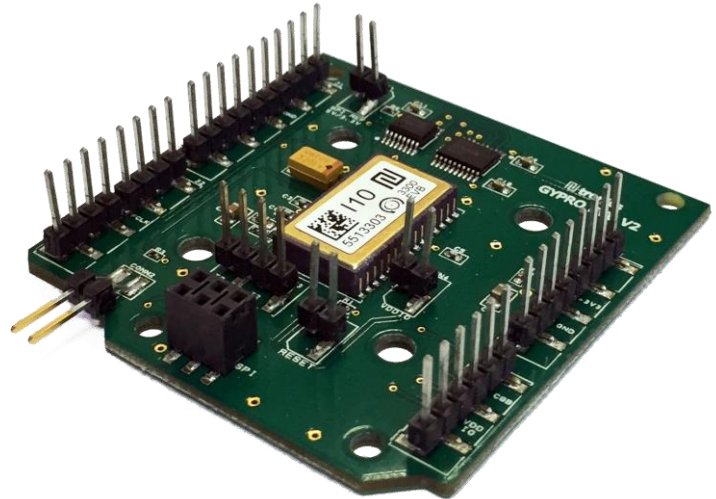


## USER MANUAL

# GYPRO<sup>®</sup>-EVB2 User Manual Evaluation board for GYPRO<sup>®</sup> products

**Doc Ref:** UMGYPRO-EVB2  
**Rev:** 1.0  
**Date:** Sept. 2016



### Key features of GYPRO<sup>®</sup>-EVB2

- Printed Circuit Board for evaluation of GYPRO<sup>®</sup> products
- Includes 1 gyroscope and external passive components
- Plug and Play SPI interface, compatible with Arduino M0
- 3.3V and 5V power supply
- 3.3V and 5V compatibility for communication interface

### Key features of GYPRO<sup>®</sup> MEMS gyroscopes

- Angular rate measurement around Z-axis (yaw sensor)
- Digital 24-bit SPI output
- Excellent bias instability of 0.8 °/h (Allan variance at room temperature)
- Ultra-low RMS noise of < 0.05°/s over [1Hz -100Hz]

### General description

GYPRO<sup>®</sup> products are a new generation of Micro-Electro-Mechanical Systems (MEMS) angular rate sensors specifically designed for demanding applications.

The sensor consists of a MEMS transducer and an integrated circuit (IC) packaged in a 30-pin Ceramic Leadless Chip carrier (CLCC) package.

This MEMS transducer is manufactured using Trionics proprietary vacuum wafer-level packaging technology based on micro-machined thick single crystal silicon.

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The IC provides a stable vibration of the 'drive' proof masses, thanks to electrostatic comb drives. When the sensor is subjected to a rotation, the Coriolis force acts on the 'sense' proof masses and forces them into a secondary movement perpendicular to the direction of drive vibration, which is itself counter balanced by electrostatic forces (sense closed-loop operation). The sensor is factory calibrated and compensated for temperature effects to provide high-accuracy digital output over a broad temperature range.

GYPRO<sup>®</sup>-EVB2 breakout board is intended to easily and quickly perform characterizations of GYPRO2300, GYPRO2300LD and GYPRO3300 gyroscopes from Tronics. GYPRO<sup>®</sup>-EVB2 was specially designed to be interfaced with an **Arduino M0 board**. The combination of GYPRO<sup>®</sup>-EVB2 with the Arduino platform is ideally suited for tests with rate table over the temperature range [-40°C to +85°C].

The 3.3V and 5V compatibility for SPI communication also enables connecting the GYPRO<sup>®</sup>-EVB2 with most of the acquisition systems and microcontrollers in the market.

This document describes the mechanical and electrical features of the GYPRO<sup>®</sup>-EVB2 board as well as the SPI protocol used for the digital communication. This document is applicable for the whole GYPRO<sup>®</sup> product line, including GYPRO2300, GYPRO2300LD and GYPRO3300 gyros.

For more information about performances of each product, please refer to the dedicated datasheet, available on our [website](#).

