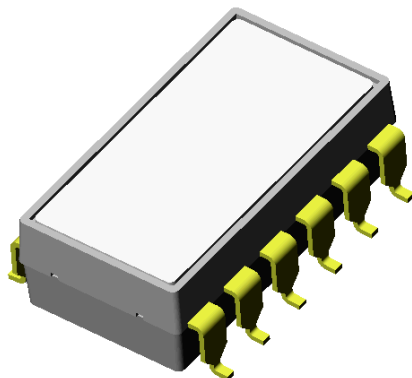


PRODUCT SPECIFICATION
FOR
SCA103T-D04
HIGH ACCURACY DIFFERENTIAL
SINGLE AXIS
DIGITAL INCLINOMETER



PRELIMINARY NOT RELEASED

Function	Signature	Date
Originator	VNu	
Engineering		
Quality		
Marketing		
Production		

Document Change Control

Version	Date	Change description	ECN #	Author
X1	11.3.2004	Preliminary release		VNu
X2	25.4.2004	Several modification		VNu

Table of Contents

1	General Description of SCA103T Inclinometers	3
1.1	SCA103T-family Accelerometer Features	3
1.2	SCA103T-family Features	3
2	Electrical Specifications.....	4
2.1	Electrical Connection	4
2.2	Differential Connection Example	5
2.3	Absolute Maximum Ratings	6
2.4	Electrical Specification.....	6

D	Output noise density ⁽¹¹⁾	From DC...100Hz		0.0003		° / $\sqrt{\text{Hz}}$
D	Long term stability ⁽¹²⁾	500 hours @ 23° temperature			0.014 0.25	° mg
S	Start-up delay	Reset and parity check			10	ms
D	Digital output resolution (acceleration)			0.009 12		° / LSB Bits

Note 1. The measuring range is limited by sensitivity, offset and supply voltage rails of the device

Note 2. $1g=9.82m/s^2$

Note 3. Offset specified as $V_{\text{offset}} = V_{\text{out}}(0g)$ [V].

Note 4. Sensitivity specified as $V_{\text{sens}} = \{V_{\text{out}}(+0.26g) - V_{\text{out}}(-0.26g)\}/0.52$ [V/g].

Note 5a. Offset calibration error specified as $\text{Offset_Calib_error} = \{V_{\text{out}}(0g) - V_{\text{dd}}/2\} / V_{\text{sens}}$ [g]

Note 5b. Offset temperature error specified as $\text{Offset Error @ temp.} = \{V_{\text{out @ temp.}} - V_{\text{out @ room temp.}}\} / V_{\text{sens}}$ [g]

Note 6a. Sensitivity calibration error specified as $\text{Sensitivity_calibr_error} = \{ [V_{\text{out}}(+0.26g)-V_{\text{out}}(-0.26g)] / 0.52 - V_{\text{sens_nom}}\} / V_{\text{sens_nom}} \times 100\%$ [%]
 $V_{\text{sens_nom}}$ = nominal sensitivity

Note 6b. Sensitivity temperature error specified as $\text{Sensitivity error @ temp} = \{ [V_{\text{sens @ temp}} - V_{\text{sens @ room temp}}] / V_{\text{sens @ room temp}}\} \times 100\%$ [%]

Note 7. From straight line through $-0.26g/-15^\circ$ and $+0.26g/15^\circ$.

Note 8. The frequency response is determined by the sensing element's internal gas damping. The output has true DC (0Hz) response.

Note 9. The ratiometric error is specified as.

$$RE = 100\% \times \left(1 - \frac{V_{\text{out}}(@V_x) \times \frac{5.00V}{V_x}}{V_{\text{out}}(@5V)} \right)$$

Note 10. The cross-axis sensitivity determines how much acceleration, perpendicular to the measuring axis, couples to the output. The total cross-axis sensitivity is the geometric sum of the sensitivities of the two axes which are perpendicular to the measuring axis.

Note 11. In addition, supply voltage noise couples to the output due to the ratiometric nature of the accelerometer.

Note 12. Power continuously connected

Note 13. Factory calibration value

- True self test by deflecting the sensing elements' proof mass by electrostatic force. Deflection voltage is adjustable with two memory bits. The self-test can be activated by digital on-off commands via dedicated pins or via SPI bus.
- Continuous sensing element interconnection failure check.
- Continuous memory parity check.

2 Electrical Specifications

2.1 Electrical Connection

If the SPI interface is not used SCK (pin1), MISO (pin3), MOSI (pin4) and CSB (pin7) must be left floating. Self-test can be activated applying logic "1" (positive supply voltage level) to ST_1 or ST_2 pins (pins 10 or 9). Self-test must not be activated for both channels at the same time but it must be used separately. If ST feature is not used pins 9 and 10 must be left floating or connected to VSS. Inclination signals are provided from pins OUT_1 and OUT_2.

