

# HIGH PERFORMANCE GYRO



SAR100

PRODUCT BRIEF

## FEATURES

- Up to  $\pm 1500^\circ/\text{s}$  input range
- Horizontal or vertical mounting
- $0.02^\circ/\text{s}$  in-run bias stability
- $0.15^\circ/\text{s}$  (RMS) noise
- $0.03^\circ/\text{s/g}$  linear acceleration effect
- 5000g shock capability
- Sensor and ASIC automotive qualified according to AEC-Q100



## DESCRIPTION

The SAR100 gyro contains a ButterflyGyro™ MEMS die and a BiCMOS mixed mode ASIC, housed in a rigid custom ceramic LCC package to accommodate both horizontal and vertical mounting. The sensor is factory-calibrated and compensated for temperature effects to provide high-accuracy digital output over a broad temperature range.

### Input ranges

SAR100 angular rate sensor has a standard full-scale input ranges of  $400^\circ/\text{s}$ ,  $250^\circ/\text{s}$  or  $100^\circ/\text{s}$ . For custom requirements, it can support ranges up to  $1500^\circ/\text{s}$ .

### Reliability and robustness

By utilizing a unique sealed cavity technology, the vibrating masses of the sensor are contained within the low-pressure hermetic environment. This provides excellent reliability without any degradation over lifetime of the device.

A closed-loop force feedback operation

with electrostatic tuning of excitation and detection frequencies, as well as perfect mechanical and electrical balancing of the vibrating masses, results in exceptionally low shock and vibration sensitivity.

### Interface

An SPI interface of the device enables easy and effective communication to the application. Serial data bus frequencies up to 8.5MHz are supported, and the angular rate data output format is 12-bit 2's complement at a maximum sampling rate of 2000SPS.

### Self diagnostics

A number of functions are available through the digital SPI interface of the device, including advanced self diagnostics.

A status register contains rate overflow information (recoverable error), excitation and detection loop diagnosis and supply voltage information etc. In case of any irregularities detected, a

specific error code is reported.

### Applications

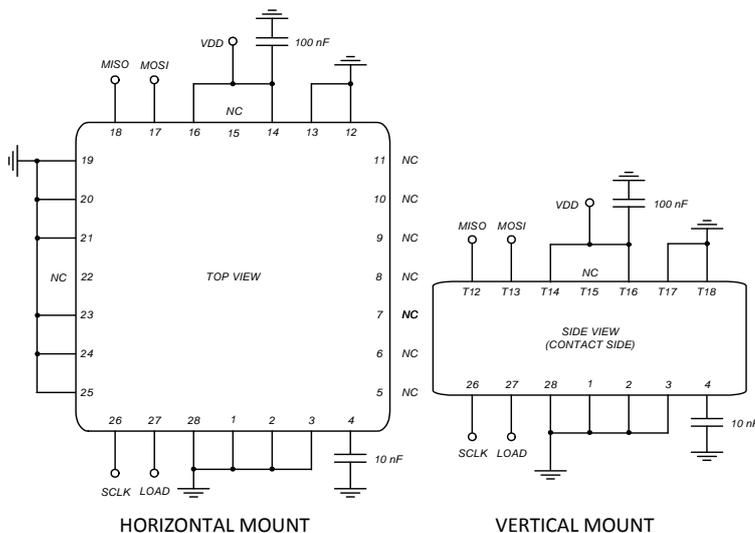
SAR100 is a product with high bias and scale factor stability, designed for demanding applications. It is highly rugged, consumes only 50mW and offers the best value of any gyro product in its class of performance.

SAR100 ideal for platform stabilization (e.g. antennas, cameras, etc.), robot head positioning, borehole surveys, inertial navigation systems (INS), smart munitions, train applications, aircraft instruments, unmanned aerial vehicles (UAV), autonomous underwater vehicles (AUV), agricultural machines, etc.

