



Features

- Precision 6-DOF MEMS Inertial Measurement Unit
- Compact and lightweight - 58.0 x 59.0 x 36.0H (mm), 190g
- Rugged, high shock survivability
- RoHS compliant
- -40°C to +75°C operating range
- RS422 interface
- Dynamic range: Angular $\pm 498^\circ/\text{s}$, Linear $\pm 30\text{g}$
- Bias instability: Angular 2.5°/hr, Linear 0.5mg
- Random walk: Angular $\leq 0.25^\circ/\text{hr}$, Velocity Acc 1: $\leq 1.2\text{m/s}/\text{hr}$, Acc 2 & 3: $\leq 0.6\text{m/s}/\text{hr}$
- Non-ITAR
- First class customer technical support

Applications

- Launch vehicles
- Small satellite stability control
- Precision guidance and navigation
- Unmanned aerial vehicles
- Unmanned marine systems
- Machine control
- INS (Inertial Navigation Systems)
- AHRS (Attitude and Heading Reference System)

1 General Description

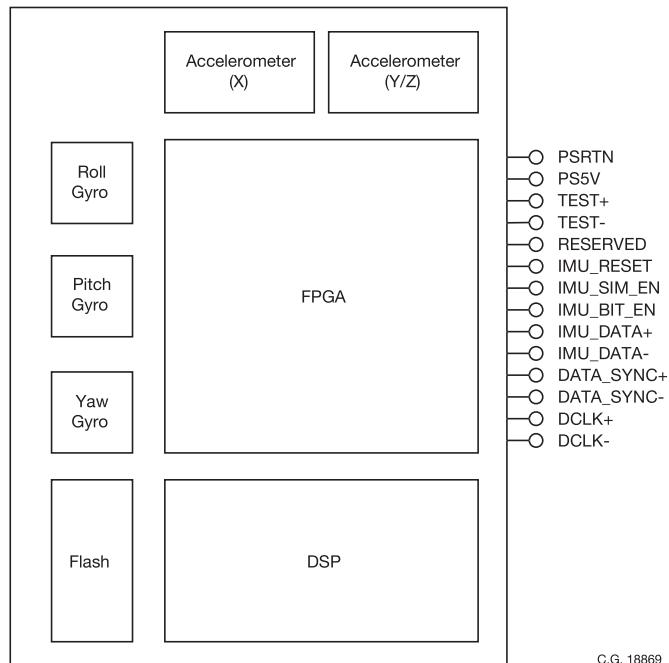
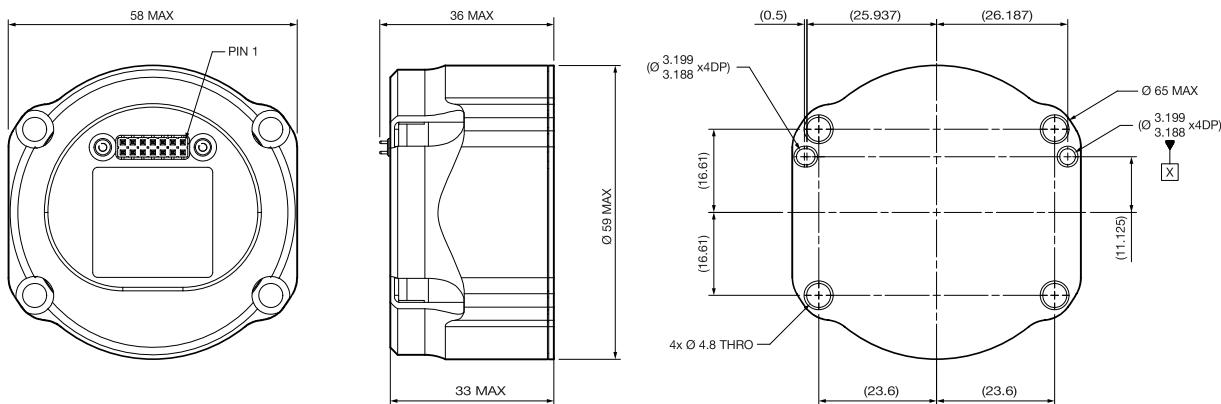
IMU20™ is a new precision all MEMS IMU incorporating Silicon Sensing's ultra-reliable industry-leading inductive resonating ring gyroscopes and high performance dual axis MEMS capacitive accelerometers.

