SCHA63T-K01 Data Sheet

SCHA63T-K01: 6-DOF XYZ-Axis Gyroscope and xyz-Axis Accelerometer with digital SPI interface

Features

- ±125°/s angular rate measurement range
- ± 6 g acceleration measurement range
- −40°C…+110°C operating temperature range
- 3.0V…3.6V supply voltage
- 2 SPI digital interfaces
- Extensive self-diagnostics features
- Size 19.71 mm x 12.15 mm x 4.6 mm (l × w × h), 32 pins
- RoHS compliant robust SOIC plastic package suitable for lead free soldering process and SMD mounting
- Proven capacitive 3D-MEMS technology
- Can be used in Safety Critical Applications

Applications

SCHA63T-K01 is targeted at applications demanding high performance with tough environmental requirements. Typical applications include:

- Inertial Measurement Units (IMUs)
- Navigation and positioning
- Machine control and guidance
- Dynamic inclination
- Robotic control and UAVs

Restriction

- https://www.murata.com/en-global/support/militaryrestriction

Overview

The SCHA63T-K01 is a combined high performance 3-axis angular rate and 3-axis accelerometer. It consists of X-, Y- and Z-axis angular rate sensors and integrated 3-axis accelerometer based on Murata's proven capacitive 3D-MEMS technology. Signal processing is done with two mixed signal ASICs that provides angular rate via flexible SPI digital interface. Sensor elements and ASIC are packaged to premolded SOIC 32 plastic housing that guarantees reliable operation over product's lifetime.

The SCHA63T-K01 is designed, manufactured and tested for high stability, reliability and quality requirements. Component has extremely stable output over temperature, humidity and vibration. Component has several advanced self-diagnostic features and is suitable for SMD mounting and is compatible with RoHS and ELV directives.

TABLE OF CONTENTS

1 Introduction

This document contains essential technical information about SCHA63T-K01 sensor including specifications, SPI interface descriptions, user accessible register details, electrical properties and application information. This document should be used as a reference when designing in SCHA63T-K01 component.

2 Product order code with packing quantity

Order Code	Description	Packing	Qty
SCHA63T-K01-004	Gyro ±125dps, Accelerometer ±6g	Bulk	4 pcs
SCHA63T-K01-05	Gyro ±125dps, Accelerometer ±6g	Tape & Reel	50 pcs/Reel
SCHA63T-K01-6	Gyro ±125dps, Accelerometer ±6g	Tape & Reel	600pcs/Reel

3 Specifications

3.1 Abbreviations

ASIC	Application Specific Integrated Circuit
CCM	Channel calibration and monitoring
Cpk	Process Capability Index
CSB	Chip Select
CST	Continuous Self Test
DPS	Degrees per second
DUE	ASIC for ZY-axis rate
FFB	Force Feedback (Gyro operating principle)
FS	Full scale
HPC	High Performance Combo
MOSI	Master Out Slave In
MISO	Master In Slave Out
MCU	Microcontroller
RT	Room Temperature
SCK	Serial Clock
SPI	Serial Peripheral Interface
UNO	ASIC for X-axis rate and XYZ-axis accelerometer
F_prim	Gyro primary frequency
Rx	Rate X axis
Ry	Rate Y axis
Rz	Rate Z axis
Ax	Accelerometer X axis
Ay	Accelerometer Y axis
Az	Accelerometer Z axis

3.2 General Specifications

General specifications for SCHA63T-K01 component are presented in Table 1. All analog voltages are related to the potential at GNDA and all digital voltages are related to the potential at GNDD.

Table 1. General specifications.

Parameter	Condition	SC/CC	Min	Typ	Max	Unit
Supply voltage: V3p3A			3.0	3.3	3.6	V
Supply voltage: V3p3D			3.0	3.3	3.6	V
Supply current: V3p3A DUE				8.5		mA
Supply current: V3p3D DUE				9.5		mA
Supply current: V3p3A+D DUE				18		mA
Supply current: V3p3A UNO				6.25		mA
Supply current: V3p3D UNO				6.25		mA
Supply current: V3p3A+D UNO				12.5		mA
Total current, I_TOTAL UNO+DUE	I_V3p3A + I_V3p3D Temperature range -40 ... +110 °C	CC		30.5		mA
Total current reset UNO+DUE	Total average current during reset				4	mA
Output update rate	Gyro, Accelerometer and Temperature sensor			F_prim /2		Hz
TMODE	Wait time to set the operation mode after the supply in the specification. Wait time needed after power on or after reset. (Wait time starts when supply is inside spec limits.) SPI is not functional during this time.		25			ms
TSPIR	SPI communication is not allowed for 2ms after SPI Hardreset.		2			ms

3.3 Performance Specifications for Gyroscope

Table 2. Gyro performance specifications (VDD = 3.3 V and at room temperature unless otherwise specified). Below values are from device Product and Process Validation (PV) phase unless otherwise specified.

Parameter	Condition	Axis	Min	Typ	Max	Unit
Measurement range	Minimum saturation flag	XYZ	± 125			°/s
Offset [A)]	Offset after calibration, 3σ N > 234	XYZ	-0.8	0	0.8	°/s
Offset temperature dependency [B)]	-40°C ≤ T ≤ +110°C, 3σ N = 234	XY	-0.65		0.65	°/s
		Z	-0.085		0.085	°/s
Offset change over lifetime [C)]	1000 hours of high temperature operating life (HTOL) at 125°C, VDD=3.6V N = 234	XY	-0.22		0.22	°/s
		Z	-0.06		0.06	°/s
Sensitivity [D)]	Sensitivity after calibration at ±125°/s, 3σ N = 30	XYZ	156.8	160	163.2	LSB/°/s
Sensitivity temperature dependency [E)]	-40°C ≤ T ≤ +110°C, 3σ N = 234	XY	-0.2		0.6	%
		Z	0		0.2	%
Sensitivity change over lifetime [F)]	1000 hours of high temperature operating life (HTOL) at 125°C, VDD=3.6V N = 234	XY	-0.75		0.75	%
		Z	-0.21		0.21	%
Linearity error [G)]	End point fit to ±125 °/s N = 30	XYZ		0.035	0.065	°/s
Noise density	3σ, N = 90	XYZ		0.0011	0.0017	$°/s/\sqrt{Hz}$
Angle Random Walk	3σ, N = 90	XYZ		0.07	0.10	$°/\sqrt{h}$
Bias Instability [H) I) J)]	At RT, Allan Variance minimum divided by 0.664, 3σ, N = 90	XYZ		1.11	1.89	°/h
Orthogonality error	Axis to axis after external cross axis compensation, 3σ, N = 234	XYZ	-0.25		0.25	%
Amplitude response −3 dB frequency	13 Hz Filter, 3σ, N = 15	XYZ	12.1	13.6	14.3	Hz
	20 Hz Filter, 3σ, N = 15		18.5	20.2	21.5	Hz
	46 Hz Filter, 3σ, N = 15		42.1	46.1	48.9	Hz
	300 Hz Filter, 3σ, N = 15		280	305.8	325.6	Hz
Power on start-up time [k)]	13 Hz filter (after SPI power on command), MAX	XYZ			620	ms
	20 Hz filter (after SPI power on command), MAX				620	ms
	46 Hz filter (after SPI power on command), MAX				500	ms
	300 Hz filter (after SPI power on command), MAX				500	ms
F_prim	Nominal operation frequency of the sensor element. All ASIC internal clocks are derived from a multiple of this frequency	XY	15.8	16.8	17.8	kHz
		Z	18.3	19.3	20.3	kHz
Output update rate		XYZ		F_prim/2		
G sensitivity(1g x,y,z axis static)	For DC gravity input, 3σ, N = 48	XYZ			0.006	(°/s)/g

A) Initial offset at Murata Production measurement after calibration

B) Offset temperature dependency is determined by the larger absolute value of [(maximum offset over temperature) – (offset at 25°C)] or [(minimum offset over temperature) – (offset at 25°C)]

C) Estimated from offset change during 1000 hours of high temperature operating live (HTOL) test at 125°C and maximum supply voltages

D) Sensitivity is defined as

$$Sensitivity = \frac{AR_{meas}(\Omega_{max}) - AR_{meas}(\Omega_{min})}{\Omega_{max} - \Omega_{min}}$$

Where
Ω_{max}=applied angular rate at maximum operating range
Ω_{min}=applied angular rate at minimum operating range
$AR_{meas}(\Omega_n)$=measured angular rate at Ω_n [LSB]

E) Sensitivity temperature dependency is determined by the larger absolute value of
[(maximum sensitivity value over temperature) - (sensitivity at 25°C)] /sensitivity at 25°C*100% or
[(minimum sensitivity value over temperature) - (sensitivity at 25°C)] /sensitivity at 25°C*100%

F) Estimated from sensitivity change during 1000 hours of high temperature operating life (HTOL) test at 125°C and maximum supply voltages

G) Linearity is the maximum deviation from the straight line defined by the measured values at the operating range end points.