SPECIFICATIONS

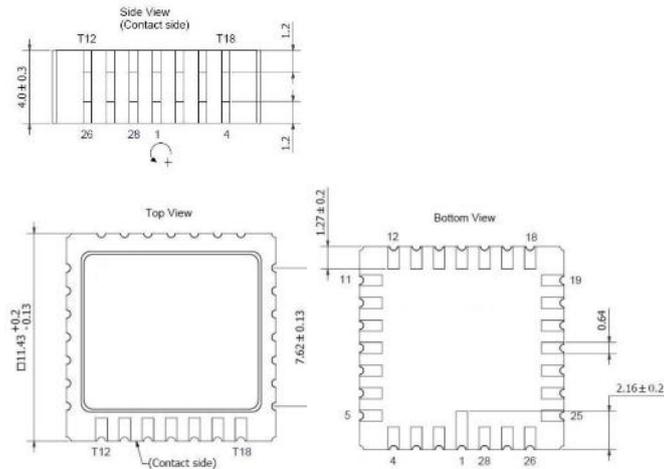
Parameter	Min	Nom	Max	Unit
Weight		1.5		g
<b>Functional characteristics</b>				
Input range (ΩFSI)		±400		°/s
		±250		°/s
		±100		°/s
Operating temperature	-40		90	°C
Power supply	4.45	5.0	5.5	V
Supply current			17	mA
Start-up time		90		ms
Maximum sampling frequency		2000		SPS
Storage temperature	-55		125	°C
Dynamic overload		5000		°/s
Mechanical shock			5000	g
<b>Angular rate measurements</b>				
Word length		12		bit
Scale factor	±400°/s (ΩFSI)	0.25		°/s/LSB
	±250°/s (ΩFSI)	0.25		°/s/LSB
	±100°/s (ΩFSI)	0.10		°/s/LSB
Scale factor temperature accuracy		±0.5		%
Bias temperature accuracy		±0.5		°/s
Sensitivity accuracy		±1		%
In-run bias stability		0.02		°/s
Noise	±400°/s (ΩFSI)	0.25		°/s (rms)
	±250°/s (ΩFSI)	0.23		°/s (rms)
	±100°/s (ΩFSI)	0.15		°/s (rms)
Bandwidth (-3dB)		50		Hz
Non-linearity		0.1		%FS
Linear acceleration effect			0.03	°/s/g
<b>Temperature measurements</b>				
Word length		8		bit
Scale factor		1		°C/LSB
Accuracy		±2		°C
<b>SPI interface</b>				
Data rate			8.5	Mbit/s

ELECTRICAL CONNECTIONS



MECHANICAL DIMENSIONS

All dimensions in mm. The sensitive axis is indicated with arrow and sign.



PIN OUT

Horizontal mount	Vertical mount	Pin name	Comment
1	1	GND	Connect to ground
2	2	AVSS	Connect to ground
3	3	-	Connect to ground
4	4	REFV	Connect a 10 nF low ESR decoupling capacitor between this pin and ground
5	-	-	NC
6	-	-	NC
7	-	-	NC
8	-	-	NC
9	-	-	NC
10	-	-	NC
11	-	-	NC
12	T18	-	Connect to ground
13	T17	-	Connect to ground
14	T16	AVDD	Connect to +5 VDC <sup>1)</sup>
15	T15	-	NC
16	T14	VDD	Connect to +5 VDC <sup>1)</sup>
17	T13	MOSI	SPI data input
18	T12	MISO	SPI data output
19	-	-	Connect to ground
20	-	-	Connect to ground
21	-	-	Connect to ground
22	-	-	NC
23	-	-	Connect to ground
24	-	-	Connect to ground
25	-	-	Connect to ground
26	26	SCLK	SPI clock
27	27	LOAD	SPI load
28	28	VSS	Connect to ground

<sup>1)</sup> Connect these pins together as close as possible to the package, and from there to ground via a 100nF low ESR decoupling capacitor.

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### FEATURES

- Up to  $\pm 1500^\circ/\text{s}$  input range
- Horizontal or vertical mounting
- $50^\circ/\text{h}$  in-run bias stability
- $0.65^\circ/\text{vh}$  angular random walk
- $0.03^\circ/\text{s/g}$  linear acceleration effect
- 5000g shock capability
- Sensor and ASIC automotive qualified according to AEC-Q100



### DESCRIPTION

The SAR150 gyro contains a ButterflyGyro™ MEMS die and a BiCMOS mixed mode ASIC, housed in a rigid custom ceramic LCC package to accommodate both horizontal and vertical mounting. The sensor is factory-calibrated and compensated for temperature effects to provide high-accuracy digital output over a broad temperature range.

#### Input ranges

SAR150 angular rate sensor has a standard full-scale input ranges of  $400^\circ/\text{s}$ ,  $250^\circ/\text{s}$  or  $100^\circ/\text{s}$ . For custom requirements, it support ranges up to  $1500^\circ/\text{s}$ .

#### Reliability and robustness

By utilizing a unique sealed cavity technology, the vibrating masses of the sensor are contained within the low-pressure hermetic environment. This provides excellent reliability without any degradation over lifetime of the device.

A closed-loop force feedback operation

with electrostatic tuning of excitation and detection frequencies, as well as perfect mechanical and electrical balancing of the vibrating masses, results in exceptionally low shock and vibration sensitivity.

#### Interface

An SPI interface of the device enables easy and effective communication to the application. Serial data bus frequencies up to 8.5MHz are supported, and the angular rate data output format is 12-bit 2's complement at a maximum sampling rate of 2000SPS.