IMU20™ is a compact six-degree of freedom inertial measurement unit providing precise outputs of angular rate, acceleration and temperature. With high levels of shock survivability, IMU20™ is designed specifically to meet the growing needs from the high-end commercial and industrial market applications for a high performance, non-ITAR IMU. IMU20™ utilises Silicon Sensing's class leading MEMS inertial sensors that are integrated and calibrated over the full temperature range using an in-house state of the art test facility.

Offering a convenient form factor when space and payload is at a premium, and able to perform through extremes, IMU20™ will continue to perform due to its ultra-reliable all MEMS sensors.

Rugged, Compact

MEMS Inertial Measurement Unit

**Figure 1.1 IMU20™ Functional Block Diagram**

All dimensions in millimetres.

Figure 1.2 IMU20™ Unit Overall Dimensions

Rugged, Compact

MEMS Inertial Measurement Unit

2 Ordering Information

Item	Description	Overall Dimensions	Part Number
	mm		
 IMU20-03-0100	High Performance MEMS Inertial Measurement Unit	58 x 59 x 36H	IMU20-03-0100
 IMU20 Evaluation Kit	Coming Soon Customer Evaluation Kit (EVK) comprising an RS422 to USB Connector, USB Driver and Data Logging Software, Cables and Connectors, Instruction Manual (IMU20™ is NOT included)	Not Applicable	Evaluation Kit not yet available

3 Specification

Parameter	Minimum	Typical (1σ)	Maximum (3σ)	Notes
Angular (Roll, Pitch, Yaw)				
Dynamic Range (°s)	-498	-	+498	Output saturates during over-range
Scale Factor Error (ppm)	-1500	500	+1500	2100 max indicative 1 year performance
Scale Factor Error Non-Linearity (ppm)	-750	250	+750	-
Bias (°/hr)	-150	50	+150	250 max indicative 1 year performance
Bias Instability (°/h)	-	-	2.5	As measured with the Allan Variance method
Random Walk (°/h)	-	-	0.25	
Gyro Misalignment and Cross Coupling (%)	-0.4	±0.06	0.4	Over operating temperature range
IMU Level Bandwidth (Hz)	-	-	>66	-90° phase
Indicative Noise (°/s rms)	-	-	0.3	Based on 85Hz bandwidth
VRE (°/hr/g rms)	-	-	5	-
g Sensitivity (°/hr/g)	-	-	8	-
Linear (X, Y, Z)				
Dynamic Range (g)	-30	-	30	Output saturates during over-range
Scale Factor Error (ppm)	-2100	700	+2100	±1g
Scale Factor Error Non-Linearity (ppm)	-4500	1500	+4500	±10g
Bias (mg)	-21	7	+21	-
Bias Instability (mg)	-	-	0.5	-
Random Walk (m/s/√h)	-	-	Acc 1: ≤1.2 Acc 2 & 3: ≤0.6	-
Acc Misalignment and Cross Coupling (%)	-0.4	±0.06	0.4	Over operating temperature range
IMU Level Bandwidth (Hz)	-	-	>87	-90° phase
Indicative Noise (mg rms)	-	-	Acc 1: ≤10 Acc 2 & 3: ≤6	Based on 85Hz bandwidth
VRE (mg/g²)	-	-	3	-

