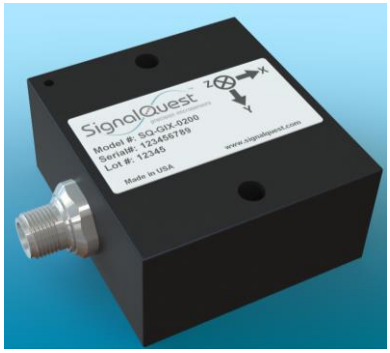
SQ-GIX-0200

GRAVITYGYRO™ INCLINOMETER

Dual Axis, Rugged



DESCRIPTION

The SQ-GIX GravityGyro™ is simply a "much better" tilt sensor that provides true clean angle even in the presence of high shock, acceleration and vibration.

The system employs high stability, temperature compensated ceramic packaged MEMS accelerometers and gyroscopes for excellent long term performance and reliability.

The complexity of multi-axis inertial calibrations, quaternion angles, Kalman filters, and dynamic adaptive sensor fusion is handled by the sensor itself. The SQ-GIX is the ultimate drop-in upgrade for legacy, static inclinometers.

KEY SPECIFICATIONS

- High accuracy while moving
- High accuracy over temperature
- Case aligned and orthogonalized

APPLICATIONS

- Measuring angle on moving vehicles in harsh environments
- Excavators, mining vehicles, skid-steers, mobile cranes

HARDWARE OPTIONS

- Rugged package (IP67) shown above
- Internal CAN terminator
- OEM (PCB only)

OUTPUT OPTIONS

- CAN bus J1939 standard
- CANopen, RS232, RS485, 0 – 10V, 4 – 20 mA by request

SPECIFICATIONS OVERVIEW

Parameter	Specification
Axes	dual, pitch and roll
Range	360 ° x 180 °
Static tilt accuracy	0.1 º
Dynamic tilt accuracy	0.5 º RMS error
Shock survival	1000 *g* ½ sin 0.1 ms, 3x any axis
Shock, vibration and acceleration vibration immunity	0.5 º RMS error Conditions: ▪ Shock: 100 *g* ½ sin 0.1 ms or 20 *g* ½ sin 10 ms ▪ Vibration: 1 *g*RMS random vibration 5 Hz to 500 Hz ▪ Linear: 1 *g* acceleration 0.5 s
Output rate	250 Hz
Temperature range	-40 º to 85 º C
Voltage	9 – 36 V
Current	40 mA
Protection	IP67

ESD, EMISSIONS AND IMMUNITY RATINGS

- IEC 61000-4-2 level 4 compliant.
- CISPR 22, Conducted Emissions, Class B
- CISPR 22, Radiated Emissions, Class B
- EN 61000-6-2, ESD
- EN 61000-4-3, Radiated Immunity
- 61000-4-4, EFT
- 61000-4-5, Surge
- EN 61000-4-6, Conducted Immunity
- EN 61000-4-11, Voltage Dips & Interrupts

DESIGNED FOR HEAVY VEHICLES

- Over 9800 pieces used by US Marines in 2013. Benefit from our efficiency of scale with this affordable upgrade in sensing technology.
- Specifically designed, tested, and qualified to meet the unique environmental operating requirements of commercial, construction, agricultural and mining vehicles.

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MSG_ID MAPPINGS

The device uses a J1939 device address (SA) of 177 (0xB1).

CAN2.0B identifiers are mapped MSG_IDs as follows:

MSG_ID	Message	Rate (normal / IMU) Hz	PGN	Priority	CAN2.0B ID [Hex]
2*	DevCon	N/A	65522	0	00FFF2B1
3	Angle	100	65523	0	00FFF3B1

* Note this message is received – the sensor looks for SA of 40 (0x28) for this message

MSG_ID 2: DEVCON

MSG_ID 2 is used to issue commands to the device.

MSG_ID 2 messages must not be sent faster than 100 Hz.

MSG_ID 2 PARAMETER DEFINITIONS

Parameter	Width (bits)	Type	Min Value	Max Value	Units
CMD	8	Byte	0x00	0xFF	n/a
Data*	8	Byte	0x00	0xFF	n/a

* may not be used depending on command value – see below.

MSG_ID 2 DATA FIELD PAYLOAD (1-8 BYTES)

1	2	3	4	5	6	7	8
CMD	Data1	Data2	Data3	Data4	Data5	Data6	Data7

MSG_ID 2 PAYLOAD DESCRIPTIONS

Field	Contents
CMD	The byte command to send to the target
Data*	Optional command data

* may not be used depending on CMD value – see below.