#### Self diagnostics

A number of functions are available through the digital SPI interface of the device, including advanced self diagnostics.

A status register contains rate overflow information (recoverable error), excitation and detection loop diagnosis bits and supply voltage information. In case of any irregularities detected, a

specific error code is reported.

#### Applications

SAR150 is a product with high bias and scale factor stability, designed for demanding applications. It is highly rugged, consumes only 50mW and offers the best value of any gyro product in its class of performance.

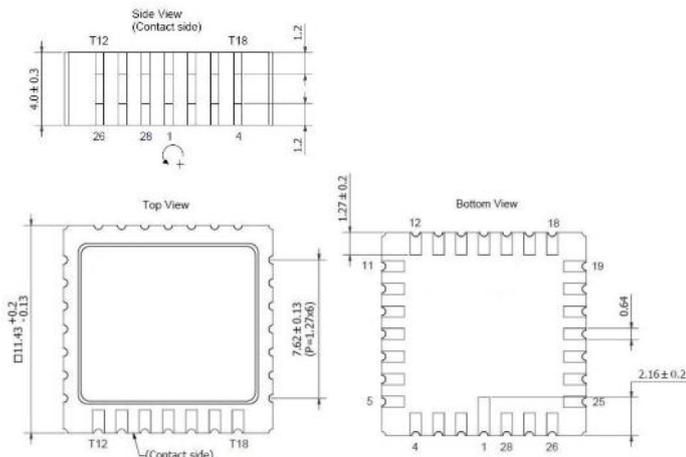
The device is ideal for platform stabilization (e.g. antennas, cameras, etc.), robot head positioning, borehole surveys, inertial navigation systems (INSs), smart munitions, train applications, aircraft instruments, unmanned aerial vehicles (UAVs), autonomous underwater vehicles (AUVs), agricultural machines, etc.

SPECIFICATIONS

Parameter	Min	Nom	Max	Unit
Weight		1.5		g
<b>Functional characteristics</b>				
Input range (ΩFSI)		±400		°/s
		±250		°/s
		±100		°/s
Operating temperature	-40		90	°C
Power supply	4.45	5.0	5.5	V
Supply current			17	mA
Start-up time		90		ms
Maximum sampling frequency		2000		SPS
Storage temperature	-55		125	°C
Dynamic overload		5000		°/s
Mechanical shock			5000	g
<b>Angular rate measurements</b>				
Word length		12		bit
Scale factor	±400°/s (ΩFSI)	0.25		°/s/LSB
	±250°/s (ΩFSI)	0.25		°/s/LSB
	±100°/s (ΩFSI)	0.10		°/s/LSB
Scale factor temperature accuracy		±0.5		%
Bias temperature accuracy		±0.5		°/s
Sensitivity accuracy		±1		%
In-run bias stability		50		°/h
ARW	±400°/s (ΩFSI)	0.80		°/√h
	±250°/s (ΩFSI)	0.75		°/√h
	±100°/s (ΩFSI)	0.65		°/√h
Bandwidth (-3dB)		50		Hz
Non-linearity		0.1		%FS
Linear acceleration effect			0.01	°/s/g
<b>Temperature measurements</b>				
Word length		8		bit
Scale factor		1		°C/LSB
Accuracy		±2		°C
<b>SPI interface</b>				
Data rate			8.5	Mbit/s

MECHANICAL DIMENSIONS

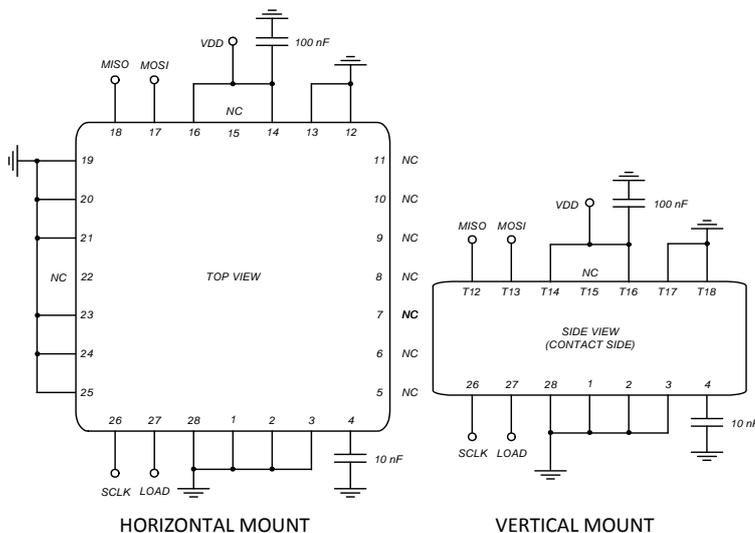
All dimensions in mm. The sensitive axis is indicated with arrow and sign.