H) Allan Variance Minimum divided by 0.664

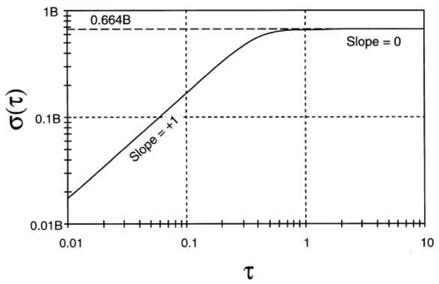


Figure C.2—σ(τ) Plot for bias instability (for f_0 = 1)

I) Optimization for SPI duty cycle or sample rate is required to achieve typical Allan variance in table

J) Device powered four hours before data collection starts to permit fully settling from power up.

K) Max values are determined from product platform validations

Note :

- Specification is valid after 24hours from reflow.
- Each system design including SCHA63T-K01 must be evaluated by the customer in advance to guarantee proper functionality during operation.
- Min and Max values are from validation mean ±3 sigma variation limits from test population at the minimum. Min and Max values are not guaranteed. Nominal values are mean values from validation test population.

3.4 Performance Specifications for Accelerometer

Table 3. Accelerometer performance specifications (VDD = 3.3 V and room temperature unless otherwise specified). Below values are from device Product and Process Validation (PV) phase unless otherwise specified.

Parameter	Condition	Axis	Min	Typ	Max	Unit
Measurement range	Minimum saturation flag	XYZ	6			g
Offset A)	Offset after calibration, 3σ N = 234	XYZ	-13.5		13.5	mg
Offset temperature dependency B)	-40°C ≤ T ≤ +110°C, 3σ N = 234	XYZ	-7.3		7.3	mg
Offset change over lifetime C)	1000 hours of high temperature operating life (HTOL) at 125°C, VDD=3.6V N = 234	XYZ	-22		22	mg
Sensitivity D)	Sensitivity after calibration at ±1g, 3σ N = 234	XYZ	4899	4905	4911	LSB/g
Sensitivity temperature dependency E)	-40°C ≤ T ≤ +110°C, 3σ N = 234	XYZ	-0.15		0.15	%
Sensitivity change over lifetime F)	1000 hours of high temperature operating life (HTOL) at 125°C, VDD=3.6V N = 234	XYZ	-0.06		0.06	%
Linearity error G)	End point fit to ±6g 3σ, N = 30	XYZ	1.9	6.3	17.2	mg
	End point fit to ±1g 3σ, N = 30	XYZ			1	mg
Noise density	3σ, N = 12	XYZ		59.5	66.0	µg/$\sqrt{Hz}$
Velocity random walk	3σ, N = 12	XYZ		35.0	38.8	mm/s /$\sqrt{h}$
Bias instability	At RT, Allan Variance minimum divided by 0.664, 3σ, N = 12	XYZ		12.2	18.3	µg
Orthogonality error	Axis to axis after external cross axis compensation, 3σ, N = 234	XYZ	-0.14		0.14	%
Amplitude response −3 dB frequency	13 Hz Filter, 3σ, N = 15	XYZ	13.2	13.7	14.2	Hz
	20 Hz Filter, 3σ, N = 15	XYZ	19.7	20.3	20.8	Hz
	46 Hz Filter, 3σ, N = 15	XYZ	45.0	46.3	47.5	Hz
	300 Hz Filter, 3σ, N = 15	XYZ	247.4	264.2	286.7	Hz
Power on start-up time H)	13 Hz filter (after SPI power on command) , MAX	XYZ			450	ms
	20 Hz filter (after SPI power on command) , MAX				450	ms
	46 Hz filter (after SPI power on command) , MAX				320	ms
	300 Hz filter (after SPI power on command) , MAX				320	ms
Output update rate	Tied to X-gyro F_prim/2	XYZ	7.9	8.4	8.9	kHz

A) Initial offset at Murata Production measurement after calibration

B) Offset temperature dependency is determined by the larger absolute value of [(maximum offset over temperature) – (offset at 25°C)] or [(minimum offset over temperature) – (offset at 25°C)]

C) Estimated from offset change during 1000 hours of high temperature operating life (HTOL) test at 125°C

D) Sensitivity is defined as

$$Sensitivity = \frac{ACC_{meas}\left(a_{+1g}\right) - ACC_{meas}\left(a_{-1g}\right)}{a_{+1g} - a_{-1g}}$$

Where
a_{+1g}=applied acceleration at +1g
a_{-1g}=applied acceleration at -1g
$ACC_{meas}(a_n)$=measured acceleration at a_n [LSB]

E) Sensitivity temperature dependency is determined by the larger absolute value of [(maximum sensitivity value over temperature) - (sensitivity at 25°C)] /sensitivity at 25°C*100% or [(minimum sensitivity value over temperature) - (sensitivity at 25°C)] /sensitivity at 25°C*100%

F) Estimated from Sensitivity change during 1000 hours of high temperature operating life (HTOL) test at 125°C

G) Linearity is the maximum deviation from the straight line defined by the measured values at the specified range end points.

H) Max values are determined from product platform validations

Note :

- Specification is valid after 24hours from reflow.
- Each system design including SCHA63T-K01 must be evaluated by the customer in advance to guarantee proper functionality during operation.
- Min and Max values are validation ±3 sigma variation limits from test population at the minimum. Min and Max values are not guaranteed. Nominal values are mean values from validation test population.

3.5 Performance Specification for Temperature Sensor

Table 4. Temperature sensor performance specifications.

Parameter	Condition	Min.	Typ	Max.	Unit
Temperature signal range		-50		+150	°C
Temperature signal sensitivity	Temperature sensor output in 2's complement format		30		LSB/°C

Temperature is converted to °C with following equation:

$$\text{Temperature [°C]} = 25 + (\text{TEMP} / 30),$$

where TEMP is temperature sensor output register content in decimal format.

3.6 Cross-Axis Compensation

SCHA63T-K01 ASIC stores the cross-axis compensation and offset fine tuning terms both for the rate and accelerometer and cross-axis compensation can be done in the external microprocessor according to the following equations.