Table 1. SCA103T pin order

No.	Node	I/O	Description
1	SCK	Input	Serial clock
2	EXT_C_1	Input	Ch1 external capacitor input
3	MISO	Output	Master in slave out; data output
4	MOSI	Input	Master out slave in; data input
5	OUT_2	Output	Ch2 Output
6	VSS	Power	Negative supply voltage (VSS)
7	CSB	Input	Chip select (active low)
8	EXT_C_2	Input	Ch2 external capacitor input
9	ST_2	Input	Self test input for Ch 2
10	ST_1 / TEST_IN	Input	Self test input for Ch 1 / Analog test input
11	OUT_1	Output	Ch1 axis output
12	VDD	Power	Positive supply voltage (VDD)

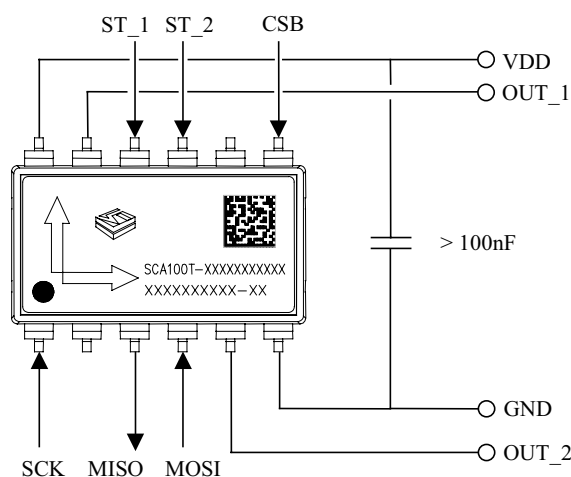


Figure 2. Typical connection

Typical output characteristics (Channels 1, 2 and differential output: OUT1-OUT2) is presented in figure 3

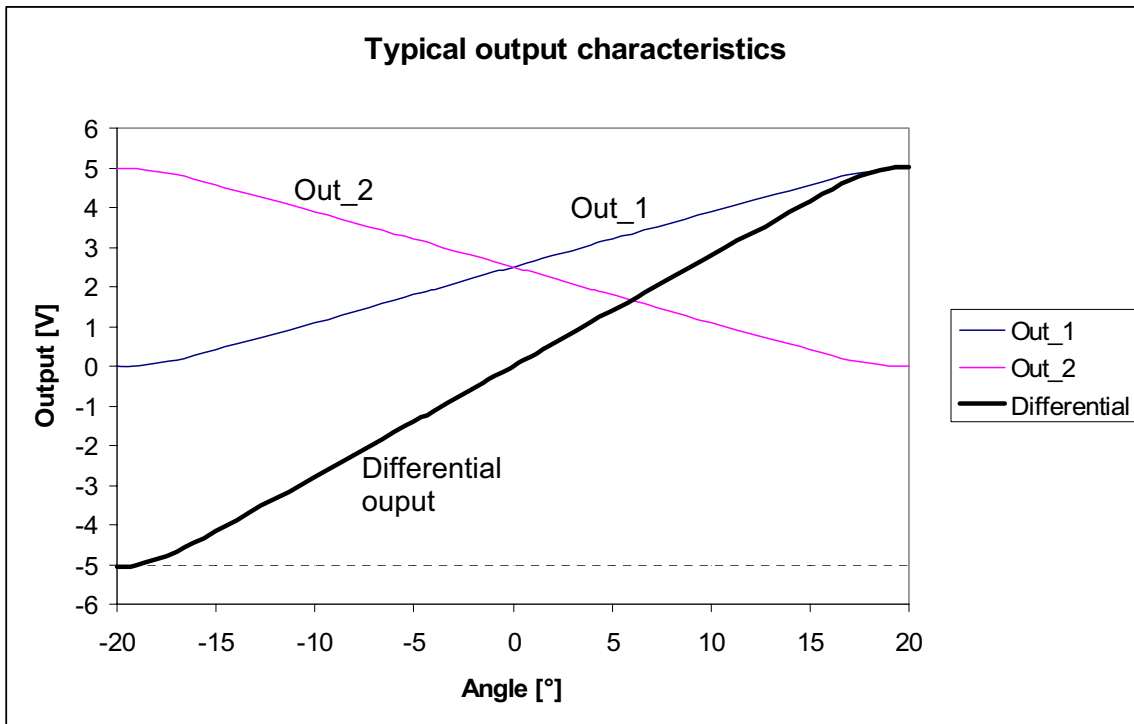


Figure 3. Output characteristics

2.2 Differential Connection Example

Typical connection using external instrumentation amplifier is presented in figure 4. To get the best performance it is recommended that Out_1 and Out_2 are filtered.