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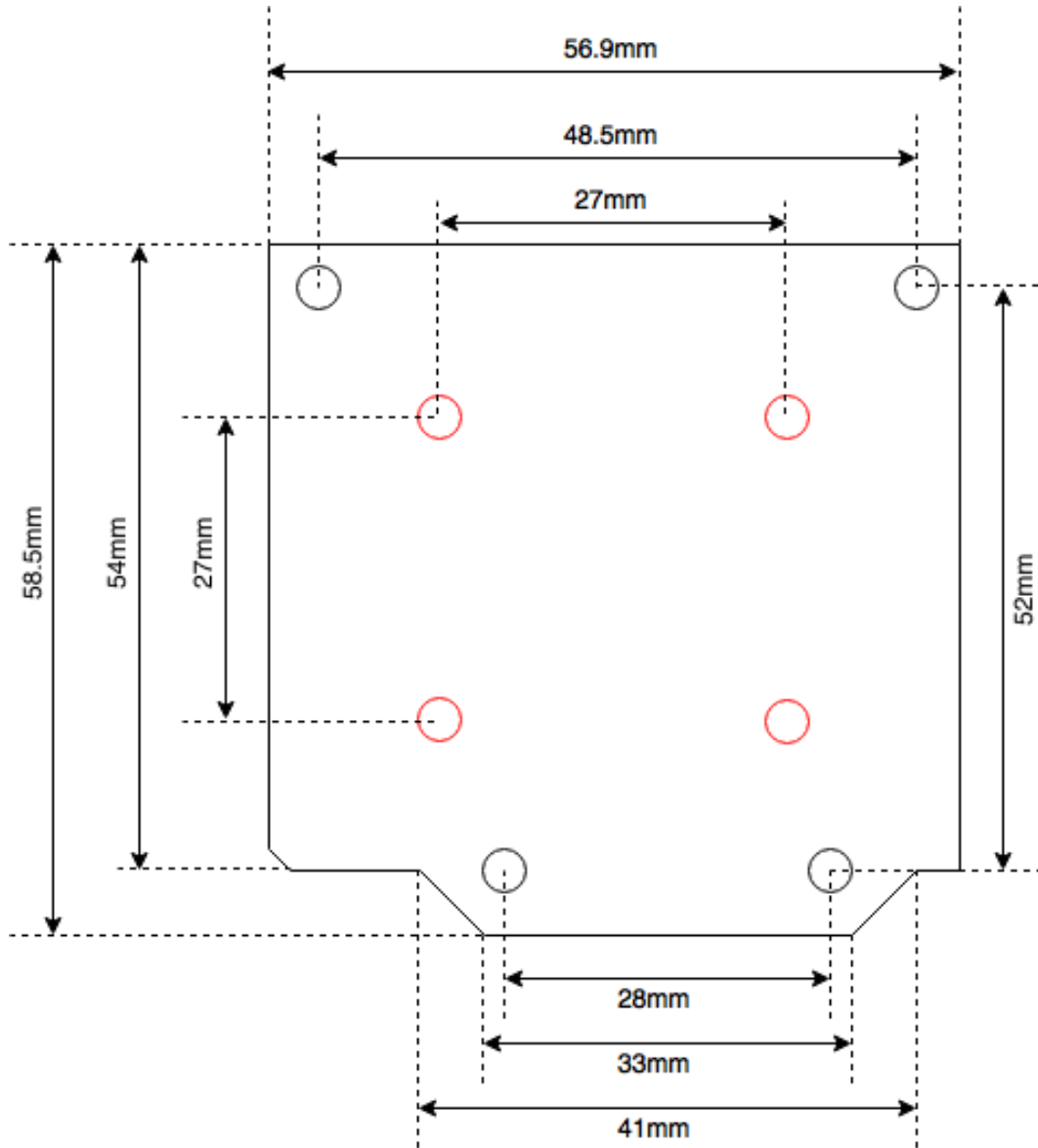
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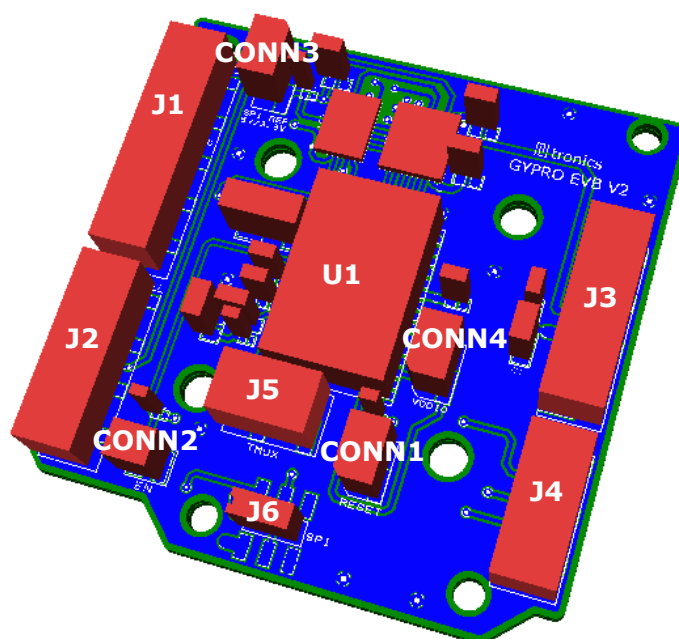
**1 Mechanical features**

