

## Compact, Low Power, 16-Bit, Easy Drive SAR ADC with I3C Interface

### FEATURES

- ▶ Small footprint, big performance
  - ▶ INL:  $\pm 0.5$  LSB maximum
  - ▶ SNR: 86.1dB with  $V_{REF} = 3.3V$
  - ▶ 1.35nJ per conversion
  - ▶ 405 $\mu W$  at 300kSPS in sample mode
  - ▶ 370 $\mu W$ /112 $\mu W$  at 1MSPS/300kSPS in autonomous modes
  - ▶ 4.1 $\mu W$  standby power
- ▶ Versatile signal conditioning integration
  - ▶ Easy Drive features enable small, low-power AFE designs
  - ▶ Compatible with differential and single-ended signal chains
  - ▶ Wide common-mode input range
- ▶ Minimizes digital host activity and power dissipation
  - ▶ Autonomous sampling with window comparator and interrupt generation
  - ▶ Averaging filter with burst sampling support
  - ▶ Power cycling synchronization for companion devices
- ▶ 2-wire I3C Interface compatible with 1.8V to 3.3V logic
- ▶ 2.00mm  $\times$  2.6mm LFCSP and 1.67mm  $\times$  1.97mm WLCSP
- ▶ Wide operating temperature range:  $-40^{\circ}C$  to  $+125^{\circ}C$

### APPLICATIONS

- ▶ Battery-powered data acquisition
- ▶ Vital signs monitoring
- ▶ Biological and chemical analysis
- ▶ Geologic and seismic sensing
- ▶ Motion and robotics

### FUNCTIONAL BLOCK DIAGRAM

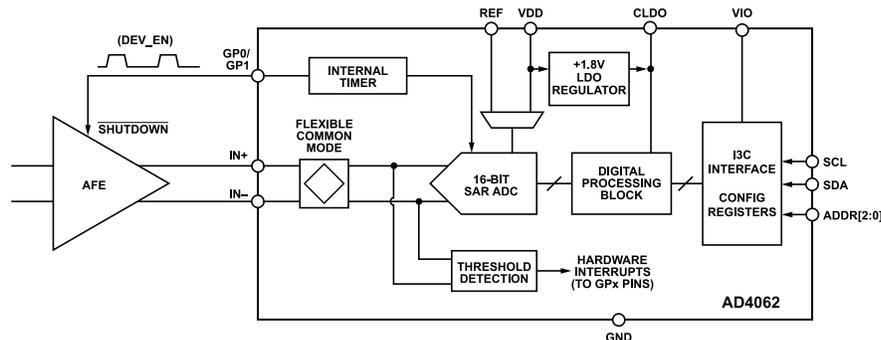


Figure 1. Functional Block Diagram

### GENERAL DESCRIPTION

The AD4062 is a versatile, 16-bit, successive approximation register (SAR) analog-to-digital converter (ADC) that enables low-power, high-density data acquisition solutions without sacrificing precision. This ADC offers a unique balance of performance and power efficiency, plus innovative features for seamlessly switching between high-resolution and low-power modes tailored to the immediate needs of the system. The AD4062 is ideal for battery-powered, compact data acquisition and edge sensing applications.

The Easy Drive features enable highly efficient analog front end (AFE) designs. The small sampling capacitors (3.4pF) maximize input impedance, thus reducing the dependence on high-bandwidth, power-hungry amplifiers typically required by SAR ADCs. The wide input common-mode range grants inherent support for both differential and single-ended signals.

The AD4062 supports microcontrollers with power-down modes and interrupt-driven firmware. The autonomous modes enable out-of-range event detection while the digital host sleeps. The burst averaging mode delivers on-demand, high-resolution measurements while offloading computations from the host processor. The self-timed device enable signal (DEV\_EN) synchronizes AFE device power cycling to the ADC sampling instant, optimizing system power consumption while minimizing power-up settling error artifacts. The AD4062 also supports power cycling the voltage reference and using the supply as the ADC reference voltage ( $V_{REF}$ ) for additional power savings.

The device configuration and ADC data readback is supported via a robust, 2-wire I3C interface with cyclic redundancy check (CRC) supported for all data transfers. The AD4062 is available in compact 14-Lead Lead Frame Chip Scale [LFCSP] and 16-Ball Wafer Level Chip Scale [WLCSP] packages and operates across a wide temperature range, making it ideal for a diverse set of applications.

## TABLE OF CONTENTS

Features.....	1	VDD Power Dissipation.....	52
Applications.....	1	Calculating Serial Interface Output Data Rate.....	54
General Description.....	1	Layout Recommendations.....	55
Functional Block Diagram.....	1	AD4062 Register Summary.....	56
Specifications.....	4	Register Details.....	57
Timing Specifications.....	7	Interface Configuration A Register.....	57
Absolute Maximum Ratings.....	10	Interface Configuration B Register.....	57
Thermal Resistance.....	10	Device Configuration Register.....	57
Electrostatic Discharge (ESD) Ratings.....	10	Device Type Register.....	58
ESD Caution.....	10	Product Identification (LSByte) Register.....	58
Pin Configuration and Function Descriptions.....	11	Product Identification (MSByte) Register.....	58
Typical Performance Characteristics.....	13	Device Grade Register.....	58
Terminology.....	18	Scratch Pad Register.....	58
Theory of Operation.....	19	MIPI Manufacturer ID (LSByte) Register.....	59
Overview.....	19	MIPI Manufacturer ID (MSByte) Register.....	59
Converter Operation.....	19	Reserved Register.....	59
Analog Inputs.....	21	Reserved Register.....	60
Voltage Reference.....	21	Interface Configuration C Register.....	60
Digital Processing Features.....	22	Interface Status Register.....	60
Internal Timer.....	23	ADC Operating Mode Configuration Register..	61
Power Supplies.....	23	ADC Setup Configuration Register.....	61
Comparator Operation.....	23	Averaging Filter Configuration Register.....	62
Interrupts and Control Signals.....	25	General Purpose Pin Configuration Register...	62
Modes of Operation.....	28	Interrupt Configuration Register.....	63
Sample Mode.....	29	Timer Configuration Register.....	64
Burst Averaging Mode.....	31	Maximum Threshold Configuration Register...	65
Autonomous Modes.....	33	Minimum Threshold Configuration Register....	65
Sleep Mode.....	35	Maximum Threshold Hysteresis Register.....	65
Serial Interface.....	36	Minimum Threshold Hysteresis Register.....	65
Dynamic Addressing.....	36	MON_VAL Scaling Register.....	66
Register Address Pointer.....	37	Interface Error IBI Enable Register.....	66
Register Writes.....	37	ADC IBI Enable Register.....	66
Register Reads.....	38	Fuse CRC Register.....	67
Register Access CRC.....	39	Device Status Register.....	67
CONV_READ Register.....	40	Maximum Interrupt Sample Register.....	68
CONV_TRIGGER Register.....	41	Minimum Interrupt Sample Register.....	68
Data Phase Ninth SDA Bit.....	42	Target Address Register.....	68
Common Command Codes (CCCs).....	42	Group Address Register.....	68
Device Reset.....	45	IBI Status Register.....	69
Applications Information.....	47	Conversion Read Result Register.....	69
Typical Applications Diagram.....	47	Conversion Trigger Register.....	70
Analog Front-End Design.....	48	Outline Dimensions.....	71
Reference Circuit Design.....	50	Ordering Guide.....	71
Synchronized Amplifier Shutdown and ADC Sampling.....	50	Evaluation Boards.....	71
Achieving High Accuracy with Reference Shutdown.....	51		

**TABLE OF CONTENTS**

**REVISION HISTORY**

**7/2025—Revision 0: Initial Version**

## SPECIFICATIONS

VDD = 2.3V to 3.6V, V<sub>REF</sub> = 2.3V to 3.6V, V<sub>IO</sub> = 1.71V to 3.6V, reference capacitance (C<sub>REF</sub>) = 2.2μF, and operating at the maximum specified sample rate (f<sub>S</sub>), unless otherwise specified. All other features in default configuration, minimum and maximum values at T<sub>A</sub> = -40°C to +125°C, and typical values at T<sub>A</sub> = +25°C, unless otherwise specified.

Table 1. Specifications

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
<b>RESOLUTION</b>					
ADC Resolution		16			Bits
Averaging Filter Resolution	Burst averaging mode	20			Bits
Comparator Mode Resolution	Autonomous modes	12			Bits
<b>SAMPLING DYNAMICS</b>					
Sampling Rate (f <sub>S</sub> ) <sup>1</sup>				2	MSPS
Aperture Delay			0.3		ns
<b>ANALOG INPUT</b>					
Input Voltage (V <sub>IN</sub> ) Range <sup>2</sup>	V <sub>IN</sub> = V <sub>IN+</sub> - V <sub>IN-</sub> Differential mode	-V <sub>REF</sub>		+V <sub>REF</sub>	V
	Single-ended mode	0		+V <sub>REF</sub>	V
Absolute Input Voltage <sup>2</sup>	V <sub>IN+</sub> , V <sub>IN-</sub>	-0.1		VDD + 0.1	V
Common-Mode Input Voltage (V <sub>CM</sub> ) Range <sup>3</sup>	V <sub>CM</sub> = (V <sub>IN+</sub> + V <sub>IN-</sub> )/2	-0.1		VDD + 0.1	V
Analog Input Leakage Current	IN+, IN-		6		nA
Sampling Capacitance (C <sub>IN</sub> )			3.4		pF
Analog Input Capacitance <sup>4</sup>	IN+, IN-				
Track Phase			5.4		pF
Hold Phase			2.0		pF
<b>DC ACCURACY</b>					
No Missing Codes	V <sub>REF</sub> = 3.3 V	16			Bits
Transition Noise	Sample mode (no averaging) Differential mode		1.1		LSB rms
	Single-ended mode		2.2		LSB rms
Low Frequency Noise	Bandwidth = 0.1Hz to 10Hz		9.3		μVpp
Integral Nonlinearity (INL)		-0.5	±0.15	+0.5	LSB
Differential Nonlinearity (DNL) <sup>5</sup>		-0.5	±0.1	+0.5	LSB
Zero Error		-350	±30	+350	μV
Zero-Error Drift			±0.03		ppm/°C
Gain Error		-0.03	±0.0008	+0.03	%FS
Gain Error Drift			±0.2		ppm/°C
Total Unadjusted Error (TUE) <sup>6</sup>		-200	±8	+200	ppm
Autonomous Mode TUE <sup>7</sup>			±7		mV
<b>REFERENCE</b>					
V <sub>REF</sub> Input Range		2.3		VDD	V
REF Standby Current	V <sub>REF</sub> = 3.3V		8		nA
REF Average Input Current <sup>8</sup>	V <sub>REF</sub> = 3.3V, f <sub>S</sub> = 300kSPS		9	10	μA
<b>AC PERFORMANCE</b>					
Total RMS Noise	V <sub>REF</sub> = 3.3V Sample mode (no averaging)		112		μVrms
	Burst averaging mode, averaging ratio (N <sub>AVG</sub> ) = 4		56		μVrms
	Burst averaging mode, averaging ratio N <sub>AVG</sub> = 4096		2.2		μVrms
Dynamic Range					

## SPECIFICATIONS

Table 1. Specifications (Continued)

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
Differential Mode	Sample mode (no averaging)		86.1		
	Burst averaging mode, $N_{AVG} = 4$		92.1		
	Burst averaging mode, $N_{AVG} = 4096$		120.7		
Single-Ended Mode	Sample mode (no averaging)		80.1		
	Burst averaging mode, $N_{AVG} = 4$		86.1		
	Burst averaging mode, $N_{AVG} = 4096$		114.7		
Signal-to-Noise Ratio (SNR)	$V_{IN} = -0.5dBFS$ , input frequency ( $f_{IN}$ ) = 1kHz				
Differential Mode	Sample mode (no averaging)		86.1		dB
Single-Ended Mode	Sample mode (no averaging)		80.1		dB
Total Harmonic Distortion (THD)	$V_{IN} = -0.5dBFS$ , $f_{IN} = 1kHz$ , sample mode	-118		-109	dB
Signal-to-Noise and Distortion (SINAD)	$V_{IN} = -0.5dBFS$ , $f_{IN} = 1kHz$ , sample mode				
Differential Mode			86.1		dB
Single-Ended Mode			80.1		dB
-3dB Input Bandwidth			200		MHz
DIGITAL INPUTS					
Input Low Voltage ( $V_{IL}$ )		$-0.1 \times V_{IO}$		$+0.3 \times V_{IO}$	V
Input High Voltage ( $V_{IH}$ )		$0.7 \times V_{IO}$		$1.1 \times V_{IO}$	V
Input Low Current ( $I_{IL}$ )		-1		+1	$\mu A$
Input High Current ( $I_{IH}$ )		-1		+1	$\mu A$
Digital Input Capacitance			3		pF
DIGITAL OUTPUTS					
Output Low Voltage ( $V_{OL}$ )					
SDA	Digital output current = +3mA			0.3	V
GP0, GP1	Digital output current = +500 $\mu A$			0.3	V
Output High Voltage ( $V_{OH}$ )					
SDA <sup>9</sup>	Digital output current = -3mA	$V_{IO} - 0.3$			V
GP0, GP1	Digital output current = -500 $\mu A$	$V_{IO} - 0.3$			V
Digital Output Short-Circuit Current	$V_{IO} = 3.3V$				
Sourcing	Logic high shorted to 0V		48		mA
Sinking	Logic low shorted to 3.3V		38		mA
POWER REQUIREMENTS					
VDD		2.3		3.6	V
VIO		1.71		3.6	V
POWER SUPPLY CURRENT					
Sleep Mode Current	$V_{DD} = 3.3V$ $f_S = 0SPS$				
VDD			10		nA
VIO	$V_{IO} = 1.8V$		20		nA
	$V_{IO} = 3.3V$		120		nA
Standby Current	$f_S = 0SPS$				
VDD			990		nA
VIO	$V_{IO} = 1.8V$		50		nA
	$V_{IO} = 3.3V$		260		nA
VDD Active Supply Current <sup>10</sup>					
Sample Mode	$f_S = 10kSPS$		4		$\mu A$

## SPECIFICATIONS

Table 1. Specifications (Continued)

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
Autonomous Modes	$f_s = 300\text{kSPS}$		120	160	$\mu\text{A}$
	$f_s = 10\text{kSPS}$		1.12		$\mu\text{A}$
	$f_s = 300\text{kSPS}$		34		$\mu\text{A}$
	$f_s = 1\text{MSPS}$		112		$\mu\text{A}$
	$f_s = 2\text{MSPS}$		224	300	$\mu\text{A}$
POWER DISSIPATION	VDD = VIO = 3.3V				
Sleep Mode Power Dissipation	$f_s = 0\text{SPS}$		430		nW
Standby Power Dissipation	$f_s = 0\text{SPS}$		4.1		$\mu\text{W}$
VDD Energy per Conversion			1.35		nJ
VDD Active Power Dissipation <sup>10</sup>					
Sample Mode	$f_s = 10\text{kSPS}$		13.6		$\mu\text{W}$
	$f_s = 300\text{kSPS}$		405	528	$\mu\text{W}$
Autonomous Modes	$f_s = 10\text{kSPS}$		3.7		$\mu\text{W}$
	$f_s = 300\text{kSPS}$		112		$\mu\text{W}$
	$f_s = 1\text{MSPS}$		370		$\mu\text{W}$
	$f_s = 2\text{MSPS}$		740	990	$\mu\text{W}$

<sup>1</sup> Sampling rate specifies the maximum sample rate capabilities of the AD4062 ADC. Output data rate is the number of ADC samples that can be transmitted over the serial interface per second and is a function of the I3C interface timing specifications. In sample mode, the I3C interface bottlenecks the AD4062 output data rate to <2MSPS. In burst averaging mode and autonomous modes, the output data rate requirements are reduced, and the AD4062 ADC core can operate at the full 2MSPS. See the [Calculating Serial Interface Output Data Rate](#) section for guidelines for estimating AD4062 I3C output data rate for each operating mode.

<sup>2</sup>  $V_{\text{IN}+}$  and  $V_{\text{IN}-}$  represent the voltages on the IN+ and IN- pins, respectively. The AD4062 samples and converts the difference between  $V_{\text{IN}+}$  and  $V_{\text{IN}-}$ .

<sup>3</sup> See the [Wide Input Common-Mode Range](#) section for a detailed description of the AD4062 common-mode input voltage range.

<sup>4</sup> In the track phase, the total input capacitance is the sum of  $C_{\text{IN}}$  and the pin capacitance. In the hold phase,  $C_{\text{IN}}$  is disconnected from the inputs, and the input capacitance is only the pin capacitance. See [Figure 43](#).

<sup>5</sup> The minimum and maximum DNL specifications are guaranteed by design.

<sup>6</sup> TUE is defined as the largest deviation from the ideal DC transfer function over the full input range for any individual device. TUE includes the combined effects of zero-error, gain error, and INL error for each device.

<sup>7</sup> Autonomous mode TUE applies to the comparator operation. See the [Comparator Operation](#) and the [Autonomous Modes](#) sections.

<sup>8</sup> The averaging REF input current scales linearly with  $f_s$  (see [Figure 26](#)).

<sup>9</sup> For push-pull operation only.

<sup>10</sup> VDD supply current and power dissipation scale linearly with  $f_s$  (see the [VDD Power Dissipation](#) section, [Figure 29](#), and [Figure 32](#)).

## SPECIFICATIONS

## TIMING SPECIFICATIONS

VDD = V<sub>REF</sub> = 2.3V to 3.6V, VIO = 1.71V to 3.6V, I3C bus capacitance (C<sub>BUS</sub>) = 50pF, and all other features in default configuration. Minimum and maximum limits at T<sub>A</sub> = -40°C to +125°C and typical values at T<sub>A</sub> = +25°C, unless otherwise indicated.

Table 2. ADC Parameters

Parameter <sup>1</sup>	Symbol	Min	Typ	Max	Unit
Sampling Rate <sup>2</sup>	f <sub>s</sub>			2	MSPS
Sample Period <sup>2</sup>	t <sub>CYC</sub>	500			ns
Conversion Time	t <sub>CONV</sub>		270	320	ns
Acquisition Time <sup>3,4</sup>	t <sub>ACQ</sub>				
f <sub>s</sub> = 2MSPS		290	327		ns
f <sub>s</sub> = 300kSPS		3123.3	3160.3		ns
Internal Timer Frequency <sup>5</sup>	f <sub>OSC</sub>	-15%	f <sub>OSC</sub>	+15%	ns

<sup>1</sup> The t<sub>CONV</sub> specifications is production tested. All other timing specifications in this table are guaranteed by characterization and design.

<sup>2</sup> Sampling rate specifies the maximum sample rate capabilities of the AD4062 ADC. Output data rate is the number of ADC samples that can be transmitted over the serial interface per second and is a function of the I3C interface timing specifications. In sample mode, the I3C interface bottlenecks the AD4062 output data rate to <2 MSPS. In burst averaging mode and autonomous modes, the output data rate requirements are reduced, and the AD4062 ADC core can operate at the full 2 MSPS. See the [Calculating Serial Interface Output Data Rate](#) section for guidelines for estimating AD4062 I3C output data rate for each operating mode.

<sup>3</sup> The t<sub>ACQ</sub> specification is the time available for the input sampling capacitors to acquire the input voltage for a given sample rate. The t<sub>ACQ</sub> specification is equivalent to the time the ADC spends in track phase. The t<sub>ACQ</sub> specification is inversely proportional to the sample rate. Therefore, the t<sub>ACQ</sub> specification increases as the sample rate decreases. The minimum t<sub>ACQ</sub> specification for any given sample period rate is given by the following equation:

$$t_{ACQ} = t_{CYC} - 210 \text{ ns} \quad (1)$$

<sup>4</sup> See the [Device Enable Signal](#) section for a description of acquisition time while using the DEV\_EN signal to power cycle the analog front end.

<sup>5</sup> The internal timer sets the sampling frequency in burst averaging mode and autonomous modes. The AD4062 is guaranteed to operate at the maximum f<sub>OSC</sub> specification. See [Table 52](#) for the nominal sampling frequency options.

Table 3. Open Drain Parameters

Parameter <sup>1</sup>	Symbol	Min	Typ	Max	Unit
SCL Low Time	t <sub>LOW_OD</sub>	200			ns
SCL High Time	t <sub>HIGH_OD</sub>	32			ns
SDA Fall Time	t <sub>FDA_OD</sub>			4.2	ns
SDA Rise Time	t <sub>RDA_OD</sub>			120	ns
SDA Data Setup Time	t <sub>SU_OD</sub>	1.5			ns
Clock After Start Time	t <sub>CAS</sub>	38.4			ns
Clock Before Stop Time	t <sub>CBP</sub>	19.2			ns
Bus Available Condition	t <sub>AVAL</sub>	1			μs

<sup>1</sup> The t<sub>LOW\_OD</sub>, t<sub>HIGH\_OD</sub>, t<sub>CAS</sub> and t<sub>CBP</sub> specifications are production tested. All other timing specifications in this table are guaranteed by characterization and design.

**SPECIFICATIONS**

**Table 4. Push-Pull Parameters**

Parameter <sup>1</sup>	Symbol	Min	Typ	Max	Unit
SCL Clock Frequency	$f_{SCL}$	0.01	12.5	12.9	MHz
SCL Clock Low Time	$t_{LOW}$	24			ns
SCL Clock High Time	$t_{HIGH}$	24			ns
SDA Data Out Hold Time	$t_{HD\_PP}$	10			ns
SDA Data Valid Delay	$t_{DSDA}$			34	ns
Time Delay to Switch from Push-Pull to High-Z State	$t_{SCO}$			12	ns
SDA Data In Setup Time	$t_{SU\_PP}$	1.5			ns
Clock Before Repeated Start	$t_{CASr}$	19.2			ns
Clock After Repeated Start	$t_{CBSr}$	19.2			ns

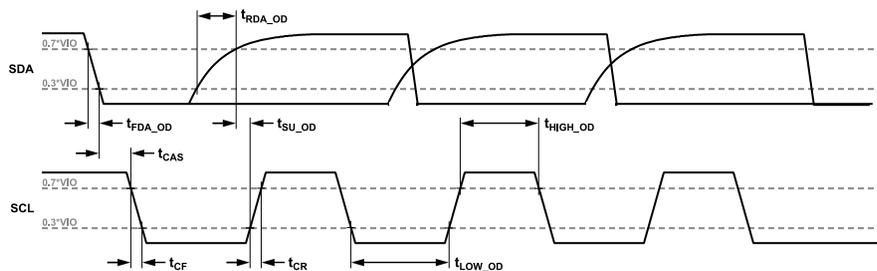
<sup>1</sup> The  $t_{LOW}$ ,  $t_{HIGH}$ ,  $t_{CASr}$  and  $t_{CBSr}$  specifications are production tested. All other timing specifications in this table are guaranteed by characterization and design.

**Table 5. Device Specific/Other Parameters**

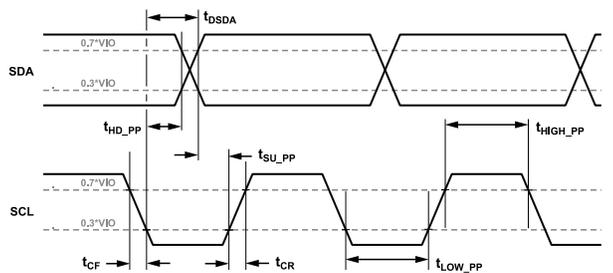
Parameter	Symbol	Min	Typ	Max	Unit
Time Between Stop and Start	$t_{BUF}$	38			ns
IBI Delay <sup>1</sup>	$t_{IBI\_ISSUE}$		28		$\mu$ s
Reset Delay for Fuse Reload	$t_{RESET\_FUSE\_RELOAD}$		5		ns
Reset Delay for Peripheral Reset	$t_{RESET\_PERIPHERAL}$		60		ns

<sup>1</sup> Time between IBI event happening and the AD4062 pulling SDA low to indicate the occurrence of an IBI event.

**Timing Diagrams**



**Figure 2. Open Drain Parameters**



**Figure 3. Push-Pull Parameters**

SPECIFICATIONS

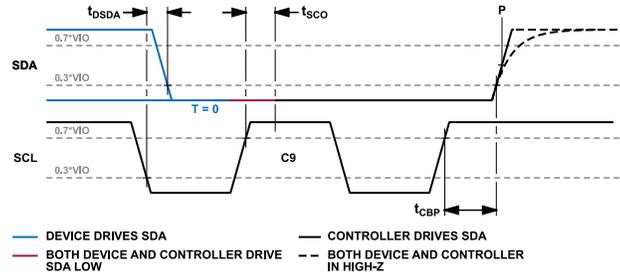


Figure 4. T-Bit When AD4062 Ends Read and Controller Generates Stop

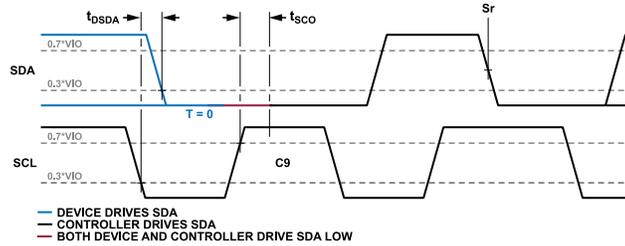


Figure 5. T-Bit When AD4062 Ends Read and Controller Generates Repeated Start

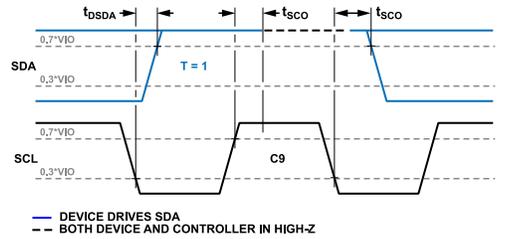


Figure 6. T-Bit When AD4062 and Controller Agree to Continue Reading Message

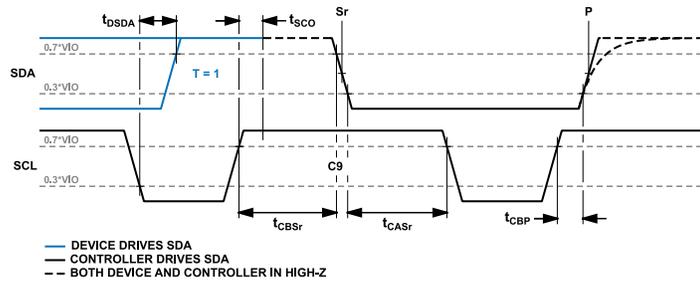


Figure 7. T-Bit When Controller Ends Read With Repeated Start and Stop

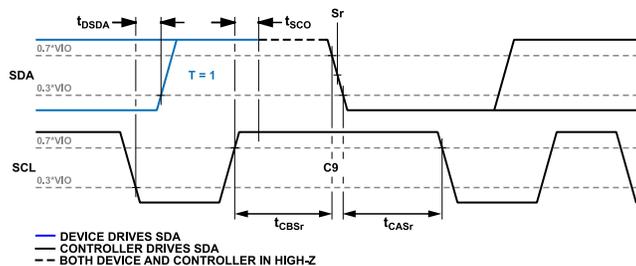


Figure 8. T-Bit When Controller Ends Read Via Repeated Start and Further Transfer

## ABSOLUTE MAXIMUM RATINGS

Table 6. Absolute Maximum Ratings

Parameter	Rating
Analog Inputs	
IN+, IN-, and REF to GND	-0.3V to VDD + 0.3V
Supply Voltages	
VDD and VIO to GND	-0.3V to +3.96V
CLDO to GND	-0.3V to +2.1V
Digital Inputs to GND	-0.3V to VIO + 0.3V
Digital Outputs to GND	-0.3V to VIO + 0.3V
Temperature	
Storage	-55°C to +150°C
Operating T <sub>J</sub> Range	-40°C to +125°C
Maximum Reflow (Package Body)	260°C

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

## THERMAL RESISTANCE

Thermal performance is directly linked to printed circuit board (PCB) design and operating environment. Careful attention to PCB thermal design is required.

Table 7. Thermal Resistance

Package Type <sup>1</sup>	$\theta_{JA}$ <sup>2</sup>	$\theta_{JC}$ <sup>3</sup>	Unit
CP-14-7	73.9	52.3	°C/W
CB-16-26	49.6	0.6	°C/W

<sup>1</sup> Test Condition 1: thermal impedance simulated values are based upon use of 2S2P JEDEC PCB.

<sup>2</sup>  $\theta_{JA}$  is the natural convection junction-to-ambient thermal resistance measured in a one cubic foot sealed enclosure.

<sup>3</sup>  $\theta_{JC}$  is the junction-to-case thermal resistance.

## ELECTROSTATIC DISCHARGE (ESD) RATINGS

The following ESD information is provided for handling of ESD-sensitive devices in an ESD-protected area only.

Human body model (HBM) per ANSI/ESDA/JEDEC JS-001.

Field induced charged device model (FICDM) per ANSI/ESDA/JEDEC JS-002.