Equation 1: Rate Cross-Axis Compensation

$$\vec{\Omega_{real}} = \begin{pmatrix} c_{xx} & c_{xy} & c_{xz} \\ c_{yx} & c_{yy} & c_{yz} \\ c_{zx} & c_{zy} & c_{zz} \end{pmatrix} * (\vec{\Omega_{meas}} - \vec{\Omega_{offs}})$$

where

c_{ii} = is the corresponding rate cross-axis compensation term (in non-volatile memory, see Table 5: Cross-Axis Compensation Register Map)

Equation 2: Compensated rate vector

$$\vec{\Omega_{real}} = \begin{pmatrix} \Omega_{rx} \\ \Omega_{ry} \\ \Omega_{rz} \end{pmatrix}$$

Equation 3: Measured rate vector (from the component)

$$\vec{\Omega_{meas}} = \begin{pmatrix} \Omega_{mx} \\ \Omega_{my} \\ \Omega_{mz} \end{pmatrix}$$

Equation 4: Rate offset compensation vector (Not stored in the memory). Rate offset zeroing in system level e.g. after PCB assembly is recommended.

$$\vec{\Omega_{offs}} = \begin{pmatrix} \Omega_{ox} \\ \Omega_{oy} \\ \Omega_{oz} \end{pmatrix}$$

For the accelerometers following equations apply:

Equation 5: Accelerometer Cross-Axis Compensation

$$\vec{a_{real}} = \begin{pmatrix} b_{xx} & b_{xy} & b_{xz} \\ b_{yx} & b_{yy} & b_{yz} \\ b_{zx} & b_{zy} & b_{zz} \end{pmatrix} * (\vec{a_{meas}} - \vec{a_{offs}})$$

where

b_{ii} = is the corresponding accelerometer cross-axis compensation term (see Table 5: Cross-Axis Compensation Register Map)

Equation 6: Compensated accelerometer vector

$$\vec{a_{real}} = \begin{pmatrix} a_{rx} \\ a_{ry} \\ a_{rz} \end{pmatrix}$$

Equation 7: Measured accelerometer vector (from the component)

$$\vec{a_{meas}} = \begin{pmatrix} a_{mx} \\ a_{my} \\ a_{mz} \end{pmatrix}$$

Equation 8: Acceleration offset compensation vector (Not stored in the memory). Acceleration offset zeroing in system level e.g. after PCB assembly is recommended.

$$\vec{a_{offs}} = \begin{pmatrix} a_{ox} \\ a_{oy} \\ a_{oz} \end{pmatrix}$$

Note: Sensing element axes are independent from each other by the mechanical design. The cross-axis compensation doesn’t affect to axis independency as long as no axes are saturated.

Table 5: Cross-Axis Compensation Register Map

Parameter	Bank (DUE ASIC)	Address (hex)	Register	Range (2's complement)	Floating number
c_{xx}	05h	0Bh	ACC_DC1[7:0]	- 128 .. 127 LSB	1+value/4096
c_{xy}	05h	0Bh	ACC_DC1[15:8]	- 128 .. 127 LSB	value/4096
c_{xz}	05h	13h	ACC_DC9[7:0]	- 128 .. 127 LSB	value/4096
c_{yx}	05h	13h	ACC_DC9[15:8]	- 128 .. 127 LSB	value/4096
c_{yy}	05h	14h	ACC_DC10[7:0]	- 128 .. 127 LSB	1+value/4096
c_{yz}	05h	14h	ACC_DC10[15:8]	- 128 .. 127 LSB	value/4096
c_{zx}	05h	15h	ACC_DC11[7:0]	- 128 .. 127 LSB	value/4096
c_{zy}	05h	15h	ACC_DC11[15:8]	- 128 .. 127 LSB	value/4096
c_{zz}	05h	16h	ACC_DC12[7:0]	- 128 .. 127 LSB	1+value/4096
b_{xx}	05h	16h	ACC_DC12[15:8]	- 128 .. 127 LSB	1+value/4096
b_{xy}	05h	17h	ACC_DC13[7:0]	- 128 .. 127 LSB	value/4096
b_{xz}	05h	17h	ACC_DC13[15:8]	- 128 .. 127 LSB	value/4096
b_{yx}	05h	18h	ACC_DC14[7:0]	- 128 .. 127 LSB	value/4096
b_{yy}	05h	18h	ACC_DC14[15:8]	- 128 .. 127 LSB	1+value/4096
b_{yz}	05h	1Bh	ACC_MD1[7:0]	- 128 .. 127 LSB	value/4096
b_{zx}	05h	1Bh	ACC_MD1[15:8]	- 128 .. 127 LSB	value/4096
b_{zy}	05h	1Ch	ACC_MD2[7:0]	- 128 .. 127 LSB	value/4096
b_{zz}	05h	1Ch	ACC_MD2[15:8]	- 128 .. 127 LSB	1+value/4096

3.6.1 Test Mode For Reading Cross-Axis Terms

Procedure
1) Activate test mode (open lock) after Step 3 (or 4 or 5 or 6) of start-up sequence in Figure 7.

- Write/Read Register 19h (Mode)
  - Write Mode='RRRRRRRR RR010RRR'b
  - Read Mode
  - Write Mode='RRRRRRRR RR001RRR'b
  - Read Mode
  - Write Mode='RRRRRRRR RR100RRR'b
  - Read Mode
  - Dummy read, for example read Mode to get Mode read response
- Verify test mode
  - Check the read data bits Mode[2:0]='111'b

2) Change bank to 5

- Write data 5'h to address 1F'h

3) Read cross-axis terms

- Read registers according to Table 5.

4) Save cross-axis terms to MCU
5) Power-off or SPI reset command via register 18h or reset by EXTRESN pin to exit test mode
6) Return to Step 1 of start-up sequence in Figure 7.

*Write operation to an unspecified register after test mode access may permanently damage the component.

3.7 Absolute Maximum Ratings

Within the maximum ratings (Table 6. Absolute maximum ratings.), no damage to the component shall occur. Parametric values may deviate from specification, yet no functional deviation shall occur. All analog voltages are related to the potential at GNDA, all digital voltages are related to GNDD.

Table 6. Absolute maximum ratings.

Parameter	Remark	Min.	Typ	Max.	Unit
VDD	Supply voltage	-0.3		4.3	V
AIN/AOUT	Maximum voltage at analog input and output pins	-0.3		VDD+0.3 (4.3)	V
DIN/DOUT	Maximum voltage at digital input and output pins	-0.3		VDD+0.3 (4.3)	V
Topr	Operating temperature range	-40		110	°C
Tstg	Storage temperature range	-40		150	°C
ESD_HBM	ESD according Human Body Model (HBM), Q100-002	±2000			V
ESD_MM	ESD according Machine Model (MM), Q100-003	±200			V
ESD_CDM	ESD according Charged Device Model (CDM), Q100-011	±500 ±750 (corner pins)			V
US	Ultrasonic agitation (cleaning, welding, etc)	Prohibited			

3.8 Pin Description

The pinout for SCHA63T-K01 is presented in Figure 1, while the pin descriptions can be found in Table 7.