The evaluation board has the following dimensions:



**Figure 1: GYPRO®-EVB2 board (unpopulated) dimensions in millimeters.**

Outer holes diameter (black holes) is  $\varnothing 3\text{mm}$   
 Inner holes diameter (red holes) is  $\varnothing 4\text{mm}$   
 Board thickness is 1.6mm



**Figure 2: 3D top view of the GYPRO®-EVB2 board**

The main GYPRO®-EVB2 components are described in the table below:

Name	Description	Information
CONN1	I/O connector	Sensor reset: <ul style="list-style-type: none"> <li>• Without jumper: no reset</li> <li>• With jumper: reset</li> </ul>
CONN2	I/O connector	Sensor Enable: <ul style="list-style-type: none"> <li>• Without jumper: sensor enable</li> <li>• With jumper: sensor disable</li> </ul>
CONN3	I/O connector	SPI level voltage reference: <ul style="list-style-type: none"> <li>• Without jumper: SPI level = +3.3V</li> <li>• With jumper: SPI level = +5V</li> </ul>
CONN4	I/O connector	Not used
J1	I/O connector	Not used
J2	I/O connector	Internal clock : FCLK
J3	I/O connector	Power supply: +5V, +3.3V, GND
J4	I/O connector	SPI Chip select: CSB Self-Test pin: ST
J5	I/O connector	Tronics reserved
J6	I/O connector	Power supply lines: 5V, GND SPI lines: MOSI, MISO, SCLK
U1	GYPRO®	Angular rate sensor

**Table 1: Main components description**

**Please note that the PCB has a flat backside and thickness of 1.6 mm. The board has been designed for a direct mounting onto the surface of your test equipment (rate table, vibration shaker...) in order to avoid parasitic mechanical resonance of the PCB.**

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### 2 Pins configuration and description

To enable compatibility with the Arduino M0 platform, some signals are redundant, such as 5V and GND signals. If you don't intend to use the Arduino platform, redundancy is not necessary. **However the pins marked with bold characters in the tables below must absolutely be connected.**

J1 gives access to the following signals:

Pin #	Name	Type	Function
#1	-	-	Not Connected
#2	-	-	Not Connected
#3	-	-	Not Connected
#4	GND	Input	Ground Power Supply
#5	-	-	Not Connected
#6	-	-	Not Connected
#7	-	-	Not Connected
#8	-	-	Not Connected
#9	-	-	Not Connected
#10	-	-	Not Connected

**Table 2 : J1 connector pinout**

J2 gives access to the following signals:

Pin #	Name	Type	Function
#1	-	-	Not Connected
#2	-	-	Not Connected
#3	-	-	Not Connected
#4	-	-	Not Connected
<b>#5</b>	<b>FCLK</b>	<b>Output</b>	<b>Internal clock</b>
#6	-	-	Not Connected
#7	-	-	Not Connected
#8	-	-	Not Connected

