Project Report
Sensor Module Interfacing

Task: Interfacing Gyroscope with ATmega2560 in Firebird V Robot

Team members

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Abstract

The project aims at interfacing a Gyroscope with Fire Bird V educational robot. This additional module can be used for measuring or maintaining the orientation, based on the principles of angular momentum. In this paper we will see about the basic L3G4200D Gyroscope module interfacing with Atmega 2560 in Fire Bird V robot. This will include the working principle, basic interfacing circuit, programming and applications of the Gyroscope.

1 Introduction

The root word in Gyroscope is derived from a Latin word guros meaning ring. The basic model of a Gyroscope is a device that consists of a disc or a wheel that is spun rapidly around an axis, such that its orientation is independent of the tilting of the mounting. Hence, they are used in providing stability or in maintaining a reference direction in navigation systems, automatic pilots, and stabilizers.

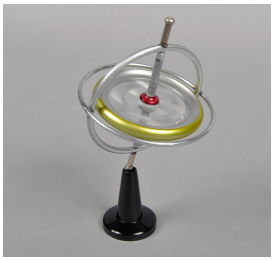


Figure 1: A Gyroscope

In this document, we are going to discuss the Gyroscope sensor L3G4200D, and understand its interfacing with the FireBird V Robot.

2 Specifications of L3G4200D Gyroscope:

- Onboard 3.3V Low Drop voltage regulator with input range of 3.6V to 6V.
- Dimensions: 0.9(L) X 0.5(W)
- 2 x Mounting holes
- I2C/SPI digital output interface
- Three selectable full scales (250/500/2000dps)
- Sensitivity:
  - 250 dps : 8.75 mdps/digit
  - 500 dps : 17.50 mdps/digit
  - 2000 dps : 70 mdps/digit
- 16 bit data output
- Embedded temperature sensor with 8-bit temperature data output
- Integrated low- and high-pass filters with user selectable bandwidth
- Embedded power-down and sleep mode
- Extended operating temperature range (-40 C to +85 C)

