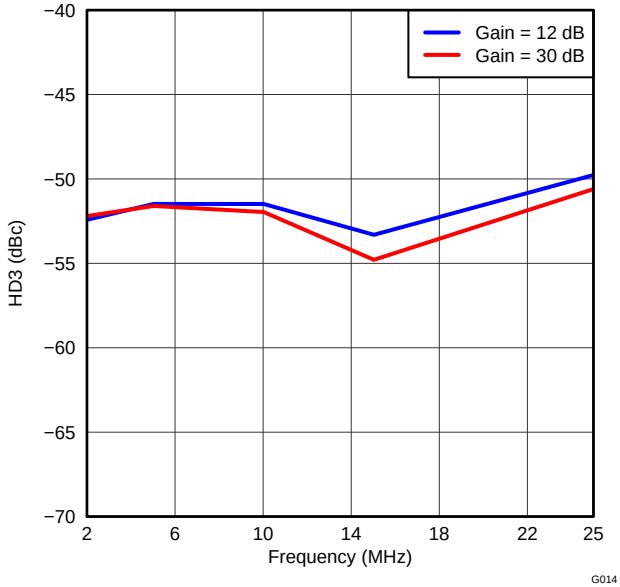



**Figure 13. THIRD-HARMONIC DISTORTION vs FREQUENCY**

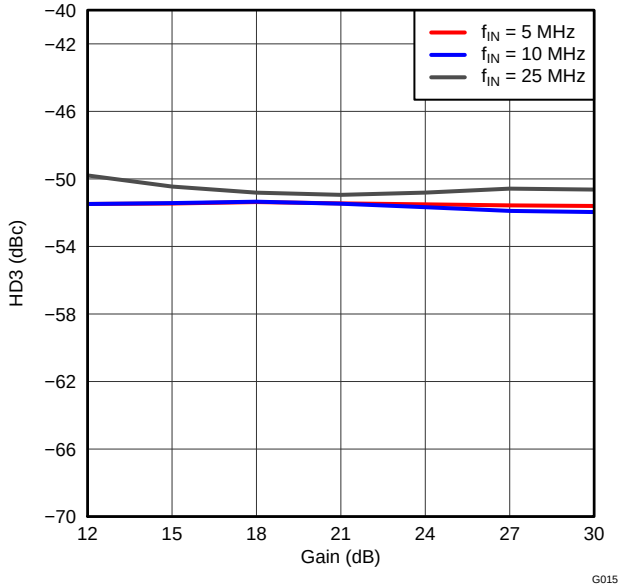



**Figure 14. THIRD-HARMONIC DISTORTION vs GAIN**

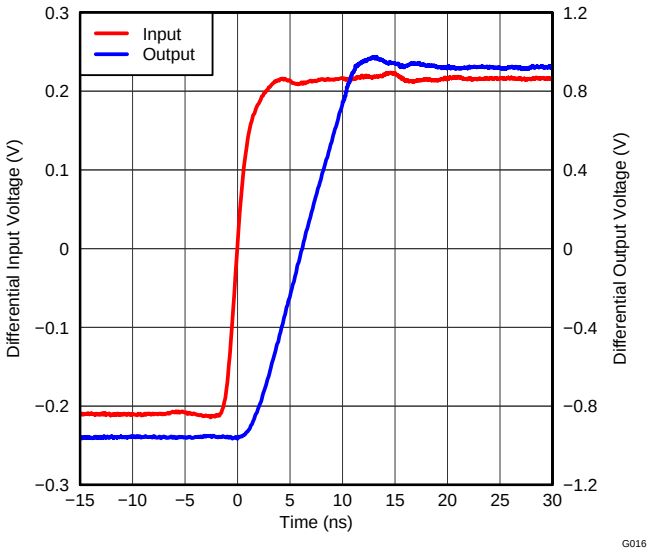



**Figure 15. DIFFERENTIAL OUTPUT RESPONSE FOR AN INPUT STEP (12-dB Total Channel Gain)**

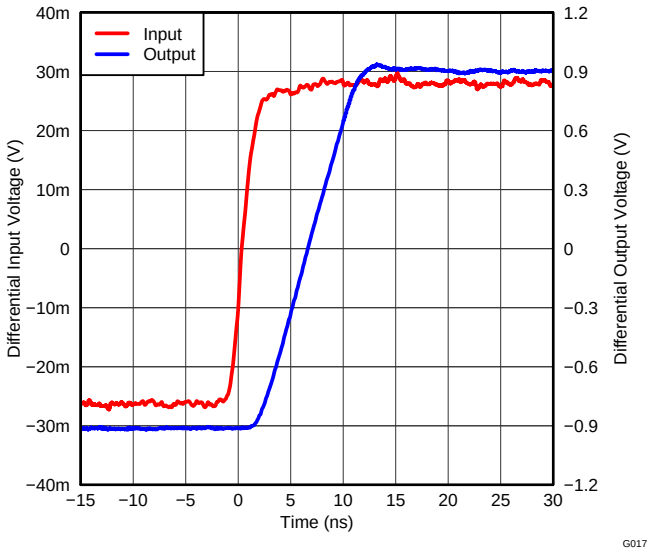



**Figure 16. DIFFERENTIAL OUTPUT RESPONSE FOR AN INPUT STEP (30-dB Total Channel Gain)**

## TYPICAL CHARACTERISTICS (continued)

At $T_A$ = +25°C, AVDD = 3.3 V, input dc-coupled with 2.1-V input common-mode, LNA gain = 12 dB, PGA gain = 18 dB, total channel gain = 30 dB, GAIN[2:0] = 000, $f_{IN}$ = 5 MHz, default LPF filter corner, and $V_{OUT}$ = –1 dBFS, unless otherwise noted.

