INTERSENSE

ISNC01-0x0

NavChip™

Precision 6-Axis MEMS Inertial Measurement Unit

GENERAL DESCRIPTION

The NavChip™ ISNC01 is a high precision MEMS 6-axis inertial measurement unit (IMU). Using proprietary MEMS technologies and advanced signal processing techniques, the NavChip achieves a level of performance, miniaturization, and environmental ruggedness superior to competing IMUs using standard off-the-shelf MEMS sensors. The ISNC01 is available in four variants with full-scale acceleration of ±8g or ±16g and full-scale angular rate of 480°/s and 2,000°/s.

The ISNC01 comes in an environmentally-sealed surface-mount package. It operates from a wide 3.25-5.5 V supply range and consumes about 65mA (typ.), making it especially well-suited for embedded applications where extremely small size, low cost, and low power consumption are required. It is fully factory-calibrated and temperature compensated over an operating range of -40°C to +85°C.

APPLICATIONS

Camera & Antenna Stabilization

Pedestrian Navigation

Robotics

UAVs

GPS/INS integration

Aiming & Alignment

Agriculture, Construction & Mining Equipment

FEATURES

- **Fully-compensated $\Delta\Theta$ and ΔV outputs**
- **Gyro bias in-run stability 10°/hr**
- **Angular random walk 0.18°/√hr**
- **Velocity random walk 0.03m/s/√hr**
- **Full-scale acceleration of ± 16g**
- **Full-scale angular rate of 2000°/s**
- **Low power consumption 215mW**
- **Selectable built-in test (BIT) modes for commanded and continuous diagnostic monitoring**
- **Factory calibrated bias, scale factor and misalignment (-40°C to +85°C)**
- **User selectable TTL UART or SPI-compatible data output interfaces**
- **Embedded temperature sensor output**
- **Single supply operation 3.25V to 5.5V**
- **Selectable output data rates up to 1000Hz**
- **External sync pin can accept optional GPS pulse-per-second or faster synchronization signal**

ABSOLUTE MAXIMUM RATINGS

Vdd to GND……………….....…-0.3V to +6.0V
Dig In/Out Voltage to GND……-0.3V to +3.3V
Analog Inputs to GND………....-0.3V to +3.3V
Max Shock, Any Axis……..…….TBD

PACKAGE CHARACTERISTICS

18-Pin LCC
Operating Temperature Range….-40°C to +85°C
Storage Temperature Range.........-40°C to +85°C
Lead Temperature (soldering, 10s).…..…+250°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

GYROSCOPE PERFORMANCE (3.3V, +25°C, unless otherwise specified)

PARAMETER	TYP[1]	MAX[2]	UNITS
Full Scale Range	± 2000		°/s
In-Run Bias Stability (Allan Variance)	10	16.5	°/hr
Bias Accuracy over Operating Temp Range	± 0.2	± 0.5	°/s
g Sensitive Bias	0.01	0.04	°/s/g
Scale Factor Accuracy over Operating Temp Range	± 0.1	± 0.5	%
Scale Factor Linearity[3]	0.05	0.15	%
Angle Random Walk	0.18	0.3	°/√hr
Noise Density (rms)	0.003	0.005	°/s/√Hz
Frequency Response (90° Phase Shift)	100		Hz
Axis Mutual Alignment Accuracy	± 1	± 4	mRad

ACCELEROMETER PERFORMANCE (3.3V, +25°C, unless otherwise specified)

PARAMETER	TYP	MAX	UNITS
Full Scale Range	± 16		g
In-Run Bias Stability (Allan Variance)	0.05	0.15	mg
Bias Accuracy over Operating Temp Range	± 8	± 20	mg
Scale Factor Accuracy over Operating Temp Range	± 0.06	± 0.2	%
Scale Factor Linearity[4]	0.1	0.2	%
Velocity Random Walk	0.03	0.05	m/s/√hr
Noise Density (rms)	50		µg/√Hz
Frequency Response (90° Phase Shift)	100		Hz
Axis Mutual Alignment Accuracy	± 1	± 4	mg

