ANALOG DEVICES

Tactical Grade, Six Degrees of Freedom Inertial Sensor

Data Sheet

ADIS16485

FEATURES

- **Triaxial, digital gyroscope, ±450°/sec dynamic range**
  - **<±0.05° orthogonal alignment**
  - **6°/hr in-run bias stability**
  - **0.3°/√hr angular random walk**
  - **0.01% nonlinearity**
- **Triaxial, digital accelerometer, ±5 *g***
- **Triaxial, delta angle, and delta velocity outputs**
- **Fast start-up time, ~500 ms**
- **Factory calibrated sensitivity, bias, and axial alignment**
  - **Calibration temperature range: −40°C to +70°C**
- **SPI-compatible serial interface**
- **Embedded temperature sensor**
- **Programmable operation and control**
  - **Automatic and manual bias correction controls**
  - **4 FIR filter banks, 120 configurable taps**
  - **Digital I/O: data-ready alarm indicator, external clock**
  - **Alarms for condition monitoring**
  - **Power-down/sleep mode for power management**
  - **Optional external sample clock input: up to 2.4 kHz**
  - **Single command self test**
- **Single-supply operation: 3.0 V to 3.6 V**
- **2000 *g* shock survivability**
- **Operating temperature range: −40°C to +85°C**

APPLICATIONS

- **Platform stabilization and control**
- **Navigation**
- **Personnel tracking**
- **Instruments**
- **Robotics**

GENERAL DESCRIPTION

The ADIS16485 *i*Sensor® device is a complete inertial system that includes a triaxial gyroscope and a triaxial accelerometer. Each inertial sensor in the ADIS16485 combines industry-leading *i*MEMS® technology with signal conditioning that optimizes dynamic performance. The factory calibration characterizes each sensor for sensitivity, bias, alignment, and linear acceleration (gyroscope bias). As a result, each sensor has its own dynamic compensation formulas that provide accurate sensor measurements.

The ADIS16485 provides a simple, cost-effective method for integrating accurate, multiaxis inertial sensing into industrial systems, especially when compared with the complexity and investment associated with discrete designs. All necessary motion testing and calibration are part of the production process at the factory, greatly reducing system integration time. Tight orthogonal alignment simplifies inertial frame alignment in navigation systems. The SPI and register structure provide a simple interface for data collection and configuration control.

The ADIS16485 uses the same footprint and connector system as the ADIS16375 and ADIS16488, which greatly simplifies the upgrade process. It comes in a module that is approximately 47 mm × 44 mm × 14 mm and has a standard connector interface.

FUNCTIONAL BLOCK DIAGRAM

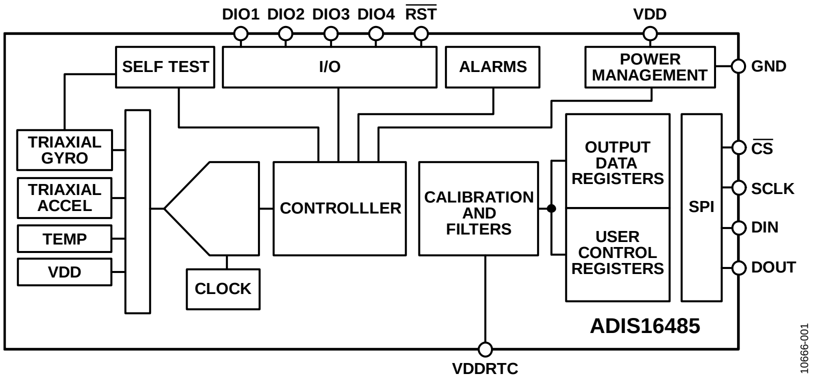

Figure 1.

Rev. 0

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REVISION HISTORY

5/12—Revision 0: Initial Version

SPECIFICATIONS

T_A = 25°C, VDD = 3.3 V, angular rate = 0°/sec, dynamic range = ±450°/sec ± 1 *g*, 300 mbar to 1100 mbar, unless otherwise noted.

Table 1.

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
GYROSCOPES					
Dynamic Range		±450		±480	°/sec
Sensitivity	x_GYRO_OUT and x_GYRO_LOW (32-bit)		3.052×10^{-7}		°/sec/LSB
Initial Sensitivity Tolerance				±1	%
Sensitivity Temperature Coefficient	$-40°C \leq T_A \leq +70°C$, 1 σ		±35		ppm/°C
Misalignment	Axis-to-axis		±0.05		Degrees
	Axis-to-frame (package)		±1.0		Degrees
Nonlinearity	Best fit straight line, FS = 450°/sec		0.01		% of FS
Initial Bias Error	1 σ		±0.2		°/sec
In-Run Bias Stability	1 σ		6.25		°/hr
Angular Random Walk	1 σ		0.3		°/√hr
Bias Temperature Coefficient	$-40°C \leq T_A \leq +70°C$, 1 σ		±0.0025		°/sec/°C
Linear Acceleration Effect on Bias	Any axis, 1 σ (CONFIG[7] = 1)		0.009		°/sec/*g*
Output Noise	No filtering		0.16		°/sec rms
Rate Noise Density	f = 25 Hz, no filtering		0.0066		°/sec/√Hz rms
3 dB Bandwidth			330		Hz
Sensor Resonant Frequency			18		kHz
ACCELEROMETERS	Each axis				
Dynamic Range		±5			*g*
Sensitivity	x_ACCL_OUT and x_ACCL_LOW (32-bit)		3.815×10^{-9}		*g*/LSB
Initial Sensitivity Tolerance				±0.5	%
Sensitivity Temperature Coefficient	$-40°C \leq T_A \leq +70C$, 1 σ		±10		ppm/°C
Misalignment	Axis-to-axis		±0.035		Degrees
	Axis-to-frame (package)		±1.0		Degrees
Nonlinearity	Best-fit straight line, ±5 *g*		0.1		% of FS
Initial Bias Error	1 σ		±3		m*g*
In-Run Bias Stability	1 σ		32		μ*g*
Velocity Random Walk	1 σ		0.023		m/sec/√hr
Bias Temperature Coefficient	$-40°C \leq T_A \leq +70°C$		±0.03		m*g*/°C
Output Noise	No filtering		1.25		m*g* rms
Noise Density	f = 25 Hz, no filtering		0.055		m*g*/√Hz rms
3 dB Bandwidth			330		Hz
Sensor Resonant Frequency			5.5		kHz
TEMPERATURE SENSOR					
Scale Factor	Output = 0x0000 at 25°C (±5°C)		0.00565		°C/LSB
LOGIC INPUTS[1]					
Input High Voltage, V_{IH}		2.0			V
Input Low Voltage, V_{IL}				0.8	V
$\overline{\text{CS}}$ Wake-Up Pulse Width		20			μs
Logic 1 Input Current, I_{IH}	V_{IH} = 3.3 V			10	μA
Logic 0 Input Current, I_{IL}	V_{IL} = 0 V				
All Pins Except $\overline{\text{RST}}$				10	μA
$\overline{\text{RST}}$ Pin			0.33		mA
Input Capacitance, C_{IN}			10		pF
DIGITAL OUTPUTS					
Output High Voltage, V_{OH}	I_{SOURCE} = 0.5 mA	2.4			V
Output Low Voltage, V_{OL}	I_{SINK} = 2.0 mA			0.4	V

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
FLASH MEMORY	Endurance[2]	100,000			Cycles
Data Retention[3]	T_J = 85°C	20			Years
FUNCTIONAL TIMES[4]	Time until data is available				
Power-On, Start-Up Time	T_A = −40°C to +85°C		400 ± 160		ms
Reset Recovery Time	T_A = −40°C to +85°C		400 ± 160		ms
Sleep Mode Recovery Time			500		µs
Flash Memory Update Time			900		ms
Flash Memory Test Time			66		ms
Automatic Self Test Time	Using internal clock, 100 SPS		12		ms
CONVERSION RATE			2.46		kSPS
Initial Clock Accuracy			0.02		%
Temperature Coefficient			40		ppm/°C
Sync Input Clock[5]		0.7		2.4	kHz
POWER SUPPLY, VDD	Operating voltage range	3.0		3.6	V
Power Supply Current[6]	Normal mode, VDD = 3.3 V, µ ± σ		197		mA
	Sleep mode, VDD = 3.3 V		12.2		mA
	Power-down mode, VDD = 3.3 V		37		µA
POWER SUPPLY, VDDRTC	Operating voltage range	3.0		3.6	V
Real-Time Clock Supply Current	Normal mode, VDDRTC = 3.3 V		13		µA

[1] The digital I/O signals are driven by an internal 3.3 V supply, and the inputs are 5 V tolerant.
[2] Endurance is qualified as per JEDEC Standard 22, Method A117, and measured at −40°C, +25°C, +85°C, and +125°C.
[3] The data retention specification assumes a junction temperature (T_J) of 85°C as per JEDEC Standard 22, Method A117. Data retention lifetime decreases with T_J.
[4] These times do not include thermal settling and internal filter response times, which may affect overall accuracy.
[5] The device functions at clock rates below 0.7 kHz but at reduced performance levels.
[6] Supply current transients can reach 450 mA for 400 µs during start-up and reset recovery.

TIMING SPECIFICATIONS

$T_A = 25°C$, VDD = 3.3 V, unless otherwise noted.

Table 2.

		Normal Mode			
Parameter	**Description**	**Min**[1]	**Typ**	**Max**[1]	**Unit**
f_{SCLK}	Serial clock	0.01		15	MHz
t_{STALL}	Stall period between data	2			µs
t_{CLS}	Serial clock low period	31			ns
t_{CHS}	Serial clock high period	31			ns
$t_{\overline{CS}}$	Chip select to clock edge	32			ns
t_{DAV}	DOUT valid after SCLK edge			10	ns
t_{DSU}	DIN setup time before SCLK rising edge	2			ns
t_{DHD}	DIN hold time after SCLK rising edge	2			ns
t_{DR}, t_{DF}	DOUT rise/fall times, ≤100 pF loading		3	8	ns
t_{DSOE}	$\overline{CS}$ assertion to data out active	0		11	ns
t_{HD}	SCLK edge to data out invalid	0			ns
t_{DSHI}	$\overline{CS}$ deassertion to data out high impedance	0		9	ns
t_1	Input sync pulse width	5			µs
t_2	Input sync to data-ready output			490	µs
t_3	Input sync period	417			µs

[1] Guaranteed by design and characterization, but not tested in production.

Timing Diagrams

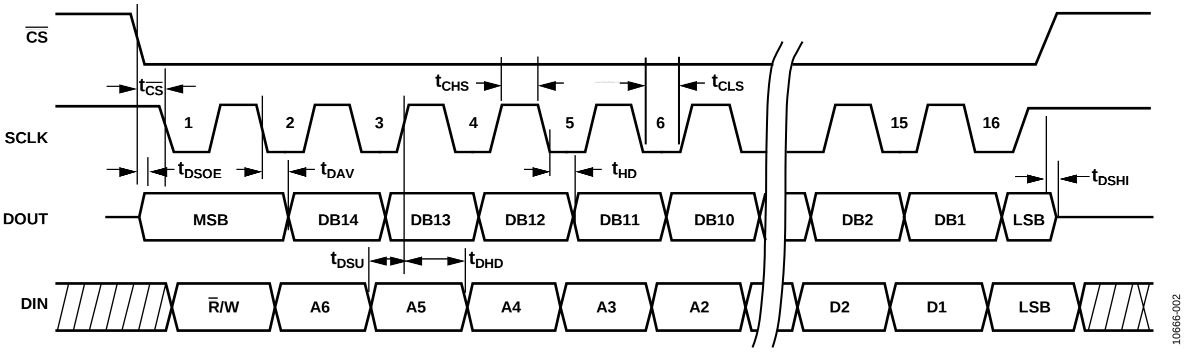


Figure 2. SPI Timing and Sequence

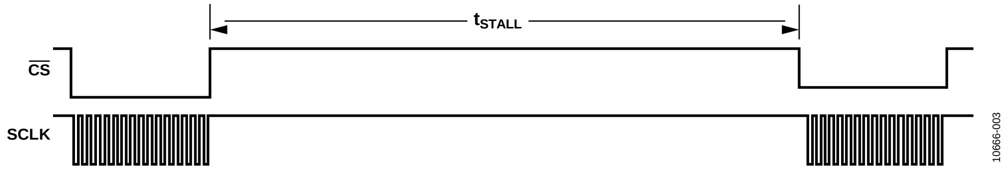


Figure 3. Stall Time and Data Rate

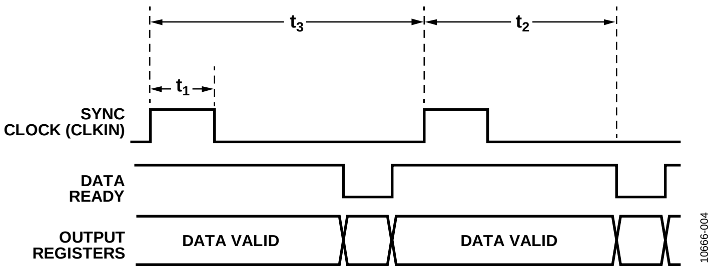


Figure 4. Input Clock Timing Diagram

ABSOLUTE MAXIMUM RATINGS

Table 3.

Parameter	Rating
Acceleration	
Any Axis, Unpowered	2000 *g*
Any Axis, Powered	2000 *g*
VDD to GND	−0.3 V to +3.6 V
Digital Input Voltage to GND	−0.3 V to VDD + 0.2 V
Digital Output Voltage to GND	−0.3 V to VDD + 0.2 V
Operating Temperature Range	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C[1]

[1] Extended exposure to temperatures that are lower than −40°C or higher than +105°C can adversely affect the accuracy of the factory calibration.

