Tri Axis Gyroscope & Accelerometer

Preliminary Technical Data

ADIS16350

FEATURES

Tri-axis gyroscope
±320 degrees/second measurement range
14-bit resolution
Tri-axis accelerometer
±10g measurement range
14-bit resolution
350Hz Bandwidth
Factory calibrated sensitivity and bias
Digitally controlled sensitivity and bias
Digitally controlled sample rate
Digitally controlled filtering
Programmable condition monitoring, alarms
Auxiliary digital I/O
Digitally activated self-test
Programmable power management
Embedded Temperature Sensor
SPI®-compatible serial interface
Auxiliary 12-bit ADC input and DAC output
Single-supply operation: +4.75V to +5.25 V
2000 *g* powered shock survivability

APPLICATIONS

Guidance and control
Platform control and stabilization
Motion control and analysis
Inertial Measurement Units
General Navigation
Image stabilization
Robotics

GENERAL DESCRIPTION

The ADIS16350 *i*Sensor™ provides complete tri axis inertial sensing (both angular and linear motion) in a compact module fully ready for system integration. With Analog Devices' iMEMS™ sensor technology at its core, the ADIS16350 includes embedded processing for sensor calibration and tuning. An SPI interface allows for simple system interface and programming.

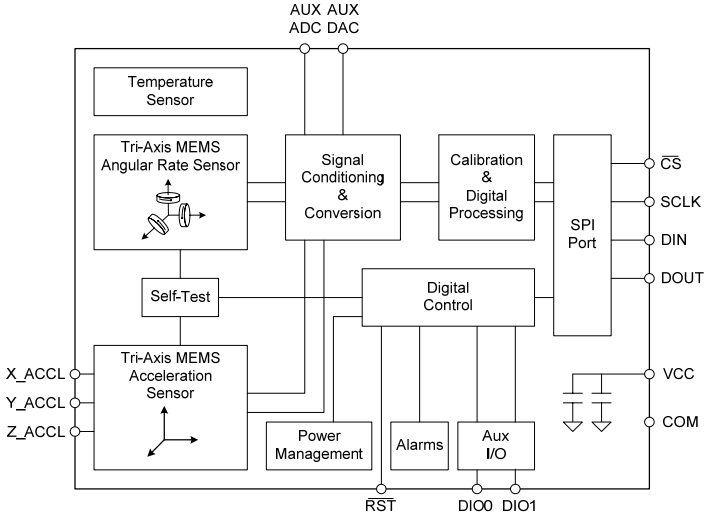
The SPI port provides access to the following embedded sensors: X, Y, and Z axis angular rate; X, Y, and Z axis linear acceleration; Internal Temperature; Power Supply; and an Auxiliary analog input. The inertial sensors are precision aligned across axis', and are calibrated for offset and sensitivity.

System interfacing is simplified with the following additional programmable features:

- In-system Bias Auto Calibration
- Digital Filtering and Sample Rate
- Self Test
- Power Management
- Condition Monitoring
- Auxiliary Digital I/O

The ultra compact module measures 22.7mmx23.2mmx22.9mm, plus mounting extensions.

FUNCTIONAL BLOCK DIAGRAM



Rev. PrA **11/10/2006 10:59 AM**

One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.
Tel: 781.329.4700 **www.analog.com**
Fax: 781.461.3113

REVISION HISTORY

9/06—Revision PSD1: Initial Version

SPECIFICATIONS

T_A = −40°C to +85°C, V_{CC} = 5.0 V, Angular Rate = 0°/s, Dynamic Range 320°/sec, ±1g, unless otherwise noted.

Table 1.