[1] TYP Specs are mean values or 1σ for values that are nominally zero.
[2] MAX Specs are maximum factory test limits unless otherwise specified.
[3] Factory test up to 810 °/s
[4] Factory test over ± 1g

DIGITAL INPUTS/OUTPUTS

PARAMETER	MIN	TYP	MAX	UNITS
Logic “0” Input Voltage	0		0.6	V
Logic “1” Input Voltage	2.1		3	V
Logic “0” Output Voltage		0	0.4	V
Logic “1” Output Voltage	2.4	3		V
Logic “0” Input Current		± 2		µA
Logic “1” Input Current		± 2		µA
Input Capacitance		10		pF

TEMPERATURE SENSOR PERFORMANCE

PARAMETER	MIN	TYP	MAX	UNITS
Temperature Sensing Range	-40		+85	^{o}C
Resolution		0.05		^{o}C
Accuracy		± 2.5	± 3.5	^{o}C
Repeatability		± 0.5		^{o}C

FLASH MEMORY

PARAMETER	Nominal	UNITS
Endurance	10,000	Cycles
Data Retention	20	Years

TIMING

PARAMETER	Nominal	UNITS
Power-on Startup	0.6	Seconds
Built In Test Time (commanded TBIT)	3	Seconds

PHYSICAL

PARAMETER	Nominal	UNITS
Size (LCC package, excluding castellations)	12.2 x 24 x 9.1	mm
Weight	6	grams
Package footprint	18-pin LCC	-
Package material	Nickel-plated brass shell	
RoHS Compliant	Yes	-

ELECTRICAL

PARAMETER	SYMBOL	CONDITIONS	MIN TYP MAX	UNITS
Supply Voltage Range	Vdd		3.25 3.3 5.5	V
Supply Current	Idd	after startup	65	mA
Internal power supply decoupling capacitance			200	µF

UART INTERFACE

PARAMETER	MIN	TYP	MAX	UNITS
Baud rate	38,400	115,200	921,600	Bits per second
Baud rate deviation from nominal	-1.5	± 0.2	1.5	%
8 data bits, 1 start bit, no parity				

FUNCTIONAL DESCRIPTION

The ISNC01 is a precision IMU chip which outputs compensated ΔΘ and ΔV data and is factory calibrated over a -40°C to +85°C temperature range. The device comes housed in a nickel-plated brass shell.

The ISNC01 command and data interface occurs through either a 3V TTL UART or a standard SPI interface. The UART is capable of operating at baud rates ranging from 38.4k baud up to 921.6k baud. Both interfaces support user-selectable packet transmission rates up to 1kHz. Communication with the NavChip is through a packet-based protocol which allows the user to configure the device and receive data and device status. See the NavChip Interface Control Document (ICD) for details on the operation of these interfaces.

Internally, the NavChip performs data acquisition and processing at a precise 1 kHz "i-rate". To minimize error accumulation under high dynamic motion, the readout electronics perform analog pre-integration, and report the integrals of angular rates over each 1 ms period. Compensation is performed at the i-rate to correct the sensors' biases, scale factors, misalignments, etc. By default, data packets are transmitted at a 200 Hz "j-rate", with each j-rate packet representing the integral of the i-rate data since the last j-rate packet. The default j-rate integration algorithm is a simple summation of i-rate **ΔΘ** and **ΔV** readings. The user may change the j-rate to other sub-multiples of the i-rate, as explained in the ICD.

Optionally, the i-rate may be synchronized to a precision external clock reference, such as a GPS pulse-per-second (PPS) signal. Any periodic signal whose period is an integer number of milliseconds can be used for synchronization. Refer to the ICD for timing diagram and details on how to configure NavChip for external synchronization.

Factory calibration corrects for misalignments between the sensor axes, resulting in measurement axes that are highly orthogonal to one another. However, because the IMU is contained in a small surface-mount chip, the alignment of these IMU "intrinsic" axes relative to a host platform (such as a robot, UAV or camera) will be affected by the precision of placement of the chip on the board, and the mounting of the board in the product. To allow customers to more easily compensate for these "extrinsic" misalignment angles, the NavChip provides registers for programming a boresight matrix which rotates the **ΔΘ** and **ΔV** vectors from the NavChip's internal (intrinsic) reference frame to the vehicle's body frame. An extrinsic calibration tool is provided with the NavChip Developer's Kit which allows the user to determine the boresight matrix relative to a reference jig having two orthogonal surfaces, and load it into the NavChip.