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

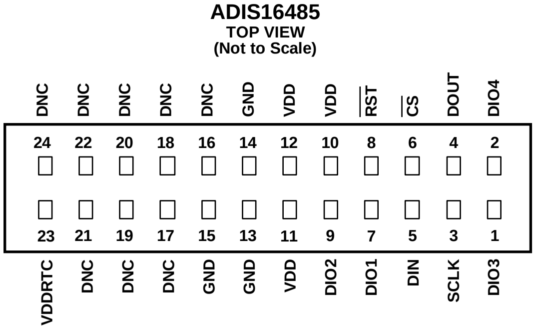
Table 4. Package Characteristics

Package Type	θ_{JA}	θ_{JC}	Device Weight
24-Lead Module (ML-24-6)	22.8°C/W	10.1°C/W	48 g

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



NOTES
1. THIS REPRESENTATION DISPLAYS THE TOP VIEW PINOUT FOR THE MATING SOCKET CONNECTOR.
2. THE ACTUAL CONNECTOR PINS ARE NOT VISIBLE FROM THE TOP VIEW.
3. MATING CONNECTOR: SAMTEC CLM-112-02 OR EQUIVALENT.
4. DNC = DO NOT CONNECT.

Figure 5. Mating Connector Pin Assignments

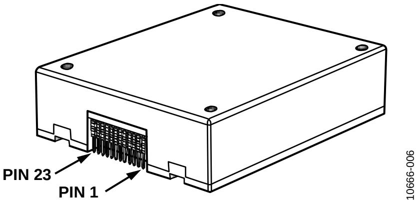


Figure 6. Axial Orientation (Top Side Facing Up)

Table 5. Pin Function Descriptions

Pin No.	Mnemonic	Type	Description
1	DIO3	Input/output	Configurable Digital Input/Output.
2	DIO4	Input/output	Configurable Digital Input/Output.
3	SCLK	Input	SPI Serial Clock.
4	DOUT	Output	SPI Data Output. Clocks output on SCLK falling edge.
5	DIN	Input	SPI Data Input. Clocks input on SCLK rising edge.
6	$\overline{\text{CS}}$	Input	SPI Chip Select.
7	DIO1	Input/output	Configurable Digital Input/Output.
8	$\overline{\text{RST}}$	Input	Reset.
9	DIO2	Input/output	Configurable Digital Input/Output.
10, 11, 12	VDD	Supply	Power Supply.
13, 14, 15	GND	Supply	Power Ground.
16 to 22, 24	DNC	Not applicable	Do Not Connect to These Pins.
23	VDDRTC	Supply	Real-Time Clock Power Supply.

TYPICAL PERFORMANCE CHARACTERISTICS

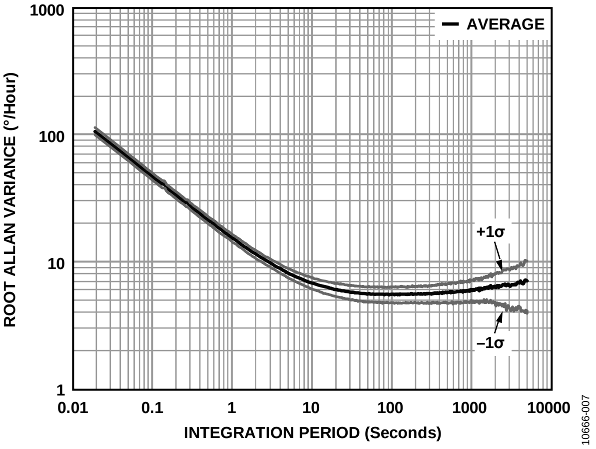


Figure 7. Gyroscope Allan Variance, 25°C

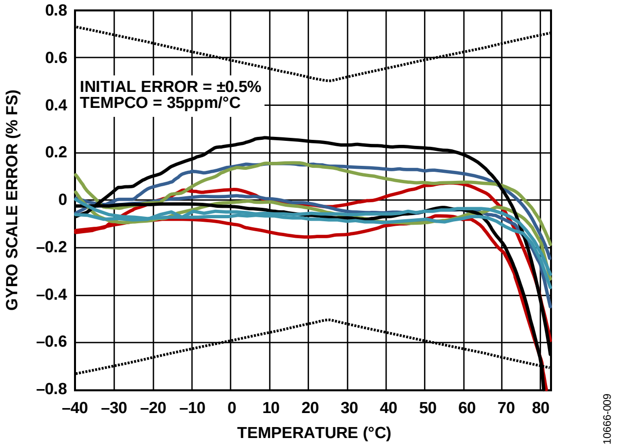


Figure 9. Gyroscope Scale (Sensitivity) Error and Hysteresis vs. Temperature

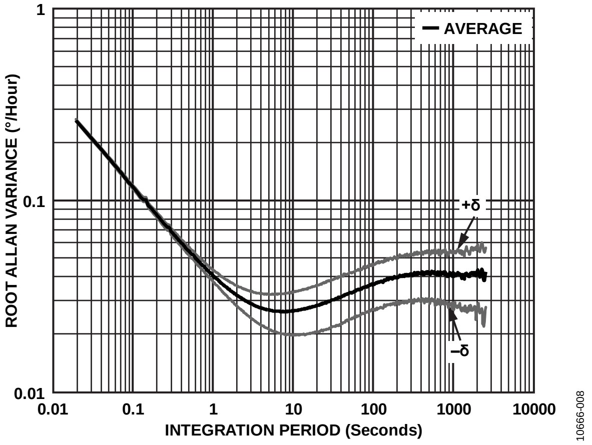


Figure 8. Accelerometer Allan Variance, 25°C

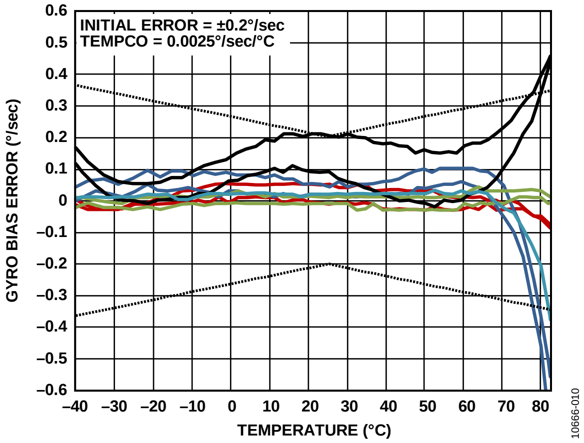


Figure 10. Gyroscope Bias Error and Hysteresis vs. Temperature

BASIC OPERATION

The ADIS16485 is an autonomous sensor system that starts up on its own when it has a valid power supply. After running through its initialization process, it begins sampling, processing, and loading calibrated sensor data into the output registers, which are accessible using the SPI port. The SPI port typically connects to a compatible port on an embedded processor, using the connection diagram in Figure 11. The four SPI signals facilitate synchronous, serial data communication. Connect $\overline{\text{RST}}$ (Pin 8, see Table 5) to VDD or leave $\overline{\text{RST}}$ open for normal operation. The factory default configuration provides users with a data-ready signal on the DIO2 pin, which pulses high when new data is available in the output data registers.

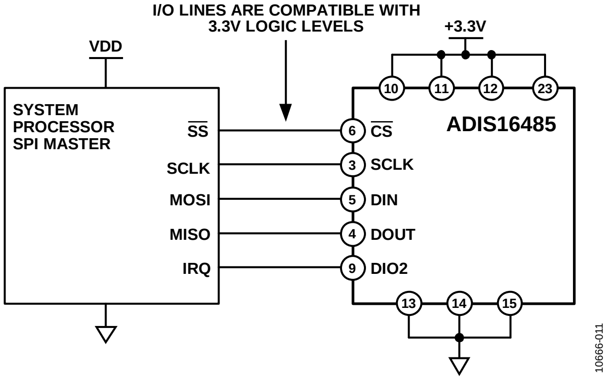


Figure 11. Electrical Connection Diagram

Table 6. Generic Master Processor Pin Names and Functions

Mnemonic	Function
$\overline{\text{SS}}$	Slave select
IRQ	Interrupt request
MOSI	Master output, slave input
MISO	Master input, slave output
SCLK	Serial clock

Embedded processors typically use control registers to configure their serial ports for communicating with SPI slave devices such as the ADIS16485. Table 7 provides a list of settings, which describe the SPI protocol of the ADIS16485. The initialization routine of the master processor typically establishes these settings using firmware commands to write them into its serial control registers.

Table 7. Generic Master Processor SPI Settings

Processor Setting	Description
Master	ADIS16485 operates as slave
SCLK ≤ 15 MHz	Maximum serial clock rate
SPI Mode 3	CPOL = 1 (polarity), and CPHA = 1 (phase)
MSB-First Mode	Bit sequence
16-Bit Mode	Shift register/data length

REGISTER STRUCTURE

The register structure and SPI port provide a bridge between the sensor processing system and an external, master processor. It contains both output data and control registers. The output data registers include the latest sensor data, a real-time clock, error flags, alarm flags, and identification data. The control registers include sample rate, filtering, input/output, alarms, calibration, and diagnostic configuration options. All communication between the ADIS16485 and an external processor involves either reading or writing to one of the user registers.

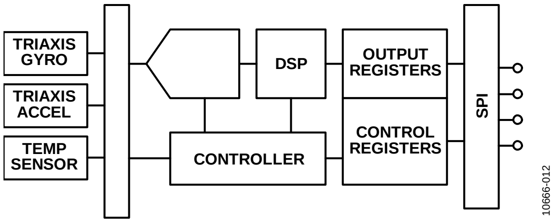


Figure 12. Basic Operation

The register structure uses a paged addressing scheme that is composed of 13 pages, with each one containing 64 register locations. Each register is 16 bits wide, with each byte having its own unique address within the memory map of that page. The SPI port has access to one page at a time, using the bit sequence in Figure 17. Select the page to activate for SPI access by writing its code to the PAGE_ID register. Read the PAGE_ID register to determine which page is currently active. Table 8 displays the PAGE_ID contents for each page, together with their basic functions. The PAGE_ID register is located at Address 0x00 on every page.

Table 8. User Register Page Assignments

Page	PAGE_ID	Function
0	0x00	Output data, clock, identification
1	0x01	Reserved
2	0x02	Calibration
3	0x03	Control: sample rate, filtering, I/O, alarms
4	0x04	Serial number
5	0x05	FIR Filter Bank A Coefficient 0 to Coefficient 59
6	0x06	FIR Filter Bank A, Coefficient 60 to Coefficient 119
7	0x07	FIR Filter Bank B, Coefficient 0 to Coefficient 59
8	0x08	FIR Filter Bank B, Coefficient 60 to Coefficient 119
9	0x09	FIR Filter Bank C, Coefficient 0 to Coefficient 59
10	0x0A	FIR Filter Bank C, Coefficient 60 to Coefficient 119
11	0x0B	FIR Filter Bank D, Coefficient 0 to Coefficient 59
12	0x0C	FIR Filter Bank D, Coefficient 60 to Coefficient 119

SPI COMMUNICATION

The SPI port supports full duplex communication, as shown in Figure 17, which enables external processors to write to DIN while reading DOUT, when the previous command was a read request. Figure 17 provides a guideline for the bit coding on both DIN and DOUT.

DEVICE CONFIGURATION

The SPI provides write access to the control registers, one byte at a time, using the bit assignments shown in Figure 17. Each register has 16 bits, where Bits[7:0] represent the lower address (listed in Table 9) and Bits[15:8] represent the upper address. Write to the lower byte of a register first, followed by a write to its upper byte. The only register that changes with a single write to its lower byte is the PAGE_ID register. For a write command, the first bit in the DIN sequence is set to 1. Address Bits[A6:A0] represent the target address, and Data Command Bits[DC7:DC0] represent the data being written to the location. Figure 13 provides an example of writing 0x03 to Address 0x00 (PAGE_ID [7:0]), using DIN = 0x8003. This write command activates the control page for SPI access.

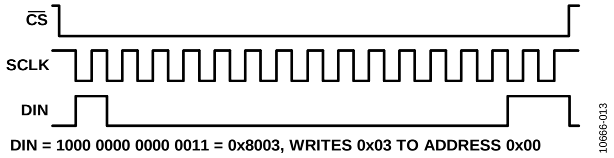


Figure 13. SPI Sequence for Activating the Control Page (DIN = 0x8003)

Dual Memory Structure

Writing configuration data to a control register updates its SRAM contents, which are volatile. After optimizing each relevant control register setting in a system, use the manual flash update command, which is located in GLOB_CMD[3] on Page 3 of the register map. Activate the manual flash update command by turning to Page 3 (DIN = 0x8003) and setting GLOB_CMD[3] = 1 (DIN = 0x8208, then DIN = 0x8300). Make sure that the power supply is within specification for the entire 375 ms processing time for a flash memory update. Table 9 provides a memory map for all of the user registers, which includes a column of flash backup information. A yes in this column indicates that a register has a mirror location in flash and, when backed up properly, automatically restores itself during startup or after a reset. Figure 14 provides a diagram of the dual memory structure used to manage operation and store critical user settings.

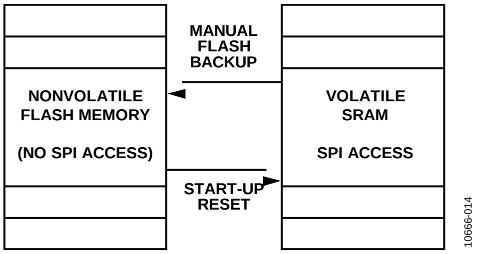


Figure 14. SRAM and Flash Memory Diagram

READING SENSOR DATA

The ADIS16485 automatically starts up and activates Page 0 for data register access. Write 0x00 to the PAGE_ID register (DIN = 0x8000) to activate Page 0 for data access after accessing any other page. A single register read requires two 16-bit SPI cycles. The first cycle requests the contents of a register using the bit assignments in Figure 17, and then the register contents follow DOUT during the second sequence. The first bit in a DIN command is zero, followed by either the upper or the lower address for the register. The last eight bits are don't care, but the SPI requires the full set of 16 SCLKs to receive the request. Figure 15 includes two register reads in succession, which starts with DIN = 0x1A00 to request the contents of the Z_GYRO_OUT register and follows with 0x1800 to request the contents of the Z_GYRO_LOW register.

