

IMU20™

Technical Datasheet

Rugged, Compact

MEMS Inertial Measurement Unit

SILICON
SENSING®

www.siliconsensing.com



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 interfaces
- Dynamic range: Angular $\pm 498^\circ/\text{s}$, Linear $\pm 30\text{g}$
- Bias instability: Angular $2.5^\circ/\text{hr}$, Linear 0.5mg
- Random walk: Angular $\leq 0.25^\circ/\sqrt{\text{hr}}$, Velocity Acc 1: $\leq 1.2\text{m/s}/\sqrt{\text{hr}}$, Acc 2 & 3: $\leq 0.6\text{m/s}/\sqrt{\text{hr}}$
- Non-ITAR
- First class customer technical support

Applications

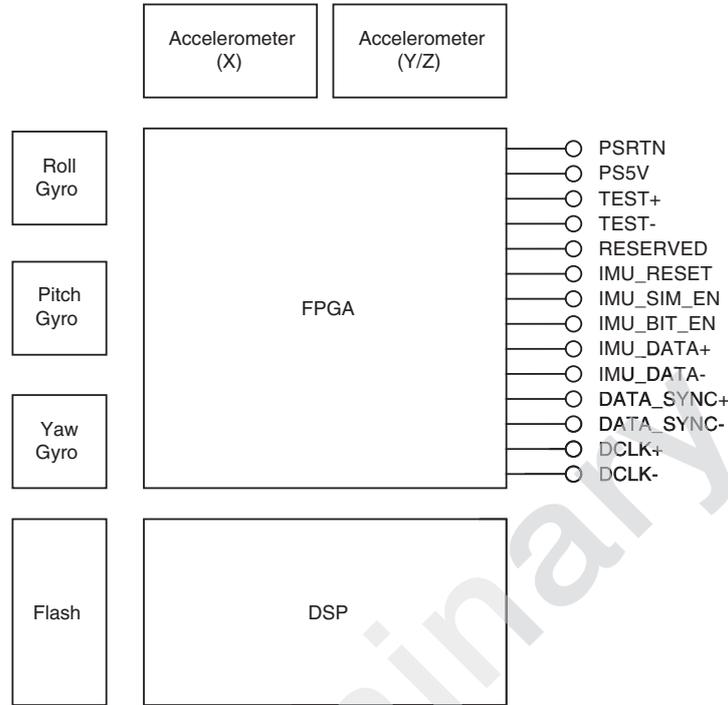
- Small satellite stability control
- Precision guidance and navigation
- Launch vehicles
- Unmanned aerial vehicles
- Unmanned marine systems
- Machine control
- INS (Inertial Navigation Systems)
- AHRS (Attitude and Heading Reference Unit)

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.

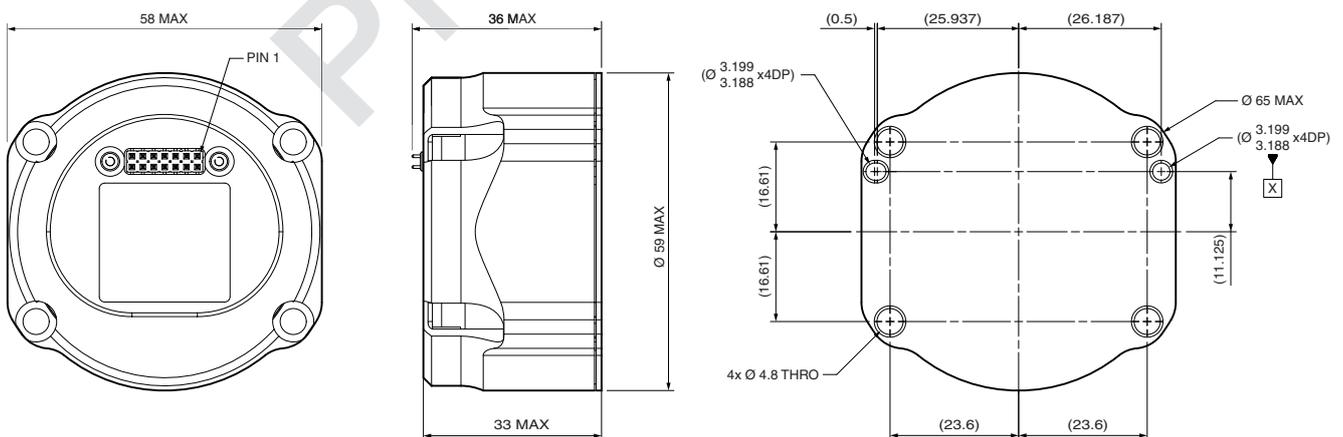
IMU20™ is a compact six-degree of freedom inertial measurement unit providing precise outputs of angular rate, acceleration and temperature. With high levels of shock survivability, IMU20™ is designed specifically to meet the growing needs from the high-end commercial and industrial market applications 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.