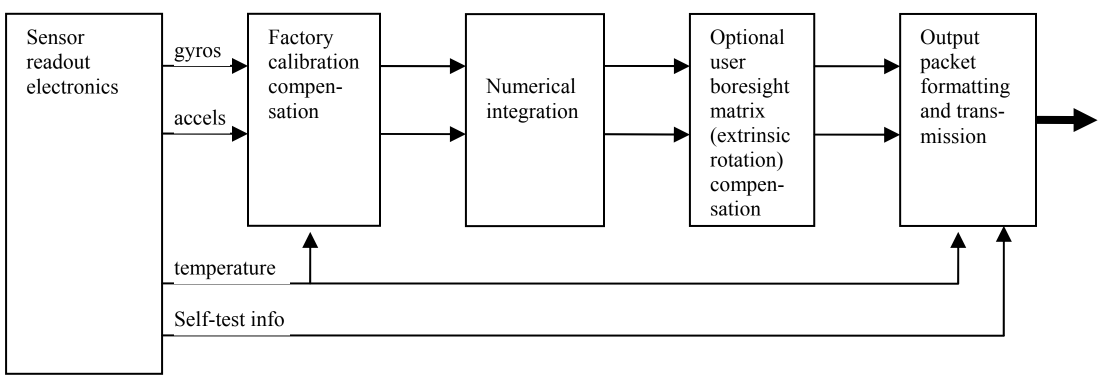


Figure 1: Functional block diagram

PIN ASSIGNMENT

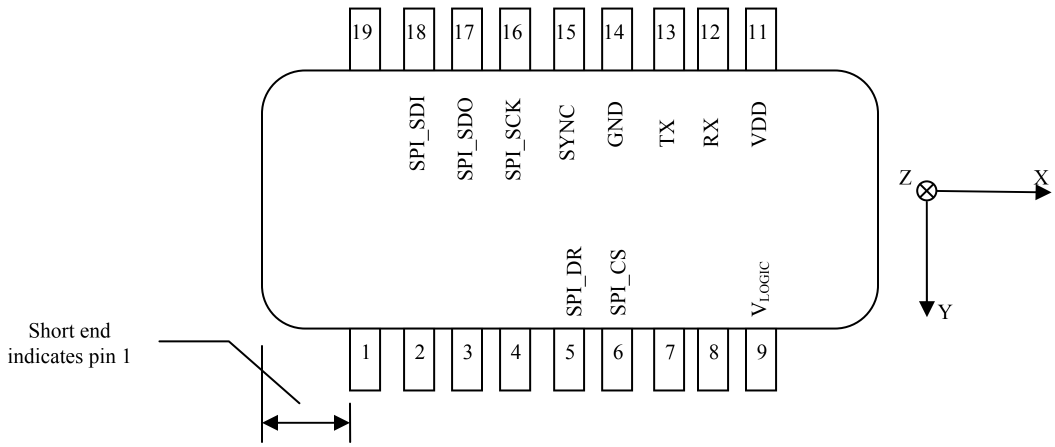


Figure 2: NavChip LCC-18 Pin Connection Diagram (Top View)

Table 1: Pin Functional Descriptions

PIN	PIN NAME	PIN TYPE	PIN DESCRIPTION
1	NC	-	Reserved for Factory Use
2	NC	-	Reserved for Factory Use
3	NC	-	Reserved for Factory Use
4	NC	-	Reserved for Factory Use
5	SPI_DR	Output (digital)	SPI data ready output
6	SPI_CS	Input (digital)	SPI chip select input
7	NC	-	Reserved for Factory Use
8	NC	-	Reserved for Factory Use
9	V_{LOGIC}	Output	3V logic reference output (25mA max.)
10	NC	-	Reserved for Factory Use
11	VDD	Power	
12	RX	Input (digital)	UART receive input
13	TX	Output (digital)	UART transmit output
14	GND	Ground	Power Ground
15	SYNC	Input (digital)	Optional digital sync input
16	SPI_SCK	Input (digital)	SPI serial clock input
17	SPI_SDO	Output (digital)	SPI data output
18	SPI_SDI	Input (digital)	SPI data input
19	NC	-	Reserved for Factory Use
20	NC	-	Reserved for Factory Use

