IIM-46234 & IIM-46230

High-performance SmartIndustrial™ 6-axis MotionTracking® MEMS Device for Industrial Applications

GENERAL DESCRIPTION

The IIM-46230 and the IIM-46234 two SmartIndustrial™ 6-axis MotionTracking devices that combine multiple 3-axis gyroscopes and 3-axis accelerometers packaged in a module that is approximately 23 mm x 23 mm x 8.5 mm and includes a standard 20 pin connector interface.

The IIM-46234 & IIM-46230 include multiple capabilities to enable easy, robust, and accurate inertial measurements in Industrial applications:

- TDK proprietary SensorFT™ (Fault Tolerance) feature that delivers built-in redundancy and early warning
- Low bias instability
- Low offset and sensitivity variation over temperature
- Robustness to shock and vibration
- Triaxial, delta angle, and delta velocity output
- Accurate timestamps, which can be set to UTC timestamp and synchronized to an external PPS pulse
- Operating temperature range: -40°C to 85°C
- Factory calibration over temperature range for bias, sensitivity, misalignment, G-sensitivity

The device features an operating voltage range from 3.6V down to 3.0V.

ORDERING INFORMATION

PART NUMBER	TEMPERATURE	PACKAGE
IIM-46230†	−40°C to +85°C	Module
IIM-46234†	−40°C to +85°C	Module

†Denotes RoHS and Green-compliant package

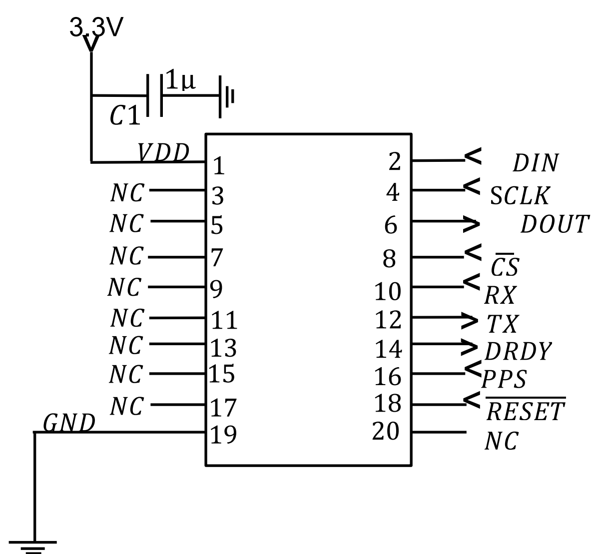
APPLICATIONS

- Agriculture and construction machinery
- Navigation
- Platform stabilization
- Asset tracking
- Robotics
- Industrial automation
- Survey equipment

FEATURES

- 3-Axis Gyroscope with FSR up to ±480 °/sec
    - 1.9°/hr (typical) bias instability (IIM-46234)
    - 4.1°/hr (typical) bias instability (IIM-46230)
- 3-Axis Accelerometer with FSR up to ±8*g*
- Digital-output temperature sensor
- Programmble digital filters
- Built-in MEMS oscillator for accurate timestamp
- PPS/External Sync input for clock corrections
- Host interface: UART or SPI
- Single-supply operation from 3.0V to 3.6V
- 2000*g* shock survivability
- RoHS and Green compliant

TYPICAL OPERATING CIRCUIT



LONGEVITY COMMITMENT

To provide the best service for customers developing products with a long-life cycle we have designed and engineered products with longevity in mind. These products are designed for harsher environments and are tested and manufactured to higher accuracy and stability.
https://invensense.tdk.com/longevity/

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This document is a product specification, providing description, specifications, and design-related information on the IIM-46234 & IIM-46230 SmartIndustrial™ MotionTracking® device.

1.2 PRODUCT OVERVIEW

The IIM-46234 & IIM-46230 are 6-axis Inertial Measurement Units that combine multiple 3-axis gyroscopes and 3-axis accelerometers in a small module that is approximately 23 mm x 23 mm x 8.5 mm and includes a standard 20 pin connector interface. These IMUs, with its 6-axis integration, enables manufacturers to eliminate the costly and complex selection, qualification, and system-level integration of discrete devices, guaranteeing optimal motion performance.

The IIM-46234 gyroscope has a full-scale range up to ±480 dps (±2000 dps for the IIM-46230). The IIM-46234 accelerometer has a full-scale range up to ±8*g* (±16g for the IIM-46230). Factory-calibrated initial sensitivity of both sensors reduces production-line calibration requirements.

The IIM-46234 & IIM-46230 devices include TDK proprietary SensorFT™ feature that delivers built-in redundancy and early warning to avoid complete disruption of the module operation.

These devices also support precise timestamps along with accelerometer and gyroscope readings. Other features include programmable bandwidth settings and an embedded temperature sensor. The devices feature a UART and a Serial Peripheral Interface (SPI) for progamming and data collection purposes and a single VDD supply with operating range of 3.0V to 3.6V.

By leveraging its patented and volume-proven CMOS-MEMS fabrication platform, which integrates Micro Electro-Mechanical Systems (MEMS) wafers with companion CMOS electronics through wafer-level bonding, TDK has driven the module size down to a footprint and thickness of 23 mm x 23 mm x 8.5 mm to provide a small yet high-performance low-cost package. The device provides high robustness by supporting 2,000*g* shock reliability.

1.3 APPLICATIONS

- Agriculture and construction machinery
- Navigation
- Platform stabilization
- Asset tracking
- Robotics
- Industrial automation
- Survey equipment

2 FEATURES

2.1 GYROSCOPE FEATURES

The triple-axis MEMS gyroscope in the IIM-46234 & IIM-46230 include a wide range of features:

- Digital-output X-, Y-, and Z-axis angular rate sensors (gyroscopes) with a full-scale range up to ±480 dps (IIM-46234) or ±2000 dps (IIM-46230)
- Digitally programmable low-pass filter
- Factory calibrated offset drift and sensitivity over temperature
- Delta angle output at user selectable ODR (internally computed at 1 kHz)
- Self-test pass/fail

2.2 ACCELEROMETER FEATURES

The triple-axis MEMS accelerometer in the the IIM-46234 & IIM-46230 include a wide range of features:

- Digital-output X-, Y-, and Z-axis accelerometer with full-scale range up to ±8g (IIM-46234) or ±16g (IIM-46230)
- Digitally programmable low-pass filter
- Factory calibrated offset drift and sensitivity over temperature
- Delta velocity output at user selectable ODR (internally computed at 1 kHz)
- Self-test pass/fail

2.3 ADDITIONAL FEATURES

The IIM-4623 include the following additional features:

- SensorFT™ feature that delivers built-in redundancy and early warning
  - Status information with each output
- Precise timestamping in microseconds (25 ppm drift) output
  - The user can optionally provide an external PPS sync pulse to synchronize the internal timestamp
  - The user can provide UTC timestamp and PPS pulse to match internal timestamps to external system time
- Digital-output temperature sensor
- SPI serial interface up to 12 MHz to communicate with the device for programming and data collection
- UART interface up to 3 Mbps, with similar functionality as the SPI interface
- MEMS structure hermetically sealed and bonded at wafer level
- 2,000*g* shock tolerance
- RoHS and Green compliant

3 TARGET ELECTRICAL CHARACTERISTICS

3.1 IIM-46234 SPECIFICATIONS

3.1.1 IIM-4234 Gyroscope Specifications

Typical Operating Circuit of section 4.2, VDD = 3.3V, VDDIO = 3.3V, T_A=25°C, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT	NOTES
Full scale	GYRO_FS_SEL = 2		±480		dps	3
	GYRO_FS_SEL = 3		±250		dps	3
Sensitivity	GYRO_FS_SEL = 2		2^{31}/480		LSB/dps	3, 6
	GYRO_FS_SEL = 3		2^{31}/250		LSB/dps	3, 6
Sensitivity error temperature drift	-40˚C to 85°C	-0.25	±0.1	0.25	%	1, 5
Bias repeatability	40˚C		0.02	0.06	dps	1
Bias error temperature drift	-40˚C to 85°C	-0.3	±0.14	0.3	dps	1, 5
Nonlinearity	Best fit straight line, 25˚C	-0.15	±0.1	0.15	%FS	1, 5
Linear acceleration effect			±0.015	0.02	dps/g	1, 5
Vibration rectification error	±2g at 50 Hz-2 kHz sweep		0.001		dps/g^2	1
In-run bias stability	40˚C		1.9		dph	1
Angular random walk	40˚C		0.07	0.09	deg/√hr	1, 5
Noise density	@ 100 Hz		0.0016	0.002	dps/√Hz	1, 5
Misalignment			0.07	0.15	deg	1, 5
Sensor resonant frequency		25	27	29	kHz	2
Bandwidth	@ODR of 1000 Hz			100	Hz	3, 4
Output Data Rate (ODR)		10		1000	Hz	3, 4

Table 1. Gyroscope Specifications

Notes:
1. Characterization means derived from validation or characterization of parts, not guaranteed in production.
2. Tested in production.
3. Guaranteed by design.
4. BW/ODR table for different possible configurations.
5. MIN/MAX or MAX specs are derived from characterization data based on a 3σ calculation.
6. Applies to fixed point representation – see section 7.5 for more details.

3.1.2 IIM-46234 Accelerometer Specifications

Typical Operating Circuit of section 4.2, VDD = 3.3V, VDDIO = 3.3V, T_A=25°C, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT	NOTES
Measurement Range	ACCEL_FS_SEL = 1 (default)		±8		g	3
	ACCEL_FS_SEL = 2		±4		g	3
	ACCEL_FS_SEL = 3		±2		g	3
Sensitivity	ACCEL_FS_SEL = 1 (default)		$2^{31}/8$		LSB/g	3, 6
	ACCEL_FS_SEL = 2		$2^{31}/4$		LSB/g	3, 6
	ACCEL_FS_SEL = 3		$2^{31}/2$		LSB/g	3, 6
Sensitivity error temperature drift	-40˚C to 85˚C	-0.3	±0.1	0.3	%	1, 5
Bias repeatability	40˚C		±0.16	0.4	mg	1, 5
Bias error temperature drift	-40˚C to 85˚C	-2	±1.0	2	mg	1, 5
Nonlinearity	Best fit straight line, 25˚C		±0.05	0.1	%FS	1, 5
In-run bias stability	X and Y-axis, 40˚C		5	7	µg	1, 5
	Z-axis, 40˚C		12	21		
Velocity random walk	40˚C		0.011	0.015	m/s/√hr	1, 5
Vibration Rectification Error	±2g at 50 Hz-2 kHz sweep		0.2	0.5	mg/g^2	1, 5
Noise density	@100 Hz		29	40	µg/√Hz	1, 5
Misalignment			0.07	0.1	deg	1, 5
Bandwidth	@ODR of 1000 Hz			100	Hz	3,4
Output Data Rate (ODR)		10		1000	Hz	3,4

Table 2. Accelerometer Specifications

Notes:
1. Derived from validation or characterization of parts, not guaranteed in production.
2. Tested in production.
3. Guaranteed by design.
4. BW/ODR table for different possible configurations.
5. MIN/MAX or MAX specs are derived from characterization data based on a 3σ calculation.
6. Applies to fixed point representation – see section 7.5 for more details.

3.2 IIM-46230 SPECIFICATIONS

3.2.1 IIM-46230 Gyroscope Specifications

Typical Operating Circuit of section 4.2, VDD = 3.3V, VDDIO = 3.3V, T_A=25°C, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT	NOTES
Full scale	GYRO_FS_SEL = 0		±2000		dps	3
	GYRO_FS_SEL = 1		±1000		dps	3
	GYRO_FS_SEL = 2		±500		dps	3
	GYRO_FS_SEL = 3		±250		dps	3
Sensitivity	GYRO_FS_SEL = 0		$2^{31}/2000$		LSB/dps	3, 6
	GYRO_FS_SEL = 1		$2^{31}/1000$		LSB/dps	3, 6
	GYRO_FS_SEL = 2		$2^{31}/500$		LSB/dps	3, 6
	GYRO_FS_SEL = 3		$2^{31}/250$		LSB/dps	3, 6
Sensitivity error temperature drift	-40˚C to 85°C	-0.4	±0.2	0.4	%	1, 5

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT	NOTES
Bias repeatability	40˚C		0.05	0.08	dps	1
Bias error temperature drift	-40˚C to 85°C		±0.3	0.65	dps	1, 5
Nonlinearity	Best fit straight line, 25˚C		±0.05	0.1	%FS	1, 5
Linear acceleration effect			±0.036	0.07	dps/g	1,5
Vibration rectification error	±2g at 50 Hz-2 kHz sweep		0.004		dps/g^2	1
In-run bias stability			4.1		dph	1
Angular random walk			0.15	0.2	deg/√hr	1, 5
Noise density	@ 100 Hz		0.003	0.004	dps/√Hz	1, 5
Misalignment			0.07	0.15	deg	1, 5
Sensor resonant frequency		25	27	29	kHz	2
Bandwidth	@ODR of 1000 Hz			100	Hz	3, 4
Output Data Rate (ODR)		10		1000	Hz	3, 4

Table 3. IIM-46230 Gyroscope Specifications

Notes:

7. Characterization means derived from validation or characterization of parts, not guaranteed in production.
8. Tested in production.
9. Guaranteed by design.
10. BW/ODR table for different possible configurations.
11. MIN/MAX or MAX specs are derived from characterization data based 3σ calculation.
12. Applies to fixed point representation – see section 7.5 for more details.

3.2.2 IIM-46230 Accelerometer Specifications

Typical Operating Circuit of section 4.2, VDD = 3.3V, VDDIO = 3.3V, T_A=25°C, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT	NOTES
Measurement Range (FSR)	ACCEL_FS_SEL = 0		±16		g	3
	ACCEL_FS_SEL = 1 (default)		±8		g	3
	ACCEL_FS_SEL = 2		±4		g	3
	ACCEL_FS_SEL = 3		±2		g	3, 6
Sensitivity	ACCEL_FS_SEL = 0		$2^{31}/16$		LSB/g	3, 6
	ACCEL_FS_SEL = 1 (default)		$2^{31}/8$		LSB/g	3, 6
	ACCEL_FS_SEL = 2		$2^{31}/4$		LSB/g	3, 6
	ACCEL_FS_SEL = 3		$2^{31}/2$		LSB/g	3, 6
Sensitivity error temperature drift	-40˚C to 85°C	-0.5	±0.2	0.5	%	1, 5
Bias repeatability	40˚C		±0.4	0.5	mg	1, 5
Bias error temperature drift	-40˚C to 85°C	-4	±2	4	mg	1, 5
Nonlinearity	Best fit straight line, 25˚C		±0.05	0.1	%FS	1
In-run bias stability	X and Y-axis		7	10	µg	1, 5
	Z-axis		15	20		
Velocity random walk			0.015	0.02	m/s/√hr	1, 5
Vibration Rectification Error	±2g at 50 Hz-2 kHz sweep		0.3	0.6	mg/g²	1, 5
Noise density	@100 Hz		41	57	µg/√Hz	1, 5
Misalignment			0.07	0.1	deg	1, 5
Bandwidth				100	Hz	3, 4
Output Data Rate (ODR)		10		1000	Hz	3, 4

Table 4. Accelerometer Specifications

Notes:

7. Derived from validation or characterization of parts, not guaranteed in production.
8. Tested in production.
9. Guaranteed by design.
10. BW/ODR table for different possible configurations
11. MIN/MAX or MAX specs are derived from characterization data based 3σ calculation.
12. Applies to fixed point representation – see section 7.5 for more details.

3.3 TEMPERATURE SENSOR SPECIFICATIONS

Typical Operating Circuit of section 4.2, VDD = 3.3V, VDDIO = 3.3V, T_A=25°C, unless otherwise noted (temperature reported is the internal die temperature).

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT	NOTES
Room temperature offset	Including all variations (over life, temperature, supply, etc.)	-5		5	°C	3
Operating range		-40		85	°C	3
ODR	Will be same as the inertial measurement unit (IMU)	10		1000	Hz	3
25°C output	Fixed point representation		0		LSB	3, 4
Sensitivity	Fixed point representation		126.8		LSB/°C	1, 4

Table 5. Temperature sensor specifications

Notes:

1. Derived from validation or characterization of parts, not guaranteed in production.
2. Tested in production.
3. Guaranteed by design.
4. Applies to fixed point representation – see section 7.5 for more details.

3.4 ELECTRICAL SPECIFICATIONS

3.4.1 D.C. Electrical Characteristics

Typical Operating Circuit of section 4.2, VDD = 3.3V, VDDIO = 3.3V, T_A=25°C, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
SUPPLY VOLTAGES						
VDD	3.3V supply range	3.0	3.3	3.6	V	1
SUPPLY CURRENTS & BOOT TIME						
IDD	Operational mode		35	40	mA	1
TEMPERATURE RANGE						
Operating Temperature Range	Performance parameters are not applicable beyond Specified Temperature Range	-40		+85	°C	1

Table 6. D.C. Electrical Characteristics

Notes:

1. Based on simulation and characterization of parts.

3.4.2 A.C. Electrical Characteristics

Typical Operating Circuit of section 4.2, VDD = 3.3V, VDDIO = 3.3V, T_A=25°C, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
SUPPLIES						
Supply Ramp Time (T_{RAMP})	Monotonic ramp. Ramp rate is 10% to 90% of the final value	0.01		10	ms	1
POWER-ON RESET						
Supply Ramp Time (T_{RAMP})	Valid power-on RESET	0.01		10	ms	1
Start-up time for register read/write	From power-up			200	ms	1
DIGITAL INPUTS (MOSI, NCS, SCLK, RESETN)						
V_{IH}, High-Level Input Voltage		0.55*VDD		VDD+0.3	V	1
V_{IL}, Low-Level Input Voltage		-0.3		0.3*VDD	V	
RESETN Pulse Width (T_{RESETN})		1			µs	2
DIGITAL OUTPUT (MISO)						
V_{OH}, High- Level Output Voltage	Iout=-1 mA	VDD-0.5		VDD+0.3	V	1
V_{OL1}, Low-Level Output Voltage	Iout=1 mA			0.5	V	

Table 7. A.C. Electrical Characteristics

Notes:

1. Derived from validation or characterization of parts, not guaranteed in production.
2. These values are based on simulation. They are not covered by production test limits or characterization

3.5 SPI TIMING CHARACTERIZATION

Typical Operating Circuit of section 4.2, VDD = 3.3V, T_A=25°C, unless otherwise noted.

PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNITS
SPI TIMING					
f_{SCLK}, SCLK Clock Frequency		4	6	12	MHz
t_{LOW}, SCLK Low Period		60			ns
t_{HIGH}, SCLK High Period		60			ns
$t_{SU;CS}$, $\overline{CS}$ Setup Time		75			ns
$t_{HD;CS}$, $\overline{CS}$ Hold Time		75			ns
$t_{SU;SDI}$, MOSI (SDI) Setup Time		9			ns
$t_{HD;SDI}$, MOSI (SDI) Hold Time		9			ns
$t_{VD;SDO}$, MISO (SDO) Valid Time	C_{load} = 20 pF			40	ns
$t_{HD;SDO}$, MISO (SDO) Hold Time	C_{load} = 20 pF	6			ns
$t_{DIS;SDO}$, MISO (SDO) Output Disable Time				20	ns
t_{Fall}, SCLK Fall Time			3	8	ns
t_{Rise}, SCLK Rise Time			3	8	ns

Table 8. SPI Timing Characteristics

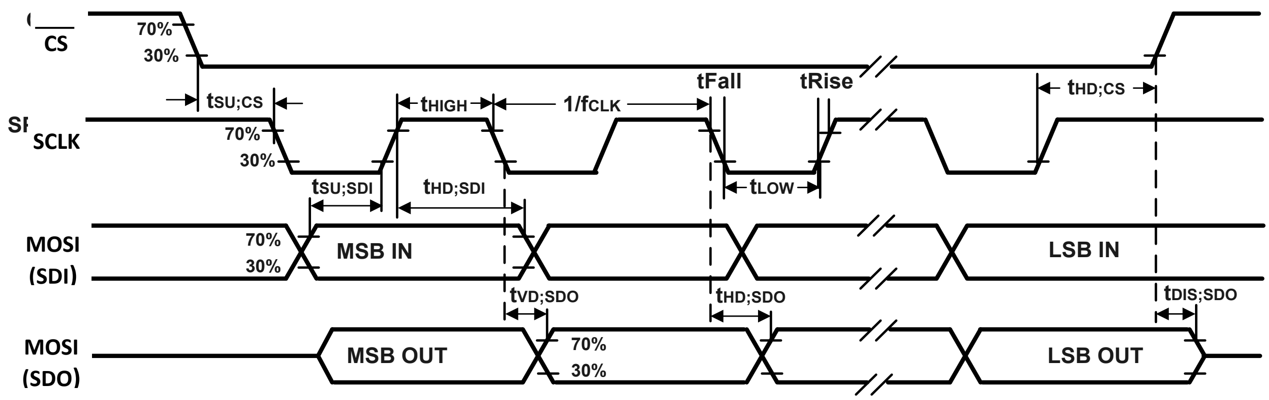


Figure 1. SPI Bus Timing Diagram

3.6 ABSOLUTE MAXIMUM RATINGS

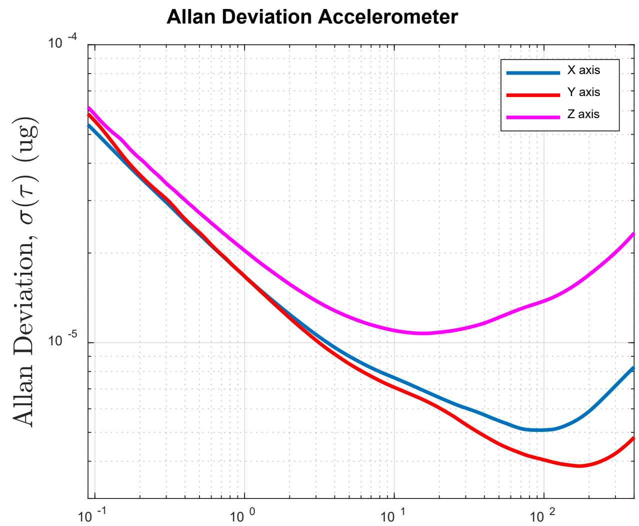
Stress above those listed as "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these conditions is not implied. Exposure to the absolute maximum ratings conditions for extended periods may affect device reliability.