C.G. 18869

Figure 1.1 IMU20™ Functional Block Diagram



All dimensions in millimetres.

Figure 1.2 IMU20™ Unit Overall Dimensions

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2 Ordering Information

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

Preliminary

3 Specification

| Parameter | Minimum | Typical | Maximum | Notes |
|--|---------|---------|--------------------------------|---|
| Angular (Roll, Pitch, Yaw) | | | | |
| Dynamic Range (°/s) | -498 | - | +498 | Output saturates during over-range |
| Scale Factor Error (ppm) | - | - | 1500 | 2100 max indicative 1 year performance |
| Scale Factor Error Non-Linearity (ppm) | - | - | 750 | - |
| Bias (°/hr) | - | - | 150 | 250 max indicative 1 year performance |
| Bias Instability (°/h) | - | - | 2.5 | As measured with the Allan Variance method. |
| Random Walk (°/√h) | - | - | 0.25 | |
| 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 | ±1g |
| Scale Factor Error Non-Linearity (ppm) | - | - | 4500 | ±10g |
| Bias (mg) | - | - | 21 | - |
| Bias Instability (mg) | - | - | 0.5 | - |
| Random Walk (m/s/√h) | - | - | Acc 1: ≤1.2 Acc 2 & 3: ≤0.6 | - |
| 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) | - | - | Will survive after 10 day diurnal cycle between 33°C and 71°C |
| 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 |
| Sealing | - | - | - | - |
| Electrical and Interface | | | | |
| Communication Protocol (standard) | - | RS-422 | - | - |
| Data Rate (Hz) | - | 200 | - | - |
| Baud Rate (BPS) | - | 460800 | - | - |
| Startup Time (ms) (operational output) | - | - | 350 | - |
| Max Current Draw (A) (in-rush) | - | - | 1.5 for 25ms | - |
| Max Current Draw (A) (steady-state) | - | - | 0.75 | - |
| Supply Voltage | +4.75 | +5 | +5.25 | - |

4 Environment, Power and Physical Continued

| Parameter | Minimum | Typical | Maximum | Notes |
|-----------------|---------|---------------|---------|-------|
| Physical | | | | |
| Size (mm) | – | 58 x 59 x 36H | – | – |
| Mass (grams) | – | 190 | – | ±10% |

5 Typical Performance Characteristics

Data to follow.

Preliminary

6 Glossary of Terms

| | |
|-------|---|
| ADC | Analogue to Digital Converter |
| ARW | Angle Random Walk |
| AWG | American Wire Gauge |
| BPS | Bits Per Second |
| BW | Bandwidth |
| C | Celsius or Centigrade |
| DAC | Digital to Analogue Converter |
| DPH | Degrees Per Hour |
| DPS | Degrees Per Second |
| DRIE | Deep Reactive Ion Etch |
| EMC | Electro-Magnetic Compatibility |
| ESD | Electro-Static Damage |
| hr | Hour |
| HPIMU | High Performance MEMS Inertial Measurement Unit |
| Hz | Hertz, Cycles Per Second |
| K | Kilo |
| MDS | Material Datasheet |
| MEMS | Micro-Electro Mechanical Systems |
| mV | Milli-Volts |
| NEC | Not Electrically Connected |
| NL | Scale Factor Non-Linearity |
| OEM | Original Equipment Manufacturer |
| OT | Over Temperature |
| PD | Primary Drive |
| PP | Primary Pick-Off |
| RC | Resistor and Capacitor filter |
| RT | Room Temperature |
| s | Seconds |
| SF | Scale Factor |
| SMT | Surface Mount Technology |
| SOG | Silicon On Glass |
| SD | Secondary Drive |
| SP | Secondary Pick-Off |
| TBA | To Be Advised |
| TBC | To Be Confirmed |
| TBD | To Be Determined |
| V | Volts |

7 Interface

Physical and electrical inter-connect and RS422 message information.