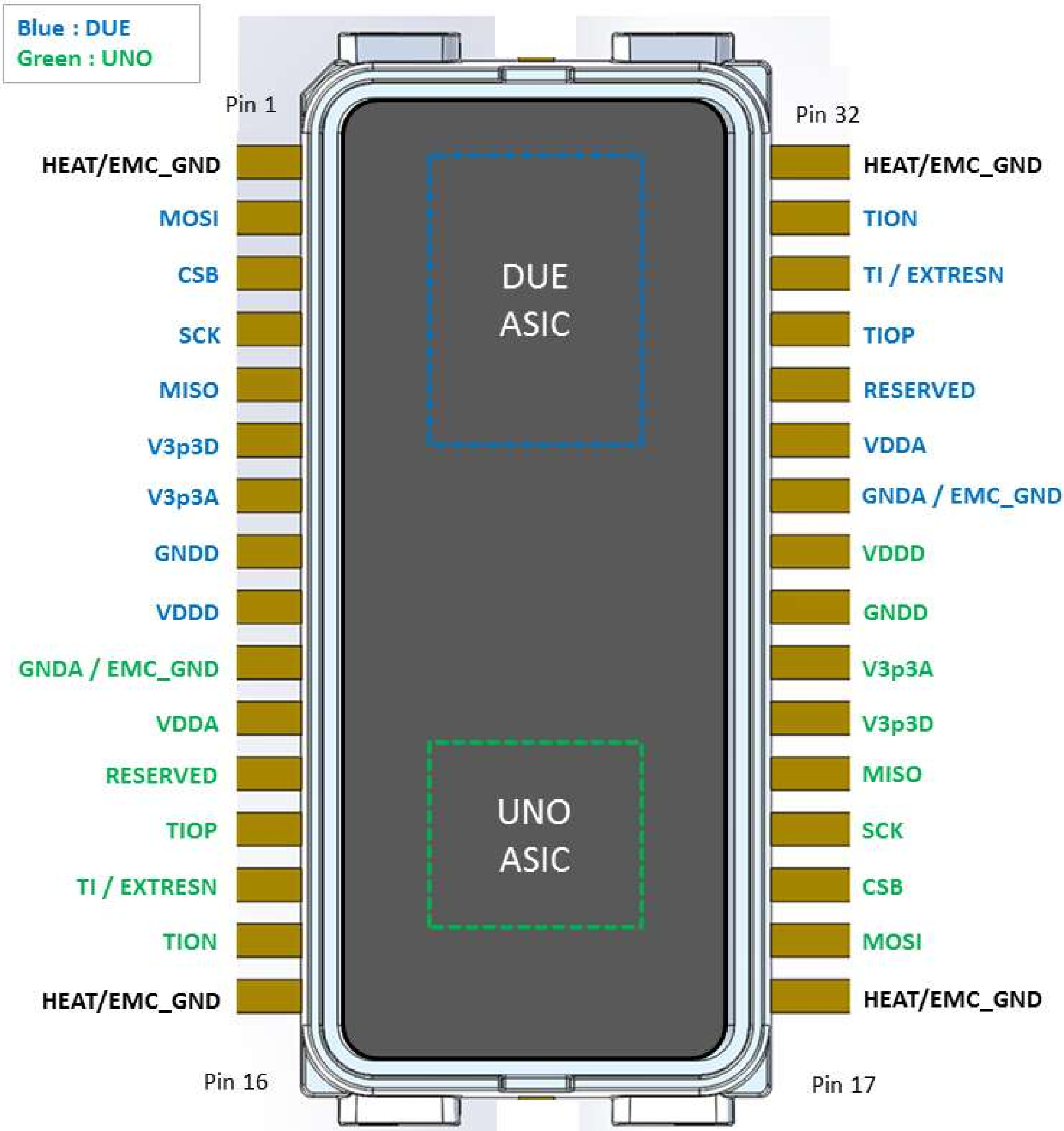


Figure 1. Pinout for SCHA63T-K01.

Table 7. SCHA63T-K01 pin descriptions.

Pin#	Name	ASIC	Type	Description
1	HEAT/EMC_GND	-	GND	Heatsink interface to GNDA
2	MOSI	DUE	DIN	Data In of SPI Interface
3	CSB	DUE	DIN	Chip Selected of SPI Interface
4	SCK	DUE	DIN	Clock Signal of SPI Interface
5	MISO	DUE	DOUT	Data Out of SPI Interface
6	V3p3D	DUE	SUPPLY	Digital Supply voltage
7	V3p3A	DUE	SUPPLY	Analog Supply voltage
8	GNDD	DUE	GND	Digital Supply return (ground), connect externally to GNDA.
9	VDDD	DUE	AOUT	Regulated supply for digital core. Use external capacitor which is connected according to the diagram in Figure 15.
10	GNDA / EMC_GND	UNO	GND	Analog Supply return (ground), connect externally to GNDD
11	VDDA	UNO	AOUT	Regulated supply for analog core. Use external capacitor which is connected according to the diagram in Figure 15.
12	RESERVED	UNO	-	Factory use only, connect to GND
13	TIOP	UNO	-	Factory use only, connect to GND.
14	TI/EXTRESN	UNO	DIN	Optional external Reset, 3.3V logic compatible Schmitt-trigger input with internal pull-up, LOW-HIGH transition causes system restart. Minimum low time 100us.
15	TION	UNO	-	Factory use only, connect to GND.
16	HEAT/EMC_GND	-	GND	Heatsink interface to GNDA
17	HEAT/EMC_GND	-	GND	Heatsink interface to GNDA
18	MOSI	UNO	DIN	Data In of SPI Interface
19	CSB	UNO	DIN	Chip Selected of SPI Interface
20	SCK	UNO	DIN	Clock Signal of SPI Interface
21	MISO	UNO	DOUT	Data Out of SPI Interface
22	V3p3D	UNO	SUPPLY	Digital Supply voltage
23	V3p3A	UNO	SUPPLY	Analog Supply voltage
24	GNDD	UNO	GND	Digital Supply return (ground), connect externally to GNDA.
25	VDDD	UNO	AOUT	Regulated supply for digital core. Use external capacitor which is connected according to the diagram in Figure 15.
26	GNDA / EMC_GND	DUE	GND	Analog Supply return (ground), connect externally to GNDD
27	VDDA	DUE	AOUT	Regulated supply for analog core. Use external capacitor which is connected according to the diagram in Figure 15.
28	RESERVED	DUE	-	Factory use only, connect to GND
29	TIOP	DUE	-	Factory use only, connect to GND.
30	TI/EXTRESN	DUE	DIN	Optional external Reset, 3.3V logic compatible Schmitt-trigger input with internal pull-up, LOW-HIGH transition causes system restart. Minimum low time 100us.
31	TION	DUE	-	Factory use only, connect to GND.
32	HEAT/EMC_GND	-	GND	EMC protection and ground