PARAMETER	RATING
Supply Voltage, VDD	3.0V MIN, 3.8V MAX
Input Voltage Level (MOSI, $\overline{CS}$, SCLK, PPS)	MIN= GND-0.5V; MAX = VDD + 0.5V
Acceleration (Any Axis, unpowered)	2000g
Operating Temperature Range	-40°C to 85°C
Storage Temperature Range	-40°C to 125°C
Electrostatic Discharge (ESD) Protection	2 kV (HBM) 500V (CDM)
Latch-up	JEDEC Class II (2),125°C

Table 9. Absolute Maximum Ratings

3.7 IIM-46234 REPRESENTATIVE PERFORMANCE CHARACTERISTICS

The figures in this section provide representative gyroscope and accelerometer performance characteristics of the IIM-46234. Please refer to Table 1 and Table 2 for the performance specificiations.



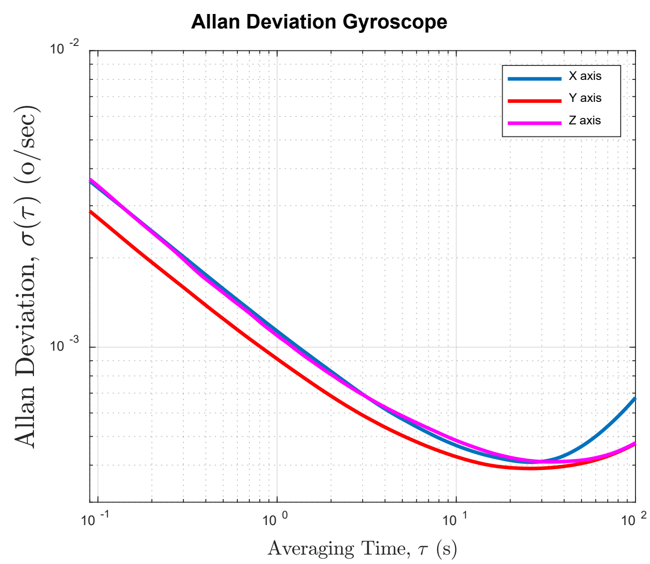


Figure 2. IIM-46234 Allan Variance

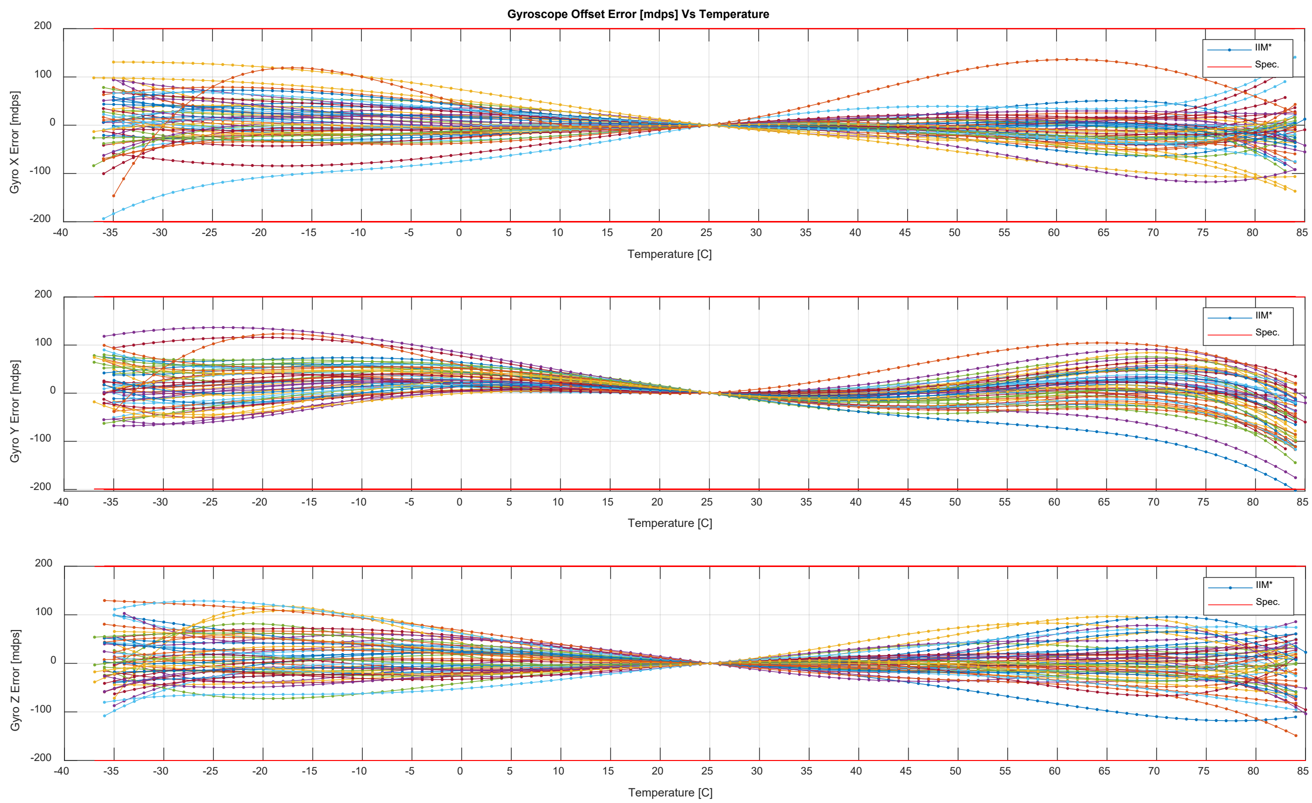


Figure 3. IIM-46234 Gyroscope offset variation over temperature

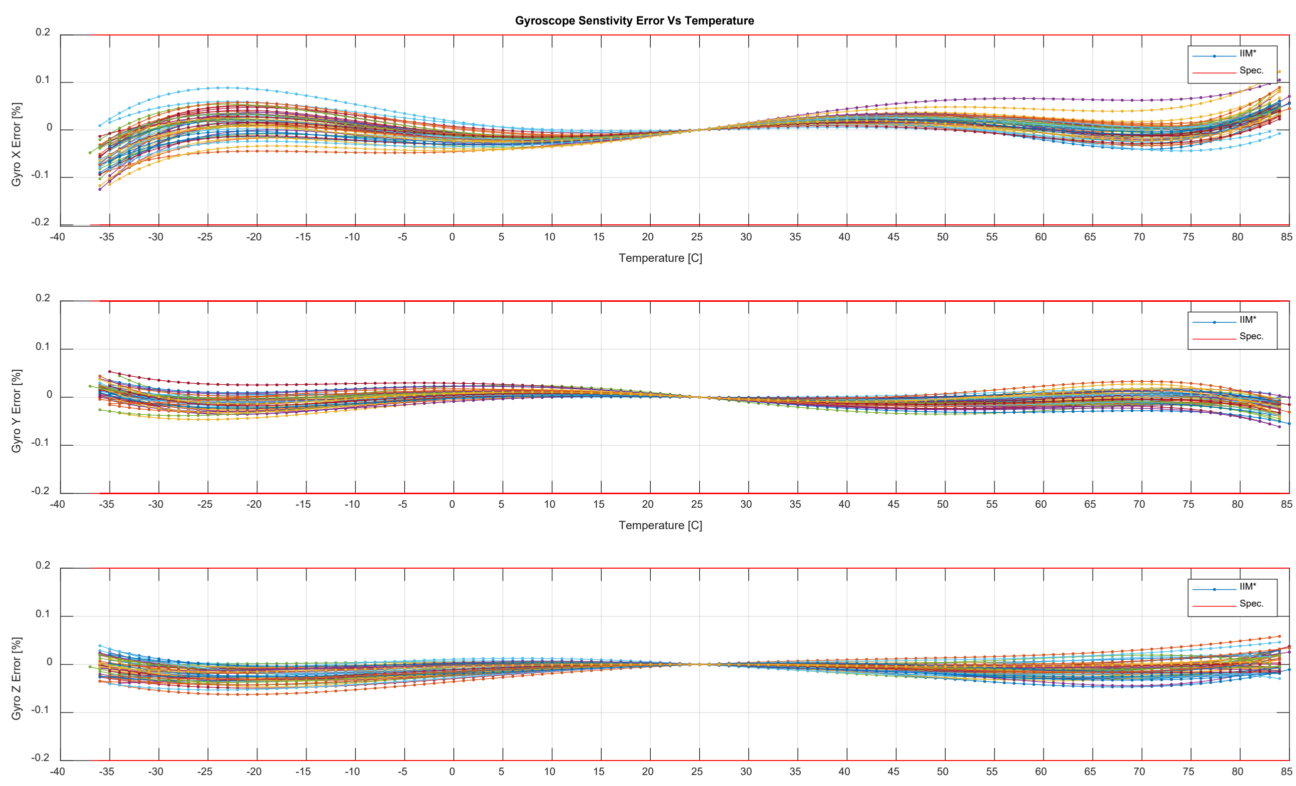


Figure 4. IIM-46234 Gyroscope Sensitivity variation over temperature

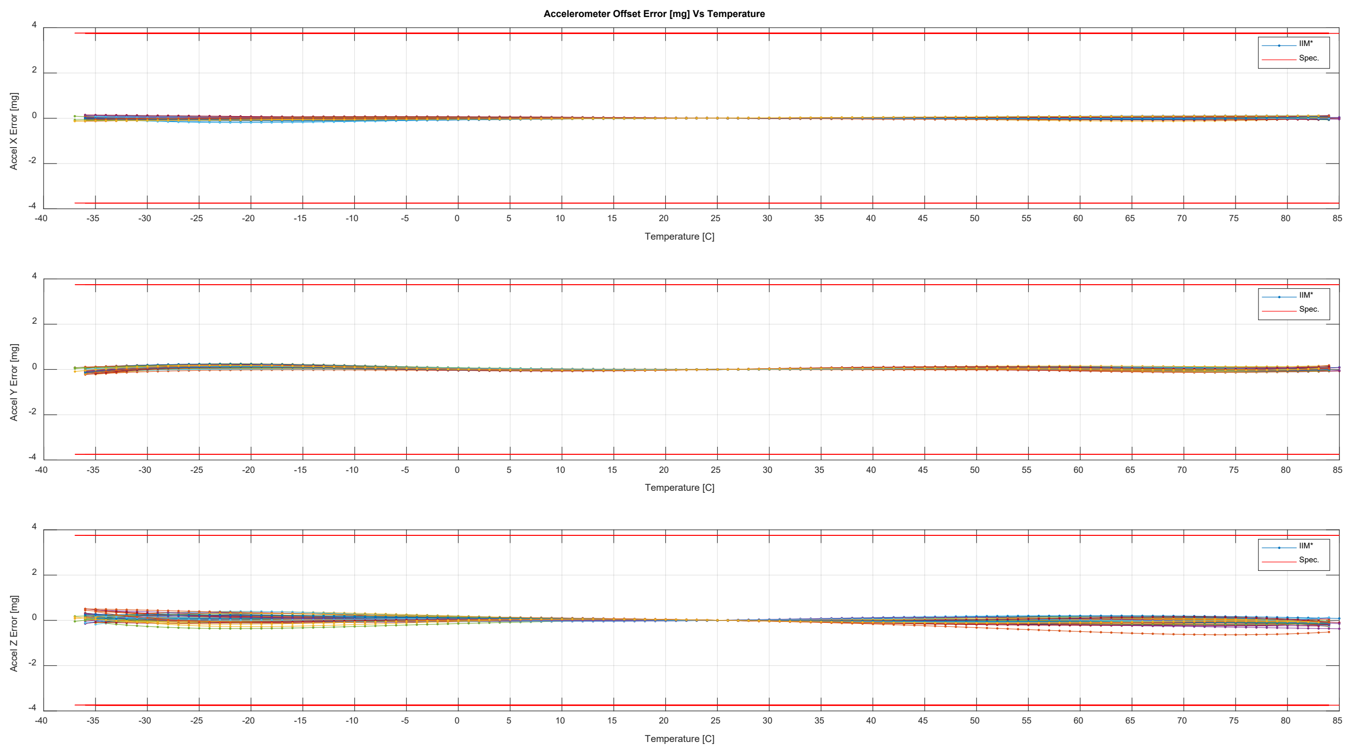


Figure 5. IIM-46234 Accelerometer offset variation over temperature

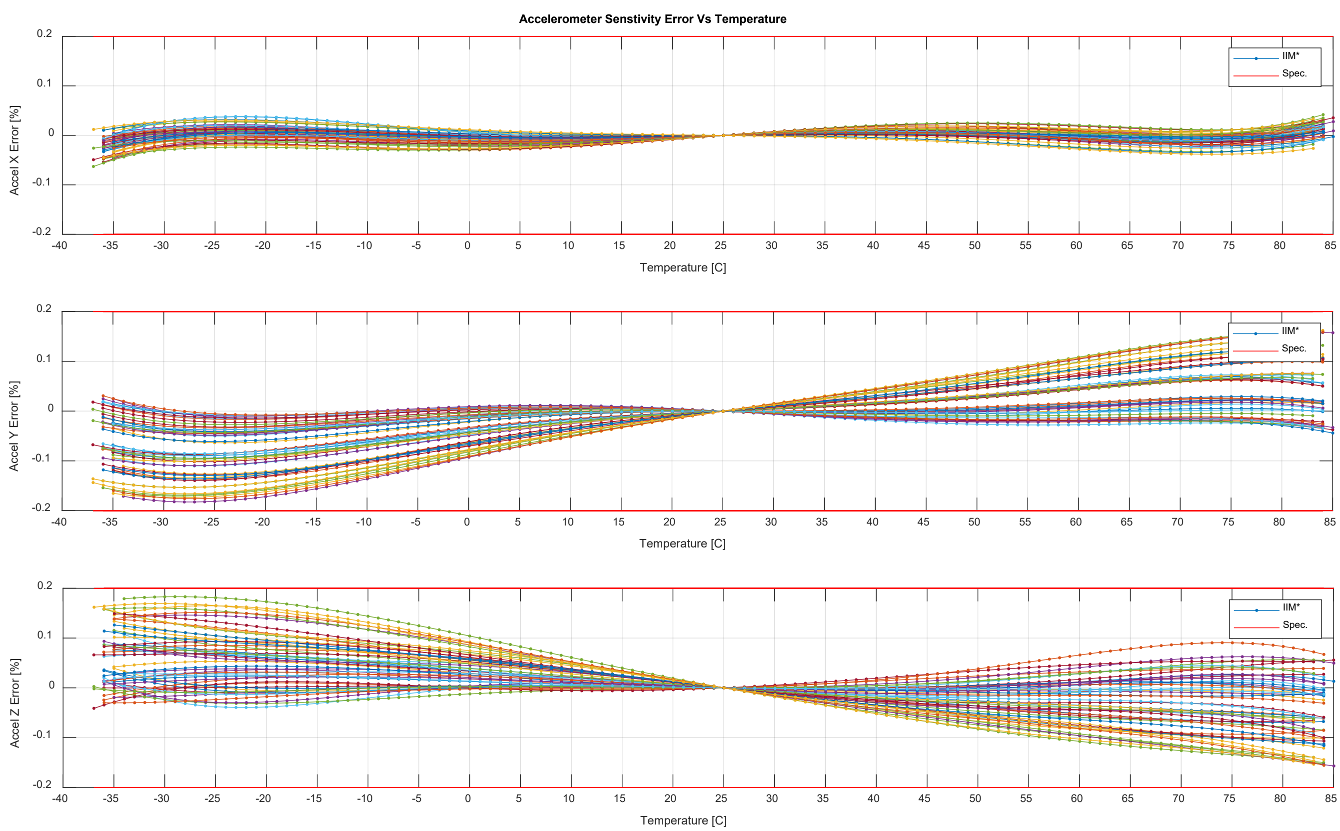
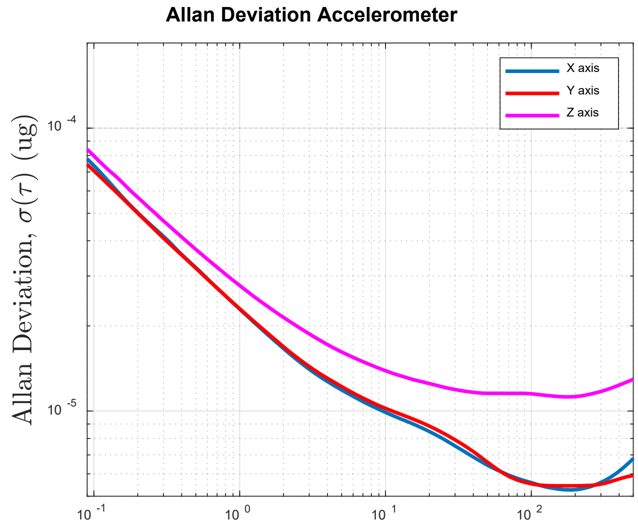


Figure 6. IIM-46234 Accelerometer Sensitivity variation over temperature

3.8 IIM-46230 REPRESENTATIVE PERFORMANCE CHARACTERISTICS

The figures in this section provide representative gyroscope and accelerometer performance characteristics of the IIM-46230. Please refer to Table 1 and Table 2 for the performance specificiations.