Parameter	Conditions	Min	Typ	Max	Unit
GYRO SENSITIVITY	Each axis				
Dynamic Range	Full-scale range over specifications range	±320			°/s
Initial	25°C, Dynamic range = ±320°/sec	0.07233	0.07326	0.07400	°/s/LSB
	25°C, Dynamic range = ±160°/sec		0.03663		°/s/LSB
	25°C, Dynamic range = ±80°/sec		0.01832		°/s/LSB
Sensitivity Drift over Temp	-20°C to 75°C		±500		ppm/°C
Axis Non-orthogonality	25°C, difference from 90 degrees ideal		TBD		degree
Axis Misalignment	25°C, relative to base-plate & guide pins		TBD		degree
Non-Linearity	Best fit straight line		±0.1		% of FS
GYRO BIAS					
In Run Bias Stability	25°C, 1 σ		0.016		°/s
Turn on – Turn on Bias Stability	25°C, 1 σ		0.035		°/s
Angular Random Walk	25°C		3.6		°/√hr
Zero Rate Bias Drift over Temp	-20°C to 75°C		±0.06		°/s/°C
g Sensitivity	Any Axis		0.2		°/s/*g*
Voltage Sensitivity	V_{CC} = 4.75 V to 5.25 V		1.0		°/s /V
GYRO NOISE PERFORMANCE					
Output Noise	At 25°C, ±320 °/s Dynamic range, no filtering		TBD		°/s rms
	At 25°C, ±160 °/s Dynamic range, minimum 4 tap filter setting		TBD		°/s rms
	At 25°C, ±80 °/s Dynamic range, minimum 16 tap filter setting		TBD		°/s rms
Rate Noise Density	At 25°C, f= 25Hz, no average		0.05		°/s/√Hz rms
GYRO FREQUENCY RESPONSE					
Sensor Bandwidth			350		Hz
Sensor Resonant Frequency			14		kHz
Turn-on Time	Power on from Sleep Mode to ±2°/s of final, no averaging, min sample period		TBD		ms
GYRO SELF-TEST STATE					
Change for positive stimulus	Relative to nominal output	439	721	1092	LSB
Change for negative stimulus	Relative to nominal output	-439	-721	-1092	LSB
ACCELEROMETER SENSITIVITY	Each axis				
Dynamic Range		±10			g
Initial	@25°C	TBD	2.78	TBD	mg/LSB
Sensitivity Drift Over Temperature			TBD		ppm/°C
Axis Non-orthogonality	25°C, difference from 90 degrees ideal		TBD		degree
Axis Misalignment	25°C, relative to base-plate & guide pins		TBD		degree
Nonlinearity	Best Fit Straight Line		±0.2		% of FS
ACCELEROMETER BIAS					
0g Offset	@25°C	TBD		TBD	mg
0g Offset Over Temperature			TBD		mg/°C
Axis Non-orthogonality	25°C, difference from 90 degrees ideal		TBD		degree
Axis Misalignment	25°C, relative to base-plate & guide pins		TBD		degree

Table 2. (Continued)

Parameter	Conditions	Min	Typ	Max	Unit
ACCELEROMETER NOISE PERFORMANCE					
Output Noise	@25°C, no filtering		TBD		LSB rms
Noise Density	@25°C, no filtering		0.072		LSB/√Hz rms
ACCELEROMETER FREQUENCY RESPONSE					
Sensor Bandwidth			350		Hz
Sensor Resonant Frequency			10		kHz
ACCELEROMETER SELF-TEST STATE					
Output Change When Active	@25°C	44	80	120	LSB
TEMPERATURE SENSOR					
Output at 25°C			1278		LSB
Scale Factor			−2.13		LSB/°C
ADC INPUT					
Resolution			12		Bits
Integral Nonlinearity			±2		LSB
Differential Nonlinearity			±1		LSB
Offset Error			±4		LSB
Gain Error			±2		LSB
Input Range		0		2.5	V
Input Capacitance	During acquisition		20		pF
DAC OUTPUT	5 kΩ/100 pF to GND				
Resolution			12		Bits
Relative Accuracy	For Code 101 to Code 4095		4		LSB
Differential Nonlinearity			1		LSB
Offset Error			±5		mV
Gain Error			±0.5		%
Output Range			0 to 2.5		V
Output Impedance			2		Ω
Output Settling Time			10		µs
LOGIC INPUTS					
Input High Voltage, V_{INH}		2.0			V
Input Low Voltage, V_{INL}				0.8	V
	For −CS signal when used to wake up from SLEEP mode			0.55	V
Logic 1 Input Current, I_{INH}	V_{IH} = 3.3 V		±0.2	±10	µA
Logic 0 Input Current, I_{INL}	V_{IL} = 0 V		−40	−60	µA
Input Capacitance, C_{IN}			10		pF
DIGITAL OUTPUTS					
Output High Voltage, V_{OH}	I_{SOURCE} = 1.6 mA	2.4			V
Output Low Voltage, V_{OL}	I_{SINK} = 1.6 mA			0.4	V
SLEEP TIMER					
Timeout Period[1]		0.5		128	Sec
FLASH MEMORY					
Endurance[2]		20,000			Cycles
Data Retention[3]	T_J = 55°C	20			Years