3.9 Typical performace characteristics

3.9.1 Gyro typical characteristics

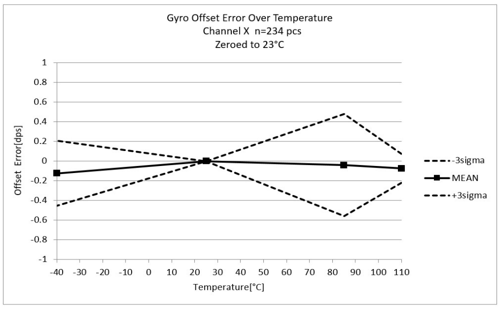


Chart 1 Gyro Offset Error over temperature X-axis

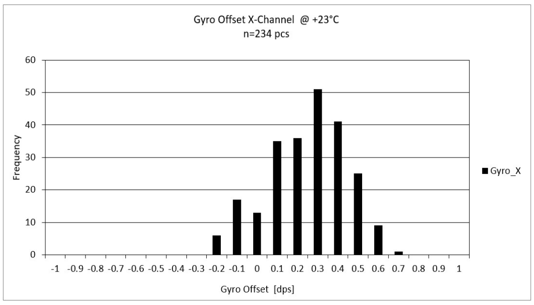


Chart 2 Gyro Offset Error @ +23°C X-axis

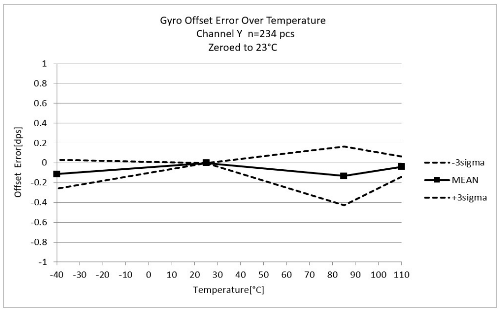


Chart 3 Gyro Offset Error over temperature Y-axis

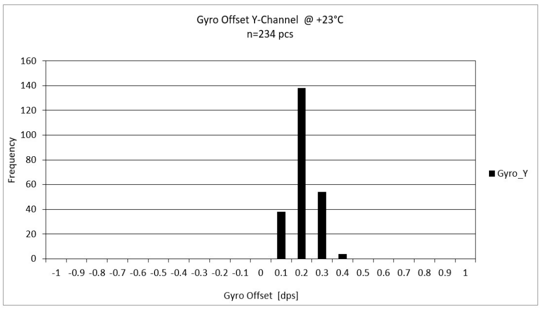


Chart 4 Gyro Offset Error @ +23°C Y-axis

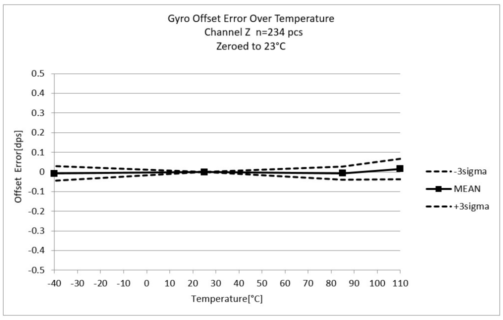


Chart 5 Gyro Offset Error over temperature Z-axis

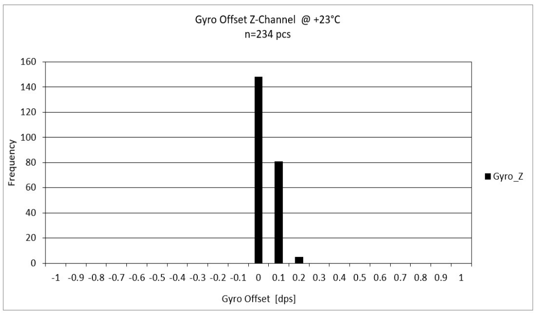


Chart 6 Gyro Offset Error @ +23°C Z-axis

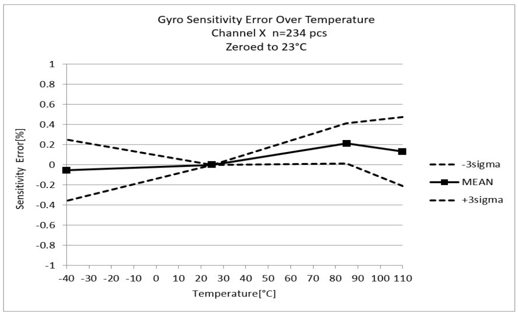


Chart 7 Gyro Sensitivity Error over temperature X-axis

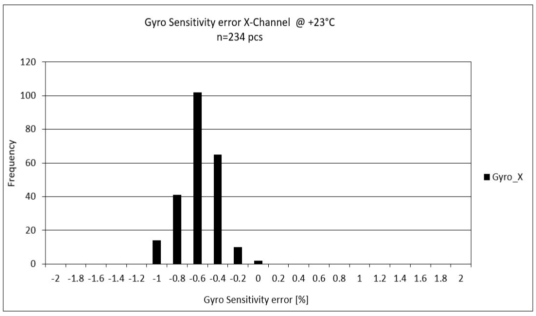


Chart 8 Gyro Sensitivity Error @ +23°C X-axis

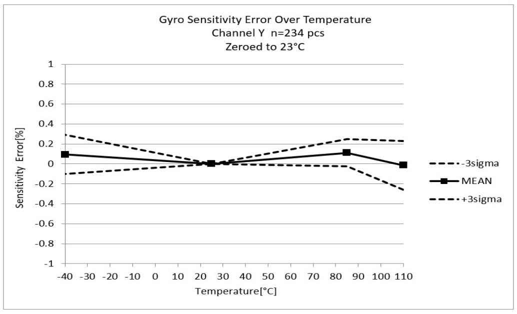


Chart 9 Gyro Sensitivity Error over temperature Y-axis

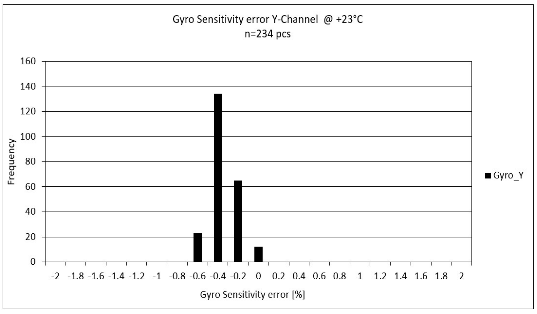


Chart 10 Gyro Sensitivity Error @ +23°C Y-axis

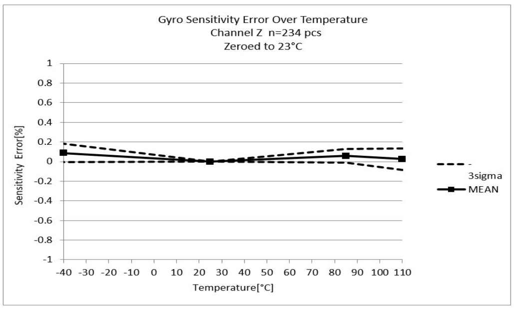


Chart 11 Gyro Sensitivity Error over temperature Z-axis

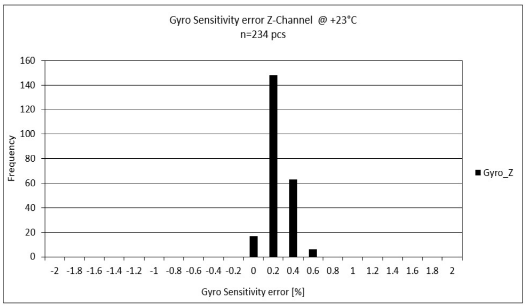


Chart 12 Gyro Sensitivity Error @ +23°C Z-axis

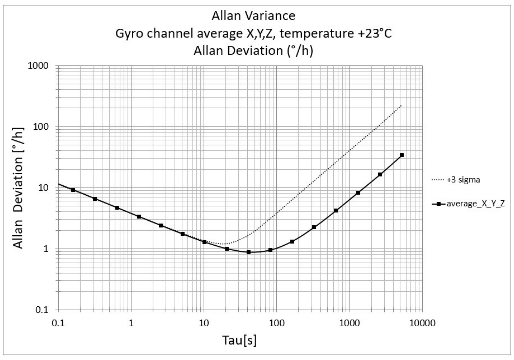


Chart 13 Gyro Allan Deviation X-,Y, and Z-axis

3.9.2 Acceleration typical characteristics

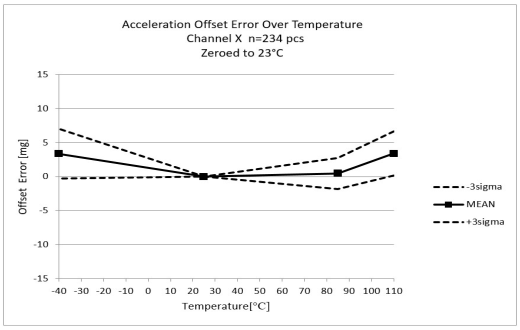


Chart 14 Accelerometer offset error over temperature X-axis

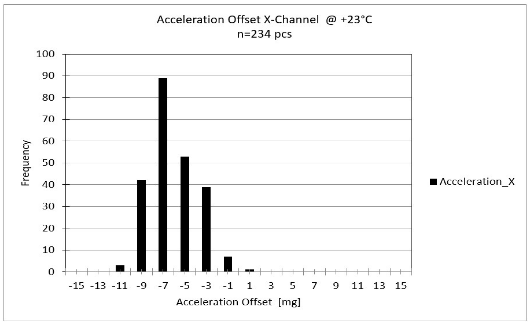


Chart 15 Accelerometer Offset Error @ +23°C X-axis

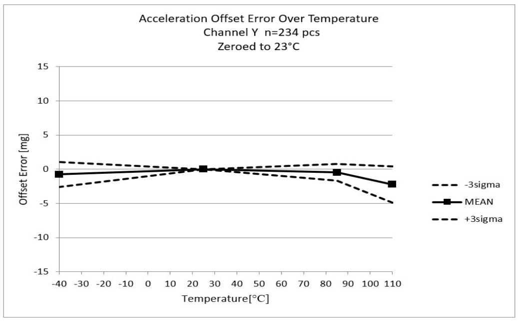


Chart 16 Accelerometer offset error over temperature Y-axis

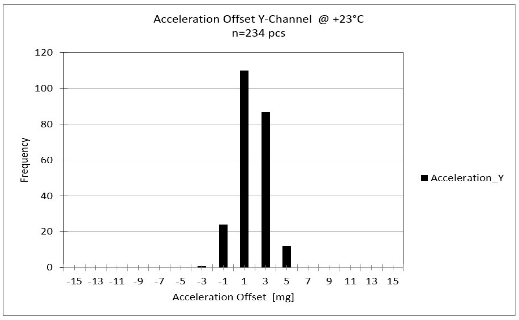


Chart 17 Accelerometer Offset Error @ +23°C Y-axis

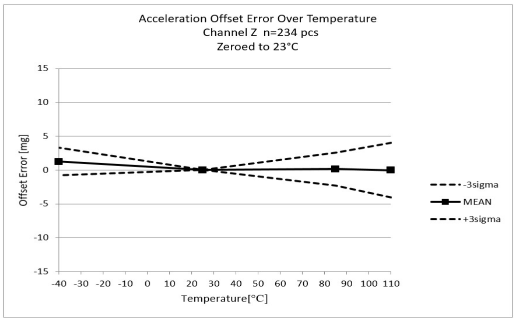


Chart 18 Accelerometer offset error over temperature Z-axis

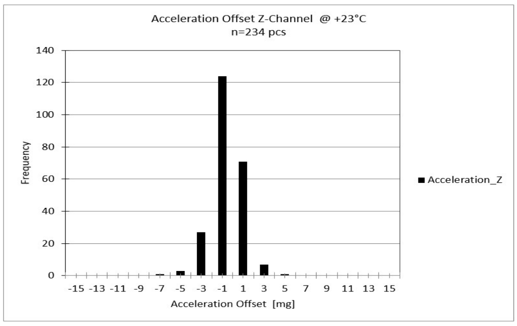


Chart 19 Accelerometer Offset Error @ +23°C Z-axis

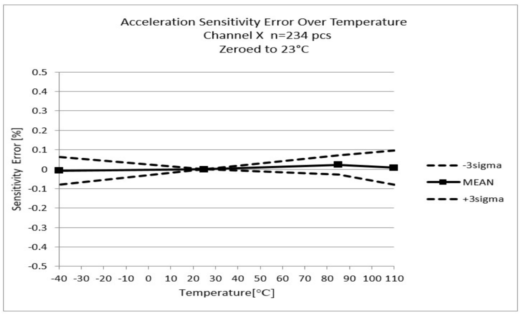


Chart 20 Accelerometer Sensitivity Error over temperature X-axis

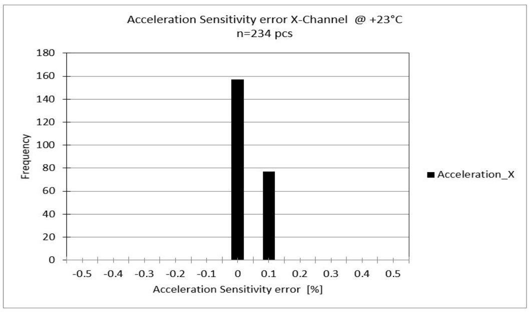


Chart 21 Accelerometer Sensitivity Error @ +23°C X-axis

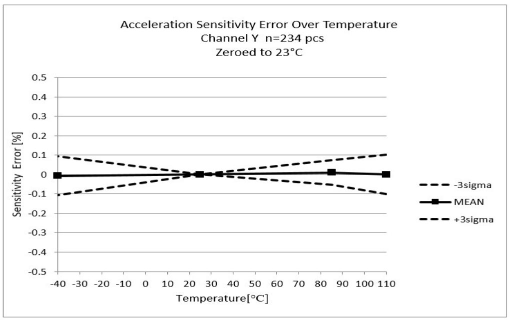


Chart 22 Accelerometer Sensitivity Error over temperature Y-axis