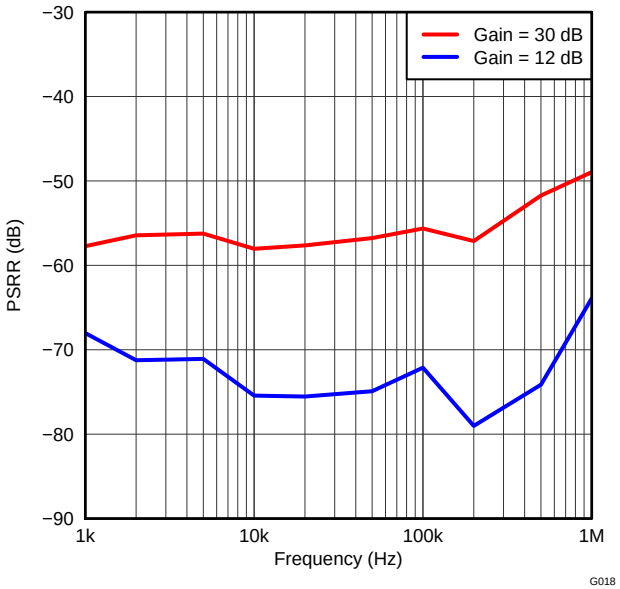



**Figure 17. POWER-SUPPLY REJECTION RATIO (100-$mV_{PP}$ Supply Noise with Different Frequencies)**

## SERIAL REGISTER TIMING

### SERIAL REGISTER WRITE DESCRIPTION

Programming different modes can be accomplished through the serial interface formed by the SEN (serial interface enable), SCLK (serial interface clock), SDATA (serial interface data), and RESET pins. Each of these pins has a 20-kΩ pull-down resistor to GND. Serially shifting bits into the device is enabled when SEN is low. SDATA serial data are latched at every SCLK rising edge when SEN is active (low). Serial data are loaded into the register at every 24th SCLK rising edge when SEN is low. If the word length exceeds a multiple of 24 bits, the excess bits are ignored. Data can be loaded in multiples of 24-bit words within a single active SEN pulse (an internal counter counts groups of 24 clocks after the SEN falling edge). The interface can function with SCLK frequencies from 20 MHz down to low speeds (of a few Hertz) and even with a non-50% duty cycle SCLK. Data are divided into two main portions to load on the addressed register: a register address (eight bits) and the actual data (16 bits). When writing to a register with unused bits, these bits should be set to '0'. Figure 18 shows a timing diagram of the write operation. Table 3 lists the serial interface timing characteristics.

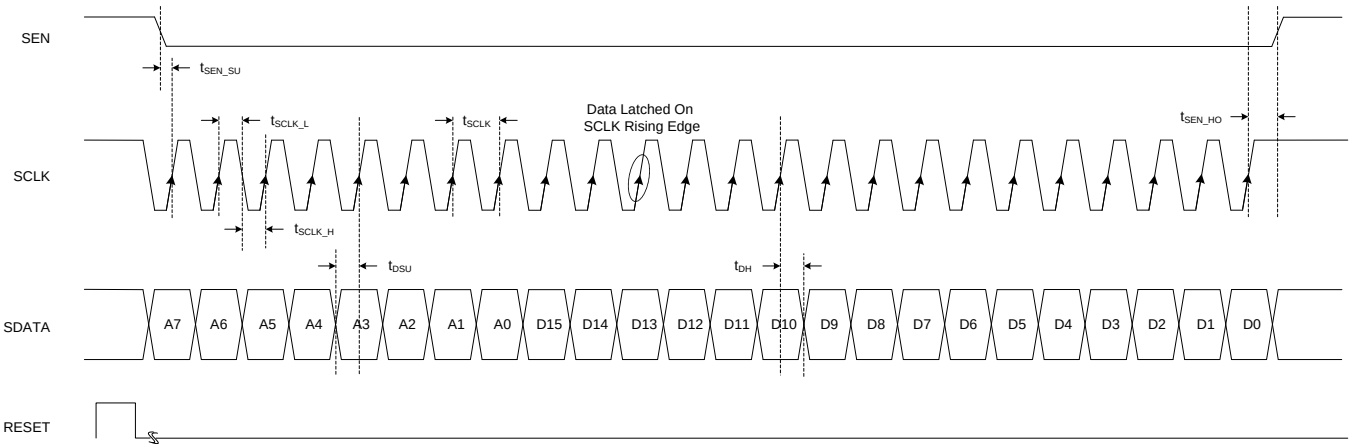



**Figure 18. Serial Interface Timing Diagram**

**Table 3. Serial Interface Timing Characteristics(1)**

| PARAMETER | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| $t_{SCLK}$ | SCLK period | 50 | | | ns |
| $t_{SCLK\_H}$ | SCLK high time | 20 | | | ns |
| $t_{SCLK\_L}$ | SCLK low time | 20 | | | ns |
| $t_{DSU}$ | Data setup time | 5 | | | ns |
| $t_{DHO}$ | Data hold time | 5 | | | ns |
| $t_{SEN\_SU}$ | SEN falling edge to SCLK rising edge | 8 | | | ns |
| $t_{SEN\_HO}$ | Time between last SCLK rising edge to SEN rising edge | 8 | | | ns |
| $t_{OUT\_DV}$(2) | Delay from SCLK falling edge to SDOUT valid | 12 | 20 | 28 | ns |

(1) Minimum values are across the full temperature range of $T_{MIN}$ = –40°C to $T_{MAX}$ = +85°C and AVDD = 3.3 V.
(2) See Figure 19.