4 Environment, Power and Physical

Parameter	Minimum	Typical	Maximum	Notes
Environment				
Operating Temperature Range (°C)	-40	-	+75	-
Storage Temperature Range (°C)	-50 (Up to 72 hours)	-	+71 (Up to 10 diurnal cycles)	-
Operational Shock (g)	-	-	250, 1.7ms half sine	-
Non-Operational Shock (g)	-	-	60, 30ms half sine	-
Operational Random Vibration (g rms)	-	-	8.85	0.04g^2/Hz from 20Hz to 2kHz
Humidity (% rh)	-	-	95	Non Condensing, between 30°C and 60°C
Electrical and Interface				
Communication Protocol (standard)	-	RS-422	-	-
Data Rate (Hz)	-	200	-	-
Baud Rate (BPS)	-	460800	-	-
Startup Time (ms) (operational output)	-	-	400	-
Max Current Draw (A) (in-rush)	-	-	1.5 for 25ms 2 for 5ms	Depending on start up power supply transient
Max Current Draw (A) (steady-state)	-	-	0.75	-
Supply Voltage	+4.75	+5	+5.25	-
Physical				
Size (mm)	-	58 x 59 x 36H	-	-
Mass (grams)	-	190	-	±10%

5 Typical Performance Characteristics

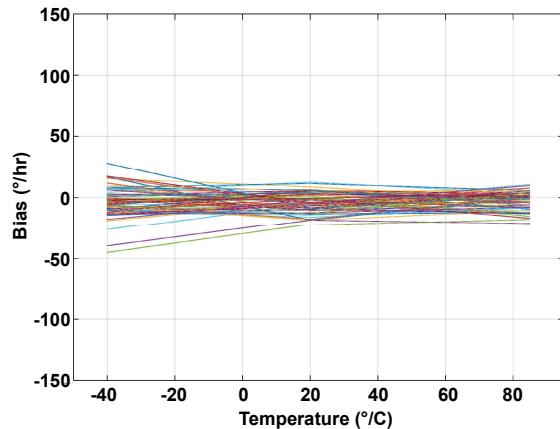


Figure 5.1 Gyro Bias over Temperature

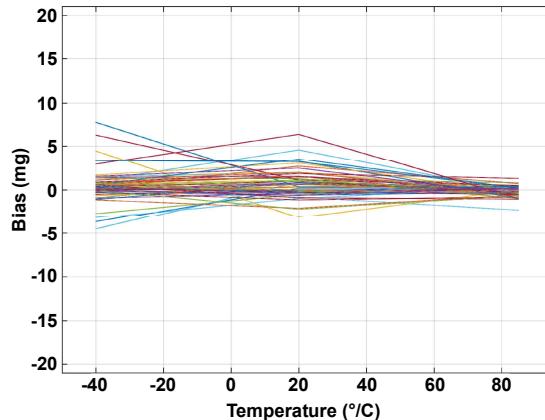


Figure 5.4 Accelerometer Bias over Temperature

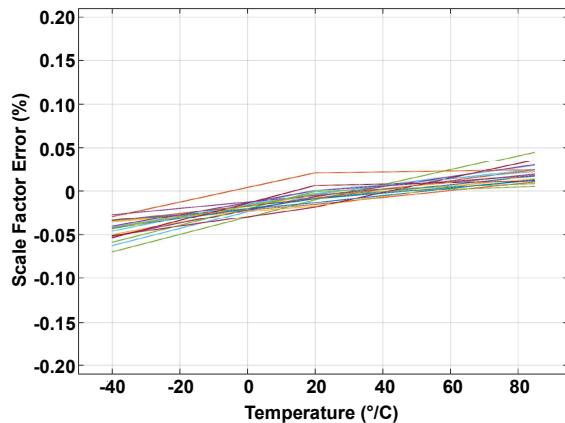


Figure 5.2 Gyro Scale Factor Error (high rate)