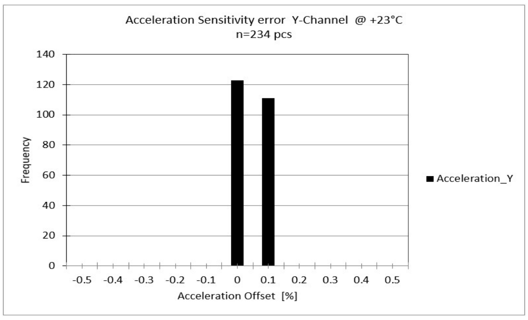


Chart 23 Accelerometer Sensitivity Error @ 23°C Y-axis

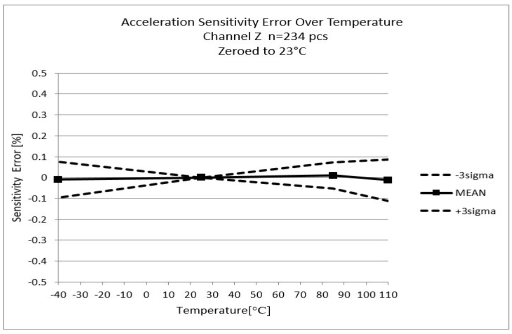


Chart 24 Accelerometer Sensitivity Error over temperature Z-axis

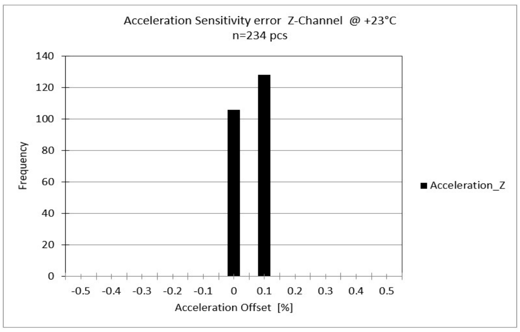


Chart 25 Accelerometer Sensitivity Error @ 23°C Z-axis

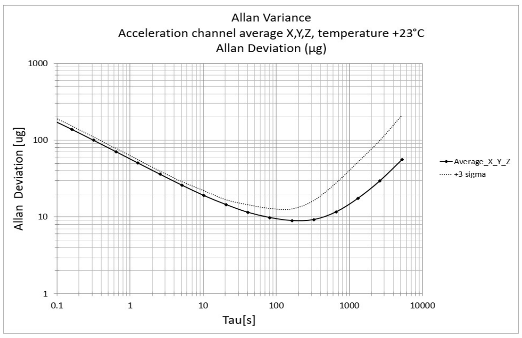


Chart 26 Acceleration Allan Deviation X-,Y- and Z-axis

3.10 Digital I/O Specification

Table 8 describes the DC characteristics of SCHA63T-K01 sensor SPI I/O pins. Supply voltage is 3.3 V unless otherwise specified. Current flowing into the circuit has a positive value.

Table 8. SPI DC characteristics.

Symbol	Description	Min.	Nom.	Max.	Unit
Serial Clock SCLK					
VinHigh	Input high voltage	2		V3p3D+0.3	V
VinLow	Input low voltage	-0.3		0.8	V
Vhy	Input hysteresis	0.2			V
Isource	Input current source (Pull down)	24		36	uA
Cin	Input capacitance			6	pF
Chip select CSB (Pull Up), low active					
VinHigh	Input high voltage	2		V3p3D+0.3	V
VinLow	Input low voltage	-0.3		0.8	V
Vhy	Input hysteresis	0.2			V
Isource	Input current source (Pull Up), Vin = 0V	24		36	uA
Cin	Input capacitance			6	pF
Vin_open	Open circuit output voltage	2			V
Serial data input MOSI (Pull Down)					
VinHigh	Input high voltage	2		V3p3D+0.3	V
VinLow	Input low voltage	-0.3		0.8	V
Vhy	Input hysteresis	0.2			V
Isource	Input current source (Pull Up), Vin = DVDD	24		36	uA
Cin	Input capacitance			6	pF
Vin_open	Open circuit output voltage			0.3	V
Serial data output MISO (Tri state)					
VoutHigh_-1mA	Output high voltage, Iout = -1mA	V3p3D-0.5			V
VinHigh_1mA	Output low voltage, Iout = +1mA			0.5	V
Iout_Hz	High impedance output current, 0V < VMISO < V3p3D	-1		1	uA
Cld_miso	Capacitive load. The slope of the MISO output signal can be controlled to meet EMI requirements under specified load conditions.			200	pF

Table 9. EXTRESN pin characteristics

Symbol	Description	Min.	Nom.	Max.	Unit
Digital pin EXTRESN					
VinHigh	Input high voltage	2		V3p3A+0.3	V
VinLow	Input low voltage	-0.3		0.8	V
Vhy	Input hysteresis	0.2			V
Isource	Start-up indication phase inactive Start-up indication phase active	60 30		160 80	µA µA

3.11 SPI AC Characteristics

The AC characteristics of SCHA63T-K01 are defined in Figure 2 and Table 10.