### ESD Ratings for AD4062

Table 8. AD4062, 14-Lead LFCSP and 16-Ball WLCSP

ESD Model	Withstand Threshold (kV)	Class
HBM	4	3A
FICDM	1.25	C3

## 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 CONFIGURATION AND FUNCTION DESCRIPTIONS

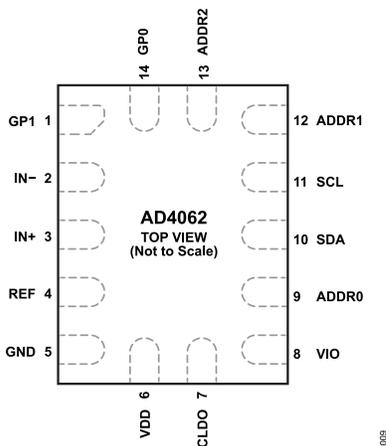


Figure 9. AD4062 LFCSP Pin Configuration

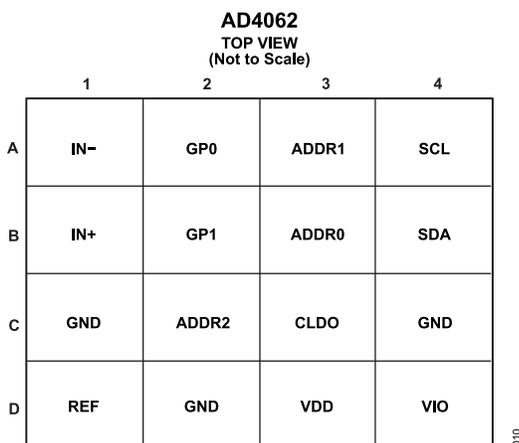


Figure 10. AD4062 WLCSP Pin Configuration

Table 9. AD4062 LFCSP and WLCSP Pin Function Descriptions

LFCSP Pin No.	WLCSP Pin No.	Mnemonic	Type	Description
1	B2	GP1	DO	General Purpose Output 1. The GP1 pin is a digital output that can be configured as multiple device interrupt signals. See the <a href="#">Interrupts and Control Signals</a> section.
2	A1	IN-	AI	Negative Analog Input. See the <a href="#">Analog Inputs</a> section.
3	B1	IN+	AI	Positive Analog Input. See the <a href="#">Analog Inputs</a> section.
4	D1	REF	AI	Reference Input. Decouple the REF pin with a 2.2 $\mu$ F capacitor to GND. See the <a href="#">Voltage Reference</a> section.
5	C1, C4, D2	GND	P	Power Supply Ground.
6	D3	VDD	P	Analog Power Supply. Decouple the VDD pin with a 1 $\mu$ F capacitor to GND. The VDD pin is also the input to the +1.8V internal LDO regulator that supplies the CLDO pin supply voltage. See the <a href="#">Power Supplies</a> section.
7	C3	CLDO	P	ADC Core Power Supply. The CLDO pin is powered by the +1.8 V internal low-dropout (LDO) regulator. Decouple the CLDO pin with a 1 $\mu$ F capacitor to GND. See the <a href="#">Power Supplies</a> section.
8	D4	VIO	P	Logic Voltage Supply. The VIO pin sets the logic voltage levels for digital inputs and digital outputs. Decouple the VIO pin with a 1 $\mu$ F capacitor to GND. See the <a href="#">Power Supplies</a> section.
9	B3	ADDR0	DI	Address 0 Input. Sets Bit[0] of the part instance in 48-bit provisional ID. See the <a href="#">Table 19</a> section. <sup>1</sup>
10	B4	SDA	DI/DO	Serial Data I/O
11	A4	SCL	DI	Serial Data Clock Input.

## PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

Table 9. AD4062 LFCSP and WLCSP Pin Function Descriptions (Continued)

LFCSP Pin No.	WLCSP Pin No.	Mnemonic	Type	Description
12	A3	ADDR1	DI	Address 1 Input. Sets Bit[1] of the part instance in 48-bit provisional ID. See the <a href="#">Table 19</a> section. <sup>1</sup>
13	C2	ADDR2	DI	Address 2 Input. Sets Bit[2] of the part instance in 48-bit provisional ID. See the <a href="#">Table 19</a> section. <sup>1</sup>
14	A2	GP0	DO	General Purpose Output 0. The GP0 pin is a digital output that can be configured as multiple device control or interrupt signals. See the <a href="#">Interrupts and Control Signals</a> section.

<sup>1</sup> The ADDR[2:0] pins enable the assignment of up to eight unique part instance values to support up to eight AD4062 devices on one I3C bus.

TYPICAL PERFORMANCE CHARACTERISTICS

VDD = 3.3V, VREF = 3.3V, VIO = 3.3V, CREF = 2.2μF, maximum fS, TA = 25°C, and all features in default configuration, unless otherwise specified.

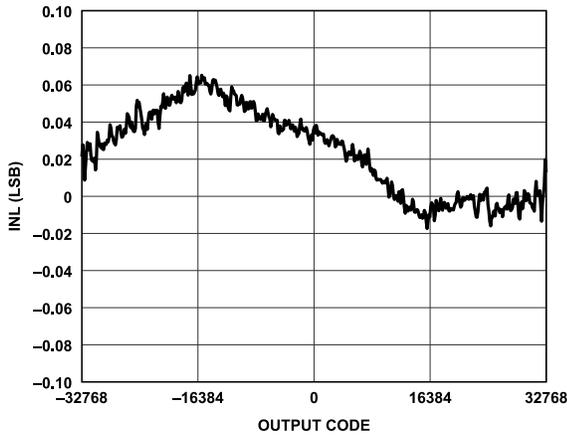


Figure 11. INL vs. Output Code

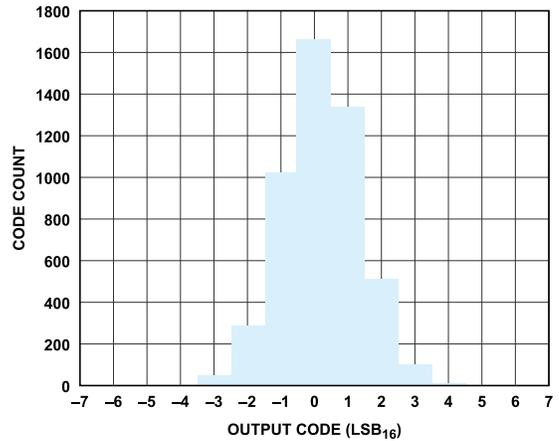


Figure 14. Histogram, Sample Mode (No Averaging)

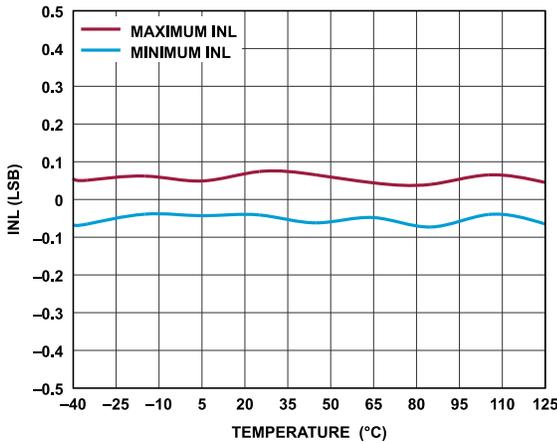


Figure 12. INL vs. Temperature

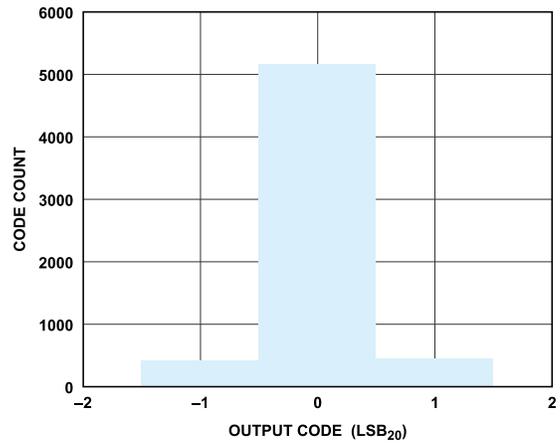


Figure 15. Histogram, Averaging Mode, N\_AVG = 4096

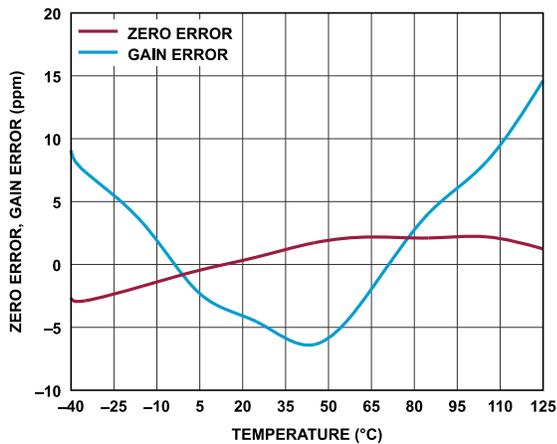


Figure 13. Zero Error and Gain Error vs. Temperature

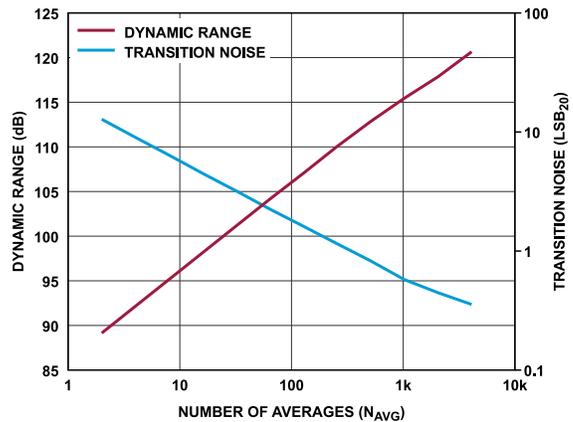


Figure 16. Dynamic Range and Transition Noise vs. N\_AVG

TYPICAL PERFORMANCE CHARACTERISTICS

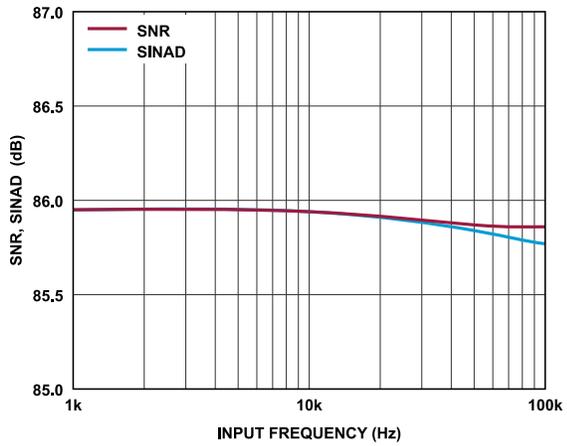


Figure 17. SNR, SINAD vs. Input Frequency

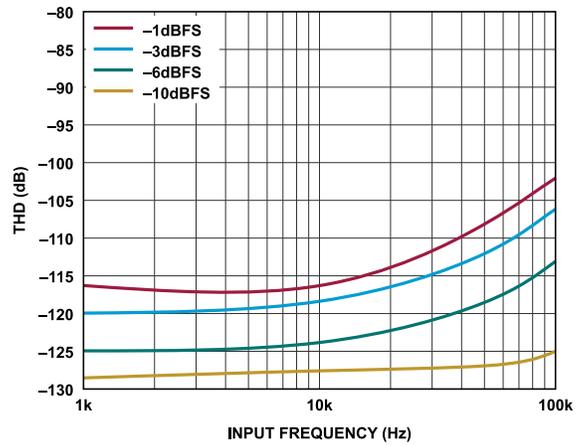


Figure 20. THD vs. Input Frequency and Amplitude

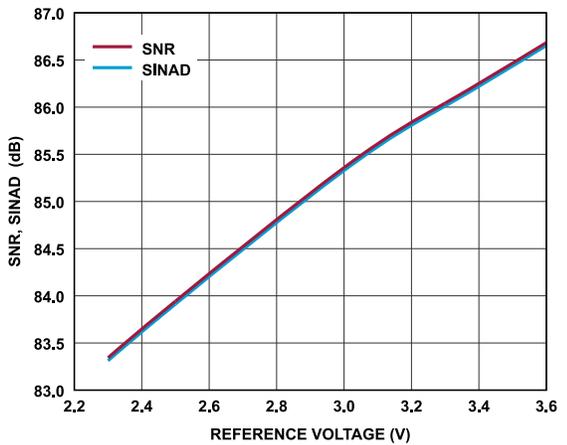


Figure 18. SNR, SINAD vs. Reference Voltage

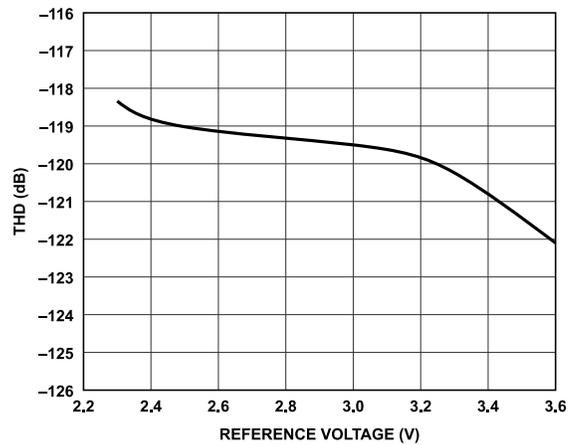


Figure 21. THD vs. Reference Voltage

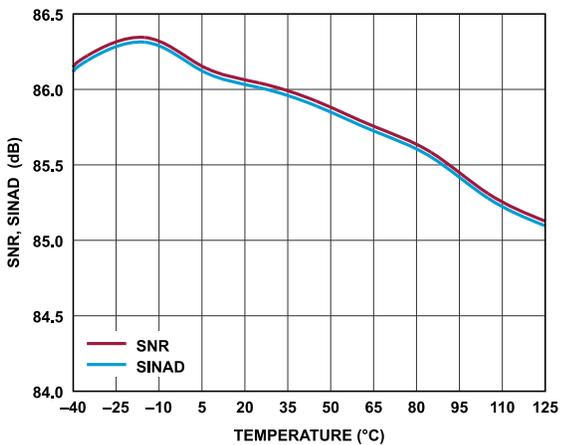


Figure 19. SNR, SINAD vs. Temperature

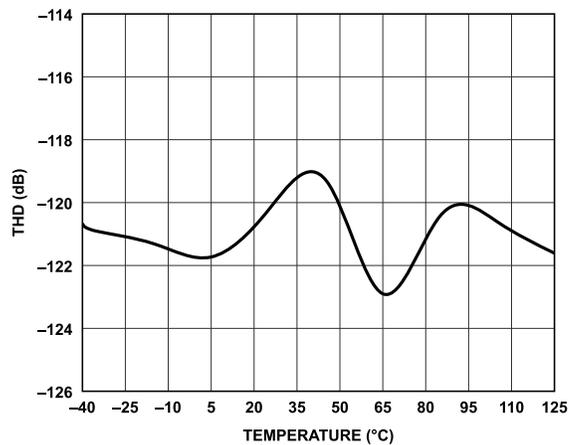


Figure 22. THD vs. Temperature

TYPICAL PERFORMANCE CHARACTERISTICS

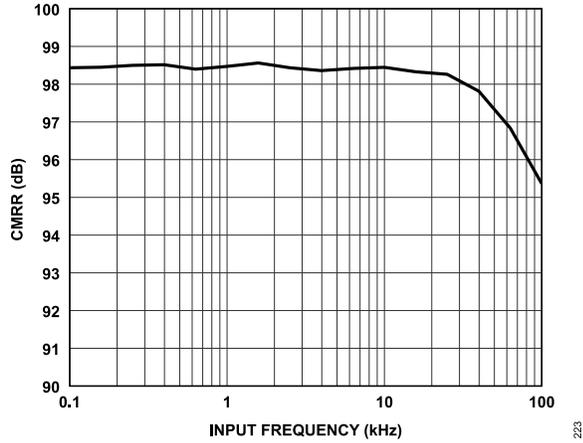


Figure 23. Common-Mode Rejection Ratio (CMRR) vs. Input Frequency

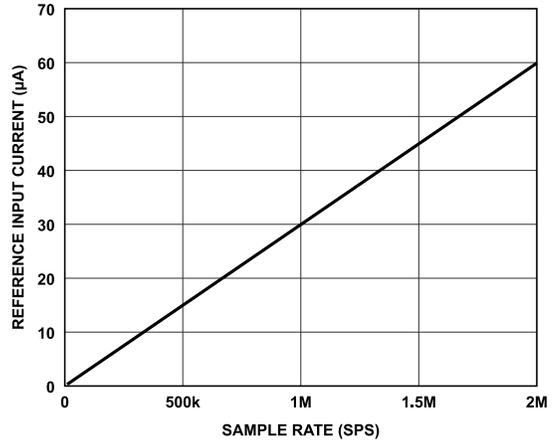


Figure 26. Reference Input Current vs. Sample Rate

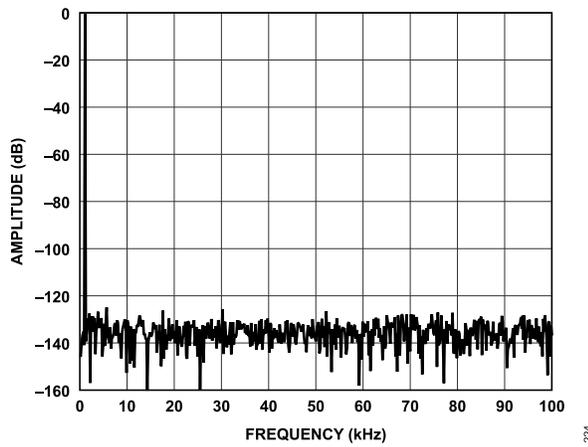


Figure 24. FFT,  $f_s = 200\text{kSPS}$ ,  $f_{IN} = 1\text{kHz}$

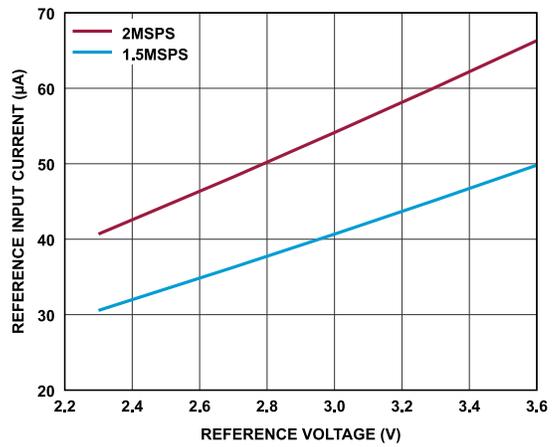


Figure 27. Reference Input Current vs. Reference Voltage

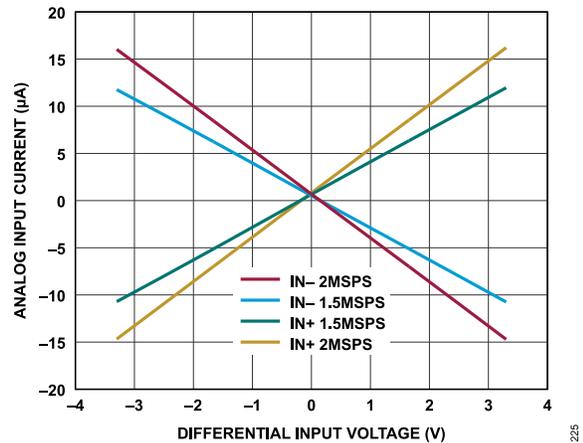


Figure 25. Analog Input Current vs. Differential Input Voltage

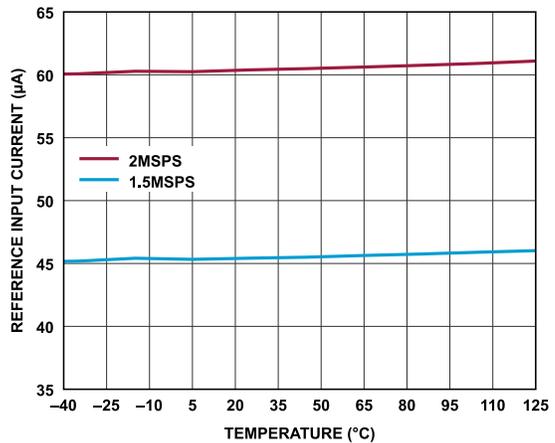


Figure 28. Reference Input Current vs. Temperature

TYPICAL PERFORMANCE CHARACTERISTICS

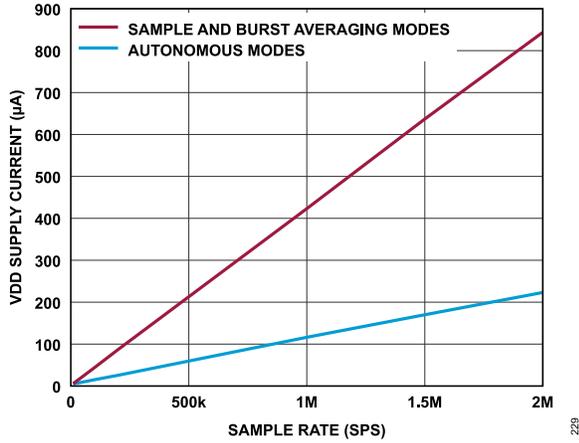


Figure 29. VDD Supply Current vs. Sample Rate

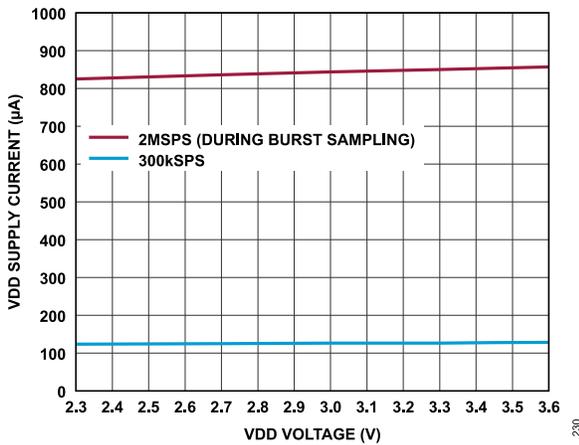


Figure 30. VDD Supply Current vs. VDD Voltage

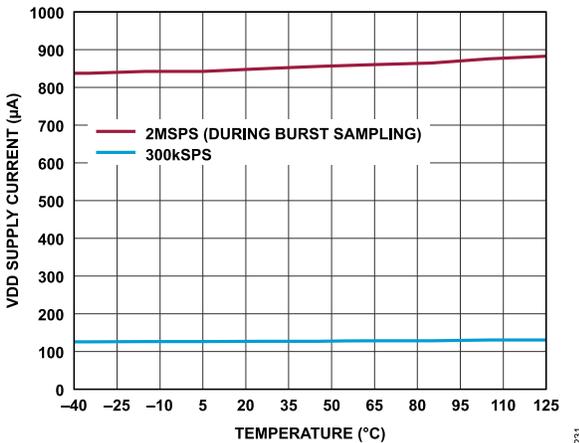


Figure 31. VDD Supply Current vs. Temperature

Figure 32. VDD Power Dissipation vs. Sample Rate

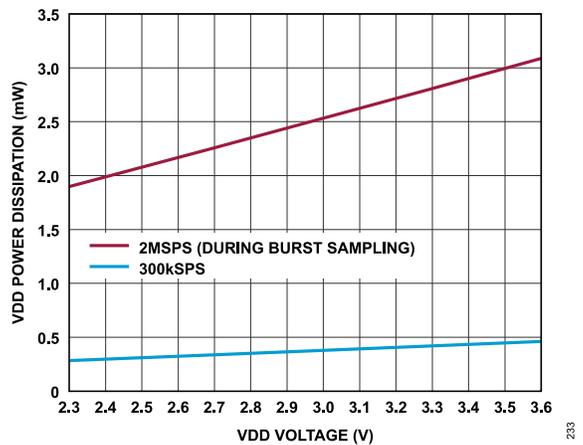
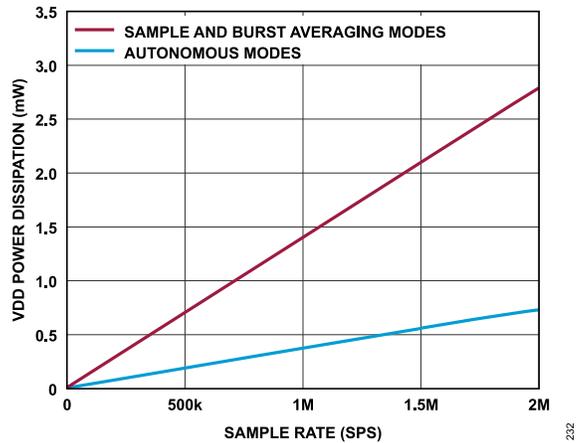


Figure 33. VDD Power Dissipation vs. VDD Voltage

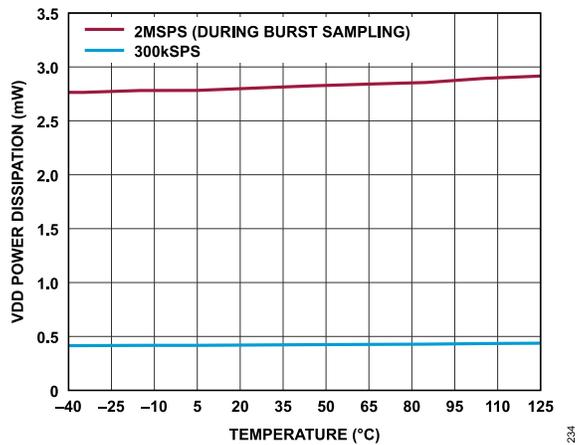


Figure 34. VDD Power Dissipation vs. Temperature

TYPICAL PERFORMANCE CHARACTERISTICS

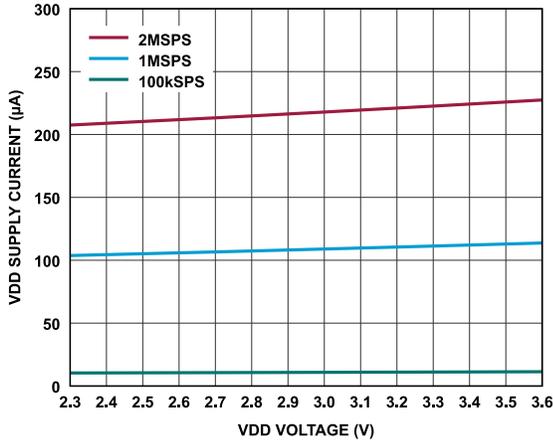


Figure 35. VDD Supply Current vs. VDD Voltage (Autonomous Modes)

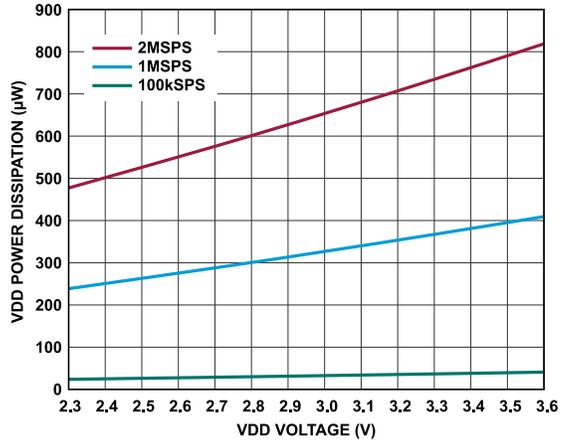


Figure 38. VDD Power Dissipation vs. VDD Voltage (Autonomous Modes)

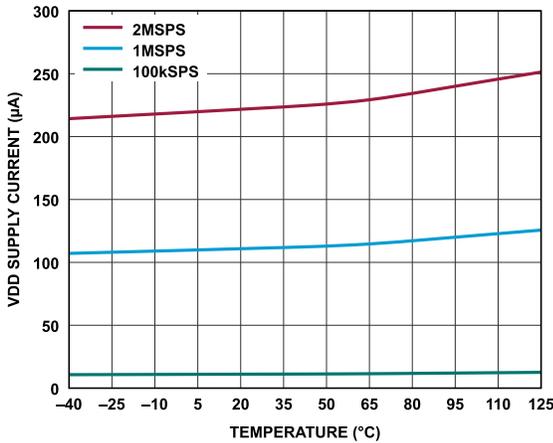


Figure 36. VDD Supply Current vs. Temperature (Autonomous Modes)

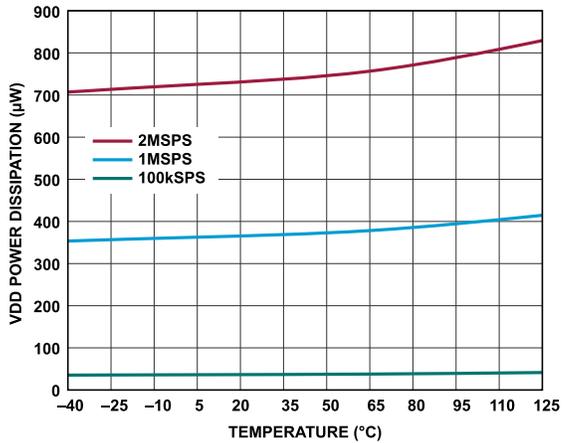


Figure 39. VDD Power Dissipation vs. Temperature (Autonomous Modes)

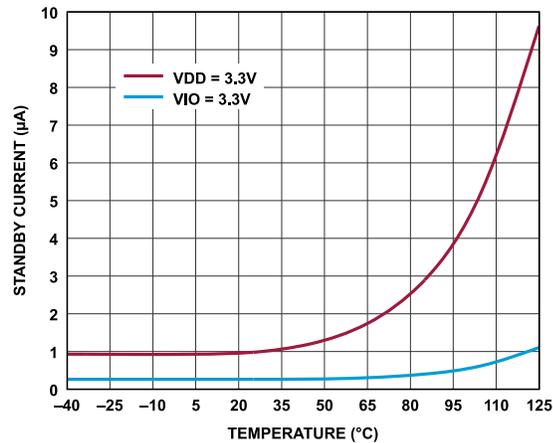


Figure 37. Standby Current vs. Temperature

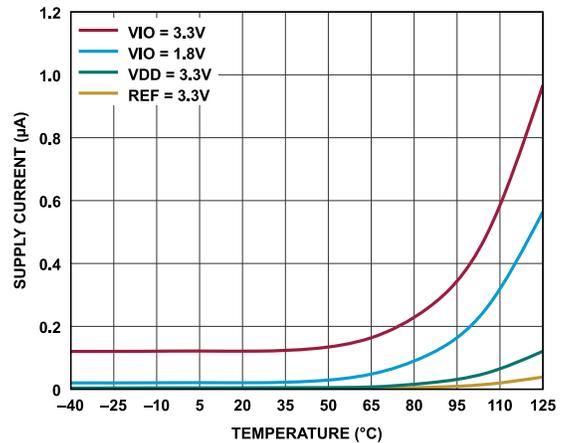


Figure 40. Supply Current (Sleep Mode) vs. Temperature

## TERMINOLOGY

### Integral Nonlinearity (INL) Error

INL is the deviation of each individual code from a line drawn from the negative full scale through the positive full scale. The point used as the negative full scale occurs  $\frac{1}{2}$  LSB before the first code transition. The positive full scale is defined as a level  $1\frac{1}{2}$  LSB beyond the last code transition. The deviation is measured from each code center to the true straight line.