IMPORTANT: DO NOT CONNECT ANY SIGNALS TO THE NC PINS. DOING SO WILL DAMAGE THE NAVCHIP OR CAUSE IT TO MALFUNCTION.

Mechanical Dimensions

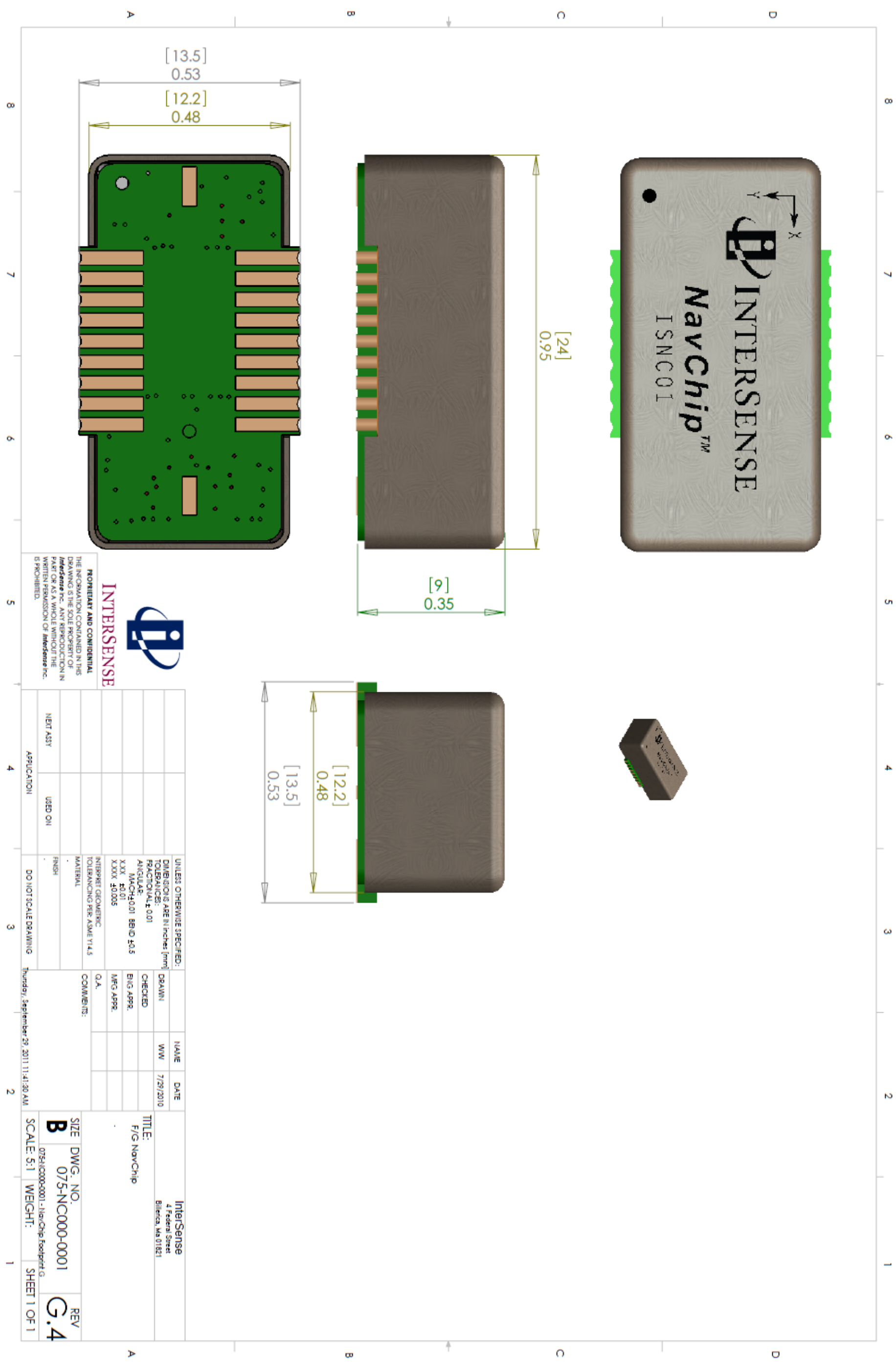


Figure 3: Mechanical dimensions

Mounting Recommendations