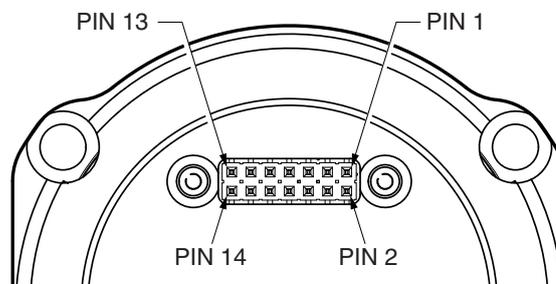
7.1 Electrical Interface

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 pin | 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

| Item | Word | Data Item | Value/Units |
|------|-------|---------------------------|---|
| 0 | 0 | Header | 16 BIT, 0x55AA Synch 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 | - |
| 9 | 16-17 | Average Temperature | Single Precision Floating Point (°C) |
| 10 | 18 | BIT Mode and Test Results | 16 BIT - see BIT Mode and Test Results |
| 11 | 19 | BIT Mode and Test Results | 16 BIT - see BIT Mode and Test Results |
| 12 | 20 | BIT Mode and Test Results | 16 BIT - see BIT Mode and Test Results |
| 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 17 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).

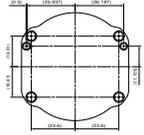
The BIT mode shall be indicated in bits 14 & 15 as follows:

| 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 |

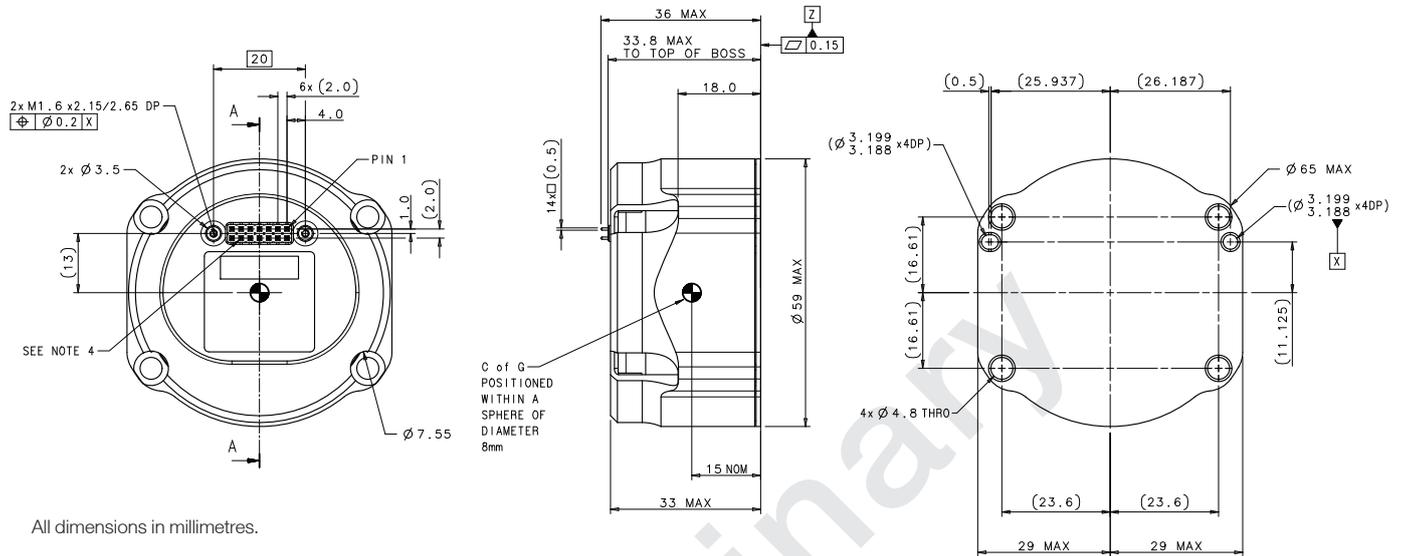
Table 7.4 BIT Modes

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



All dimensions in millimetres.

Figure 9.1 IMU20™ Installation Drawing

10 Axis Definitions and Sensing Points

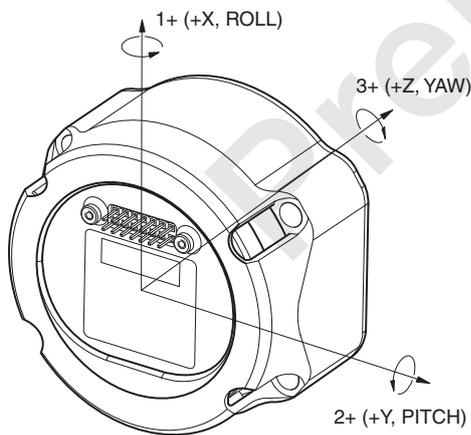


Figure 10.1 Axis Definitions

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