### Differential Nonlinearity (DNL) Error

In an ideal ADC, code transitions are 1 LSB apart. DNL is the maximum deviation from this ideal value. DNL is often specified in terms of resolution for which no missing codes are guaranteed.

### Zero Error (ZE)

Zero error is the difference between the ideal midscale voltage, 0 V, and the actual voltage producing the midscale output code, 0 LSB.

### Gain Error (GE)

The first transition (from 100 ... 00 to 100 ... 01) occurs at a level  $\frac{1}{2}$  LSB above the nominal negative full scale. The last transition (from 011 ... 10 to 011 ... 11) occurs for an analog voltage  $1\frac{1}{2}$  LSB below the nominal full scale. The gain error is the deviation of the difference between the actual level of the last transition and the actual level of the first transition from the difference between the ideal levels.

### Total Unadjusted Error (TUE)

TUE is the worst-case measured deviation from the ideal ADC transfer function over the full input range, specified in ppm of full-scale. TUE includes the combined effects of zero error, gain error, and INL error for any given device.

### Dynamic Range (DR)

Dynamic range is the RMS voltage of a full-scale sine wave to the total RMS voltage of the noise measured. The value for dynamic range is expressed in decibels. Dynamic range is measured with a signal at  $-60$  dBFS so that it includes all noise sources and DNL artifacts.

### Spurious-Free Dynamic Range (SFDR)

SFDR is the difference, in decibels (dB), between the RMS amplitude of a full-scale input signal and the peak spurious signal.

### Signal-to-Noise Ratio (SNR)

SNR is the ratio of the RMS voltage of a full-scale sine wave to the RMS sum of all other spectral components below the Nyquist frequency, excluding harmonics and DC. The value for SNR is expressed in decibels.

### Total Harmonic Distortion (THD)

THD is the ratio of the RMS sum of the first five harmonic components to the RMS value of a full-scale input signal and is expressed in decibels.

### Signal-to-Noise-and-Distortion (SINAD) Ratio

SINAD is the ratio of the RMS voltage of a full-scale sine wave to the RMS sum of all other spectral components that are less than the Nyquist frequency, including harmonics but excluding DC. The value of SINAD is expressed in decibels.

### Effective Number of Bits (ENOB)

ENOB is a measurement of the resolution with a sine wave input. ENOB is related to SINAD as follows:  
 $ENOB = (SINAD\text{ dB} - 1.76)/6.02$ .  
 ENOB is expressed in bits.

### Common-Mode Rejection Ratio (CMRR)

CMRR is the ratio of the power in the ADC output at the frequency,  $f$ , to the power of a  $-1$  dBFS sine wave applied to the input common-mode voltage of frequency,  $f$ .

$$CMRR(dB) = 10 \times \log(P_{ADC\_IN}/P_{ADC\_OUT})$$

where:

$P_{ADC\_IN}$  is the common-mode power at the frequency,  $f$ , applied to the inputs.

$P_{ADC\_OUT}$  is the power at the frequency,  $f$ , in the ADC output.

### Aperture Delay

Aperture delay is the time between the rising edge of the CNV input and when the input signal is held for a conversion.

## THEORY OF OPERATION

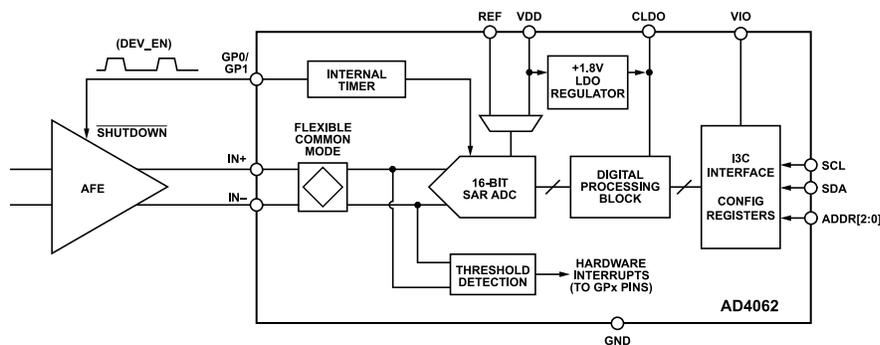


Figure 41. AD4062 Functional Block Diagram

## OVERVIEW

The AD4062 is a compact, ultra-low power, 16-bit, Easy Drive SAR ADC. The AD4062 feature set eases the design of low-power precision measurement systems by reducing the AFE design constraints and minimizing the digital host overhead. The low input capacitance and wide common-mode input range broaden the selection of compatible AFE components, allowing for simpler and lower power signal chain solutions. The block averaging filter provides noise reduction while offloading computations from the host processor. The internal timer block enables autonomous monitoring modes, burst sampling, and device power cycling controls synchronized to the ADC sampling instant. Various hardware interrupts allow the digital host to sleep between user-defined events.

The AD4062 offers a unique balance of performance and power efficiency, with 86.1dB of SNR and guaranteed INL of  $\pm 0.5$  LSBs at only 1.35nJ per conversion. The AD4062 only consumes 2.7mW at 2MSPS when operated on a single 3.3V supply. The power dissipation scales linearly with sample rate for the AD4062 (see Figure 32). The devices consume 4.1 $\mu$ W standby power while not performing conversions. A sleep mode is available to further reduce standby power to 430nW during long periods of idle operation.

The AD4062 features 2-wire I3C with CRC for device configuration and ADC data readback, and the I3C is compatible with 1.8V to 3.3V logic levels.

The AD4062 has several operating modes, each optimized for either high precision measurement or power-efficient signal monitoring. The [Theory of Operation](#) section describes the AD4062 functional blocks, and the [Modes of Operation](#) section describes the utilization of the functional blocks in each operating mode. The [Serial Interface](#) section describes the I3C protocols for accessing configuration registers and ADC data. The [AD4062 Register Summary](#) section documents the configuration registers.

## CONVERTER OPERATION

The AD4062 operates in two phases, the acquisition phase and the conversion phase. In the acquisition phase, the internal track-and-hold circuitry is connected to each input pin (IN+ and IN-) and acquires the voltage on each pin independently. The AD4062 remains

in the acquisition phase until the CONV\_READ or CONV\_TRIGGER register initiates a conversion. At the start of the conversion phase, the track-and-hold circuitry samples the acquired analog input signal, and the SAR ADC core generates a corresponding 16-bit digital code. The conversion phase ends when the 16-bit conversion result is ready, which is given by the  $t_{\text{CONV}}$  specification in [ADC Timing Specifications](#). The AD4062 acquisition and conversion phases overlap to maximize acquisition time ( $t_{\text{ACQ}}$ ).

In sample mode and burst averaging mode, the conversions are initiated by accessing either the CONV\_READ or the CONV\_TRIGGER registers (see the [Register Address Pointer](#), [CONV\\_READ Register](#), and [CONV\\_TRIGGER Register](#) sections for more detail).

The AD4062 offers several modes where the convert start is triggered by an internal oscillator, including the autonomous modes. Refer to the [Modes of Operation](#) section for specific ADC timing information for each of the relevant operating modes.

## Transfer Function

Figure 42 shows the ideal transfer function of the AD4062 SAR ADC core. The AD4062 encodes the sampled voltage difference between IN+ and IN- as a fraction of the full-scale range (FSR) into a 16-bit digital code. The unit of 1 LSB refers to the smallest discrete voltage step that can be resolved by the ADC and is a function of the  $V_{\text{REF}}$  voltage. In burst averaging mode, the block averaging filter averages multiple 16-bit samples into one 20-bit code. Table 10 and Table 11 summarize the mapping of input voltages to digital output codes.

## THEORY OF OPERATION

Following the conversions, the ADC data are stored in the CONV\_READ and CONV\_TRIGGER registers. CONV\_READ and CONV\_TRIGGER are accessed in 8-bit segments via the I3C Interface. (See the [CONV\\_READ Register](#) and [CONV\\_TRIGGER Register](#) sections for more detail.)

As described in the [Wide Input Common-Mode Range](#) section, the AD4062 supports arbitrary input common-mode voltages, therefore the devices inherently support both differential and single-ended type signals. The AD4062 supports both two's complement (signed) and straight binary (unsigned) formats to map either differential signals or single-ended signals to the full 16-bit ADC transfer function. The DATA\_FORMAT bit in the ADC\_MODES register selects between the differential mode and single-ended mode transfer functions as seen in [Table 10](#) and [Table 11](#).

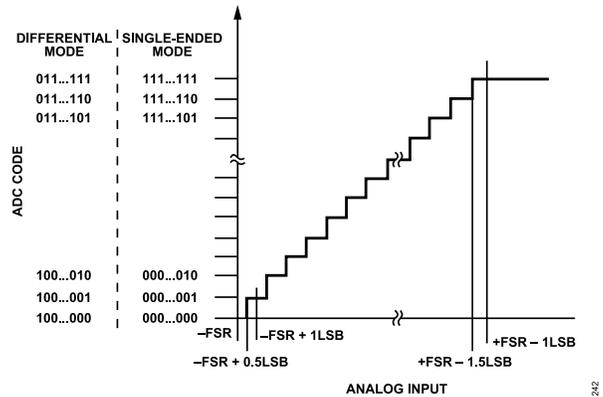


Figure 42. ADC Ideal Transfer Function

Table 10. ADC Input Voltage to Output Code Mapping (Sample Mode)

Description	Differential Mode		Single-Ended Mode	
	$V_{IN}$	Digital Output Code	$V_{IN}$	Digital Output Code
FSR - 1 LSB	$(32767/32768) \times V_{REF}$	0x7FFF	$(65535/65536) \times V_{REF}$	0xFFFF
...	...	...	...	...
Midscale + 1 LSB	$(1/32768) \times V_{REF}$	0x0001	$(32769/65536) \times V_{REF}$	0x8001
Midscale	0 V	0x0000	$(\frac{1}{2}) \times V_{REF}$	0x8000
Midscale - 1 LSB	$-(1/32768) \times V_{REF}$	0xFFFF	$(32767/65536) \times V_{REF}$	0x7FFF
...	...	...	...	...
-FSR + 1 LSB	$(-32767/32768) \times V_{REF}$	0x8001	$(1/65536) \times V_{REF}$	0x0001
-FSR	$-V_{REF}$	0x8000	0 V	0x0000

Table 11. ADC Input Voltage to Output Code Mapping (Burst Averaging Mode)

Description	Differential Mode		Single-Ended Mode	
	$V_{IN}$	Digital Output Code	$V_{IN}$	Digital Output Code
FSR - 1 LSB	$(524287/524288) \times V_{REF}$	0x7FFFF	$(1048575/1048576) \times V_{REF}$	0xFFFFF
...	...	...	...	...
Midscale + 1 LSB	$(1/524288) \times V_{REF}$	0x00001	$(524289/1048576) (8193/16384) \times V_{REF}$	0x80001
Midscale	0 V	0x00000	$(\frac{1}{2}) \times V_{REF}$	0x80000
Midscale - 1 LSB	$(-1/524288) (-1/8192) \times V_{REF}$	0xFFFFF	$(524287/1048576) \times V_{REF}$	0x7FFFF
...	...	...	...	...
-FSR + 1 LSB	$(-524287/524288) \times V_{REF}$	0x80001	$(1/1048576) \times V_{REF}$	0x00001
-FSR	$-V_{REF}$	0x80000	0 V	0x00000

## THEORY OF OPERATION

## ANALOG INPUTS

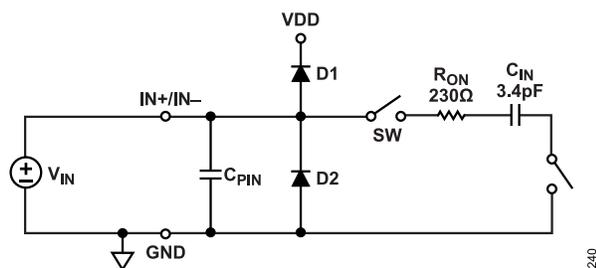


Figure 43. Equivalent Analog Input Circuit

Figure 43 shows an equivalent circuit for each of the AD4062 analog inputs (IN+ and IN−). The analog inputs are modeled as a switched capacitive load. During the acquisition phase, the sampling switch (SW) connects each input pin to the 3.4pF sampling capacitor ( $C_{IN}$ ) in series with the 230Ω switch on resistance ( $R_{ON}$ ). During the conversion phase, SW disconnects to sample the voltages on the IN+ and IN− pins onto the sampling capacitors. D1 and D2 represent the ESD diodes from the IN+ and IN− pins to the VDD supply and GND, respectively.  $C_{PIN}$  represents the pin capacitance of each input pin to GND and is typically 2pF.

See the [AD4062 Equivalent Analog Input Model](#) section for more information on the effective loading characteristics of the AD4062 analog inputs.

## Easy Drive Features

The AD4062 Easy Drive analog inputs are designed to enable compact, low-power precision signal chains by minimizing dependence on specialized high-speed, low-noise, high-power ADC driver amplifiers. The small sampling capacitors minimize the transient current glitches typical of SAR ADCs, and the long acquisition phase maximizes the settling time—even at high sample rates. The RC kickback filter uses smaller capacitors and larger resistors, alleviating amplifier stability concerns and enabling the use of tiny passive components (for example, 0201 NP0/COG capacitors). These Easy Drive features ensure the AD4062 interface with front-end circuits with high output impedance without incurring settling errors, expanding compatibility with low-power amplifiers and sensors (see the [Analog Front-End Design](#) section).

The AD4062 is available in the [LTspice](#) component library and support cosimulation with a wide variety of companion amplifiers. The LTspice model emulates the input-referred noise spectral density and input transient loading for system noise and settling accuracy simulations.

## VOLTAGE REFERENCE

The  $V_{REF}$  voltage sets the ADC FSR (see the [Transfer Function](#) section). The AD4062  $V_{REF}$  range is 2.3 V to VDD, where the maximum VDD supply voltage is 3.6 V (see [Table 1](#)).

The  $V_{REF}$  voltage is polled during the SAR bit trials to determine the ADC output code. During the bit trials, the SAR core exhibits transient charge draw. To ensure the  $V_{REF}$  voltage remains stable during the SAR bit trials, place a 2.2  $\mu$ F decoupling capacitor as close to the REF pin as possible. Lower decoupling capacitance values (for example, 1  $\mu$ F) may be used with slight performance degradations. See the [Reference Circuit Design](#) section for more recommendations for pairing voltage references with the AD4062.

## Reference Selection Modes

The AD4062  $V_{REF}$  voltage can be sourced from either the REF input pin or the VDD supply pin. By default, the REF pin acts as the  $V_{REF}$  source, and this setting is the intended mode to achieve the performance specifications given in [Table 1](#). The VDD supply option is provided to support low-power measurements where accuracy is not critical or to allow the system to power cycle the voltage reference for long periods of time to save system power. The  $V_{REF}$  source option is controlled with the REF\_SEL bit in the ADC\_CONFIG register (see [Table 48](#)).

The AD4062 includes an automated gain scaling function, where the ADC core samples the REF voltage as a fraction of the VDD supply voltage and stores the appropriate gain scaling value into the MON\_VAL register, such that using VDD as the  $V_{REF}$  source has the same ADC transfer function as REF. This allows the system to power down the voltage reference circuitry for extended periods of time with similar levels of performance. See the [Achieving High Accuracy with Reference Shutdown](#) section for a detailed description of the automated gain scaling feature.

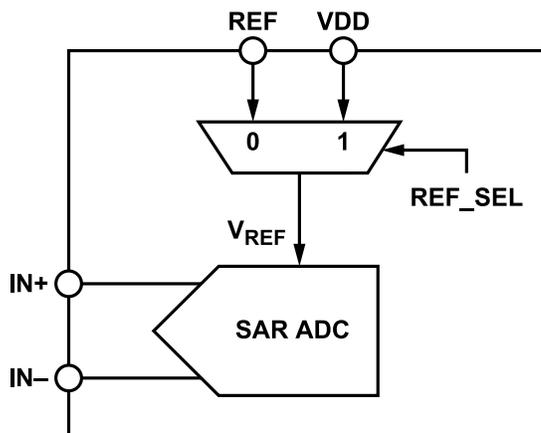


Figure 44. Reference Source Selection

## THEORY OF OPERATION

## DIGITAL PROCESSING FEATURES

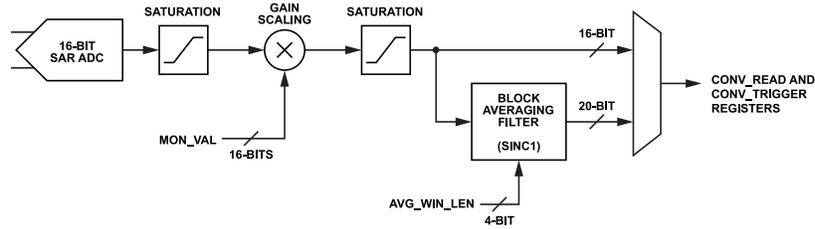


Figure 45. AD4062 Digital Processing Functionality

The AD4062 includes several data processing features that can be applied to ADC data to offload computations from the digital host processor. Figure 45 shows a block diagram of the available data processing functions. Functionality and configuration of each block is described in detail in following sections. Note that these digital processing functions are not used in the autonomous modes.

### Gain Scaling

The gain scaling function applies a 16-bit unsigned digital gain factor to the 16-bit ADC results. Gain scaling can be applied to calibrate out system gain error. The gain scaling factor is set by the MON\_VAL bit field in the MON\_VAL scaling register with the following equation:

$$Code_{OUT} = Code_{IN} \times \left( \frac{MON\_VAL}{0x8000} \right) \quad (2)$$

where  $0x0000 \leq MON\_VAL \leq 0xFFFF$ , giving an effective gain range of 0 to 1.99997.

Gain scaling can also be used to scale the ADC transfer function when using the VDD supply as the  $V_{REF}$  source (see the [Reference Selection Modes](#) section). The AD4062 can be configured to measure the ratio of the VDD supply and the REF input voltage and automatically adjust the MON\_VAL register value to set the transfer functions to be the same. The external voltage reference circuitry can then be powered down to reduce system power dissipation. See the [Achieving High Accuracy with Reference Shutdown](#) section for more information.

Note that applying gain to the samples can cause numerical saturation when  $Code_{OUT}$  in Equation 2 exceeds the 16-bit full scale (see the [Full-Scale Saturation](#) section). Ensure the MON\_VAL bit field is set accordingly to prevent the gain scaling block output from saturating.

Gain scaling is disabled by default and enabled by setting the SCALE\_EN bit field in the ADC\_CONFIG register to 1 (see [Table 48](#)).

### Full-Scale Saturation

The conversion results saturate digitally (prior to any data processing) when the sampled analog input voltage exceeds the input range limits specified in [Table 1](#). The AD4062 includes saturation blocks at the output of the ADC core and the output of the gain

scaling block that detect when the digital output codes or the ADC core and gain scaling block reach the maximum or minimum values, respectively.

The OVER\_RNG\_ERR and UNDER\_RNG\_ERR flags in the DEVICE\_STATUS register are set when either of the saturation blocks detect a maximally or minimally saturated code. In differential mode, the 16-bit results saturate maximally at 0x7FFF and minimally at 0x8000. In single-ended mode the 16-bit results saturate maximally at 0xFFFF and minimally at 0x0000. (See the [Transfer Function](#) section for a description of differential and single-ended modes.)

The OVER\_RNG\_ERR and UNDER\_RNG\_ERR flags can be periodically polled when using the block averaging filter to verify none of the filter input data has saturated. The OVER\_RNG\_ERR and UNDER\_RANGE\_ERR flags are write-1-to-clear bits and, therefore, hold their states until the digital host is able to poll them.

### Block Averaging Filter

The AD4062 includes a block averaging filter with programmable averaging ratios ( $N_{AVG}$ ) from 2 to 4096. The block averaging filter is automatically enabled when the device is in burst averaging mode. The block averaging filter exhibits a SINC1 frequency response. [Figure 46](#) shows the frequency response of the averaging filter for  $N_{AVG}$  of 2, 4, 8, 16, and 32.

When enabled, the block averaging filter accumulates a block of 16-bit ADC results before generating a 20-bit averaged result.  $N_{AVG}$  refers to the number of ADC samples per averaged result. The block averaging filter is reset (cleared) after processing each block of  $N_{AVG}$  samples. The  $N_{AVG}$  configuration is set by the AVG\_WIN\_LEN bit field in the AVG\_CONFIG register (see [Table 49](#)) using the following equation:

$$N_{AVG} = 2^{AVG\_WIN\_LEN + 1} \quad (3)$$

## THEORY OF OPERATION

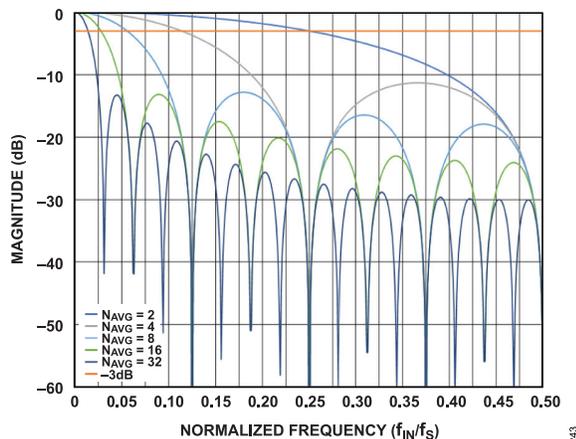


Figure 46. Frequency Response Examples for the Block Averaging Filter

### INTERNAL TIMER

The AD4062 includes an internal timer to generate the ADC sampling clock in burst averaging mode and both the autonomous modes (monitor mode and trigger mode). The sampling frequency in these modes is set by the FS\_BURST\_AUTO bit field in the TIMER\_CONFIG register and ranges from 2MSPS to 111SPS. See Table 52 in the Register Details section for the full set of nominal sampling clock frequencies ( $f_{OSC}$ ) offered on the AD4062. The actual sampling frequency in these modes is guaranteed to be within  $\pm 15\%$  of  $f_{OSC}$  (see Timing Specifications).

The internal timer also controls the DEV\_EN signal delay (see the Device Enable Signal section). The  $t_{PWR\_ON}$  delay is set by the TIMER\_PWR\_ON bit field, which is also in the TIMER\_CONFIG register. The  $t_{PWR\_ON}$  settings range from  $0.5\mu s$  to  $9000\mu s$ . See Table 52 in the Register Details section for the full set of nominal  $t_{PWR\_ON}$  delay options.

In monitor mode, threshold detection events do not disable the internal sampling clock, and the device continues sampling even after the MAX/MIN threshold interrupt bit fields and signals are asserted. See the Monitor Mode section for detail.

In trigger mode, threshold detection events do disable the internal sampling clock. Simultaneously, the ADC is enabled and performs an N-bit conversion, and updates the contents of MAX\_SAMPLE, MIN\_SAMPLE, MAX\_THRESH\_INTR, MIN\_THRESH\_INTR, and THRESH\_OVERRUN bit field/registers. See the Trigger Mode section for detail.

### POWER SUPPLIES

The AD4062 has the following three power domains, the ranges for which are given in Table 1:

- ▶ VDD is the analog supply rail.
- ▶ CLDO is the +1.8V ADC core supply rail, generated by an internal +1.8V LDO regulator.
- ▶ VIO is the digital interface logic supply rail.

The VDD and VIO supplies must be supplied externally. The CLDO supply is generated internally by an internal +1.8V LDO regulator sourced by the VDD rail. The VDD supply current is a function of the ADC sampling rate, because it supplies the internal LDO regulator that then supplies the SAR ADC core (see the VDD Power Dissipation section). In sleep mode, the internal LDO regulator is powered down to reduce the VDD standby current to 10nA (see Table 1 and the Sleep Mode section).

The AD4062 has no power supply sequencing requirements. The minimum allowable rise time for the VDD and VIO supplies is  $100\mu s$ . It is recommended to perform a device reset after the VDD and VIO supplies are stable (see the Power-On Reset section).

It is recommended to decouple the VDD, CLDO, and VIO pins to GND each with a  $1\mu F$  capacitor. When selecting VDD as the  $V_{REF}$  source (as described in the Reference Selection Modes section), or when driving the VDD and REF pins with a common external source, it is recommended to decouple VDD and REF with a shared  $2.2\mu F$  capacitor.

### COMPARATOR OPERATION

The AD4062 ADC core offers a lower power, 16-bit window comparator mode for autonomous threshold detection and monitoring. Figure 47 shows a simplified schematic of the window comparator used in the autonomous modes.

The AD4062 has two autonomous sampling modes, as described in the Autonomous Modes section. When either of the autonomous modes are enabled, the ADC enters comparator mode, and the internal timer acts as the sampling clock (see the Internal Timer section). The comparator steps through a sequence of comparisons against four user-programmable threshold regions on each sample and generates alert flags and hardware interrupts when the signal enters those regions.

Figure 48 illustrates the out-of-bounds regions set by the maximum and minimum threshold values. The maximum and minimum thresholds are user-programmable via the MAX\_LIMIT and MIN\_LIMIT bit fields. The MAX\_LIMIT and MIN\_LIMIT fields are each 12 bits wide for 12-bit comparator resolution. There are also independent hysteresis settings for maximum and minimum limits, set by the MAX\_HYST and MIN\_HYST fields, respectively, that define a second set of limits for autoclearing the alert signals. See the Autonomous Modes section for more information.

The data format of the MAX\_LIMIT and MIN\_LIMIT fields corresponds to the selected input range mode (as described in the Transfer Function section). The MAX\_LIMIT and MIN\_LIMIT fields are in twos complement in differential mode ( $DATA\_FORMAT = 1'b1$ ) and straight binary in single-ended mode ( $DATA\_FORMAT = 1'b0$ ). The MAX\_HYST and MIN\_HYST fields are always straight binary regardless of input mode setting.

The comparator includes two alert signals and two sticky alert bits in the register map. The MAX\_INTR and MIN\_INTR signals are the alert signals for maximum and minimum threshold events,

**THEORY OF OPERATION**

respectively. The MAX\_INTR and MIN\_INTR signals may be routed to either or both of the GP0 and GP1 pins (see the [Interrupts and Control Signals](#) section). The MAX\_FLAG and MIN\_FLAG bits are sticky, write 1 to clear the bits in the DEVICE\_STATUS register. The DEVICE\_STATUS register also includes a threshold overrun bit (THRESH\_OVERRUN) that is set whenever the comparator tries to

set either the MAX\_FLAG or MIN\_FLAG bits before they have been cleared.

Maximum and minimum threshold events also trigger the MAX\_IBI and MIN\_IBI respectively if these IBIs are enabled. See [In-Band Interrupts](#) for more detail.

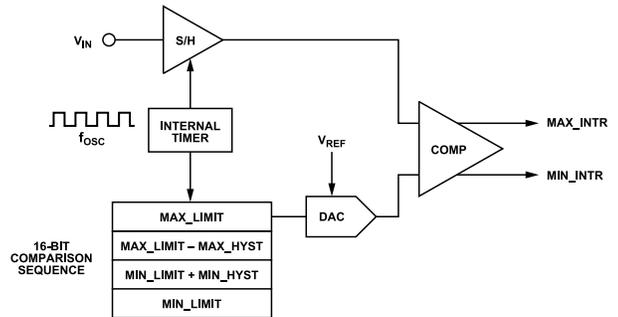


Figure 47. Simplified Schematic of Autonomous Mode Window Comparator

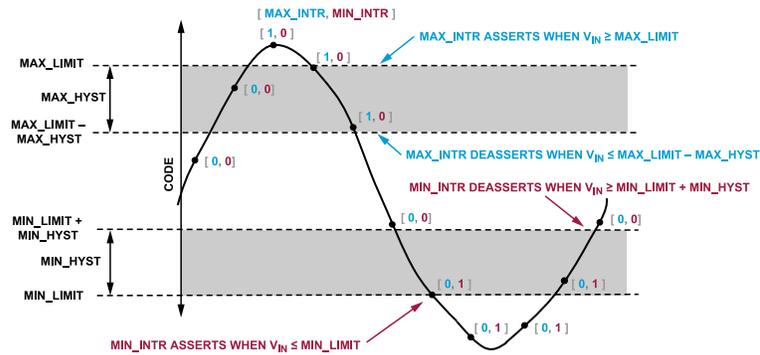


Figure 48. Threshold Event Regions

## THEORY OF OPERATION

### INTERRUPTS AND CONTROL SIGNALS

The AD4062 generates several digital signals for synchronizing the analog front-end and digital back-end processes to the ADC sampling. These signals can be assigned to the two general purpose pins (GP0 and GP1) via the GP0\_MODE and GP1\_MODE fields in the GP\_CONFIG register, respectively. The following sections describe the functionality and timing details for each of the AD4062 digital signals. [Table 12](#) and [Table 50](#) list the GPx signal assignments that correspond to each GPx\_MODE bit field setting.