## REGISTER READOUT

The device includes an option where the contents of the internal registers can be read back. This readout may be useful as a diagnostic test to verify the serial interface communication between the external controller and the AFE. First, the REGISTER READOUT ENABLE bit (bit 1, register 00h) must be set to '1'. Then, initiate a serial interface cycle specifying the register address (A[7:0]) to be read. The data bits are *don't care*. The device outputs the contents (D[15:0]) of the selected register on the SDOUT pin. SDOUT has a typical 20-ns delay ($t_{OUT\_DV}$) from the SCLK falling edge. For a lower speed SCLK, SDOUT can be latched on the SCLK rising edge. For a higher speed SCLK (for example, with an SCLK period less than 60 ns), latching SDOUT at the next SCLK falling edge is preferable. Figure 19 shows the read operation timing diagram (timing specifications follow the same information provided in Table 3). In readout mode, REGISTER READOUT ENABLE can still be accessed through SDATA, SCLK, and SEN. To enable serial register writes, set the REGISTER READOUT ENABLE bit back to '0'.

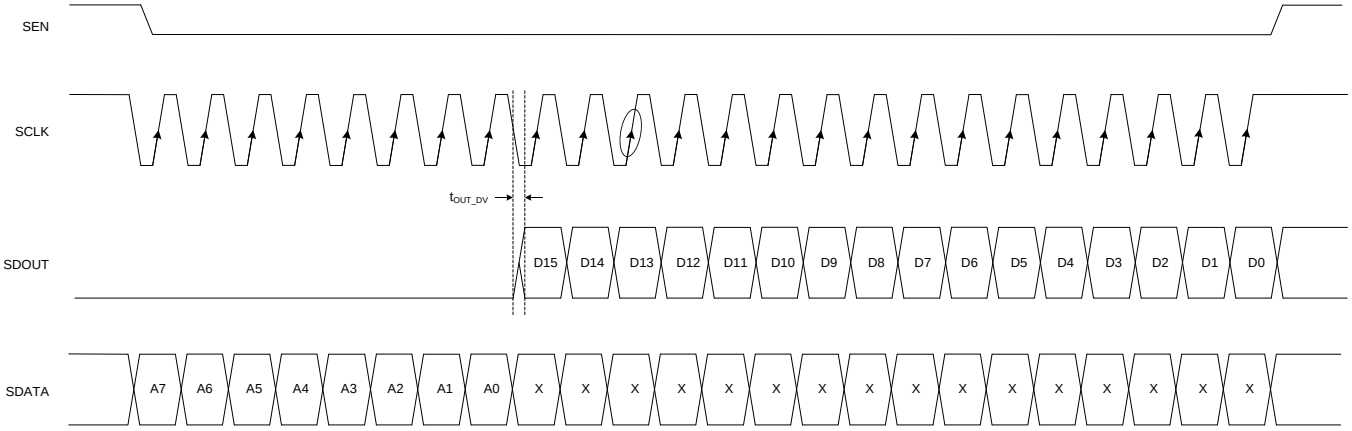



**Figure 19. Serial Interface Register Read Timing Diagram**

## REGISTER MAP

A reset process is required at the device initialization stage. Initialization can be accomplished in one of two ways:

1. Through a hardware reset, by applying a positive pulse on the RESET pin, or
2. Through a software reset (using the serial interface), by setting the SW_RESET bit high. Setting this bit initializes the internal registers to the respective default values (all '0's) and then self-resets the SW_RESET bit low. In this case, the RESET pin can remain low (inactive).

After reset, all PGA registers are set to '0' (default). During register programming, all reserved or unlisted register bits must be set to '0'. Register settings are maintained when the device is in either partial or complete power-down mode. Table 4 lists the PGA register map.

**Table 4. PGA Register Map**

| REGISTER (Hex) | DECIMAL VALUE | Bit 15 | BIT 14 | BIT 13 | BIT 12 | BIT 11 | BIT 10 | BIT 9 | BIT 8 | BIT 7 | BIT 6 | BIT 5 | BIT 4 | BIT 3 | BIT 2 | BIT 1 | BIT 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 00 | 0 | X(1) | X | X | X | X | X | X | X | X | X | X | X | X | X | REGISTER READOUT ENABLE(2) | SW_RESET |
| 35 | 53 | COMPLETE PDN | PARTIAL PDN | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 3B | 59 | X | X | X | X | X | X | X | X | LOW _ FILTER_BW | PGA_GAIN | | | X | X | X | X |

(1) X = don't care.
(2) Shaded cells indicate used bits.

## Register Descriptions

**Table 5. Register 00h**

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| X | X | X | X | X | X | REGISTER READOUT ENABLE | SW_RESET |

**Bits 15:2** **Don't care**

Default = 0.

**Bit 1** **REGISTER READOUT ENABLE**

0 = Readout disabled (default)
1 = Register readout enabled at SDOUT pin

**Bit 0** **SW_RESET**

0 = Normal operation (default)
1 = Resets the device and self-clears the bit to '0'

**Table 6. Register 35h**

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| COMPLETE PDN | PARTIAL PDN | X | X | X | X | X | X |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| X | X | X | X | X | X | X | X |

**Bit 15** **COMPLETE PDN**

**Bit 14** **PARTIAL PDN**

0 = Normal operation (default)
1 = LNA and PGA powered down

**Bits 13:0** **Don't care**

Default = 0.

**Table 7. Register 3Bh**

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| LOW_FILTER_BW | PGA_GAIN | | | X | X | X | X |

**Bits 15:8** **Don't care**

Default = 0.

**Bit 7** **LOW_FILTER_BW**

0 = 75-MHz bandwidth (default)
1 = 60-MHz bandwidth

**Bits 6:4** **PGA_GAIN**

000 = 18-dB PGA gain (default)
001 = 15-dB PGA gain
010 = 12-dB PGA gain
011 = 9-dB PGA gain
100 = 6-dB PGA gain
101 = 3-dB PGA gain
110 = 0-dB PGA gain

**Bits 3:0** **Don't care**

Default = 0.