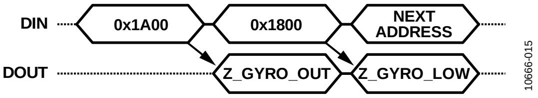


Figure 15. SPI Read Example

Figure 16 provides an example of the four SPI signals when reading PROD_ID in a repeating pattern. This is a good pattern to use for troubleshooting the SPI interface setup and communications because the contents of PROD_ID are predefined and stable.

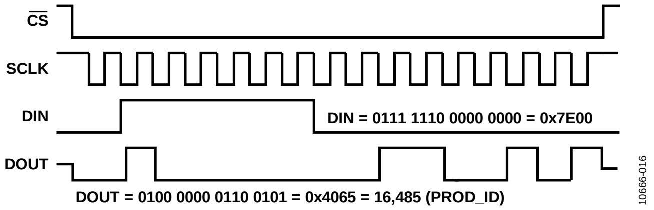
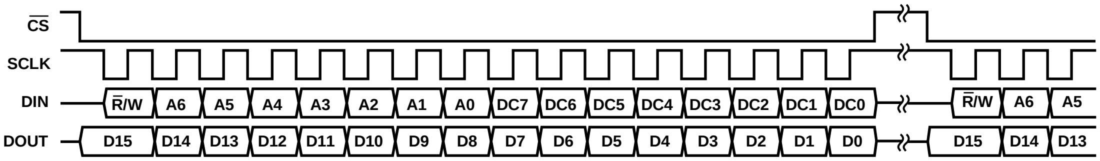


Figure 16. SPI Read Example, Second 16-Bit Sequence



NOTES
1. DOUT BITS ARE PRODUCED ONLY WHEN THE PREVIOUS 16-BIT DIN SEQUENCE STARTS WITH $\overline{\text{R}}$/W = 0.
2. WHEN $\overline{\text{CS}}$ IS HIGH, DOUT IS IN A THREE-STATE, HIGH IMPEDANCE MODE, WHICH ALLOWS MULTIFUNCTIONAL USE OF THE LINE FOR OTHER DEVICES.

Figure 17. SPI Communication Bit Sequence

USER REGISTERS

Table 9. User Register Memory Map (N/A = Not Applicable)

Name	R/W	Flash	PAGE_ID	Address	Default	Register Description	Format
PAGE_ID	R/W	No	0x00	0x00	0x00	Page identifier	N/A
Reserved	N/A	N/A	0x00	0x02 to 0x06	N/A	Reserved	N/A
SYS_E_FLAG	R	No	0x00	0x08	0x0000	Output, system error flags	Table 40
DIAG_STS	R	No	0x00	0x0A	0x0000	Output, self test error flags	Table 41
ALM_STS	R	No	0x00	0x0C	0x0000	Output, alarm error flags	Table 42
TEMP_OUT	R	No	0x00	0x0E	N/A	Output, temperature	Table 38
X_GYRO_LOW	R	No	0x00	0x10	N/A	Output, x-axis gyroscope, low word	Table 14
X_GYRO_OUT	R	No	0x00	0x12	N/A	Output, x-axis gyroscope, high word	Table 10
Y_GYRO_LOW	R	No	0x00	0x14	N/A	Output, y-axis gyroscope, low word	Table 15
Y_GYRO_OUT	R	No	0x00	0x16	N/A	Output, y-axis gyroscope, high word	Table 11
Z_GYRO_LOW	R	No	0x00	0x18	N/A	Output, z-axis gyroscope, low word	Table 16
Z_GYRO_OUT	R	No	0x00	0x1A	N/A	Output, z-axis gyroscope, high word	Table 12
X_ACCL_LOW	R	No	0x00	0x1C	N/A	Output, x-axis accelerometer, low word	Table 21
X_ACCL_OUT	R	No	0x00	0x1E	N/A	Output, x-axis accelerometer, high word	Table 17
Y_ACCL_LOW	R	No	0x00	0x20	N/A	Output, y-axis accelerometer, low word	Table 22
Y_ACCL_OUT	R	No	0x00	0x22	N/A	Output, y-axis accelerometer, high word	Table 18
Z_ACCL_LOW	R	No	0x00	0x24	N/A	Output, z-axis accelerometer, low word	Table 23
Z_ACCL_OUT	R	No	0x00	0x26	N/A	Output, z-axis accelerometer, high word	Table 19
Reserved	N/A	N/A	0x00	0x28 to 0x3E	N/A	Reserved	N/A
X_DELTANG_LOW	R	No	0x00	0x40	N/A	Output, x-axis delta angle, low word	Table 28
X_DELTANG_OUT	R	No	0x00	0x42	N/A	Output, x-axis delta angle, high word	Table 24
Y_DELTANG_LOW	R	No	0x00	0x44	N/A	Output, y-axis delta angle, low word	Table 29
Y_DELTANG_OUT	R	No	0x00	0x46	N/A	Output, y-axis delta angle, high word	Table 25
Z_DELTANG_LOW	R	No	0x00	0x48	N/A	Output, z-axis delta angle, low word	Table 30
Z_DELTANG_OUT	R	No	0x00	0x4A	N/A	Output, z-axis delta angle, high word	Table 26
X_DELTVEL_LOW	R	No	0x00	0x4C	N/A	Output, x-axis delta velocity, low word	Table 35
X_DELTVEL_OUT	R	No	0x00	0x4E	N/A	Output, x-axis delta velocity, high word	Table 31
Y_DELTVEL_LOW	R	No	0x00	0x50	N/A	Output, y-axis delta velocity, low word	Table 36
Y_DELTVEL_OUT	R	No	0x00	0x52	N/A	Output, y-axis delta velocity, high word	Table 32
Z_DELTVEL_LOW	R	No	0x00	0x54	N/A	Output, z-axis delta velocity, low word	Table 37
Z_DELTVEL_OUT	R	No	0x00	0x56	N/A	Output, z-axis delta velocity, high word	Table 33
Reserved	N/A	N/A	0x00	0x58 to 0x76	N/A	Reserved	N/A
TIME_MS_OUT	R	Yes	0x00	0x78	N/A	Factory configuration time: minutes/seconds	Table 95
TIME_DH_OUT	R	Yes	0x00	0x7A	N/A	Factory configuration date/time: day/hour	Table 96
TIME_YM_OUT	R	Yes	0x00	0x7C	N/A	Factory configuration date: year/month	Table 97
PROD_ID	R	Yes	0x00	0x7E	0x4065	Output, product identification (16,485)	Table 46
Reserved	N/A	N/A	0x01	0x00 to 0x7E	N/A	Reserved	N/A
PAGE_ID	R/W	No	0x02	0x00	0x00	Page identifier	N/A
Reserved	N/A	N/A	0x02	0x02	N/A	Reserved	N/A
X_GYRO_SCALE	R/W	Yes	0x02	0x04	0x0000	Calibration, scale, x-axis gyroscope	Table 63
Y_GYRO_SCALE	R/W	Yes	0x02	0x06	0x0000	Calibration, scale, y-axis gyroscope	Table 64
Z_GYRO_SCALE	R/W	Yes	0x02	0x08	0x0000	Calibration, scale, z-axis gyroscope	Table 65
X_ACCL_SCALE	R/W	Yes	0x02	0x0A	0x0000	Calibration, scale, x-axis accelerometer	Table 73
Y_ACCL_SCALE	R/W	Yes	0x02	0x0C	0x0000	Calibration, scale, y-axis accelerometer	Table 74
Z_ACCL_SCALE	R/W	Yes	0x02	0x0E	0x0000	Calibration, scale, z-axis accelerometer	Table 75
XG_BIAS_LOW	R/W	Yes	0x02	0x10	0x0000	Calibration, offset, gyroscope, x-axis, low word	Table 59
XG_BIAS_HIGH	R/W	Yes	0x02	0x12	0x0000	Calibration, offset, gyroscope, x-axis, high word	Table 56
YG_BIAS_LOW	R/W	Yes	0x02	0x14	0x0000	Calibration, offset, gyroscope, y-axis, low word	Table 60
YG_BIAS_HIGH	R/W	Yes	0x02	0x16	0x0000	Calibration, offset, gyroscope, y-axis, high word	Table 57
ZG_BIAS_LOW	R/W	Yes	0x02	0x18	0x0000	Calibration, offset, gyroscope, z-axis, low word	Table 61
ZG_BIAS_HIGH	R/W	Yes	0x02	0x1A	0x0000	Calibration, offset, gyroscope, z-axis, high word	Table 58

Name	R/W	Flash	PAGE_ID	Address	Default	Register Description	Format
XA_BIAS_LOW	R/W	Yes	0x02	0x1C	0x0000	Calibration, offset, accelerometer, x-axis, low word	Table 70
XA_BIAS_HIGH	R/W	Yes	0x02	0x1E	0x0000	Calibration, offset, accelerometer, x-axis, high word	Table 67
YA_BIAS_LOW	R/W	Yes	0x02	0x20	0x0000	Calibration, offset, accelerometer, y-axis, low word	Table 71
YA_BIAS_HIGH	R/W	Yes	0x02	0x22	0x0000	Calibration, offset, accelerometer, y-axis, high word	Table 68
ZA_BIAS_LOW	R/W	Yes	0x02	0x24	0x0000	Calibration, offset, accelerometer, z-axis, low word	Table 72
ZA_BIAS_HIGH	R/W	Yes	0x02	0x26	0x0000	Calibration, offset, accelerometer, z-axis, high word	Table 69
Reserved	N/A	N/A	0x02	0x28 to 0x72	N/A	Reserved	N/A
USER_SCR_1	R/W	Yes	0x02	0x74	0x0000	User Scratch Register 1	Table 91
USER_SCR_2	R/W	Yes	0x02	0x76	0x0000	User Scratch Register 2	Table 92
USER_SCR_3	R/W	Yes	0x02	0x78	0x0000	User Scratch Register 3	Table 93
USER_SCR_4	R/W	Yes	0x02	0x7A	0x0000	User Scratch Register 4	Table 94
FLSHCNT_LOW	R	Yes	0x02	0x7C	N/A	Diagnostic, flash memory count, low word	Table 86
FLSHCNT_HIGH	R	Yes	0x02	0x7E	N/A	Diagnostic, flash memory count, high word	Table 87
PAGE_ID	R/W	No	0x03	0x00	0x0000	Page identifier	N/A
GLOB_CMD	W	No	0x03	0x02	N/A	Control, global commands	Table 85
Reserved	N/A	N/A	0x03	0x04	N/A	Reserved	N/A
FNCTIO_CTRL	R/W	Yes	0x03	0x06	0x000D	Control, I/O pins, functional definitions	Table 88
GPIO_CTRL	R/W	Yes	0x03	0x08	0x00X0[1]	Control, I/O pins, general purpose	Table 89
CONFIG	R/W	Yes	0x03	0x0A	0x00C0	Control, clock, and miscellaneous correction	Table 66
DEC_RATE	R/W	Yes	0x03	0x0C	0x0000	Control, output sample rate decimation	Table 48
NULL_CNFG	R/W	Yes	0x03	0x0E	0x070A	Control, automatic bias correction configuration	Table 62
SLP_CNT	R/W	No	0x03	0x10	N/A	Control, power-down/sleep mode	Table 90
Reserved	N/A	N/A	0x03	0x12 to 0x14	N/A	Reserved	N/A
FILTR_BNK_0	R/W	Yes	0x03	0x16	0x0000	Filter selection	Table 49
FILTR_BNK_1	R/W	Yes	0x03	0x18	0x0000	Filter selection	Table 50
Reserved	N/A	N/A	0x03	0x1A to 0x1E	N/A	Reserved	N/A
ALM_CNFG_0	R/W	Yes	0x03	0x20	0x0000	Alarm configuration	Table 82
ALM_CNFG_1	R/W	Yes	0x03	0x22	0x0000	Alarm configuration	Table 83
Reserved	N/A	N/A	0x03	0x24 to 0x26	N/A	Reserved	N/A
XG_ALM_MAGN	R/W	Yes	0x03	0x28	0x0000	Alarm, x-axis gyroscope threshold setting	Table 76
YG_ALM_MAGN	R/W	Yes	0x03	0x2A	0x0000	Alarm, y-axis gyroscope threshold setting	Table 77
ZG_ALM_MAGN	R/W	Yes	0x03	0x2C	0x0000	Alarm, z-axis gyroscope threshold setting	Table 78
XA_ALM_MAGN	R/W	Yes	0x03	0x2E	0x0000	Alarm, x-axis accelerometer threshold	Table 79
YA_ALM_MAGN	R/W	Yes	0x03	0x30	0x0000	Alarm, y-axis accelerometer threshold	Table 80
ZA_ALM_MAGN	R/W	Yes	0x03	0x32	0x0000	Alarm, z-axis accelerometer threshold	Table 81
Reserved	N/A	N/A	0x03	0x34 to 0x76	N/A	Reserved	N/A
FIRM_REV	R	Yes	0x03	0x78	N/A	Firmware revision	Table 43
FIRM_DM	R	Yes	0x03	0x7A	N/A	Firmware programming date: day/month	Table 44
FIRM_Y	R	Yes	0x03	0x7C	N/A	Firmware programming date: year	Table 45
Reserved	N/A	N/A	0x03	0x7E	N/A	Reserved	N/A
Reserved	N/A	N/A	0x04	0x00 to 0x18	N/A	Reserved	N/A
SERIAL_NUM	R	Yes	0x04	0x20	N/A	Serial number	Table 47
Reserved	N/A	N/A	0x04	0x22 to 0x7F	N/A	Reserved	N/A
FIR_COEF_Axxx	R/W	Yes	0x05	0x00 to 0x7E	N/A	FIR Filter Bank A, Coefficients 0 through 59	Table 51
FIR_COEF_Axxx	R/W	Yes	0x06	0x00 to 0x7E	N/A	FIR Filter Bank A, Coefficients 60 through 119	Table 51
FIR_COEF_Bxxx	R/W	Yes	0x07	0x00 to 0x7E	N/A	FIR Filter Bank B, Coefficients 0 through 59	Table 52
FIR_COEF_Bxxx	R/W	Yes	0x08	0x00 to 0x7E	N/A	FIR Filter Bank B, Coefficients 60 through 119	Table 52
FIR_COEF_Cxxx	R/W	Yes	0x09	0x00 to 0x7E	N/A	FIR Filter Bank C, Coefficients 0 through 59	Table 53
FIR_COEF_Cxxx	R/W	Yes	0x0A	0x00 to 0x7E	N/A	FIR Filter Bank C, Coefficients 60 through 119	Table 53
FIR_COEF_Dxxx	R/W	Yes	0x0B	0x00 to 0x7E	N/A	FIR Filter Bank D, Coefficients 0 through 59	Table 54
FIR_COEF_Dxxx	R/W	Yes	0x0C	0x00 to 0x7E	N/A	FIR Filter Bank D, Coefficients 60 through 119	Table 54

[1] The GPIO_CTRL[7:4] bits reflect the logic levels on the DIOx lines and do not have a default setting.