3 Pin Connections of L3G4200D:

3.1 Pin Diagram

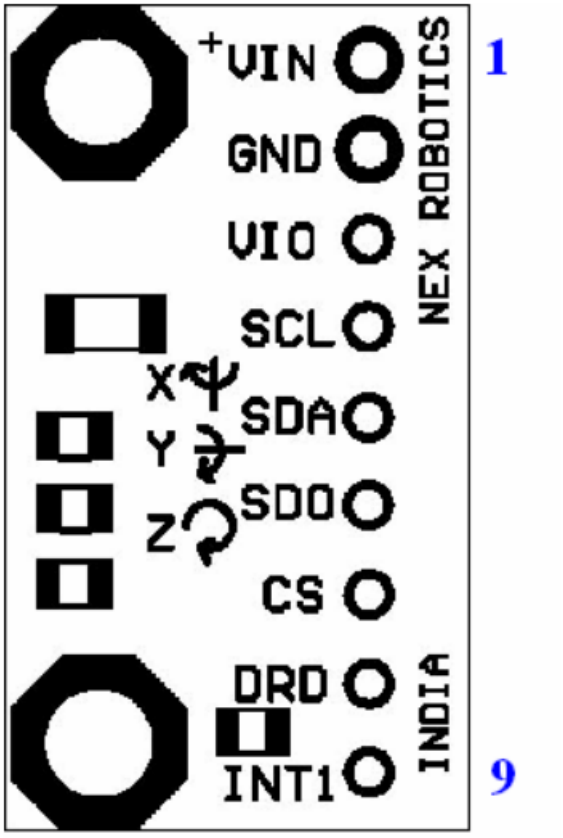


Figure 2: Pin Diagram

3.2 Useful Pins in the L3G4200D Gyroscope and its Connections with the Firebird V Robot

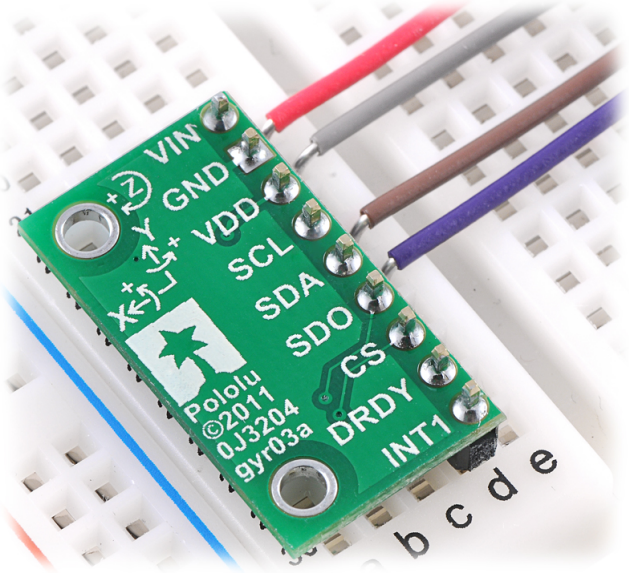


Figure 3: Useful Pins in the L3G4200D Gyroscope

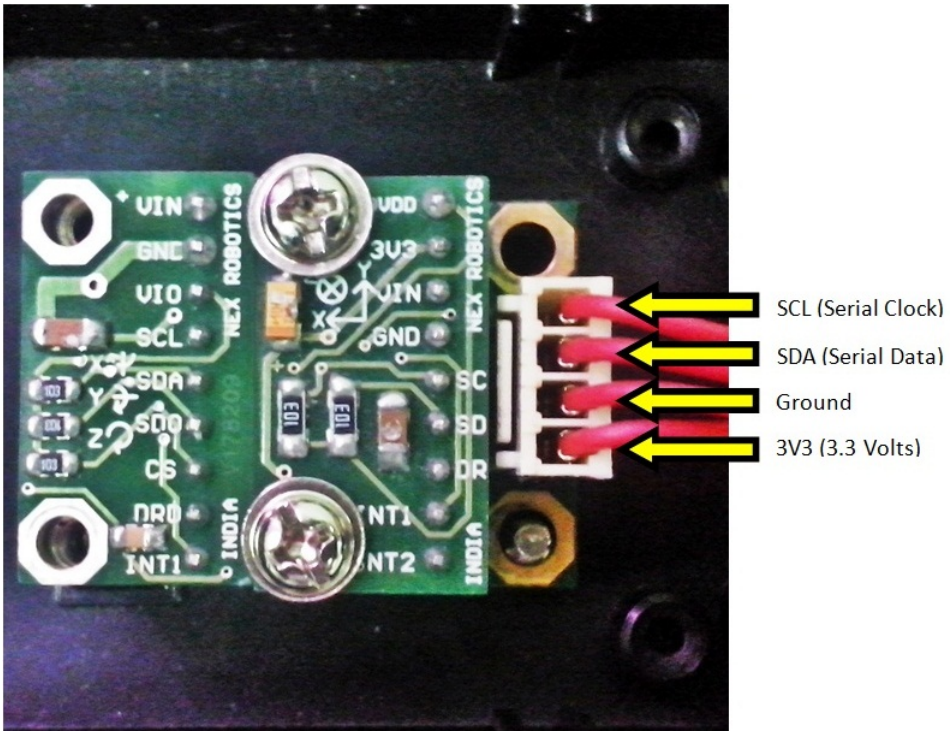


Figure 4: Useful Pins in the L3G4200D Gyroscope

Table 1

$Pins of L3G4200D$ Gyroscope Sensor	$Pins of Firebird V Robot$
GND	Pin 23/24 (Ground) in Microcontroller Expansion Slot
Vin	3.3 Volts in Xbee Module in Firebird V
SDA	Pin 19 in Microcontroller Expansion Slot
SCL	Pin 20 in Microcontroller Expansion Slot