Table 3. (Continued)

CONVERSION RATE					
Minimum Conversion Time			0.9766		ms
Maximum Conversion Time			1.937		Sec
Maximum Throughput Rate			1024		SPS
Minimum Throughput Rate			0.516		SPS
POWER SUPPLY					
Operating Voltage Range V_{CC}		4.75	5.0	5.25	V
Power Supply Current	Normal mode at 25°C		48		mA
	Fast mode at 25°C		77		mA
	Sleep mode at 25°C		500		µA

[1] Guaranteed by design
[2] Endurance is qualified as per JEDEC Standard 22 Method A117 and measured at −40°C, +25°C, +85°C, and +125°C.
[3] Retention lifetime equivalent at junction temperature (T_J) 55°C as per JEDEC Standard 22 Method A117. Retention lifetime decreases with junction temperature.

TIMING SPECIFICATIONS

T_A = +25°C, VCC = +5.0 V, angular rate = 0°/sec, unless otherwise noted.

Table 4.

Parameter	Description	Min[1]	Typ	Max	Unit
f_{SCLK}	Fast mode, SMPL_TIME ≤ 0x07 (f_S ≥ 256 Hz)	0.01		2.5	MHz
	Normal mode, SMPL_TIME ≥ 0x08 (f_S ≤ 228 Hz)	0.01		1.0	MHz
$t_{DATARATE}$	Chip select period, fast mode, SMPL_TIME ≤ 0x07 (f_S ≥ 256 Hz)	40			µs
	Chip select period, normal mode, SMPL_TIME ≥ 0x08 (f_S ≤ 228 Hz)	100			µs
t_{CS}	Chip select to clock edge	48.8			ns
t_{DAV}	Data output valid after SCLK falling edge[2]			100	ns
t_{DSU}	Data input setup time before SCLK rising edge	24.4			ns
t_{DHD}	Data input hold time after SCLK rising edge	48.8			ns
t_{DF}	Data output fall time		5	12.5	ns
t_{DR}	Data output rise time		5	12.5	ns
t_{SFS}	$\overline{CS}$ high after SCLK edge[3]	5			ns

[1] Guaranteed by design, not production tested.
[2] The MSB presents an exception to this parameter. The MSB clocks out on the falling edge of $\overline{CS}$. The rest of the DOUT bits are clocked after the falling edge of SCLK and are governed by this specification.
[3] This parameter may need to be expanded to allow for proper capture of the LSB. After $\overline{CS}$ goes high, the DOUT line goes into a high impedance state.