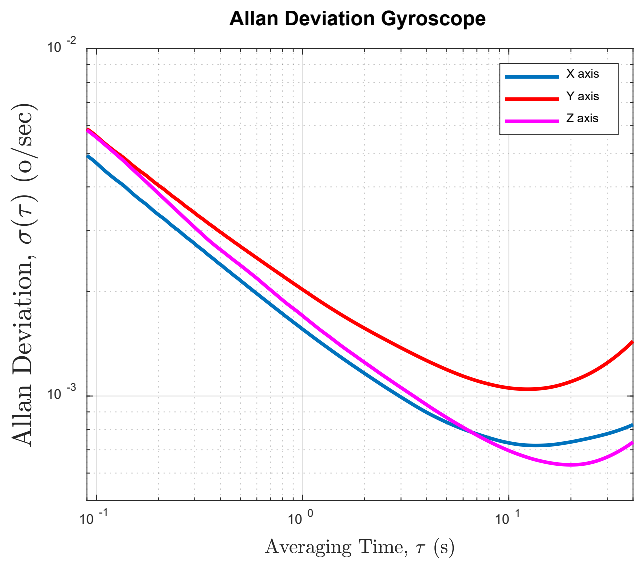


Figure 7. IIM-46230 Allan Variance

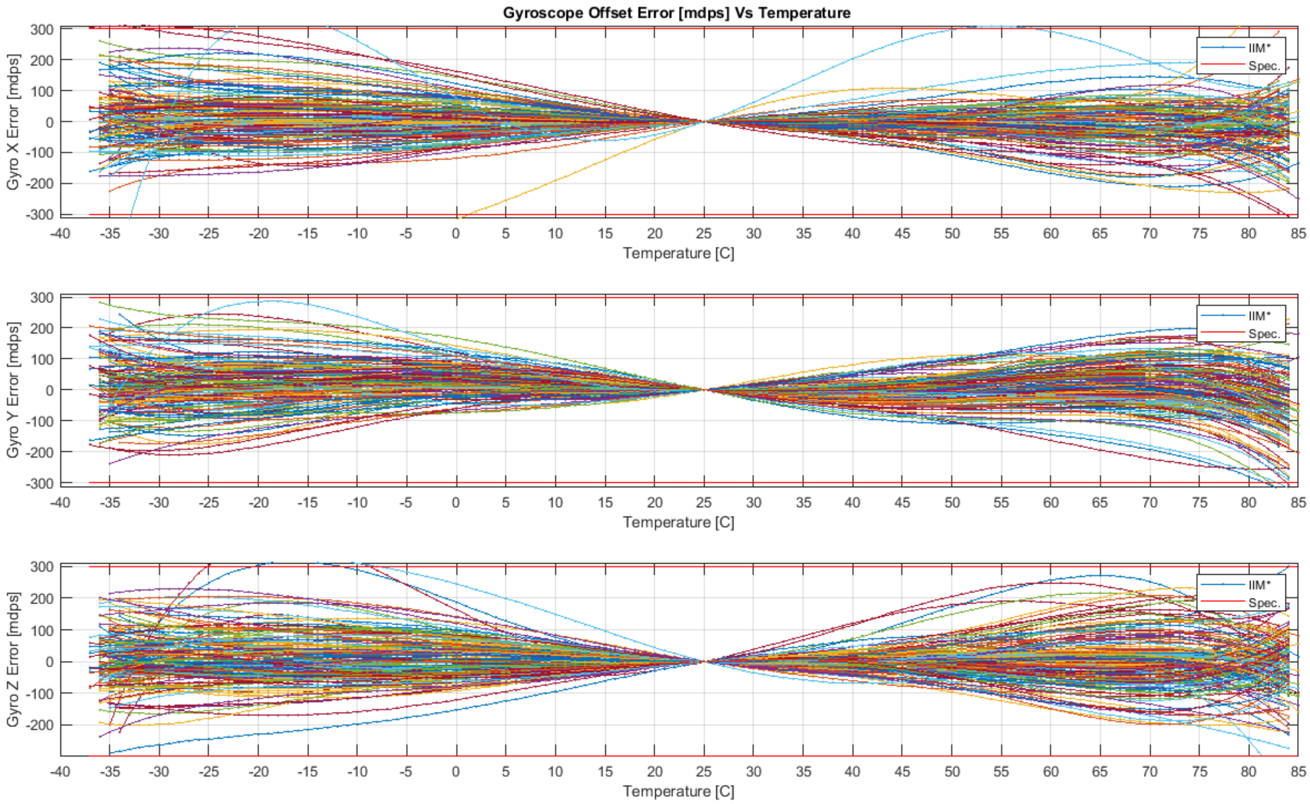


Figure 8. IIM-46230 Gyroscope offset variation over temperature

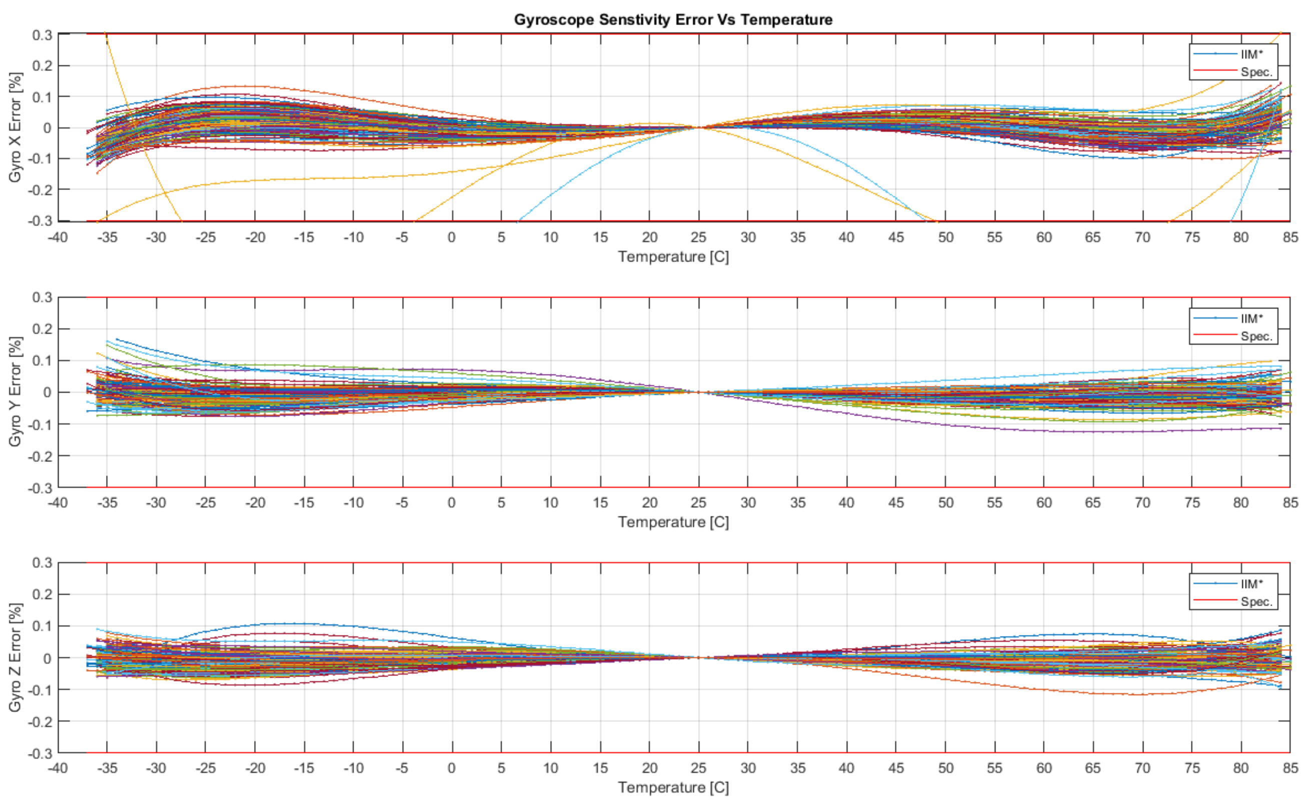


Figure 9. IIM-46230 Gyroscope sensitivity variation over temperature

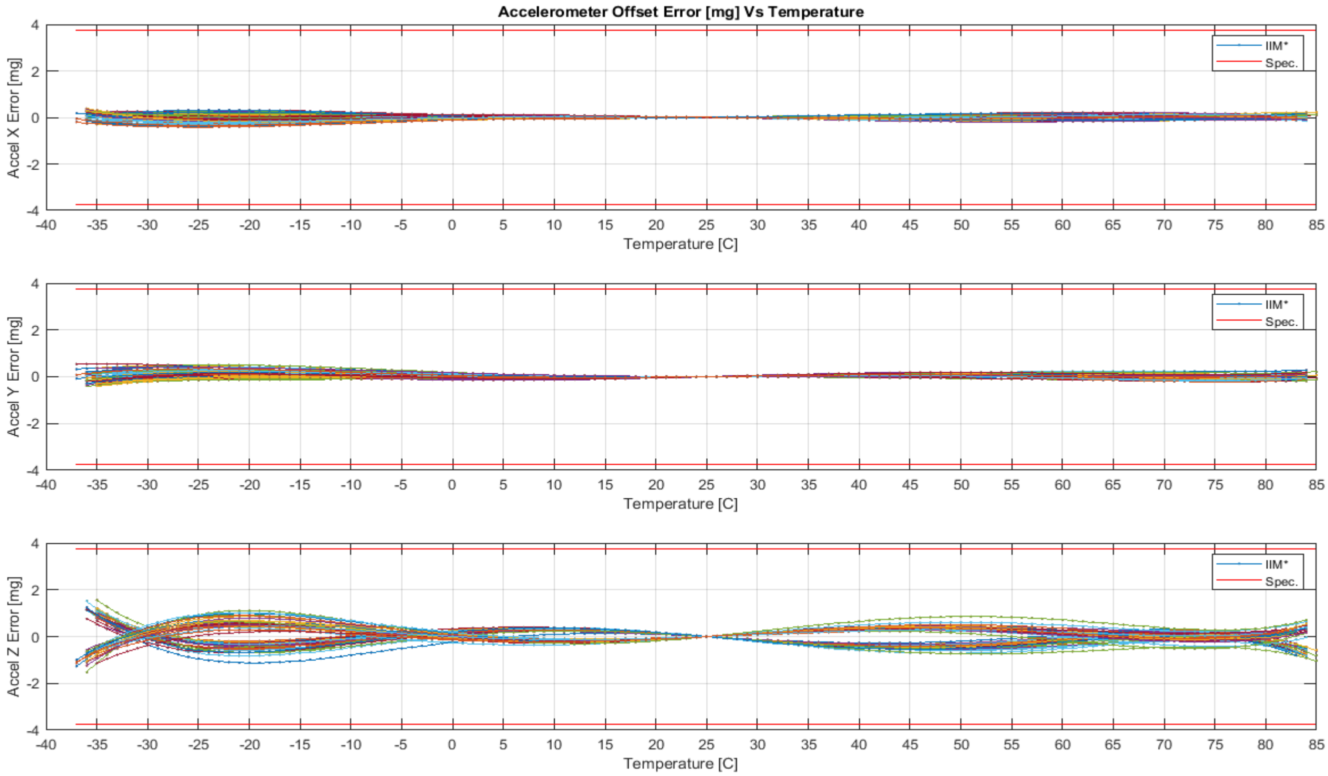


Figure 10. IIM-46230 Accelerometer offset variation over temperature

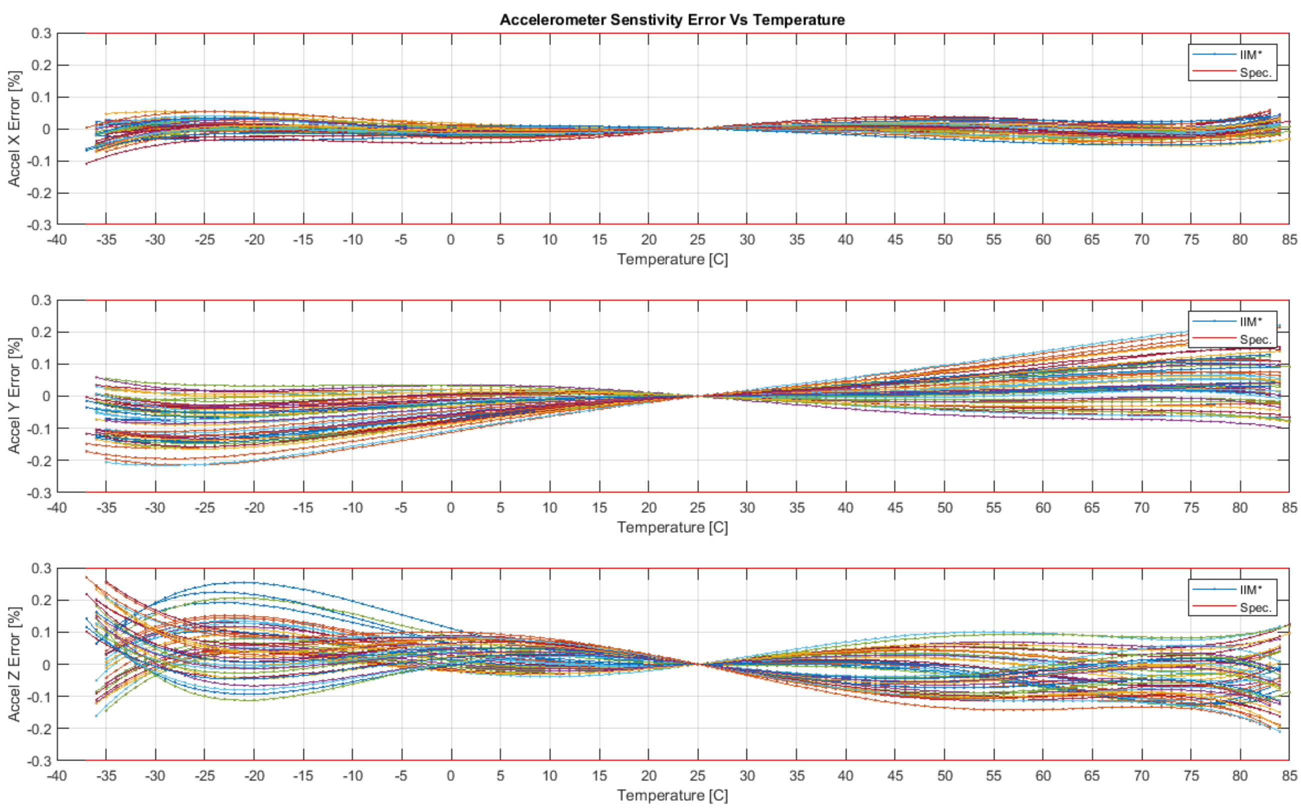


Figure 11. IIM-46230 Accelerometer sensitivity variation over temperature

4 APPLICATIONS INFORMATION

4.1 IIM-46234 & IIM-46230 PINOUT DIAGRAM AND SIGNAL DESCRIPTION

PIN NUMBER	PIN NAME	PIN DESCRIPTION
2	MOSI	Connect to host SPI MOSI pin
4	SCLK	Connect to host SPI SCLK pin
6	MISO	Connect to host SPI MISO pin
8	$\overline{CS}$	Connect to host $\overline{CS}$ pin and is active low
10	RX	Connect to host TX pin of UART interface
12	TX	Connect to host RX pin of UART interface
14	DRDY	Data ready pin
16	PPS	Input PPS; if unused, connect to GND
18	$\overline{RESET}$	Connect to host GPIO, active low to high will invoke a reset
1	VDD	Connect to 3.3V supply voltage
3, 5, 7, 9, 11, 15, 20	RSRVD	Reserved. Leave floating
17	RSRVD	This output pin is internally connected to GND. This pin can be used for detecting the presence of this device. If detection is not required, leave this pin as floating.
19	GND	Connect to ground

Table 10. Pin Descriptions

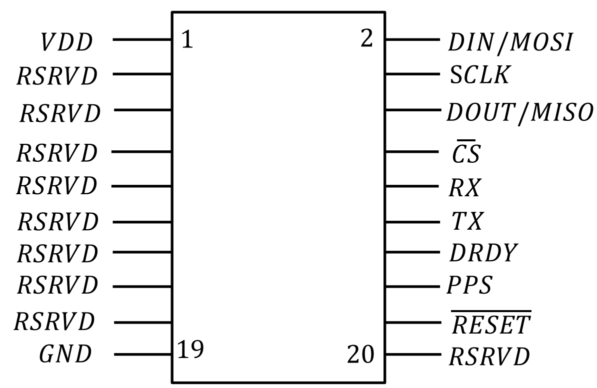


Figure 12. Pin Out Diagram for IIM-46234 & IIM-46230 23 mm x 23 mm x 8.5 mm module with 20-pin connector

4.2 TYPICAL OPERATING CIRCUIT

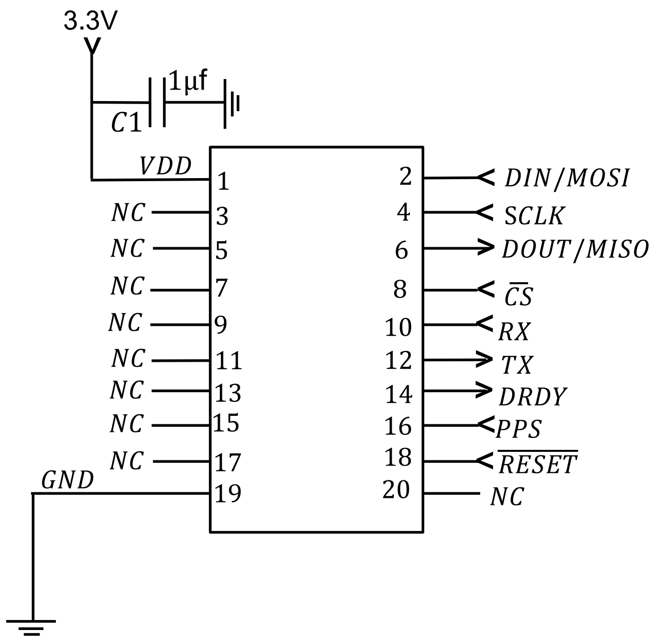


Figure 13. IIM-46234 & IIM-46230 Application Schematic

4.3 BILL OF MATERIALS FOR EXTERNAL COMPONENTS

COMPONENT	LABEL	SPECIFICATION	QUANTITY
VDD Bypass Capacitors	C1	X7R, 1 uF ±10%	1
Screw	M1.6	Steel	2
Nut	M1.6	Steel	2
Mating connector	CLM-110-02-H-D-P-TR-ND	Samtec connector	1
Alignment pin	91585A062 or 91585A062	McMaster, 1 mm dowel pins 8 mm in length	2

Table 11. Bill of Materials

4.4 BLOCK DIAGRAM

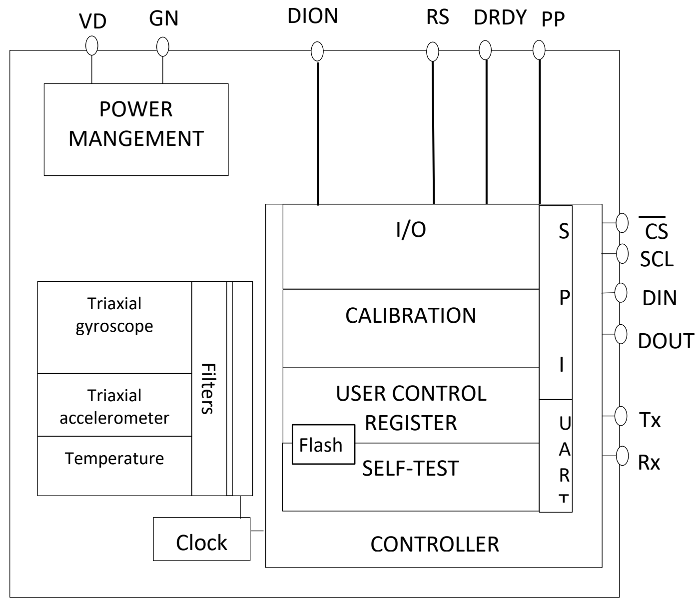


Figure 14. IIM-46234 & IIM-46230 Block Diagram

4.5 OVERVIEW

The IIM-46234 & IIM-46230 are comprised of the following key blocks and functions:

- Three-axis MEMS rate gyroscope sensor with ADCs and signal conditioning
- Three-axis MEMS accelerometer sensor with ADCs and signal conditioning
- Digital-Output Temperature Sensor
- UART and SPI serial communications interface
- Self-Test
- Clocking
- User Control Registers

4.6 THREE-AXIS MEMS GYROSCOPE WITH ADCS AND SIGNAL CONDITIONING

The IIM-46234 & IIM-46230 gyroscope detects rotation about the X-, Y-, and Z- axes. When the gyroscope is rotated about any of the sense axes, the Coriolis Effect causes a vibration that is detected by a capacitive pickoff. The resulting signal is amplified, demodulated, and filtered to produce a voltage that is proportional to the angular rate. This voltage is digitized using on-chip Analog-to-Digital Converters (ADCs) to sample each axis. The full-scale range of the gyroscope digital output is up to ±480(IIM-46234) & ±2000(IIM-46230) degrees per second (dps). The output rate is programmable from 1000 samples per second, down to 10 samples per second, and user-selectable low-pass filters enable a wide range of cut-off frequencies.

4.7 THREE-AXIS MEMS ACCELEROMETER WITH ADCS AND SIGNAL CONDITIONING

The IIM-46234 & IIM-46230 accelerometer detects linear movements in the X-, Y-, and Z- axes. The accelerometer uses separate proof masses for each axis. Acceleration along a particular axis induces displacement on the corresponding proof mass, and capacitive sensors detect the displacement differentially. When the device is placed on a flat surface, it will measure 0*g* on the X- and Y-axes and +1*g* on the Z-axis. The full-scale range of the accelerometer digital output is up to ±8*g*.

4.8 DIGITAL-OUTPUT TEMPERATURE SENSOR

An on-chip temperature sensor is used to measure the IIM-46234 & IIM-46230 internal temperature.

4.9 UART AND SPI SERIAL COMMUNICATION INTERFACES

The IIM-46234 & IIM-46230 communicate to a system processor using either a SPI or UART interface. These sensors always act as a slave when communicating to the system processor.

DRDY interrupt is triggered when new data is available to be read.

4.10 FAULT TOLERANCE AND EARLY WARNING (SENSORFT™), SUPPORTED IN FIRMWARE >3.10

The SensorFT™ feature uses TDK proprietary fault detection and recovery algorithm to deliver built-in redundancy and early warning capabilities. The IIM-46234 & IIM-46230 module continuously monitors the module performance, i.e. the quality of the accelerometer and gyroscope measurement output of the module. The module automatically tries to recover when it detects performance degradation. The built-in redundancy may be able to recover the module to a full performance or a partial performance level.

The current performance level is made available to the user as 3-bit status with each accelerometer measurement and 5-bit status with each gyroscope measurement. The status bits represent the following:

- 0x0 – the accelerometer or gyroscope output is reliable (either no failure has occurred, or the module was able to recover from a failure without impacting its performance)
- 0x7 (for accelerometer status)– the accelerometer output is not reliable
- 0x1F (for gyroscope status) – the gyroscope output is not reliable
- Any other value – the accelerometer or gyroscope output is partially reliable (This should be considered as early warning of a complete failure in the future).

The Sensor can be configured using the following commands in sections 5.3.4.10 & 5.3.4.11

4.11 SELF-TEST

Self-test can be used to test the mechanical and electrical portions of the sensors when the module is at no motion state. Self-test failure may be reported for a good IMU if it is executed while the IMU is in motion.

When the self-test is activated, the electronics causes the sensors to be actuated and produce an output signal. When the value of the self-test response signal is within the specified limits, the part has passed self-test. When the self-test response exceeds the specified limits, the part is deemed to have failed self-test.

IMU Self-Test Result (section 5.3.4.5) will return six bytes. Self-test pass is indicated by a 0x03 value for each of the six bytes. Any other value is considered a self-test failure. Please note the module may continue to perform as expected even after self-test fails, due to the SensorFT (built-in redundancy) feature. A self-test failure either indicates an issue with the environment where the self-test is conducted or a failure with some part of the module since shipment from the factory.

4.12 CLOCKING

The IIM-46234 & IIM-46230 have an on-chip MEMS oscillator that acts as an internal clock source to be used for the internal synchronous circuitry. This synchronous circuitry includes the signal conditioning, ADCs, and various control circuits and registers.

Users can optionally provide a PPS pulse, which can be used in combination with the SET_UTC_TIME command to update the system time to absolute UTC time sent from host. The timestamp inside the IIM-46234 & IIM-46230 will be stored in UNIX time format. More details on PPS pulse implementation can be found in section 5.4.

4.13 USER REGISTERS

The detailed description of the user registers is found in section 7. These registers can be accessed via the communication interfaces using the protocol described in section 5.3. Certain registers can be backed up in the flash memory so that these values are not lost during power cycling. Section 6 includes information on whether or not flash back up is available for a particular register. The SAVE_ALL_CONFIG register is used to save the register values into flash memory. A maximum of 10,000 writes to the flash memory is allowed during the life of the product. Please refer to the FLASH_ENDURANCE register value to track the number of flash memory write cycles. An error code in the ACK packet corresponding to a register write command will indicate if the number of writes (FLASH_ENDURANCE register value) have exceeded the limit.

5 DIGITAL INTERFACE

The IIM-46234 & IIM-46230 use a Serial Peripheral Interface (SPI) or a universal asynchronous receiver-transmitter (UART) interface to communicate with the host processor. Connection should use either SPI or UART but not both. Connecting both SPI and UART at the same time is not supported and may result in unexpected behavior.

The user registers inside IIM-46234 & IIM-46230 devices are accessed through either SPI or UART using the communication protocol described in section 5.3.

5.1 SERIAL INTERFACE PIN DESCRIPTIONS

The user registers of the IIM-46234 & IIM-46230 can be accessed using a SPI interface. The maximum serial clock rate is 12 MHz, and the minimum serial clock rate is 4 MHz.