3.3 Communication between Firebird V and L3G4200D using I2C Protocol

I2C interface between L3G4200D and 3.3V microcontroller

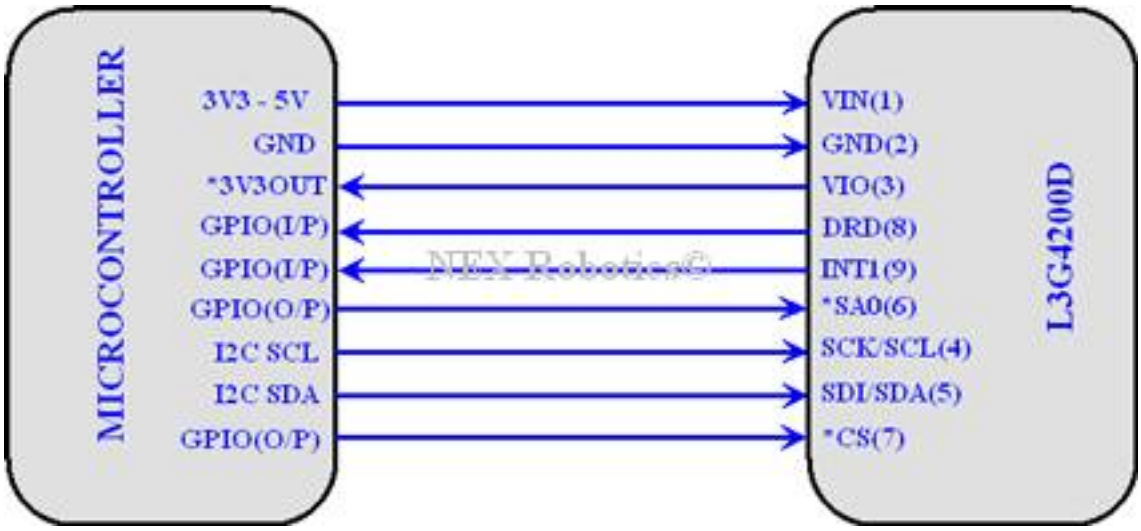


Figure 5: I2C interface between L3G4200D and 3.3V microcontroller

4 Procedure to interface IMU to FireBird V

4.1 Procedure to write data into a slave

1. Send START condition to initiate the process.
2. Sending the start condition will generate an interrupt. Wait for TWINT flag to be set.
3. Load SLA_W into TWDR Register to switch to Master Write mode. The address is 0xD2 for gyroscope.
4. Clear the TWINT flag to start transmission of slave address.
5. Wait for TWINT flag to be set which signifies that the slave address has been transmitted.
6. Send address of register byte that we want to access.
7. Clear the TWINT flag to start transmission of the register address.
8. Wait for TWINT flag set which means that an interrupt is generated for sending the register address.
9. Convert the character to equivalent BCD value and load into TWDR.
10. Clear the TWINT flag to start transmission of data byte.
11. Wait for the TWINT flag to be set.
12. Send STOP condition to terminate the data transfer.

4.2 Procedure to read data from a slave

1. Send the START condition.
2. START condition sent will generate an interrupt. Wait for TWINT Flag set which means that the interrupt has occurred.
3. Load SLA_W into TWDR Register to switch to Master Write mode.
4. Then clear the TWINT flag to start transmission of slave address.
5. Transmission of slave address will generate an interrupt. Wait for TWINT flag to be set.
6. Send the address of the register byte that we want to access.
7. Then clear the TWINT flag to start transmission of slave address.
8. Transmission of slave address will generate an interrupt. Wait for TWINT Flag to be set.
9. Send RESTART condition and start again to operate in Master Read mode.

10. RESTART condition sent will also generate an interrupt. So wait for TWINT Flag set which means that the interrupt has occured.
11. Load SLA_R into TWDR Register to switch to Master Read mode. The address is D3 for Gyroscope.
12. Clear the TWINT flag to start the transmission of slave address.
13. Wait for TWINT flag to be set.
14. Clear the TWINT flag to read the addressed register.
15. Wait for the TWINT flag set.
16. Load the NO-ACK value to TWDR register.
17. Clear TWINT flag to start transmission of NO_ACK signal.
18. Wait for TWINT flag to be set.
19. Now the value read can be used for any purpose.

Important Note:

- SA0 pin is internally pulled up to VIO which sets LSB of I2C address as 1.
- CS pin is internally pulled up to VIO which enables I2C mode.
- 3V3OUT is capable of delivering 3.3V@ 40mAmps. It can be used set up pull ups for I/O pins related to L3G4200D. It should not be used for other purposes.