PIN OUT

Horizontal mount	Vertical mount	Pin name	Comment
1	1	GND	Connect to ground
2	2	AVSS	Connect to ground
3	3	-	Connect to ground
4	4	REFV	Connect a 10 nF low ESR decoupling capacitor between this pin and ground
5	-	-	NC
6	-	-	NC
7	-	-	NC
8	-	-	NC
9	-	-	NC
10	-	-	NC
11	-	-	NC
12	T18	-	Connect to ground
13	T17	-	Connect to ground
14	T16	AVDD	Connect to +5 VDC <sup>1)</sup>
15	T15	-	NC
16	T14	VDD	Connect to +5 VDC <sup>1)</sup>
17	T13	MOSI	SPI data input
18	T12	MISO	SPI data output
19	-	-	Connect to ground
20	-	-	Connect to ground
21	-	-	Connect to ground
22	-	-	NC
23	-	-	Connect to ground
24	-	-	Connect to ground
25	-	-	Connect to ground
26	26	SCLK	SPI clock
27	27	LOAD	SPI load
28	28	VSS	Connect to ground

ELECTRICAL CONNECTIONS



1) Connect these pins together as close as possible to the package, and from there to ground via a 100nF low ESR decoupling capacitor.

# ULTRA-HIGH PERFORMANCE GYRO MODULE



STIM202

PRODUCT BRIEF

- Small size, low weight and low cost
- ITAR free
- Insensitive to magnetic fields
- 0.5°/h bias instability
- 0.2°/√h angular random walk
- ±400°/s angular rate input range
- 1500g shock capability



(39mm x 45mm x 20mm)

STIM202 is a multi-axis gyro module with up to 3 axes of highly accurate MEMS gyros. Each axis is factory calibrated for bias and sensitivity, and compensated for temperature effects over the full temperature operating range.

For many applications STIM202 replaces FOG's and improve system solutions directly with respect to robustness, reliability, size/ weight, power and cost. STIM202 industrialization is realized by combining the well proven Sensoror ButterflyGyro™ technology with full digital operation.

## Input range, orthogonality and output formats

The STIM202 full-scale angular rate input range is 400°/s and the output is capped at ±480°/s. 3-axis modules feature electronic axis alignment, improving orthogonality between axis (down to 1mrad). Selectable output formats are angular rate, increment angle, average angular rate and integrated angle, at sampling rates up to 1000 samples per second.

## Reliability and robustness

Perfect tuning of excitation and detection frequencies, as well as perfectly balanced vibrational masses, result in very low sensitivity to vibration and shock. For use in extreme environments, the STIM202 provides a vibration isolated internal assembly to avoid rectification errors.

## Power and Interface

The unit is powered by a single +5V supply and communicates via a Plug-and-Play high-level RS422 interface at bit rates up to 921600 bits/s.

## Device configurations and self diagnostics

The use of a 32-bit RISC ARM microcontroller provides flexibility in device configuration. Choices for output unit, sampling frequency, LP filter cut-off frequency, RS422 transmission bit rate, line termination ON/OFF, etc. can be done in device Service Mode. The Service Mode also provides the ability to perform single measurements on demand and access detailed diagnostics information.

## Evaluation kits

STIM202 evaluation kits for PCI and USB connectivity are available. The PCI kit is the recommended choice for thorough characterization. The PCI kit supports all STIM202 RS422 transmission bit rates (374400, 460800 and 921600 bits/s). The USB kit is the alternative solution, e.g. for smaller, portable laptop setups, providing an excellent choice for quick gyro module configurations and shorter measurement series. The USB kit supports the default STIM202 RS422 transmission bit rate (460800 bits/s).

## Applications

Typical STIM202 applications are attitude heading reference systems (AHRs), platform stabilization and pointing systems (antennas, cameras, gimbals,..), high performance industrial applications, unmanned aerial vehicles (UAVs), autonomous underwater vehicles (AUVs), automated ground vehicles (AGVs), space applications, and more. STIM202 can also open new markets, where adequate solutions previously have not yet been possible to realize.