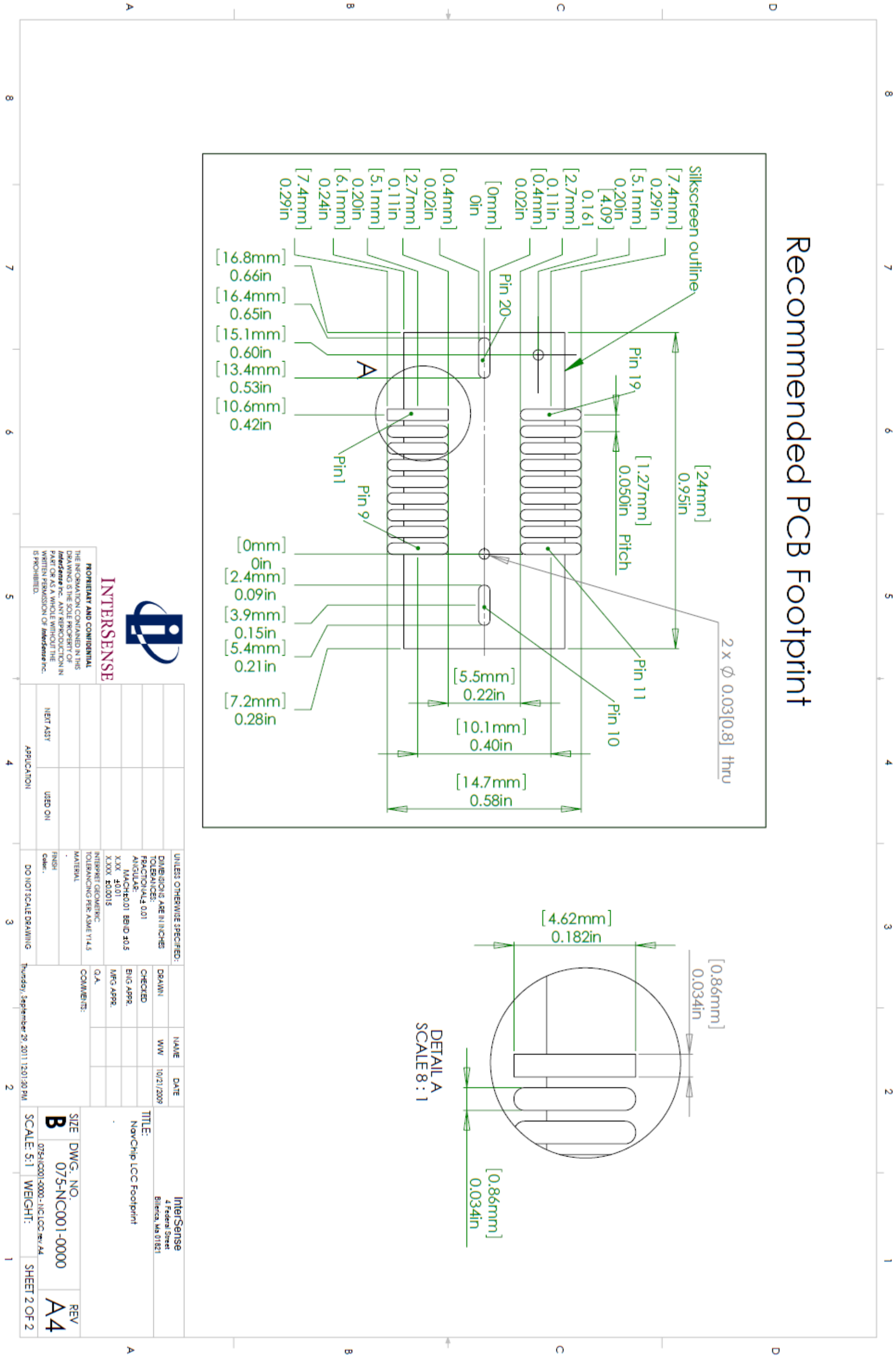
The ISNC01 is designed to be mounted onto a surface mount location; use of the recommended footprint (on the following page) will allow access to the device's LCC pads and the PCB's footprint for proper mounting.