**Table 3: J2 connector pinout**

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J3 gives access to the following signals:

Pin #	Name	Type	Function
#1	-	-	Not Connected
#2	-	-	Not Connected
#3	-	-	Not Connected
<b>#4</b>	<b>3V3</b>	<b>Input</b>	<b>3.3V Power Supply</b>
<b>#5</b>	<b>5V</b>	<b>Input</b>	<b>5V Power Supply</b>
<b>#6</b>	<b>GND</b>	<b>Input</b>	<b>Ground Power Supply</b>
#7	GND	Input	Ground Power Supply
#8	-	-	Not Connected

**Table 4: J3 connector pinout**

J4 gives access to the following signals:

Pin #	Name	Type	Function
#1	-	-	Not Connected
<b>#2</b>	<b>CSB</b>	<b>Input</b>	<b>SPI chip select</b>
<b>#3</b>	<b>ST</b>	<b>Output</b>	<b>Self-test pin</b>
#4	VDDIO	Input	Tronics Reserved
#5	-	-	Not Connected
#6	-	-	Not Connected

**Table 5: J4 connector pinout**

J5 gives access to the following signals:

Pin #	Name	Type	Function
#1	T0	Output	Tronics Reserved
#2	T1	Output	Tronics Reserved
#3	T2	Output	Tronics Reserved
#4	T3	Output	Tronics Reserved

**Table 6: J5 connector pinout**

J6 gives access to the following signals:

Pin #	Name	Type	Function
#1	5V	Input	5V Power Supply
<b>#2</b>	<b>DIN</b>	<b>Input</b>	<b>SPI data input</b>
#3	GND	Input	Ground Power Supply
<b>#4</b>	<b>DOUT</b>	<b>Output</b>	<b>SPI data output</b>
<b>#5</b>	<b>SCLK</b>	<b>Input</b>	<b>SPI serial clock</b>
#6	-	-	Not Connected

**Table 7: J6 connector pinout**

### 3 Electrical circuit

The following figure presents the electrical schematic of the board with its passive components (resistors & capacitances).