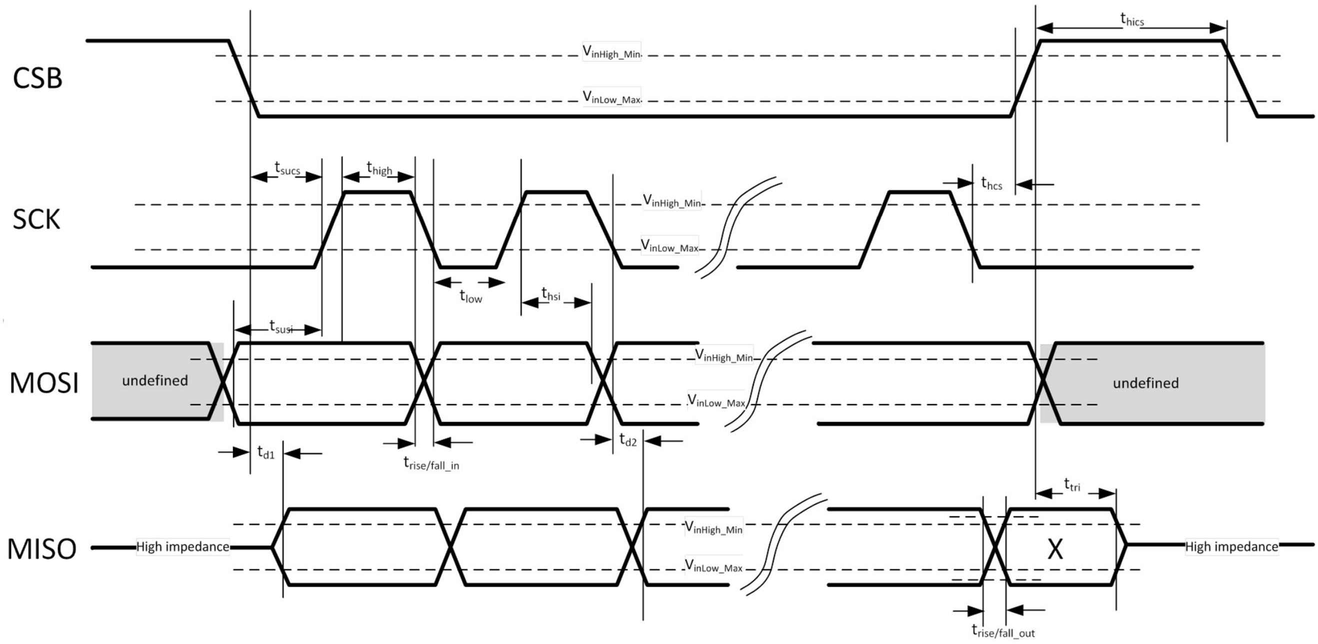


Figure 2. Timing diagram of SPI communication (SPI mode 0).

Table 10. SPI AC electrical characteristics.

Symbol	Description	Min.	Nom.	Max.	Unit
fSPI	Master (MCU): SPI SCLK frequency	0.1	-	10	MHz
tSPI	Master (MCU): SPI SCLK period	-	1/ fSPI	-	-
thigh	Master (MCU): High time: duration of logical high level at SCLK (from VinHigh_min to VinHigh_min)	35	tSPI/2	-	ns
tlow	Master (MCU): Low time: duration of logical low level at SCLK (from VinLow_max to VinLow_max)	35	tSPI/2	-	ns
tsucs	Master (MCU): Setup time CSB: time between the falling edge of CSB and the rising edge of SCLK (from VinLow_max to VinLow_max)	40	tSPI/2	-	ns

tsusi	Master (MCU): Setup time at MOSI: setup time of MOSI before the rising edge of SCLK (from VinLow_max to VinLow_max or from VinHigh_min to VinLow_max)	10	-	-	ns
thsi	Master(MCU): Hold time at MOSI: hold time of MOSI after rising edge of SCLK (from VinHigh_min to VinLow_max or to VinHigh_min)	20	-	-	ns
thcs	Master (MCU): Hold time of CSB: time between the falling edge of SCLK and the rising edge of CSB (from VinLow_max to VinLow_max)	30	tSPI/2	-	ns
thics	Master (MCU): Minimum high time of CSB between two consecutive transfers (from VinHigh_min to VinHigh_min)	30	tSPI/2		ns
trise/fall_in	Master (MCU): Rise/fall time of SCK/MOSI signals (from VinLow_max to VinHigh_min or from VinHigh_min to VinLow_max)	-	-	0.15x tSPI	ns
td1	Slave(=SCHA63T-K01 ASIC): Delay time: time delay from the falling edge of CSB to data valid at MISO (from VinLow_max to VInLow_max or to VInHigh_min)	-	-	30	ns
td2	Slave(=SCHA63T-K01 ASIC): Delay time: time delay from falling edge of SCLK to data valid at MISO (from VinLow_max to VInLow_max or to VInHigh_min)	0	-	30	ns
ttri	Slave(=SCHA63T-K01 ASIC): Tri-state delay time: time between the rising edge of CSB to MISO in Tri-state (from VinHigh_min to X)	-	-	25	ns
trise/fall_out	Slave(=SCHA63T-K01 ASIC): Rise/fall time of MISO signal (VOut_10% to VOut_90% and from VOut_90% to VOut_10%) User selectable MISO slew rate control in Mode register (19h)	4	10	16	ns

3.12 Measurement Axis and Directions

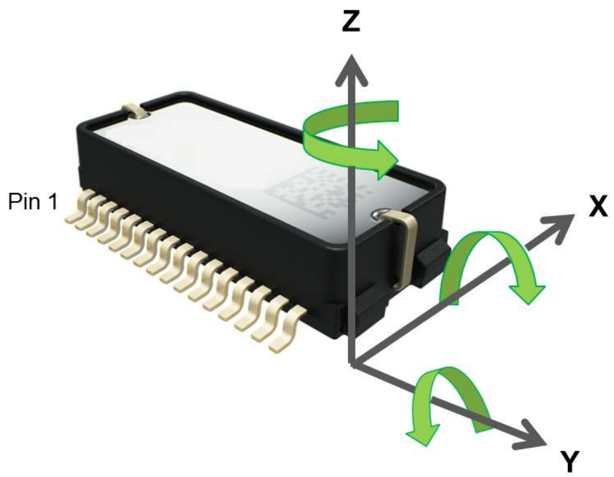
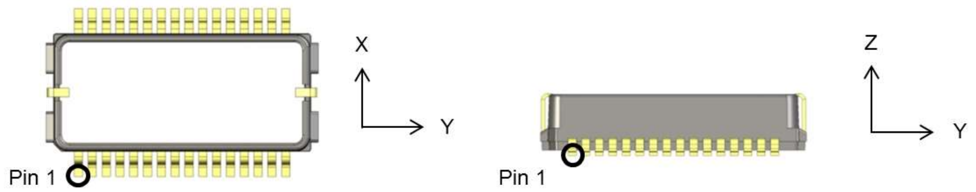
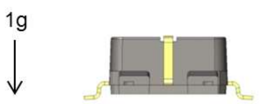
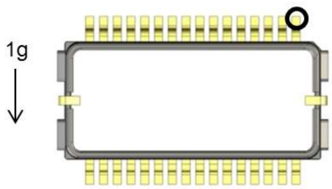
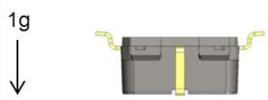
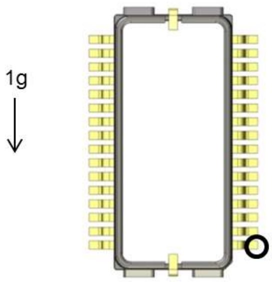
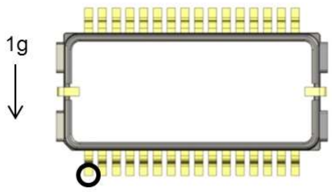
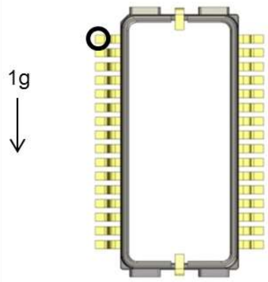


Figure 3. SCHA63T-K01 measurement directions.