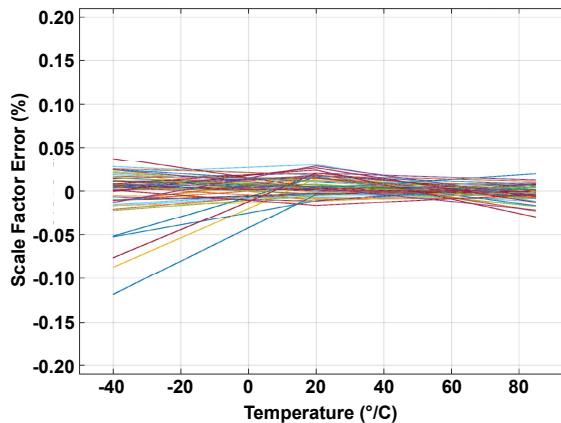


Figure 5.5 Accelerometer Scale Factor Error

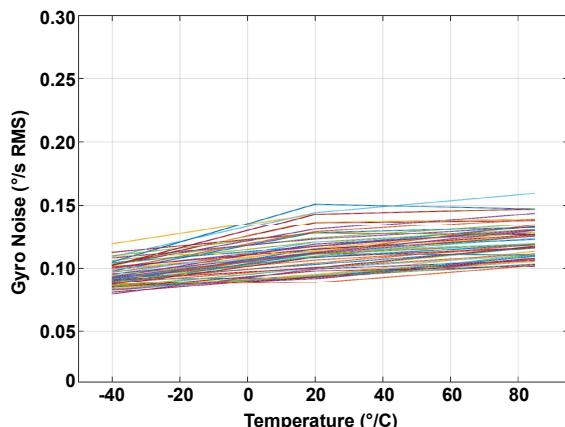


Figure 5.3 Gyro Noise over Temperature

6 Glossary of Terms

A	Amps
Acc	Accelerometer
BIT	Built In Test
BPS	Bits Per Second
C	Celsius or Centigrade
CAD	Computer Aided Design
dc	Direct Current
DOF	Degrees of Freedom
DSP	Digital Signal Processor
EPROM	Erasable Prog'ble Read-Only Memory
EVK	Evaluation Kit
FPGA	Field Programmable Gate Array
Freq	Frequency
g	Acceleration due to gravity
hr	Hour
Hz	Hertz, Cycles Per Second
IMU	Inertial Measurement Unit
ITAR	Internat'l Traffic in Arms Regulations
k	Kilo
MDS	Material Datasheet
MEMS	Micro-Electro Mechanical Systems
mm	Millimeters
ms	Milliseconds
PD	Primary Drive
ppm	Parts Per Million
Quad	Quadrature
RAM	Random Access Memory
RH	Relative Humidity
rms	Root Mean Square
RoHS	Restriction of Hazardous Substances
s	Seconds
USB	Universal Serial Bus
V	Volts
VRE	Vibration Rectification Error

7 Interface

Physical and electrical inter-connect and RS422 message information.

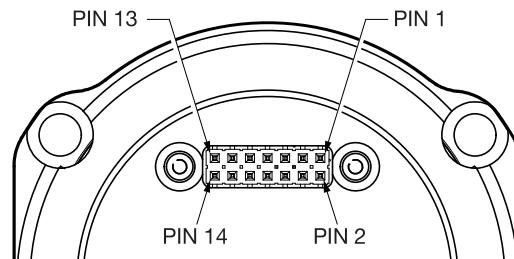
7.1 Electrical Interface

The IMU20™ has a 14-pin connector for integrating to the host system.

Pin No.	Signal Name	Signal Description	In/Out
1	PSRTN	5V dc Supply return path	I
2	PS5V	5V dc Supply	I
3	TEST+	Programming input: Not available to user	I
4	TEST-	Programming input: Not available to user	I
5	RESERVED	Test input: Not available to user	I
6	IMU_RESET	Logic 1 = Reset IMU Logic 0 = Normal operation (pulled low internally if not connected)	I
7	IMU_SIM_EN-	Logic 1 = Normal operation (pulled high internally if not connected) Logic 0 = Tri-state RS-485 outputs	I
8	IMU_BIT_EN-	Logic 1 = Normal operation (pulled high internally if not connected) Logic 0 = IMU perform Command BIT	I
9	IMU_DATA+	Inertial Data Stream: RS-485 levels	O
10	IMU_DATA-	Inertial Data Stream: RS-485 levels	O
11	DATA_SYNC+	Synchronisation Signal: RS-485 levels	O
12	DATA_SYNC-	Synchronisation Signal: RS-485 levels	O
13	DCLK+	Clock Signal: RS-485 levels	-
14	DCLK-	Clock Signal: RS-485 levels	-