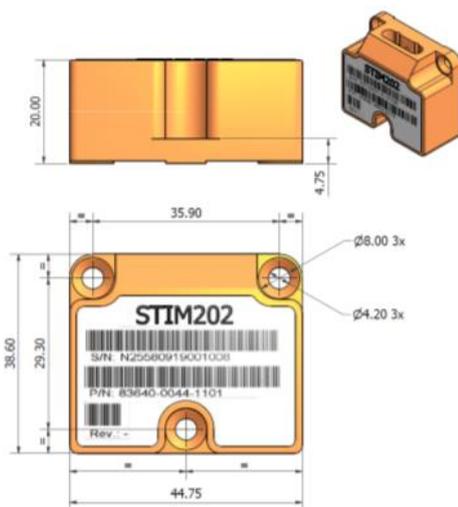
SPECIFICATIONS

Parameter	Min	Nom	Max	Unit
Weight		55		g
Input range		±400 <sup>1</sup>		°/s
Resolution		24		bit
Operating temperature	-40		85	°C
Storage temperature	-50		90	°C
Power supply	4.5	5.0	5.5	V
Supply current		200		mA
Start-up time		5		s
Sample Rate			1000	SPS
Dynamic overload			5000	°/s
Mechanical shock			1500	g
Bias instability (Root Allan Variance)		0.5		°/h
Angular random walk (Root Allan Variance)		0.2		°/√h
Bandwidth (-3dB)			262	Hz
Non-linearity (BSL over +/- 200 °/s)		200		ppm
Scale Factor accuracy		±0.2		%
Bias error over temperature gradients		±30		°/h rms
Linear acceleration effect		7		°/h/g
RS422 bit rate			921600	bit/s
Input resistance (termination ON)		120		Ω
Input resistance (termination OFF)				Ω
Logic levels NRST and EXT TRIGGER pins	CMOS and TTL compatible			

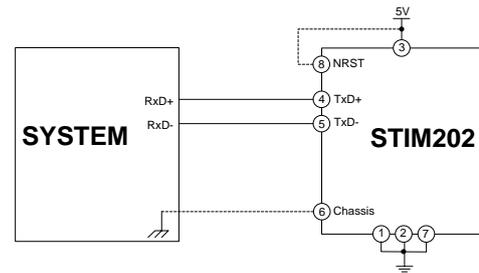
1) Optional ranges are available

MECHANICAL DIMENSIONS

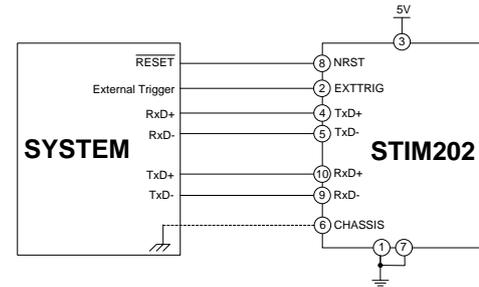
All dimensions in mm.



ELECTRICAL CONNECTIONS

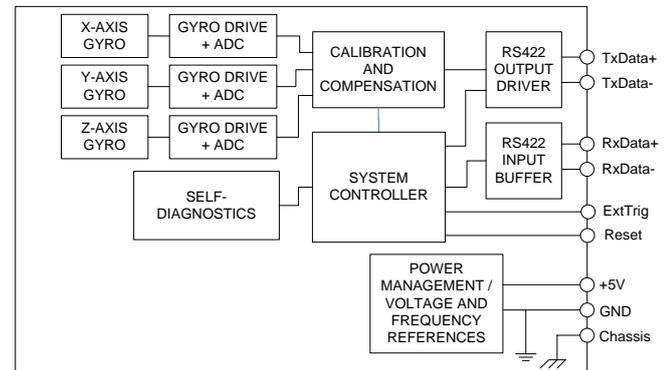


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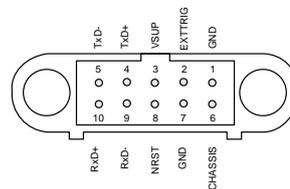


(FULL FUNCTION)

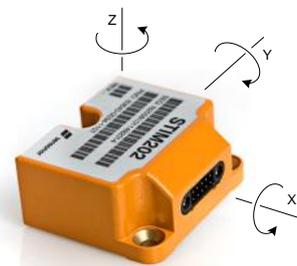
FUNCTIONAL BLOCK DIAGRAM



PIN OUT



AXIS DEFINITIONS



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# ULTRA-HIGH PERFORMANCE GYRO MODULE



STIM210

PRODUCT BRIEF

- Small size, low weight and low cost
- ITAR free
- Insensitive to magnetic fields
- $10^\circ/\text{h}$  bias error over temperature gradients
- $0.5^\circ/\text{h}$  bias instability
- $0.15^\circ/\sqrt{\text{h}}$  angular random walk
- $\pm 400^\circ/\text{s}$  angular rate input range
- 2000 samples per second
- 1500g shock capability



(39mm x 45mm x 22mm)

STIM210 is a multi-axis gyro module with up to 3 axes of highly accurate MEMS gyros. Each axis is factory calibrated for bias and sensitivity, and compensated for temperature effects. This new design of the STIM200-series allows for improved bias error over temperature gradients ( $10^\circ/\text{h}$ ) and improved non-linearity (50ppm BSL over FS). STIM210 industrialization is realized by combining the well proven Sensoror ButterflyGyro™ technology with full digital operation.