PIN NUMBER	PIN NAME	PIN DESCRIPTION
2	DIN/MOSI	Master Output, Slave Input
4	SCLK	Serial Clock
6	DOUT/MISO	Master Input, Slave Output
8	$\overline{CS}$	Chip Select, active low
14	DRDY	Data Ready

Table 12. Serial Interface Pins Description

5.1.1 SPI Interface Operation

SPI is a 4-wire synchronous serial interface that uses two control lines and two data lines. The IIM-46234 & IIM-46230 always operate as a slave device during standard master-slave SPI operation. Using the communication protocol described in section 5.3, the host device can send commands and recieve replies/acknowledgments and streaming data packets over the SPI interface.

A typical master-slave configuration is shown in Figure 15. With respect to the master, MOSI, MISO, and SCLK are shared among the slave devices. Each SPI slave device requires its own Chip Select ($\overline{\text{CS}}$)line from the master. The SPI master must pull the Chip Select line ($\overline{\text{CS}}$) of the desired slave low to initiate a transaction.

$\overline{\text{CS}}$ goes low (active) at the start of transmission and goes back to high (inactive) at the end. Only one chip select line can be active at any given time, ensuring that only one slave is selected at any given time. The $\overline{\text{CS}}$ lines of the non-selected slave devices are held high, causing their MISO lines to remain in a high-impedance (high-Z) state so that they do not interfere with any active devices.

The master and slave prepare data to send via their respective shift registers, while the master generates the serial clock on the SCLK line. Data are always shifted from master to slave on the Master Output Slave Input line (MOSI); data are shifted from slave to master on the Master Input Slave Output line (MISO).

Each time a character is shifted out from the master, a character will be shifted out from the slave simultaneously. To signal the end of a transaction, the master will pull the $\overline{\text{CS}}$ line high.

SPI Operational Features:

1. Data are delivered MSB first and LSB last
2. Data are latched on the rising edge of SCLK
3. Data should be transitioned on the falling edge of SCLK
4. The maximum frequency of SCLK is 12 MHz and the minimum frequency of SCLK is 4 MHz.

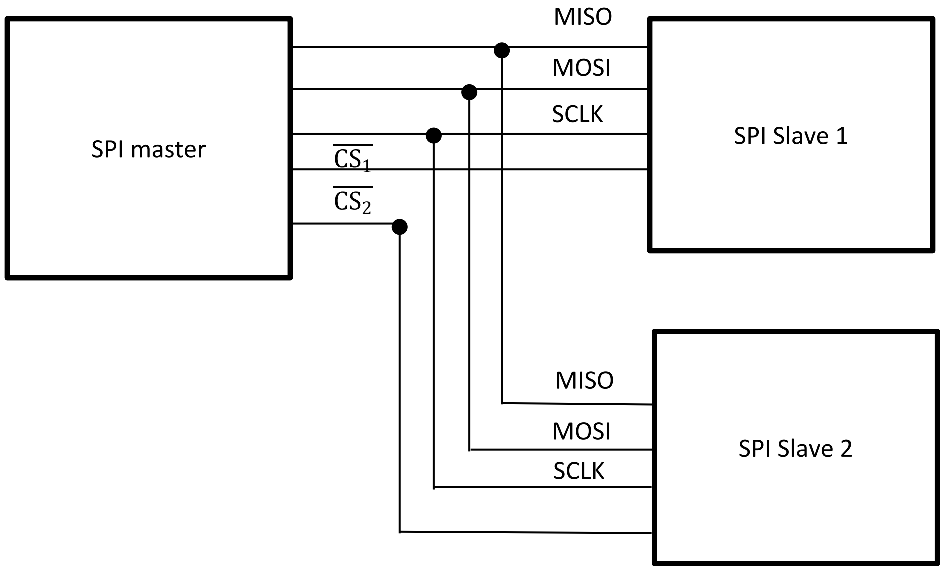


Figure 15. Typical Master/Slave Configuration

OPERATING MODE	DESCRIPTION
SPI Mode 3	CPOL = 1 (polarity), CPHA = 1 (phase)
4 MHz ≤ SCLK ≤ 12 MHz	Maximum of SCLK is 12 MHz Minimum of SCLK is 4 MHz
SPI Slave device	IIM-46234 & IIM-46230 work as SPI Slave devices

Table 13. Serial Interface Operating Mode

The IIM-46234 & IIM-46230 are each configured as a SPI slave device which supports a Serial Clock rate between 4 MHz and 12 MHz in SPI mode 3 (Clock Polarity, CPOL = 1 and Clock Phase, CPHA = 1).

CPOL determines the polarity of the clock.

CPOL=1 is a clock which idles at 1, and each cycle consists of a pulse of 0. That is, the leading edge is a falling edge, and the trailing edge is a rising edge.

CPHA determines the timing of the data bits relative to the clock pulses.

For CPHA=1, the "out" side changes the data on the leading edge of the current clock cycle, while the "in" side captures the data on (or shortly after) the trailing edge of the clock cycle. The “out” side holds the data valid until the leading edge of the following clock cycle. For the last cycle, the slave holds the MISO line valid until the chip select is deasserted.

5.2 UART INTERFACE PIN DESCRIPTIONS

Using the communication protocol described in section 5.3, the IIM-46234 & IIM-46230 devices can recieve commands (RX pin) and transmit responses/acknowledgments and streaming data packets (TX pin) to a host device over the UART interface. The default baud rate of the UART is 921600 baud. It can be set to 2Mbaud or 3Mbaud, using UART_IF_CONFIG register.

PIN NUMBER	PIN NAME	PIN DESCRIPTION
10	RX	Receive
12	TX	Transmit
14	DRDY	Data Ready

Table 14. UART Pins Description

SETTINGS	DESCRIPTION
N,8,1	No parity, 8 bits data, 1 stop bit
Baud rate: 921600 or 2000000 or 3000000	Default baud rate is 921600. The baud rate depends on the UART_IF_CONFIG register.

Table 15. UART Interface Settings

5.3 COMMUNICATION PROTOCOL

IIM-46234 & IIM-46230 have two operational modes – command mode and streaming mode. Figure 16 shows possible transition paths between different modes of the device.

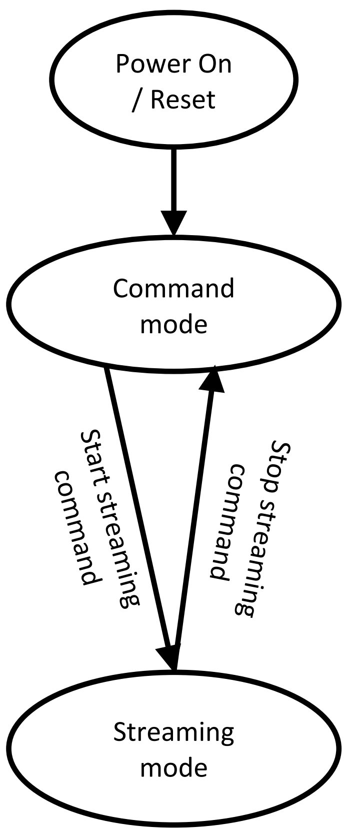


Figure 16. Transition diagram between various modes of operation

The device by default enters the command mode after it is power-recycled or reset. When a host device sends the "start streaming" command, IIM-46234 & IIM-46230 will enter streaming mode. In streaming mode, these IMUs will stream raw data in the pre-defined packet format. "Stop streaming" command can be sent to stop the streaming mode and return to the command mode. Reading and Writing the User Register is only available in the command mode.

The rest of this section describes the protocol used to communicate with IIM-46234 & IIM-46230, and how to assemble command packets and the corresponding responses.

5.3.1 Command mode and Streaming mode details

5.3.1.1 Command mode

In command mode, half-duplex communication is used because a response from the IIM-46234 & IIM-46230 can be prepared after parsing the request from the host.

In commands mode, the following commands are available:

i. Get Version command
ii. Get Serial Number command
iii. Read User Register command
iv. Write User Register command
v. Self-Test command
vi. Set UTC Time command
vii. Select Streaming Interface command
viii. Start Streaming command

5.3.1.2 Streaming mode

In streaming mode, full-duplex communication is used for transmitting IMU data. While streaming data, the host can send only two commands to the IIM-46234 & IIM-46230:

i. Stop Streaming command
ii. Set UTC Time command

5.3.1.3 Buffering in Streaming mode

Both IIM-46234 & IIM-46230 support the streaming of sensor data with the streaming mode.

In Streaming mode, these IMUs put the sensor data into the queue buffer according to the ODR (Output Data Rate). For example, with an ODR setting of 1 kHz, the sensor output data is added to the queue every 1 ms. Similarly, with an ODR setting of 100 Hz, the sensor output data is added to the queue every 10 ms.

In the queue buffer, the first data added to the queue will be the first one to be removed.

There are 40 buffers in the queue of IIM-46234 & IIM-46230. If the buffer is full when new data is ready, the oldest data in the queue buffer will be deleted so that the new data can be added.

Host device should retrieve the data from the queue buffer of IIM-46234 & IIM-46230 before it is deleted/discarded.

5.3.1.4 Timing of DRDY signal (SPI) in Command and Streaming mode

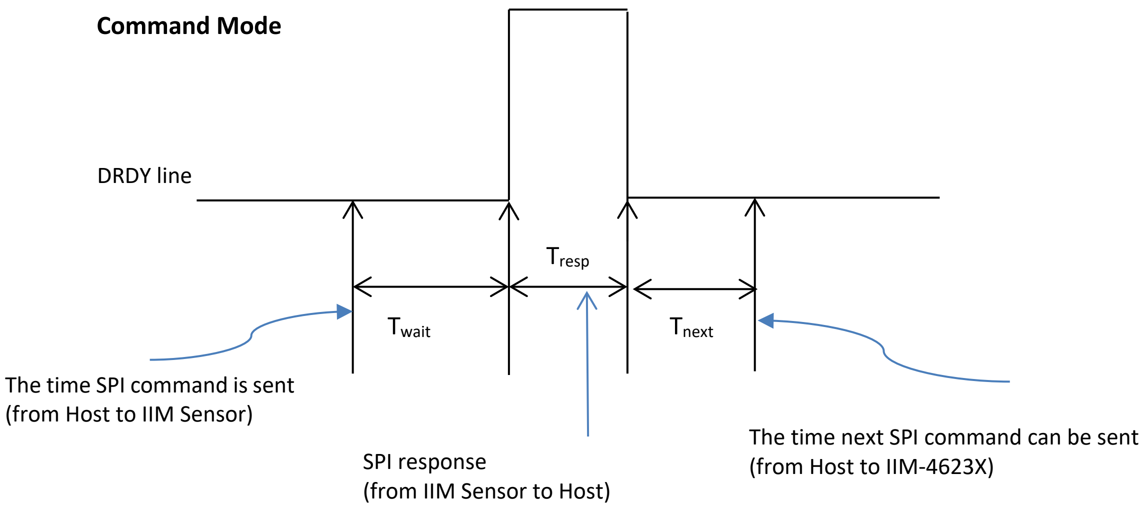


Figure 17. Command mode timing requirements

Mode	Parameter	Value (ms) In case f_{SPI} is 6 MHz	Remarks
Command	T_{wait}	0.6 ms for Start Streaming command. 5803 ms for Self-Test command. 0.05 ms for other commands	Minimum time before DRDY is high after command received.
Command	T_{resp}	0.05 ms for 20 bytes response. Max 20 ms in case of Timeout	Response duration. This duration depends on the total length of response. (Time out will happen if no response from Host)
Command	T_{next}	0.3 ms	Minimum time before Next command can be sent

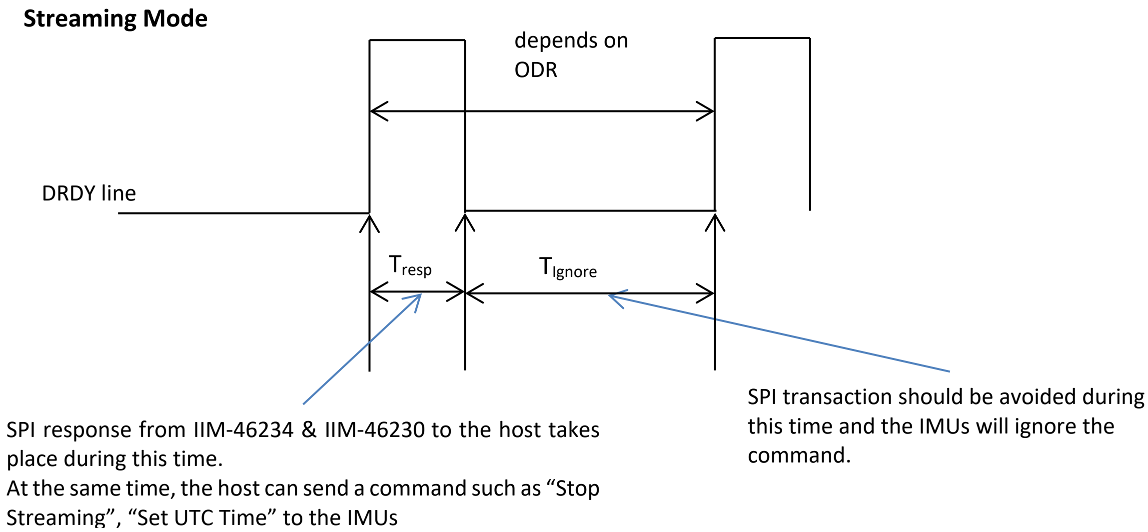


Figure 18. Streaming mode timing requirements

Mode	Parameter	Value (ms) In case f_{SPI} is 6 MHz	Remarks
Streaming	T_{resp}	0.15 ms for 46 bytes response. Max 20 ms in case of Timeout	Response duration. This duration depends on the total length of response. (Time out will happen if no response from the host)
Streaming	T_{Ignore}	1 ms - T_{resp} for 1 kHz ODR	Time until DRDY line is high after T_{resp} During this time, IIM-46234 & IIM-46230 ignores the incoming SPI command.

- T_{resp} timeout would occur if the host does not read the data within the limited time of DRDY. This limited time in streaming mode vary depending on the ODR setting. "1 ms * 20" in case of 1 kHz ODR and "1/ODR* 10" in case of other ODRs less than 1 kHz. For example, 20 ms for 1 kHz ODR, 100 ms for 100 Hz ODR, 1000 ms for 10 Hz ODR.

5.3.2 Command mode communications

When a COMMAND is sent to the IIM-46234 & IIM-46230, the devices reply with either an ACK or a RESPONSE packet. The RESPONSE packet has data when the host is requesting for information, while ACK is an acknowledgment (ACK) indicating the status of data transfer with a success or error code. Note that RESPONSE or ACK packets are not sent for Set UTC Time, Start Streaming and Stop streaming commands.

5.3.2.1 General Packet Structure

Each packet being sent or received by IIM-46234 & IIM-46230 has six sections: Header, Length, Packet Type, Check Sum, and Footer. Payload section is packet specific and may not be present for some packets.

Header: It is either $$ or ##, ("0x24, 0x24" or "0x23, 0x23" in hexadecimal notation) depending on whether it is a command (i.e. the host is sending the packet to the IMUs) or a response/acknowledgement (i.e. the host is receiving the packet from the IMUs)

Length: It is the length of the total packet including all the bytes in the packet

Type: This defines the process/functionality to which this packet belongs

Packet number: The IIM-46234 & IIM-46230 responses have an additional packet number to help identify any missing packets. The number will increment up to 65535 and roll back to 0 and continue in this loop.

Payload: The payload is all the data between type & checksum. Payload excludes Header, Length, Type, Check Sum and Footer. This is the information packet and may not be present for some packets. Note that Payload will not be present when Length is 8.

Checksum: Sum of all bytes comprising of packet type and payload

Footer: \r\n (in hex 0x0D, 0x0A), it marks the end of a packet

COMMAND						
Format	**Header**	**Length**	**Type**	**Payload**	**Check Sum**	**Footer**
Bytes	2	1	1		2	2
In Hex	0x24,0x24		-			0x0D,0x0A

COMMAND RESPONSE							
Format	**Header**	**Length**	**Type**	**Packet number**	**Payload**	**Check Sum**	**Footer**
Bytes	2	1	1	2		2	2
In Hex	0x23,0x23		-				0x0D,0x0A

5.3.2.2 Packet Padding

Each packet being sent to the IMUs must be of a length of 20 bytes. When the packet size is smaller than 20 bytes, it should be padded with ZEROS at the end (after the footer).

5.3.2.3 ACK Packet

The table below shows the ACK packet. Below is the description of fields present in the ACK packet.

1. TYPE: Command Type ID for which acknowledgement is being sent.
2. ERROR_CODE: Indicates success or failure for the command.

Note, the ACK packet does not have a packet number field.

COMMAND ACKNOWLEDGEMENT							
Format	**Header**	**Length**	**Type**	**Error Code**	**Reserved**	**Check Sum**	**Footer**
Bytes	2	1	1	1	1	2	2
In Hex	0x23,0x23	0x0A	<Command-Type>	0 – Success 1-255 – Error			0x0D,0x0A

The table below shows the description of Error code values in the ACK packet.

ERROR CODE IN ACK PACKET	DESCRIPTION
1	Negative Acknowledgement which means unsupported command type or unsupported page ID.
2	Error in writing to IIM-46234 & IIM-46230
3	Error in reading from IIM-46234 & IIM-46230
4	Unsupported argument is included the command
5	Reserved
6	Error in writing to the Flash memory
7	Error in reading from the Flash memory
8 to 9	Reserved
10	Wrong command for writing to user Register
11	Wrong command for reading from user Register
12	FLASH_ENDURANCE register value exceeded the limit
13 to 255	Reserved

5.3.3 Streaming mode communications

In streaming mode, IIM-46234 & IIM-46230 will stream sensor output data in the packet format shown below.

Data Stream									
Format	Header	Length	Type	Sensor Satus	Sample Counter	Time Stamp	Data	Check Sum	Footer
Bytes	2	1	1	1	1	8	Up to 52 bytes	2	2
Value	0x23,0x23	0x2E	0xAB						0x0D,0x0A

Sensor Status indicates the status of accelerometer and gyroscope output. The 1byte Sensor Status is comprised of 3 bits of accelerometer status and 5-bits of gyroscope status.

The 3 bits from MSB (Most Significant Bit) indicate the accelerometer status while the other 5 bits from LSB (Least Significant Bit) incidcates the gyroscope status.

Status of accelerometer output

000: Reliable output

001 to 110: Partially reliable output (i.e. this should be treated as an early warning)

111: Unreliable output

Status of gyroscope output

00000: Reliable output

00001 to 11110: Partially reliable output (i.e. this should be treated as an early warning)

11111: Unreliable output

Data Steam packet has a Sample Counter to help understand any missing packets. The number will increment up to 255 and roll back to 0 and continue in this loop.

The presence or absence of fields in the IIM-46234 & IIM-46230 data is configurable by configuring SELECT_OUT_DATA register. For details of the register, please refer to section 7.7 of this document.

When all fields are enabled by setting SELECT_OUT_DATA=0x1F, the IIM-46234 & IIM-46230 data will be formatted as shown below:

Format	Accel X	Accel Y	Accel Z	Gyro X	Gyro Y	Gyro Z	Tempera ture	Delta Velocity X	Delta Velocity Y	Delta Velocity Z	Delta angle X	Delta angle Y	Delta angle Z
Bytes	4	4	4	4	4	4	4	4	4	4	4	4	4

Timestap data is shown in microseconds.

The representation and units of the Accelerometer, Gyro, Temperature, delta angle, and delta velocity value are configurable by OUT_DATA_FORM register (Please refer to section 7.5 for more details).

5.3.4 Command and Response Formats

5.3.4.1 Get Version

The Get Version command is used to query the version of the device. The version is defined by the major and minor version.

Get Version					
Format	**Header**	**Length**	**Type**	**Check Sum**	**Footer**
Bytes	2	1	1	2	2
Value	0x24,0x24	0x08	0x20		0x0D,0x0A

Response packet for the Get Version command has the following structure:

Response to Get Version									
Format	**Header**	**Length**	**Type**	**Packet No.**	**Version Info.**		**Reserved**	**Check Sum**	**Footer**
					Major	**Minor**			
Bytes	2	1	1	2	1	1	8	2	2
Value	0x23, 0x23	0x14	0x20						0x0D, 0x0A

5.3.4.2 Get Serial Number

Get Serial Number will return the serial number (content of the SERIAL_NUM register) which is unique to the specific IIM-46234 & IIM-46230 devices. Please refer to the section 7.2 for more details regarding the SERIAL_NUM register.

Get Serial Number					
Format	**Header**	**Length**	**Type**	**Check Sum**	**Footer**
Bytes	2	1	1	2	2
Value	0x24,0x24	0x08	0x26	0x0026	0x0D,0x0A

Response packet for the Get Serial Number command has the following structure:

Response to Get Serial Number							
Format	**Header**	**Length**	**Type**	**Packet Number**	**Serial Number**	**Check Sum**	**Footer**
Bytes	2	1	1	2	16	2	2
Value	0x23, 0x23	0x1A	0x26				0x0D,0x0A

5.3.4.3 READ USER REGISTERS

The Read User Register command can be used to read one register in the first page whose Page ID is 0 or read several consecutive registers in the 2nd page whose Page ID is 1 from IIM-46234 & IIM-46230 starting from the specified address in the command (Address).

User Register Address shall be a value in the range 0-255 and the Page ID should be in the range 0-4.

Read Length specifies how many bytes are to be read starting from Address.

The RESERVED field is for future use.