The following are valid commands:

CMD	Function	Additional Data Bytes
0x00	Reset and self-test	0
0x85	Set trim	0
0x86	Clear trim	0

Command behaviors are explained in detail on the following pages.

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CMD 0X00 – RESET AND SELF-TEST

Force the device to initiate reset and self-test. During self-test the device will only send MSG_ID 0 (DevInfo) messages. All remaining messages will be paused until self-test is complete.

MSG_ID 2 CMD 0X00 (SELF TEST) PAYLOAD – 1 BYTE

1
CMD [0x00]

CMD 0X85 – TRIM

The device will trim all values to 0.0 (deg/sec for gyro data). The device cannot be re-trimmed without clearing any current trim – see CMD 0x86.

MSG_ID 2 CMD 0X85 (TRIM) PAYLOAD – 1 BYTE

1
CMD [0x85]

CMD 0X86 – CLEAR TRIM

This command is used to re-set device trim. The device returns to its factory default "Device Trim not Set" status.

MSG_ID 2 CMD 0X86 (CLEAR TRIM) PAYLOAD – 1 BYTE

1
CMD [0x86]

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MSG_ID 3: ANGLE

MSG_ID 3 is used to communicate pitch, and roll values. Pitch and Roll are 0.0 when the device is horizontal and stationary.

MSG_ID 3 PARAMETER DEFINITIONS

Parameter	Width (bits)	Type	Min Value	Max Value	Units
Pitch	16	Signed short	0	1800	Tenths of a degree
Roll	16	Signed short	0	3600	Tenths of a degree
Zero	16	Signed short	0	0	n/a
FRPC	8	Unsigned byte	0	255	n/a
DataStatus	8	Bit vector	00000000	11111111	n/a

MSG_ID 3 DATA FIELD PAYLOAD (8 BYTES)

1	2	3	4	5	6	7	8
PitchHigh	PitchLow	RollHigh	RollLow	ZeroHigh	ZeroLow	FRPC	DataStatus

MSG_ID 3 PAYLOAD DESCRIPTIONS

Field	Contents
PitchHigh	High byte of Pitch
PitchLow	Low byte of Pitch
RollHigh	High byte of Roll
RollLow	Low byte of Roll
ZeroHigh	High byte of Zero
ZeroLow	Low byte of Zero
FRPC	Free running packet counter
DataStatus	Device Data status bit vector

The FRPC is a free running packet counter. It will increment from 0 to 255 with each MSG_ID 3 packet sent. At 255 the counter rolls over and starts again at 0. The FRPC can be used to determine if packets are dropped by the device, bus or controller.

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DATA STATUS FLAGS

Bit Vector Position	Flag	Meaning	Persistent
7 (MSB)	0x80	<unused>	No
6	0x40	<unused>	No
5	0x20	<unused>	No
4	0x10	<unused>	No
3	0x08	<unused>	No
2	0x04	<unused>	No
1	0x02	<unused>	No
0 (LSB)	0x01	CAN Bus Transmit Buffer Overflow (busy too busy to Transmit all queued messages)	2 sec. then auto cleared

<UNUSED>:

This flag is not used and will always be zero.

DEVICE TRIM NOT SET:

The device has not been trimmed. Once installed, the Set Trim command must be issued to zero the device.

CAN bus Transmit Buffer Overflow: If the CAN bus is not available when a message is ready to be sent the device will queue it and wait for the CAN bus to become available. The device can queue up to 12 messages. If a message needs to be queued but the queue is full the device will drop the message (it will never be sent). When this occurs the CAN bus Transmit Buffer Overflow flag is set and will remain set for two seconds after the CAN bus becomes available again (all messages sent for two seconds after the CAN bus becomes available again will have this flag set).