Table 7.1 Pin Information

7.2 Pin Information



IMU20™ uses a SAMTEC TMM-107-06-L-D-SM connector.

Figure 7.1 Pin Numbering as Viewed onto the Pins

7.3 Message Information

Item	Word	Data Item	Value/Units
0	0	Header	16 bit, 0x55AA Sync Pattern
1	1	Message Count	16 bit, 0 to 65535 Decimal
2	2-3	Axis 1 Rate	Single Precision Floating Point (°/s)
3	4-5	Axis 1 Accelerometer	Single Precision Floating Point (g)
4	6-7	Axis 2 Rate	Single Precision Floating Point (°/s)
5	8-9	Axis 2 Accelerometer	Single Precision Floating Point (g)
6	10-11	Axis 3 Rate	Single Precision Floating Point (°/s)
7	12-13	Axis 3 Accelerometer	Single Precision Floating Point (g)
8	14-15	Tacho Data (Factory use)	Single Precision Floating Point (°/s)
9	16-17	Average Temperature	Single Precision Floating Point (°C)
10	18	BIT Mode and Test Results	16 bit - see Table 7.3
11	19	BIT Mode and Test Results	16 bit - see Table 7.3
12	20	BIT Mode and Test Results	16 bit - see Table 7.3
13	21	Checksum	16 bit 2's complement of the 16 bit sum of the previous 21 16 bit words

Table 7.2 Data Output Definition

Data Item 10,11 and 12 Bit Number	Value/Units
0	Gyro 1
1	Gyro 2
2	Gyro 3
3	Accelerometer 1
4	Accelerometer 2
5	Accelerometer 3
6	RAM
7	EPROM
8	Gyro Freq
9	Gyro Rate
10	Gyro Quad
11	Gyro PD
12	Acc
13	Acc Temp
14	BIT Mode - See Table 4
15	BIT Mode - See Table 4

Table 7.3 BIT Output Definition

Note that in the event of a failure, bits 0 to 7 indicate which sensor(s) or sub-system(s) has (have) failed, and bits 8 to 13 show the reason for the failure(s).

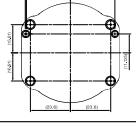
The BIT mode shall be indicated in bits 14 & 15 as follows:

Bit#15	Bit#14	Status Information	Bits 0 to 15 Valid ?
0	0	Start Up or Commanded BIT reporting	Yes
0	1	Start Up BIT in progress	Incomplete
1	0	Commanded BIT in progress	Incomplete
1	1	Periodic BIT reporting	Yes

Table 7.4 BIT Modes

Note that the Start Up and Commanded BIT results are latched for 10 messages (bits 14 and 15 set to "00") before the BIT mode reverts to its default state of Periodic BIT reporting (bits 14 and 15 set to "11").