OUTPUT DATA REGISTERS

After the ADIS16485 completes its start-up process, the PAGE_ID register contains 0x0000, which sets Page 0 as the active page for SPI access. Page 0 contains the output data, real-time clock, status, and product identification registers.

INERTIAL SENSOR DATA FORMAT

The gyroscope, accelerometer, delta angle, and delta velocity output data registers use a 32-bit, twos complement format. Each output uses two registers to support this resolution. Figure 18 provides an example of how each register contributes to each inertial measurement. In this case, X_GYRO_OUT is the most significant word (upper 16 bits), and X_GYRO_LOW is the least significant word (lower 16 bits). In many cases, using the most significant word registers alone provide sufficient resolution for preserving key performance metrics.

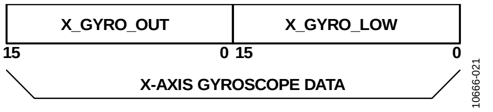


Figure 18. Gyroscope Output Format Example, DEC_RATE > 0

The arrows in Figure 19 describe the direction of the motion, which produces a positive output response in each sensor's output register. The accelerometers respond to both dynamic and static forces associated with acceleration, including gravity. When lying perfectly flat, as shown in Figure 19, the z-axis accelerometer output is 1 *g*, and the x and y accelerometers are 0 *g*.

ROTATION RATE (GYROSCOPE)

The registers that use the x_GYRO_OUT format are the primary registers for the gyroscope measurements (see Table 10, Table 11, and Table 12). When processing data from these registers, use a 16-bit, twos complement data format. Table 13 provides x_GYRO_OUT digital coding examples.

Table 10. X_GYRO_OUT (Page 0, Base Address = 0x12)

Bits	Description
[15:0]	X-axis gyroscope data; twos complement, ±450°/sec range, 0°/sec = 0x0000, 1 LSB = 0.02°/sec

Table 11. Y_GYRO_OUT (Page 0, Base Address = 0x16)

Bits	Description
[15:0]	Y-axis gyroscope data; twos complement, ±450°/sec range, 0°/sec = 0x0000, 1 LSB = 0.02°/sec

Table 12. Z_GYRO_OUT (Page 0, Base Address = 0x1A)

Bits	Description
[15:0]	Z-axis gyroscope data; twos complement, ±450°/sec range, 0°/sec = 0x0000, 1 LSB = 0.02°/sec

Table 13. x_GYRO_OUT Data Format Examples

Rotation Rate	Decimal	Hex	Binary
+450°/sec	+22,500	0x57E4	0101 0111 1110 0100
+0.04/sec	+2	0x0002	0000 0000 0000 0010
+0.02°/sec	+1	0x0001	0000 0000 0000 0001
0°/sec	0	0x0000	0000 0000 0000 0000
−0.02°/sec	−1	0xFFFF	1111 1111 1111 1111
−0.04°/sec	−2	0xFFFE	1111 1111 1111 1110
−450°/sec	−22,500	0xA81C	1010 1000 0001 1100

The registers that use the x_GYRO_LOW naming format provide additional resolution for the gyroscope measurements (see Table 14, Table 15, and Table 16). The MSB has a weight of 0.01°/sec, and each subsequent bit has ½ the weight of the previous one.

Table 14. X_GYRO_LOW (Page 0, Base Address = 0x10)

Bits	Description
[15:0]	X-axis gyroscope data; additional resolution bits

Table 15. Y_GYRO_LOW (Page 0, Base Address = 0x14)

Bits	Description
[15:0]	Y-axis gyroscope data; additional resolution bits

Table 16. Z_GYRO_LOW (Page 0, Base Address = 0x18)

Bits	Description
[15:0]	Z-axis gyroscope data; additional resolution bits

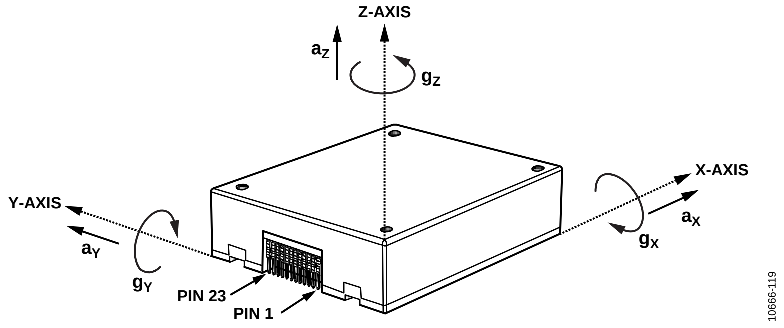


Figure 19. Inertial Sensor Direction Reference Diagram

ACCELERATION

The registers that use the x_ACCL_OUT format are the primary registers for the accelerometer measurements (see Table 17, Table 18, and Table 19). When processing data from these registers, use a 16-bit, twos complement data format. Table 20 provides x_ACCL_OUT digital coding examples.

Table 17. X_ACCL_OUT (Page 0, Base Address = 0x1E)

Bits	Description
[15:0]	X-axis accelerometer data; twos complement, ±5 *g* range, 0 *g* = 0x0000, 1 LSB = 0.25 m*g*

Table 18. Y_ACCL_OUT (Page 0, Base Address = 0x22)

Bits	Description
[15:0]	Y-axis accelerometer data; twos complement, ±5 *g* range, 0 *g* = 0x0000, 1 LSB = 0.25 m*g*

Table 19. Z_ACCL_OUT (Page 0, Base Address = 0x26)

Bits	Description
[15:0]	Z-axis accelerometer data; twos complement, ±5 *g* range, 0 *g* = 0x0000, 1 LSB = 0.25 m*g*

Table 20. x_ACCL_OUT Data Format Examples

Acceleration	Decimal	Hex	Binary
+5 *g*	+20,000	0x4E20	0100 1110 0010 0000
+0.5 m*g*	+2	0x0002	0000 0000 0000 0010
+0.25 m*g*	+1	0x0001	0000 0000 0000 0001
0 m*g*	0	0x0000	0000 0000 0000 0000
−0.25 m*g*	−1	0xFFFF	1111 1111 1111 1111
−0.5 m*g*	−2	0xFFFE	1111 1111 1111 1110
−5 *g*	−20,000	0xB1E0	1011 0001 1110 0000

The registers that use the x_ACCL_LOW naming format provide additional resolution for the accelerometer measurements (see Table 21, Table 22, and Table 23). The MSB has a weight of 0.125 m*g*, and each subsequent bit has ½ the weight of the previous one.

Table 21. X_ACCL_LOW (Page 0, Base Address = 0x1C)

Bits	Description
[15:0]	X-axis accelerometer data; additional resolution bits

Table 22. Y_ACCL_LOW (Page 0, Base Address = 0x20)

Bits	Description
[15:0]	Y-axis accelerometer data; additional resolution bits

Table 23. Z_ACCL_LOW (Page 0, Base Address = 0x24)

Bits	Description
[15:0]	Z-axis accelerometer data; additional resolution bits

DELTA ANGLES

The delta angle outputs represent an integration of the gyroscope measurements and use the following formula for all three axes (x-axis displayed):

$$\Delta\theta_x = \frac{\Delta t_S}{2} \times \left(\omega_{x,n+1} + \omega_{x,n}\right);\ \Delta t_S = \frac{DEC\_RATE + 1}{f_S}$$

where:
ω_x is the gyroscope, x-axis.
Δt_S is the time between samples.

When using the internal sample clock, f_S is equal to 2.46 kHz. When using the external clock option, the time between samples is the time between active edges on the input clock signal, as measured by the internal clock (252 MHz). See Table 48 for more information on the DEC_RATE register. The registers that use the x_DELTANG_OUT format are the primary registers for the delta angle calculations. When processing data from these registers, use a 16-bit, twos complement data format (see Table 24, Table 25, and Table 26). Table 27 provides x_DELTANG_OUT digital coding examples.

Table 24. X_DELTANG_OUT (Page 0, Base Address = 0x42)

Bits	Description
[15:0]	X-axis delta angle data; twos complement, ±720° range, 0° = 0x0000, 1 LSB = 720°/2^{15} = ~0.022°

Table 25. Y_DELTANG_OUT (Page 0, Base Address = 0x46)

Bits	Description
[15:0]	Y-axis delta angle data; twos complement, ±720° range, 0° = 0x0000, 1 LSB = 720°/2^{15} = ~0.022°

Table 26. Z_DELTANG_OUT (Page 0, Base Address = 0x4A)

Bits	Description
[15:0]	Z-axis delta angle data; twos complement, ±720° range, 0° = 0x0000, 1 LSB = 720°/2^{15} = ~0.022°

Table 27. x_DELTANG_OUT Data Format Examples

Angle (°)	Decimal	Hex	Binary
$+720 \times (2^{15} - 1)/2^{15}$	+32,767	0x7FFF	0111 1111 1111 1111
$+1440/2^{15}$	+2	0x0002	0000 0000 0000 0010
$+720/2^{15}$	+1	0x0001	0000 0000 0000 0001
0	0	0x0000	0000 0000 0000 0000
$-720/2^{15}$	−1	0xFFFF	1111 1111 1111 1111
$-1440/2^{15}$	−2	0xFFFE	1111 1111 1111 1110
−720	−32,768	0x8000	1000 0000 0000 0000

The registers that use the x_DELTANG_LOW format provide additional resolution for the gyroscope measurements (see Table 28, Table 29, and Table 30). The MSB has a weight of ~0.011° (720°/2^{16}), and each subsequent bit carries a weight of ½ of the previous one.

Table 28. X_DELTANG_LOW (Page 0, Base Address = 0x40)

Bits	Description
[15:0]	X-axis delta angle data; additional resolution bits

Table 29. Y_DELTANG_LOW (Page 0, Base Address = 0x44)

Bits	Description
[15:0]	Y-axis delta angle data; additional resolution bits

Table 30. Z_DELTANG_LOW (Page 0, Base Address = 0x48)

Bits	Description
[15:0]	Z-axis delta angle data; additional resolution bits

DELTA VELOCITY

The delta velocity outputs represent an integration of the accelerometer measurements and use the following formula for all three axes (x-axis displayed):

$$\Delta\theta_x = \frac{\Delta t_S}{2} \times \left(a_{x,n+1} + a_{x,n}\right); \Delta t_S = \frac{DEC\_RATE + 1}{f_S}$$

where:

a_x is the accelerometer, x-axis.

Δt_S is the time between samples.

When using the internal sample clock, f_S is equal to 2.46 kHz. When using the external clock option, the time between samples is the time between active edges on the input clock signal, as measured by the internal clock (252 MHz). See Table 48 for more information on the DEC_RATE register. The registers that use the x_DELTVEL_OUT format are the primary registers for the delta velocity calculations. When processing data from these registers, use a 16-bit, twos complement data format (see Table 31, Table 32, and Table 33). Table 34 provides x_DELTVEL_OUT digital coding examples.

Table 31. X_DELTVEL_OUT (Page 0, Base Address = 0x4E)

Bits	Description
[15:0]	X-axis delta velocity data; twos complement, ±50 m/sec range, 0 m/sec = 0x0000, 1 LSB = 50 m/sec ÷ (2^{15} − 1) = ~1.526 mm/sec

Table 32. Y_DELTVEL_OUT (Page 0, Base Address = 0x52)

Bits	Description
[15:0]	Y-axis delta velocity data; twos complement, ±50 m/sec range, 0 m/sec = 0x0000, 1 LSB = 50 m/sec ÷ (2^{15} − 1) = ~1.526 mm/sec

Table 33. Z_DELTVEL_OUT (Page 0, Base Address = 0x56)

Bits	Description
[15:0]	Z-axis delta velocity data; twos complement, ±50 m/sec range, 0 m/sec = 0x0000, 1 LSB = 50 m/sec ÷ (2^{15} − 1) = ~1.526 mm/sec

Table 34. x_DELTVEL_OUT, Data Format Examples

Velocity (m/sec)	Decimal	Hex	Binary
$+50 \times (2^{15} - 1)/2^{15}$	+32,767	0x7FFF	0111 1111 1111 1111
$+100/2^{15}$	+2	0x0002	0000 0000 0000 0010
$+50/2^{15}$	+1	0x0001	0000 0000 0000 0001
0	0	0x0000	0000 0000 0000 0000
$-50/2^{15}$	−1	0xFFFF	1111 1111 1111 1111
$-100/2^{15}$	−2	0xFFFE	1111 1111 1111 1110
−50	−32,768	0x8000	1000 0000 0000 0000

The registers that use the x_DELTVEL_LOW naming format provide additional resolution for the gyroscope measurements (see Table 35, Table 36, and Table 37). The MSB has a weight of ~0.7629 mm/sec (50 m/sec ÷ 2^{16}), and each subsequent bit carries a weight of ½ of the previous one.