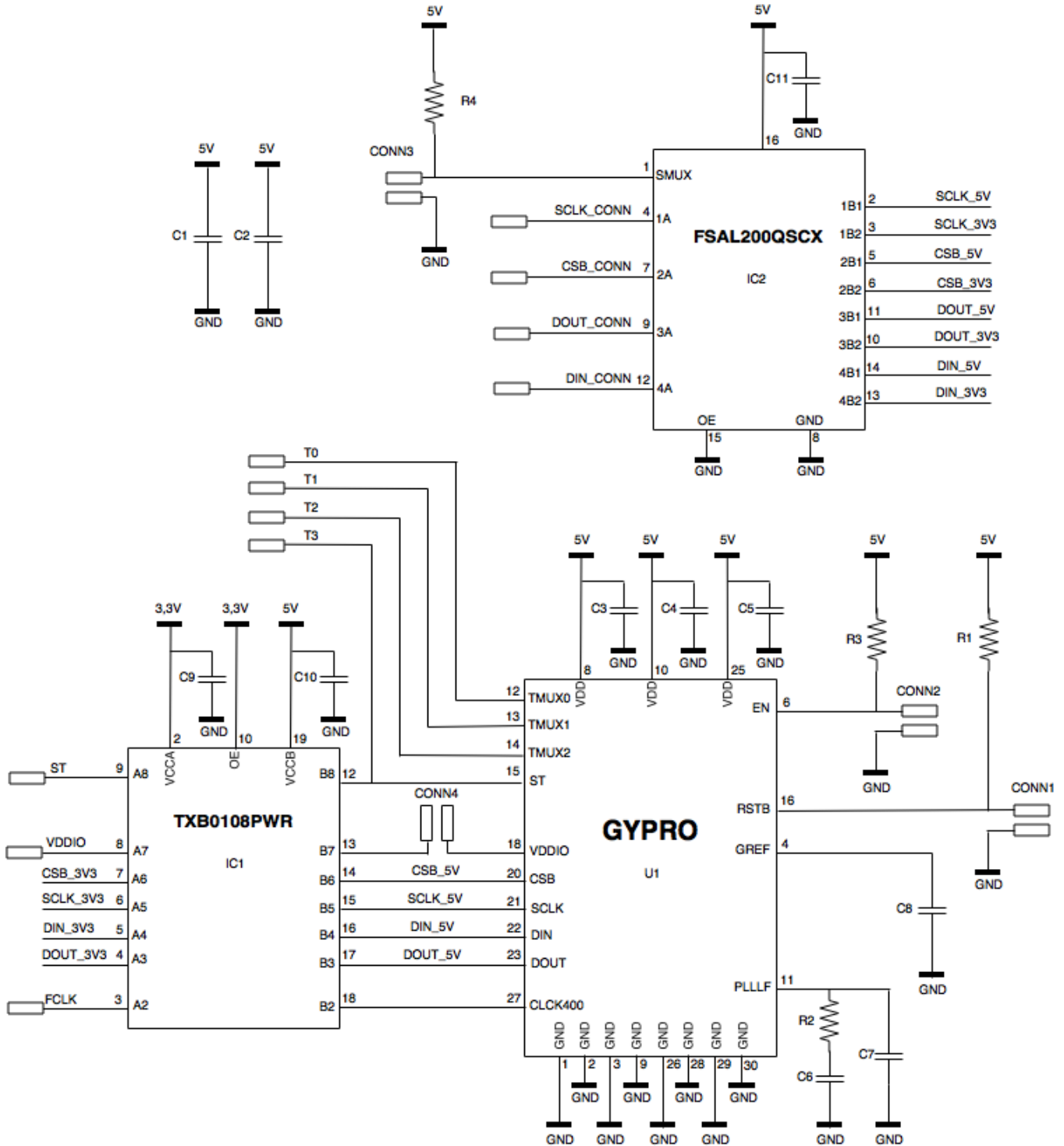


Figure 3: Electrical schematic



## 4 Electrical Characteristics

Parameter	Min	Typical	Max	Units
5V Power Supply	4.75	5	5.25	V
3.3V Power Supply	3.05	3.3	3.55	V
Current consumption <sup>1)</sup>		25		mA
Output		Digital 24 bits		-
Digital interface		SPI		-

1) The specified value represents the typical current consumption of GYPRO<sup>®</sup> products.

**Table 8: Electrical characteristics**

For compatibility with multiple acquisition devices (e.g. microcontrollers), a 3.3V level shifter (TXB0108PWR), paired with a demultiplexer switch (FSAL200QSCX), has been implemented on the board. The user can choose a 3.3V or a 5V logic voltage level on the SPI, by connecting or disconnecting a jumper on the CONN3 connector.

**If you would like to operate with a 3.3V logic voltage level, it is mandatory to power the board with both 3.3V AND 5V. To operate with a 5V logic voltage level, you can supply only the 5V power supply.**

## 5 Environment

Environmental specifications for GYPRO<sup>®</sup> gyroscopes and GYPRO<sup>®</sup>-EVB are the following:

Parameter	Condition	Min	Typ	Max	Units
Operating temperature range		-40		+85	°C
Humidity	At 45°C			98	%

**Table 9 : Environmental specifications**

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### 6 Communication protocol

GYPRO® products have a standard 4-wire SPI interface for communication and operate as a slave. **Only the SPI mode 0 is supported** (clock polarity CPOL=0, clock phase CPHA=0). The following sections detail the SPI interface and communication characteristics.

#### 6.1 Electrical parameters

The sensor's digital interface operates at 5V logic levels. The reset signal has an internal pull up resistance. Electrical characteristics of the SPI interface are detailed in the table below.