TIMING DIAGRAMS

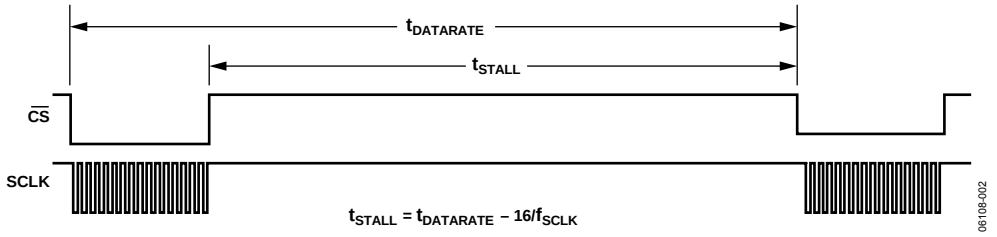


Figure 1. SPI Chip Select Timing

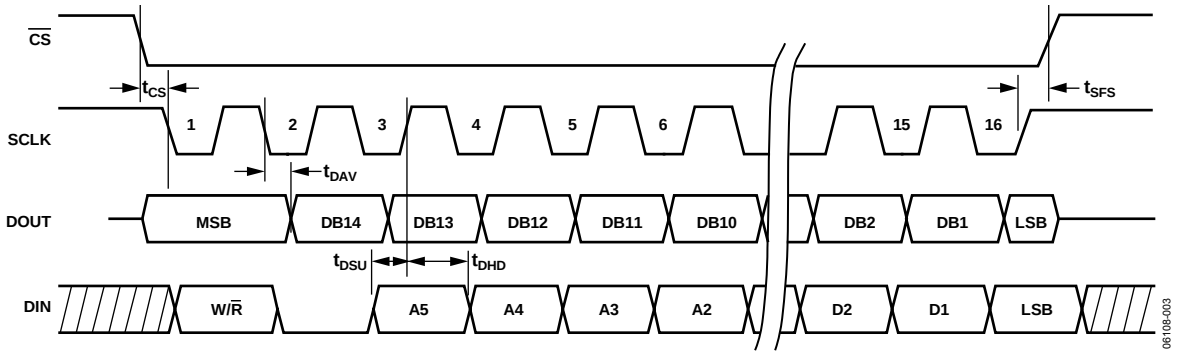


Figure 2. SPI Timing, Utilizing SPI Settings Typically Identified as Phase = 1, Polarity = 1

ABSOLUTE MAXIMUM RATINGS

Table 5.

Parameter	Rating
Acceleration (Any Axis, Unpowered)	2000 *g*
Acceleration (Any Axis, Powered)	2000 *g*
VDD to COM	−0.3 V to +7.0 V
Digital Input/Output Voltage to COM	−0.3 V to +5.5 V
Analog Inputs to COM	−0.3 V to VCC + 0.3 V
Operating Temperature Range	−40°C to +105°C
Storage Temperature Range	−65°C to +150°C[1]

[1] Extended exposure to temperatures outside of the specified temperature range of -40°C to +85°C can adversely affect the accuracy of the factory calibration. For best accuracy, store the parts within the specified operating range of -40°C to +85°C.

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above 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.

Table 6. Package Characteristics

Package Type	θ_{JA}	θ_{JC}	Device Weight
TBD	TBD	TBD	TBD

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

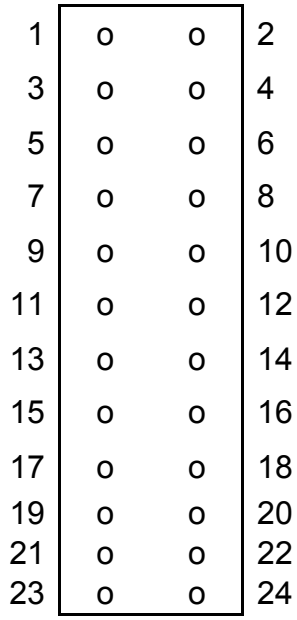


Figure 3. Pin Configuration, Bottom, Pin View

Table 7. Pin Function Descriptions

Pin No.	Mnemonic	Type[1]	Description
1	DNC		Do not connect
2	DNC		Do not connect
3	SCLK	I	SPI, Serial clock
4	DOUT	O	SPI, Data output
5	DIN	I	SPI, Data input
6	~CS	I	SPI, Chip Select
7	DIO0	I/O	Digital I/O
8	~RST	I	Reset
9	DIO1	I/O	Digital I/O
10	VCC	S	Power supply
11	VCC	S	Power supply
12	VCC	S	Power supply
13	GND	S	Power ground
14	GND	S	Power ground
15	GND	S	Power ground
16	DNC	N/A	Do not connect
17	DNC	N/A	Do not connect
18	DNC	N/A	Do not connect
19	DNC	N/A	Do not connect
20	AUX_DAC	O	Auxiliary, 12-bit digital-to-analog converter output
21	AUX_ADC	I	Auxiliary, 12-bit, analog-to-digital converter in put
22	Y_ACCL	O	Y-Axis acceleration
23	X_ACCL	O	X-Axis acceleration
24	Z_ACCL	O	Z-Axis acceleration

[1] S = supply, O = output, I = input.