# APPLICATION INFORMATION

## THEORY OF OPERATION

The PGA5807A is a programmable gain amplifier (PGA) for applications with input frequencies up to 25 MHz. The device includes a low-noise amplifier (LNA) with a fixed gain, followed by a PGA and an antialiasing filter to reduce noise. The LNA is a fully-differential amplifier with a 12-dB fixed gain and can support a 500-$mV_{PP}$ maximum linear differential input swing. The PGA is implemented as an attenuator followed by a fixed-gain amplifier with 18-dB gain. The attenuator can provide attenuation from 0 dB to –18 dB in 3-dB steps. The attenuator can be controlled by the GAIN[2:0] pins or by using register 3Bh (bits 6 to 4). The antialiasing filter is combined with the fixed-gain amplifier. The filter has one active pole and a passive pole for a combined bandwidth of 75 MHz. For low-frequency applications, bandwidth can be reduced to 60 MHz where better noise can be achieved. The device can be programmed in this mode either by using the SDATA pin while RESET is high or by using bit 7 of register 3Bh. This device can directly drive ADCs such as the ADS5296.

### Low-Noise Amplifier (LNA)

In most data-acquisition systems, an LNA is required at the front-end to obtain good noise performance. The PGA5807A has a fully-differential LNA with a 12-dB fixed gain. The LNA input-referred noise is 1.9 nV/$\sqrt{Hz}$, and supports a differential 500-$mV_{PP}$ input swing. The LNA input can be applied either directly or through an ac-coupling capacitor. Internally, the LNA input is connected to a 2.1-V common-mode voltage via a large resistor (8 kΩ). For direct input coupling, the LNA supports an input common-mode range from 1.9 V to 2.3 V. The LNA input circuits are shown in Figure 20.

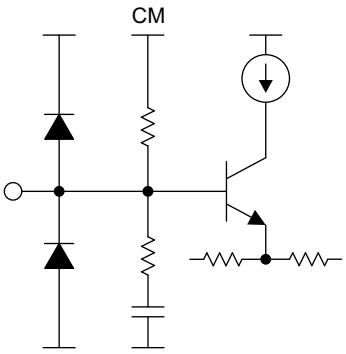



**Figure 20. INP and INM Equivalent Circuits of LNA Inputs**

### Programmable Gain Amplifier (PGA) and Filter

The LNA output is transmitted to a PGA with a programmable gain from 0 dB to 18 dB in 3-dB steps. This gain can either be controlled through a serial interface or through pins, as explained in the *Serial Register Write Description* section. The PGA is implemented as a programmable attenuator and as a fixed-gain amplifier with an 18-dB gain. This architecture helps achieve the same bandwidth across different gain settings. The attenuator provides programmable attenuation from 0 dB to 18 dB.

The attenuator architecture is shown in Figure 21. There are six shunt resistors that can be connected or disconnected to achieve programmable attenuation. The network provides 0-dB attenuation when no shunt resistors are connected. When the first shunt resistor ($RS_1$) is turned on, an attenuation of 3 dB is obtained. For achieving 6-dB attenuation, both $RS_1$ and $RS_2$ are turned on. Similarly, by turning on additional resistors, greater attenuation can be achieved; by turning on all resistors, an effective 18-dB attenuation is achieved.

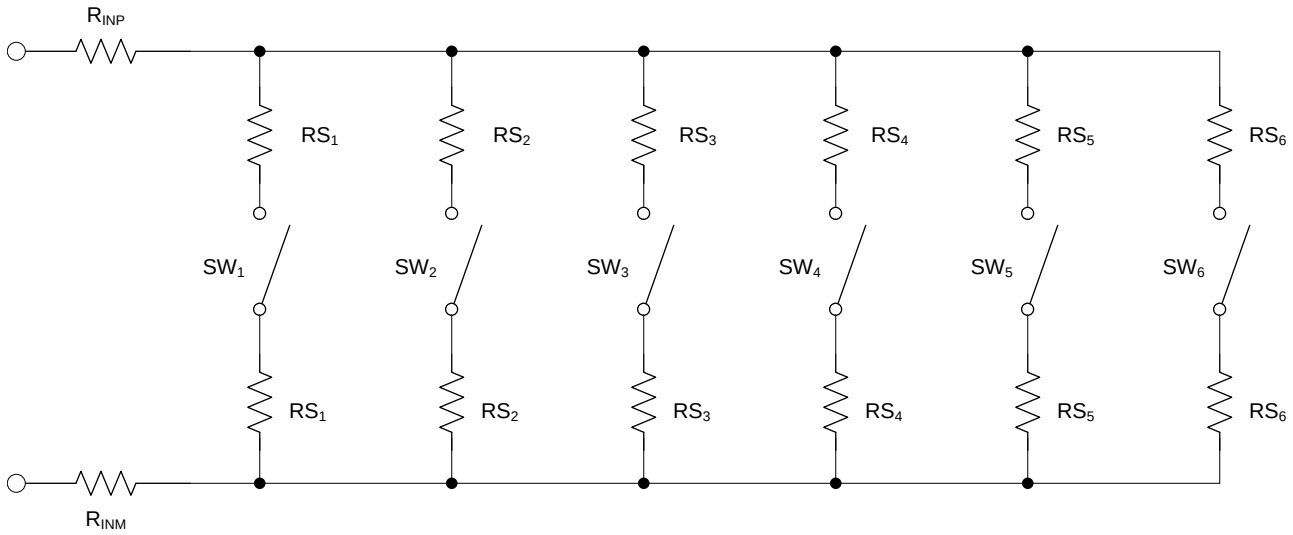



**Figure 21. Programmable Attenuator**

The attenuator is followed by a 18-dB fixed-gain amplifier. The amplifier is implemented as a voltage-to-current (V-to-I) converter followed by a current-to-voltage (I-to-V) converter. The I-to-V bandwidth is limited so that it functions as an LPF and is followed by a passive filter, as shown in Figure 22. Both the active and passive filters provide an antialiasing filter action, which helps reduce noise when the PGA output is sampled by an ADC. The architecture of the passive filter is selected to reduce the glitches that can occur when the PGA5807A output is sampled by an ADC. For example, the PGA5807A can be directly connected to ADC devices (such as the ADS5295 or ADS5296) without any external components between the ADC and PGA5807A. Figure 23 shows an example of the PGA5807A connected directly to the ADS5296.