## Input range, orthogonality and output formats

The STIM210 full-scale angular rate input range is  $400^\circ/\text{s}$  and the output is capped at  $\pm 480^\circ/\text{s}$ . 3-axis modules feature electronic axis alignment, improving orthogonality between axis (down to 1mrad). Selectable output formats are angular rate, increment angle, average angular rate and integrated angle, at sample rates up to 2000 samples per second.

## Reliability and robustness

STIM210 modules have MTBF > 120k hours per axis (according to MIL-HDBK

217), which is outperforming current FOG systems. Tuning of excitation and detection frequencies, as well as perfectly balanced vibrational masses, result in very low vibration and shock sensitivity in any direction.

## Power and interface

The unit is powered by a single +5V supply and communicates via a Plug-and-Play high-level RS422 interface at bit rates up to 1.8 Mbits/s.

## Device configurations and self diagnostics

The use of a 32-bit RISC ARM microcontroller provides flexibility in device configuration. Choices for output unit, sample rate, LP filter cut-off frequency, RS422 transmission bit rate, line termination ON/OFF, etc. can be done in device Service Mode. The Service Mode also provides the ability to perform single measurements on demand and access detailed diagnostics information.

## Evaluation kits

STIM210 evaluation kits for PCI and USB connectivity are available. The PCI kit is

the recommended choice for thorough characterization. The PCI kit supports all STIM210 RS422 transmission bit rates (374400, 460800, 921600 and 1843200 bits/s). The USB kit is the alternative solution, e.g. for smaller, portable laptop setups, providing an excellent choice for quick gyro module configurations and shorter measurement series. The USB kit supports the default STIM210 RS422 transmission bit rate (460800 bits/s).

## Application areas

STIM210 applications are typically found within Industrial, Aerospace and Defense markets, for various platform stabilizations, pointing and navigation systems (e.g. antennas, cameras and gimbals), attitude heading reference systems (AHRs), inertial navigation systems (INSs) for UAVs, AUVs, AGVs, UGVs and ROVs, smart munitions, 3D mapping systems, range finders, trains, robotics, and more.

For many applications STIM210 directly replaces FOGs and improves system solutions with respect to robustness, reliability, size, weight, power and cost. STIM210 can also open new markets, where adequate solutions previously have not yet been possible to realize.

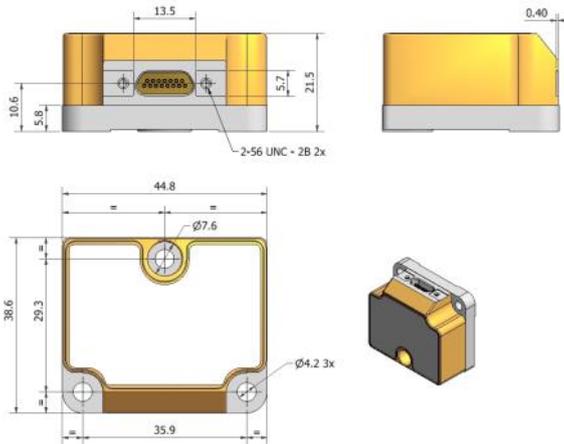
SPECIFICATIONS

Parameter	Min	Nom	Max	Unit
Weight		52		g
Input range		±400 <sup>1</sup>		°/s
Resolution		24		bit
Operating temperature	-40		85	°C
Storage temperature	-50		90	°C
Power supply	4.5	5.0	5.5	V
Supply current			300	mA
Start-up time		3		s
Sample rate			2000	SPS
Mechanical shock			1500	g
Bias instability (Root Allan Variance)		0.5		°/h
Angular random walk (Root Allan Variance)		0.15		°/√h
Bias error over temperature gradients		±10		°/h rms
Bandwidth (-3dB)		262		Hz
Group delay		1.6		ms
Non-linearity (BSL over FS)		50		ppm
Scale Factor accuracy		500		ppm
RS422 bit rate			1.84	Mbit/s
Linear acceleration effect		7		°/h/g
Logic levels NRST, EXT TRIGGER and TOV pins	CMOS and TTL compatible			

1) Optional ranges are available

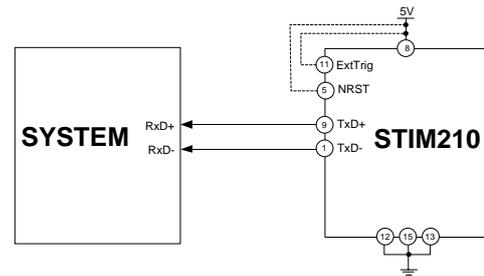
MECHANICAL DIMENSIONS

All dimensions in mm.