Table 35. X_DELTVEL_LOW (Page 0, Base Address = 0x4C)

Bits	Description
[15:0]	X-axis delta velocity data; additional resolution bits

Table 36. Y_DELTVEL_LOW (Page 0, Base Address = 0x50)

Bits	Description
[15:0]	Y-axis delta velocity data; additional resolution bits

Table 37. Z_DELTVEL_LOW (Page 0, Base Address = 0x54)

Bits	Description
[15:0]	Z-axis delta velocity data; additional resolution bits

INTERNAL TEMPERATURE

The TEMP_OUT register provides an internal temperature measurement that can be useful for observing relative temperature changes inside of the ADIS16485 (see Table 38). Table 39 provides TEMP_OUT digital coding examples. Note that this temperature reflects a higher temperature than ambient, due to self heating.

Table 38. TEMP_OUT (Page 0, Base Address = 0x0E)

Bits	Description
[15:0]	Temperature data; twos complement, 0.00565°C per LSB, 25°C = 0x0000

Table 39. TEMP_OUT Data Format Examples

Temperature (°C)	Decimal	Hex	Binary
+85	+10,619	0x297B	0010 1001 0111 1011
+25 + 0.0113	+2	0x0002	0000 0000 0000 0010
+25 + 0.00565	+1	0x0001	0000 0000 0000 0001
+25	0	0x0000	0000 0000 0000 0000
+25 − 0.00565	−1	0xFFFF	1111 1111 1111 1111
+25 − 0.0113	−2	0xFFFE	1111 1111 1111 1110
−40	−11,504	0xD310	1101 0011 0001 0000

STATUS/ALARM INDICATORS

The SYS_E_FLAG register in Table 40 provides the system error flags for a variety of conditions (see Table 40). Note that reading SYS_E_FLAG also resets it to 0x0000.

Table 40. SYS_E_FLAG (Page 0, Base Address = 0x08)

Bits	Description (Default = 0x0000)
15	Watch dog timer flag (1 = timed out)
[14:8]	Not used
7	Processing overrun (1 = error)
6	Flash memory update, result of GLOB_CMD[3] = 1 (1 = failed update, 0 = update successful)
5	Inertial self test failure (1 = DIAG_STS ≠ 0x0000)
4	Sensor overrange (1 = at least one sensor overranged)
3	SPI communication error (1 = error condition, when the number of SCLK pulses is not equal to a multiple of 16)
[2:1]	Not used
0	Alarm status flag (1 = ALM_STS ≠ 0x0000)

The DIAG_STS register in Table 41 provides the flags for the internal self test function, which is from GLOB_CMD[1] (see Table 85). Note that reading DIAG_STS also resets it to 0x0000.

Table 41. DIAG_STS (Page 0, Base Address = 0x0A)

Bits	Description (Default = 0x0000)
[15:6]	Not used
5	Self test failure, z-axis accelerometer (1 = failure)
4	Self test failure, y-axis accelerometer (1 = failure)
3	Self test failure, x-axis accelerometer (1 = failure)
2	Self test failure, z-axis gyroscope (1 = failure)
1	Self test failure, y-axis gyroscope (1 = failure)
0	Self test failure, x-axis gyroscope (1 = failure)

The ALM_STS register in Table 42 provides the alarm bits for the programmable alarm levels of each sensor. Note that reading ALM_STS also resets its value to 0x0000.

Table 42. ALM_STS (Page 0, Base Address = 0x0C)

Bits	Description (Default = 0x0000)
[15:6]	Not used
5	Z-axis accelerometer alarm flag (1 = alarm is active)
4	Y-axis accelerometer alarm flag (1 = alarm is active)
3	X-axis accelerometer alarm flag (1 = alarm is active)
2	Z-axis gyroscope alarm flag (1 = alarm is active)
1	Y-axis gyroscope alarm flag (1 = alarm is active)
0	X-axis gyroscope alarm flag (1 = alarm is active)

FIRMWARE REVISION

The FIRM_REV register (see Table 43) provides the firmware revision for the internal processor. Each nibble represents a digit in this revision code. For example, if FIRM_REV = 0x0102, the firmware revision is 1.02.

Table 43. FIRM_REV (Page 3, Base Address = 0x78)

Bits	Description
[15:12]	Binary, revision, 10s digit
[11:8]	Binary, revision, 1s digit
[7:4]	Binary, revision, tenths digit
[3:0]	Binary, revision, hundredths digit

The FIRM_DM register (see Table 44) contains the month and day of the factory configuration date. FIRM_DM[15:12] and FIRM_DM[11:8] contain digits that represent the month of factory configuration. For example, November is the 11th month in a year and represented by FIRM_DM[15:8] = 0x11. FIRM_DM[7:4] and FIRM_DM[3:0] contain digits that represent the day of factory configuration. For example, the 27th day of the month is represented by FIRM_DM[7:0] = 0x27.

Table 44. FIRM_DM (Page 3, Base Address = 0x7A)

Bits	Description
[15:12]	Binary, month 10s digit, range: 0 to 1
[11:8]	Binary, month 1s digit, range: 0 to 9
[7:4]	Binary, day 10s digit, range: 0 to 3
[3:0]	Binary, day 1s digit, range: 0 to 9

The FIRM_Y register (see Table 45) contains the year of the factory configuration date. For example, the year of 2013 is represented by FIRM_Y = 0x2013.

Table 45. FIRM_Y (Page 3, Base Address = 0x7C)

Bits	Description
[15:12]	Binary, year 1000s digit, range: 0 to 9
[11:8]	Binary, year 100s digit, range: 0 to 9
[7:4]	Binary, year 10s digit, range: 0 to 9
[3:0]	Binary, year 1s digit, range: 0 to 9

PRODUCT IDENTIFICATION

The PROD_ID register (see Table 46) contains the binary equivalent of the part number (16,485 = 0x4065), and the SERIAL_NUM register (see Table 47) contains a lot-specific serial number.

Table 46. PROD_ID (Page 0, Base Address = 0x7E)

Bits	Description (Default = 0x4065)
[15:0]	Product identification = 0x4065 (16,485)

Table 47. SERIAL_NUM (Page 4, Base Address = 0x20)

Bits	Description
[15:0]	Lot specific serial number

DIGITAL SIGNAL PROCESSING

GYROSCOPES/ACCELEROMETERS

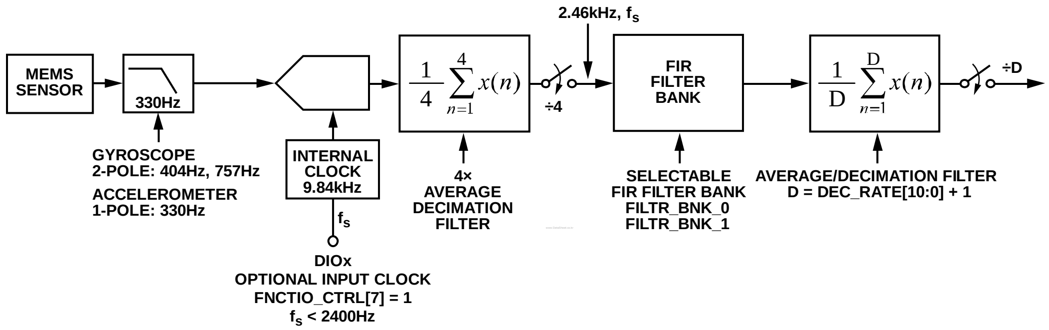
Figure 20 provides a signal flow diagram for all the components and settings that influence the frequency response for the accelerometers and gyroscopes. The sample rate for each accelerometer and gyroscope is 9.84 kHz. Each sensor has its own averaging/decimation filter stage that reduces the update rate to 2.46 kSPS. When using the external sync clock option (FNCTIO_CTRL[7:4], see Table 88), the input clock drives a 4-sample burst at a sample rate of 9.84 kSPS, which feeds into the 4× averaging/decimation filter. This results in a data rate that is equal to the input clock frequency.

AVERAGING/DECIMATION FILTER

The DEC_RATE register (see Table 48) provides user control for the final filter stage (see Figure 20), which averages and decimates the accelerometers, gyroscopes, delta angle, and delta velocity data. The output sample rate is equal to 2460/(DEC_RATE + 1). When using the external sync clock option (FNCTIO_CTRL[7:4], see Table 88), replace the 2460 number in this relationship with the input clock frequency. For example, turn to Page 3 (DIN = 0x8003), and set DEC_RATE = 0x18 (DIN = 0x8C18, then DIN = 0x8D00) to reduce the output sample rate to 98.4 SPS (2460 ÷ 25).

Table 48. DEC_RATE (Page 3, Base Address = 0x0C)

Bits	Description (Default = 0x0000)
[15:11]	Don't care
[10:0]	Decimation rate, binary format, maximum = 2047, see Figure 20 for impact on sample rate



NOTES
1. WHEN FNCTIO_CTRL[7] = 1, EACH CLOCK PULSE ON THE DESIGNATED DIOx LINE (FNCTIO_CTRL[5:4]) STARTS A 4-SAMPLE BURST, AT A SAMPLE RATE OF 9.84kHz. THESE FOUR SAMPLES FEED INTO THE 4x AVERAGE/DECIMATION FILTER, WHICH PRODUCES A DATA RATE THAT IS EQUAL TO THE INPUT CLOCK FREQUENCY.

Figure 20. Sampling and Frequency Response Block Diagram

FIR FILTER BANKS

The ADIS16485 provides four configurable, 120-tap FIR filter banks. Each coefficient is 16 bits wide and occupies its own register location with each page. When designing a FIR filter for these banks, use a sample rate of 2.46 kHz and scale the coefficients so that their sum equals 32,768. For filter designs that have less than 120 taps, load the coefficients into the lower portion of the filter and start with Coefficient 1. Make sure that all unused taps are equal to zero, so that they do not add phase delay to the response. The FILTR_BNK_x registers provide three bits per sensor, which configure the filter bank (A, B, C, D) and turn filtering on and off. For example, turn to Page 3 (DIN = 0x8003), then write 0x002F to FILTR_BNK_0 (DIN = 0x962F, DIN = 0x9700) to set the x-axis gyroscope to use the FIR filter in Bank D, to set the y-axis gyroscope to use the FIR filter in Bank B, and to enable these FIR filters in both x- and y-axis gyroscopes. Note that the filter settings update after writing to the upper byte; therefore, always configure the lower byte first. In cases that require configuration to only the lower byte of either FILTR_BNK_0 or FILTR_BNK_1, complete the process by writing 0x00 to the upper byte.

Table 49. FILTR_BNK_0 (Page 3, Base Address = 0x16)

Bits	Description (Default = 0x0000)
15	Don't care
14	Y-axis accelerometer filter enable (1 = enabled)
[13:12]	Y-axis accelerometer filter bank selection: 00 = Bank A, 01 = Bank B, 10 = Bank C, 11 = Bank D
11	X-axis accelerometer filter enable (1 = enabled)
[10:9]	X-axis accelerometer filter bank selection: 00 = Bank A, 01 = Bank B, 10 = Bank C, 11 = Bank D
8	Z-axis gyroscope filter enable (1 = enabled)
[7:6]	Z-axis gyroscope filter bank selection: 00 = Bank A, 01 = Bank B, 10 = Bank C, 11 = Bank D
5	Y-axis gyroscope filter enable (1 = enabled)
[4:3]	Y-axis gyroscope filter bank selection: 00 = Bank A, 01 = Bank B, 10 = Bank C, 11 = Bank D
2	X-axis gyroscope filter enable (1 = enabled)
[1:0]	X-axis gyroscope filter bank selection: 00 = Bank A, 01 = Bank B, 10 = Bank C, 11 = Bank D

Table 50. FILTR_BNK_1 (Page 3, Base Address = 0x18)

Bits	Description (Default = 0x0000)
[15:3]	Don't care
2	Z-axis accelerometer filter enable (1 = enabled)
[1:0]	Z-axis accelerometer filter bank selection: 00 = Bank A, 01 = Bank B, 10 = Bank C, 11 = Bank D

Filter Memory Organization

Each filter bank uses two pages of the user register structure. See Table 51, Table 52, Table 53, and Table 54 for the register addresses in each filter bank.