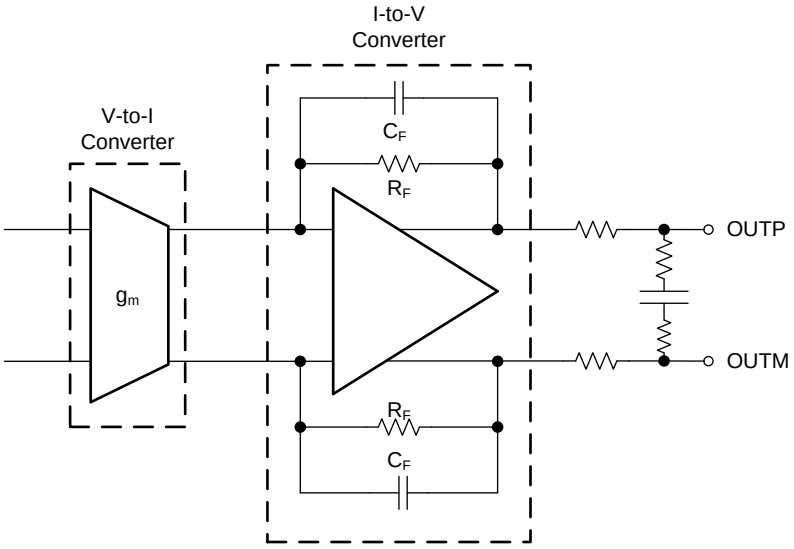



**Figure 22. Antialias Filter**

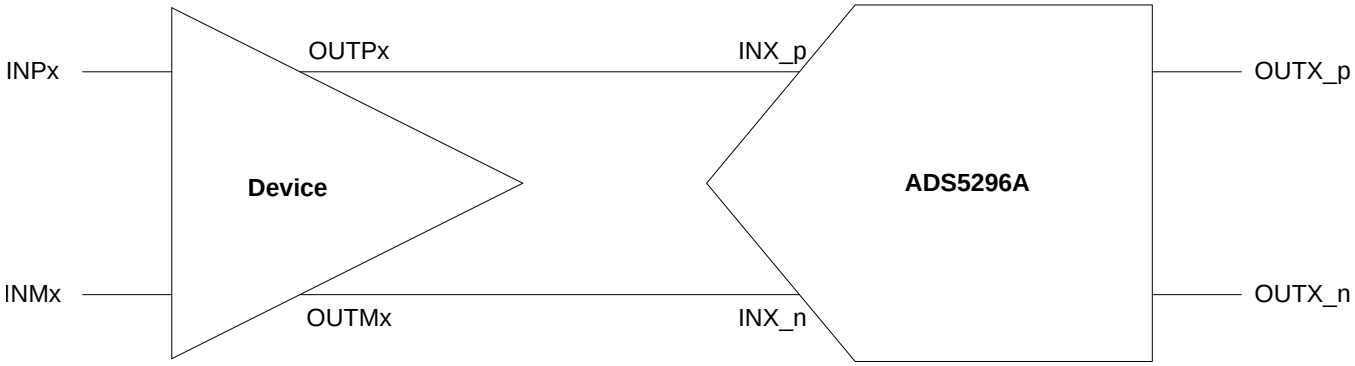



**Figure 23. PGA Connected to an ADC**

## DEVICE CONFIGURATION USING SERIAL INTERFACE OR PARALLEL PINS

Different device modes (such as channel gain and bandwidth) can be programmed by either using the serial interface or external pins. The device can be configured via the serial interface only when the device RESET pin is pulsed and remains low. In this configuration, device gain can be programmed through register 3Bh (bits 6 to 4) and bandwidth can be programmed by register 3Bh (bit 7). When the RESET pin is connected to 3.3 V or is pulled high, the serial interface is unable to control the device. In this configuration, the GAIN[2:0] pins can be used to control gain and the SDATA pin can be used to control bandwidth.

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PGA5807ARGCR | ACTIVE | VQFN | RGC | 64 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | PGA5807 | Samples |
| PGA5807ARGCT | ACTIVE | VQFN | RGC | 64 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | PGA5807 | 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.
**OBSOLETE:** TI has discontinued the production of the device.

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

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

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

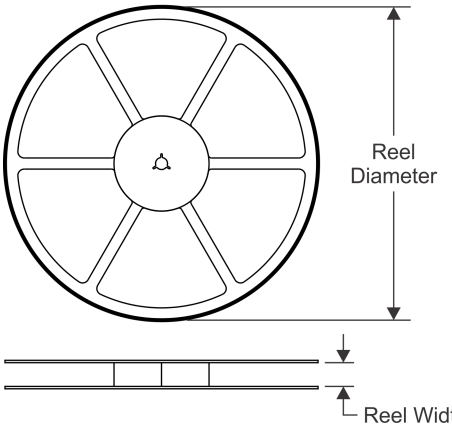
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

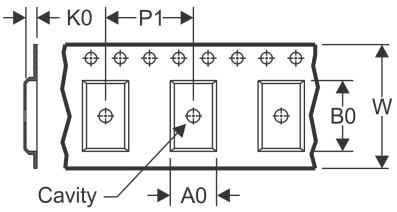
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