Read User Registers									
Format	**Header**	**Length**	**Type**	**RESERVED**	**Read Length**	**Address**	**Page ID**	**Check Sum**	**Footer**
Bytes	2	1	1	1	1	1	1	2	2
Value	0x24,0x24	0x0C	0x11		1-72	0 – 255	0 – 4		0x0D,0x0A

The Response packet for Read User Registers had the following structure:

Response to Read User Registers													
Format	**Header**	**Length**	**Type**	**Packet No.**	**RESERVED**	**Addr**	**Page ID**	**Read Length**	**Err. Code**	**Err. Mask**	**Content of USER Register**	**Check Sum**	**Footer**
Bytes	2	1	1	2	1	1	1	1	1	1	<XX>	2	2
Value	0x23, 0x23	16 + <XX>	0x11			0 to 255	0 – 4						0x0D, 0x0A
<XX> = Read Length													

User Register values are returned in order.

5.3.4.4 WRITE USER REGISTER

Write User Registers can be used to alter the values of one register inside the IIM-46234 & IIM-46230. There will be an ACK (Acknowledgement) packet sent from the IMUs after the register value has been updated.

Write User Register										
Format	**Header**	**Length**	**Type**	**RESERVED**	**Write Length**	**Address**	**Page ID**	**Values**	**Check Sum**	**Footer**
Bytes	2	1	1	1	1	1	1	<YY> : from 1 to 8	2	2
Value	0x24,0x24	12 + <YY> : from 0x0D to 0x14	0x12		1-8	0 – 255	0 – 4	Contents to write		0x0D,0x0A
<YY> = Write Length										

ACK (acknowledgment) packet for Write User Registers had the following structure:

Acknowledgment to Write User Register							
Format	**Header**	**Length**	**Type**	**Error Code**	**Reserved**	**Check Sum**	**Footer**
Bytes	2	1	1	1	1	2	2
In Hex	0x23,0x23	0x0A	<Command-Type>	0: Success 1-255: Error			0x0D,0x0A

5.3.4.5 IMU SELF-TEST

Self-test can be used to test the mechanical and electrical portions of the sensors when the module is at no motion state. Self-test failure may be reported for a good IMU if it is executed while the IMU is in motion.

IMU Self-test will run self-test on the IIM-46234 & IIM-46230 and provide the respoannse in approximately 6 seconds.

IMU Self-Test					
Format	Header	Length	Type	Check Sum	Footer
Bytes	2	1	1	2	2
Value	0x24,0x24	0x08	0x2B	0x00 0x2B	0x0D,0x0A

Response packet for IMU Self-Test has the following structure:

Response to IMU Self-Test							
Format	Header	Length	Type	Packet Number	IMU Self-Test Result (*)	Check Sum	Footer
Bytes	2	1	1	2	6	2	2
Value	0x23,0x23	0x10	0x2B				0x0D,0x0A

(*) - IMU Self-Test Result will report 6 bytes; self-test pass is indicated by 0x03 value for each of the 6 bytes. Any other value is considered a self-test failure. Please note the module may continue to perform as expected even after self-test fails, due to the SensorFT (built-in redundancy) feature. A self-test failure either indicates an issue with the environment where the self-test is conducted or failure with some part of the module since shipment from the factory.

5.3.4.6 SET UTC TIME

SET_UTC_TIME command is used to update the system time to absolute UTC time sent from the host. In command mode, the IIM-46234 & IIM-46230 will send an ACK packet in response to the SET_UTC_TIME command. Please note, the device does not send an ACK packet in streaming mode. The timestamp inside the IMUs will be stored in UNIX format.

SET_UTC_TIME											
Format	Header	Length	Type	Year	Month	Day	HH	MM	SS	Check Sum	Footer
Bytes	2	1	1	2	1	1	1	1	1	2	2
Value	0x24,0x24	0x0F	0x2D								0x0D,0x0A

5.3.4.7 SELECT STREAMING INTERFACE

By default, the SPI slave will be used for streaming data. The UART can be selected for data streaming by using Select Streaming Interface command. The streaming interface cannot be switched during data streaming. An ACK packet will be sent by the IMUs as response to SELECT STREAMING INTERFACE command indicating failure or success.

Select Streaming Interface Command						
Format	Header	Length	Command Type	Interface Type	Check Sum	Footer
Bytes	2	1	1	1	2	2
Value	0x24,0x24	0x09	0x30	1-2		0x0D,0x0A

Interface Type
[1] – UART, [2] – SPI

5.3.4.8 START STREAMING

The IIM-46234 & IIM-46230 support the streaming of sensor data from the device, when the start streaming packet is sent. Please note, the device does not send an ACK packet in response to the Start Streaming command.

The Start Streaming packet is shown in the following table:

Start Streaming					
Format	Header	Length	Type	Check Sum	Footer
Bytes	2	1	1	2	2
Value	0x24,0x24	0x08	0x27	0x00,0x27	0x0D,0x0A

5.3.4.9 STOP STREAMING

The stop streaming packet below can be sent to stop streaming raw data from the IMUs. Note that stop streaming does not have an ACK packet. A 'no' response for more than ODR rate is a good indicator that the STOP sequence is obtained.

Stop Streaming Command					
Format	Header	Length	Command Type	Check Sum	Footer
Bytes	2	1	1	2	2
Value	0x24,0x24	0x08	0x28	0x00 0x28	0x0D,0x0A

5.3.4.10 ENABLE SENSORFT

The ENABLE_SENSORFT command is used to enable the sensorFT™ feature if it has been disabled.

In command mode, the IIM-46234 & IIM-46230 will send an ACK packet in response to the ENABLE_SENSORFT command. Please note, the device does not send an ACK packet in streaming mode.

Enable SensorFT Command					
Format	Header	Length	Command Type	Check Sum	Footer
Bytes	2	1	1	2	2
Value	0x24,0x24	0x08	0x2E	0x00 0x28	0x0D,0x0A

5.3.4.11 DISABLE SENSORFT

The DISABLE_SENSORFT command is used to disable the sensorFT™ feature if it has been enabled.

If the feature is disabled, all accelerometers and gyroscopes will have their status bit set to 0. Accelerometers and gyroscopes will not be automatically switched on or off and the SensorFT analysis will not be run.

In command mode, the IMUs will send an ACK packet in response to the ENABLE_SENSORFT command. Please note, the device does not send an ACK packet in streaming mode.

Enable SensorFT Command					
Format	Header	Length	Command Type	Check Sum	Footer
Bytes	2	1	1	2	2
Value	0x24,0x24	0x08	0x2F	0x00 0x28	0x0D,0x0A

5.4 PPS INTERFACE

One of the value-added features of IIM-46234 & IIM-46230 is their ability to provide timestamps with microsecond level resolution (IMU timestmp) along with each sensor data output. The user can synchronize the IMU timestamps with other sensors or the rest of the system by providing continued 1 PPS pulse from an external source on PIN 16. If unused, PIN-16 should be connected to the system ground. In the absence of PPS pulses, the IMU timestamps will be incremented based on the internal clock of the device. When the user provides a continuous 1 PPS pulse, it helps the IMU timestamp to correct for the clock drift and deviations relative to the rest of the system.

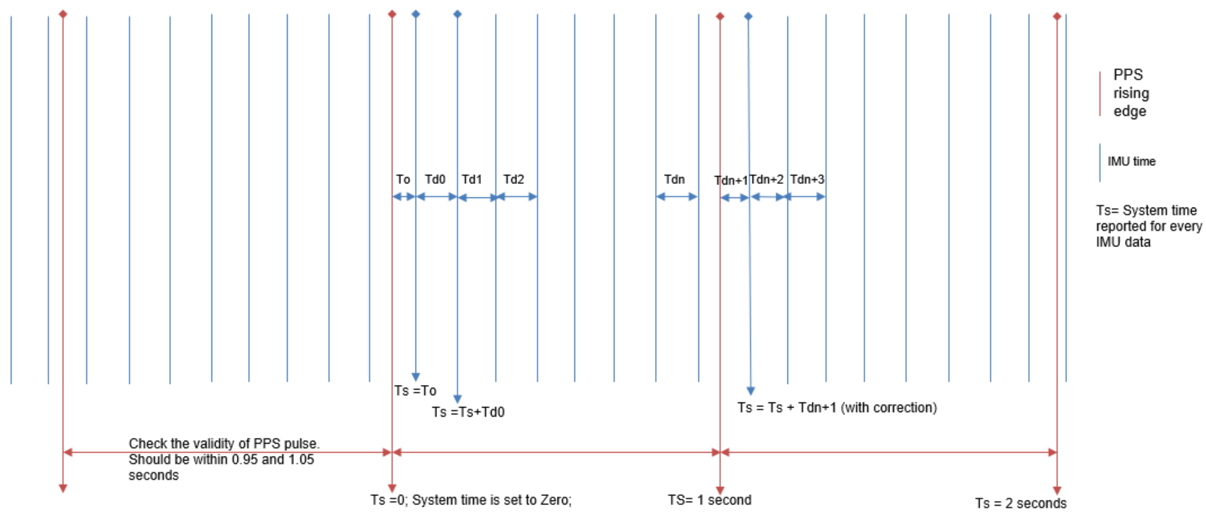


Figure 19. PPS timing diagram

A first valid PPS signal is recognized when the device receives two consecutive pulses separated by a time interval between 0.95 and 1.05 seconds. In Figure 19, Ts represents the system time and is set to zero after the first valid PPS and incremented by 1 second from the next PPS pulse. IMU timestamps are corrected and labelled with respect to the PPS time. If the user provides absolute UTC time by using the SET_UTC_TIME command from the host alongwith a continued PPS pulse from an external source, then the device will update its system time to user provided UTC time in the next valid PPS pulse and increment by 1 second from the next PPS pulse onwards.

The PPS signal should be provided continuously, and two consecutive PPS pulses should be separated by a time interval between 0.95 and 1.05 seconds. If PPS signals are not 1 second apart, it will affect the time stamp reported.

6 REGISTER MAP

Table 16 lists the register map for the IIM-46234 & IIM-46230 devices.

Address (Hex)	Page ID	Register Name	R/W	Flash Backup*	Default value	Register description
0x00	0	WHO_AM_I	R	Yes	0xEA (for IIM-46234 device) 0xE6 (for IIM-46230 device)	Device Identifier
0x01 to 0x10	0	SERIAL_NUM	R	Yes	N/A	Serial number of the IIM-46234 & IIM-46230
0x11 to 0x12	0	FIRMWARE_REV	R	Yes	0x0102 for version 1.2	Device Revision
0x13 to 0x14	0	N/A				RESERVED (for future use)
0x15 to 0x18	0	FLASH_ENDURANCE	R	Yes	0x00000000	Flash memory endurance counter
0x19	0	OUT_DATA_FORM	R/W	Yes	0x00 (for Floating point)	Output Data Format
0x1A to 0x1B	0	SAMPLE_RATE_DIV	R/W	Yes	0x0001	Divisor for averaging the sensor data
0x1C	0	SELECT_OUT_DATA	R/W	Yes	0x07 for enabling Accelerometer & Gyroscope & Temperature data and disabling delta angle & delta velocity data	Output Data Configuration
0x1D	0	UART_IF_CONFIG	R/W	Yes	0x00 for 921600 baud	UART configuration such as Baud Rate
0x1E	0	SYNC_CONFIG	R/W	Yes	0x00 for "Disable Sync mode"	Configuration for synchronization
0x1F to 0x26	0	USER_SCRATCH1	R/W	Yes	N/A	User Scratch Register1
0x27 to 0x2E	0	USER_SCRATCH2	R/W	Yes	N/A	User Scratch Register2
0x2F	0	SAVE_ALL_CONFIG	R/W	Yes	N/A	Save the modified registers in flash memory and then show the result
0x30	0	BW_CONFIG	R/W	Yes	0x44 for 100 Hz bandwidth	Bandwidth for Accel LPF and Gyro LPF
0x31 to 0x32	0	N/A				RESERVED for future use
0x33	0	ACCEL_CONFIG0	R/W	Yes	0x26	User FSR of Accelerometer
0x34	0	GYRO_CONFIG0	R/W	Yes	0x46	User FSR of Gyroscope
0x35 to 0x3E	0	N/A				RESERVED for future use
0x3F	0	EXT_CALIB_CONFIG	R/W	Yes	0x00	Configuration for external bias calibration
0x40 to 0x43	0	EXT_ACCEL_X_BIAS	R/W	Yes	0x00000000	Bias calibration value for accelerometer X-axis
0x44 to 0x47	0	EXT_ACCEL_Y_BIAS	R/W	Yes	0x00000000	Bias calibration value for accelerometer Y-axis
0x48 to 0x4B	0	EXT_ACCEL_Z_BIAS	R/W	Yes	0x00000000	Bias calibration value for accelerometer Z-axis
0x4C to 0x4F	0	EXT_GYRO_X_BIAS	R/W	Yes	0x00000000	Bias calibration value for gyroscope X-axis
0x50 to 0x53	0	EXT_GYRO_Y_BIAS	R/W	Yes	0x00000000	Bias calibration value for gyroscope Y-axis
0x54 to 0x57	0	EXT_GYRO_Z_BIAS	R/W	Yes	0x00000000	Bias calibration value for gyroscope Z-axis
0x58 to 0x5B	0	EXT_ACC_SENS_MAT11	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for accelerometer
0x5C to 0x5F	0	EXT_ACC_SENS_MAT12	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for accelerometer
0x60 to 0x63	0	EXT_ACC_SENS_MAT13	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for accelerometer
0x64 to 0x67	0	EXT_ACC_SENS_MAT21	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for accelerometer
0x68 to 0x6B	0	EXT_ACC_SENS_MAT21	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for accelerometer
0x6C to 0x6F	0	EXT_ACC_SENS_MAT23	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for accelerometer

Address (Hex)	Page ID	Register Name	R/W	Flash Backup*	Default value	Register description
0x70 to 0x73	0	EXT_ACC_SENS_MAT31	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for accelerometer
0x74 to 0x77	0	EXT_ACC_SENS_MAT32	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for accelerometer
0x78 to 0x7B	0	EXT_ACC_SENS_MAT33	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for accelerometer
0x7C to 0x7F	0	EXT_GYR_SENS_MAT11	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for gyroscope
0x80 to 0x83	0	EXT_GYR_SENS_MAT12	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for gyroscope
0x84 to 0x87	0	EXT_GYR_SENS_MAT13	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for gyroscope
0x88 to 0x8B	0	EXT_GYR_SENS_MAT21	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for gyroscope
0x8C to 0x8F	0	EXT_GYR_SENS_MAT21	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for gyroscope
0x90 to 0x93	0	EXT_GYR_SENS_MAT23	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for gyroscope
0x94 to 0x97	0	EXT_GYR_SENS_MAT31	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for gyroscope
0x98 to 0x9B	0	EXT_GYR_SENS_MAT32	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for gyroscope
0x9C to 0x9F	0	EXT_GYR_SENS_MAT33	R/W	Yes	floating-point value for identity matrix element	Sensitivity and Misalignment correction matrix for gyroscope
0xA0 to 0xA3	0	N/A				RESERVED for future use
0xA4 to 0xA7	0	CUSTOM_GRAVITY	R/W	Yes	0x411CCCCD (floating-point value of 9.8)	Custom gravity value for delta velocity computation
0xA8	0	RESET_ALL_CONFIG	R/W	Yes	N/A	Reset all the register values to default (Except UART_IF_CONFIG) and Save those in flash memory and then show the result
0xA9 to 0xFF	0	N/A				RESERVED for future use
0x00	1	SAMPLE_STATUS	R	No	N/A	Sample Status such as the sample_updated_flag
0x01	1	SENSOR_STATUS	R	No	N/A	Current performance level of sensor measurements
0x02	1	SAMPLE_COUNTER	R	No	N/A	Sample Counter
0x03 to 0x0A	1	TIMESTAMP_OUT	R	No	N/A	Timestamp data
0x0B to 0x0E	1	ACCEL_X_OUTPUT	R	No	N/A	Accelerometer X-axis data
0x0F to 0x12	1	ACCEL_Y_OUTPUT	R	No	N/A	Accelerometer Y-axis data
0x13 to 0x16	1	ACCEL_Z_OUTPUT	R	No	N/A	Accelerometer Z-axis data
0x17 to 0x1A	1	GYRO_X_OUTPUT	R	No	N/A	Gyroscope X-axis data
0x1B to 0x1E	1	GYRO_Y_OUTPUT	R	No	N/A	Gyroscope Y-axis data
0x1F to 0x22	1	GYRO_Z_OUTPUT	R	No	N/A	Gyroscope Z-axis data
0x23 to 0x26	1	TEMPERA_OUTPUT	R	No	N/A	Temperature data
0x27 to 0x2A	1	DELTA_VEL _X	R	No	N/A	Delta Velocity X-axis
0x2B to 0x2E	1	DELTA_VEL _Y	R	No	N/A	Delta Velocity Y-axis
0x2F to 0x32	1	DELTA_VEL _Z	R	No	N/A	Delta Velocity Z-axis
0x33 to 0x36	1	DELTA_ANGLE_X	R	No	N/A	Delta Angle X-axis
0x37 to 0x3A	1	DELTA_ANGLE_Y	R	No	N/A	Delta Angle Y-axis
0x3B to 0x3E	1	DELTA_ANGLE_Z	R	No	N/A	Delta Angle Z-axis
0x3F to 0xFF	1	N/A				RESERVED (for future use)

Table 16. Register map

* A maximum of 10,000 writes to the flash memory are allowed during the life of the product. Please refer to the FLASH_ENDURANCE register value to track the number of flash memory write cycles.

7 REGISTER DESCRIPTIONS

This section describes the function and contents of each register in the IIM-46234 & IIM-46230. For accessing its user registers, a COMMAND is sent to these IMUs. The IMUs responds with either an ACK or a RESPONSE packet. The RESPONSE packet has the content of user register, while ACK is an acknowledgment indicating the transfer of data with a success/error code.

7.1 WHO_AM_I

Register Name: WHO_AM_I Address: 0 (0x00), Page ID: 0 Available Operation: Read, Flash backup: Yes, Default value: 234 (0xEA)		
BIT	**NAME**	**FUNCTION**
7:0	DEVICE_ID	Device ID 11101010(0xEA): IIM-46234 device (default) 11100110(0xE6): IIM-46230 device (default) *This register indicates which kind of device is being accessed. This register is used to verify the identity of the device.*

7.2 SERIAL_NUM

This register indicates the unique serial number of each IIM-46234 & IIM-46230 device. The sixteen bytes of this register combine to support 16 Bytes ASCII data.

Register Name: SERIAL_NUM Address: 1 to 16 (0x01 to 0x10), Page ID: 0 Available Operation: Read, Flash backup: Yes, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:0 of Address 1	SERIAL_NUM [127:120]	Highest byte of the serial number
…	…	…
7:0 of Address 16	SERIAL_NUM [7:0]	Lowest byte of the serial number

Please follow the steps below to convert the content of the SERIAL_NUM register into a decimal value.

- Group the register value into four groups
  SERIAL NUM (bit 96:127) = W3
  SERIAL NUM (bit 64:95) = W2
  SERIAL NUM (bit 32:63) = W1
  SERIAL NUM (bit 0:31) = W0
  Where W0, W1, W2, and W3 are in big endian format and are unsigned integers
- Convert W0, W1, W2, and W3 to little endian format
- Then concatenate these values to get to single 128-bit unsigned integer value. This should be as the first 16 digits of the QR code printed on the device.

For example, if the user reads the following content from the user register SERIAL_NUM

0x57	0x34	0x45	0xAA	0x33	0x39	0x39	0x53	0x20	0x20	0x20	0x38	0x1A	0x07	0x07	0xFF

In the next step, the content of the register is grouped into 4 groups of 4 bytes and labelled as W0, W1, W2 and W3.

0x57	0x34	0x45	0xAA	0x33	0x39	0x39	0x53	0x20	0x20	0x20	0x38	0x1A	0x07	0x07	0xFF
W0				W1				W2				W3			

In the next step, we convert W0, W1, W2, and W3 to little endian format to get the following value.

0xAA	0x45	0x34	0x57	0x53	0x39	0x39	0x33	0x38	0x20	0x20	0x20	0xFF	0x07	0x07	0x1A
W0				W1				W2				W3			

Now if we combine the above into a single heaxadecimal value, in the order W3: W2: W1:W0, then we get 0x1A0707FF2020203853393953573445AA which converted to decimal would result in 34596436158408581280944625714940102058. It should match the device ID number printed in the QR code on the package.

7.3 FIRMWARE_REV

Register Name: FIRMWARE_REV Address: 17 to 18 (0x11 to 0x12), Page ID: 0 Available Operation: Read, Flash backup: Yes, Default value: 256 (0x0100)		
BIT	**NAME**	**FUNCTION**
7:0 at Address 18	APP_MAIN_VER	Main version of the IIM-46234 & IIM-46230 application firmware 1-Byte ASCII code
7:0 at Address 17	APP_SUB_VER	Sub version of the IIM-46234 & IIM-46230 application firmware 1-Byte ASCII code

7.4 FLASH_ENDURANCE

This register provides a 32-bit binary counter that tracks the number of flash memory write cycles. These four bytes combine to support 32-bit counter values. The value of this register should not exceed 10,000 because of the endurance limit of the internal flash memory. This value increments each time the modified registers are saved into the flash memory using SAVE_ALL_CONFIG register or if any internal operation of the device stores value to the flash memory.

The order in which a sequence of bytes is stored in memory follows the big-endian. Big-endian is an order in which the "big end" (most significant value in the sequence) is stored first. For example, in a big-endian system, the two bytes required for the hexadecimal number 5678 would be stored as 5678 (56 is stored at address 0, 78 will be at address 1).