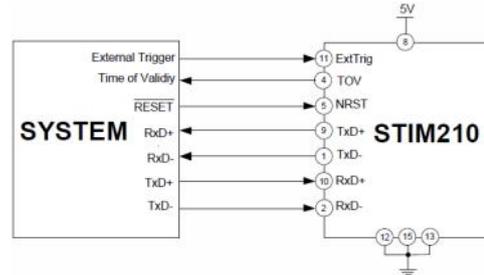


Volume < 2,0 cu. in (33cm<sup>3</sup>)

ELECTRICAL CONNECTIONS

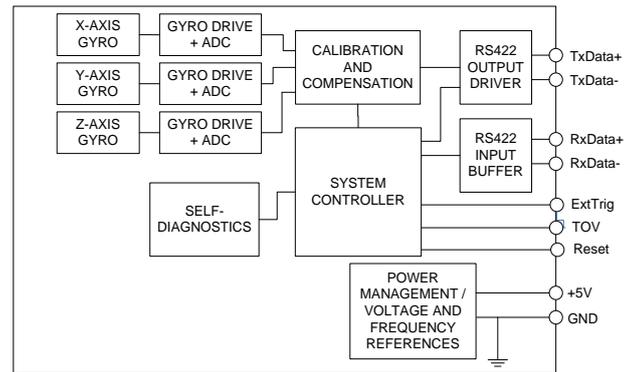


(TRANSMIT ONLY)

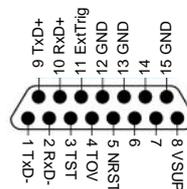


(FULL FUNCTION)

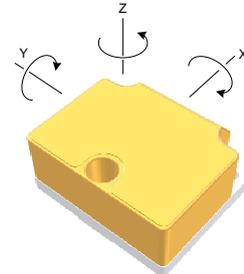
FUNCTIONAL BLOCK DIAGRAM



PIN OUT



AXIS DEFINITIONS



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# ULTRA-HIGH PERFORMANCE INERTIAL MEASUREMENT UNIT (IMU)



STIM300

PRODUCT BRIEF

- Small size, low weight and low cost
- ITAR free
- Insensitive to magnetic fields
- 0.5°/h gyro bias instability
- 0.15°/√h angular random walk
- ±400°/s angular rate input range
- 10°/h gyro bias error over temperature gradients
- 0.05mg accelerometer bias instability
- ±10g acceleration input range (optional ranges avail.)
- 3 inclinometers for accurate levelling
- Auxiliary input

STIM300 is a high performance and rugged Inertial Measurement Unit (IMU) comprised of 3 highly accurate MEMS gyros, 3 high stability accelerometers and 3 inclinometers. The IMU is factory calibrated and compensated for temperature effects over the full temperature operating range.

The STIM300 is based upon Sensoror's proven gyro sensor technology in production for more than a decade, and its high precision Gyro Modules are already designed into many applications worldwide. Another advantage of the Sensoror MEMS technology is the very low vibration and shock sensitivity in any direction.

## Range and features

STIM300 full-scale angular rate input range is ±400°/s and the output is capped at ±480°/s. Standard acceleration input range is ±10g. Axis misalignment of as little as 1mrad is achieved by electronic axis alignment. STIM300 requires a single +5Vdc power supply and has a digital serial RS422 interface.

STIM300 offers several user selectable output formats and sample rates for gyro and accelerometer data:

- Angular Rate
- Incremental Angle
- Average Angular Rate
- Integrated Angle
- Acceleration
- Incremental Velocity
- Average Acceleration

## Device configurations and self-diagnostics

A reliable RISC ARM microcontroller enables easy device configuration and programming. The user selectable Service Mode allows for setting the output unit format, sample frequency, LP filter cut-off frequency, RS422 transmission bit rate and line termination. Service Mode also enables single measurements on demand, and to access detailed diagnostics information.



(39mm x 45mm x 22mm)

## Evaluation tools

STIM300 evaluation tools supporting PCI or USB connectivity are available. The evaluation tools offer easy access to measurement data and configuration of the IMU. It supports data sampling at alternative rates, graphical presentation, and data logging to file. The evaluation tools contain a RS422 interface for USB or PCI hardware setup, all necessary cabling, and PC software.

## Application areas

The STIM300 IMU is well suited for stabilization, guidance and navigation applications in Industrial, Aerospace and Defense markets. It is a crucial building block for inertial navigation systems in UAVs, AUVs, AGVs, UGVs and ROVs, robotics, and more, and offers the designer an ITAR free alternative. In many applications, STIM300 can competitively replace IMU's based on Fiber Optic Gyros (FOGs) and improve system performance with respect to robustness, reliability, size, weight, power and cost.