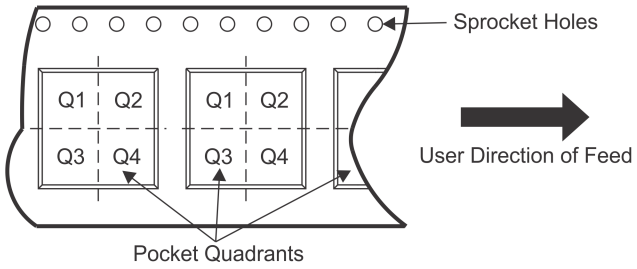



**TAPE DIMENSIONS**




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

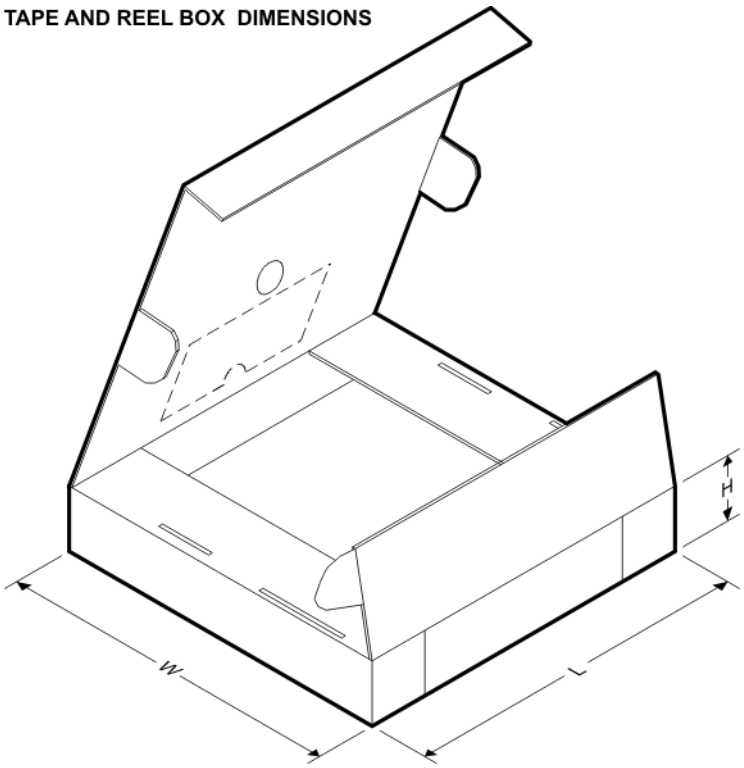
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PGA5807ARGCR | VQFN | RGC | 64 | 2000 | 330.0 | 16.4 | 9.3 | 9.3 | 1.5 | 12.0 | 16.0 | Q2 |
| PGA5807ARGCT | VQFN | RGC | 64 | 250 | 180.0 | 16.4 | 9.3 | 9.3 | 1.5 | 12.0 | 16.0 | Q2 |

TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| PGA5807ARGCR | VQFN | RGC | 64 | 2000 | 350.0 | 350.0 | 43.0 |
| PGA5807ARGCT | VQFN | RGC | 64 | 250 | 213.0 | 191.0 | 55.0 |