Table 51. Filter Bank A Memory Map, FIR_COEF_Axxx

Page	PAGE_ID	Address	Register
5	0x05	0x00	PAGE_ID
5	0x05	0x02 to 0x07	Not used
5	0x05	0x08	FIR_COEF_A000
5	0x05	0x0A	FIR_COEF_A001
5	0x05	0x0C to 0x7C	FIR_COEF_A002 to FIR_COEF_A058
5	0x05	0x7E	FIR_COEF_A059
6	0x06	0x00	PAGE_ID
6	0x06	0x02 to 0x07	Not used
6	0x06	0x08	FIR_COEF_A060
6	0x06	0x0A	FIR_COEF_A061
6	0x06	0x0C to 0x7C	FIR_COEF_A062 to FIR_COEF_A118
6	0x06	0x7E	FIR_COEF_A119

Table 52. Filter Bank B Memory Map, FIR_COEF_Bxxx

Page	PAGE_ID	Address	Register
7	0x07	0x00	PAGE_ID
7	0x07	0x02 to 0x07	Not used
7	0x07	0x08	FIR_COEF_B000
7	0x07	0x0A	FIR_COEF_B001
7	0x07	0x0C to 0x7C	FIR_COEF_B002 to FIR_COEF_B058
7	0x07	0x7E	FIR_COEF_B059
8	0x08	0x00	PAGE_ID
8	0x08	0x02 to 0x07	Not used
8	0x08	0x08	FIR_COEF_B060
8	0x08	0x0A	FIR_COEF_B061
8	0x08	0x0C to 0x7C	FIR_COEF_B062 to FIR_COEF_B118
8	0x08	0x7E	FIR_COEF_B119

Table 53. Filter Bank C Memory Map, FIR_COEF_Cxxx

Page	PAGE_ID	Address	Register
9	0x09	0x00	PAGE_ID
9	0x09	0x02 to 0x07	Not used
9	0x09	0x08	FIR_COEF_C000
9	0x09	0x0A	FIR_COEF_C001
9	0x09	0x0C to 0x7C	FIR_COEF_C002 to FIR_COEF_C058
9	0x09	0x7E	FIR_COEF_C059
10	0x0A	0x00	PAGE_ID
10	0x0A	0x02 to 0x07	Not used
10	0x0A	0x08	FIR_COEF_C060
10	0x0A	0x0A	FIR_COEF_C061
10	0x0A	0x0C to 0x7C	FIR_COEF_C062 to FIR_COEF_C118
10	0x0A	0x7E	FIR_COEF_C119

Table 54. Filter Bank D Memory Map, FIR_COEF_Dxxx

Page	PAGE_ID	Address	Register
11	0x0B	0x00	PAGE_ID
11	0x0B	0x02 to 0x07	Not used
11	0x0B	0x08	FIR_COEF_D000
11	0x0B	0x0A	FIR_COEF_D001
11	0x0B	0x0C to 0x7C	FIR_COEF_D002 to FIR_COEF_D058
11	0x0B	0x7E	FIR_COEF_D059
12	0x0C	0x00	PAGE_ID
12	0x0C	0x02 to 0x07	Not used
12	0x0C	0x08	FIR_COEF_D060
12	0x0C	0x0A	FIR_COEF_D061
12	0x0C	0x0C to 0x7C	FIR_COEF_D062 to FIR_COEF_D118
12	0x0C	0x7E	FIR_COEF_D119

Default Filter Performance

The FIR filter banks have factory programmed filter designs. They are all low-pass filters that have unity dc gain. Table 55 provides a summary of each filter design, and Figure 21 shows the frequency response characteristics. The phase delay is equal to ½ of the total number of taps.

Table 55. FIR Filter Descriptions, Default Configuration

FIR Filter Bank	Taps	−3 dB Frequency (Hz)
A	120	310
B	120	55
C	32	275
D	32	63

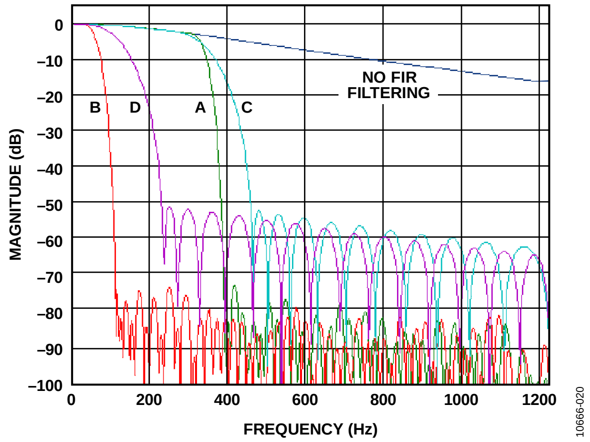


Figure 21. FIR Filter Frequency Response Curves

CALIBRATION

The ADIS16485 factory calibration produces correction formulas for the gyroscopes and the accelerometers and then programs them into the flash memory. In addition, there are a series of user-configurable calibration registers for in-system tuning.

GYROSCOPES

The user calibration for the gyroscopes includes registers for adjusting bias and sensitivity, as shown in Figure 22.

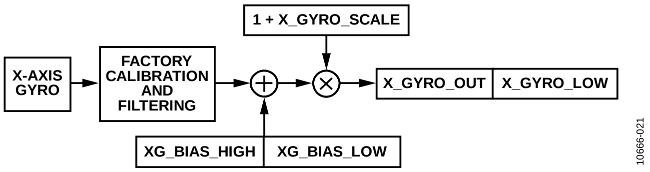


Figure 22. User Calibration Signal Path, Gyroscopes

Manual Bias Correction

The xG_BIAS_HIGH registers (see Table 56, Table 57, and Table 58) and xG_BIAS_LOW registers (see Table 59, Table 60, and Table 61) provide a bias adjustment function for the output of each gyroscope sensor.

Table 56. XG_BIAS_HIGH (Page 2, Base Address = 0x12)

Bits	Description (Default = 0x0000)
[15:0]	X-axis gyroscope offset correction, upper word; twos complement, 0°/sec = 0x0000, 1 LSB = 0.02°/sec

Table 57. YG_BIAS_HIGH (Page 2, Base Address = 0x16)

Bits	Description (Default = 0x0000)
[15:0]	Y-axis gyroscope offset correction, upper word; twos complement, 0°/sec = 0x0000, 1 LSB = 0.02°/sec

Table 58. ZG_BIAS_HIGH (Page 2, Base Address = 0x1A)

Bits	Description (Default = 0x0000)
[15:0]	Z-axis gyroscope offset correction, upper word; twos complement, 0°/sec = 0x0000, 1 LSB = 0.02°/sec

Table 59. XG_BIAS_LOW (Page 2, Base Address = 0x10)

Bits	Description (Default = 0x0000)
[15:0]	X-axis gyroscope offset correction, lower word; twos complement, 0°/sec = 0x0000, 1 LSB = 0.02°/sec ÷ 2^{16} = ~0.000000305°/sec

Table 60. YG_BIAS_LOW (Page 2, Base Address = 0x14)

Bits	Description (Default = 0x0000)
[15:0]	Y-axis gyroscope offset correction, lower word; twos complement, 0°/sec = 0x0000, 1 LSB = 0.02°/sec ÷ 2^{16} = ~0.000000305°/sec

Table 61. ZG_BIAS_LOW (Page 2, Base Address = 0x18)

Bits	Description (Default = 0x0000)
[15:0]	Z-axis gyroscope offset correction, lower word; twos complement, 0°/sec = 0x0000, 1 LSB = 0.02°/sec ÷ 2^{16} = ~0.000000305°/sec

Bias Null Command

The continuous bias estimator (CBE) accumulates and averages data in a 64-sample FIFO. The average time (t_A) for the bias estimates relies on the sample time base setting in NULL_CNFG[3:0] (see Table 62). Users can load the correction factors of the CBE into the gyroscope offset correction registers (see Table 56, Table 57, Table 58, Table 59, Table 60, and Table 61) using the bias null command in GLOB_CMD[0] (see Table 85). NULL_CNFG[13:8] provide on/off controls for the sensors that update when issuing a bias null command. The factory default configuration for NULL_CNFG enables the bias null command for the gyroscopes, disables the bias null command for the accelerometers, and establishes the average time to ~26.64 seconds. For best results, make sure the ADIS16485 is stationary for this entire time.

Table 62. NULL_CNFG (Page 3, Base Address = 0x0E)

Bits	Description (Default = 0x070A)
[15:14]	Not used
13	Z-axis acceleration bias correction enable (1 = enabled)
12	Y-axis acceleration bias correction enable (1 = enabled)
11	X-axis acceleration bias correction enable (1 = enabled)
10	Z-axis gyroscope bias correction enable (1 = enabled)
9	Y-axis gyroscope bias correction enable (1 = enabled)
8	X-axis gyroscope bias correction enable (1 = enabled)
[7:4]	Not used
[3:0]	Time base control (TBC), range: 0 to 13 (default = 10); $t_B = 2^{TBC}/2460$, time base, $t_A = 64 \times t_B$, average time

Turn to Page 3 (DIN = 0x8003) and set GLOB_CMD[0] = 1 (DIN = 0x8201, then DIN = 0x8300) to update the user offset registers with the correction factors of the CBE.

Manual Sensitivity Correction

The x_GYRO_SCALE registers enable sensitivity adjustment (see Table 63, Table 64, and Table 65).

Table 63. X_GYRO_SCALE (Page 2, Base Address = 0x04)

Bits	Description (Default = 0x0000)
[15:0]	X-axis gyroscope scale correction; twos complement, 0x0000 = unity gain, 1 LSB = 1 ÷ 2^{15} = ~0.003052%

Table 64. Y_GYRO_SCALE (Page 2, Base Address = 0x06)

Bits	Description (Default = 0x0000)
[15:0]	Y-axis gyroscope scale correction; twos complement, 0x0000 = unity gain, 1 LSB = 1 ÷ 2^{15} = ~0.003052%

Table 65. Z_GYRO_SCALE (Page 2, Base Address = 0x08)

Bits	Description (Default = 0x0000)
[15:0]	Z-axis gyroscope scale correction; twos complement, 0x0000 = unity gain, 1 LSB = 1 ÷ 2^{15} = ~0.003052%

Linear Acceleration on Effect on Gyroscope Bias

MEMS gyroscopes typically have a bias response to linear acceleration that is normal to their axes of rotation. The ADIS16485 offers an optional compensation function for this effect. Turn to Page 3 (DIN = 0x8003) and set CONFIG[7] = 1 (DIN = 0x9080, DIN = 0x9100). The factory default configuration enables this function.

Table 66. CONFIG (Page 3, Base Address = 0x0A)

Bits	Description (Default = 0x00C0)
[15:8]	Not used
7	Linear-*g* compensation for gyroscopes (1 = enabled)
6	Point of percussion alignment (1 = enabled)
[5:2]	Not used
1	Real-time clock, daylight savings time (1: enabled, 0: disabled)
0	Real-time clock control (1: relative/elapsed timer mode, 0: calendar mode)

ACCELEROMETERS

The user calibration for the accelerometers includes registers for adjusting bias and sensitivity, as shown in Figure 23.

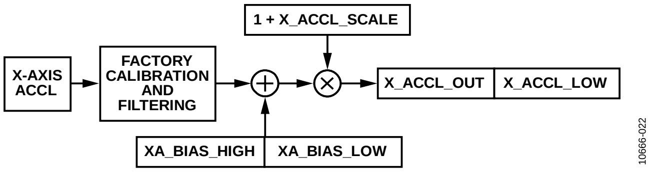


Figure 23. User Calibration Signal Path, Gyroscopes

Manual Bias Correction

The xA_BIAS_HIGH (see Table 67, Table 68, and Table 69) and xA_BIAS_LOW (see Table 70, Table 71, and Table 72) registers provide a bias adjustment function for the output of each gyroscope sensor. The xA_BIAS_HIGH registers use the same format as x_ACCL_OUT registers. The xA_BIAS_LOW registers use the same format as x_ACCL_LOW registers.

Table 67. XA_BIAS_HIGH (Page 2, Base Address = 0x1E)

Bits	Description (Default = 0x0000)
[15:0]	X-axis accelerometer offset correction, high word; twos complement, 0 *g* = 0x0000, 1 LSB = 0.25 m*g*

Table 68. YA_BIAS_HIGH (Page 2, Base Address = 0x22)

Bits	Description (Default = 0x0000)
[15:0]	Y-axis accelerometer offset correction, high word; twos complement, 0 *g* = 0x0000, 1 LSB = 0.25 m*g*

Table 69. ZA_BIAS_HIGH (Page 2, Base Address = 0x26)

Bits	Description (Default = 0x0000)
[15:0]	Z-axis accelerometer offset correction, high word; twos complement, 0 *g* = 0x0000, 1 LSB = 0.25 m*g*

Table 70. XA_BIAS_LOW (Page 2, Base Address = 0x1C)

Bits	Description (Default = 0x0000)
[15:0]	X-axis accelerometer offset correction, low word; twos complement, 0 *g* = 0x0000, 1 LSB = 0.25 m*g* ÷ 2^{16} = ~0.000003815 m*g*

Table 71. YA_BIAS_LOW (Page 2, Base Address = 0x20)

Bits	Description (Default = 0x0000)
[15:0]	Y-axis accelerometer offset correction, low word; twos complement, 0 *g* = 0x0000, 1 LSB = 0.25 m*g* ÷ 2^{16} = ~0.000003815 m*g*

Table 72. ZA_BIAS_LOW (Page 2, Base Address = 0x24)

Bits	Description (Default = 0x0000)
[15:0]	Z-axis accelerometer offset correction, low word; twos complement, 0 *g* = 0x0000, 1 LSB = 0.25 m*g* ÷ 2^{16} = ~0.000003815 m*g*

Manual Sensitivity Correction

The x_ACCL_SCALE registers enable sensitivity adjustment (see Table 73, Table 74, Table 75).

Table 73. X_ACCL_SCALE (Page 2, Base Address = 0x0A)

Bits	Description (Default = 0x0000)
[15:0]	X-axis accelerometer scale correction; twos complement, 0x0000 = unity gain, 1 LSB = 1 ÷ 2^{15} = ~0.0003052%

Table 74. Y_ACCL_SCALE (Page 2, Base Address = 0x0C)

Bits	Description (Default = 0x0000)
[15:0]	Y-axis accelerometer scale correction; twos complement, 0x0000 = unity gain, 1 LSB = 1 ÷ 2^{15} = ~0.0003052%

Table 75. Z_ACCL_SCALE (Page 2, Base Address = 0x0E)

Bits	Description (Default = 0x0000)
[15:0]	Z-axis accelerometer scale correction; twos complement, 0x0000 = unity gain, 1 LSB = 1 ÷ 2^{15} = ~0.0003052%

RESTORING FACTORY CALIBRATION

Turn to Page 3 (DIN = 0x8003) and set GLOB_CMD[6] = 1 (DIN = 0x8240, DIN = 0x8300) to execute the factory calibration restore function. This function resets each user calibration register to zero, resets all sensor data to 0, and automatically updates the flash memory within 900 ms. See Table 85 for more information on GLOB_CMD.

POINT OF PERCUSSION ALIGNMENT

CONFIG[6] offers a point of percussion alignment function that maps the accelerometer sensors to the corner of the package identified in Figure 24. To activate this feature, turn to Page 3 (DIN = 0x8003), then set CONFIG[6] = 1 (DIN = 0x8A40, DIN = 0x8B00). See Table 66 for more information on the CONFIG register.