Register Name: FLASH_ENDURANCE Address: 21 to 24 (0x15 to 0x18), Page ID: 0 Available Operation: Read, Flash backup: No, Default value: 0x00000000		
BIT	**NAME**	**FUNCTION**
7:0 at Address 21	FLASH_ENDURE_CNT [31:24]	Highest byte of Flash endurance counter
7:0 at Address 22	FLASH_ENDURE_CNT [23:16]	2nd Highest byte of Flash endurance counter
7:0 at Address 23	FLASH_ENDURE_CNT [15:8]	2nd Lowest byte of Flash endurance counter
7:0 at Address 24	FLASH_ENDURE_CNT [7:0]	Lowest byte of Flash endurance counter

7.5 OUT_DATA_FORM

Register Name: OUT_DATA_FORM Address: 25 (0x19), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: 0 (0x00)		
BIT	**NAME**	**FUNCTION**
7:1	--	RESERVED for internal use
0	OUT_DATA_FORMAT	Format of Accelerometer, Gyroscope, Temperature, delta velocity and delta angle output value 0: 32-Bit IEEE 754 single-precision floating point (default) 1: 32-Bit Fixed point 2's Complement representation

Please use the following table to convert Accel, Gyro, Temperature, delta velocity and delta angle values based on the formats chosen above.

Measured value	Floating point	Fixed point
Accel output	g	(FSR)*LSB/2^{31} g
Gyro output	dps	(FSR)*LSB/2^{31} dps
Temperature	°C	(LSB / 126.8) + 25 °C
Delta angle	degrees	(2160)*LSB/ 2^{31} degrees
Delta velocity*	m/sec	(3000)*LSB/ 2^{31} m/sec

* g value programmed in CUSTOM_GRAVITY register (default 9.8m/sec^2) is used for delta velocity calculations

7.6 SAMPLE_RATE_DIV

This register provides user control for reducing the output data rate by averaging the accelerometers and gyroscopes data.

Output Sample Rate = User’s ODR = ODR_RAW/DIVISOR_OF_ODR

ODR_RAW is fixed as 1 kHz.

The data format of this register is “16-Bit Fixed point 2's Complement representation”.

For example, if ODR needs to be set to 50 Hz, then the value of SAMPLE_RATE_DIV should be set to 20 (0x0014). In this case, the SAMPLE_RATE_DIV register should contain 0x00 at address 26, 0x14 at address 27.

Register Name: SAMPLE_RATE_DIV Address: 26 to 27 (0x1A to 0x1B), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: 0x0001		
BIT	**NAME**	**FUNCTION**
7:0 of Address 26	DIVISOR_OF_ODR [15:8]	High byte of the Divisor
7:0 of Address 27	DIVISOR_OF_ODR [7:0]	Low byte of the Divisor

- This SAMPLE_RATE_DIV register is used to change the user's ODR (Output Data Rate) which is same as the Output Sample Rate.
- Table 17 lists the recommended sample rate divider option

User's ODR (=SAMPLE RATE)		SAMPLE_RATE_DIV register (16 bit) value															
	Decimal (Hex)	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1000 Hz	1 (0x01)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
500 Hz	2 (0x02)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
250 Hz	4 (0x04)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
200 Hz	5 (0x05)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
125 Hz	8 (0x08)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
100 Hz	10 (0x0A)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
50 Hz	20 (0x14)	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
25 Hz	40 (0x28)	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
20 Hz	50 (0x32)	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0
10 Hz	100(0x64)	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0

Table 17. USER's ODR Table of Accelerometer and Gyroscope

7.7 SELECT_OUT_DATA

This register is used to select the content of the Data field contained in the streaming data packet (described in section 5.3.3). Please note that this register does not control any user register including accel, gyro, and temperature output registers.

Register Name: SELECT_OUT_DATA Address: 28 (0x1C), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: 7 (0x07)		
BIT	**NAME**	**FUNCTION**
7:5	-	Reserved for internal use
4	ENABLE_DELTA_VEL_OUT	Delta velocity Output Mode 0: Disable the output of Delta velocity all axis data (default) 1: Enable the output of Delta velocity X, Y, Z-axis data
3	ENABLE_DELTA_ANGEL_OUT	Delta angle Output Mode 0: Disable the output of Delta angle all axis data (default) 1: Enable the output of Delta angle X, Y, Z-axis data
2	ENABLE_TEMPERA_OUT	Temperature Output Mode 0: Disable the output of Temperature data 1: Enable the output of Temperature data (default)
1	ENABLE_GYRO_OUT	Gyroscope Output Mode 0: Disable the output of Accelerometer all axis data 1: Enable the output of Accelerometer X, Y, Z-axis data (default)
0	ENABLE_ACCEL_OUT	Accelerometer Output Mode 0: Disable the output of Accelerometer all axis data 1: Enable the output of Accelerometer X, Y, Z-axis data (default)

For example, when SELECT_OUT_DATA = 0x7 (default)

The IIM-46234 & IIM-46230 data field in the streaming packet output has a length of 28 bytes and is formatted as shown below:

Format	Accel X	Accel Y	Accel Z	Gyro X	Gyro Y	Gyro Z	Temperature
Bytes	4	4	4	4	4	4	4

For example, when SELECT_OUT_DATA = 0x1F

The IIM-46234 & IIM-46230 data field in the streaming packet output has a length of 52 bytes and is formatted as shown below:

Format	Accel X	Accel Y	Accel Z	Gyro X	Gyro Y	Gyro Z	Tempera ture	Delta Velocity X	Delta Velocity Y	Delta Velocity Z	Delta angle X	Delta angle Y	Delta angle Z
Bytes	4	4	4	4	4	4	4	4	4	4	4	4	4

The representation and units of the accelerometer, gyro, temperature, delta angle, and delta velocity value are configurable by OUT_DATA_FORM register (Please refer to section 7.5 for more details).

7.8 UART_IF_CONFIG

Register Name: UART_IF_CONFIG Address: 29 (0x1D), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: 0 (0x00)		
BIT	**NAME**	**FUNCTION**
7:3	-	Reserved for internal use
2:0	UART_BAUD_RATE	UART Baud Rate 000: 921,600 (default) 001: 1500000 010: 2000000 011: 3000000 100, 101, 110, 111: RESERVED for internal use

7.9 SYNC_CONFIG

Register Name: SYNC_CONFIG Address: 30 (0x1E), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: 0 (0x00)		
BIT	**NAME**	**FUNCTION**
7:2	-	Reserved for internal use
1:0	SYNC_MODE	Sync Mode 00: Disable Sync Mode 01: Synchronize with PPS 10: RESERVED 11: RESERVED

7.10 USER_SCRATCH1

This register provides a location for the user to store information. The 8 bytes of this register combine to support 8 bytes ASCII data.

Register Name: USER_SCRATCH1 Address: 31 to 38 (0x1F to 0x26), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:0 of Address 38	USER_SCRATCH1 [63:56]	Highest byte of the USER_SCRATCH
7:0 of Address 37	USER_SCRATCH1 [55:48]	middle byte of the USER_SCRATCH
…	…	…
7:0 of Address 32	USER_SCRATCH1 [15:8]	middle byte of the USER_SCRATCH
7:0 of Address 31	USER_SCRATCH1 [7:0]	Lowest byte of the USER_SCRATCH

7.11 USER_SCRATCH2

This register provides a location for the user to store information. The 8 bytes of this register combine to support 8 bytes ASCII data.

Register Name: USER_SCRATCH2 **Address: 39 to 46 (0x27 to 0x2E), Page ID: 0** **Available Operation: Read and Write, Flash backup: Yes, Default value: N/A**		
BIT	**NAME**	**FUNCTION**
7:0 of Address 46	USER_SCRATCH2 [63:56]	Highest byte of the USER_SCRATCH
…	…	…
7:0 of Address 32	USER_SCRATCH2 [7:0]	Lowest byte of the USER_SCRATCH

7.12 SAVE_ALL_CONFIG

This register is used for saving the modified registers in flash memory and then showing the result.

Register Name: SAVE_ALL_CONFIG **Address: 47 (0x2F), Page ID: 0** **Available Operation: Read and Write, Flash backup: Yes, Default value: N/A**		
BIT	**NAME**	**FUNCTION**
4:7	SAVING_COMMAND	Saving Command 0000 to 0100: RESERVED 0101: Save the all the modified registers 0110 to 1111: RESERVED
3:0	SAVING_RESULT	Saving Result 0000: Saving in progress 0001: Saved successfully 0010: Not saved 0011 to 1111: RESERVED

7.13 BW_CONFIG

This register is used for changing the bandwidth for accelerometer & gyroscope.

Register Name: BW_CONFIG **Address: 48 (0x30), Page ID: 0** **Available Operation: Read and Write, Flash backup: Yes, Default value: 68 (0x44)**		
BIT	**NAME**	**FUNCTION**
7:4	ACCEL_BANDWIDTH	Bandwidth for Accelerometer 0100: BW4 *in Table 16 and Table 17 (Bandwidth & RMS Noise Tables)* 0101: BW5 0110: BW6 0111: BW7 0000 to 0011, 1000 to 1111: RESERVED

Register Name: BW_CONFIG Address: 48 (0x30), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: 68 (0x44)		
3:0	GYRO_BANDWIDTH	Bandwidth for Gyroscope 0100: BW4 *in Table 16 and Table 17 (Bandwidth & RMS Noise Tables)* 0101: BW5 0110: BW6 0111: BW7 0000 to 0011, 1000 to 1111: RESERVED

Table 18 shows values for Bandwidth and RMS Noise corresponding ODR (Output Data Rate) setting, which can be configured using SAMPLE_RATE_DIV register. Note that ODR (Output Data rate) is the same as SAMPLE RATE.

User's ODR (=SAMPLE RATE)	3dB Bandwidth				Noise Bandwidth			
	BW4	BW5	BW6	BW7	BW4	BW5	BW6	BW7
1000 Hz	98	61	47	25	100	63	49	26
500 Hz	95	60	46	25	97	62	48	26
250 Hz	84	57	45	25	83	58	46	26
200 Hz	77	55	44	25	76	56	45	26
125 Hz	55	48	40	24	55	47	40	25
100 Hz	44	42	37	24	45	41	37	24
50 Hz	22	22	22	19	24	23	22	19
25 Hz	11	11	11	11	12	12	12	11
20 Hz	9	9	9	9	10	10	10	9
10 Hz	4	4	4	4	5	5	5	5

Table 18. Bandwidth Table of Accelerometer and Gyroscope

ODR	RMS Noise of Gyroscope (unit is mdps)				RMS Noise of Accelerometer (unit is μg)			
	BW4	BW5	BW6	BW7	BW4	BW5	BW6	BW7
1000 Hz	15.84	12.50	10.97	8.00	290.0	230.2	203.0	147.9
500 Hz	15.59	12.39	10.85	8.00	285.6	228.3	200.9	147.9
250 Hz	14.66	12.08	10.73	8.00	264.2	220.9	196.7	147.9
200 Hz	14.04	11.87	10.61	8.00	252.8	217.0	194.5	147.9
125 Hz	11.87	11.09	10.12	7.84	215.1	198.8	183.4	145.0
100 Hz	10.61	10.37	9.73	7.84	194.5	185.7	176.4	142.1
50 Hz	7.50	7.50	7.50	6.97	142.1	139.1	136.0	126.4
25 Hz	5.31	5.31	5.31	5.31	100.5	100.5	100.5	96.2
20 Hz	4.80	4.80	4.80	4.80	91.7	91.7	91.7	87.0
10 Hz	3.20	3.20	3.20	3.20	64.8	64.8	64.8	64.8

Table 19. RMS Noise Table of Accelerometer and Gyroscope

7.14 IIM-46234 & IIM-46230 ACCEL_CONFIG0

This register is used for changing the FSR (Full Scale Range) of accelerometer.

7.14.1 IIM-46234 ACCEL_CONFIG0

Register Name: ACCEL_CONFIG0 Address: 51 (0x33), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: 38 (0x26)		
BIT	NAME	FUNCTION
7:5	ACCEL_FS_SEL	Full scale factor for Accelerometer output 000: RESERVED 001: ±8g (default) 010: ±4g 011: ±2g 100 to 111: RESERVED
4:0	-	RESERVED

7.14.2 IIM-46230 ACCEL_CONFIG0

Register Name: ACCEL_CONFIG0 Address: 51 (0x33), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: 38 (0x26)		
BIT	NAME	FUNCTION
7:5	ACCEL_FS_SEL	Full scale factor for Accelerometer output 000: ±16g 001: ±8g (default) 010: ±4g 011: ±2g 100 to 111: RESERVED
4:0	-	RESERVED

7.15 IIM-46234 & IIM-46230 GYRO_CONFIG0

This register is used for changing the FSR (Full Scale Range) of gyroscope.

7.15.1 IIM-46234 GYRO_CONFIG0

Register Name: GYRO_CONFIG0 Address: 52 (0x34), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: 70 (0x46)		
BIT	NAME	FUNCTION
7:5	GYRO_FS_SEL	Full scale factor for Gyroscope output 000 to 001: RESERVED 010: ±480dps (default) 011: ±250dps 100 to 111: RESERVED
4:0	-	RESERVED

7.15.2 IIM-46230 GYRO_CONFIG0

BIT	NAME	FUNCTION
Register Name: GYRO_CONFIG0 **Address: 52 (0x34), Page ID: 0** **Available Operation: Read and Write, Flash backup: Yes, Default value: 70 (0x46)**		
7:5	GYRO_FS_SEL	Full scale factor for Gyroscope output 000: ±2000dps 001: ±1000dps 010: ±480dps (default) 011: ±250dps 100 to 111: RESERVED
4:0	-	RESERVED

7.16 EXT_CALIB_CONFIG

This register is used to enable or disable correction of the output of Acceleromer & Gyroscope measurements with user configured bias, sensitivity, and misalignment values.

BIT	NAME	FUNCTION
Register Name: EXT_CALIB_CONFIG **Address: 63 (0x3F), Page ID: 0** **Available Operation: Read and Write, Flash backup: Yes, Default value: 0 (0x00)**		
7:4	-	Reserved for internal use
3	ENABLE_EXT_GYRO_SENS	External Sensitivity & Misalignment calibration for Gyroscope 0: Disable the external Sensitivity calibration for Gyroscope (default) 1: Enable the external Sensitivity calibration for Gyroscope
2	ENABLE_EXT_ACCEL_SENS	External Sensitivity & Misalignment calibration for Accelerometer 0: Disable the external Sensitivity calibration for Accel (default) 1: Enable the external Sensitivity calibration for Accel
1	ENABLE_EXT_GYRO_BIAS	External Bias calibration for Gyroscope 0: Disable the external Bias calibration for Gyro all axis (default) 1: Enable the external Bias calibration for Gyro X, Y, Z-axis
0	ENABLE_EXT_ACCEL_BIAS	External Bias calibration for Accelerometer 0: Disable the external Bias calibration for Accel all axis (default) 1: Enable the external Bias calibration for Accel X, Y, Z-axis

The configured values of the EXT_CALIB_CONFIG register are used in the following way to report the accel measurements -

1) If ENABLE_EXT_ACCEL_BIAS = 0 and ENABLE_EXT_ACCEL_SENS = 0,

   The accel output values (e.g. ACCEL_X_OUTPUT, ACCEL_Y_OUTPUT, and ACCEL_Z_OUTPUT) are exactly the same as the measurements made by the IIM-46234 & IIM-46230 devices.

2) If ENABLE_EXT_ACCEL_BIAS = 1 and ENABLE_EXT_ACCEL_SENS = 0,

   The values of EXT_ACCEL_X_BIAS, EXT_ACCEL_Y_BIAS, EXT_ACCEL_Z_BIAS are used to correct the reported accel measurements.

   ACCEL_X_OUTPUT = ACCEL X axis measurements + EXT_ACCEL_X_BIAS

ACCEL_Y_OUTPUT = ACCEL Y axis measurements + EXT_ACCEL_Y_BIAS
ACCEL_Z_OUTPUT = ACCEL Z axis measurements + EXT_ACCEL_Z_BIAS

3) If ENABLE_EXT_ACCEL_BIAS = 0 and ENABLE_EXT_ACCEL_SENS = 1,

   The values of EXT_ACC_SENS_MAT11 to EXT_ACC_SENS_MAT33 are used to correct the reported accel measurements.

   ACCEL_X_OUTPUT = EXT_ACC_SENS_MAT11 * ACCEL X axis measurements + EXT_ACC_SENS_MAT12 * ACCEL Y axis measurements + EXT_ACC_SENS_MAT13 * ACCEL Z axis measurements
   ACCEL_Y_OUTPUT = EXT_ACC_SENS_MAT21 * ACCEL X axis measurements + EXT_ACC_SENS_MAT22 * ACCEL Y axis measurements + EXT_ACC_SENS_MAT23 * ACCEL Z axis measurements
   ACCEL_Z_OUTPUT = EXT_ACC_SENS_MAT31 * ACCEL X axis measurements + EXT_ACC_SENS_MAT32 * ACCEL Y axis measurements + EXT_ACC_SENS_MAT33 * ACCEL Z axis measurements

4) If ENABLE_EXT_ACCEL_BIAS = 1 and ENABLE_EXT_ACCEL_SENS = 1,

   The values of EXT_ACCEL_X_BIAS, EXT_ACCEL_Y_BIAS, EXT_ACCEL_Z_BIAS and EXT_ACC_SENS_MAT11 to EXT_ACC_SENS_MAT33 are used to correct the reported accel measurements.

   ACCEL_X_OUTPUT = (EXT_ACC_SENS_MAT11 * ACCEL X axis measurements + EXT_ACC_SENS_MAT12 * ACCEL Y axis measurements + EXT_ACC_SENS_MAT13 * ACCEL Z axis measurements) + EXT_ACCEL_X_BIAS
   ACCEL_Y_OUTPUT = (EXT_ACC_SENS_MAT21 * ACCEL X axis measurements + EXT_ACC_SENS_MAT22 * ACCEL Y axis measurements + EXT_ACC_SENS_MAT23 * ACCEL Z axis measurements) + EXT_ACCEL_Y_BIAS
   ACCEL_Z_OUTPUT = (EXT_ACC_SENS_MAT31 * ACCEL X axis measurements + EXT_ACC_SENS_MAT32 * ACCEL Y axis measurements + EXT_ACC_SENS_MAT33 * ACCEL Z axis measurements) + EXT_ACCEL_Z_BIAS

The configured values of the EXT_CALIB_CONFIG register are used in the following way to report the gyro measurements -

5) If ENABLE_EXT_GYRO_BIAS =0 and ENABLE_EXT_GYRO_SENS = 0

   The gyro output values (e.g. GYRO _X_OUTPUT, GYRO _Y_OUTPUT and GYRO _Z_OUTPUT) are exactly same as the measurements made by the IIM-46234 & IIM-46230 devices.

6) If ENABLE_EXT_GYRO_BIAS = 1 and ENABLE_EXT_GYRO_SENS = 0,

   The values of EXT_GYRO_X_BIAS, EXT_GYRO_Y_BIAS, EXT_GYRO_Z_BIAS are used to correct the reported gyro measurements.

   GYRO_X_OUTPUT = GYRO X axis measurements + EXT_ GYRO_X_BIAS
   GYRO_Y_OUTPUT = GYRO Y axis measurements + EXT_ GYRO_Y_BIAS
   GYRO_Z_OUTPUT = GYRO Z axis measurements + EXT_ GYRO_Z_BIAS

7) If ENABLE_EXT_ GYRO_BIAS = 0 and ENABLE_EXT_ GYRO_SENS = 1,

   The values of EXT_GYR_SENS_MAT11 to EXT_GYR_SENS_MAT33 are used to correct the reported gyro measurements.

   GYRO_X_OUTPUT = EXT_GYR_SENS_MAT11 * GYRO X axis measurements + EXT_GYR_SENS_MAT12 * GYRO Y axis measurements + EXT_GYR_SENS_MAT13 * ACCEL Z axis measurements
   GYRO_Y_OUTPUT = EXT_GYR_SENS_MAT21 * GYRO X axis measurements + EXT_GYR_SENS_MAT22 * GYRO Y axis measurements + EXT_GYR_SENS_MAT23 * ACCEL Z axis measurements
   GYRO_Z_OUTPUT = EXT_GYR_SENS_MAT31 * GYRO X axis measurements + EXT_GYR_SENS_MAT32 * GYRO Y axis measurements + EXT_GYR_SENS_MAT33 * GYRO Z axis measurements

8) If ENABLE_EXT_GYRO_BIAS = 1 and ENABLE_EXT_ACCEL_SENS = 1,

   The values of EXT_ GYRO_X_BIAS, EXT_ GYRO_Y_BIAS, EXT_ GRO _Z_BIAS and EXT_GYR_SENS_MAT11 to EXT_GYR_SENS_MAT33 are used to correct the reported gyro measurements.

GYRO_X_OUTPUT = (EXT_GYR_SENS_MAT11 * GYRO X axis measurements + EXT_GYR_SENS_MAT12 * GYRO Y axis measurements + EXT_GYR_SENS_MAT13 * GYRO Z axis measurements) + EXT_GYRO_X_BIAS
GYRO_Y_OUTPUT = (EXT_GYR_SENS_MAT21 * GYRO X axis measurements + EXT_GYR_SENS_MAT22 * GYRO Y axis measurements + EXT_GYR_SENS_MAT23 * GYRO Z axis measurements) + EXT_GYRO_Y_BIAS
GYRO_Z_OUTPUT = (EXT_GYR_SENS_MAT31 * GYRO X axis measurements + EXT_GYR_SENS_MAT32 * GYRO Y axis measurements + EXT_GYR_SENS_MAT33 * GYRO Z axis measurements) + EXT_GYRO_Z_BIAS

7.17 EXT_ACCEL_X_BIAS

EXT_ACCEL_X_BIAS register is used to adjust the bias of the accelerometers X-axis output when the external bias calibration for Accelerometer is enabled by EXT_CALIB_CONFIG register. Each bias consists of four bytes register. These four bytes combine to support a 32-bit IEEE 754 single-precision floating point value. Unit is g.