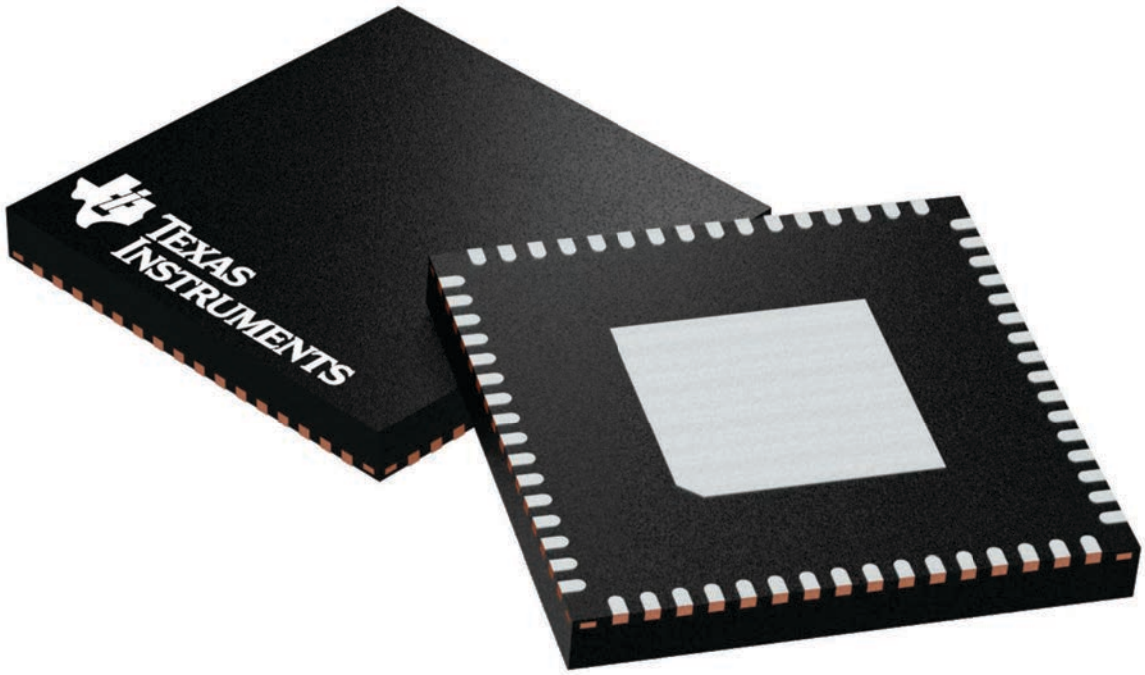
# GENERIC PACKAGE VIEW

## RGC 64

## VQFN - 1 mm max height

**9 x 9, 0.5 mm pitch**

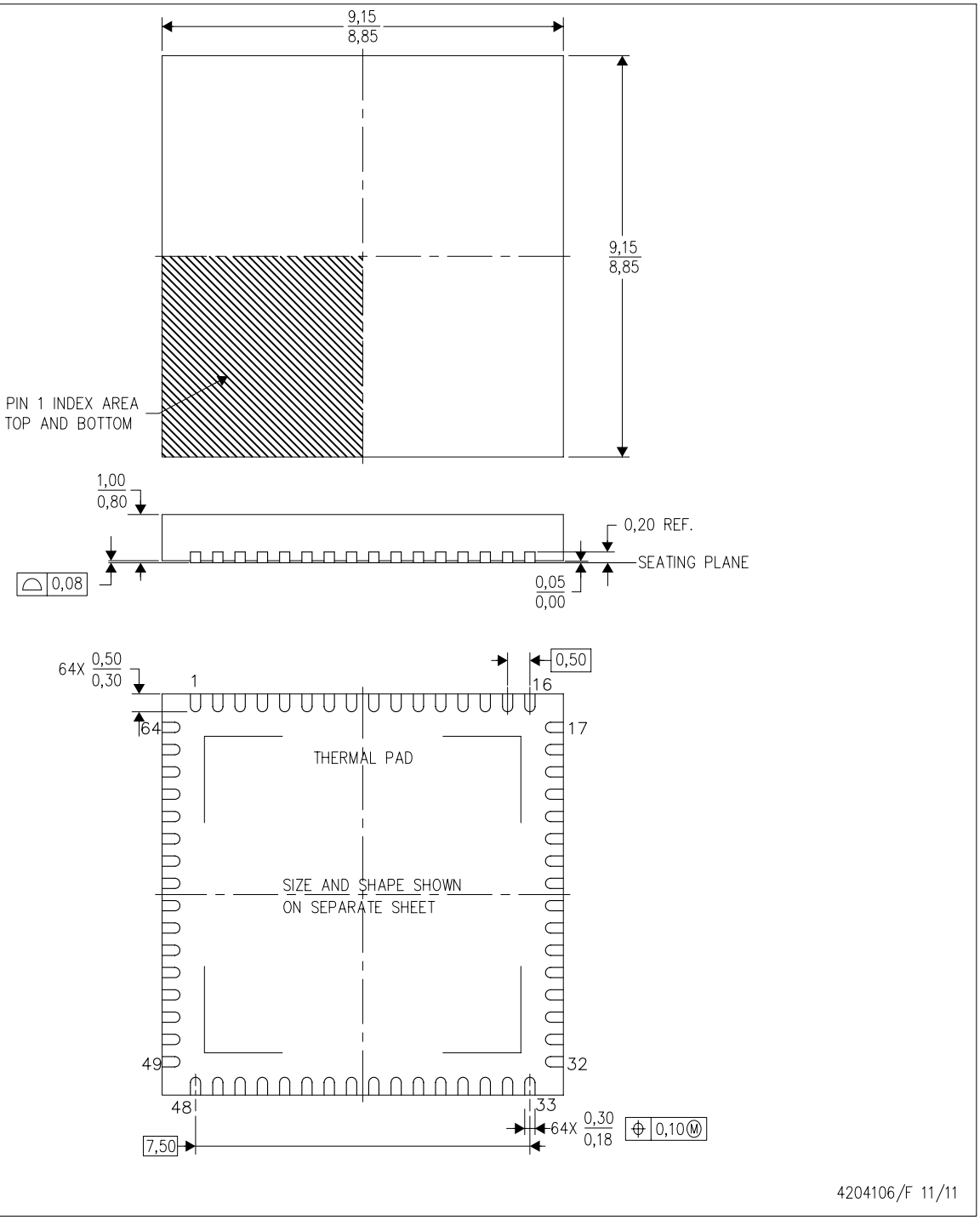
PLASTIC QUAD FLATPACK - NO LEAD




Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4224597/A

RGC(S–PVQFN–N64) CUSTOM DEVICE PLASTIC QUAD FLATPACK NO–LEAD




NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5–1994.
B. This drawing is subject to change without notice.
C. Quad Flatpack, No–leads (QFN) package configuration.
D. The package thermal pad must be soldered to the board for thermal and mechanical performance.
E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.

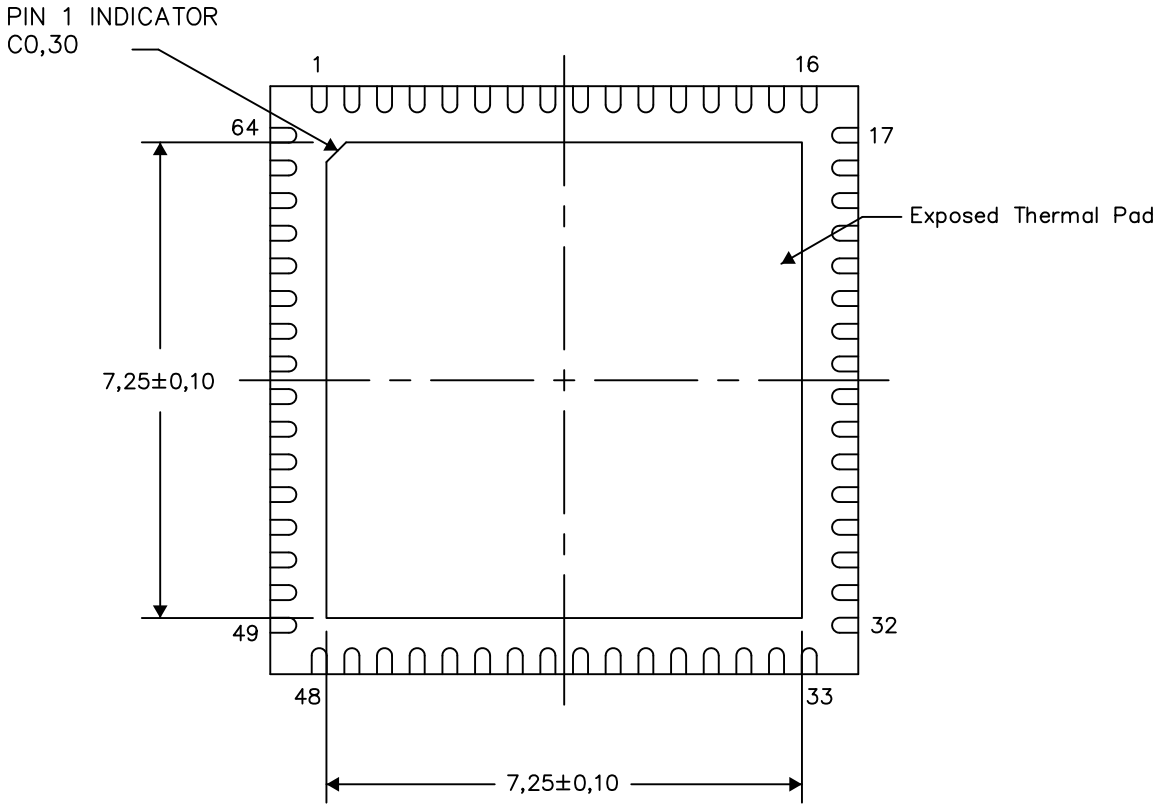
RGC (S–PVQFN–N64) PLASTIC QUAD FLATPACK NO–LEAD