OUTLINE DIMENSIONS

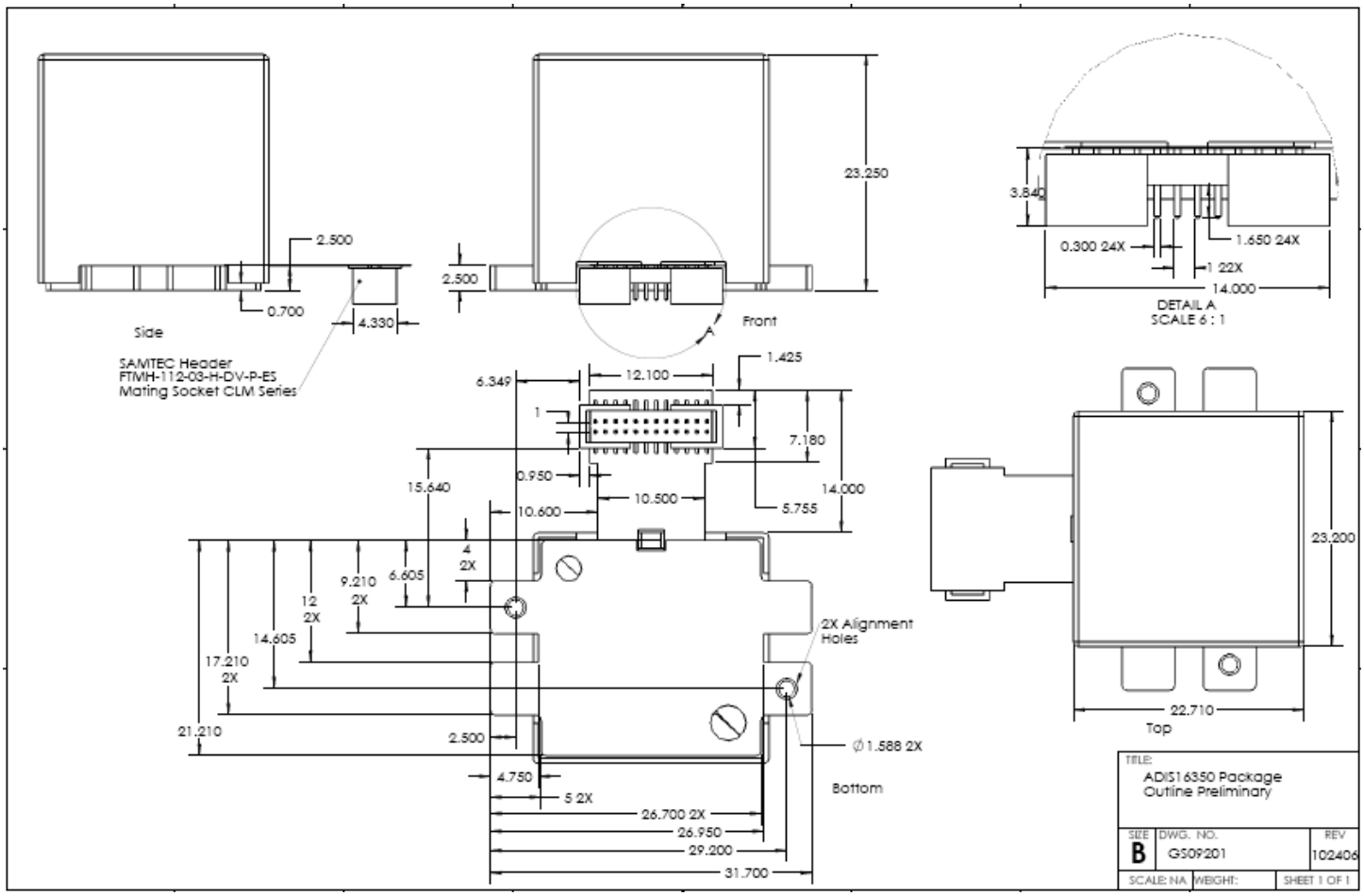


Figure 4.
Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
ADIS16350AML	-40°C to +85°C		
ADIS16350/PCBZ			

NOTES