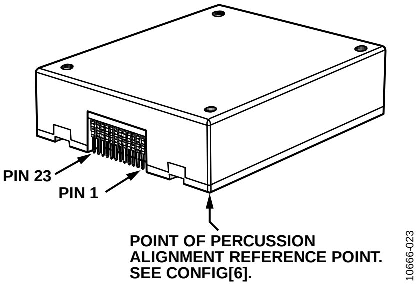


Figure 24. Point of Percussion Reference Point

ALARMS

Each sensor has an independent alarm function that provides controls for alarm magnitude, polarity, and enabling a dynamic rate-of-change option. The ALM_STS register (see Table 42) contains the alarm output flags and the FNCTIO_CTRL register (see Table 88) provides an option for configuring one of the digital I/O lines as an alarm indicator.

STATIC ALARM USE

The static alarm setting compares the output of each sensor with the trigger settings in the xx_ALM_MAGN registers (see Table 76, Table 77, Table 78, Table 79, Table 80, and Table 81) of that sensor. The polarity controls for each alarm are in the ALM_CNFG_x registers (see Table 82 and Table 83). The polarity bit establishes whether greater than or less than produces an alarm condition. The comparison between the xx_ALM_MAGN value and the output data applies only to the upper word or 16 bits of the output data.

DYNAMIC ALARM USE

The dynamic alarm setting provides the option of comparing the change in each sensor's output over a period of 48.7 ms with that sensor's xx_ALM_MAGN register.

Table 76. XG_ALM_MAGN (Page 3, Base Address = 0x28)

Bits	Description (Default = 0x0000)
[15:0]	X-axis gyroscope alarm threshold settings; twos complement, 0°/sec = 0x0000, 1 LSB = 0.02°/sec

Table 77. YG_ALM_MAGN (Page 3, Base Address = 0x2A)

Bits	Description (Default = 0x0000)
[15:0]	Y-axis gyroscope alarm threshold settings; twos complement, 0°/sec = 0x0000, 1 LSB = 0.02°/sec

Table 78. ZG_ALM_MAGN (Page 3, Base Address = 0x2C)

Bits	Description (Default = 0x0000)
[15:0]	Z-axis gyroscope alarm threshold settings; twos complement, 0°/sec = 0x0000, 1 LSB = 0.02°/sec

Table 79. XA_ALM_MAGN (Page 3, Base Address = 0x2E)

Bits	Description (Default = 0x0000)
[15:0]	X-axis accelerometer alarm threshold settings; twos complement, 0 *g* = 0x0000, 1 LSB = 0.25 m*g*

Table 80. YA_ALM_MAGN (Page 3, Base Address = 0x30)

Bits	Description (Default = 0x0000)
[15:0]	Y-axis accelerometer alarm threshold settings; twos complement, 0 *g* = 0x0000, 1 LSB = 0.25 m*g*

Table 81. ZA_ALM_MAGN (Page 3, Base Address = 0x32)

Bits	Description (Default = 0x0000)
[15:0]	Z-axis accelerometer alarm threshold settings; twos complement, 0 *g* = 0x0000, 1 LSB = 0.25 m*g*

Table 82. ALM_CNFG_0 (Page 3, Base Address = 0x20)

Bits	Description (Default = 0x0000)
15	X-axis accelerometer alarm (1 = enabled)
14	Not used
13	X-axis accelerometer alarm polarity 1 = active when X_ACCL_OUT > XA_ALM_MAGN 0 = active when X_ACCL_OUT > XA_ALM_MAGN
12	X-axis accelerometer dynamic enable (1 = enabled)
11	Z-axis gyroscope alarm (1 = enabled)
10	Not used
9	Z-axis gyroscope alarm polarity 1 = active when Z_GYRO_OUT > ZG_ALM_MAGN 0 = active when Z_GYRO_OUT > ZG_ALM_MAGN
8	Z-axis gyroscope dynamic enable (1 = enabled)
7	Y-axis gyroscope alarm (1 = enabled)
6	Not used
5	Y-axis gyroscope alarm polarity 1 = active when Y_GYRO_OUT > YG_ALM_MAGN 0 = active when Y_GYRO_OUT > YG_ALM_MAGN
4	Y-axis gyroscope dynamic enable (1 = enabled)
3	X-axis gyroscope alarm (1 = enabled)
2	Not used
1	X-axis gyroscope alarm polarity 1 = active when X_GYRO_OUT > XG_ALM_MAGN 0 = active when X_GYRO_OUT > XG_ALM_MAGN
0	X-axis gyroscope dynamic enable (1 = enabled)

Table 83. ALM_CNFG_1 (Page 3, Base Address = 0x22)

Bits	Description (Default = 0x0000)
[15:8]	Don't care
7	Z-axis accelerometer alarm (1 = enabled)
6	Not used
5	Z-axis accelerometer alarm polarity 1 = active when Z_ACCL_OUT > ZA_ALM_MAGN 0 = active when Z_ACCL_OUT > ZA_ALM_MAGN
4	Z-axis accelerometer dynamic enable (1 = enabled)
3	Y-axis accelerometer alarm (1 = enabled)
2	Not used
1	Y-axis accelerometer alarm polarity 1 = active when Y_ACCL_OUT > YA_ALM_MAGN 0 = active when Y_ACCL_OUT > YA_ALM_MAGN
0	Y-axis accelerometer dynamic enable (1 = enabled)

Alarm Example

Table 84 offers an alarm configuration example, which sets the z-axis gyroscope alarm to trip when Z_GYRO_OUT > 131.1°/sec (0x199B).

Table 84. Alarm Configuration Example

DIN	Description
0xAC9B, 0xAD19	Set ZG_ALM_MAGN = 0x199B
0xA000, 0xA10A	Set ALM_CNFG_0 = 0x0A00

SYSTEM CONTROLS

The ADIS16485 provides a number of system level controls for managing its operation, which include reset, self test, calibration, memory management, and I/O configuration.

GLOBAL COMMANDS

The GLOB_CMD register (see Table 85) provides trigger bits for several operations. Write 1 to the appropriate bit in GLOB_CMD to start a function. After the function completes, the bit restores to 0.

Table 85. GLOB_CMD (Page 3, Base Address = 0x02)

Bits	Description	Execution Time
[15:8]	Not used	Not applicable
7	Software reset	120 ms
6	Factory calibration restore	75 ms
[5:4]	Not used	Not applicable
3	Flash memory update	375 ms
2	Flash memory test	50 ms
1	Self test	12 ms
0	Bias null	See Table 62

Software Reset

Turn to Page 3 (DIN = 0x8003) and then set GLOB_CMD[7] = 1 (DIN = 0x8280, DIN = 0x8300) to reset the operation, which removes all data, initializes all registers from their flash settings, and starts data collection. This function provides a firmware alternative to the $\overline{\text{RST}}$ line (see Table 5, Pin 8).

Automatic Self Test

Turn to Page 3 (DIN = 0x8003) and then set GLOB_CMD[1] = 1 (DIN = 0x8202, then DIN = 0x8300) to run an automatic, self test routine, which executes the following steps:

1. Measure the output on each sensor.
2. Activate the self test on each sensor.
3. Measure the output on each sensor.
4. Deactivate the self test on each sensor.
5. Calculate the difference with the self test on and off.
6. Compare the difference with the internal pass/fail criteria.
7. Report the pass/fail results for each sensor in DIAG_STS.

After waiting 12 ms for this test to complete, turn to Page 0 (DIN = 0x8000) and read DIAG_STS using DIN = 0x0A00. Note that using an external clock can extend this time. When using an external clock of 100 Hz, this time extends to 35 ms. Note that 100 Hz is too slow for optimal sensor performance.

MEMORY MANAGEMENT

The data retention of the flash memory depends on the temperature and the number of write cycles. Figure 25 characterizes the dependence on temperature, and the FLSHCNT_LOW and FLSHCNT_HIGH registers (see Table 86 and Table 87) provide a running count of flash write cycles. The flash updates every time GLOB_CMD[6], GLOB_CMD[3], or GLOB_CMD[0] is set to 1.

Table 86. FLSHCNT_LOW (Page 2, Base Address = 0x7C)

Bits	Description
[15:0]	Binary counter; number of flash updates, lower word

Table 87. FLSHCNT_HIGH (Page 2, Base Address = 0x7E)

Bits	Description
[15:0]	Binary counter; number of flash updates, upper word

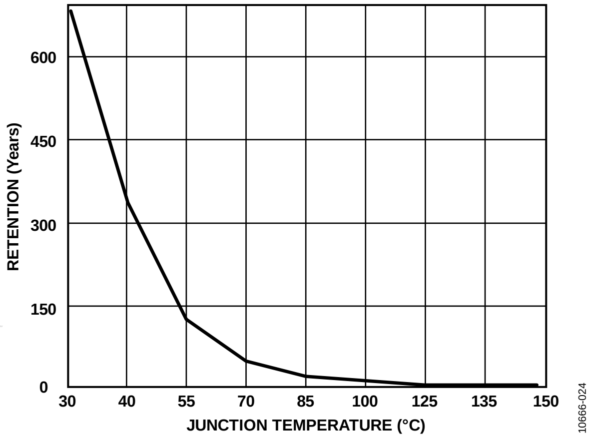


Figure 25. Flash Memory Retention

Flash Memory Test

Turn to Page 3 (DIN = 0x8003), and then set GLOB_CMD[2] = 1 (DIN = 0x8204, DIN = 0x8300) to run a checksum test of the internal flash memory, which compares a factory programmed value with the current sum of the same memory locations. The result of this test loads into SYS_E_FLAG[6]. Turn to Page 0 (DIN = 0x8000) and use DIN = 0x0800 to read SYS_E_FLAG.

GENERAL-PURPOSE I/O

There are four general-purpose I/O lines: DIO1, DIO2, DIO3, and DIO4. The FNCTIO_CTRL register controls the basic function of each I/O line. Each I/O line only supports one function at a time. In cases where a single line has two different assignments, the enable bit for the lower priority function automatically resets to zero and is disabled. The priority is (1) data-ready, (2) sync clock input, (3) alarm indicator, and (4) general-purpose, where 1 identifies the highest priority and 4 indicates the lowest priority.

Table 88. FNCTIO_CTRL (Page 3, Base Address = 0x06)

Bits	Description (Default = 0x000D)
[15:12]	Not used
11	Alarm indicator: 1 = enabled, 0 = disabled
10	Alarm indicator polarity: 1 = positive, 0 = negative
[9:8]	Alarm indicator line selection: 00 = DIO1, 01 = DIO2, 10 = DIO3, 11 = DIO4
7	Sync clock input enable: 1 = enabled, 0 = disabled
6	Sync clock input polarity: 1 = rising edge, 0 = falling edge
[5:4]	Sync clock input line selection: 00 = DIO1, 01 = DIO2, 10 = DIO3, 11 = DIO4
3	Data-ready enable: 1 = enabled, 0 = disabled
2	Data-ready polarity: 1 = positive, 0 = negative
[1:0]	Data-ready line selection: 00 = DIO1, 01 = DIO2, 10 = DIO3, 11 = DIO4

Data-Ready Indicator

FNCTIO_CTRL[3:0] provide some configuration options for using one of the DIOx lines as a data-ready indicator signal, which can drive the interrupt control line of a processor. The factory default assigns DIO2 as a positive polarity, data-ready signal. Use the following sequence to change this assignment to DIO1 with a negative polarity: turn to Page 3 (DIN = 0x8003) and set FNCTIO_CTRL[3:0] = 1000 (DIN = 0x8608, then DIN = 0x8700). The timing jitter on the data-ready signal is ±1.4 µs.

Input Sync/Clock Control

FNCTIO_CTRL[7:4] provide some configuration options for using one of the DIOx lines as an input synchronization signal for sampling inertial sensor data. For example, use the following sequence to establish DIO4 as a positive polarity, input clock pin and keep the factory default setting for the data-ready function: turn to Page 3 (DIN = 0x8003) and set FNCTIO_CTRL[7:0] = 0xFD (DIN = 0x86FD, then DIN = 0x8700). Note that this command also disables the internal sampling clock, and no data sampling takes place without the input clock signal. When selecting a clock input frequency, consider the 330 Hz sensor bandwidth, because under sampling the sensors can degrade noise and stability performance.

General-Purpose I/O Control

When FNCTIO_CTRL does not configure a DIOx pin, GPIO_CTRL provides register controls for general-purpose use of the pin. GPIO_CTRL[3:0] provides input/output assignment controls for each line. When the DIOx lines are inputs, monitor their levels by reading GPIO_CTRL[7:4]. When the DIOx lines are used as outputs, set their levels by writing to GPIO_CTRL[7:4]. For example, use the following sequence to set DIO1 and DIO3 as high and low output lines, respectively, and set DIO2 and DIO4 as input lines. Turn to Page 3 (DIN = 0x8003) and set GPIO_CTRL[7:0] = 0x15 (DIN = 0x8815, then DIN = 0x8900).

Table 89. GPIO_CTRL (Page 3, Base Address = 0x08)

Bits	Description (Default = 0x00X0)[1]
[15:8]	Don't care
7	General-Purpose I/O Line 4 (DIO4) data level
6	General-Purpose I/O Line 3 (DIO3) data level
5	General-Purpose I/O Line 2 (DIO2) data level
4	General-Purpose I/O Line 1 (DIO1) data level
3	General-Purpose I/O Line 4 (DIO4) direction control (1 = output, 0 = input)
2	General-Purpose I/O Line 3 (DIO3) direction control (1 = output, 0 = input)
1	General-Purpose I/O Line 2 (DIO2) direction control (1 = output, 0 = input)
0	General-Purpose I/O Line 1 (DIO1) direction control (1 = output, 0 = input)

[1] The GPIO_CTRL register, Bits[7:4], reflects the levels on the DIOx lines.