**Table 12. GP0 and GP1 Signal Assignment Control**

GPx_MODE Setting	GP0 Signal Assignment	GP1 Signal Assignment
3'h0	Disabled/high-Z (default)	Disabled/high-Z
3'h1	GP0_INTR	GP1_INTR
3'h2	$\overline{\text{RDY}}$	$\overline{\text{RDY}}$
3'h3	DEV_EN	DEV_EN
3'h4	Invalid	Invalid
3'h5	Logic low	Logic low
3'h6	Logic high	Logic high
3'h7	Invalid	DEV_RDY (default)

### In-Band Interrupts

The AD4062 includes In-Band Interrupts (IBIs) as per the MIPI I3C specification in response to specific events. When an IBI event is triggered, the AD4062 sends an interrupt request to the digital host. The AD4062 conforms to the I3C specification for standards and rules about when an I3C target device is allowed to transmit an IBI over the I3C bus.

According to Section 5.1.3.2.2 of the MIPI I3C specifications, the I3C bus must be in the bus available state (see  $t_{\text{IBI\_ISSUE}}$  in [Table 5](#)) for the target device to issue the start of an IBI transmission. When IBIs are enabled, it is recommended to precede each I3C frame with the broadcast address 0x7E to allow the AD4062 to drive its TGT\_ADDR to initiate an IBI request.

IBIs can be enabled or disabled using the ENEC and DISEC CCCs respectively. (See [Common Command Codes \(CCCs\)](#) for more detail). [Table 13](#) lists the AD4062 IBIs along with their trigger conditions, and the enable bits. Each IBI can be individually enabled or disabled. (See the [Interface Error IBI Enable Register](#) section and the [ADC IBI Enable Register](#) section for more detail.)

The IBI\_PENDING bit field in the IBI\_STATUS register indicates whether the AD4062 has a pending IBI. The IBI stays pending until the controller services the IBI request. Section 5.1.6.2 of the MIPI I3C specification outlines the ways in which a controller can service a target device's IBI request. The IBI\_EN bit field in the IBI\_STATUS register indicates whether IBIs are currently enabled or disabled. (See the [IBI Status Register](#) section for more detail.)

The MAX\_IBI indicates the occurrence of a MAX threshold event which means the input signal value has exceeded the limit stored in the MAX\_LIMIT register

The MIN\_IBI indicates the occurrence of a MIN threshold event which means the input signal value is lower than the limit stored in the MIN\_LIMIT register

The DATA\_READY\_IBI is defined for the event where new ADC data are ready to read from the CONV\_TRIGGER register. The DATA\_READY\_IBI is triggered by the end-of-conversion events in both the sample mode and burst averaging modes when the single conversion or the burst of conversions are complete, and the data is ready to be read by the controller on the I3C bus.

The INTERFACE\_ERROR\_IBI occurs when there is an error in the I3C bus interface. This IBI can be triggered by any of the enabled interface error sources including parity error, SCL error, CRC error, write invalid error, and address invalid error.

**Table 13. IBI Triggers and Enable Bits**

IBI	IBI Trigger	IBI Enable Bit
MAX_IBI	MAX Threshold Event	MAX_IBI_EN
MIN_IBI	MIN Threshold Event	MIN_IBI_EN
DATA_READY_IBI	End of Conversion/ Data Valid (Address Pointer → CONV_TRIGGER)	DATA_READY_IBI_EN
INTERFACE ERROR IBI	Parity Error SCL Error CRC Error Write Invalid Error Address Invalid Error	PARITY_ERROR_IBI_EN SCL_ERROR_IBI_EN CRC_ERROR_IBI_EN WRITE_INVALID_IBI_EN ADDR_INVALID_IBI_EN

### Mandatory Data Byte

The AD4062 will transmit a Mandatory Data Byte (MDB) on the I3C bus as defined by the MIPI I3C specification when the controller reads the IBI generated by a target device. The MDB indicates what type of IBI has been generated through the interrupt group identifier field (MDB[7:5]) and the specific group identifier field (MDB[4:0]).

The INTERFACE\_ERR asserts when an interface error has been detected on the I3C bus. When an interface error occurs, the user will have to check the INTERFACE\_STATUS register to find the specific field associated with the error. The INTERFACE\_ERR is cleared when the user writes a 1 to it via a register write.

The MAX\_THRESH\_INTR asserts when the input signal is greater than MAX\_LIMIT.

The MIN\_THRESH\_INTR asserts when the input signal is less than MIN\_LIMIT.

MAX\_THRESH\_INTR and MIN\_THRESH\_INTR are sticky bits which means that once they are set to 1, they do not self-clear

## THEORY OF OPERATION

even when the input signal goes back in range as dictated by the MAX\_HYST and MIN\_HYST registers. They are cleared when the user writes a 1 to them via a register write. (see the [Autonomous Modes](#) section for more detail).

The MAX\_THRESH\_INTR and MIN\_THRESH\_INTR bit fields are not to be confused with the MAX\_INTR and MIN\_INTR signals which are optionally output on the GP1 or GP0 pins. MAX\_INTR and MIN\_INTR are defined to self-clear when input voltage is back in range as defined by the MAX\_HYST and MIN\_HYST registers.

**Table 14. Mandatory Data Byte - Interrupts Group Identifier Field**

IBI	Interrupt Group Identifier Field	MDB[7:5]
MAX_IBI (Monitor Mode)	User Defined	3'b000
MIN_IBI (Monitor Mode)	User Defined	3'b000
MAX_IBI (Trigger Mode)	Pending Read Notification <sup>1</sup>	3'b101
MIN_IBI (Trigger Mode)	Pending Read Notification	3'b101
DATA_READY_IBI	Pending Read Notification	3'b101
INTERFACE_ERROR_IBI	Either User Defined or Pending Read Notification <sup>2</sup>	3'b000 or 3'b101

<sup>1</sup> Section 5.1.6.2.2 of the MIPI I3C specifications explains what the controller's responsibilities are when a target device sends an IBI request and an MDB with a pending read notification

<sup>2</sup> The INTERFACE\_ERROR\_IBI can occur independent of the ADC Operating mode, and at times, this IBI can exhibit either of the interrupt group identifier codes. Thus, if the Interface Error flag (MDB[3]) gets set to '1' (see [Table 15](#)), then any pending read shall be treated as invalid, and ADC data should not be read until the interface error has been cleared

**Table 15. Mandatory Data Byte - Specific Interrupt Identifier Field**

MDB[4]	MDB[3]	MDB[2]	MDB[1]	MDB[0]
1'b1	INTERFACE_ERR	1'b0	MAX_THRESH_INTR	MIN_THRESH_INTR

### Static Logic Outputs

The AD4062 GP0 and GP1 digital outputs can be set to a static logic low or logic high level. This function allows the digital host to control logic settings for external devices through the AD4062 and reduces the required number of GPIO resources. The logic output voltage specifications and corresponding load current conditions are given by  $V_{OL}$  and  $V_{OH}$  in [Table 1](#).

### Data Ready Signal

The data ready signal ( $\overline{RDY}$ ) is an active-low interrupt signal that indicates when new ADC data are ready to read via the I3C interface.

$\overline{RDY}$  is always driven high following any form of device reset.  $\overline{RDY}$  is also driven high when the ADDR\_PTR is pointing to any address besides the CONV\_READ and CONV\_TRIGGER registers.

When the ADDR\_PTR is pointing to CONV\_READ or CONV\_TRIGGER,  $\overline{RDY}$  gets driven high at the convert-start instant, and transitions from high to low any time a new conversion result is ready to read. In sample mode,  $\overline{RDY}$  goes low at the end of the conversion phase to indicate a new 16-bit result is available (see [Sample Mode Timing Diagram](#)). In burst averaging mode,  $\overline{RDY}$  goes low after  $N_{AVG}$  conversions to indicate a new 20-bit averaged result is available (see [Burst Averaging Mode Timing Diagram](#)).

### Threshold Alert Signals

The comparator threshold alert signals MAX\_INTR and MIN\_INTR can be routed to the GP0 or GP1 pins via the GP0\_INTR and GP1\_INTR signals (see the [Autonomous Modes](#) section). Either of the GPx\_INTR signals can be assigned to the MAX\_INTR signal, the MIN\_INTR signal, or the logical OR of both, giving the flexibility to either drive independent hardware interrupts for maximum and minimum crossings or to combine together for a single interrupt. By default, MAX\_INTR is assigned to GP1\_INTR and MIN\_INTR is assigned to GP0\_INTR.

The mapping of the alert signals to the GPx pins is controlled via the GP0\_INTR\_EN and GP1\_INTR\_EN bit fields in the INTR\_CONFIG register (see [Table 16](#) and [Table 51](#)).

**Table 16. GPx\_INTR Settings**

GPx_INTR_EN Setting	GPx_INTR Signal Assignment
2'h0	Neither interrupt
2'h1	MIN_INTR
2'h2	MAX_INTR
2'h3	(MAX_INTR) OR (MIN_INTR)

### Device Ready Signal

The device ready signal (DEV\_RDY) is an active-high signal that indicates when the AD4062 completes power-up or reset routines and is ready to accept serial interface communications. The DEV\_RDY signal is routed to the GP1 pin after power-up or reset, so the digital host can monitor it to know when the AD4062 is active. See the [Device Reset](#) section for timing diagrams of the DEV\_RDY signal.

### Device Enable Signal

The AD4062 includes a signal chain power-cycling control signal called DEV\_EN. The DEV\_EN signal synchronizes the enable and power-down states of signal chain devices (such as amplifiers, sensors, and voltage references) with the ADC sampling instant, optimizing system power consumption while minimizing sampling error from power-on delays. [Figure 49](#) shows a typical application

## THEORY OF OPERATION

circuit utilizing the DEV\_EN signal to power down an amplifier between samples.

When the DEV\_EN signal is enabled, the internal timer acts as a one-shot timer triggered by the ADC convert-start rising edge. The timer delay ( $t_{PWR\_ON}$ ) controls how long the amplifier is powered on before the ADC sampling instant and is programmable to tailor to the connected device's specific power-on settling time specifications. Table 52 in the Register Details section shows the nominal  $t_{PWR\_ON}$  settings available via the TIMER\_PWR\_ON bit field.

The DEV\_EN signal is enabled by assigning it to either the GP0 or GP1 digital outputs (see Table 12). The DEV\_EN signal can be configured as active high or active low via the DEV\_EN\_POL bit field in the GP\_CONFIG register (see Table 50). DEV\_EN is active high by default.

Figure 54, and Figure 58 show timing diagrams of the DEV\_EN signal and the ADC sampling instant relative to the ADC convert-start.

When using the CONV\_READ register to trigger ADC conversions, the convert-start happens on the SDA rising edge of the stop (P) at the end of the read command (see CONV\_READ Register). The DEV\_EN signal asserts at this convert-start instant. When using the CONV\_TRIGGER register to trigger ADC conversions, the convert-start happens on the SDA rising edge of the stop (P) at the end of the write command (see CONV\_TRIGGER Register). The DEV\_EN signal asserts at this convert-start instant.

In sample mode, DEV\_EN deasserts after each conversion. In burst averaging mode, DEV\_EN remains asserted until the last conversion in the burst of samples. DEV\_EN is not supported in the autonomous modes.

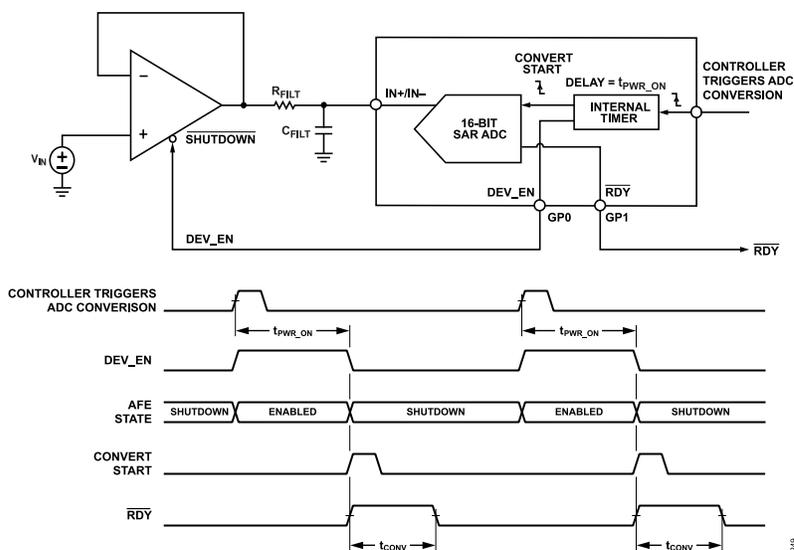


Figure 49. Typical Application Circuit with DEV\_EN Signal

**MODES OF OPERATION**

Table 18 shows an overview of the AD4062 functional modes. The ADC and serial interface functionality for each mode is given in the subsequent sections.

The AD4062 ADC code is idle following power-up and device resets. The operating modes are selected via the configuration registers as shown in Table 18. The I3C protocol for register writes and reads is described in the Register Reads and Register Writes sections.

Figure 50 shows the AD4062 operating mode selection as a state machine diagram.

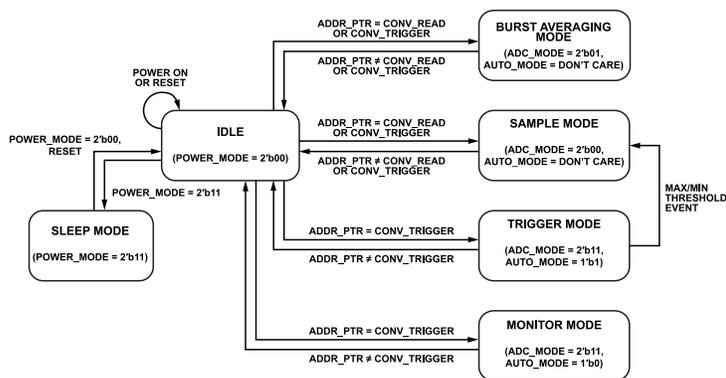
Table 17 shows the recommended address pointer setting for reading ADC data in each functional mode.

**Table 17. Address Pointer Recommended Values**

Mode	Conversion Register	Recommended Address Pointer Value
Sample Mode	CONV_READ	0x51
	CONV_TRIGGER	0x57
Burst Averaging Mode	CONV_READ	0x52
	CONV_TRIGGER	0x58
Monitor Mode	CONV_TRIGGER	0x57
Trigger Mode	CONV_TRIGGER	0x57

**Table 18. AD4062 Functional Modes**

Mode	ADC_MODE	AUTO_MODE	POWER_MODE
Sample Mode	2'b00	Don't care	2'b00
Burst Averaging Mode	2'b01	Don't care	2'b00
Monitor Mode	2'b11	1'b0	2'b00
Trigger Mode	2'b11	1'b1	2'b00
Sleep Mode	Don't care	Don't care	2'b11



**Figure 50. AD4062 State Machine Diagram**

MODES OF OPERATION

SAMPLE MODE

In sample mode, a convert-start triggers a single conversion. At the end of the conversion, the AD4062 generates a 16-bit result that the controller device reads via the I3C bus. Table 18 lists the configuration register settings to select sample mode. Figure 51 shows a typical connection diagram for the AD4062 digital interface.

Figure 52 and Figure 53 show interface timing diagrams for sample mode using the CONV\_READ and CONV\_TRIGGER registers respectively. The  $t_{CONV}$  specification quantifies the time delay between the convert-start and the end of conversion. The controller must wait for the maximum  $t_{CONV}$  delay before reading the result over the I3C bus. The  $\overline{RDY}$  signal acts as an optional hardware interrupt to synchronize I3C reads to the ADC sampling phases (see the Data Ready Signal section).

When reading from the CONV\_READ register to trigger ADC conversions, each conversion result is output on each subsequent read on the I3C bus (see the CONV\_READ Register section). When using the CONV\_TRIGGER register to trigger ADC conversions, the conversion result must be read from the register after each conversion, or else the next write (and convert-start) will overwrite the conversion results from the previous conversion (see the CONV\_TRIGGER Register section).

It is recommended to read the lower 16-bits of the CONV\_READ and CONV\_TRIGGER registers in sample mode for the most efficient readback. See Table 17 for the recommended ADDR\_PTR setting for data readback in sample mode.

In sample mode, the maximum sampling rate ( $f_S$ ) is limited by the output data rate of the I3C bus, which is a function of the output data length and the I3C bus characteristics. The fastest output data rate is achieved by repeatedly reading from the CONV\_READ register, as shown in Figure 66. See the Calculating Serial Interface Output Data Rate section for details on estimating the maximum achievable  $f_S$  for the given operating conditions.

When the DEV\_EN signal is enabled, the start of the conversion is delayed by the programmable  $t_{PWR\_ON}$  delay relative to the convert-start. See the Device Enable Signal section and Figure 54 for specific timing details when using the DEV\_EN signal.

If enabled, the DATA\_READY\_IBI occurs at the end-of-conversion for the CONV\_TRIGGER register and indicates that the ADC data is ready to be read from the CONV\_TRIGGER register by the controller. (See In-Band Interrupts for more detail.)

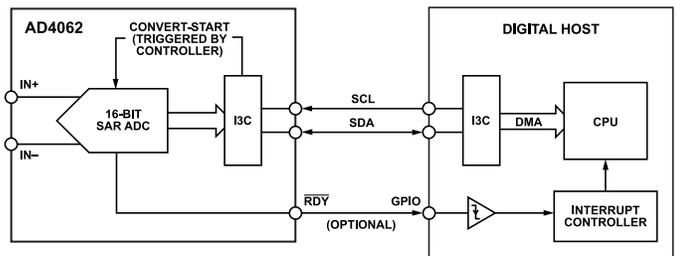


Figure 51. Sample Mode Example Connection Diagram

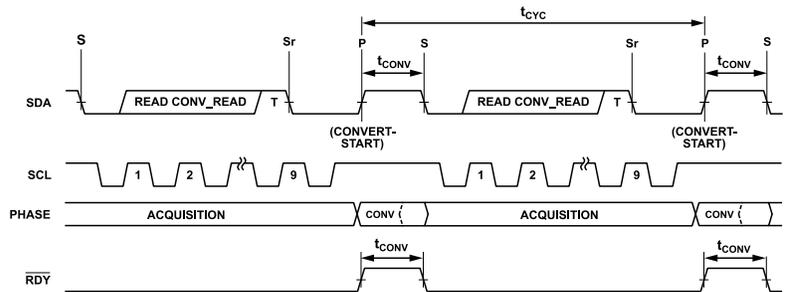


Figure 52. Sample Mode Timing Diagram Using CONV\_READ

MODES OF OPERATION

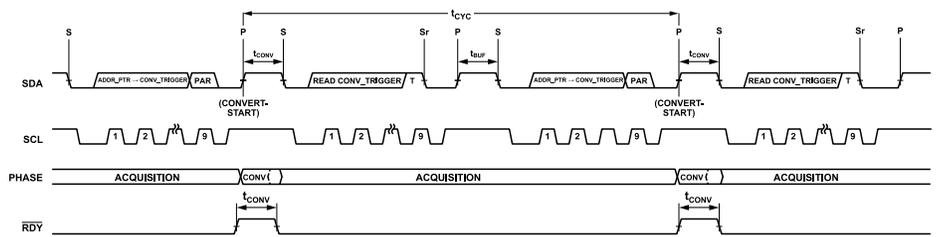


Figure 53. Sample Mode Timing Diagram Using CONV\_TRIGGER

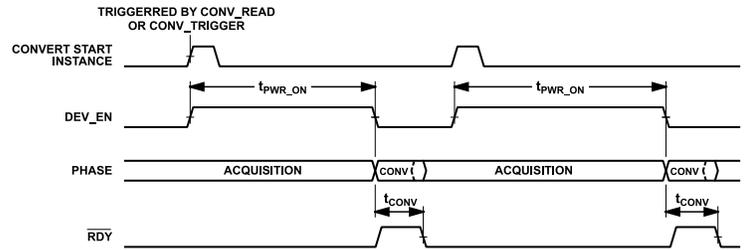


Figure 54. Sample Mode Timing with DEV\_EN Enabled

MODES OF OPERATION

BURST AVERAGING MODE

In burst averaging mode, a convert-start triggers the internal timer to perform a burst of conversions for the averaging filter to accumulate and generate a 20-bit averaged result. Table 18 lists the configuration register settings to select burst averaging mode. Figure 55 shows a typical connection diagram for the AD4062 digital interface.

Figure 56 and Figure 57 show interface timing diagrams for burst averaging mode using the CONV\_READ and CONV\_TRIGGER registers respectively. The ADC sampling period ( $t_{CYC}$ ) is set by the internal timer frequency ( $f_{OSC}$ ) and the number of samples per burst is set by the averaging ratio ( $N_{AVG}$ ). Table 52 lists the options for  $f_{OSC}$ . The averaging filter supports averaging ratios from 2 to 4096 and is set by the AVG\_WIN\_LEN bit field, as described in the Block Averaging Filter section.

The controller must wait for the averaged result to be ready before reading the results on the I3C bus. The RDY signal acts as an optional hardware interrupt to synchronize the I3C data reads to the ADC sampling phases (see the Data Ready Signal section).

The total latency between the convert-start trigger and data ready is given by the following equation:

$$\frac{(N_{AVG} - 1)}{f_{OSC}} + t_{CONV} \tag{4}$$

It is recommended to read the lower 24-bits of the CONV\_READ and CONV\_TRIGGER registers in burst-averaging mode for the most efficient readback. See Table 17 for the recommended ADDR\_PTR setting for data readback in burst-averaging mode.

When the DEV\_EN signal is enabled, the start of the burst of conversions is delayed by the programmable  $t_{PWR\_ON}$  delay, relative to the convert-start trigger. The DEV\_EN signal remains asserted until the end of the burst of samples. See the Device Enable Signal section and Figure 58 for specific timing details when using the DEV\_EN signal.

If enabled, the DATA\_READY\_IBI occurs at the end-of-conversion for the CONV\_TRIGGER register and indicates that the ADC data is ready to be read from the CONV\_TRIGGER register by the controller. (See In-Band Interrupts for more detail)

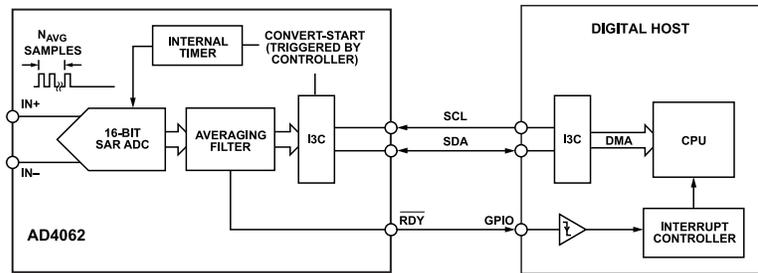


Figure 55. Burst Averaging Mode Example Connection Diagram

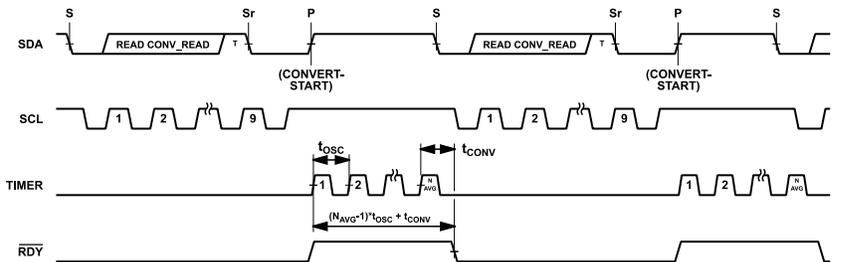


Figure 56. Burst Averaging Mode Timing Diagram Using CONV\_READ

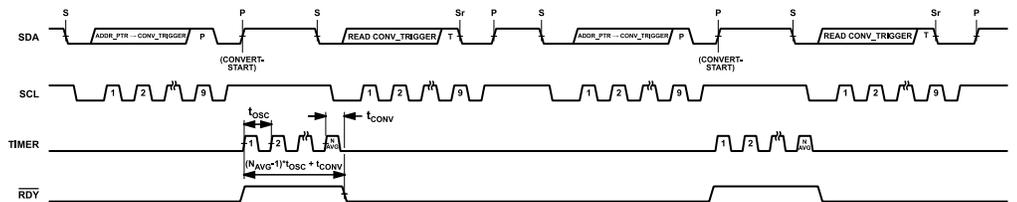


Figure 57. Burst Averaging Mode Timing Diagram Using CONV\_TRIGGER

MODES OF OPERATION

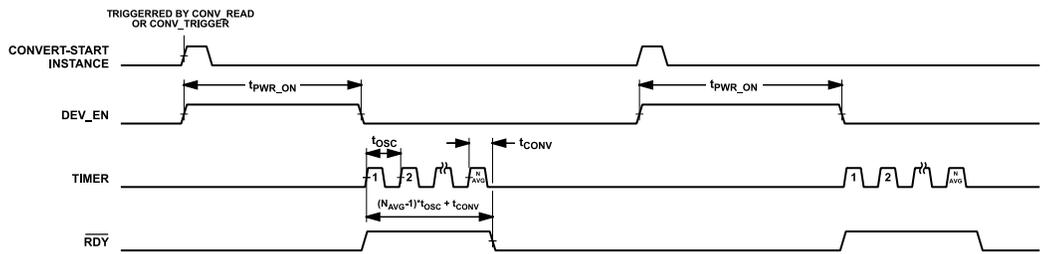


Figure 58. Burst Averaging Mode Timing with DEV\_EN Enabled

MODES OF OPERATION

AUTONOMOUS MODES

The autonomous modes allow the AD4062 to autonomously monitor the input signal to detect out-of-range events. The autonomous modes feature lower power dissipation than nonautonomous modes, because the ADC core enters a low-power comparator mode, as described in the [Comparator Operation](#) section (see [Table 1](#) for power dissipation specifications for each mode).

The AD4062 offers two autonomous modes named monitor mode and trigger mode. Both autonomous modes are described in the subsequent sections. When either autonomous mode is selected, the ADC core functions as a window comparator, and the ADC sampling clock is driven by the internal timer, as described in the [Comparator Operation](#) section. The sampling clock frequency is set by the FS\_BURST\_AUTO bit field in the TIMER\_CONFIG register (see [Table 52](#)).

The comparator performs the following four sample-and-comparison operations in a repeated sequence, each taking one sample period to execute, for a total sequence time of four sample periods as follows:

1.  $V_{IN} \geq MAX\_LIMIT$
2.  $V_{IN} \leq MAX\_LIMIT - MAX\_HYST$
3.  $V_{IN} \geq MIN\_LIMIT + MIN\_HYST$
4.  $V_{IN} \leq MIN\_LIMIT$

The comparator includes two hardware alert signals for the maximum and minimum threshold events (MAX\_INTR and MIN\_INTR, respectively). These signals can be assigned to either or both of the GP0 and GP1 pins, as described in the [Threshold Alert Signals](#) section. [Figure 61](#) shows a typical connection diagram for a microcontroller using these alert signals as hardware interrupts.

Monitor Mode

[Table 18](#) shows the ADC\_MODE and AUTO\_MODE bit field settings for entering monitor mode. After setting the ADC\_MODE and the AUTO\_MODE bits, setting the ADDR\_PTR to CONV\_TRIGGER enables the internal timer, and the AD4062 starts autonomously functioning as a window comparator. The AD4062 continuously operates in autonomous mode until the controller changes the ADDR\_PTR from the CONV\_TRIGGER register to a different value (see [Figure 50](#)). Monitor mode makes use of the user-programmable hysteresis settings to self-clear the MAX\_INTR and MIN\_INTR signals when the input signal goes back in range (see [Figure 48](#)).

[Figure 59](#) shows a flowchart for register configuration, the comparison sequence operations, and the behavior of the hardware interrupts and alert flags following threshold crossings in monitor mode.

When the maximum or minimum threshold crossings are detected, the MAX\_INTR or MIN\_INTR signal asserts, respectively. The internal timer continues to generate the sampling clock, and the MAX\_INTR or MIN\_INTR signal is deasserted when the sampled input signal is back in bounds as set by the MAX\_HYST and MIN\_HYST bit fields, respectively.

The MAX\_FLAG or MIN\_FLAG bit is also asserted when MAX\_INTR or MIN\_INTR asserts, respectively. The MAX\_FLAG and MIN\_FLAG are sticky and do not self-clear when the signal goes back in range. It is recommended to reset the MAX\_FLAG and MIN\_FLAG bits after exiting and before returning to monitor mode.

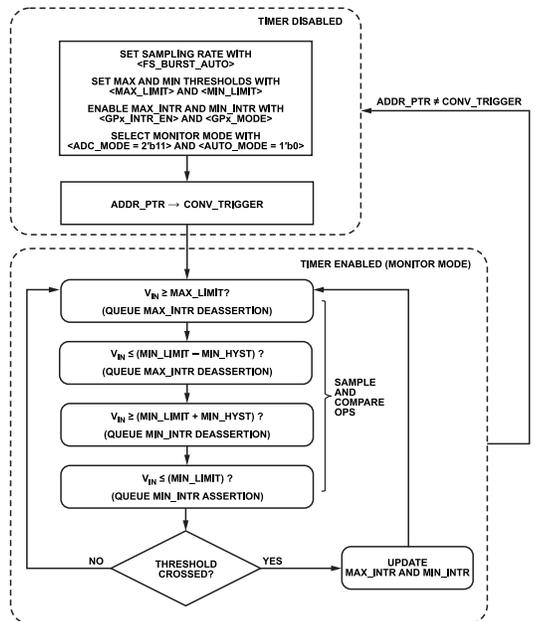


Figure 59. Monitor Mode Flowchart

## MODES OF OPERATION

### Trigger Mode

Table 18 shows the ADC\_MODE and AUTO\_MODE bit field settings for entering trigger mode. After setting the ADC\_MODE and the AUTO\_MODE bits, setting the ADDR\_PTR to CONV\_TRIGGER enables the internal timer, and the AD4062 starts autonomously functioning as a window comparator. In trigger mode, threshold crossings trigger the AD4062 to automatically perform a 16-bit conversion of the input signal and transition into sample mode. The corresponding alert signals and status bits are asserted to send the MAX or MIN IBI on the I3C bus. The controller can then read the 16-bit result from the MAX\_SAMPLE\_REG or MIN\_SAMPLE\_REG registers in configuration mode.