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No–Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



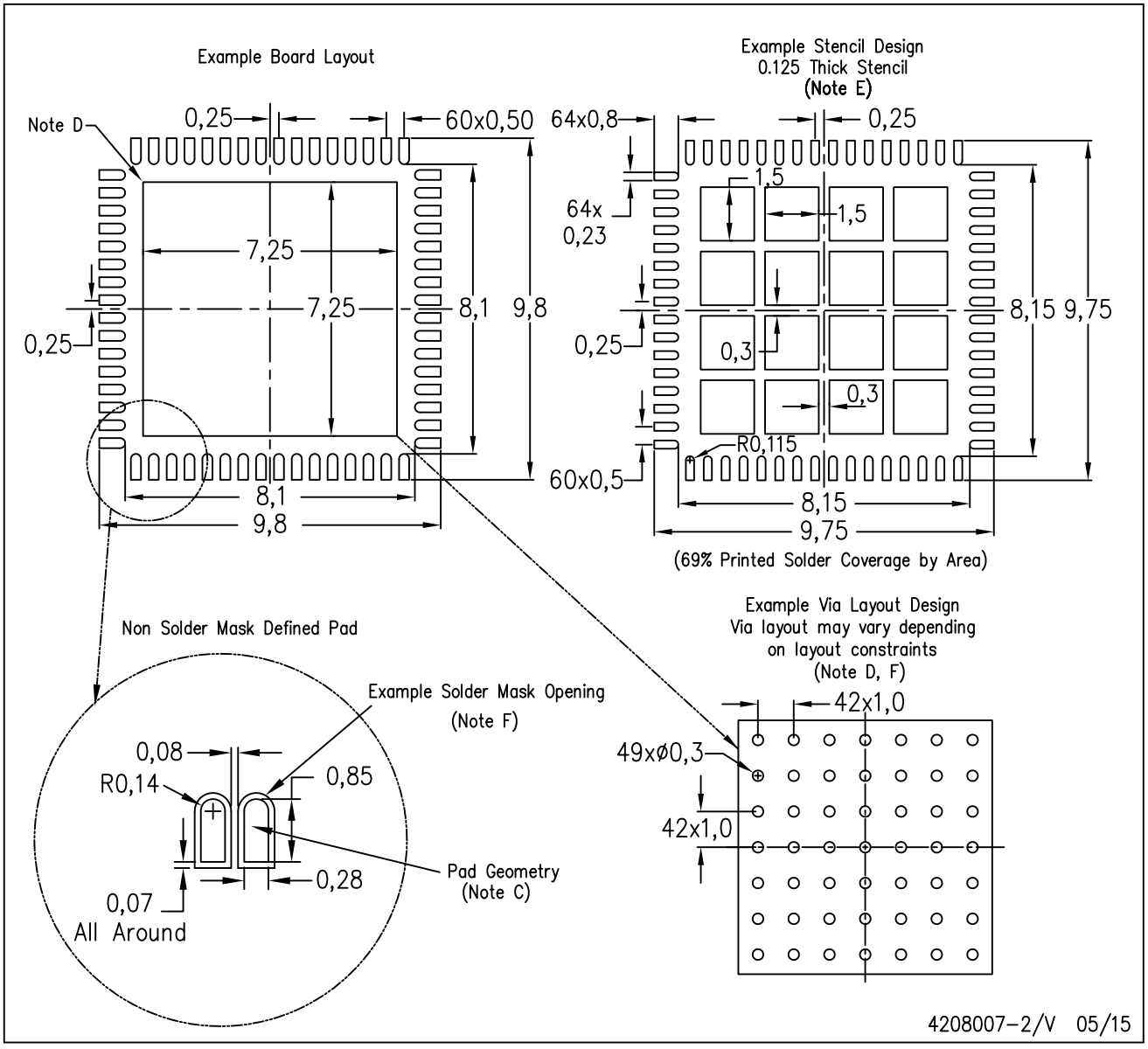

Bottom View

Exposed Thermal Pad Dimensions

4206192–2/AE 03/15

NOTE: A. All linear dimensions are in millimeters

RGC (S–PVQFN–N64) PLASTIC QUAD FLATPACK NO–LEAD




NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat–Pack Packages, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <http://www.ti.com>.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
F. Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in thermal pad.

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