Register Name: EXT_ACCEL_X_BIAS **Address: 64 to 67 (0x40 to 0x43), Page ID: 0** **Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for 0**		
BIT	**NAME**	**FUNCTION**
7:0 at Address 64	EXT_ACCEL_X_BIAS [31:24]	Highest byte of Accelerometer X-axis Bias
7:0 at Address 65	EXT_ACCEL_X_BIAS [23:16]	2nd Highest byte of Accelerometer X-axis Bias
7:0 at Address 66	EXT_ACCEL_X_BIAS [15:8]	2nd Lowest byte of Accelerometer X-axis Bias
7:0 at Address 67	EXT_ACCEL_X_BIAS [7:0]	Lowest byte of Accelerometer X-axis Bias

7.18 EXT_ACCEL_Y_BIAS

EXT_ACCEL_Y_BIAS register is used to adjust the bias of the accelerometers Y-axis output when the external bias calibration for Accelerometer is enabled by EXT_CALIB_CONFIG register. Each bias consists of four bytes register. These four bytes combine to support a 32-bit IEEE 754 single-precision floating point value. Unit is g.

Register Name: EXT_ACCEL_Y_BIAS **Address: 68 to 71 (0x44 to 0x47), Page ID: 0** **Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for 0**		
BIT	**NAME**	**FUNCTION**
7:0 at Address 68	EXT_ACCEL_Y_BIAS [31:24]	Highest byte of Accelerometer Y-axis Bias
7:0 at Address 69	EXT_ACCEL_Y_BIAS [23:16]	2nd Highest byte of Accelerometer Y-axis Bias
7:0 at Address 70	EXT_ACCEL_Y_BIAS [15:8]	2nd Lowest byte of Accelerometer Y-axis Bias
7:0 at Address 71	EXT_ACCEL_Y_BIAS [7:0]	Lowest byte of Accelerometer Y-axis Bias

7.19 EXT_ACCEL_Z_BIAS

EXT_ACCEL_Z_BIAS register is used to adjust the bias of the accelerometers Z-axis output when the external bias calibration for Accelerometer is enabled by EXT_CALIB_CONFIG register. Each bias consists of four bytes register. These four bytes combine to support a 32-bit IEEE 754 single-precision floating point value. Unit is g.

Register Name: EXT_ACCEL_Z_BIAS Address: 72 to 75 (0x48 to 0x4B), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for 0		
BIT	**NAME**	**FUNCTION**
7:0 at Address 72	EXT_ACCEL_Z_BIAS [31:24]	Highest byte of Accelerometer Z-axis Bias
7:0 at Address 73	EXT_ACCEL_Z_BIAS [23:16]	2nd Highest byte of Accelerometer Z-axis Bias
7:0 at Address 74	EXT_ACCEL_Z_BIAS [15:8]	2nd Lowest byte of Accelerometer Z-axis Bias
7:0 at Address 75	EXT_ACCEL_Z_BIAS [7:0]	Lowest byte of Accelerometer Z-axis Bias

7.20 EXT_GYRO_X_BIAS

EXT_GYRO_X_BIAS register is used to adjust the bias of the gyroscope X-axis output when the external bias calibration for gyroscope is enabled by EXT_CALIB_CONFIG register. Each bias consists of four bytes register. These four bytes combine to support a 32-bit IEEE 754 single-precision floating point value. Unit is degrees per second(°/s).

Register Name: EXT_GYRO_X_BIAS Address: 76 to 79 (0x4C to 0x4F), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for 0		
BIT	**NAME**	**FUNCTION**
7:0 at Address 76	EXT_GYRO_X_BIAS [31:24]	Highest byte of Gyroscope X-axis Bias
7:0 at Address 77	EXT_GYRO_X_BIAS [23:16]	2nd Highest byte of Gyroscope X-axis Bias
7:0 at Address 78	EXT_GYRO_X_BIAS [15:8]	2nd Lowest byte of Gyroscope X-axis Bias
7:0 at Address 79	EXT_GYRO_X_BIAS [7:0]	Lowest byte of Gyroscope X-axis Bias

7.21 EXT_GYRO_Y_BIAS

EXT_GYRO_Y_BIAS register is used to adjust the bias of the gyroscope Y-axis output when the external bias calibration for gyroscope is enabled by EXT_CALIB_CONFIG register. Each bias consists of four bytes register. These four bytes combine to support a 32-bit IEEE 754 single-precision floating point value. Unit is degrees per second(°/s).

Register Name: EXT_GYRO_Y_BIAS Address: 80 to 83 (0x50 to 0x53), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for 0		
BIT	**NAME**	**FUNCTION**
7:0 at Address 80	EXT_GYRO_Y_BIAS [31:24]	Highest byte of Gyroscope Y-axis Bias
7:0 at Address 81	EXT_GYRO_Y_BIAS [23:16]	2nd Highest byte of Gyroscope Y-axis Bias
7:0 at Address 82	EXT_GYRO_Y_BIAS [15:8]	2nd Lowest byte of Gyroscope Y-axis Bias
7:0 at Address 83	EXT_GYRO_Y_BIAS [7:0]	Lowest byte of Gyroscope Y-axis Bias

7.22 EXT_GYRO_Z_BIAS

EXT_GYRO_Z_BIAS register is used to adjust the bias of the gyroscope Z-axis output when the external bias calibration for gyroscope is enabled by EXT_CALIB_CONFIG register. Each bias consists of four bytes register. These four bytes combine to support a 32-bit IEEE 754 single-precision floating point value. Unit is degrees per second(°/s).

Register Name: EXT_GYRO_Z_BIAS Address: 84 to 87 (0x54 to 0x57), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for 0		
BIT	**NAME**	**FUNCTION**
7:0 at Address 84	EXT_GYRO_Z_BIAS [31:24]	Highest byte of Gyroscope Z-axis Bias
7:0 at Address 85	EXT_GYRO_Z_BIAS [23:16]	2nd Highest byte of Gyroscope Z-axis Bias
7:0 at Address 86	EXT_GYRO_Z_BIAS [15:8]	2nd Lowest byte of Gyroscope Z-axis Bias
7:0 at Address 87	EXT_GYRO_Z_BIAS [7:0]	Lowest byte of Gyroscope Z-axis Bias

7.23 EXT_ACC_SENS_MAT

EXT_ACC_SENS_MATxx registers are used for Sensitivity and Misalignment correction of the accelerometer output when the external Sensitivity calibration for Accelerometer is enabled by EXT_CALIB_CONFIG register.

EXT_ACC_SENS_MATxx register is an element of 3*3 matrix. Each element in 3*3 matrix consists of four bytes register. These four bytes combine to support a 32-bit IEEE 754 single-precision floating point value.

Register Name: EXT_ACC_SENS_MAT11 Address: 88 to 91 (0x58 to 0x5B), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 88	EXT_ACC_SENS_MAT11 [31:24]	Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 89	EXT_ACC_SENS_MAT11 [23:16]	2nd Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 90	EXT_ACC_SENS_MAT11 [15:8]	2nd Lowest byte of Accelerometer Sensitivity matrix element
7:0 at Address 91	EXT_ACC_SENS_MAT11 [7:0]	Lowest byte of Accelerometer Sensitivity matrix element

Register Name: EXT_ACC_SENS_MAT12 Address: 92 to 95 (0x5C to 0x5F), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 92	EXT_ACC_SENS_MAT12 [31:24]	Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 93	EXT_ACC_SENS_MAT12 [23:16]	2nd Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 94	EXT_ACC_SENS_MAT12 [15:8]	2nd Lowest byte of Accelerometer Sensitivity matrix element
7:0 at Address 95	EXT_ACC_SENS_MAT12 [7:0]	Lowest byte of Accelerometer Sensitivity matrix element

Register Name: EXT_ACC_SENS_MAT13 Address: 96 to 99 (0x60 to 0x63), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 96	EXT_ACC_SENS_MAT13 [31:24]	Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 97	EXT_ACC_SENS_MAT13 [23:16]	2nd Highest byte of Accelerometer Sensitivity matrix element

Register Name: EXT_ACC_SENS_MAT13 Address: 96 to 99 (0x60 to 0x63), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
7:0 at Address 98	EXT_ACC_SENS_MAT13 [15:8]	2nd Lowest byte of Accelerometer Sensitivity matrix element
7:0 at Address 99	EXT_ACC_SENS_MAT13[7:0]	Lowest byte of Accelerometer Sensitivity matrix element

Register Name: EXT_ACC_SENS_MAT21 Address: 100 to 103 (0x64 to 0x67), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 100	EXT_ACC_SENS_MAT21 [31:24]	Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 101	EXT_ACC_SENS_MAT21 [23:16]	2nd Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 102	EXT_ACC_SENS_MAT21 [15:8]	2nd Lowest byte of Accelerometer Sensitivity matrix element
7:0 at Address 103	EXT_ACC_SENS_MAT21 [7:0]	Lowest byte of Accelerometer Sensitivity matrix element

Register Name: EXT_ACC_SENS_MAT22 Address: 104 to 107 (0x68 to 0x6B), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 104	EXT_ACC_SENS_MAT22 [31:24]	Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 105	EXT_ACC_SENS_MAT22 [23:16]	2nd Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 106	EXT_ACC_SENS_MAT22 [15:8]	2nd Lowest byte of Accelerometer Sensitivity matrix element
7:0 at Address 107	EXT_ACC_SENS_MAT22 [7:0]	Lowest byte of Accelerometer Sensitivity matrix element

Register Name: EXT_ACC_SENS_MAT23 Address: 108 to 111 (0x6C to 0x6F), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 108	EXT_ACC_SENS_MAT23 [31:24]	Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 109	EXT_ACC_SENS_MAT23 [23:16]	2nd Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 110	EXT_ACC_SENS_MAT23 [15:8]	2nd Lowest byte of Accelerometer Sensitivity matrix element
7:0 at Address 111	EXT_ACC_SENS_MAT23 [7:0]	Lowest byte of Accelerometer Sensitivity matrix element

Register Name: EXT_ACC_SENS_MAT31 Address: 112 to 115 (0x70 to 0x73), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 112	EXT_ACC_SENS_MAT31 [31:24]	Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 113	EXT_ACC_SENS_MAT31 [23:16]	2nd Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 114	EXT_ACC_SENS_MAT31 [15:8]	2nd Lowest byte of Accelerometer Sensitivity matrix element
7:0 at Address 115	EXT_ACC_SENS_MAT31 [7:0]	Lowest byte of Accelerometer Sensitivity matrix element

Register Name: EXT_ACC_SENS_MAT32 Address: 116 to 119 (0x74 to 0x77), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 116	EXT_ACC_SENS_MAT32 [31:24]	Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 117	EXT_ACC_SENS_MAT32 [23:16]	2nd Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 118	EXT_ACC_SENS_MAT32 [15:8]	2nd Lowest byte of Accelerometer Sensitivity matrix element
7:0 at Address 119	EXT_ACC_SENS_MAT32 [7:0]	Lowest byte of Accelerometer Sensitivity matrix element

Register Name: EXT_ACC_SENS_MAT33 Address: 120 to 123 (0x78 to 0x7B)), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 120	EXT_ACC_SENS_MAT33 [31:24]	Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 121	EXT_ACC_SENS_MAT33 [23:16]	2nd Highest byte of Accelerometer Sensitivity matrix element
7:0 at Address 122	EXT_ACC_SENS_MAT33 [15:8]	2nd Lowest byte of Accelerometer Sensitivity matrix element
7:0 at Address 123	EXT_ACC_SENS_MAT33 [7:0]	Lowest byte of Accelerometer Sensitivity matrix element

7.24 EXT_GYR_SENS_MAT

EXT_GYR_SENS_MATxx registesr are used for Sensitivity and Misalignment correction of the gyroscope output when the external Sensitivity calibration for gyroscope is enabled by EXT_CALIB_CONFIG register.

EXT_GYR_SENS_MATxx register is an element of 3*3 matrix. Each element in 3*3 matrix consists of four bytes register. These four bytes combine to support a 32-bit IEEE 754 single-precision floating point value.

Register Name: EXT_GYR_SENS_MAT11 Address: 124 to 127 (0x7C to 0x7F), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 124	EXT_GYR_SENS_MAT11 [31:24]	Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 125	EXT_GYR_SENS_MAT11 [23:16]	2nd Highest byte of Gyroscope Sensitivity matrix element

Register Name: EXT_GYR_SENS_MAT11 Address: 124 to 127 (0x7C to 0x7F), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
7:0 at Address 126	EXT_GYR_SENS_MAT11 [15:8]	2nd Lowest byte of Gyroscope Sensitivity matrix element
7:0 at Address 127	EXT_GYR_SENS_MAT11 [7:0]	Lowest byte of Gyroscope Sensitivity matrix element

Register Name: EXT_GYR_SENS_MAT12 Address: 128 to 131 (0x80 to 0x83), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	NAME	FUNCTION
7:0 at Address 128	EXT_GYR_SENS_MAT12 [31:24]	Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 129	EXT_GYR_SENS_MAT12 [23:16]	2nd Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 130	EXT_GYR_SENS_MAT12 [15:8]	2nd Lowest byte of Gyroscope Sensitivity matrix element
7:0 at Address 131	EXT_GYR_SENS_MAT12 [7:0]	Lowest byte of Gyroscope Sensitivity matrix element

Register Name: EXT_GYR_SENS_MAT13 Address: 132 to 135 (0x84 to 0x87), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	NAME	FUNCTION
7:0 at Address 132	EXT_GYR_SENS_MAT13 [31:24]	Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 133	EXT_GYR_SENS_MAT13 [23:16]	2nd Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 134	EXT_GYR_SENS_MAT13 [15:8]	2nd Lowest byte of Gyroscope Sensitivity matrix element
7:0 at Address 135	EXT_GYR_SENS_MAT13 [7:0]	Lowest byte of Gyroscope Sensitivity matrix element

Register Name: EXT_GYR_SENS_MAT21 Address: 136 to 139 (0x88 to 0x8B), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	NAME	FUNCTION
7:0 at Address 136	EXT_GYR_SENS_MAT21 [31:24]	Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 137	EXT_GYR_SENS_MAT21 [23:16]	2nd Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 138	EXT_GYR_SENS_MAT21 [15:8]	2nd Lowest byte of Gyroscope Sensitivity matrix element
7:0 at Address 139	EXT_GYR_SENS_MAT21 [7:0]	Lowest byte of Gyroscope Sensitivity matrix element

Register Name: EXT_GYR_SENS_MAT22 Address: 140 to 143 (0x8C to 0x8F), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 140	EXT_GYR_SENS_MAT22 [31:24]	Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 141	EXT_GYR_SENS_MAT22 [23:16]	2nd Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 142	EXT_GYR_SENS_MAT22 [15:8]	2nd Lowest byte of Gyroscope Sensitivity matrix element
7:0 at Address 143	EXT_GYR_SENS_MAT22 [7:0]	Lowest byte of Gyroscope Sensitivity matrix element

Register Name: EXT_GYR_SENS_MAT23 Address: 144 to 147 (0x90 to 0x93), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 144	EXT_GYR_SENS_MAT23 [31:24]	Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 145	EXT_GYR_SENS_MAT23 [23:16]	2nd Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 146	EXT_GYR_SENS_MAT23 [15:8]	2nd Lowest byte of Gyroscope Sensitivity matrix element
7:0 at Address 147	EXT_GYR_SENS_MAT23 [7:0]	Lowest byte of Gyroscope Sensitivity matrix element

Register Name: EXT_GYR_SENS_MAT31 Address: 148 to 151 (0x94 to 0x97), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 148	EXT_GYR_SENS_MAT31 [31:24]	Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 149	EXT_GYR_SENS_MAT31 [23:16]	2nd Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 150	EXT_GYR_SENS_MAT31 [15:8]	2nd Lowest byte of Gyroscope Sensitivity matrix element
7:0 at Address 151	EXT_GYR_SENS_MAT31 [7:0]	Lowest byte of Gyroscope Sensitivity matrix element

Register Name: EXT_GYR_SENS_MAT32 Address: 152 to 155 (0x98 to 0x9B), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 152	EXT_GYR_SENS_MAT32 [31:24]	Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 153	EXT_GYR_SENS_MAT32 [23:16]	2nd Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 154	EXT_GYR_SENS_MAT32 [15:8]	2nd Lowest byte of Gyroscope Sensitivity matrix element
7:0 at Address 155	EXT_GYR_SENS_MAT32 [7:0]	Lowest byte of Gyroscope Sensitivity matrix element

Register Name: EXT_GYR_SENS_MAT33 Address: 156 to 159 (0x9C to 0x9F), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for identity matrix element		
BIT	**NAME**	**FUNCTION**
7:0 at Address 156	EXT_GYR_SENS_MAT33 [31:24]	Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 157	EXT_GYR_SENS_MAT33 [23:16]	2nd Highest byte of Gyroscope Sensitivity matrix element
7:0 at Address 158	EXT_GYR_SENS_MAT33 [15:8]	2nd Lowest byte of Gyroscope Sensitivity matrix element
7:0 at Address 159	EXT_GYR_SENS_MAT33 [7:0]	Lowest byte of Gyroscope Sensitivity matrix element

7.25 CUSTOM_GRAVITY

This CUSTOM_GRAVITY register is used to set the custom value of gravity value. The calculation of delta velocity uses this custom gravity value for conversion.

The gravity value is usually dependent on location and altitude. The allowed range of this value is from “9.7” to “9.9.”

The value of this register is four bytes. These four bytes combine to support a 32-bit IEEE 754 single-precision floating point value.

Register Name: CUSTOM_GRAVITY Address: 164 to 167 (0xA4 to 0xA7), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: floating-point value for “9.8”		
BIT	**NAME**	**FUNCTION**
7:0 at Address 164	CUSTOM_GRAVITY [31:24]	Highest byte of the custom gravity value
7:0 at Address 165	CUSTOM_GRAVITY [23:16]	2nd Highest byte of custom gravity value
7:0 at Address 166	CUSTOM_GRAVITY [15:8]	2nd Lowest byte of custom gravity value
7:0 at Address 167	CUSTOM_GRAVITY [7:0]	Lowest byte of custom gravity value

7.26 RESET_ALL_CONFIG

This register can be used to reset all the register values to default (except UART_IF_CONFIG) and save in the flash memory. The RESET_CONFIG_RESULT field show the status of the reset action.

Register Name: RESET_ALL_CONFIG Address: 168 (0xA8), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: N/A		
BIT	**NAME**	**FUNCTION**
4:7	RESET_CONFIG_COMMAND	Reset the configuration Command 0000 to 1001: RESERVED 1010: Reset all the register values to default (Except UART_IF_CONFIG) and Save those registers 1011 to 1111: RESERVED

Register Name: RESET_ALL_CONFIG Address: 168 (0xA8), Page ID: 0 Available Operation: Read and Write, Flash backup: Yes, Default value: N/A		
3:0	RESET_CONFIG_RESULT	Result of Reset Configuration 0000: Saving the default value is in progress 0001: Saved the default value successfully 0010: Not saved 0011 to 1111: RESERVED

7.27 DATA_READY_STATUS

Register Name: DATA_READY_STATUS Address: 0 (0x00), Page ID: 1 Available Operation: Read, Flash backup: No, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:1	-	Reserved for internal use
0	DATA_READY_FLAG	Flag to show if sample is updated or not 0: Sample data is not yet updated 1: Sample data has been updated and is ready to be read

7.28 SENSOR_STATUS

The Sensor Status register indicate the status of the Accelerometer and Gyroscope output.

Register Name: SENSOR_STATUS Address: 1 (0x01), Page ID: 1 Available Operation: Read, Flash backup: No, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:5	ACCEL_STATUS_FLAG	Status of acceleromter ouput 000: Reliable output 001 to 110: Partially reliable output 111: Unreliable output
4:0	GYRO_STATUS_FLAG	Status of gyroscope output 00000: Reliable output 00001 to 11110: Partially reliable output 11111: Unreliable output

7.29 SAMPLE_COUNTER

This register is used for showing the Sample Counter to help understand any missing data packet.

Register Name: SAMPLE_COUNTER Address: 2 (0x02), Page ID: 1 Available Operation: Read, Flash backup: No, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:0	SAMPLE_COUNTER	Sample counter of Data Packet 00000000 to 11111111: The number will increment up to 11111111 and roll back to 00000000 and continue in this loop

7.30 TIMESTAMP_OUT

This register provides a timestamp in microseconds corresponding to the sensor measurements (e.g. Accel_X_output, Gyro_X_Output, Sensor_status etc). The eight bytes of this register combine to support 8 Bytes ASCII data.

Register Name: TIMESTAMP_OUT Address: 3 to 10 (0x03 to 0x0A), Page ID: 1 Available Operation: Read, Flash backup: No, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:0 of Address 10	TIMESTAMP_OUT [63:56]	Highest byte of the time stamp
…	…	…
7:0 of Address 3	TIMESTAMP_OUT [7:0]	Lowest byte of the time stamp

7.31 ACCEL_X_OUTPUT

The IIM-46234 & IIM-46230 measure the acceleration along three orthogonal axes (x, y, and z). Each axis has four bytes output data register. These four bytes combine to support a 32-bit data values. The output format is either "32-Bit IEEE 754 single-precision floating point" or "32-Bit Fixed point 2's Complement representation" based on the value of OUT_DATA_FORM register (refer to section 7.5 for more details).

For example, if OUT_DATA_FORM register is configured for floating point representation and the IIM-46234 & IIM-46230 measure an acceleration of 1g for X-axis, the correponding measured value in hexadecimal would be 0x3f800000. The ACCEL_X_OUTPUT register would contain 0x3f at address 11, 0x80 at address 12, 0x00 at address 13, 0x00 at address 14.

If OUT_DATA_FORM register is configured for fixed point representation with FSR (Full Scale Range) programmed as 8*g*, and the IIM-46234 & IIM-46230 measure an acceleration of 1g for X-axis, then the correponding measured value in hexadecimal would be0x10000000. The ACCEL_X_OUTPUT register would contain 0x10 at address 11, 0x00 at address 12, 0x00 at address 13, 0x00 at address 14.