SPECIFICATIONS

Parameter	Min	Nom	Max	Unit
<b>GENERAL</b>				
Weight		55		g
Operating temperature	-40		85	°C
Supply voltage	4.5	5.0	5.5	V
Supply current		300		mA
Start-up time		3		s
Sample rate			2000	SPS
Mechanical shock, any direction			1500	g
RS422 transmission bit rate			1.84	Mbit/s
Misalignment		1		mrad
<b>GYRO</b>				
Input range		±400 <sup>1)</sup>		°/s
Non-Linearity (conditions: ±200)		15		ppm
Resolution		0.22		°/h
Bias instability		0.5		°/h
Angular random walk		0.15		°/√h
Bias error over temperature gradients		±10 <sup>2)</sup>		°/h rms
Linear acceleration effect				
Bias		1 <sup>4)</sup>		°/h/g
Scale Factor		50 <sup>4)</sup>		°/h/g
Scale factor accuracy		±500		ppm
<b>ACCELEROMETER</b>				
Input range		±10 <sup>3)</sup>		g
Resolution		1.9		µg
Bias instability		0.05		mg
Velocity random walk		0.07		m/s/√h
Bias error over temperature gradients		±2 <sup>2)</sup>		mg rms
Scale factor accuracy		±300		ppm
<b>INCLINOMETER</b>				
Input range		±1.7		g
Resolution		0.2		µg
Scale factor accuracy		±500		ppm

1) Optional ranges are available

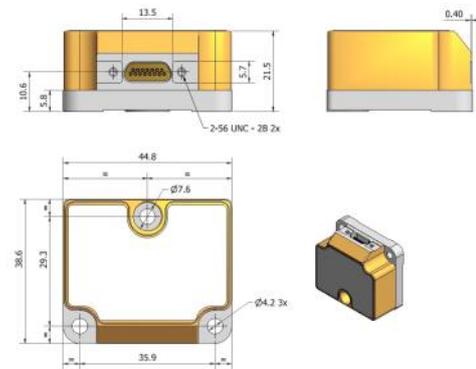
2) Condition: ΔT ≤ 1°C/min

3) Optional ranges: ±5g, ±30g, ±80g

4) With g-compensation

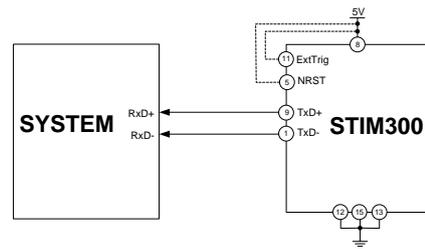
MECHANICAL DIMENSIONS

All dimensions in mm.

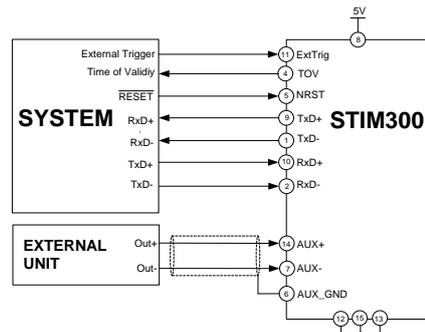


Volume < 2,0 cu. in (33cm<sup>3</sup>)

ELECTRICAL CONNECTIONS

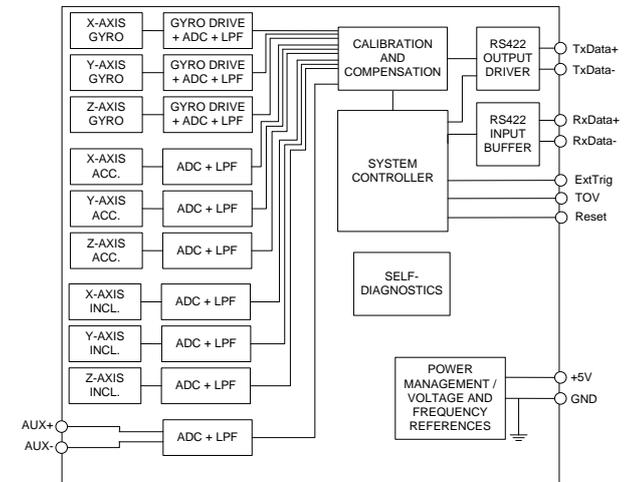


(TRANSMIT ONLY)

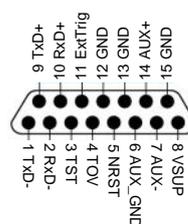


(FULL FUNCTION)

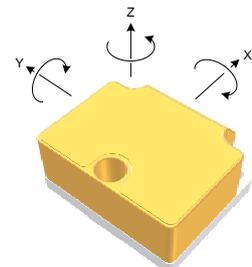
FUNCTIONAL BLOCK DIAGRAM



PIN OUT



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