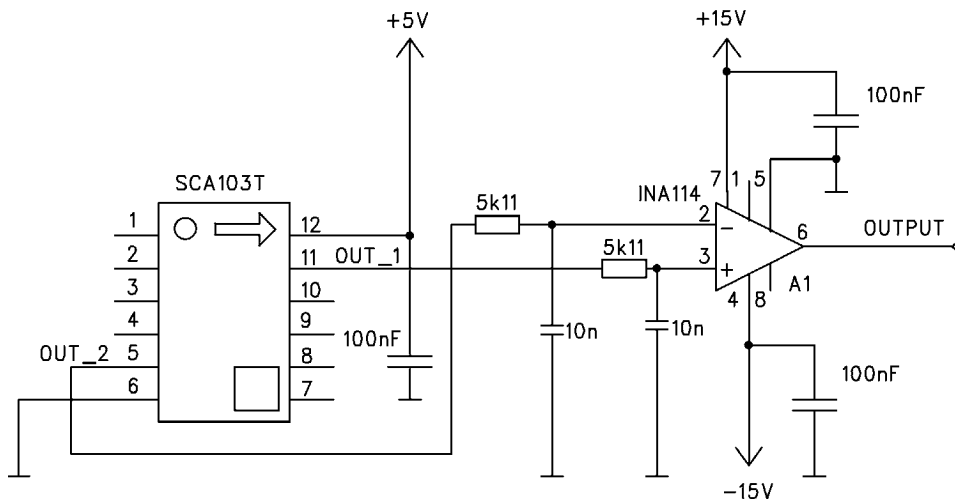


Figure 4. Typical differential connection when analog signals are used

2.3 Absolute Maximum Ratings

Supply voltage (V _{DD})	-0.3 V to +5.5V
Voltage at input / output pins	-0.3V to (V _{DD} + 0.3V)
Storage temperature	-55°C to +125°C
Operating temperature	-40°C to +125°C
Mechanical shock	Drop from 1 meter on a concrete surface. Powered or non-powered. Must be in the final product or in the shipping package.

2.4 Electrical Specification

Table 2. Electrical specification. V_{dd}=5.00V and ambient temperature unless otherwise specified. Parameters marked as D are measured in differential mode using external differential amplifier. The performance of selected amplifier may have an effect on some parameters. Differential signal is determined as a $Out_diff = Out_1 - Out_2$ (pin 11 – pin 5)

D/S	Parameter	Condition	Min.	Typ	Max.	Units
D	Measuring range ⁽¹⁾	Nominal	-15 -0.26		+15 0.26	° g ⁽²⁾
D	Measuring direction	In relation to mounting plane	Parallel			
D/S	Supply voltage V _{dd}		4.75	5.0	5.25	V
D/S	Current consumption	V _{dd} = 5 V; No load		3.8		mA
D/S	Operating temperature		-40		+125	°C
S	Analog resistive output load	V _{out} to V _{dd} or V _{ss}	10			kOhm
S	Analog capacitive output load	V _{out} to V _{dd} or V _{ss}			20	nF
S	Offset (Output at 0g) ^(3, 12, 13) Offset calibration error ^(5a)		-0.057 -1	V _{dd} /2	0.057 1	V ° mg
D	Sensitivity ^(4,12,13) Sensitivity calibration error ^(6a)	between 0...1°	-0.5	16 280	0.5	V/g mV/° %
D	Offset temperature error (Output at 0g) ^(5b, 12)	0...70°C	-0.11 -2		0.11 2	° mg
		-25...85°C	-0.14 -2.5		0.14 2.5	° mg
		-40...125°C	-0.29 -5		0.29 5	° mg
D	Sensitivity error ^(6b, 12, 14)	-40...85°C	-1		1	%
		85...125°C	-2.5		1	%
D	Typical non-linearity ⁽⁷⁾	Range -15°...+15°	-0.057 -1		0.057 1	° mg
S	Frequency response –3dB LP ⁽⁸⁾		8		28	Hz
S	Ratiometric error ⁽⁹⁾	V _{dd} = 4.75...5.25V	-1		1	%
S	Cross-axis sensitivity ⁽¹⁰⁾				4	%

D	Output noise density ⁽¹¹⁾	From DC...100Hz		0.0003		° / $\sqrt{\text{Hz}}$
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