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ABSOLUTE MAXIMUM RATINGS

PARAMETER	NOTES	MIN		MAX	UNITS
Supply Voltage		-30		30	V_{dc}
Voltage on CANH, CANL with respect to GND		-27		30	V_{dc}
Current on CANH/CANL		-120		120	mA
CANH-CANL Differential		-6		6	V_{dc}

ELECTRICAL CHARACTERISTICS

PARAMETER	NOTES	MIN	TYP	MAX	UNITS
Supply Voltage (V+)		10		30	V_{dc}
Supply Current			60	200	mA
CAN Bus Rate			250		kbps

PERFORMANCE CHARACTERISTICS

PARAMETER	SPECIFICATION*	UNITS	NOTES
Axes	2	º	
Range	360 x 180	º	
Resolution	0.1	º	
Zero point temp drift	0.3	º	Over full temp range
Case null alignment	0.1	º	
Static Accuracy	0.1	º	
Settling time	0.1	s	
Output data rate	100	Hz	
Transverse sensitivity	< 1	% at 30ºC	

* 1 sigma

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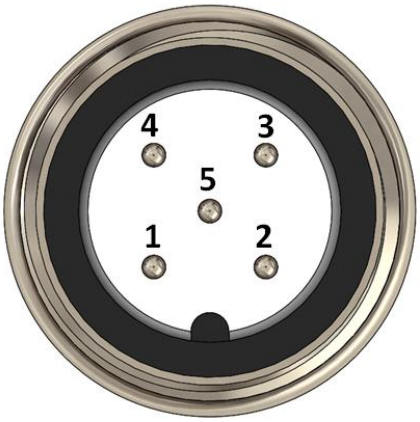
CONNECTOR DIAGRAM

M12, Male, 5-pin Connector:



Male End External View

PIN DESCRIPTIONS

PIN	NAME	DESCRIPTION
1	CAN Shield	Shield (Case)
2	CAN V+	Supply Voltage
3	CAN GND	Ground (Power Return)
4	CAN H	CAN Bus High
5	CAN L	CAN Bus Low

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ENVIRONMENT PROTECTION AND TESTING

ENVIRONMENTAL CONDITIONS				
Description	**Specification**	**Reference**	**SQ Test**	**Date Conducted**
Natural Environment				
Operating Temperature	-40 °C to 85 °C	IEC 60068-2-1 & IEC 60068-2-2	RPS-TP-02	5/25/2011
Storage Temperature	-51 °C to 85 °C	IEC 60068-2-1 & IEC 60068-2-2	RPS-TP-06	6/6/2011
Relative Humidity	95% RH no condensing	IEC 60068-2-30	RPS-TP-07	5/25/2011
Sand and Dust	IP67	IEC 60529	RPS-TP-03	5/25/2011
Altitude	Sea Level to 12,000 ft		RPS-TP-08	5/18/2011
Drop Shock	Drop Survival: 0.8 m drop onto concrete, each face, 1X Shock Survival: 500 gn, 6 ms, half sine, 5x repetitions 50 gn, 6 ms, half sine, 1000x repetitions Operating Shock: 10 gn, 6 ms	IEC60068-2-29 & IEC60068-2-31	RPS-TP-04	5/25/2011
Vibration	Vibration Survival: 1) Random, flat spectrum, 5 - 500 Hz, 25 gRMS, 10 hours 2) Swept Sine, 3 axes, 5 - 500 Hz, 25 gn, 10 sweeps, 1 hour per sweep Operating Vibration Swept Sine 2.0 g-pk, 10 Hz to 500 Hz Operating Vibration Swept Sine 2.0 gRMS, flat spectrum, 5 Hz to 500 Hz	MIL-STD-810G, Method 514.6, Procedure I, Annex D, Category 20. IEC60068-2-6 & IEC60068-2-64	RPS-TP-05	5/25/2011

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Induced Environment				
Electromagnetic Environment	ESD, Radiated Immunity, EFT, Surge, Conducted Immunity, & Power Supply Integrity; Voltage Dips, Interrupts & Power Cycling	RE102 and RE103 30 MHz to 1 GHz, EN 61000-6-2, EN 61000-4-3 , EN 61000-4-4, EN 61000- 4-5 & EN 61000-4-6	RPS-TP-09	8/23/2010 & 5/26/2011
Electromagnetic Interference	ESD, Radiated Immunity, EFT, Surge, Conducted Immunity, & Power Supply Integrity; Voltage Dips, Interrupts & Power Cycling	RE102 and RE103 30 MHz to 1 GHz, EN 61000-6-2, EN 61000-4-3 , EN 61000-4-4, EN 61000- 4-5 & EN 61000-4-6	RPS-TP-09	8/23/2010 & 5/26/2011

CAN BUS SHIELDING & WIRING REQUIREMENTS

In order to meet the immunity described above, the following installation requirements must be observed:

1. The CAN Shield signal must have a direct connection to GND at some point in the wiring harness and this point should be as close as possible to the battery negative terminal.
2. Shielded cabling for all communications/power signals between the sensor and the CAN bus controller is required.
3. It is also required to strap the sensor's enclosure to a chassis ground via the 0.25" deep 6-32 screw hole available on the surface of the sensor. Use a screw, washer and lock washer and braided copper mesh to attach the enclosure to a bare metal tapped hole in the vehicle's metal floor. Some conductive epoxy may be useful to prevent the screws from coming loose over time.