Symbol	Parameter	Condition	Min	Typ	Max	Units
VIL	Low level input voltage		0		0.1x VDD**	V
VIH	High level input voltage		0.8 x VDD**		VDD**	V
VOL	Low level output voltage	ioI=0mA (Capacitive Load)		GND		V
VOH	High level output voltage	ioH=0mA (Capacitive Load)		VDD**		V
R <sub>pull_up</sub>	Pull-up resistor*	Internal pull-up resistance to VDD		100		kΩ
R <sub>pull_down</sub>	Pull-down resistor	Internal pull-down resistance to GND		-		kΩ

\* Only used for Reset input

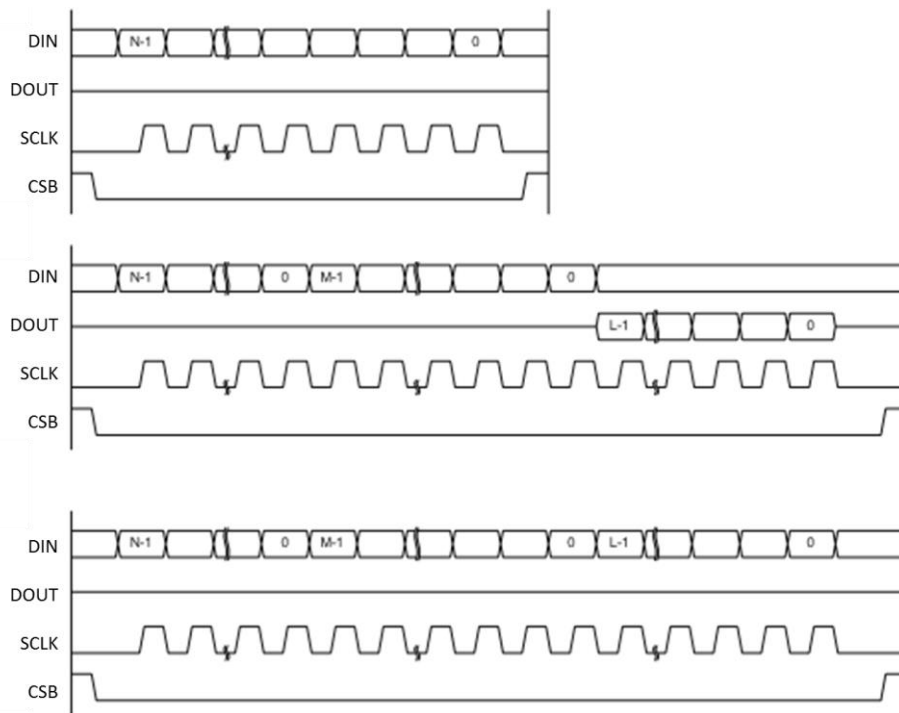
\*\* VDD=5V

**Table 10 : Electrical characteristics of the SPI interface**

In order to initiate the communication, the CSB level must be kept low. The changes in the data lines DOUT and DIN must be synchronized with the falling edge of the SCLK, while the master and slave sample their inputs on the rising edge of SCLK.

Different scenarios for SPI communication are shown in the figure hereafter.

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**Figure 4: Different scenarios for SPI communication**

**6.2 Timing parameters**

The SPI timings are described in the table hereafter:

Symbol	Parameter	Condition	Min	Typ	Max	Units
Fspi	SPI clock input frequency	Maximal load 25pF on DIN or DOUT		0.2	8	MHz
Tlow_sclk	SCLK low pulse		62.5			ns
Thigh-sclk	SCLK high pulse		62.5			ns
Tsetup_din	DIN setup time		10			ns
Thold_din	DIN hold time		5			ns
Tdelay_dout	DOUT output delay	Load 25pF			40	ns
Tsetup_csb	CSB setup time		1			Tsclk
Thold_csb	CSB hold time		1			Tsclk