8 Design Tools and Resources Available

Item	Description of Resource	Part Number	Order/Download
	IMU20™ Brochure: A one page sales brochure describing the key features of the IMU20™ Inertial Measurement Unit.	IMU20-00-0100-900	Download (www.siliconsensing.com)
	IMU20™ Datasheet: Full technical information on all IMU20™ Dynamic Measurement Unit part number options. Specification and other essential information for assembling and interfacing to IMU20™ Inertial Measurement Unit, and getting the most out of it.	IMU20-03-0100-132	Download (www.siliconsensing.com)
	Evaluation Kit: Delivered with an RS422 to USB interface, plug-and-play real time display and logging software and two interface cabling solutions IMU20™ unit NOT included.	Evaluation Kit not yet available	-
	IMU20™ Presentation: A useful presentation describing the features, construction, principles of operation and applications for the IMU20™ Inertial Measurement Unit.	-	-
	Solid Model CAD files for IMU20™ Inertial Measurement Unit: Available in .STP and .IGS file formats.	IMU20-00-0100-408	-
	IMU20™ Installation Drawing: CAD file containing host interface geometry. Available in .STP and .IGS file formats.	IMU20-00-0100-403	-
	RoHS compliance statement for IMU20™: IMU20™ is fully compliant with RoHS. For details of the materials used in the manufacture please refer to the MDS Report.	-	Download (www.siliconsensing.com)

9 Installation Details

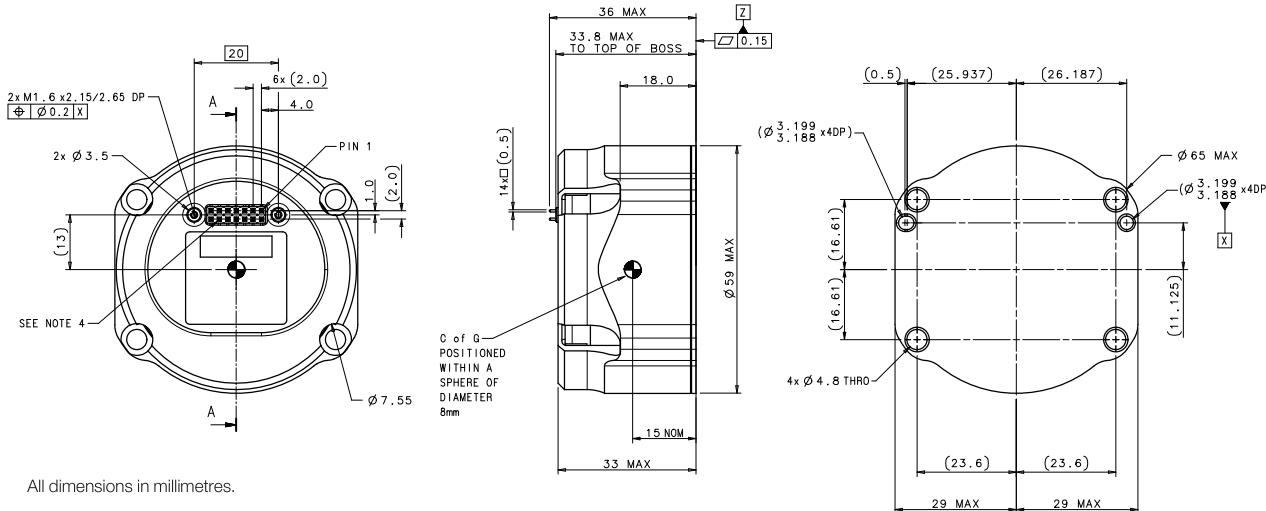


Figure 9.1 IMU20™ Installation Drawing

10 Axis Definitions and Sensing Points

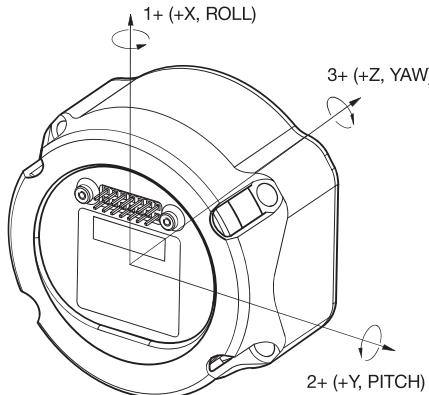


Figure 10.1 Axis Definitions

IMU20™

Rugged, Compact
MEMS Inertial Measurement Unit

Technical Datasheet

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Notes

IMU20™

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Notes

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