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DEVICE ORIENTATION

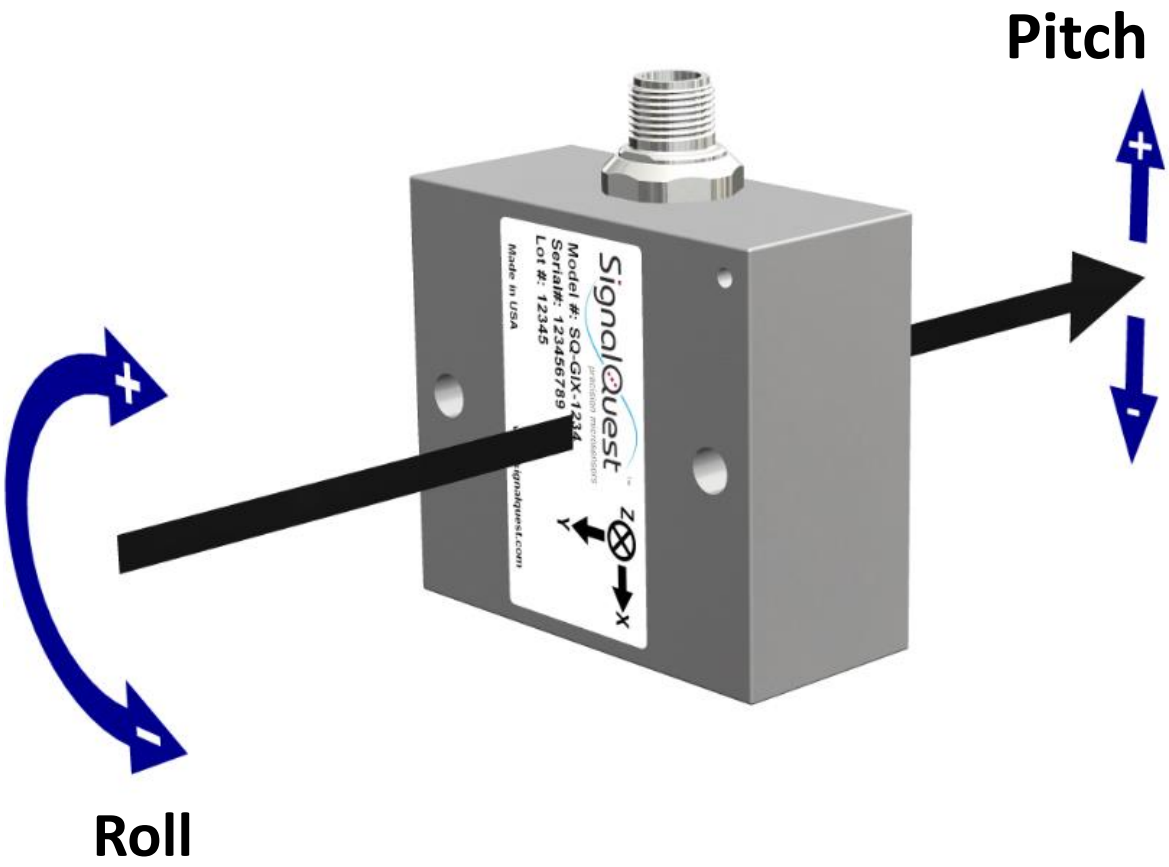
TERMINOLOGY

Gravity means a vector pointing from the device toward the center of the earth.

X means a vector parallel to the "X" arrow printed on housing label.
Y means a vector parallel to the "Y" arrow printed on the housing label.
Z means a vector passing through "Z" arrow printed on the housing label.
Pitch means the elevation angle of the Pitch axis with respect to Horizontal.
Roll means a positive right handed rotation about the Pitch axis.

Position:
Roll = 180˚ as pictured
Pitch = 90˚ as pictured

Horizontal means an axis's positive direction (arrow) is pointing at a right angle to gravity.
Straight Down means an axis's positive direction (arrow) the arrow is parallel to gravity and pointing toward the center of the Earth.