**Table 11 : SPI timing parameters**

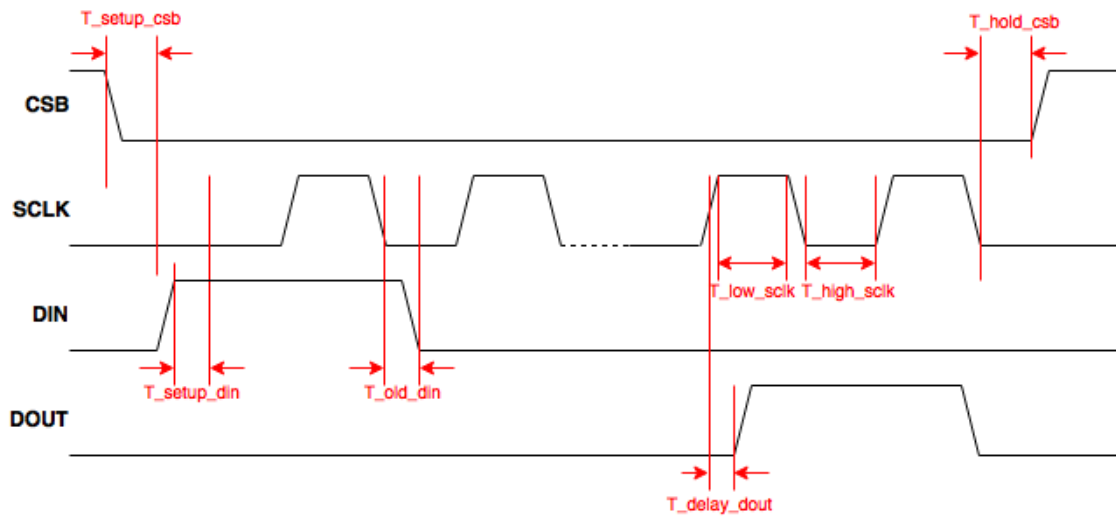


Figure 5: Timing parameters illustration

6.3 SPI register recommendations.

It is forbidden to keep SPI pads at a high level while VDD is at 0V due to ESD protection diodes and buffers.

SPI pad voltages must be kept between GND - 0.3V and VDD + 0.3V.

6.4 SPI register map

The SPI register map consists of 6 read-only registers, with addresses ranging from address 0x0 to 0x5. The SPI register address is a 4 bits word. Each SPI register is an 8-bit width data (from bit 0 to 7).

SPI register map									
Address	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
0x0	DATARDY								
0x1	Gyro_output [23:0]								
0x2									
0x3	TRONICS RESERVED							SifTest	
0x4	0	0	Temperature_output[11:0 ]						
0x5	TRONICS RESERVED								

Table 12 : SPI Register map

The data inside the SPI register map are organized as follows:

Name	Description	Width
<b>DATARDY</b>	This bit is used to indicate that a new gyro reading data is available. `1`: The data has never been read and is available for reading `0`: The data has already been read, it must be discarded	1
<b>Gyro_output</b>	Angular rate output (temperature-compensated data by default)	24
<b>SlfTest</b>	Continuous and automatic self-test bit. `1`: The sensor is operating properly `0`: The sensor is in a faulty mode	1
<b>Temperature_out</b>	Temperature output (raw data by default)	12

**Table 13 : Output data description**

### 6.5 SPI reading frames

The SPI register is directly accessed through the SPI interface using the SPI frames. The SPI frame includes a command, an address and the data to be read. The SPI command and address are 4-bit words. The SPI data are composed of several 8-bit words (the registers).

The SPI frame used to read the 4 registers including the gyro output is:

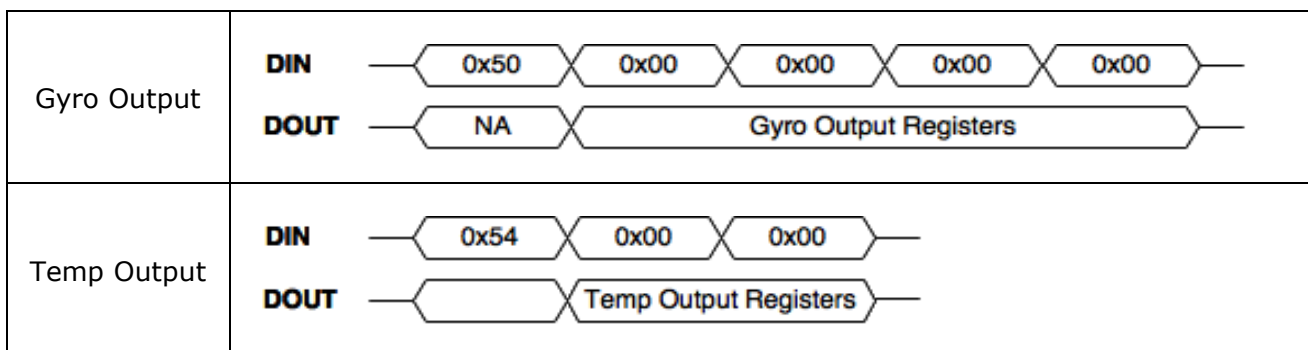
Reading Command	1 <sup>st</sup> register address	4 data registers are read from the address 0x0 (i.e. 0x0, 0x1, 0x2, 0x3)			
0x5	0x0	0x00	0x00	0x00	0x00