Register Name: ACCEL_X_OUTPUT Address: 11 to 14 (0x0B to 0x0E), Page ID: 1 Available Operation: Read, Flash backup: No, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:0 at Address 11	ACCEL_X_OUT [31:24]	Highest byte of Accelerometer X-axis data
7:0 at Address 12	ACCEL_X_OUT [23:16]	2nd Highest byte of Accelerometer X-axis data

Register Name: ACCEL_X_OUTPUT Address: 11 to 14 (0x0B to 0x0E), Page ID: 1 Available Operation: Read, Flash backup: No, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:0 at Address 13	ACCEL_X_OUT [15:8]	2^{nd} Lowest byte of Accelerometer X-axis data
7:0 at Address 14	ACCEL_X_OUT [7:0]	Lowest byte of Accelerometer X-axis data

7.32 ACCEL_Y_OUTPUT

Follows the same format as ACCEL_X_OUTPUT register.

Register Name: ACCEL_Y_OUTPUT Address: 15 to 18 (0x0F to 0x12), Page ID: 1 Available Operation: Read, Flash backup: No, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:0 at Address 15	ACCEL_Y_OUT [31:24]	Highest byte of Accelerometer Y-axis data
7:0 at Address 16	ACCEL_Y_OUT [23:16]	2^{nd} Highest byte of Accelerometer Y-axis data
7:0 at Address 17	ACCEL_Y_OUT [15:8]	2^{nd} Lowest byte of Accelerometer Y-axis data
7:0 at Address 18	ACCEL_Y_OUT [7:0]	Lowest byte of Accelerometer Y-axis data

7.33 ACCEL_Z_OUTPUT

Follows the same format as ACCEL_X_OUTPUT register.

Register Name: ACCEL_Z_OUTPUT Address: 19 to 22 (0x13 to 0x16), Page ID: 1 Available Operation: Read, Flash backup: No, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:0 at Address 19	ACCEL_Z_OUT [31:24]	Highest byte of Accelerometer Z-axis data
7:0 at Address 20	ACCEL_Z_OUT [23:16]	2^{nd} Highest byte of Accelerometer Z-axis data
7:0 at Address 21	ACCEL_Z_OUT [15:8]	2^{nd} Lowest byte of Accelerometer Z-axis data
7:0 at Address 22	ACCEL_Z _OUT [7:0]	Lowest byte of Accelerometer Z-axis data

7.34 GYRO_X_OUTPUT

The gyroscopes in the IIM-46234 & IIM-46230 measure the angular rate of rotation around three orthogonal axes (x, y, and z). Each gyroscope has four bytes output data register. These four bytes combine to support a 32-bit data values. The output format of this gyroscope data is either "32-Bit IEEE 754 single-precision floating point" or "32-Bit Fixed point 2's Complement representation" according to the OUT_DATA_FORM register (refer to section 7.5 for details).

Register Name: GYRO_X_OUTPUT Address: 23 to 26 (0x17 to 0x1A), Page ID: 1 Available Operation: Read, Flash backup: No, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:0 at Address 23	GYRO_X_OUT [31:24]	Highest byte of Gyroscope X-axis data
7:0 at Address 24	GYRO _X_OUT [23:16]	2nd Highest byte of Gyroscope X-axis data
7:0 at Address 25	GYRO _X_OUT [15:8]	2nd Lowest byte of Gyroscope X-axis data
7:0 at Address 26	GYRO _X_OUT [7:0]	Lowest byte of Gyroscope X-axis data

7.35 GYRO_Y_OUTPUT

Follows the same format as the GYRO_X_OUTPUT register.

Register Name: GYRO_Y_OUTPUT Address: 27 to 30 (0x1B to 0x1E), Page ID: 1 Available Operation: Read, Flash backup: No, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:0 at Address 26	GYRO_Y_OUT [31:24]	Highest byte of Gyroscope Y-axis data
7:0 at Address 27	GYRO _Y_OUT [23:16]	2nd Highest byte of Gyroscope Y-axis data
7:0 at Address 28	GYRO _Y_OUT [15:8]	2nd Lowest byte of Gyroscope Y-axis data
7:0 at Address 29	GYRO _Y_OUT [7:0]	Lowest byte of Gyroscope Y-axis data

7.36 GYRO_Z_OUTPUT

Follows the same format as the GYRO_X_OUTPUT register.

Register Name: GYRO_Z_OUTPUT Address: 31 to 34 (0x1F to 0x22), Page ID: 1 Available Operation: Read, Flash backup: No, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:0 at Address 31	GYRO_Z_OUT [31:24]	Highest byte of Gyroscope Z-axis data
7:0 at Address 32	GYRO _Z_OUT [23:16]	2nd Highest byte of Gyroscope Z-axis data
7:0 at Address 33	GYRO _Z_OUT [15:8]	2nd Lowest byte of Gyroscope Z-axis data
7:0 at Address 34	GYRO _Z_OUT [7:0]	Lowest byte of Gyroscope Z-axis data

7.37 TEMPERA_OUTPUT

The output format of this temperature data is "32-Bit IEEE 754 single-precision floating point" or "32-Bit Fixed point 2's Complement representation" according to the OUT_DATA_FORM register (refer to section 7.5 for details).

Register Name: TEMPERA_OUTPUT **Address: 35 to 38 (0x23 to 0x26), Page ID: 1** **Available Operation: Read, Flash backup: No, Default value: N/A**		
BIT	**NAME**	**FUNCTION**
7:0 at Address 35	TEMPERA_OUTPUT [31:24]	Highest byte of temperature data
7:0 at Address 36	TEMPERA_OUTPUT [23:16]	2nd Highest byte of temperature data
7:0 at Address 37	TEMPERA_OUTPUT [15:8]	2nd Lowest byte of temperature data
7:0 at Address 38	TEMPERA_OUTPUT [7:0]	Lowest byte of temperature data

7.38 DELTA_VEL_X

In addition to acceleration measurements, the IIM-46234 & IIM-46230 measure the delta velocity along three orthogonal axes (x, y, and z). Each delta velocity measurement has four bytes output data register. These four bytes combine to support a 32-bit data values. The output format of this delta velocity along x-axis is either "32-Bit IEEE 754 single-precision floating point" or "32-Bit Fixed point 2's Complement representation" based on the OUT_DATA_FORM register value (refer to section 7.5). The "g" value programmed in CUSTOM_GRAVITY register (default 9.8m/sec^2) is used for delta velocity calculations.

Register Name: DELTA_VEL_X **Address: 39 to 42 (0x27 to 0x2A), Page ID: 1** **Available Operation: Read, Flash backup: No, Default value: N/A**		
BIT	**NAME**	**FUNCTION**
7:0 at Address 39	DELTA_VEL_X [31:24]	Highest byte of Delta Velocity X-axis data
7:0 at Address 40	DELTA_VEL_X [23:16]	2nd Highest byte of Delta Velocity X-axis data
7:0 at Address 41	DELTA_VEL_X [15:8]	2nd Lowest byte of Delta Velocity X-axis data
7:0 at Address 42	DELTA_VEL_X [7:0]	Lowest byte of Delta Velocity X-axis data

7.39 DELTA_VEL_Y

Follows the same format as DELTA_VEL_X.

Register Name: DELTA_VEL_Y **Address: 43 to 46 (0x2B to 0x2E), Page ID: 1** **Available Operation: Read, Flash backup: No, Default value: N/A**		
BIT	**NAME**	**FUNCTION**
7:0 at Address 43	DELTA_VEL_Y [31:24]	Highest byte of Delta Velocity Y-axis data
7:0 at Address 44	DELTA_VEL_Y [23:16]	2nd Highest byte of Delta Velocity Y-axis data
7:0 at Address 45	DELTA_VEL_Y [15:8]	2nd Lowest byte of Delta Velocity Y-axis data
7:0 at Address 46	DELTA_VEL_Y [7:0]	Lowest byte of Delta Velocity Y-axis data

7.40 DELTA_VEL_Z

Follows the same format as DELTA_VEL_X.

Register Name: DELTA_VEL_Z **Address: 47 to 50 (0x2F to 0x32), Page ID: 1** **Available Operation: Read, Flash backup: No, Default value: N/A**		
BIT	**NAME**	**FUNCTION**
7:0 at Address 47	DELTA_VEL_Z [31:24]	Highest byte of Delta Velocity Z-axis data
7:0 at Address 48	DELTA_VEL_Z [23:16]	2nd Highest byte of Delta Velocity Z-axis data
7:0 at Address 49	DELTA_VEL_Z [15:8]	2nd Lowest byte of Delta Velocity Z-axis data
7:0 at Address 50	DELTA_VEL_Z [7:0]	Lowest byte of Delta Velocity Z-axis data

7.41 DELTA_ANGLE_X

In addition to angular rate of rotation measurements, the IIM-46234 & IIM-46230 measure the delta angle around three orthogonal axes (x, y, and z). Each delta angle measurement has four bytes output data register. These four bytes combine to support a 32-bit data values. The output format of this delta angle around x-axis is either “32-Bit IEEE 754 single-precision floating point” or “32-Bit Fixed point 2’s Complement representation” based on the OUT_DATA_FORM register value (refer to section 7.5).

Register Name: DELTA_ANGLE_X **Address: 51 to 54 (0x33 to 0x36), Page ID: 1** **Available Operation: Read, Flash backup: No, Default value: N/A**		
BIT	**NAME**	**FUNCTION**
7:0 at Address 51	DELTA_ANGLE_X [31:24]	Highest byte of Delta Angle X-axis data
7:0 at Address 52	DELTA_ANGLE_X [23:16]	2nd Highest byte of Delta Angle X-axis data
7:0 at Address 53	DELTA_ANGLE_X [15:8]	2nd Lowest byte of Delta Angle X-axis data
7:0 at Address 54	DELTA_ANGLE_X [7:0]	Lowest byte of Delta Angle X-axis data

7.42 DELTA_ANGLE_Y

Follows the same format as DELTA_ANGLE_X.

Register Name: DELTA_ANGLE_Y **Address: 55 to 58 (0x37 to 0x3A), Page ID: 1** **Available Operation: Read, Flash backup: No, Default value: N/A**		
BIT	**NAME**	**FUNCTION**
7:0 at Address 55	DELTA_ANGLE_Y [31:24]	Highest byte of Delta Angle Y-axis data
7:0 at Address 56	DELTA_ANGLE_Y [23:16]	2nd Highest byte of Delta Angle Y-axis data
7:0 at Address 57	DELTA_ANGLE_Y [15:8]	2nd Lowest byte of Delta Angle Y-axis data
7:0 at Address 58	DELTA_ANGLE_Y [7:0]	Lowest byte of Delta Angle Y-axis data

7.43 DELTA_ANGLE_Z

Follows the same format as DELTA_ANGLE_X.

Register Name: DELTA_ANGLE_Z Address: 59 to 62 (0x3B to 0x3E), Page ID: 1 Available Operation: Read, Flash backup: No, Default value: N/A		
BIT	**NAME**	**FUNCTION**
7:0 at Address 59	DELTA_ANGLE_Z [31:24]	Highest byte of Delta Angle Z-axis data
7:0 at Address 60	DELTA_ANGLE_Z [23:16]	2^{nd} Highest byte of Delta Angle Z-axis data
7:0 at Address 61	DELTA_ANGLE_Z [15:8]	2^{nd} Lowest byte of Delta Angle Z-axis data
7:0 at Address 62	DELTA_ANGLE_Z [7:0]	Lowest byte of Delta Angle Z-axis data

8 ASSEMBLY

This section provides general guidelines for assembling TDK Micro Electro-Mechanical Systems (MEMS) gyroscopes and accelerometers packaged in an approximately 23 mm x 23 mm x 8.5 mm aluminum module package.

8.1 ORIENTATION OF AXES

Figure 20 shows the orientation of the axes of sensitivity and the polarity of rotation.

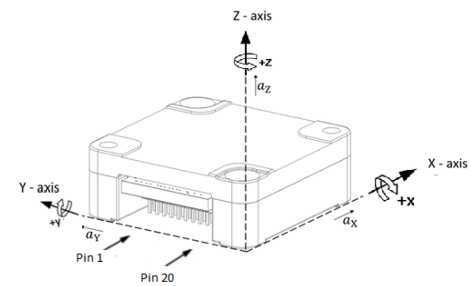
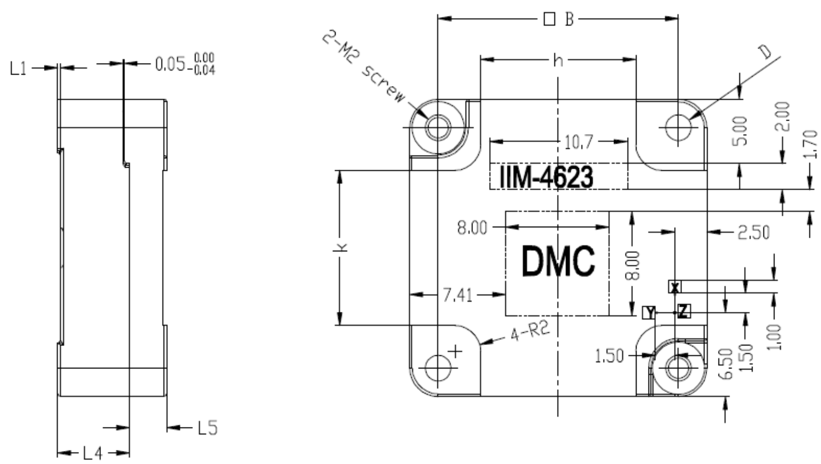


Figure 20. IIM-46234 & IIM-46230 Orientation of Axes and Polarity of Rotation

8.2 PACKAGE DIMENSIONS

The package top and side view are shown in Figure 16 while the bottom view is shown in Figure 17. The package dimensions and tolerances are shown in Table 20.



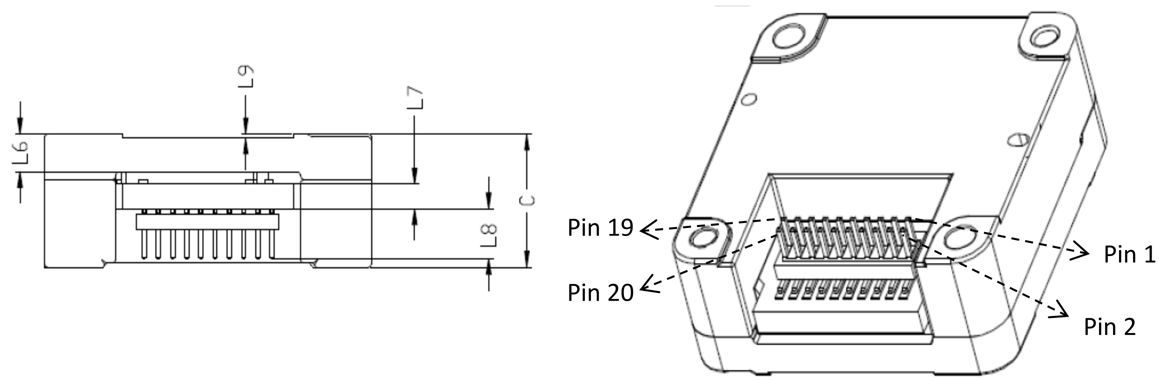


Figure 21. Package Top and Side View

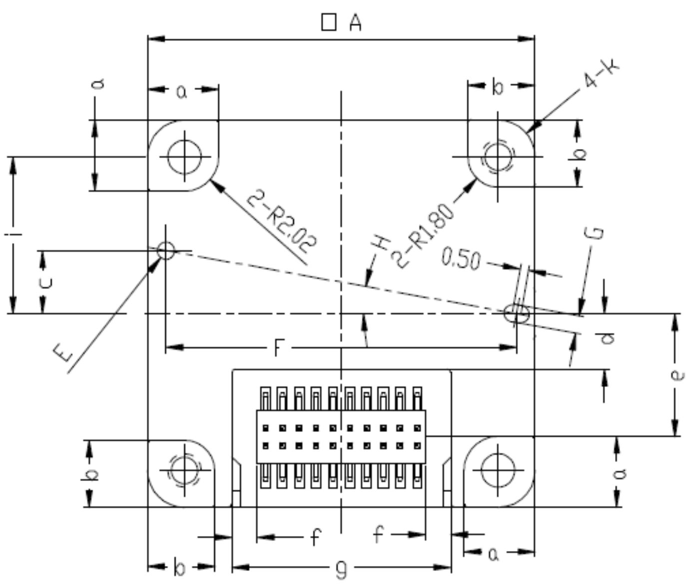


Figure 22. Package Bottom View

SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	22.90	23.0	23.2
B	18.55	18.60	18.65
C	8.33	8.43	8.53
a	4.12	4.22	4.32
b	3.9	4.0	4.1
c	3.72	3.74	3.76
d	3.19	3.29	3.39
e	7.22	7.32	7.42
D	Φ2.04	Φ 2.05	Φ 2.06
E	Φ 1.04	Φ 1.05	Φ 1.06
F	20.78	20.8	20.82
f	1.4	1.5	1.6
G	Φ 1.04	Φ 1.05	Φ 1.06
H	10.1°	10.2°	10.3°
g	12.9	13.0	13.1
L1	0.15	0.25	0.35
L4	5.50	5.55	5.60

L5	2.73	2.88	2.93
L6	2.28	2.38	2.48
L7	1.475	1.575	1.675
L8	3.05	3.18	3.44
h	11.9	12.0	12.1
i	9.28	9.3	9.32
j	R2,1	R2,2	R2,3
k	11.9	12	12.1
L9	0.15	0.25	0.35

Table 20. Package Dimensions

8.3 MOUNTING BEST PRACTICES

Follow the rules below when installing the IIM-46234 & IIM-46230 into a system to prevent irregular force profiles which can introduce bias errors in the sensors:

- Avoid any translational force (in the X, Y axis) on the electrical connector (as shown in Figure 18)
- Use M1.6 screws for the passthrough holes to install the IMUs on the PCB with the mating connector.
- Apply a suggested torque setting of 0.15 Nm uniformly on the two screws to avoid any unwanted warpage in the module.
- Care should be taken that the exposed dowel pin is less than 2.7 mm alignment pin hole on the IMUs, use the table below to determine the alignment dowel length

Description of Stackup	Length	units
Drill dept of the IMUs alignment hole	2.7	mm
Thickness of the customer PCB	2	mm
Drill dept of the customer alignment hole	4	mm
Length of Dowel from Section 4.3	8	mm
Mechanical/Tolerance clearance	**-0.7**	mm

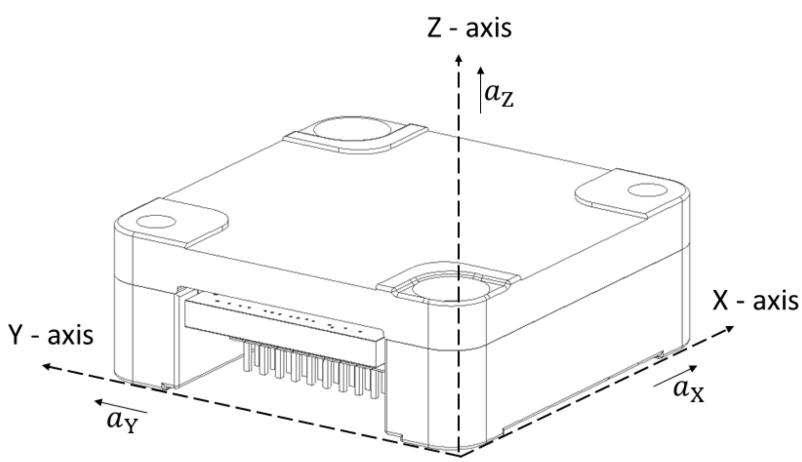


Figure 23. Accelerometer Axis in the module

9 PART NUMBER PACKAGE MARKING

The part number package marking for the IIM-46234 & IIM-46230 is summarized below:

PART NUMBER	PART NUMBER PACKAGE MARKING
IIM-46234	IIM-46234
IIM-46230	IIM-46230

Table 21. Part number package marking

Please note that the E in the symbol denotes engineering samples. The QR code contains

- The serial ID unique for each device (same as the value of the SERIAL_NUM register)
- Lot Traceability code – XXX XXX YY WW XX
  Where YY – Year code and WW – Work Week

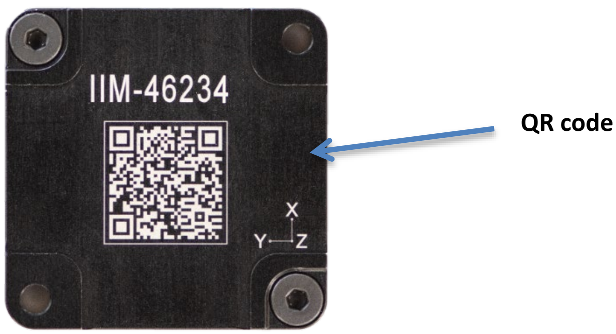


Figure 24. Part number package marking

10 SMARTINDUSTRIAL PRODUCT FAMILY

Industrial applications include precision agriculture, construction machinery, drones, automatic guided vehicles (AGVs), robots and industrial motors. Motion sensor data has become critical in enabling automation, improving efficiency, and monitoring conditions in these industrial applications. TDK's SmartIndustrial™ portfolio of **6-axis IMU** and **3-axis Accelerometer** products delivers the precise motion, vibration, and inclination measurements that these applications need. These products offer the ability to take precise measurements in harsh environments with vibration and wide temperature variations.

TDK's broad portfolio of Industrial Motion Sensing solutions offers customers a range of performance and cost choices, enabling a wide variety of Industrial navigation, stabilization, and monitoring applications.

By combining its innovative **MEMS Motion Sensor** technologies with its expertise of Industrial applications, TDK offers unique capabilities such as Fault-tolerant motion sensing solution.

11 REVISION HISTORY

REVISION DATE	REVISION	DESCRIPTION
01/13/2021	1.0	Initial release
09/17/2021	1.1	Updated Sections 7.14 to 7.16
02/14/2022	1.2	Added longevity info.
09/28/2022	1.3	Changed IIM-4623X to correct part number (IIM-46230 & IIM-46234)

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10 YEAR
COMMITMENT
LONGEVITY PROGRAM

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