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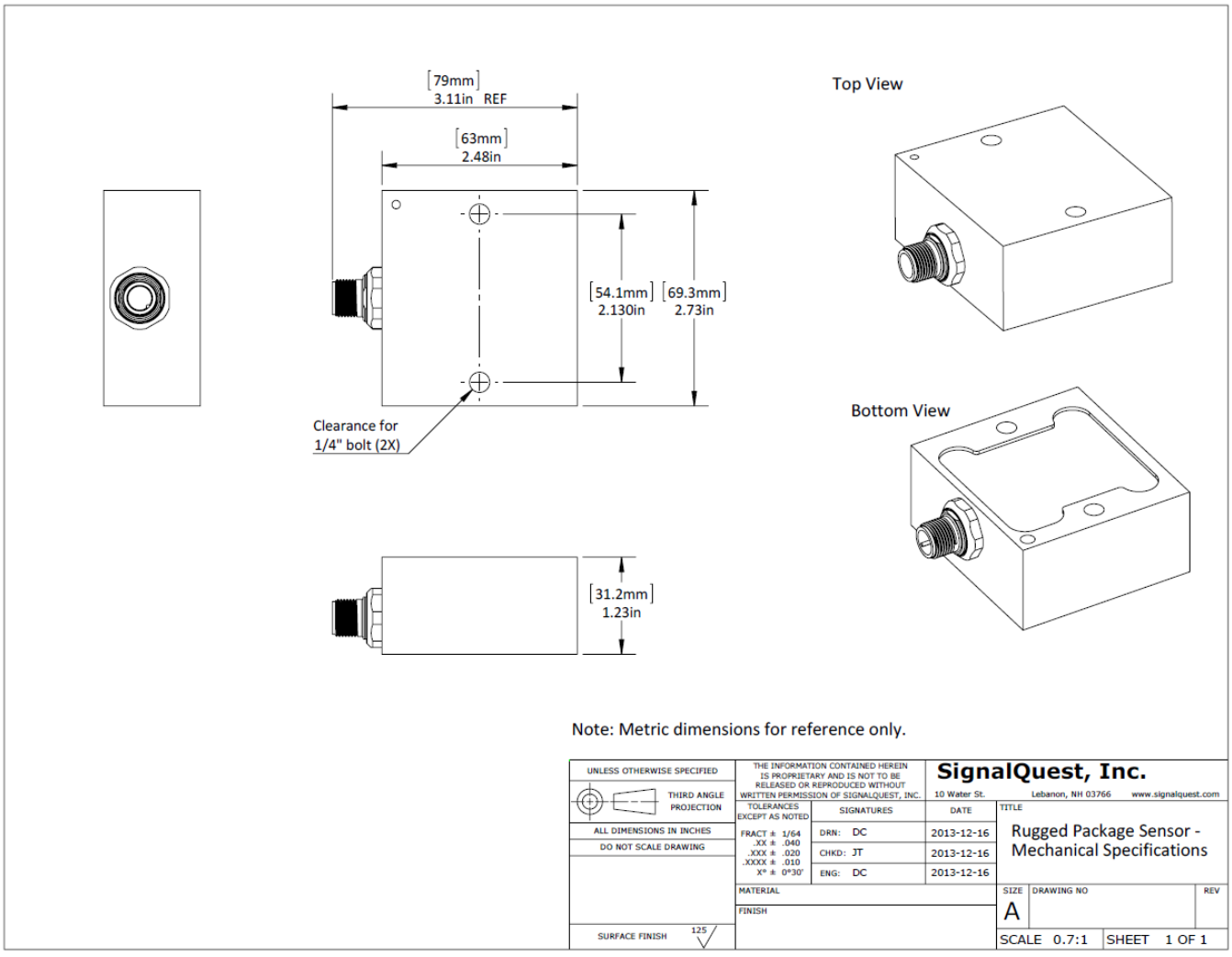
PACKAGING

SINGLE CONNECTOR MODEL



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LIMITATIONS AND WARNINGS

TESTING

The performance of each system is verified through build-time testing. Each system is tested before and after factory calibration to ensure reliable performance.

SYSTEM INTEGRATION TESTING

Thorough testing should be carried out prior to product release to ensure system integration has not introduced unforeseen problems. The system integrator assumes the ultimate responsibility for the safety of the target application.

NOTICE

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