**Table 14 : SPI frame for reading the gyro output**

The SPI frame used to read the 2 registers including the temperature output is:

Reading Command	1 <sup>st</sup> register address	2 registers are read from the address 0x4 (i.e. 0x4, 0x5)	
0x5	0x4	0x00	0x00

**Table 15 : SPI frame for reading the temperature output**



**Table 16 : SPI MOSI/MISO frame content**

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### 6.6 Gyro output extraction

The gyro output (24-bit word) needs to be extracted from the 4 read registers (32-bit word).

The following table presents the 4 read registers including the 24-bit gyro output:

Address	Bit7 (msb)	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0 (lsb)
0x0	DATARDY	Gyro_Out[23]	Gyro_Out[22]	Gyro_Out[21]	Gyro_Out[20]	Gyro_Out[19]	Gyro_Out[18]	Gyro_Out[17]
0x1	Gyro_Out[16]	Gyro_Out[15]	Gyro_Out[14]	Gyro_Out[13]	Gyro_Out[12]	Gyro_Out[11]	Gyro_Out[10]	Gyro_Out[9]
0x2	Gyro_Out[8]	Gyro_Out[7]	Gyro_Out[6]	Gyro_Out[5]	Gyro_Out[4]	Gyro_Out[3]	Gyro_Out[2]	Gyro_Out[1]
0x3	Gyro_Out[0]	X	X	X	X	X	X	Self-Test

**Table 17 : Gyro output data description**

The 24-bit gyro output is coded in two's complement. To translate this value into an angular rate (°/sec), the 24-bit value has to be divided by the factor **10 000**.

-300.0000 °/s		⇔	1101 0010 0011 1001 0100 0000
...			
-0.0002 °/s	i.e. -0.72 °/h	⇔	1111 1111 1111 1111 1111 1110
-0.0001 °/s	i.e. -0.36 °/h	⇔	1111 1111 1111 1111 1111 1111
0.0000 °/s	i.e. 0.00 °/h	⇔	0000 0000 0000 0000 0000 0000
+0.0001 °/s	i.e. +0.36 °/h	⇔	0000 0000 0000 0000 0000 0001
+0.0002 °/s	i.e. +0.72 °/h	⇔	0000 0000 0000 0000 0000 0010
...			
+300.0000 °/s		⇔	0010 1101 1100 0110 1100 0000

### 6.7 Temperature output extraction

The temperature output (12-bit word) needs to be extracted from the 2 read registers (16-bit word).

The following table presents the 2 read registers including the 12-bit temperature output:

Address	Bit7 (msb)	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0 (lsb)
0x0	X	X	Temp_Out[11]	Temp_Out[10]	Temp_Out[9]	Temp_Out[8]	Temp_Out[7]	Temp_Out[6]
0x1	Temp_Out[5]	Temp_Out[4]	Temp_Out[3]	Temp_Out[2]	Temp_Out[1]	Temp_Out[0]	X	X

**Table 18 : Temperature output data description**

**Note:** The 12-bit output temperature sensor **is not factory-calibrated**, since the calibration (offset and scale factor) is not required to compensate the gyro with respect to temperature.

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### 7 Document change control

Rev	Date	Page	Change description
1.0	Sept. 2016	All	Initial release