Table 11 SCHA63T-K01 accelerometer measurement directions and outputs

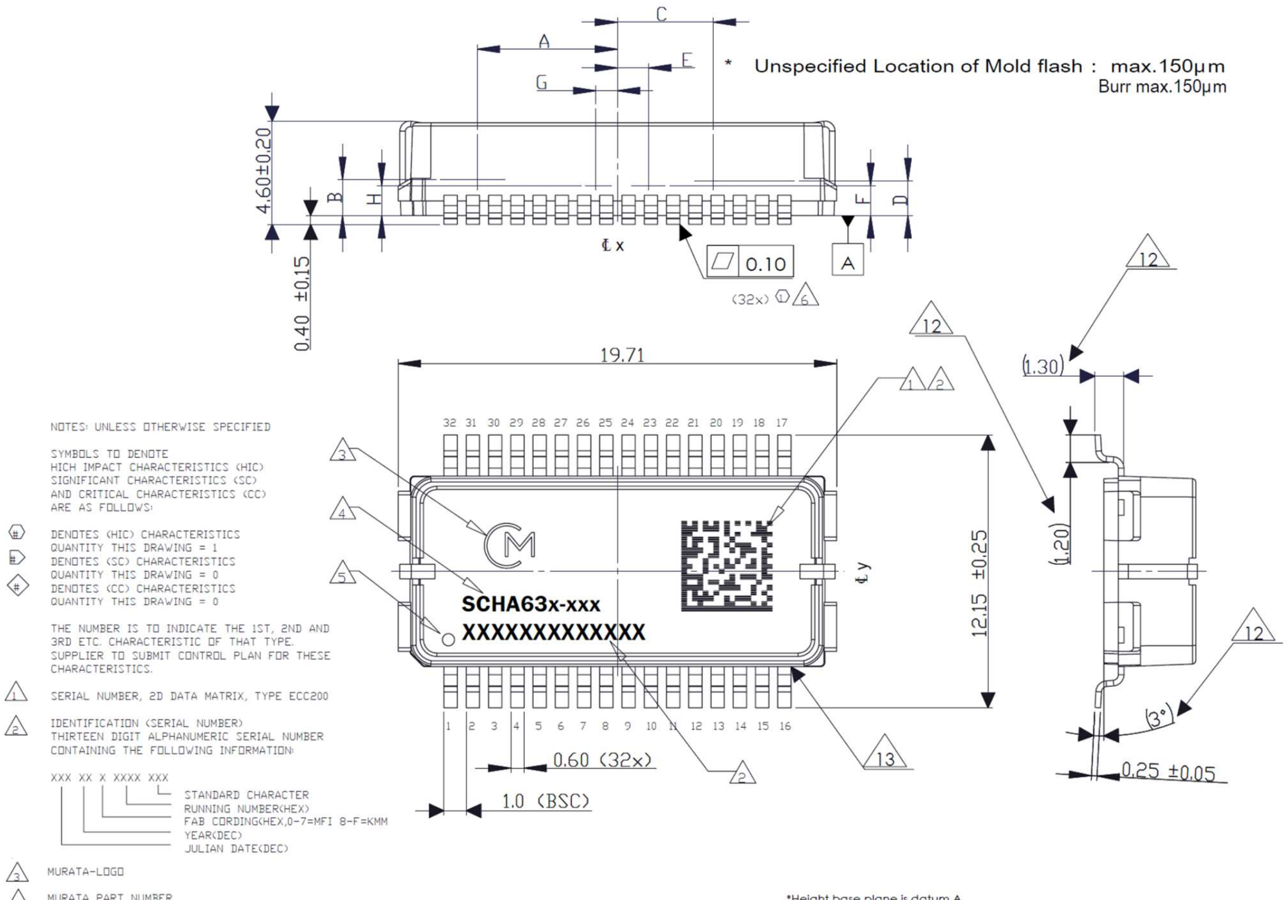


 X: 0g 0LSB Y: 0g 0LSB Z: 1g 4905LSB	 X: -1g -4905LSB Y: 0g 0LSB Z: 0g 0LSB	 X: 0g 0LSB Y: 0g 0LSB Z: -1g -4905LSB
 X: 0g 0LSB Y: 1g 4905LSB Z: 0g 0LSB	 X: 1g 4905LSB Y: 0g 0LSB Z: 0g 0LSB	 X: 0g 0LSB Y: -1g -4905LSB Z: 0g 0LSB

3.13 Package Characteristics

3.13.1 Package Outline Drawing

The SCHA600 package outline and dimensions are presented in Figure 4 and Table 12.



*Height base plane is datum A

8 Center Point of The Sensor Element				
Item	sym.	Xdim.	Ydim.	Zdim.
CL(X/Y) to GyroY Center	A	-6.250	0.080	-
Height of GyroY Surface	B	-	-	2.370
CL(X/Y) to ACC Center	C	4.300	-0.270	-
Height of ACC Surface	D	-	-	2.335
CL(X/Y) to GyroX Center	E	1.380	0	-
Height of GyroX Surface	F	-	-	1.750
CL(X/Y) to GyroZ Center	G	-0.980	0	-
Height of GyroZ Surface	H	-	-	1.730

Figure 4 The outline of the SCHA63T-K01 package (SOIC-32) in mm.

Table 12. Limits for linear measures (ISO2768-f) Unless tolerance is not specified in **Figure 4** It is not applicable for number shown in table of center point of the sensor element in **Figure 4**, which is only for reference.

Tolerance class	Limits in mm for nominal size in mm			
	0.5 to 3	Above 3 to 6	Above 6 to 30	Above 30 to 120
f (fine)	±0.05	±0.05	±0.1	±0.15

3.14 PCB Footprint

SCHA63T-K01 footprint dimensions are presented in Figure 5. Recommended PWB pad layout for SCHA63T-K01.

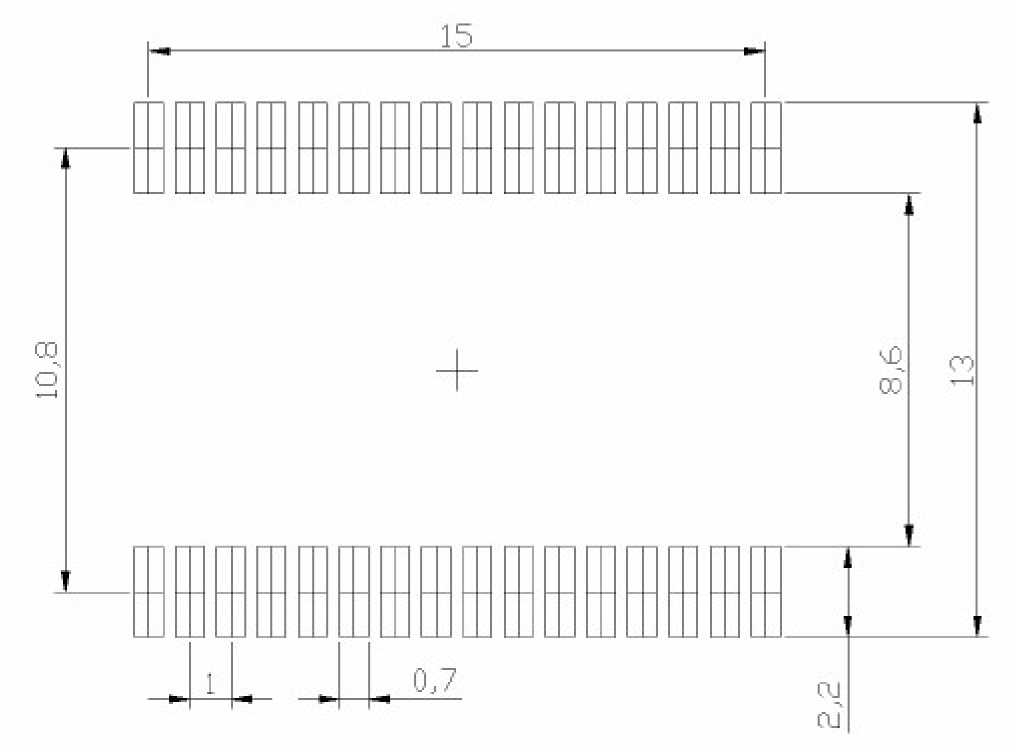


Figure 5. Recommended PWB pad layout for SCHA63T-K01.