5 Output of the Gyroscope L3G4200D

5.1 Output Displayed on LCD

6 Applications

- Quadrotor
- Balancing robots
- Advance robotics
- Navigation
- Motion Control with MMI (Man Machine Interface)
- Gaming and virtual reality input devices

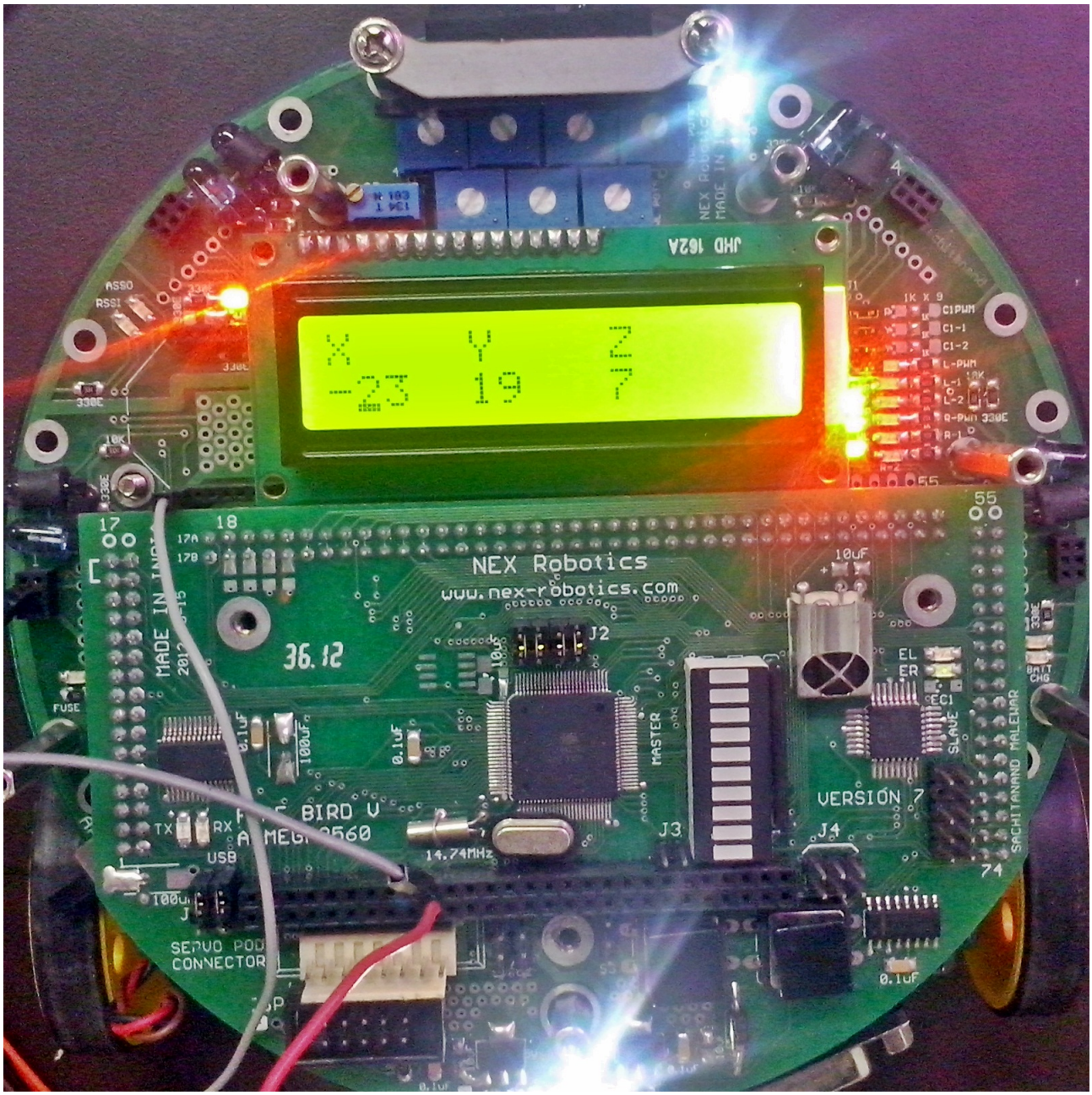
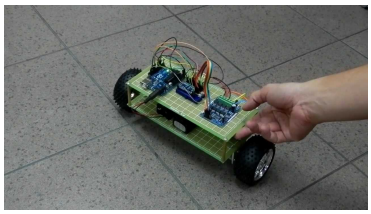


Figure 6: Output of Gyroscope on LCD

(a) Quadrotor



(b) Self-Balancing Robot

(c) Gyroscope in Gaming

Figure 7: Gyroscope Applications

7 Reference

1. L3G4200D IMU datasheet.
2. LSM303DLHC accelerometer datasheet.
3. ATMEGA 2560 datasheet.