Figure 60 shows a flowchart for register configuration, the comparison sequence operations, and the behavior of the hardware interrupts and alert flags following threshold crossings in trigger mode.

When a maximum or minimum crossing is detected, the MAX\_INTR or MIN\_INTR signal asserts, respectively. The internal timer is disabled to stop autonomous sampling, and the ADC core powers up to

convert the input signal. Figure 62 shows a timing diagram for the threshold detection and ADC sampling in trigger mode. Following the threshold event, the firmware can either continue operating the AD4062 in sample mode to perform more conversions, or the firmware can set the ADDR\_PTR to a different value besides the CONV\_TRIGGER register to exit sample mode and read the alert registers. The MAX\_INTR and MIN\_INTR signals hold their states until the ADDR\_PTR is updated to a different value besides CONV\_TRIGGER.

Note that following the transition to sample mode, the ADC\_MODE bit field in the register map is internally overwritten to 2'h0 and must be rewritten to 2'h3 to reenter autonomous mode.

The MAX\_FLAG or MIN\_FLAG bit is also asserted when MAX\_INTR or MIN\_INTR asserts, respectively. The MAX\_FLAG and MIN\_FLAG bits are sticky and do not clear until the host sets them to 1'b1 with a register write. It is recommended to reset the MAX\_FLAG and MIN\_FLAG bits before returning to autonomous mode.

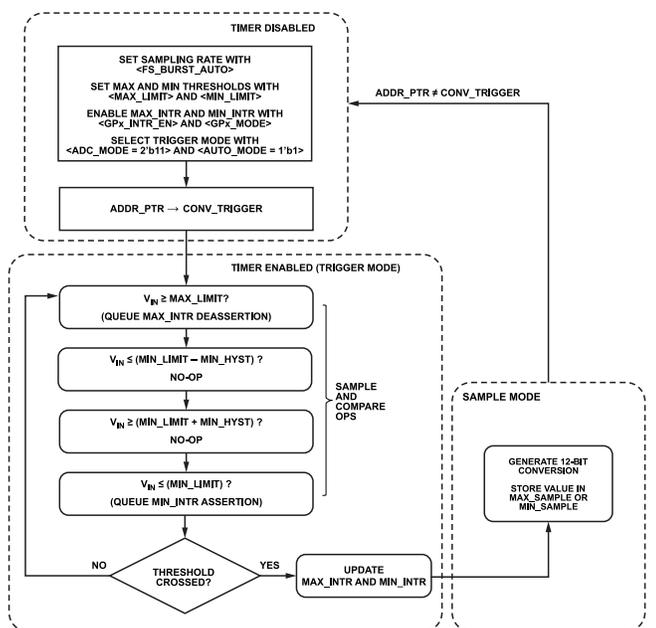


Figure 60. Trigger Mode Flowchart

## MODES OF OPERATION

### Autonomous Mode Diagrams

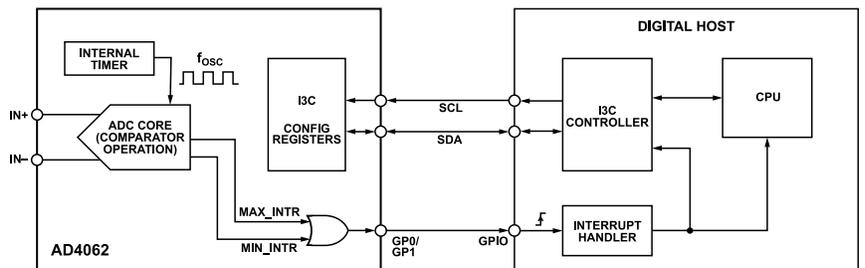


Figure 61. Autonomous Mode Example Connection Diagram

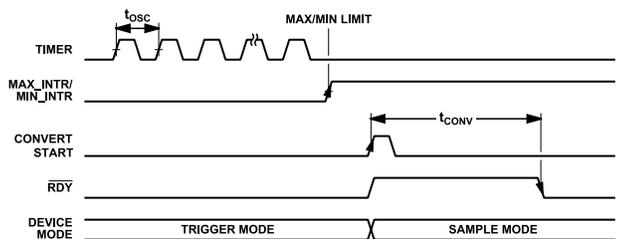


Figure 62. Trigger Mode Timing Diagram

### SLEEP MODE

In sleep mode, the AD4062 powers down all functional blocks, except the digital interface, to achieve an ultra-low power consumption of 430nW for extended periods of idle time (see [Table 1](#)). Set the POWER\_MODE bit field in the DEVICE\_CONFIG register to 2'h3 to put the AD4062 into sleep mode.

The internal LDO regulator is powered down and stops supplying the +1.8V CLDO supply while in sleep mode. This feature powers down the ADC core and most other functional blocks. The digital interface remains active, so the digital host can rewrite the POWER\_MODE bit field to 2'h0 to exit sleep mode and power up the device. When the device exits sleep mode, it enters configuration mode. The configuration register states persist, so the digital host does not need to reprogram the device configuration after exiting sleep mode.

## SERIAL INTERFACE

The AD4062 digital interface includes a 2-wire I3C interface for serial data transfer, and two general-purpose digital outputs, GP0 and GP1. The I3C interface is primarily used for reading and writing the AD4062 configuration registers and for reading the ADC results. The [Modes of Operation](#) sections describe the I3C functionality and protocols for each operating mode.

The AD4062 adheres to the I3C specifications as defined by MIPI I3C v1.1 that are also referenced throughout this document. Section 4.2.2 of the MIPI I3C specifications outlines the role of an I3C target device. The AD4062 is an SDR-only target and does not support HDR modes. The AD4062 supports the common command codes (CCCs) listed in the [Common Command Codes \(CCCs\)](#) section, and in-band Interrupts (IBIs) as described in the [In-Band Interrupts](#) section. The AD4062 does not support the hot-join mechanism and is not capable of functioning as an I3C controller device. The AD4062 is not compatible with I2C controllers.

Refer to Section 5.1.3.1 of the MIPI specifications for guidance on the open drain pull-up requirements for SDA and SCL.

The SDA data are read on the SCL rising edge and updated on the SCL falling edge.

The AD4062 includes a CRC for register reads and writes supporting robust data transfers (see the [Register Access CRC](#) section for more detail). The ADC data are formatted to integer multiples of bytes to maximize compatibility with microcontroller internal memory transfer operations such as direct memory access (DMA).

The interface logic level is set by the VIO supply voltage, as specified in [Specifications](#). The AD4062 supports 1.8V, 2.5V, and 3.3V logic systems.

## DYNAMIC ADDRESSING

The AD4062 is addressed by the I3C controller with a unique dynamic address (TGT\_ADDR). Following each start or repeated

start, the AD4062 compares the first byte against its TGT\_ADDR to determine if it is being addressed.

Following a device reset, and at the start of the I3C bus initialization, the controller must initiate the dynamic address assignment (DAA) procedure by sending the broadcast ENTDAACCC on the bus indicating to all the target devices to enter the DAA mode (See the [Common Command Codes \(CCCs\)](#) section for more detail).

During the DAA routine, the AD4062 (along with any other I3C targets on the bus) sends its unique 48-bit Provisional ID (PID) to the controller. [Table 19](#) shows the contents of the AD4062 48-bit PID. The controller then assigns a unique 7-bit dynamic address to each target device on the bus (section 5.1.4 of the MIPI I3C specifications describes the DAA Procedure in detail).

The TGT\_ADDR is stored in the TGT\_ADDR\_REG after it is assigned.

The AD4062 includes three address logic inputs called ADDR0, ADDR1, and ADDR2 (see [Table 19](#)). The ADDR<sub>x</sub> pins allow up to eight unique PIDs, enabling up to eight AD4062 devices to be populated on one I3C bus without address conflicts.

The AD4062 supports group addressing, allowing an I3C controller to write to multiple devices simultaneously. Group addressing can be used to trigger simultaneous sampling of multiple AD4062 devices via the CONV\_TRIGGER register, for example. Group addresses are assigned with the SETGRPA CCC (see the [SETGRPA](#) section).

The AD4062 does not include a static I2C address.

**Table 19. AD4062 48-Bit Provisional ID Definition**

PID <sup>1</sup> Bit Field Name	PID Bit Field Offset	Value	Description
MIPI Manufacturer ID (MID)	PID[47:33]	15'h0177	ADI MIPI assigned vendor ID.
PID Type Selector	PID[32]	1'b0	Vendor fixed value.
Part ID	PID[31:16]	16'h007C	ADI product ID.
Instance ID	PID[15:12]	PID[15] = 1'b0 PID[14:12] = [ADDR2, ADDR1, ADDR0]	Allows pin-strap selection of up to eight unique device instances. (See the <a href="#">Pin Configuration and Function Descriptions</a> section for more detail.)
Vendor-Defined	PID[11:0]	PID[11:8] = 4'b0 PID[7:0] = DCR[7:0]	Device revision number. Device characteristics register (DCR) byte. See the <a href="#">Register Details</a> section for more detail.

<sup>1</sup> Fixed by vendor.

SERIAL INTERFACE

REGISTER ADDRESS POINTER

The register address pointer (ADDR\_PTR) is a one byte long standalone register for selecting the active AD4062 register for reading or writing. When an I3C read command is initiated, the controller will read data from the register address currently stored in the ADDR\_PTR. Similarly, when an I3C write is initiated, the controller will write data to the register address currently stored in the ADDR\_PTR. The ADDR\_PTR register itself is not directly addressable for readback.

The ADDR\_PTR is updated during the instruction phase of an I3C write command (see Figure 63). The ADDR\_PTR holds the value written to it until it is updated, or until a device reset.

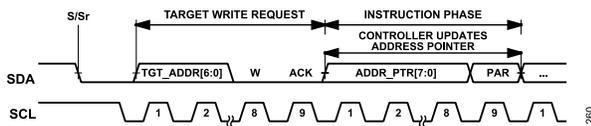


Figure 63. Updating the Address Pointer

REGISTER WRITES

The register write process for the AD4062 on an I3C bus consists of three separate phases—target write request phase, instruction phase, and data phase.

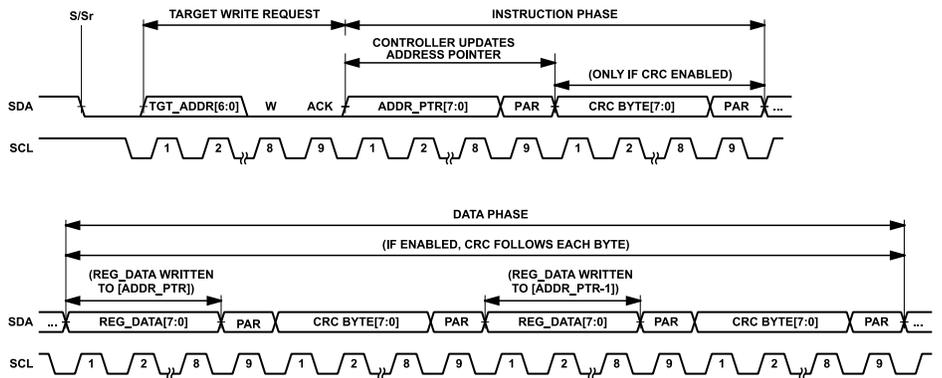


Figure 64. AD4062 Register Write Sequence

Figure 64 shows a register write sequence for the AD4062.

In the target write request phase, the controller initiates a register write by sending a start (S) or a repeated start (Sr) with the device's dynamic target or group address with the RnW bit = '0'. The device acknowledges this by sending an ACK by pulling SDA low. If the controller addresses multiple AD4062 devices via a group address, then the subsequent register write data shall be applied to all AD4062 devices on the I3C bus.

In the instruction phase, the controller updates the ADDR\_PTR. If CRC is enabled, a CRC byte is included in the ADDR\_PTR. Both the ADDR\_PTR Byte(s) and the CRC byte each have their own parity bit (see the Data Phase Ninth SDA Bit section).

In the data phase, the controller sends write-data (plus CRC if enabled) to consecutive-addressed registers one byte at a time. The first data byte (plus CRC) corresponds to the data in the register at address = <ADDR\_PTR>. Each subsequent data byte (plus CRC) corresponds to the next-lowest addressed register after <ADDR\_PTR> and so on.

The write frame is concluded when the controller initiates a repeated start (Sr) or a stop (P).

**SERIAL INTERFACE**

**REGISTER READS**

The register read process for the AD4062 on an I3C bus consists of three separate phases—a write to update the ADDR\_PTR, target read request phase, and data phase.

Figure 65 shows a register read sequence for the AD4062.

The ADDR\_PTR specifies which register will be read back during the target read request. Set the ADDR\_PTR to the desired register address value prior to sending a target read request (see the Register Address Pointer section).

In the target read request phase, the controller initiates a register read by sending a start (S) or a repeated start (Sr) with the device's TGT\_ADDR with the RnW bit = '1'. The device acknowledges this by sending an ACK by pulling SDA low.

In the data phase, the AD4062 outputs read-data (plus CRC if enabled) from consecutive-addressed registers one byte at time. The first data byte (plus CRC) corresponds to the data in the register at address = <ADDR\_PTR>. Each subsequent data byte (plus CRC) corresponds to the data in the next-lowest addressed register after <ADDR\_PTR> and so on.

The read frame is concluded when the controller initiates a repeated start (Sr). Each register read byte is terminated with a T-bit. The T-bit is always = '1' for register reads, so the controller is responsible for ending the register read frame (see Figure 7 and Figure 8).

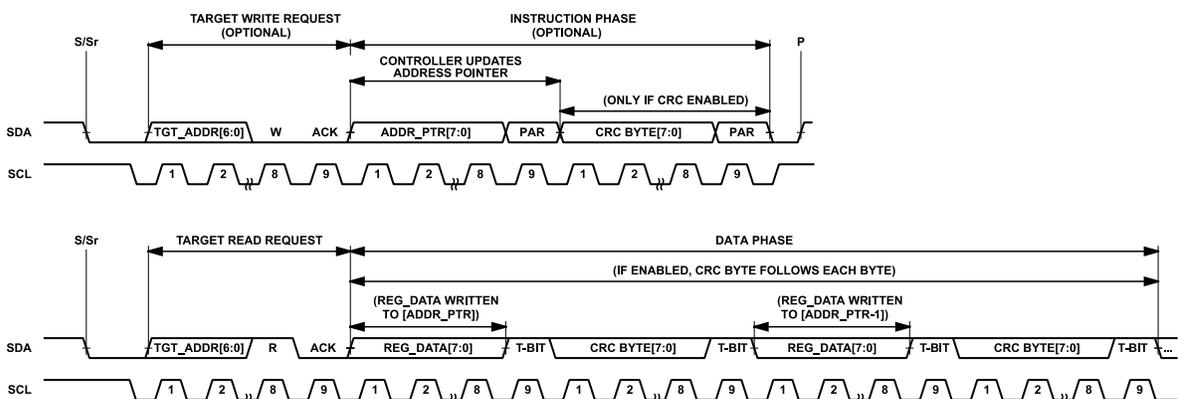


Figure 65. AD4062 Register Read Sequence

## SERIAL INTERFACE

## REGISTER ACCESS CRC

The AD4062 includes optional error checking for register reads and writes based on CRC-8, using the following polynomial:

$$x^8 + x^2 + x + 1 \quad (5)$$

The CRC is enabled by setting the CRC\_EN and CRC\_EN\_B bit fields to 0x1 and 0x2, respectively. When the CRC is enabled, an 8-bit checksum code is appended to each register data byte. The value of the checksum is calculated from the data read or written over the I3C bus, which allows the AD4062 and the controller to detect corrupted serial communications.

The CRC bytes are half duplex and are only sent by the controller or the target at any one time. The CRC-8 calculation is seeded by a nonzero value to detect if the SDA is stuck low. The seed for the first CRC following each ACK bit is 0xA5. [Table 20](#) summarizes the data and seed values for all possible register read and write transactions in configuration mode.

When the AD4062 receives a checksum that is inconsistent with its corresponding I3C transaction, the transaction is considered invalid,

and the CRC\_ERR bit in the INTERFACE\_STATUS register is set to 1. The CRC\_ERR bit is a write-1-to-clear bit (R/W1C). When the CRC is enabled, it is recommended to check the CRC\_ERR bit after each register read and write attempt.

For register writes and ADDR\_PTR writes, the controller must send a valid CRC byte following each byte of data. The CRC bytes following the register writes and ADDR\_PTR writes also have a parity bit that the AD4062 verifies before updating the write data. When a register write has an invalid CRC, the contents of the register are not updated, and the CRC\_ERR bit is asserted.

For register reads, the AD4062 calculates and sends a CRC byte following the register data. The CRC byte transmitted by the AD4062 following the first register read data byte factors in its dynamic address so that the controller can validate that it is accessing data from the intended device. When the controller receives an invalid CRC, the data must be assumed corrupted. The controller should ignore the received data and retry the register read.

**Table 20. CRC Data and Seed Values for I3C Writes**

Instruction Phase CRC		Data Phase CRCs	
Seed Input 0xA5	Data Input TGT_ADDR, RnW Bit, ADDR_PTR[7:0] Byte	Seed Input LSByte of Current Register Address	Data Input Data Phase Byte(s)

**Table 21. CRC Data and Seed Values for I3C Reads**

First Data Phase CRC		Subsequent Data Phase CRCs	
Seed Input 0xA5	Data Input TGT_ADDR, RnW Bit, Data Phase Byte(s)	Seed Input LSByte of Current Register Address	Data Input Data Phase Byte(s)

SERIAL INTERFACE

CONV\_READ REGISTER

The CONV\_READ register can be used to trigger continuous ADC conversions in a loop where reading the conversion results of one ADC conversion initiates the next ADC conversion.

To trigger ADC conversions using the CONV\_READ register, update the ADDR\_PTR to point to any of the register addresses of the CONV\_READ register (from 0x50 to 0x53). Then, perform a dummy I3C read from the AD4062 and issue a repeated start (Sr) followed by a stop (P) at the end of the data phase. The SDA rising edge of the stop (P) triggers an ADC convert-start as shown in Figure 66. In sample mode, the convert-start trigger results in a single conversion. In burst averaging mode, the convert-start trigger results in a burst of multiple conversions which are used to generate a single averaged result (see the Modes of Operation section).

When the next I3C read is performed, the data bits read from the target will be the ADC conversion results stored in CONV\_READ. The repeated start (Sr) followed by a stop (P) of this read will trigger the next ADC conversion, and therefore the host can repeatedly read from CONV\_READ to continuously generate and read back ADC samples.

Note that before reading conversion results from CONV\_READ, it is important to ensure that the correct number of data bytes will be read from the AD4062 depending on the operating mode. Table 22 shows the contents of the CONV\_READ register for sample mode, trigger mode, and burst averaging mode. Table 17 shows the recommended ADDR\_PTR setting for reading out data in each mode to minimize the number of bytes to be read per conversion.

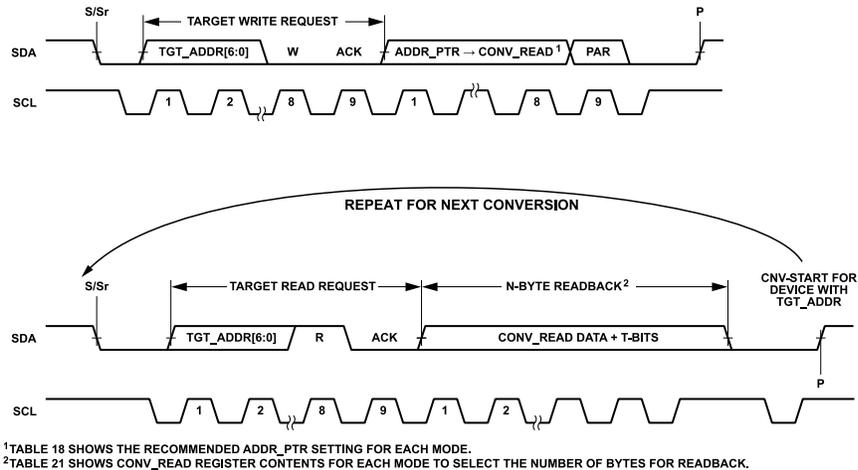


Figure 66. Triggering ADC Conversions Using CONV\_READ

Table 22. CONV\_READ Register Contents

ADC Mode	Byte 0x53 (CONV_READ [31:24])	Byte 0x52 (CONV_READ [23:16])	Byte 0x51 (CONV_READ [15:8])	Byte 0x50 (CONV_READ [7:0])
Sample Mode and Trigger Mode	SE[15:8] <sup>1</sup>	SE[7:0]	DATA[15:8]	DATA[7:0]
Burst Averaging Mode	SE[11:4]	SE[3:0], DATA[19:16]	DATA[15:8]	DATA[7:0]

<sup>1</sup> SE refers to the Sign Extension bits. When the ADC is in differential mode, the value of the SE bits is the same as the most significant data bit. When the ADC is in single-ended mode, the SE bits are always = 0.

SERIAL INTERFACE

CONV\_TRIGGER REGISTER

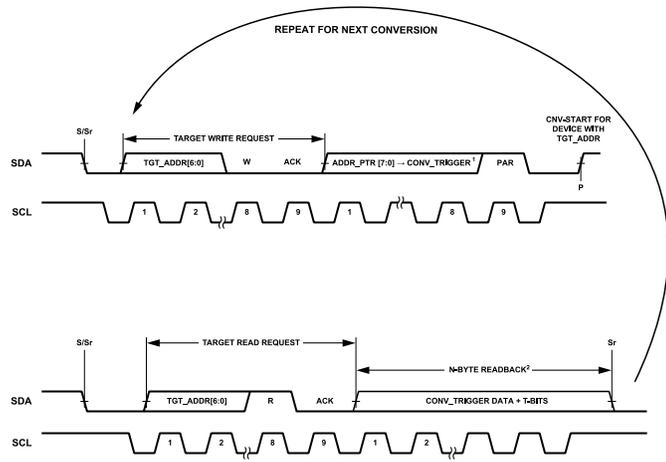
The CONV\_TRIGGER register is an alternative to the CONV\_READ register that allows for triggering ADC conversions or entering autonomous modes. CONV\_TRIGGER allows the controller to trigger simultaneous sampling of multiple AD4062 devices on the same bus using group addressing.

To trigger an ADC conversion using the CONV\_TRIGGER register, perform an I3C write to the target device, and update the ADDR\_PTR to point to any of the register addresses of CONV\_TRIGGER (0x56 to 0x59). The convert-start trigger occurs on the SDA rising edge of the stop (P) as shown in Figure 67. In sample mode, the convert-start trigger results in a single conversion. In burst averaging mode, the convert-start trigger results in a

burst of multiple conversions which are used to generate a single averaged result (see the Modes of Operation section).

While the ADDR\_PTR is still pointing to CONV\_TRIGGER, the results of the previous conversion can be read by performing an I3C read from the target device after the data is ready. Table 23 shows the contents of the CONV\_TRIGGER register for sample mode, trigger mode, and burst averaging mode. Table 17 shows the recommended ADDR\_PTR setting for reading out data in each mode.

If IBIs are enabled, performing ADC conversions via the CONV\_TRIGGER register results in the DATA\_READY\_IBI (see the In-Band Interrupts section for detail).



<sup>1</sup> TABLE 18 SHOWS THE RECOMMENDED ADDR\_PTR SETTING FOR EACH MODE.  
<sup>2</sup> TABLE 22 SHOWS CONV\_TRIGGER REGISTER CONTENTS FOR EACH MODE TO SELECT THE NUMBER OF BYTES FOR READBACK.

Figure 67. Using CONV\_TRIGGER to trigger ADC conversions

Table 23. CONV\_TRIGGER Register Contents

ADC Mode	Byte 0x59 (CONV_TRIGGER [31:24])	Byte 0x58 (CONV_TRIGGER [23:16])	Byte 0x57 (CONV_TRIGGER [15:8])	Byte 0x56 (CONV_TRIGGER [7:0])
Sample Mode and Trigger Mode	SE[15:8] <sup>1</sup>	SE[7:0]	DATA[15:8]	DATA[7:0]
Burst Averaging Mode	SE[11:4]	SE[3:0], DATA[19:16]	DATA[15:8]	DATA[7:0]

<sup>1</sup> SE refers to the Sign Extension bits. When the ADC is in differential mode, the value of the SE bits is the same as the most significant data bit. When the ADC is in single-ended mode, the SE bits are always = 0.

SERIAL INTERFACE

DATA PHASE NINTH SDA BIT

In the data phase of an I3C read or write command, the data is sent or received by the AD4062 in 8-bit packets.

In an I3C write command, each byte of data is followed by the parity bit which is calculated using odd parity and is sent from the controller to the target during the ninth SCL clock period. This data byte along with the parity bit is used by the AD4062 to determine if any errors occurred during the transmission of this data. If the AD4062 receives an even number of 1s in the data plus parity bits, then this data byte is discarded and treated as an invalid write. The AD4062 then waits for the controller to issue a stop (P) or a repeated start (Sr). When a parity error is detected, the PARITY\_ERROR bit field in the INTERFACE\_STATUS\_A register is set to 1. PARITY\_ERROR is a W1C field and needs to be cleared by the user before proceeding.

In an I3C read command, the data byte is followed the T-bit which is sent from the AD4062 to the controller during the ninth SCL high period. T = 0 forces the digital host to end the current readback, while T = 1 allows the digital host to either continue or end the current readback.

During register reads, the AD4062 always outputs T = 1, so the controller can decide to continue reading the next register byte (as shown in Figure 6) or end the frame (as shown in Figure 7 and Figure 8).

During direct CCCs that involve the target device sending data to the controller (for example, GETPID, GETBCR, GETDCR, GETSTATUS, and GETCAPS), the T-bit is set to 0 after the last required data byte is sent to the controller to force the end of the CCC.

COMMON COMMAND CODES (CCCS)

Common Command Codes (CCCs) are the I3C command set as described by MIPI specifications in Section 5.1.9. Table 24 shows the CCCs that the AD4062 supports. CCCs are categorized as either broadcast (sent to all targets on the I3C bus) or direct (sent to one specific target on the bus). Section 5.1.9.1 of the MIPI specifications describes the I3C frame format for a broadcast vs a direct CCC.

Table 24. Common Command Code Support for the AD4062

CCC	Description	Supported Format	Command Code(s)
ENEC	Enable Events	Direct	0x80
		Broadcast	0x00
DISEC	Disable Events	Direct	0x81
		Broadcast	0x01
RSTDAA	Reset Dynamic Address Assignment	Broadcast	0x06
ENTDAA	Enter Dynamic Address Assignment	Broadcast	0x07

Table 24. Common Command Code Support for the AD4062 (Continued)

CCC	Description	Supported Format	Command Code(s)
RSTACT	Target Reset Action	Broadcast	0x2A, 0x9A
RSTGRPA	Reset Group Address	Direct Broadcast	0x9C 0x2C
SETNEWDA	Set New Dynamic Address	Direct	0x88
GETPID	Get Provisioned ID	Direct	0x8D
GETBCR	Get Bus Characteristics Register	Direct	0x8E
GETDCR	Get Device Characteristics Register	Direct	0x8F
GETSTATUS	Get Device Status	Direct	0x90
GETCAPS	Get Optional Feature Capabilities	Direct	0x95
SETGRPA	Set Group Address	Direct	0x9B

The following sections describe each CCC and its format in more detail.

ENEC/DISEC

The ENEC and DISEC direct or broadcast CCCs can be used to enable or disable target driven IBIs, respectively.

Figure 70 shows the target events byte that is transmitted by the controller to the target during the ENEC/DISEC CCC. Setting the ENINT bit = 1 in the ENEC command byte enables IBIs for the AD4062. Setting DISINT = 1 in the DISEC Command Byte disables IBIs for the AD4062. The ENHJ, ENCR, DISHJ, and DISCR bits are don't care for the AD4062.



Figure 68. ENEC/DISEC Direct Format

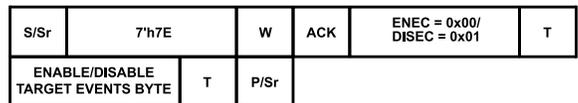


Figure 69. ENEC/DISEC Broadcast Format

## SERIAL INTERFACE

TARGET EVENTS BYTE FOR ENEC

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
RESERVED			ENHJ (DON'T CARE)	RESERVED	ENCR (DON'T CARE)		ENINT

TARGET EVENTS BYTE FOR DISEC

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
RESERVED			DISHJ (DON'T CARE)	RESERVED	DISCR (DON'T CARE)		DISINT

Figure 70. ENEC/DISEC Target Events Byte

## RSTDAA

The RSTDAA broadcast CCC indicates all target devices connected on the I3C bus to clear/reset their controller-assigned dynamic addresses

S/Sr	7'h7E	W	ACK	RSTDAA = 0x06	T	P/Sr
------	-------	---	-----	---------------	---	------

Figure 71. RSTDAA Broadcast Format

## RSTACT

The RSTACT CCC can be used to configure the reset actions that will be performed by a target device when it is commanded to perform a reset by the controller (see the [Reset Bits](#) and [Reset Pattern](#) sections for more detail). MIPI specifications define RSTACT as a broadcast, direct read or a direct write type CCC. However, the AD4062 only supports the broadcast version of the RSTACT CCC.