The ISNC01 is precision calibrated during manufacturing final test. The technologies used in the ISNC01 can be sensitive to extreme thermal stresses. In order to maintain its precise calibration, it is important that caution be used when mounting the device to a printed circuit board. The materials and processes used to manufacture electronic assemblies containing the NavChip shall be selected such that their use, in combination, produces products acceptable to industry guidelines. InterSense is a proponent of environmental ideals and thus NavChip is lead-free and RoHS compatible. Hand-soldering under the following conditions should be used to attach the NavChip to an electronic assembly.

1. Only handle the ISNC01 in an ESD controlled environment. Proper ESD guidelines (i.e. a grounded strap) should be used when handling the ISNC01
2. Surface preparation: surface should be clean and dry.
3. Use of surface mount adhesives[1] such as Loctite 3629 is highly recommended both to aid alignment and preserve the mechanical integrity of the assembly against forces such as shock and vibration.
4. Flux selection is critical as it may become entrapped under the device. It is recommended that a no-clean flux be used that conforms to J-STD-004 ROLO or ROMO. The flux will leave a clear, tack-free, non-corrosive residue.
5. The use of solder paste is not recommended for this application as there is a propensity for solder balls to become trapped under the NavChip causing a latent defect.
6. Pre-Tinning of the circuit board pads is recommended: InterSense suggests tinning one lead at a time using a fine-tipped soldering iron and lead free solder wire. The tinned leads should be flat and uniform in appearance. Any excess solder should be removed with RoHS compliant solder braid.
7. The solder iron tip should be clean, well tinned and the correct shape to maximize the contact area of the castellation being soldered.
8. Position the NavChip so all 18 of its connections are centered on the PCB pads. Simultaneously heat the surface mount pad and the LCC pad with the soldering iron. Apply the soldering iron to each pin for no longer than required for proper solder "wetting". Heat the connection to ≥ 100°C above the melting point of solder being used for a duration of no more than 3 seconds – Tip temperature should not exceed 370°C.
9. Begin by soldering opposite corner pads while continually verifying alignment. Once the two opposite corner pads are soldered, work your way around soldering the remaining 16 connections using a crisscrossing pattern (i.e. solder pin 1, first followed by pin 11, followed by pin 2, etc.). Allow the NavChip to cool in between soldering each pin to prevent overheating.
10. The surface finish and shape of lead free solder joints are significantly different from those observed with tin/lead alloys (lead free solder has a matte grainy appearance compared to SnPb solder, which has high luster finish).

    Note: For increased mechanical support, it is recommended that the NavChip assembly be mounted additionally with a low temperature (≤125°C) thermoset epoxy. The process of dispensing the adhesive prior to component placement is corner bonding (Loctite 3629). Alternatively, edge bonding can be used by placement of the adhesive on the edge of the package post soldering. Both methods are acceptable and are considered essential for the assembly to withstand stress from mechanical shock. Corner bonding has the advantage of helping to align the device through the adhesives green tack properties. Edge bonding has the advantage of being able to functionally test the device before anchoring it into place with solder.

Figure 4: Recommended PCB Footprint



ORDERING INFORMATION

The ISNC01 is available in four variants with full-scale acceleration of ±8g or ±16g and full-scale angular rate of 480°/s and 2,000°/s.

	Max. angular rate 480°/s	**Max. angular rate 2,000°/s**
Full-scale acceleration ± 8g	ISNC01-010	ISNC01-000
Full-scale acceleration ± 16g	ISNC01-030	ISNC01-020

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