POWER MANAGEMENT

The SLP_CNT register (see Table 90) provides controls for both power-down mode and sleep mode. The trade-off between power-down mode and sleep mode is between idle power and recovery time. Power-down mode offers the best idle power consumption but requires the most time to recover. Also, all volatile settings are lost during power-down but are preserved during sleep mode.

For timed sleep mode, turn to Page 3 (DIN = 0x8003), write the amount of sleep time to SLP_CNT[7:0] and then, set SLP_CNT[8] = 1 (DIN = 0x9101) to start the sleep period. For a timed power-down period, change the last command to set SLP_CNT[9] = 1 (DIN = 0x9102). To power down or sleep for an indefinite period, set SLP_CNT[7:0] = 0x00 first, then set either SLP_CNT[8] or SLP_CNT[9] to 1. Note that the command takes effect when the $\overline{\text{CS}}$ line goes high. To awaken the device from sleep or power-down mode, use one of the following options to restore normal operation:

- Assert $\overline{\text{CS}}$ from high to low.
- Pulse $\overline{\text{RST}}$ low, then high again.
- Cycle the power.

For example, set SLP_CNT[7:0] = 0x64 (DIN = 0x9064), then set SLP_CNT[8] = 1 (DIN = 0x9101) to start a sleep period of 100 seconds.

Table 90. SLP_CNT (Page 3, Base Address = 0x10)

Bits	Description
[15:10]	Not used
9	Power-down mode
8	Normal sleep mode
[7:0]	Programmable time bits; 1 sec/LSB; 0x00 = indefinite

If the sleep mode and power-down mode bits are both set high, the normal sleep mode (SLP_CNT[8]) bit takes precedence.

General-Purpose Registers

The USER_SCR_x registers (see Table 91, Table 92, Table 93, and Table 94) provide four 16-bit registers for storing data.

Table 91. USER_SCR_1 (Page 2, Base Address = 0x74)

Bits	Description
[15:0]	User-defined

Table 92. USER_SCR_2 (Page 2, Base Address = 0x76)

Bits	Description
[15:0]	User-defined

Table 93. USER_SCR_3 (Page 2, Base Address = 0x78)

Bits	Description
[15:0]	User-defined

Table 94. USER_SCR_4 (Page 2, Base Address = 0x7A)

Bits	Description
[15:0]	User-defined

Real-Time Clock Configuration/Data

The VDDRTC power supply pin (see Table 5, Pin 23) provides a separate supply for the real-time clock (RTC) function. This enables the RTC to keep track of time, even when the main supply (VDD) is off. Configure the RTC function by selecting one of two modes in CONFIG[0] (see Table 66). The real-time clock data is available in the TIME_MS_OUT register (see Table 95), TIME_DH_OUT register (see Table 96), and TIME_YM_OUT register (see Table 97). When using the elapsed timer mode, the time data registers start at 0x0000 when the device starts up (or resets) and begin keeping time in a manner that is similar to a stopwatch. When using the clock/calendar mode, write the current time to the real-time registers in the following sequence: seconds (TIME_MS_OUT[5:0]), minutes (TIME_ MS_OUT[13:8]), hours (TIME_DH_OUT[5:0]), day (TIME_DH_OUT[12:8]), month (TIME_YM_OUT[3:0]), and year (TIME_YM_OUT[14:8]).

The updates to the timer do not become active until there is a successful write to the TIME_ YM_OUT[14:8] byte. The real-time clock registers reflect the newly updated values only after the next seconds tick of the clock that follows the write to TIME_YM_OUT[14:8] (year). Writing to TIME_YM_OUT[14:8] activates all timing values; therefore, always write to this location last when updating the timer, even if the year information does not require updating.

Write the current time to each time data register after setting CONFIG[0] = 1 (DIN = 0x8003, DIN = 0x8A01). Note that CONFIG[1] provides a bit for managing daylight savings time. After the CONFIG and TIME_xx_OUT registers are configured, set GLOB_CMD[3] = 1 (DIN = 0x8003, DIN = 0x8208, DIN = 0x8300) to back these settings up in flash, and use a separate 3.3 V source to supply power to the VDDRTC function. Note that access to time data in the TIME_xx_OUT registers requires normal operation (VDD = 3.3 V and full startup), but the timer function only requires that VDDRTC = 3.3 V when the rest of the ADIS16485 is turned off.

Table 95. TIME_MS_OUT (Page 0, Base Address = 0x78)

Bits	Description
[15:14]	Not used
[13:8]	Minutes, binary data, range = 0 to 59
[7:6]	Not used
[5:0]	Seconds, binary data, range = 0 to 59

Table 96. TIME_DH_OUT (Page 0, Base Address = 0x7A)

Bits	Description
[15:13]	Not used
[12:8]	Day, binary data, range = 1 to 31
[7:6]	Not used
[5:0]	Hours, binary data, range = 0 to 23

Table 97. TIME_YM_OUT (Page 0, Base Address = 0x7C)

Bits	Description
[15]	Not used
[14:8]	Year, binary data, range = 0 to 99, relative to 2000 A.D.
[7:4]	Not used
[3:0]	Month, binary data, range = 1 to 12

APPLICATIONS INFORMATION

PROTOTYPE INTERFACE BOARD

The ADIS16485/PCBZ includes one ADIS16485AMLZ, one interface printed circuit board (PCB), and four M2 × 0.4 × 18 mm machine screws. The interface PCB provides four holes for ADIS16485AMLZ attachment and four larger holes for attaching the interface PCB to another surface. The ADIS16485AMLZ attachment holes are pretapped for M2 × 0.4 mm machine screws and the four larger holes, located in each corner, support attachment with M2.5 or #4 machine screws. J1 is a dual-row, 2 mm (pitch) connector that works with a number of ribbon cable systems, including 3M Part Number 152212-0100-GB (ribbon crimp connector) and 3M Part Number 3625/12 (ribbon cable). Note that J1 has 16 pads but currently uses a 12-pin connector. The extra pins accommodate future evaluation system plans.

Figure 27 provides the pin assignments for J1. The pin descriptions match those listed in Table 5. The C1 and C2 locations provide solder pads for extra capacitors, which can provide additional filtering for start-up transients and supply noise.

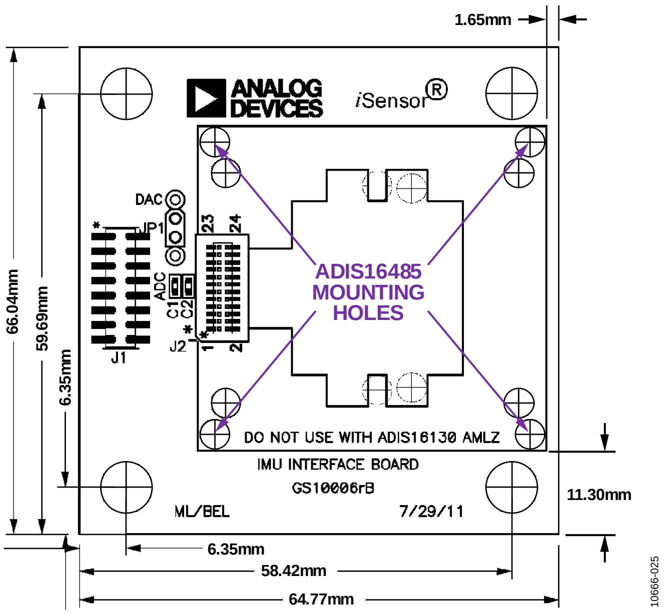
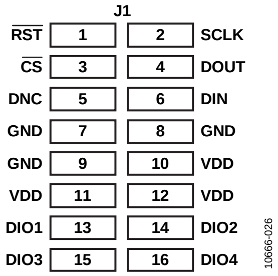


Figure 26. Physical Diagram for the ADIS16485/PCBZ



J1

$\overline{\text{RST}}$	1	2	SCLK
$\overline{\text{CS}}$	3	4	DOUT
DNC	5	6	DIN
GND	7	8	GND
GND	9	10	VDD
VDD	11	12	VDD
DIO1	13	14	DIO2
DIO3	15	16	DIO4

Figure 27. ADIS16485/PCBZ J1 Pin Assignments

INSTALLATION TIPS

Figure 28 and Figure 29 provide the mechanical design information used for the ADIS16485/PCBZ. Use Figure 28 and Figure 29 when implementing a connector-down approach, where the mating connector and the ADIS16485AMLZ are on the same surface. When designing a connector-up system, use the mounting holes shown in Figure 28 as a guide in designing the bulkhead mounting system and use Figure 29 as a guide in developing the mating connector interface on a flexible circuit or other connector system. The suggested torque setting for the attachment hardware is 40 inch-ounces, or 0.2825 N-m.

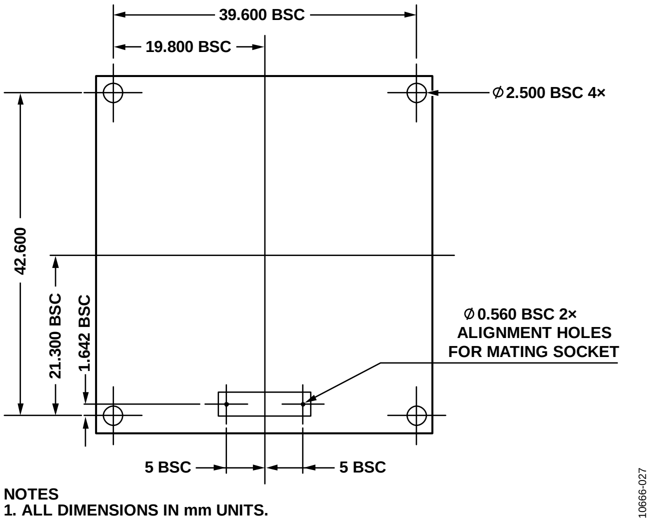


Figure 28. Suggested Mounting Hole Locations, Connector Down

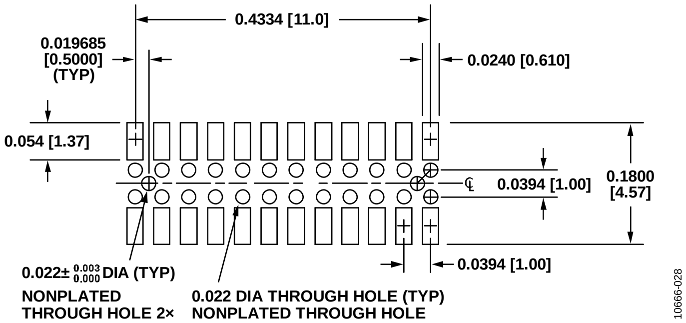


Figure 29. Suggested Layout and Mechanical Design for the Mating Connector

PC EVALUATION WITH EVAL-ADIS

The EVAL-ADIS (see UG-287) and IMU evaluation software provide PC-based evaluation support for the ADIS16485AMLZ. See www.analog.com/EVAL-ADIS for documentation and software downloads.

OUTLINE DIMENSIONS

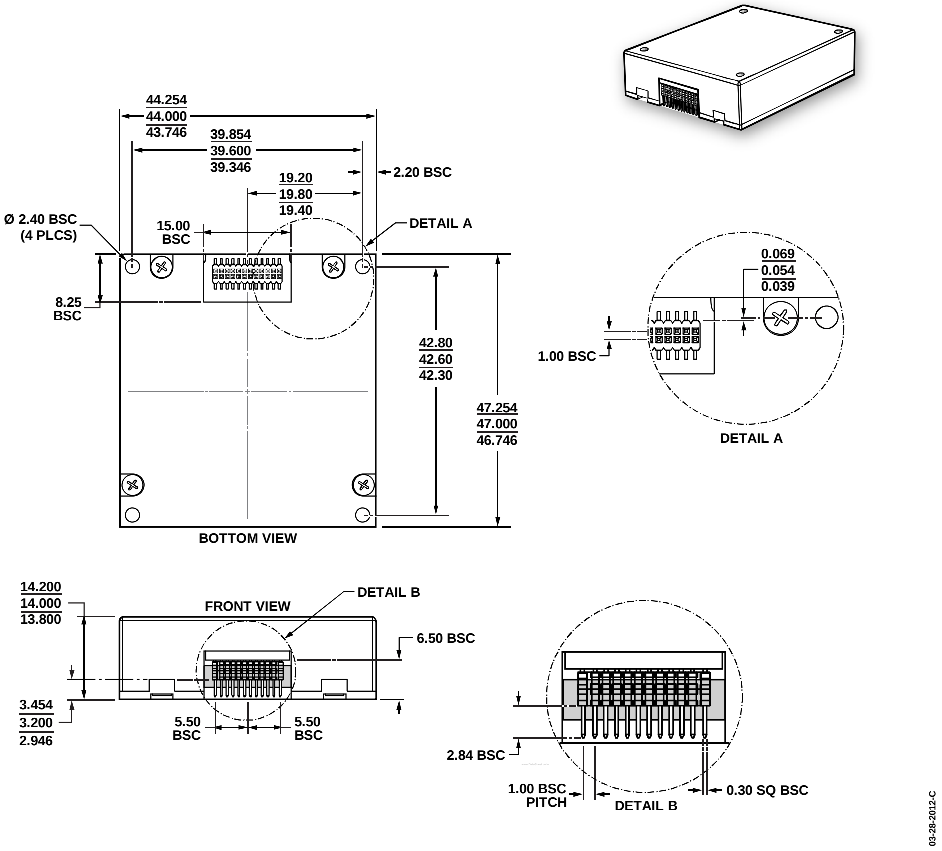


Figure 30. 24-Lead Module with Connector Interface [MODULE]
(ML-24-6)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1, 2]	Temperature Range	Package Description	Package Option
ADIS16485AMLZ	−40°C to +85°C	24-Lead Module with Connector Interface [MODULE]	ML-24-6
ADIS16485/PCBZ		Interface PCB	

[1] Z = RoHS Compliant Part.
[2] The ADIS16485/PCBZ includes one ADIS16485AMLZ and one interface board PCB. See Figure 26 for more information on the interface PCB.

D10666-0-5/12(0)