S/Sr	7'h7E	W	ACK	RSTACT = 0x2A	T	
DEFINING BYTE		T	P/Sr			

Figure 72. RSTACT Broadcast Format

In the broadcast format of RSTACT, the controller sends a defining byte (DByte) to the target devices which indicates the target reset action. Section 5.1.9.3.26 of the MIPI specifications lists the DByte values available for the controller to use. The AD4062 only supports DByte values of 0x00, 0x01, and 0x02. [Table 25](#) highlights the reset actions for the AD4062 based on the DByte value received from the controller.

Table 25. AD4062 RSTACT Actions

RSTACT Defining Byte Value	Reset Action
0x00	No Reset
0x01	I3C Peripheral Only Reset <sup>1</sup>
0x02	I3C peripheral, fuse reload, register map, and address pointer reset.

<sup>1</sup> An I3C peripheral reset resets the target's dynamic assigned address (both target and group), as well as other fields set by the CCC commands. It does not include the register memory map, hence none of the registers/bit fields are reset, nor are the fuses reloaded. The controller must perform the dynamic address assignment routine again following an I3C peripheral reset.

## ENTDAA

The ENTDAABroadcast CCC indicates all target devices connected on the I3C bus to enter the dynamic address assignment mode as described in Section 5.1.4 of the MIPI specifications.

S/Sr	7'h7E	W	ACK	ENTDAA = 0x07	P/Sr	ACK
DAA MODE		P				

Figure 73. ENTDAABroadcast Format

## SETNEWDA

The SETNEWDA direct CCC can be used to assign a new dynamic address to a target device on the I3C bus that already has a controller-assigned dynamic address. The use of this CCC is invalid if the target device does not already have a dynamic address. After the use of this CCC, the target device shall only respond to its newly assigned dynamic address and ignore the previous one.

S/Sr	7'h7E	W	ACK	SETNEWDA = 0x88	T	Sr
CURRENT TARGET ADDRESS		W	ACK	NEW 7-BIT DYNAMIC ADDRESS	1'b0	T
		P/Sr				

Figure 74. SETNEWDA Direct Format

## RSTGRPA

The RSTGRPA direct or broadcast CCC indicates target devices to reset/clear their controller-assigned group addresses. This CCC gives the controller the ability to disband any created groups. When used in direct (individual) mode, a target that receives this command shall clear the group address assigned to it, thus removing itself from the group. When used in direct (group) mode, all devices in the group shall clear their group address, thus disbanding the group. In broadcast mode, all targets shall clear all of their group addresses thus removing all groups from the I3C bus.

S/Sr	7'h7E	W	ACK	RSTGRPA = 0x9C	T	Sr
TARGET ADDRESS		W	ACK	P/Sr		

Figure 75. RSTGRPA Direct (Individual) Format

S/Sr	7'h7E	W	ACK	RSTGRPA = 0x9C	T	Sr
GROUP ADDRESS		W	ACK	P/Sr		

Figure 76. RSTGRPA Direct (Group) Format

S/Sr	7'h7E	W	ACK	RSTGRPA = 0x2C	T	P/Sr
------	-------	---	-----	----------------	---	------

Figure 77. RSTGRPA Broadcast Format

## SETGRPA

The SETGRPA direct CCC can be used to assign a group address to a target device on the I3C bus that already has a dynamic

## SERIAL INTERFACE

address assigned. The use of this CCC is invalid for a target device that does not already have a controller-assigned dynamic address. The target's dynamic address is used to initiate this CCC and then it can be assigned a group address as well. After assigning a group address to a target, it shall respond to both its dynamic address and the group address when addressed by the controller.

Once the AD4062 has been assigned a group address after the successful use of the SETGRPA CCC, this group address can be read from the GRP\_ADDR\_REG register. Until group address has been assigned, the GRP\_ADDR\_REG always returns its default value of 7'h7E.

S/Sr	7'h7E	W	ACK	SETGRPA = 0x9B	T	Sr
TARGET ADDRESS	W	ACK	7-BIT GROUP ADDRESS	1'b0	T	P/Sr

Figure 78. SETGRPA Direct Format

## GETPID

The GETPID direct CCC can be used by the controller to obtain the 48-bit provisional ID (PID) from a target device. The PID is used in the dynamic address assignment procedure as described in Section 5.1.4 of the MIPI specifications. Upon receiving this CCC, the target device transmits six bytes of the PID with the MSB first. (See the [Dynamic Addressing](#) section for more detail about the AD4062's 48-bit PID).

S/Sr	7'h7E	W	ACK	GETPID = 0x8D	T	Sr	
TARGET ADDRESS	R	ACK	GETPID BYTE 5	T	GETPID BYTE 4	T	
GETPID BYTE 3	T	GETPID BYTE 2	T	GETPID BYTE 1	T	GETPID BYTE 0	T
							P/Sr

Figure 79. GETPID Direct Format

## GETBCR

The GETBCR direct CCC can be used by the controller to obtain the bus characteristics register (BCR) value from a target device on the I3C bus. The BCR is transmitted by the target as one byte with the MSB first.

Upon receiving the GETBCR CCC, the AD4062 transmits the values described in [Table 26](#) as its BCR.

S/Sr	7'h7E	W	ACK	GETBCR = 0x8E	T	Sr
TARGET ADDRESS	R	ACK	GETBCR BYTE	T	P/Sr	

Figure 80. GETBCR Direct Format

Table 26. AD4062 Bus Characteristics Register Byte

Bit Field Offset	Bit Field Name	Value	Characteristic
BCR[7:6]	Device Role [1:0]	2'b00	I3C target only
BCR[5]	Advanced Capabilities	1'b1	Supports some advanced capabilities. See the <a href="#">GETCAPS</a> section

Table 26. AD4062 Bus Characteristics Register Byte (Continued)

Bit Field Offset	Bit Field Name	Value	Characteristic
BCR[4]	Virtual Target Support	1'b0	No virtual target support
BCR[3]	Offline Capable	1'b0	Always responds to I3C commands
BCR[2]	IBI Payload	1'b1	IBIs contain one mandatory data byte
BCR[1]	IBI Request Capable	1'b1	Capable of sending IBIs
BCR[0]	Max Data Speed Limitation	1'b0	No limitation

## GETDCR

The GETDCR direct CCC can be used by the controller to obtain the device characteristics register (DCR) value from a target device on the I3C bus. The BCR is transmitted by the target as one byte with the MSB first.

Upon receiving the GETDCR CCC, the AD4062 transmits an 8'b00 as the GETDCR byte indicating a generic device type as defined by MIPI.

S/Sr	7'h7E	W	ACK	GETDCR = 0x8F	T	Sr
TARGET ADDRESS	R	ACK	GETDCR BYTE	T	P/Sr	

Figure 81. GETDCR Direct Format

## GETSTATUS

The GETSTATUS direct CCC can be used by the controller to obtain the status bytes of a target on the I3C bus. The GETSTATUS CCC has two formats as described in Section 5.1.9.3.15 of the MIPI specifications. The AD4062 only supports Format 1 and does not support Format 2. If the AD4062 receives the GETSTATUS CCC with Format 2, it NACKs its address on the SDA line.

S/Sr	7'h7E	W	ACK	GETSTATUS = 0x90	T	Sr
TARGET ADDRESS	R	ACK	GETSTATUS MSByte	T	GETSTATUS LSByte	T
						P/Sr

Figure 82. GETSTATUS Direct Format

Upon receiving the GETSTATUS CCC Format 1, the AD4062 transmits the following two bytes to the controller as defined in [Table 27](#).

Table 27. AD4062 GETSTATUS Bytes

Byte	Bits	Field	Value	Description
MSB	15:8	Vendor Reserved	DEVICE_ST ATUS[7:0]	Bit fields in the device status register
LSB	7:6	Activity Mode	2'b00	Power mode bit field in the DEVICE_CONFIG register

## SERIAL INTERFACE

Table 27. AD4062 GETSTATUS Bytes (Continued)

Byte	Bits	Field	Value	Description
	5	Protocol Error	1'b1: Protocol Error Detected 1'b0: No Protocol Error	Indicates if the target detected a protocol error since the last status read
	4	Reserved	1'b0	Reserved by MIPI
	3:0	Pending Interrupt	MDB[3:0]	Lowest four bits of the mandatory data byte register

## GETCAPS

The GETCAPS direct CCC allows the controller to obtain the optional feature set support for a target device on the I3C bus. The GETCAPS CCC has two formats as described in Section 5.1.9.3.19 of the MIPI specifications. The AD4062 only supports GETCAPS Format 1. If the AD4062 receives a GETCAPS Format 2 CCC, it NACKs its address on the SDA line.

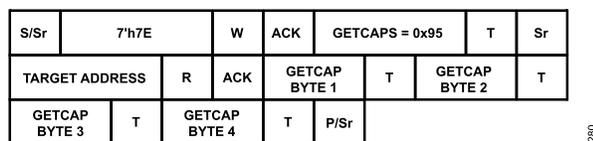


Figure 83. GETCAPS Direct Format

Upon receiving the GETCAPS CCC Format 1, the AD4062 transmits the four GETCAPS bytes described in Table 28.

Table 28. AD4062 GETCAPS Byte

GETCAPS Byte	Bit Field	Value	Description
GETCAP1	7:0	8'b00	No HDR support
GETCAP2	7:6	2'b00	No HDR support
	5:4	2'b01	Support for one group address
GETCAP3	3:0	4b'0001	Conforms to I3Cv1.1 specifications
	7	1'b0	Reserved by MIPI
	6	1'b1	Support for pending read notification
	5	1'b0	No HDR support
	4	1'b0	No GETSTATUS Format 2 support
	3	1'b0	No GETCAPS Format 2 support
	2	1'b0	No support for device-to-device transfer IBI
	1	1'b0	No support for device-to-device transfers
0	1'b0	No support for multilane data transfer	
GETCAP4	7:0	8'b00	Reserved by MIPI

## DEVICE RESET

A device reset returns the device registers to the default settings and resets the AD4062 target address. The following sections describe the AD4062 device reset mechanisms.

The AD4062 includes a hardware interrupt signal (DEV\_RDY) that indicates when the device reset is complete. The DEV\_RDY signal is active high and is assigned to the GP1 pin by default, so the digital host can monitor the GP1 pin for a rising edge to inform the firmware that the AD4062 is ready for operation. See the [Device Ready Signal](#) for more information.

The DEVICE\_RESET bit in the DEVICE\_STATUS register indicates when a device reset has occurred. The DEVICE\_RESET bit is a write-1-to-clear bit and holds its state until the host writes it to the value 1'b1. The DEVICE\_RESET bit can be referenced to confirm a reset executed as expected or if an unintended reset occurred (for example, if the power supplies failed during operation).

## Reset Bits

A reset is initiated by setting both the SW\_RESET\_MSB and SW\_RESET\_LSB bits in the INTERFACE\_CONFIG\_A register to 1'b1 in the same write instruction (see the [Interface Configuration A Register](#) section). Two reset bit fields are used to reduce the likelihood of an unintended reset from interference on the I3C bus. Using these reset bits performs a fuse reload and resets the register map and the address pointer values. It does not reset the I3C peripheral.

Figure 84 shows the timing diagram for resetting the AD4062 with the reset bits. The digital host must wait for the  $t_{\text{RESET\_FUUSE\_RELOAD}}$  delay to elapse before initiating I3C transactions (see [Timing Specifications](#)).

## Reset Pattern

The reset pattern shown in Figure 85 allows the digital host to reset the AD4062 from any of its operating modes.

The reset pattern is described in Section 5.1.11.3 of the MIPI specifications and is equivalent to fourteen SDA transitions while SCL is kept low, followed by a repeated start (Sr) and a stop (P). Figure 85 shows the timing diagram for resetting the AD4062 with the reset pattern. The digital host must wait for the delay time associated with the reset action of the device (see the [Table 5](#)) to elapse before initiating I3C transactions.

The RSTACT CCC is used to assign a reset action for the AD4062 (see [RSTACT](#) section). If the AD4062 does not have a reset action defined yet, sending the reset pattern once only resets the I3C peripheral, and a second time performs a full device reset.

If the AD4062 does have a reset action defined, then the AD4062 takes the reset action mentioned in [Table 25](#) when the reset pattern is issued.

SERIAL INTERFACE

Power-On Reset

The AD4062 is designed to generate a power-on reset (POR) when the VDD and VIO rails are first applied or when the rails are power cycled. A POR on the VDD or VIO supplies resets the state of the user configuration registers. The configuration registers are not reset when the AD4062 enters sleep mode and disables the internal LDO regulator (see the [Sleep Mode](#) section).

Figure 86 shows the timing diagram for the AD4062 PORs. The controller must wait for the  $t_{\text{RESET\_FUSE\_RELOAD}}$  delay after the power supplies are stable. Then the controller can send the broadcast RSTACT CCC with DByte = 0x02 followed by a reset pattern, or the controller can send the reset pattern twice to perform a full reset (see Figure 86 and Figure 87). Finally, an additional  $t_{\text{RESET\_FUSE\_RELOAD}}$  delay must elapse before performing other I3C transactions.

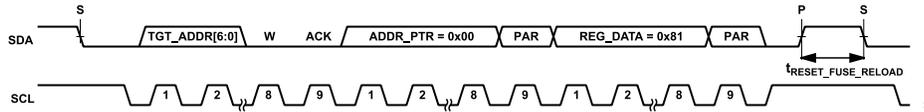


Figure 84. Reset Bit Timing Diagram

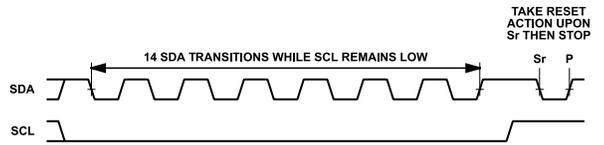


Figure 85. Reset Pattern Timing Diagram

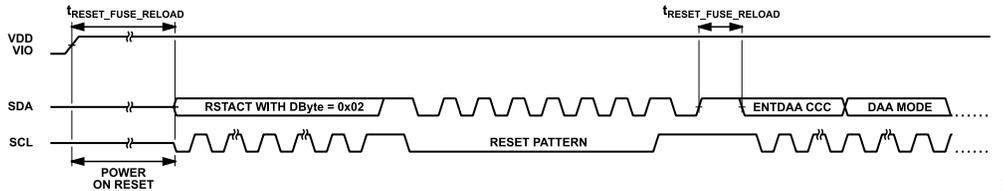


Figure 86. POR Timing Diagram with RSTACT

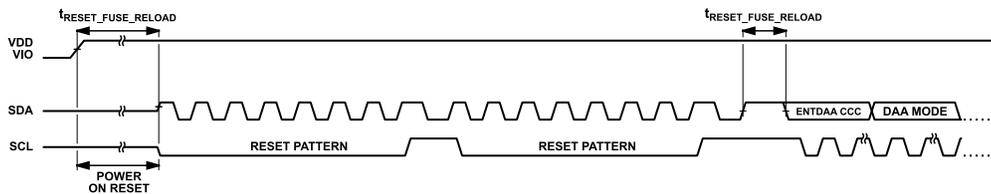


Figure 87. POR Timing Diagram with 2 Reset Patterns

## APPLICATIONS INFORMATION

## TYPICAL APPLICATIONS DIAGRAM

Figure 88 shows an example connection diagram with the AD4062. Common companion circuitry for the AD4062 includes power management, voltage reference circuitry, analog front-end and signal conditioning circuitry, and an I3C-compatible digital host (such as a microcontroller or a field programmable gate array (FPGA)).

The components shown in Figure 88 are general recommendations for best performance when operating the AD4062 and not intended for all use cases. The following sections provide more guidelines for component selection.

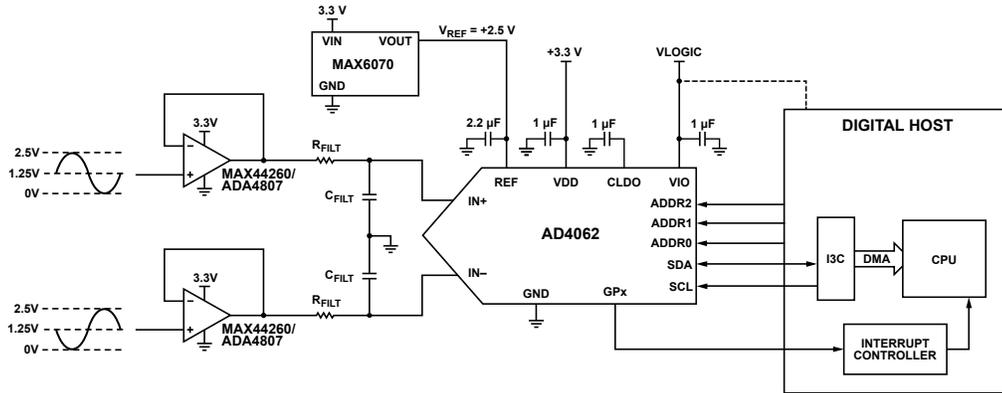


Figure 88. AD4062 Typical Application Diagram

## APPLICATIONS INFORMATION

## ANALOG FRONT-END DESIGN

## Wide Input Common-Mode Range

The AD4062 analog inputs feature a wide common-mode input voltage range that is only restricted by the absolute voltage range for each input (see Table 1). The IN+ and IN- signals can span anywhere between 0V and  $V_{REF}$  without violating the common-mode input voltage specification ( $V_{CM}$ ), ensuring compatibility with both differential and single-ended type signals. The  $V_{CM}$  voltage is given in the following equation and illustrated in Figure 89.

The AD4062 convert the differential voltage between IN+ and IN-, and the common-mode signal is attenuated by the CMRR (see Table 1 and Figure 23).

$$V_{CM} = \frac{V_{IN+} + V_{IN-}}{2} \quad (6)$$

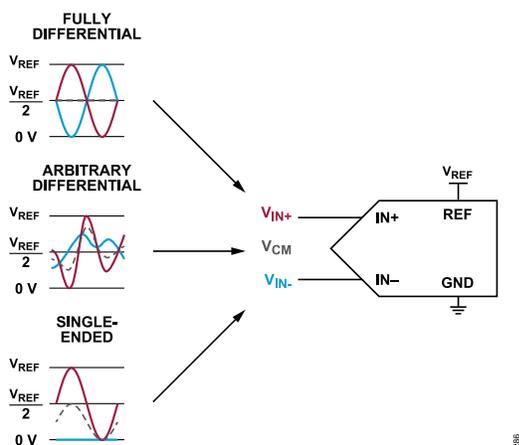


Figure 89. AD4062 Wide Input Common-Mode Range

## AD4062 Equivalent Analog Input Model

As described in the Analog Inputs section, the AD4062 analog inputs can be modeled as switched capacitive loads, with the IN+ and IN- inputs each connected to a 3.4 pF sampling capacitor through a set of sampling switches (SW1). As part of each conversion phase, the SW1 switch disconnects and reconnects the sampling capacitors ( $C_{IN}$ ) from the IN+ and IN- pins, causing transient input current and voltage glitches at the output of the AFE circuit. The small  $C_{IN}$  of the AD4062 ensures the magnitude of the transient current and voltage spikes is minimal compared to other SAR ADCs, but the AFE must still be designed to settle these glitches quickly enough (before the next conversion) to meet the accuracy and performance specifications in Specifications.

AD4062 Equivalent Analog Input Model shows an equivalent load circuit model of the AD4062 IN+ and IN- inputs. SW1 represents the sampling switches and SW2 represents the  $C_{IN}$  reset switch. The SW1 switch opens at the beginning of the conversion phase to

sample the IN+ and IN- voltages on the  $C_{IN}$  capacitors. Before the start of the acquisition phase, the SW2 switch shorts the sampling capacitors together to reset them to a known, predictable state. Because the  $C_{IN}$  capacitance is the same for both IN+ and IN-, the reset voltages on each capacitor are equivalent and are given by the following equation:

$$\frac{V_{IN+} + V_{IN-}}{2} \quad (7)$$

where  $V_{IN+}$  and  $V_{IN-}$  are the sampled IN+ and IN- voltages, respectively. Note that this formula is the same as the common-mode input voltage formula given in Wide Input Common-Mode Range.

As mentioned in the Converter Operation section, the AD4062 acquisition and conversion phases overlap. The acquisition phase starts 210ns after the start of the conversion phase. At the start of the acquisition phase, the SW2 switch opens and the SW1 switch closes to reconnect  $C_{IN}$  to the AD4062 inputs to acquire the signal. At the instant SW1 closes, the IN+ and IN- inputs sink or source some charge from the AFE circuit to recharge the  $C_{IN}$  capacitors to the intended signal voltage. The transient current spike causes transient voltage glitches on each pin, with magnitudes that are a function of the amount of charge pulled by the  $C_{IN}$  capacitors and the output impedance of the AFE circuit.

The SW2 switch is implemented to minimize linearity errors if the AFE cannot completely settle the input glitch before the next conversion phase. The SW2 switch ensures the charge transfer per sample is linearly related to the input signal voltage. The worst-case current and voltage glitch magnitude occur when the differential input voltage is equal to  $V_{REF}$ . For example, when  $V_{IN-} = 0V$ , and  $V_{IN+} = V_{REF} = 3.3V$ , the charge transfer per sample is 5.6pC into the IN- input and out of the IN+ input. The steady-state input current is, therefore, also linearly related to input voltage, as shown in Figure 25. Settling error with the AD4062, therefore, appears as additional gain error rather than degradation in INL and THD.

An RC kickback filter is recommended on each of the IN+ and IN- pins to attenuate the voltage glitch on the output of the AFE circuit (see Figure 88). The Front-End Amplifier and RC Filter Design for a Precision SAR Analog-to-Digital Converter article provides guidance for selecting the RC components of the kickback filter to ensure proper settling. Table 29 provides general RC component recommendations for the AD4062 for several sample rates ( $R_{FILT}$  and  $C_{FILT}$  are the resistor and capacitor values in the RC kickback filter, respectively). The values in Table 29 are provided for initial guidance, and the system designer must verify the companion amplifier is stable driving these RC loads. The values corresponding to sample rates of 500kSPS and above are only applicable for the burst of conversions during the burst averaging mode.

The AD4062 LTspice model emulates the equivalent analog input model shown in Figure 90 when configured for transient simulations.

APPLICATIONS INFORMATION

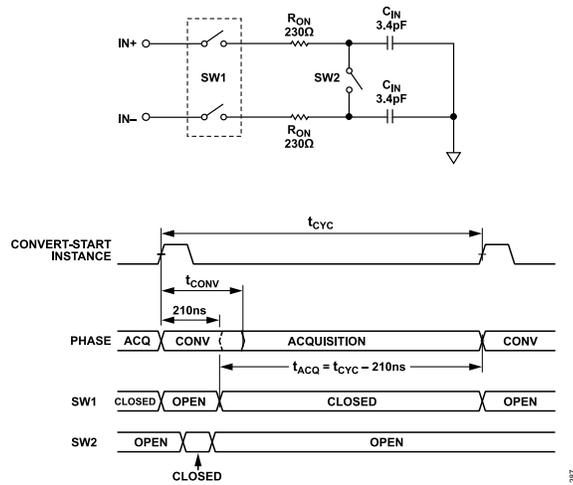


Figure 90. AD4062 Equivalent Input Load Model

Table 29. AD4062 RC Kickback Filter Recommendations

Sample Rate	$t_{ACQ}$	$R_{FILT}$	$C_{FILT}$	-3dB Bandwidth
2MSPS	290ns	52.3Ω	1nF	3.04MHz
		124Ω	360pF	3.57MHz
1MSPS	790ns	143Ω	1nF	1.11MHz
		332Ω	360pF	1.33MHz
500kSPS	1790ns	301Ω	1nF	528.75kHz
		634Ω	360pF	697.31kHz
100kSPS	9790ns	1.78kΩ	1nF	89.4kHz
		4.12kΩ	360pF	107.3kHz

## APPLICATIONS INFORMATION

### Noise and Distortion Considerations

The noise and distortion specifications of the AFE circuit must be considered, because they combine with the AD4062 noise and distortion specifications to determine the overall system performance. The total system noise ( $v_{N,TOTAL}$ ) is the root sum of squares (RSS) of the AFE RMS noise ( $v_{N,AFE}$ ) and ADC RMS noise ( $v_{N,ADC}$ ), referred to the inputs of the AD4062 as shown the following equation:

$$v_{N,TOTAL} = \sqrt{v_{N,AFE}^2 + v_{N,ADC}^2} \quad (8)$$

[MT-049](#) and [MT-050](#) describe how to estimate  $v_{N,AFE}$  for operational amplifier circuits, as a function of the amplifier and passive component noise specifications and amplifier configuration. The [Front-End Amplifier and RC Filter Design for a Precision SAR Analog-to-Digital Converter](#) article describes how to estimate system SNR vs.  $v_{N,AFE}$  and  $v_{N,ADC}$ .

As noted in the [AD4062 Equivalent Analog Input Model](#) section, the primary purpose of the RC kickback filter between the AFE and the ADC is to minimize settling error and not to filter AFE noise or perform anti-aliasing. The RC kickback filter bandwidth cannot be set arbitrarily low, and it is recommended to implement any additional noise or anti-alias filtering before or within the amplifier circuit instead of the RC kickback filter. NP0/C0G type dielectric capacitors are recommended for all capacitors used in the AFE circuit to minimize signal distortion artifacts caused by capacitor voltage and temperature derating.

## REFERENCE CIRCUIT DESIGN

### Equivalent REF Input Model

The AD4062 requires an external voltage reference to define the input range of the device. A low-noise, stable reference is critical for maximizing accuracy and performance.

The AD4062 REF pin draws charge ( $Q_{CONV}$ ) from the external reference circuit during each conversion phase to perform the SAR ADC bit trials. The REF input current ( $I_{REF}$ ) can, therefore, be expressed as a transient current load that occurs once per conversion and as an equivalent average DC current load that is a function of the sample rate (see [Table 1](#) and [Figure 26](#)). The voltage reference circuit must maintain a stable and accurate  $V_{REF}$  voltage, despite the charge transient from the AD4062 REF pin, to prevent gain error or stuck bits in the conversion results.

A reference decoupling capacitor ( $C_{REF}$ ) is strongly recommended to supply the instantaneous charge drawn by the REF pin while maintaining the  $V_{REF}$  voltage to within an LSB. For optimal performance, populate  $C_{REF}$  with a 2.2  $\mu\text{F}$  capacitor with a case size of 0402 or larger to ensure suitable capacitor voltage coefficient. For space-constrained applications, a 1  $\mu\text{F}$  capacitor in a case size of 0201 may be used with slight degradation to gain error and INL. Place the  $C_{REF}$  capacitor on the same PCB layer and as close to the REF pin as possible with a wide trace to minimize series impedance (see the [Layout Recommendations](#) section).

While the AD4062 is idling (not performing conversions), the REF pin draws only a small standby current (8 nA). In applications where the AD4062 intermittently switches between idling and performing bursts of conversions (for example, when using burst averaging mode), the  $I_{REF}$  quickly shifts from near-zero current to 60  $\mu\text{A}/15 \mu\text{A}$  for  $f_S = 2\text{MSPS}/500\text{kSPS}$ . This step in load current triggers an output load transient response in the reference circuit that must be considered if  $V_{REF}$  varies by more than  $\frac{1}{2}$  LSB. The [MAX6070](#) voltage reference is recommended for its exceptional transient response with low power dissipation. [Figure 91](#) illustrates the transient loading effects on the reference circuit in response to a burst of conversions.

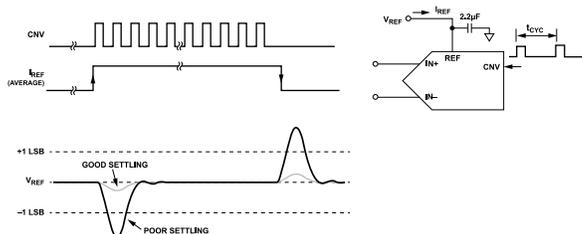


Figure 91. Burst Sampling and Voltage Reference Settling

### Reference Noise Considerations

The voltage reference circuit noise is critical for achieving the system-level dynamic range and SNR target specifications. For large input signals near full scale, any noise from the reference circuit will couple into the conversion results and modulate around the fundamental frequency. Reference noise will also limit the SNR and resolution improvements gained from using high averaging ratios in burst averaging mode.

## SYNCHRONIZED AMPLIFIER SHUTDOWN AND ADC SAMPLING

The DEV\_EN signal is an amplifier power-down signal generated by the AD4062 and synchronized to the ADC to maximize amplifier power-up settling time prior to the sampling instant. [Figure 49](#) shows a typical connection diagram when using the AD4062 DEV\_EN signal with an operational amplifier. The DEV\_EN signal is assigned to the GPO output pin in this example.

When the DEV\_EN signal is asserted (see the [Device Enable Signal](#) section), it enables the connected amplifier. The sampling instant is delayed until the user-programmable  $t_{PWR\_ON}$  delay elapses. After the  $t_{PWR\_ON}$  delay elapses, the DEV\_EN signal is deasserted to power down the amplifier. Consult the amplifier data sheet for its shutdown pin logic levels to ensure compatibility with the AD4062 logic levels that are set by the VIO voltage and given in [Specifications](#).

To ensure the amplifier output settles before the ADC sampling instant, set the  $t_{PWR\_ON}$  delay to be longer than the amplifier turn-on time specification. Turn-on time indicates the time needed for the amplifier output to settle to a specified accuracy following assertion of its ENABLE/SHUTDOWN input. Note that turn-on time varies

## APPLICATIONS INFORMATION

for different loads and amplifier configurations. The [Introduction to Dynamic Power Scaling](#) article provides guidance on configuring and evaluating operational amplifier power cycling relative to the SAR ADC sampling.

See [Figure 54](#) and [Figure 58](#) for timing diagrams using DEV\_EN in the various AD4062 operating modes.

### ACHIEVING HIGH ACCURACY WITH REFERENCE SHUTDOWN

Low-noise, high-accuracy voltage references are generally recommended to pair with precision SAR ADCs to maximize system-level performance. The voltage reference circuit also needs to have low output impedance and fast transient response to deal with the SAR ADC REF input transient load, especially when performing bursts of samples (see the [Reference Circuit Design](#) section). Low-power voltage references generally cannot satisfy all of these requirements simultaneously, which often forces system designers to add a reference buffer amplifier, increasing overall system power dissipation.

The [MAX6070](#) is an exceptionally low-power voltage reference that can drive the AD4062 REF pin directly without an intermediate reference buffer amplifier. For extremely power-sensitive applications, however, the AD4062 offer unique features that allow the voltage reference to be disabled without degrading precision.

The AD4062 can select the VDD supply as the  $V_{REF}$  source, as described in the [Reference Selection Modes](#) section. To maintain accuracy while using VDD as the  $V_{REF}$ , the AD4062 can directly measure the ratio between the VDD supply and the REF input voltages and calculate a corresponding digital correction factor to automatically scale the ADC samples accordingly. The digital

correction uses the MON\_VAL field described in the [Gain Scaling](#) section to scale the ADC transfer function between the REF and VDD domains.

The automatic MON\_VAL scaling calculation consist of two phases. [Figure 92](#) illustrates the AD4062 configuration while measuring and calculating the MON\_VAL digital correction factor. [Figure 93](#) shows the configuration after MON\_VAL is updated and the AD4062 begin sampling the inputs with  $V_{DD}$  as the  $V_{REF}$  source. [Table 30](#) gives the relevant configuration settings for both phases.

In the MON\_VAL calculation phase, the REF pin is driven by an accurate voltage reference, like the MAX6070, and the REF pin is selected as the  $V_{REF}$  source. The VDD voltage is internally scaled by  $\frac{1}{2}$  and sampled by the ADC. When the controller triggers the AD4062 to perform a burst of samples in burst averaging mode, and the averaged result is generated, the AD4062 automatically calculates a 16-bit digital correction factor and loads it into the MON\_VAL field. The  $\overline{RDY}$  signal can optionally be assigned to the GP0 or GP1 pins to indicate when the calculation is complete.

In the MON\_VAL application phase, the ADC is reconfigured to sample the input signal via the IN+ and IN- pins, with VDD selected as the  $V_{REF}$  source. The external voltage reference is powered down to reduce system power. When the ADC samples the inputs, the MON\_VAL scaling factor is applied to the digital output codes to scale them to the transfer function set by the REF voltage instead of the VDD voltage.

Depending on the stability of the VDD supply circuit, the MON\_VAL calculation may need to be repeated periodically to maintain system accuracy targets.

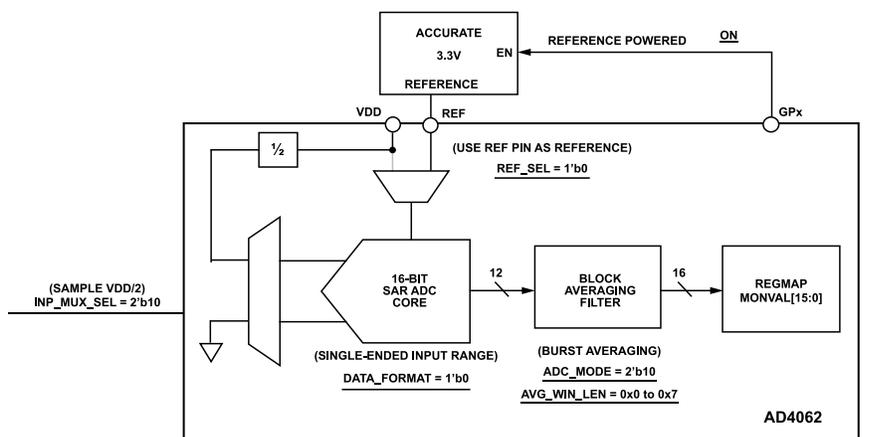


Figure 92. MON\_VAL Calculation Configuration

## APPLICATIONS INFORMATION

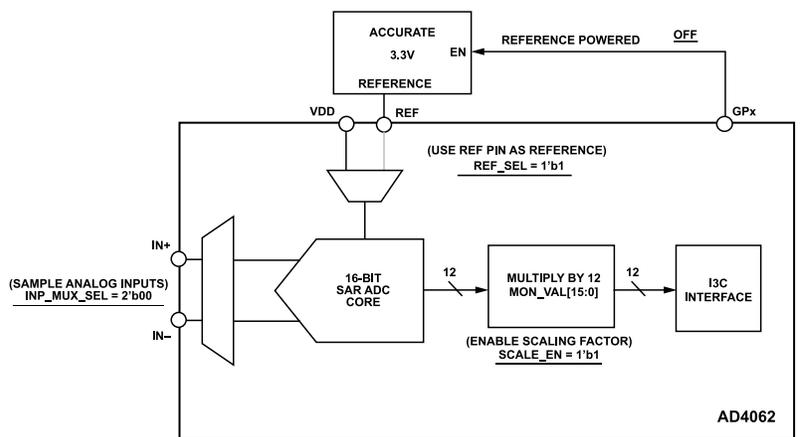


Figure 93. MON\_VAL Application Configuration

Table 30. Configuration Settings for MON\_VAL Scaling

Bit Field Name	MON_VAL Calculation	MON_VAL Application
REF_SEL	1'b0: $V_{REF} = REF$	1'b1: $V_{REF} = VDD$
DATA_FORMAT	1'b0: Single-ended mode	Don't care
INP_MUX_SEL	2'b10: Sample $VDD/2$	2'b00: sample IN+ and IN-
ADC_MODE	2'b10: Burst averaging mode	Don't care
AVG_WIN_LEN	Don't care <sup>1</sup>	Don't care
SCALE_EN	1'b0: Scaling disabled	1'b1: scaling enabled
GP0_SEL	3'b010: $\overline{RDY}$ on GP0 <sup>2</sup>	Don't care
GP1_SEL	3'b110: Logic high on GP1 <sup>3</sup>	3'b011: logic low on GP1 <sup>3</sup>

- MON\_VAL calculations do not require a specific value for  $N_{AVG}$ , but it is recommended to set  $N_{AVG}$  based on the VDD supply circuit noise and the system accuracy targets.
- Optional. The  $\overline{RDY}$  signal can act as a hardware interrupt to notify the digital host when MON\_VAL calculation is complete.
- Optional. The static logic levels can act as the voltage reference enable pin if its input logic levels are consistent with the AD4062 output logic levels.

## VDD POWER DISSIPATION

SAR ADCs such as the AD4062 are ideal for precision measurement applications with tight power dissipation budgets. The ADC core is effectively duty-cycled and only consumes active power while performing a conversion, so the effective power dissipation is lower at slower sample rates. Figure 94 illustrates the instantaneous and average VDD input current ( $I_{DD}$ ) vs. ADC sampling. Table 1 gives the average supply current and power dissipation for several operating modes and sample rates.

The AD4062 ADC core is exceptionally power efficient and can operate in several lower power operating modes. As described in the [Analog Front-End Design](#) section, slower sampling rates also relax the load drive requirements for the AFE and reference circuitry, allowing the AD4062 to interface with low-power amplifiers and voltage references for overall system power optimization.

While the AD4062 is idle, VDD draws only 990nA standby current (see Figure 37). In sample mode, the AD4062 average VDD current is 400 $\mu$ A at 1MSPS, and 120 $\mu$ A at 300kSPS, equivalent to 400pC per conversion. In the autonomous modes, the VDD current is reduced to 112 $\mu$ A at 1MSPS, and 56 $\mu$ A at 500kSPS, equivalent to 112pC per comparison operation. Figure 29 and Figure 32 show the average  $I_{DD}$  and power dissipation vs. the ADC sample rate and operating mode. The supply current and power dissipation scale linearly with the sample rate.

In burst averaging mode, the AD4062 performs a burst of conversions to generate an averaged result. The average power dissipation in burst averaging mode is, therefore, a function of the average number of conversions performed per second over many bursts of samples. This is a function of the burst sampling rate,  $N_{AVG}$ , and the period of the conversion instances. Figure 95 illustrates the VDD power dissipation over the burst sampling and idle phases in burst averaging mode.

APPLICATIONS INFORMATION

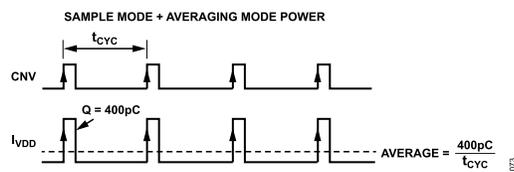


Figure 94.  $I_{DD}$  vs. Conversion Periods in Sample Mode

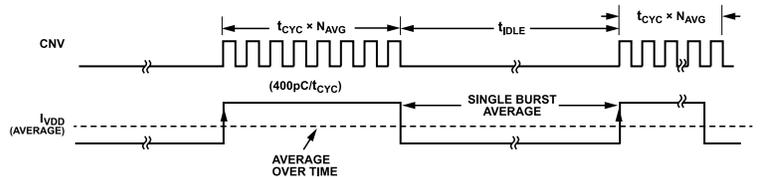


Figure 95.  $I_{DD}$  vs. Burst Conversions in Burst Averaging Mode

APPLICATIONS INFORMATION

CALCULATING SERIAL INTERFACE OUTPUT DATA RATE

The AD4062 ADC core performance is specified for  $f_s$  up to 2MSPS, but the maximum achievable output data rate ( $f_{ODR\_MAX}$ ) is a function of the operating conditions and serial interface specifications and may limit the practical  $f_s$ , especially in sample mode.

When using CONV\_READ to trigger ADC conversions, each read of the conversion result (followed by a repeated start and a stop) results in another ADC conversion. When using CONV\_TRIGGER to trigger ADC conversions requires sending a write command to update the Address Pointer to trigger each conversion, followed by a read command to read the conversion results before the triggering the next conversion. Reading from CONV\_READ therefore enables a faster  $f_{ODR\_MAX}$ .

Table 31 shows the maximum serial interface output data rate in sample mode using the CONV\_READ and CONV\_TRIGGER registers. The maximum output data rate numbers are obtained by assuming all the specifications mentioned in Equation 9 through Equation 19 at their specified minimum values, and using the maximum conversion time of 320ns.  $t_{OD\_Clock}$  is assumed to be =  $t_{LOW\_OD\_Min} + t_{HIGH\_OD\_Min} = 232ns$ .  $t_{PP\_Clock}$  is assumed to be = 80ns using an  $f_{SCL}$  value of 12.5MHz (see Timing Specifications). Since the AD4062 does not have any SDA falling or rising edge rate detection restrictions when SDA is driven by the controller, the controller driven SDA rise and fall times are assumed to be = 0.

Equation 9 to Equation 13 can be used to estimate  $f_{ODR\_MAX}$  in sample mode using CONV\_READ. Equation 14 to Equation 19 can be used to estimate  $f_{ODR\_MAX}$  in sample mode using CONV\_TRIGGER.

Table 31. Maximum Serial Interface Output Data Rate

Conversion register	$f_{ODR\_MAX}$
CONV_READ	251.03kSPS
CONV_TRIGGER	146.88kSPS

$$t_{OD} = t_{CAS} + 9 \times (t_{OD\_Clock}) \tag{9}$$

$$t_{PP} = 18 \times (t_{PP\_Clock}) \tag{10}$$

$$t_{Transition} = t_{CBSr} + t_{CASr} + \frac{1}{2}(t_{PP\_Clock}) + t_{CBP} + t_{CONV} \tag{11}$$

$$t_{CYC\_MIN} = t_{OD} + t_{PP} + t_{Transition} \tag{12}$$

$$f_{ODR\_MAX} = 1/t_{CYC} \tag{13}$$

$$t_{OD} = t_{CAS} + 9 \times (t_{OD\_Clock}) \tag{14}$$

$$t_{PP} = 9 \times (t_{PP\_Clock}) \tag{15}$$

$$t_{Transition} = t_{CBP} + t_{CONV} \tag{16}$$

$$t_{Read} = t_{CAS} + 9 \times (t_{OD\_Clock}) + 18 \times (t_{PP\_Clock}) + t_{CBP} + t_{BUF} \tag{17}$$

$$t_{CYC\_MIN} = t_{OD} + t_{PP} + t_{Transition} + t_{Read} \tag{18}$$

$$f_{ODR\_MAX} = 1/t_{CYC} \tag{19}$$

where:

- $t_{CYC}$  is the minimum achievable sample period.
- $f_{ODR\_MAX}$  is the maximum achievable output data rate.
- $t_{CAS}$  is the clock wait time after a start.
- $t_{OD\_Clock}$  is a clock period in open drain (see Table 3)
- $t_{PP\_Clock}$  is a clock period in push pull (see Table 4)
- $t_{CBSr}$  is the clock wait time before a repeated start.
- $t_{CASr}$  is the clock wait time after a repeated start.
- $t_{CBP}$  is the clock wait time before a stop.
- $t_{CONV}$  is the ADC conversion time.
- $t_{BUF}$  is the wait time between a stop and a start.

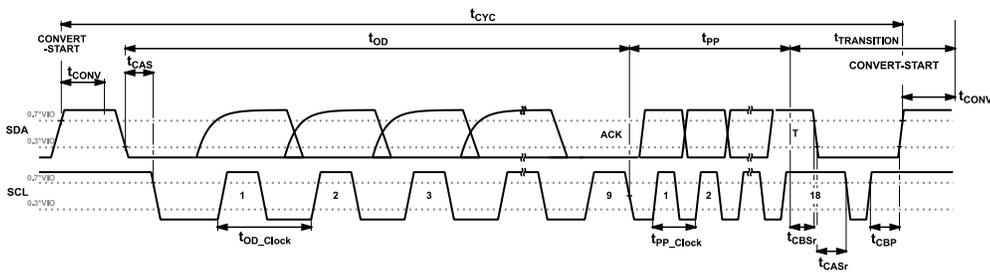


Figure 96. Calculating  $f_{ODR\_MAX}$  Using CONV\_READ

## APPLICATIONS INFORMATION

### LAYOUT RECOMMENDATIONS

The following PCB layout guidelines are recommended to maximize performance using the AD4062:

- ▶ Include a solid ground plane in the PCB layer underneath the AD4062. Ensure there are low-impedance connections between the AD4062 GND pins and the ground plane layer.
- ▶ Ensure the analog input and REF traces are physically separated from the digital interface traces to minimize crosstalk from digital signal edges. Include a GND fill between the analog and digital traces. Avoid routing the digital interface traces underneath the AD4062 or the analog signal traces without including a solid ground plane layer in between.
- ▶ Ensure the impedance between the voltage reference circuitry and the AD4062 REF pin is as low as possible to prevent  $V_{REF}$  settling issues. Place a low effective series resistance (ESR) decoupling capacitor as close to the AD4062 REF pin as possible (see the [Reference Circuit Design](#) section). Use wide traces between the voltage reference and the AD4062 REF pin.
- ▶ Place the RC kickback filter capacitors as close to the IN+ and IN- pins as possible (see the [Analog Front-End Design](#) section).
- ▶ Place the supply decoupling capacitors as close to the VDD, CLDO, and VIO pins as possible (see the [Power Supplies](#) section).

## AD4062 REGISTER SUMMARY

Table 32. AD4062 Register Summary

Address	Name	Description	Reset	Access
0x00	INTERFACE_CONFIG_A	Interface Configuration A.	0x00	R/W
0x01	INTERFACE_CONFIG_B	Interface Configuration B.	0x08	R/W
0x02	DEVICE_CONFIG	Device Configuration.	0xF0	R/W
0x03	DEVICE_TYPE	Device Type.	0x07	R
0x04	PRODUCT_ID_L	Product Identification (LSByte).	0x7C	R
0x05	PRODUCT_ID_H	Product Identification (MSByte).	0x00	R
0x06	DEVICE_GRADE	Device Grade.	0x00	R
0x0A	SCRATCH_PAD	Scratch Pad.	0x00	R/W
0x0C	MANUFACTURER_ID_L	MIPI Manufacturer ID (LSByte).	0x77	R
0x0D	MANUFACTURER_ID_H	MIPI Manufacturer ID (MSByte).	0x01	R
0x0E	LOOP_COUNT	Reserved.	0x00	R/W
0x0F	TRANSFER_CONFIG	Reserved.	0x00	R/W
0x10	INTERFACE_CONFIG_C	Interface Configuration C.	0x03	R/W
0x11	INTERFACE_STATUS	Interface Status.	0x00	R/W
0x21	ADC_MODES	ADC Operating Mode Configuration.	0x80	R/W
0x22	ADC_CONFIG	ADC Setup Configuration.	0x00	R/W
0x23	AVG_CONFIG	Averaging Filter Configuration.	0x00	R/W
0x24	GP_CONFIG	General Purpose Pin Configuration.	0xF0	R/W
0x25	INTR_CONFIG	Interrupt Configuration.	0x21	R/W
0x27	TIMER_CONFIG	Timer Configuration.	0x00	R/W
0x28	MAX_LIMIT_REG	Maximum Threshold Configuration.	0x0000	R/W
0x2A	MIN_LIMIT_REG	Minimum Threshold Configuration.	0x0000	R/W
0x2C	MAX_HYST_REG	Maximum Threshold Hysteresis.	0x00	R/W
0x2D	MIN_HYST_REG	Minimum Threshold Hysteresis.	0x00	R/W
0x2E	MON_VAL_REG	MON_VAL Scaling.	0x0000	R/W
0x30	INTERFACE_IBI_EN	Interface Error IBI Enable.	0x00	R/W
0x31	ADC_IBI_EN	ADC IBI Enable.	0x00	R/W
0x40	FUSE_CRC	Fuse CRC.	0x00	R/W
0x41	DEVICE_STATUS	Device Status.	0x40	R/W
0x42	MAX_SAMPLE_REG	Maximum Interrupt Sample.	0x0000	R
0x44	MIN_SAMPLE_REG	Minimum Interrupt Sample.	0x0000	R
0x46	TGT_ADDR_REG	Target Address.	0x00	R
0x47	GRP_ADDR_REG	Group Address.	0xFF	R
0x48	IBI_STATUS	IBI Status.	0x00	R
0x50	CONV_READ	Conversion Read Result.	0x00000000	R
0x56	CONV_TRIGGER	Conversion Trigger.	0x00000000	R

## REGISTER DETAILS

## INTERFACE CONFIGURATION A REGISTER

Interface configuration settings.

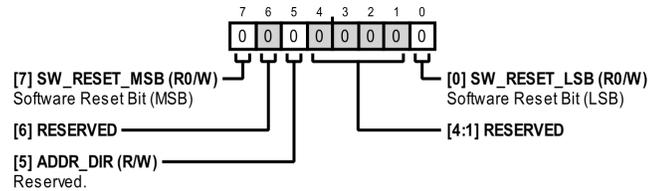


Figure 97. Address: 0x00, Reset: 0x00, Name: INTERFACE\_CONFIG\_A

Table 33. Bit Descriptions for INTERFACE\_CONFIG\_A

Bits	Bit Name	Description	Reset	Access
7	SW_RESET_MSB	Software Reset Bit (MSB). Set both SW_RESET_MSB and SW_RESET_LSB to 1 in the same register write to initiate a software reset of the device.	0x0	R0/W
6	RESERVED	Reserved.	0x0	R
5	ADDR_DIR	Reserved. This bit must be set to 0. This bit is not reset by software resets, and must be reset by the software reset pattern or power-on reset.	0x0	R/W
[4:1]	RESERVED	Reserved.	0x0	R
0	SW_RESET_LSB	Software Reset Bit (LSB). Set both SW_RESET_MSB and SW_RESET_LSB to 1 in the same register write to initiate a software reset of the device.	0x0	R0/W

## INTERFACE CONFIGURATION B REGISTER

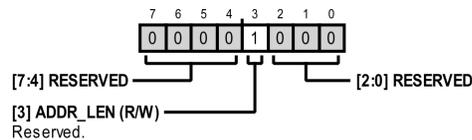


Figure 98. Address: 0x01, Reset: 0x08, Name: INTERFACE\_CONFIG\_B

Table 34. Bit Descriptions for INTERFACE\_CONFIG\_B

Bits	Bit Name	Description	Reset	Access
[7:4]	RESERVED	Reserved.	0x0	R
3	ADDR_LEN	Reserved. This bit must be set to 1.	0x1	R/W
[2:0]	RESERVED	Reserved.	0x0	R

## DEVICE CONFIGURATION REGISTER

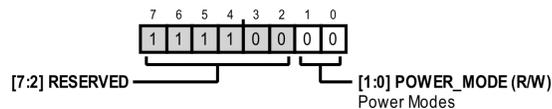


Figure 99. Address: 0x02, Reset: 0xF0, Name: DEVICE\_CONFIG

Table 35. Bit Descriptions for DEVICE\_CONFIG

Bits	Bit Name	Description	Reset	Access
[7:2]	RESERVED	Reserved.	0x3C	R
[1:0]	POWER_MODE	Power Modes. 00: Active Mode. 11: Sleep Mode (Low Power).	0x0	R/W

## REGISTER DETAILS

## DEVICE TYPE REGISTER

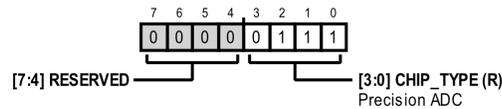


Figure 100. Address: 0x03, Reset: 0x07, Name: DEVICE\_TYPE

Table 36. Bit Descriptions for DEVICE\_TYPE

Bits	Bit Name	Description	Reset	Access
[7:4]	RESERVED	Reserved.	0x0	R
[3:0]	CHIP_TYPE	Precision ADC.	0x7	R

## PRODUCT IDENTIFICATION (LSBYTE) REGISTER

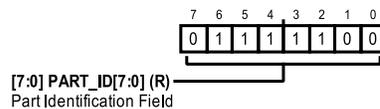


Figure 101. Address: 0x04, Reset: 0x7C, Name: PRODUCT\_ID\_L

Table 37. Bit Descriptions for PRODUCT\_ID\_L

Bits	Bit Name	Description	Reset	Access
[7:0]	PART_ID[7:0]	Part Identification Field.	0x7C	R

## PRODUCT IDENTIFICATION (MSBYTE) REGISTER

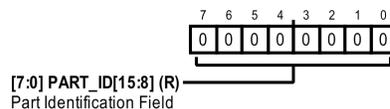


Figure 102. Address: 0x05, Reset: 0x00, Name: PRODUCT\_ID\_H

Table 38. Bit Descriptions for PRODUCT\_ID\_H

Bits	Bit Name	Description	Reset	Access
[7:0]	PART_ID[15:8]	Part Identification Field.	0x0	R

## DEVICE GRADE REGISTER

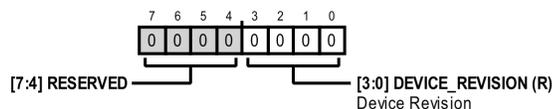


Figure 103. Address: 0x06, Reset: 0x00, Name: DEVICE\_GRADE

Table 39. Bit Descriptions for DEVICE\_GRADE

Bits	Bit Name	Description	Reset	Access
[7:4]	RESERVED	Reserved.	0x0	R
[3:0]	DEVICE_REVISION	Device Revision. Indicates the device revision.	0x0	R

## SCRATCH PAD REGISTER

Interface read/write test register.

## REGISTER DETAILS

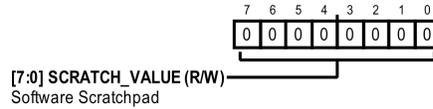


Figure 104. Address: 0x0A, Reset: 0x00, Name: SCRATCH\_PAD

Table 40. Bit Descriptions for SCRATCH\_PAD

Bits	Bit Name	Description	Reset	Access
[7:0]	SCRATCH_VALUE	Software Scratchpad. Use this register to test I3C communications with the device. Values written to this register have no impact on device behavior.	0x0	R/W

## MIPI MANUFACTURER ID (LSBYTE) REGISTER

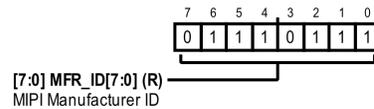


Figure 105. Address: 0x0C, Reset: 0x77, Name: MANUFACTURER\_ID\_L

Table 41. Bit Descriptions for MANUFACTURER\_ID\_L

Bits	Bit Name	Description	Reset	Access
[7:0]	MFR_ID[7:0]	MIPI Manufacturer ID. The MFR_ID[15:0] field is the same value (0x0177) for all Analog Devices products.	0x77	R

## MIPI MANUFACTURER ID (MSBYTE) REGISTER

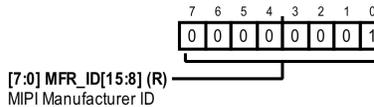


Figure 106. Address: 0x0D, Reset: 0x01, Name: MANUFACTURER\_ID\_H

Table 42. Bit Descriptions for MANUFACTURER\_ID\_H

Bits	Bit Name	Description	Reset	Access
[7:0]	MFR_ID[15:8]	MIPI Manufacturer ID. The MFR_ID[15:0] field is the same value (0x0177) for all Analog Devices products.	0x1	R

## RESERVED REGISTER

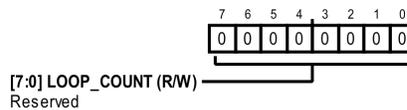


Figure 107. Address: 0x0E, Reset: 0x00, Name: LOOP\_COUNT

Table 43. Bit Descriptions for LOOP\_COUNT

Bits	Bit Name	Description	Reset	Access
[7:0]	LOOP_COUNT	Reserved. This bit field must be set to 0x00.	0x0	R/W

## REGISTER DETAILS

## RESERVED REGISTER

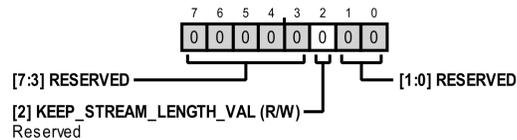


Figure 108. Address: 0x0F, Reset: 0x00, Name: TRANSFER\_CONFIG

Table 44. Bit Descriptions for TRANSFER\_CONFIG

Bits	Bit Name	Description	Reset	Access
[7:3]	RESERVED	Reserved.	0x0	R
2	KEEP_STREAM_LENGTH_VAL	Reserved. This bit must be set to 0.	0x0	R/W
[1:0]	RESERVED	Reserved.	0x0	R

## INTERFACE CONFIGURATION C REGISTER

Additional interface configuration settings.

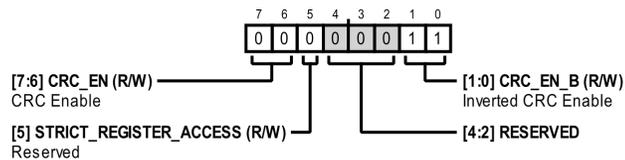


Figure 109. Address: 0x10, Reset: 0x03, Name: INTERFACE\_CONFIG\_C

Table 45. Bit Descriptions for INTERFACE\_CONFIG\_C

Bits	Bit Name	Description	Reset	Access
[7:6]	CRC_EN	CRC Enable. Set CRC_EN to 0x1 and CRC_EN_B to 0x2 in the same register write to enable interface CRC. 0x0: CRC Disabled. 0x1: CRC Enabled. Enables CRC if CRC_EN_B = 0x2.	0x0	R/W
5	STRICT_REGISTER_ACCESS	Reserved. This bit must be set to 0.	0x0	R/W
[4:2]	RESERVED	Reserved.	0x0	R
[1:0]	CRC_EN_B	Inverted CRC Enable. To enable CRC, write as the inverted value of CRC_ENABLE.	0x3	R/W

## INTERFACE STATUS REGISTER

Status bits indicating errors in register reads and/or writes in configuration mode. The interface status bits are active high and are cleared by writing a 1 to their corresponding bit locations.

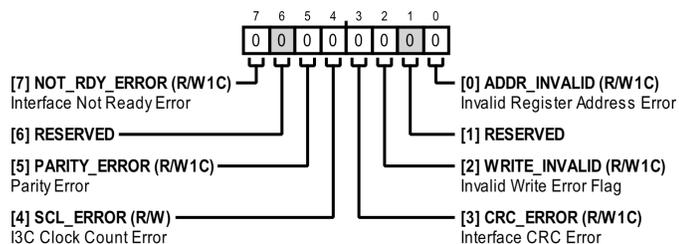


Figure 110. Address: 0x11, Reset: 0x00, Name: INTERFACE\_STATUS

REGISTER DETAILS

Table 46. Bit Descriptions for INTERFACE\_STATUS

Bits	Bit Name	Description	Reset	Access
7	NOT_RDY_ERROR	Interface Not Ready Error. This error bit is set if the user attempts to execute an I3C transaction before the completion of digital initialization. For example, before a device reset is complete.	0x0	R/W1C
6	RESERVED	Reserved.	0x0	R
5	PARITY_ERROR	Parity Error. This error bit is set when the parity bit in an I3C write transaction does not match the parity of the accompanying data.	0x0	R/W1C
4	SCL_ERROR	I3C Clock Count Error. This error bit is set when an incorrect number of serial clock periods is received in an I3C read/write transaction.	0x0	R/W
3	CRC_ERROR	Interface CRC Error. This error bit is set when the device receives an invalid CRC checksum value on SDA during a register read/write. This error bit is only active when CRC is enabled.	0x0	R/W1C
2	WRITE_INVALID	Invalid Write Error Flag. This error bit is set to 1 when the I3C controller attempts a register write to a register that contains exclusively read-only bits.	0x0	R/W1C
1	RESERVED	Reserved.	0x0	R
0	ADDR_INVALID	Invalid Register Address Error. This error bit is set to 1 when the I3C controller attempts to read from or write to an undefined register address.	0x0	R/W1C

ADC OPERATING MODE CONFIGURATION REGISTER

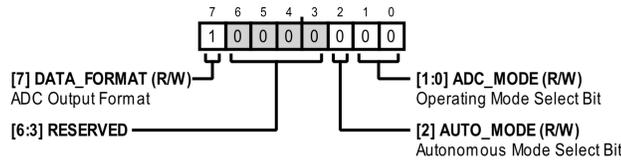


Figure 111. Address: 0x21, Reset: 0x80, Name: ADC\_MODES

Table 47. Bit Descriptions for ADC\_MODES

Bits	Bit Name	Description	Reset	Access
7	DATA_FORMAT	ADC Output Format. 0: Single-Ended Mode. ADC data are in straight binary (unsigned) format. 1: Differential Mode. ADC data are in twos complement (signed) format.	0x1	R/W
[6:3]	RESERVED	Reserved.	0x0	R
2	AUTO_MODE	Autonomous Mode Select Bit. 0: Monitor Mode. 1: Trigger Mode.	0x0	R/W
[1:0]	ADC_MODE	Operating Mode Select Bit. 0x0: Sample Mode. 0x1: Burst Averaging Mode. 0x3: Autonomous Mode. Select between persistent and nonpersistent autonomous mode via the AUTO_MODE bit.	0x0	R/W

ADC SETUP CONFIGURATION REGISTER

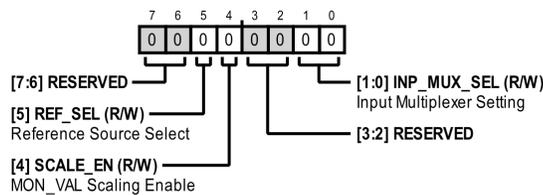


Figure 112. Address: 0x22, Reset: 0x00, Name: ADC\_CONFIG

## REGISTER DETAILS

Table 48. Bit Descriptions for ADC\_CONFIG

Bits	Bit Name	Description	Reset	Access
[7:6]	RESERVED	Reserved.	0x0	R
5	REF_SEL	Reference Source Select. Selects which pin is used as the ADC reference source. 0: REF. 1: VDD.	0x0	R/W
4	SCALE_EN	MON_VAL Scaling Enable. MON_VAL scaling is enabled when SCALE_EN is set to 1 while the input multiplexer is configured to monitor the analog inputs (see the INP_MUX_SEL bit).	0x0	R/W
[3:2]	RESERVED	Reserved.	0x0	R
[1:0]	INP_MUX_SEL	Input Multiplexer Setting. 0x0: Analog Inputs. ADC connected to analog inputs (IN+ and IN-). 0x1: Invalid. 0x2: Invalid. 0x3: CLDO. ADC monitors CLDO. This setting is used to verify the CLDO supply voltage.	0x0	R/W

## AVERAGING FILTER CONFIGURATION REGISTER

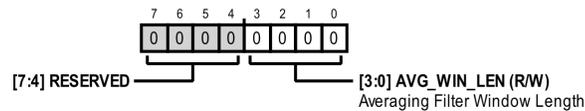


Figure 113. Address: 0x23, Reset: 0x00, Name: AVG\_CONFIG

Table 49. Bit Descriptions for AVG\_CONFIG

Bits	Bit Name	Description	Reset	Access
[7:4]	RESERVED	Reserved.	0x0	R
[3:0]	AVG_WIN_LEN	Averaging Filter Window Length. Sets the averaging ratio for averaging and burst averaging modes. The averaging ratio ranges from 2 to 4096 in powers of 2. 0x0: 2. 0x1: 4. 0x2: 8. 0x3: 16. 0x4: 32. 0x5: 64. 0x6: 128. 0x7: 256. 0x8: 512. 0x9: 1024. 0xA: 2048. 0xB: 4096.	0x0	R/W

## GENERAL PURPOSE PIN CONFIGURATION REGISTER

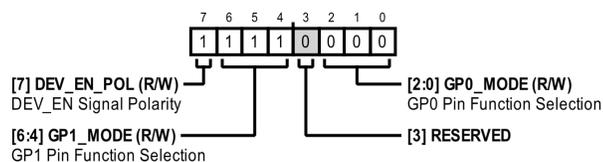


Figure 114. Address: 0x24, Reset: 0xF0, Name: GP\_CONFIG

## REGISTER DETAILS

Table 50. Bit Descriptions for GP\_CONFIG

Bits	Bit Name	Description	Reset	Access
7	DEV_EN_POL	DEV_EN Signal Polarity. Sets the polarity of the DEV_EN signal for compatibility with active high and active low amplifier enable pins. 0: DEV_EN Active Low. 1: DEV_EN Active High. Default	0x1	R/W
[6:4]	GP1_MODE	GP1 Pin Function Selection. 0x0: Disabled/High-Z. 0x1: GP1_INTR Signal. 0x2: Data Ready Signal. 0x3: DEV_EN Signal. 0x5: Static Logic Low (GND). 0x6: Static Logic High (VIO). 0x7: DEV_RDY Signal (Default).	0x7	R/W
3	RESERVED	Reserved.	0x0	R
[2:0]	GP0_MODE	GP0 Pin Function Selection. 0x0: Disabled/High-Z (Default). 0x1: GP0_INTR Signal. 0x2: Data Ready Signal. 0x3: DEV_EN Signal. 0x5: Static Logic Low (GND). 0x6: Static Logic High (VIO).	0x0	R/W

## INTERRUPT CONFIGURATION REGISTER

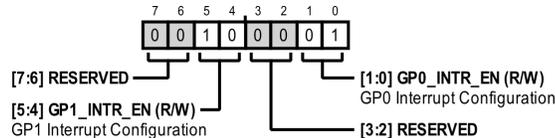


Figure 115. Address: 0x25, Reset: 0x21, Name: INTR\_CONFIG

Table 51. Bit Descriptions for INTR\_CONFIG

Bits	Bit Name	Description	Reset	Access
[7:6]	RESERVED	Reserved.	0x0	R
[5:4]	GP1_INTR_EN	GP1 Interrupt Configuration. Selects which of the threshold detection interrupt signals are passed through to the GP1_INTR output signal. 0x0: Neither Interrupt. 0x1: MIN_INTR. 0x2: MAX_INTR. Default. 0x3: Either Interrupt. GP1 outputs the logical OR of MIN_INTR and MAX_INTR signals.	0x2	R/W
[3:2]	RESERVED	Reserved.	0x0	R
[1:0]	GP0_INTR_EN	GP0 Interrupt Configuration. Selects which of the threshold detection interrupt signals are passed through to the GP0_INTR output signal. 0x0: Neither Interrupt. 0x1: MIN_INTR. Default. 0x2: MAX_INTR. 0x3: Either Interrupt. GP0 outputs the logical OR of MIN_INTR and MAX_INTR signals.	0x1	R/W

## REGISTER DETAILS

## TIMER CONFIGURATION REGISTER

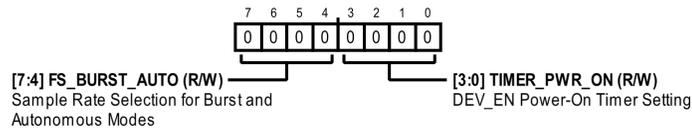


Figure 116. Address: 0x27, Reset: 0x00, Name: TIMER\_CONFIG

Table 52. Bit Descriptions for TIMER\_CONFIG

Bits	Bit Name	Description	Reset	Access
[7:4]	FS_BURST_AUTO	Sample Rate Selection for Burst and Autonomous Modes. 0x0: 2MSPS. 0x1: 1MSPS. 0x2: 300kSPS. 0x3: 100kSPS. 0x4: 33.3kSPS. 0x5: 10kSPS. 0x6: 3kSPS. 0x7: 1kSPS. 0x8: 500SPS. 0x9: 333SPS. 0xA: 250SPS. 0xB: 200SPS. 0xC: 166SPS. 0xD: 140SPS. 0xE: 125SPS. 0xF: 111SPS.	0x0	R/W
[3:0]	TIMER_PWR_ON	DEV_EN Power-On Timer Setting. Selects the delay between DEV_EN assertion and ADC sampling instant when DEV_EN is selected for either GP0 or GP1 pins. 0x0: 500ns. 0x1: 1μs. 0x2: 3.3μs. 0x3: 10μs. 0x4: 30μs. 0x5: 100μs. 0x6: 330μs. 0x7: 1000μs. 0x8: 2000μs. 0x9: 3000μs. 0xA: 4000μs. 0xB: 5000μs. 0xC: 6000μs. 0xD: 7000μs. 0xE: 8000μs. 0xF: 9000μs.	0x0	R/W

## REGISTER DETAILS

## MAXIMUM THRESHOLD CONFIGURATION REGISTER

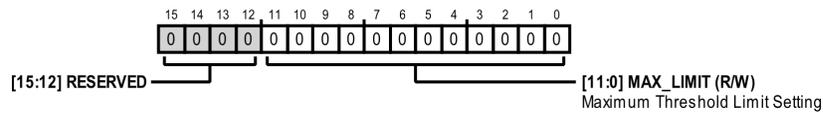


Figure 117. Address: 0x28, Reset: 0x0000, Name: MAX\_LIMIT\_REG

Table 53. Bit Descriptions for MAX\_LIMIT\_REG

Bits	Bit Name	Description	Reset	Access
[15:12]	RESERVED	Reserved.	0x0	R
[11:0]	MAX_LIMIT	Maximum Threshold Limit Setting. Sets the maximum threshold limit for autonomous modes. Uses the same data format (twos complement or straight binary) as the ADC as set by the DATA_FORMAT bit.	0x0	R/W

## MINIMUM THRESHOLD CONFIGURATION REGISTER

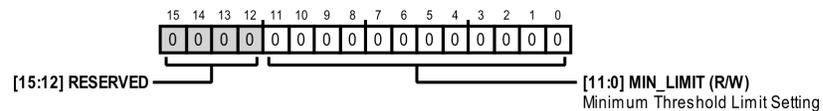


Figure 118. Address: 0x2A, Reset: 0x0000, Name: MIN\_LIMIT\_REG

Table 54. Bit Descriptions for MIN\_LIMIT\_REG

Bits	Bit Name	Description	Reset	Access
[15:12]	RESERVED	Reserved.	0x0	R
[11:0]	MIN_LIMIT	Minimum Threshold Limit Setting. Sets the minimum threshold limit for autonomous modes. Uses the same data format (twos complement or straight binary) as the ADC as set by the DATA_FORMAT bit.	0x0	R/W

## MAXIMUM THRESHOLD HYSTERESIS REGISTER

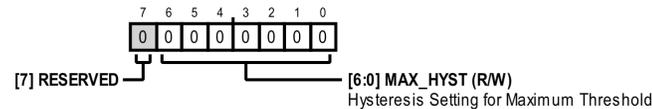


Figure 119. Address: 0x2C, Reset: 0x00, Name: MAX\_HYST\_REG

Table 55. Bit Descriptions for MAX\_HYST\_REG

Bits	Bit Name	Description	Reset	Access
7	RESERVED	Reserved.	0x0	R
[6:0]	MAX_HYST	Hysteresis Setting for Maximum Threshold. Sets the hysteresis setting for self-clearing the MAX_INTR signal in monitor mode. Uses straight binary (unsigned) format.	0x0	R/W

## MINIMUM THRESHOLD HYSTERESIS REGISTER

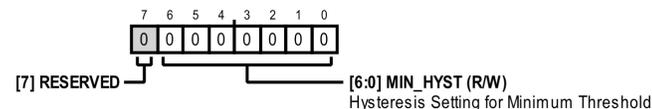


Figure 120. Address: 0x2D, Reset: 0x00, Name: MIN\_HYST\_REG

Table 56. Bit Descriptions for MIN\_HYST\_REG

Bits	Bit Name	Description	Reset	Access
7	RESERVED	Reserved.	0x0	R

REGISTER DETAILS

Table 56. Bit Descriptions for MIN\_HYST\_REG (Continued)

Bits	Bit Name	Description	Reset	Access
[6:0]	MIN_HYST	Hysteresis Setting for Minimum Threshold. Sets the hysteresis setting for self-clearing the MIN_INTR signal in monitor mode. Uses straight binary (unsigned) format.	0x0	R/W

MON\_VAL SCALING REGISTER

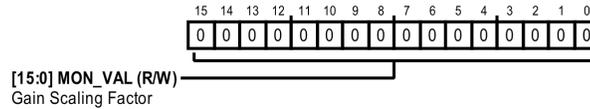


Figure 121. Address: 0x2E, Reset: 0x0000, Name: MON\_VAL\_REG

Table 57. Bit Descriptions for MON\_VAL\_REG

Bits	Bit Name	Description	Reset	Access
[15:0]	MON_VAL	Gain Scaling Factor. Sets the scaling factor for ADC results when using MON_VAL scaling. MON_VAL can be automatically generated or set manually.	0x0	R/W

INTERFACE ERROR IBI ENABLE REGISTER

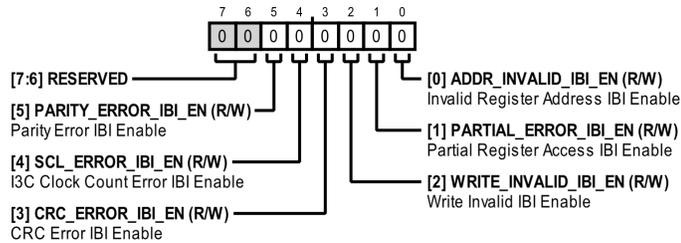


Figure 122. Address: 0x30, Reset: 0x00, Name: INTERFACE\_IBI\_EN

Table 58. Bit Descriptions for INTERFACE\_IBI\_EN

Bits	Bit Name	Description	Reset	Access
[7:6]	RESERVED	Reserved.	0x0	R
5	PARITY_ERROR_IBI_EN	Parity Error IBI Enable. Set this bit to 1 to enable the PARITY_ERROR_IBI.	0x0	R/W
4	SCL_ERROR_IBI_EN	I3C Clock Count Error IBI Enable. Set this bit to 1 to enable the SCL_ERROR_IBI.	0x0	R/W
3	CRC_ERROR_IBI_EN	CRC Error IBI Enable. Set this bit to 1 to enable the CRC_ERROR_IBI.	0x0	R/W
2	WRITE_INVALID_IBI_EN	Write Invalid IBI Enable. Set this bit to 1 to enable the WRITE_INVALID_IBI.	0x0	R/W
1	PARTIAL_ERROR_IBI_EN	Partial Register Access IBI Enable. Set this bit to 1 to enable the PARTIAL_ERROR_IBI.	0x0	R/W
0	ADDR_INVALID_IBI_EN	Invalid Register Address IBI Enable. Set this bit to 1 to enable the ADDR_INVALID_IBI.	0x0	R/W

ADC IBI ENABLE REGISTER

If GRP\_NOT\_ASSIGNED is 0, GRP\_ADDR contains the assigned group address. Otherwise, GRP\_ADDR reads back all 1's. In other words, GRP\_ADDR\_REG either reads back 0xFF or the assigned group address.

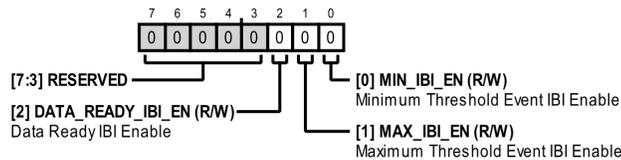


Figure 123. Address: 0x31, Reset: 0x00, Name: ADC\_IBI\_EN

## REGISTER DETAILS

Table 59. Bit Descriptions for ADC\_IBI\_EN

Bits	Bit Name	Description	Reset	Access
[7:3]	RESERVED	Reserved.	0x0	R
2	DATA_READY_IBI_EN	Data Ready IBI Enable. If this IBI enable bit is set, an IBI will be triggered when the ADC result is ready after doing a conversion with CONV_TRIGGER.	0x0	R/W
1	MAX_IBI_EN	Maximum Threshold Event IBI Enable. If this IBI enable bit is set, the maximum threshold event will trigger an IBI. Only the first event that sets the MAX_THRESH_INTR bit will trigger an IBI. No IBI will be triggered for subsequent events after MAX_THRESH_INTR has been set.	0x0	R/W
0	MIN_IBI_EN	Minimum Threshold Event IBI Enable. If this IBI enable bit is set, the minimum threshold event will trigger an IBI. Only the first event that sets the MIN_THRESH_INTR bit will trigger an IBI. No IBI will be triggered for subsequent events after MIN_THRESH_INTR has been set.	0x0	R/W

## FUSE CRC REGISTER

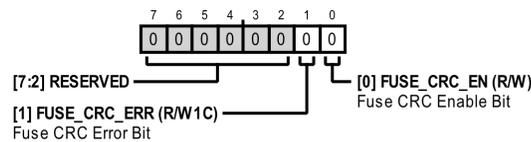


Figure 124. Address: 0x40, Reset: 0x00, Name: FUSE\_CRC

Table 60. Bit Descriptions for FUSE\_CRC

Bits	Bit Name	Description	Reset	Access
[7:2]	RESERVED	Reserved.	0x0	R
1	FUSE_CRC_ERR	Fuse CRC Error Bit. Indicates an invalid fuse map CRC check. If this bit is set following the fuse map CRC check, reset the device.	0x0	R/W1C
0	FUSE_CRC_EN	Fuse CRC Enable Bit. Setting this bit to 1 triggers a CRC check on the internal device fuse map. This bit self-clears when the fuse map CRC check is complete.	0x0	R/W

## DEVICE STATUS REGISTER

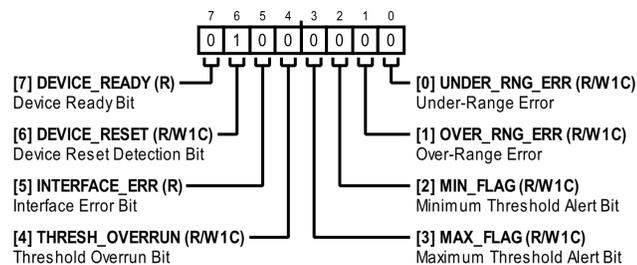


Figure 125. Address: 0x41, Reset: 0x40, Name: DEVICE\_STATUS

Table 61. Bit Descriptions for DEVICE\_STATUS

Bits	Bit Name	Description	Reset	Access
7	DEVICE_READY	Device Ready Bit. This bit is automatically set to 1 when the device reset and startup sequence is complete and is ready for serial communications from the digital host.	0x0	R
6	DEVICE_RESET	Device Reset Detection Bit. Indicates a device reset occurred. This bit is cleared by setting it to 1.	0x1	R/W1C
5	INTERFACE_ERR	Interface Error Bit. Indicates if one or more interface communication errors occurs. This bit is the logical OR of all bits in INTERFACE_STATUS_A register.	0x0	R
4	THRESH_OVERRUN	Threshold Overrun Bit. This bit is set to 1 when a threshold overrun event is detected. This bit is sticky and is only cleared by writing it to a 1.	0x0	R/W1C
3	MAX_FLAG	Maximum Threshold Alert Bit. This bit is set to 1 when a maximum threshold violation is detected. This bit is sticky and is only cleared by writing it to a 1.	0x0	R/W1C

## REGISTER DETAILS

Table 61. Bit Descriptions for DEVICE\_STATUS (Continued)

Bits	Bit Name	Description	Reset	Access
2	MIN_FLAG	Minimum Threshold Alert Bit. This bit is set to 1 when a minimum threshold violation is detected. This bit is sticky and is only cleared by writing it to a 1.	0x0	R/W1C
1	OVER_RNG_ERR	Over-Range Error. Write 1 to clear.	0x0	R/W1C
0	UNDER_RNG_ERR	Under-Range Error. Write 1 to clear.	0x0	R/W1C

## MAXIMUM INTERRUPT SAMPLE REGISTER

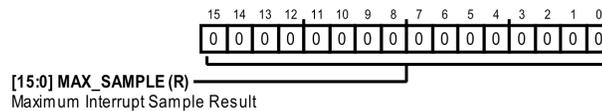


Figure 126. Address: 0x42, Reset: 0x0000, Name: MAX\_SAMPLE\_REG

Table 62. Bit Descriptions for MAX\_SAMPLE\_REG

Bits	Bit Name	Description	Reset	Access
[15:0]	MAX_SAMPLE	Maximum Interrupt Sample Result. Contains ADC result generated by maximum threshold interrupt in trigger mode. Uses the same data format (twos complement or straight binary) as the ADC as set by the DATA_FORMAT bit.	0x0	R

## MINIMUM INTERRUPT SAMPLE REGISTER

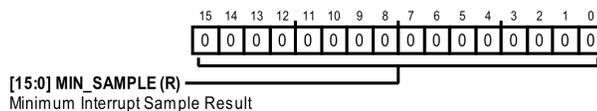


Figure 127. Address: 0x44, Reset: 0x0000, Name: MIN\_SAMPLE\_REG

Table 63. Bit Descriptions for MIN\_SAMPLE\_REG

Bits	Bit Name	Description	Reset	Access
[15:0]	MIN_SAMPLE	Minimum Interrupt Sample Result. Contains ADC result generated by minimum threshold interrupt in trigger mode. Uses the same data format (twos complement or straight binary) as the ADC as set by the DATA_FORMAT bit.	0x0	R

## TARGET ADDRESS REGISTER

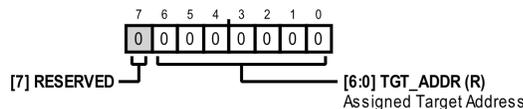


Figure 128. Address: 0x46, Reset: 0x00, Name: TGT\_ADDR\_REG

Table 64. Bit Descriptions for TGT\_ADDR\_REG

Bits	Bit Name	Description	Reset	Access
7	RESERVED	Reserved.	0x0	R
[6:0]	TGT_ADDR	Assigned Target Address. Contains the Target address assigned to the AD4055 during dynamic address assignment (DAA).	0x0	R

## GROUP ADDRESS REGISTER

If GRP\_NOT\_ASSIGNED is 0, GRP\_ADDR contains the assigned group address. Otherwise, GRP\_ADDR reads back all 1's. In other words, GRP\_ADDR\_REG either reads back 0xFF or the assigned group address.

REGISTER DETAILS

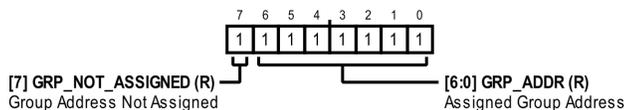


Figure 129. Address: 0x47, Reset: 0xFF, Name: GRP\_ADDR\_REG

Table 65. Bit Descriptions for GRP\_ADDR\_REG

Bits	Bit Name	Description	Reset	Access
7	GRP_NOT_ASSIGNED	Group Address Not Assigned. Indicates whether the device has been assigned a valid Group address with the SETGRPA CCC command. 0: Group Address Assigned. GRP_ADDR contains the assigned Group address for the device. 1: Group Not Assigned. GRP_NOT_ASSIGNED will be set to 0 after Group address is assigned with the SETGRPA CCC command.	0x1	R
[6:0]	GRP_ADDR	Assigned Group Address. Contains the Group address assigned to the AD4055 by the SETGRPA CCC command. If GRP_NOT_ASSIGNED is 0, GRP_ADDR contains the assigned group address. Otherwise, GRP_ADDR reads back all 1's.	0x7F	R

IBI STATUS REGISTER

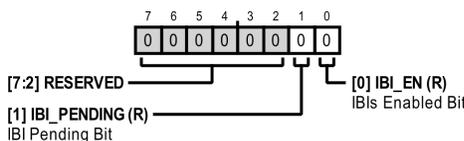


Figure 130. Address: 0x48, Reset: 0x00, Name: IBI\_STATUS

Table 66. Bit Descriptions for IBI\_STATUS

Bits	Bit Name	Description	Reset	Access
[7:2]	RESERVED	Reserved.	0x0	R
1	IBI_PENDING	IBI Pending Bit. Asserted while IBI is pending. Deasserted when Controller ACKs the IBI or when I3C peripheral or whole device is reset.	0x0	R
0	IBI_EN	IBIs Enabled Bit. Indicates if IBIs are enabled on the device. IBIs are enabled and disabled with the ENEC and DISEC CCC commands, respectively. Following the ENEC CCC, IBIs are enabled and IBI_EN reads back 1. Following the DISEC CCC, IBIs are disabled and IBI_EN reads back 0.	0x0	R

CONVERSION READ RESULT REGISTER

The AD4055 ADC core performs conversion(s) following I3C reads while the ADDR\_PTR is pointing to the CONV\_READ register address.

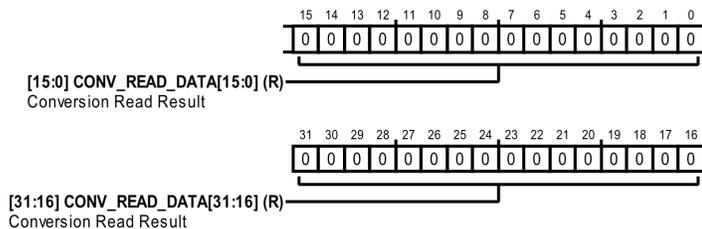


Figure 131. Address: 0x50, Reset: 0x00000000, Name: CONV\_READ

Table 67. Bit Descriptions for CONV\_READ

Bits	Bit Name	Description	Reset	Access
[31:0]	CONV_READ_DATA	Conversion Read Result. This bit field contains the most recent ADC result.	0x0	R

## REGISTER DETAILS

## CONVERSION TRIGGER REGISTER

The AD4055 ADC core performs conversion(s) following I3C writes which set the ADDR\_PTR to the CONV\_TRIGGER register address. By using I3C Group addressing, this register can be used to synchronize conversions across multiple AD4055 devices on the same I3C bus.

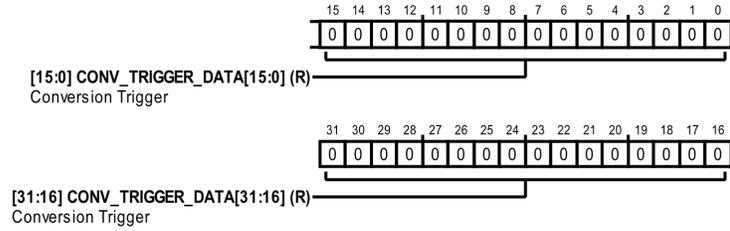
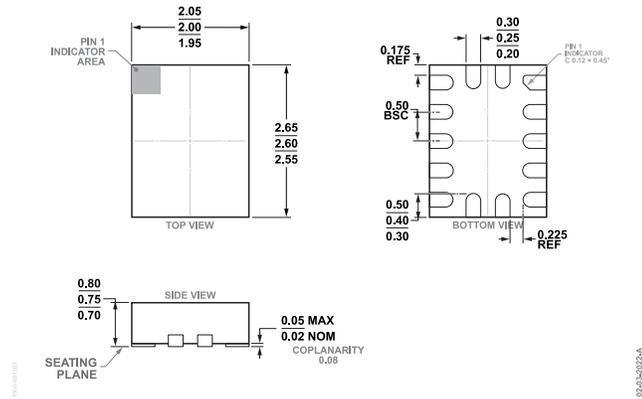


Figure 132. Address: 0x56, Reset: 0x00000000, Name: CONV\_TRIGGER

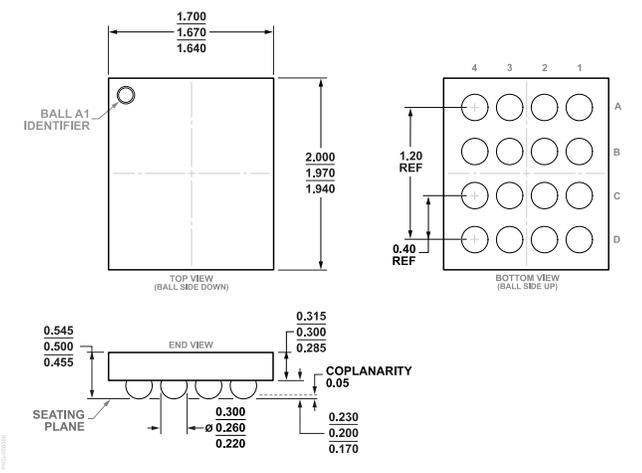
Table 68. Bit Descriptions for CONV\_TRIGGER

Bits	Bit Name	Description	Reset	Access
[31:0]	CONV_TRIGGER_DATA	Conversion Trigger. This bit field contains the most recent ADC result.	0x0	R

OUTLINE DIMENSIONS



**Figure 133. 14-Lead Lead Frame Chip Scale Package [LFCSP]  
2 mm × 2.6 mm Body and 0.75 mm Packaging Height  
(CP-14-7)  
Dimensions shown in millimeters**



**Figure 134. 16-Ball Wafer Level Chip Scale Package [WLCSP]  
(CB-16-26)  
Dimensions shown in millimeters**

ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Packing Quantity	Package Option
AD4062BCPZ-RL7	-40°C to +125°C	14-Lead Lead Frame Chip Scale Package [LFCSP] (2.00mm × 2.6mm × 0.75mm)	REEL, 3000	CP-14-7
AD4062BCBZ-RL7	-40°C to +125°C	16-Ball Wafer Level Chip Scale Package [WLCSP] (1.67mm × 1.97mm × 0.5mm)	REEL, 3000	CB-16-26

<sup>1</sup> Z = RoHS Compliant Part.

EVALUATION BOARDS

Model <sup>1</sup>	Description
EVAL-AD4062-ARDZ	Evaluation Board

<sup>1</sup> Z = RoHS-Compliant Part.