

PIC16F1825 I2C PWM and UltraSonic Guide

MK-24316

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IONOTRONICS Corporation

<http://www.ionotronics.com>

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1 Introduction

This is a guide for using the PIC16F1825 as an I2C device for PWM control of Servos (e.g. HiTech) and ADC measurement in addition to UltraSonic support. Users can also program the 16F1825 using the CCS C Compiler or C Compiler from MicroChip for their own applications.

The I2C interface allows for the I2C address to be changed in the field using the IONOTRONICS PyroRaptor USB/I2C Bridge Hardware (MK-11009) and the Java PyroRaptor Graphical User Interface.

The MK-24316 has a 4 pin Hirose connector for the I2C interface and a 16 pin Hirose connector for programming and GPIO signals. See Figure 1. The PIC16F1825 is shown in Figure 2. Figure 3 shows the board dimensions.



Figure 1 MK-24316 PIC16F1825 Based I2C Slave for PWM Servo Control or Ultra Sonic Sensors

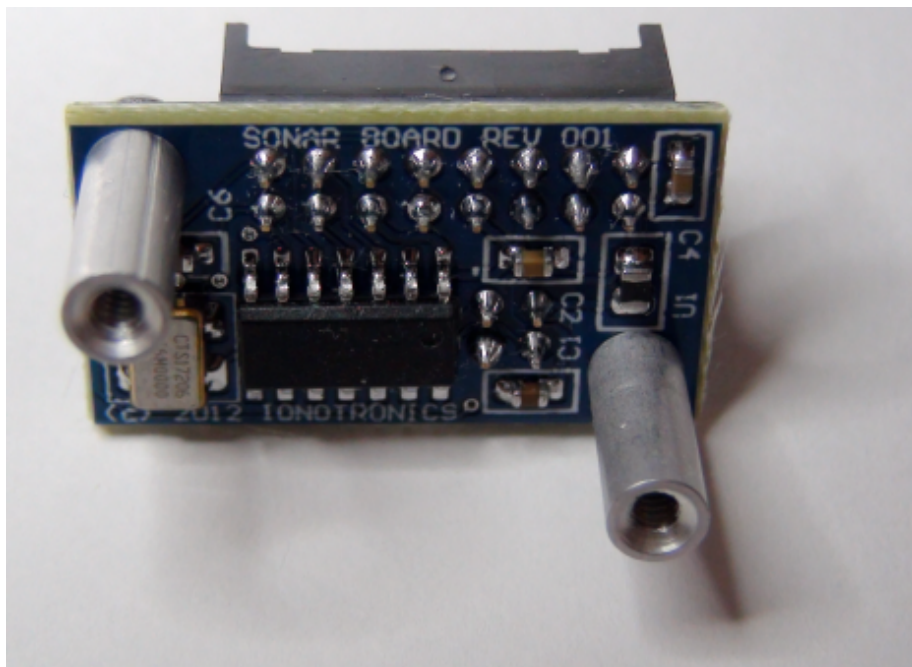


Figure 2 MK-24316 Bottom View Showing PIC16F1825

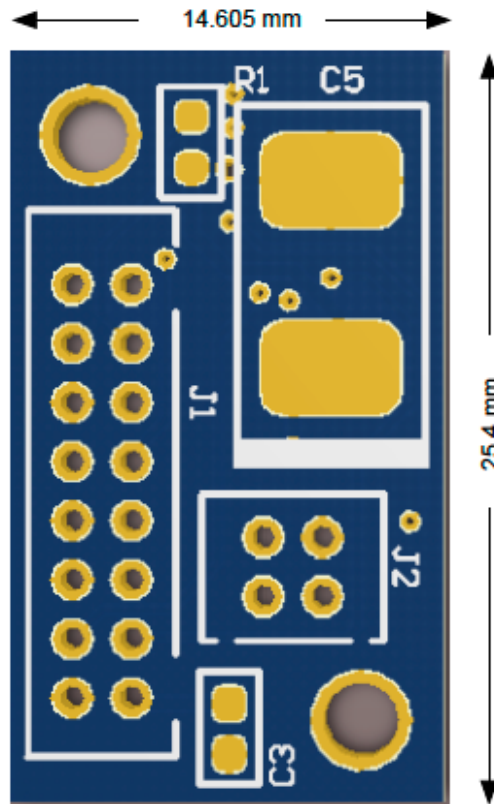


Figure 3 Board Dimensions

2 Changing I2C Address

To change the default I2C address (0x3A) send the command 0xFE to the I2C device. Next send the new I2C address (twice the actual address). Note these are two separate commands. That is, send the command then start a new I2C transaction and send the address. For example, to set the I2C address to 0x4e send 0x9C.

3 PWM and ADC Measurement Mode

3.1 Commands

3.1.1 Introduction

Commands are sent as a single byte. Each command should be a single I2C transaction. When a command requires multiple bytes, the bytes are sent in subsequent I2C transactions and not as a sequence of bytes.

3.1.2 Set the PWM (0xA1)

Step 1: Write the command value 0xA1 to the device(PIC16F1825).

Step 2: Write the Most Significant Byte (MSB)to the I2C device.

Step 2: Write the Least Significant Byte (LSB) to the I2C device.

The device will set the PWM value as:

$\text{pwm value} = \text{MSB} * 256 + \text{LSB}$.

Note that if a Time Interval has been set, the pwm will start from the current value and ramp up or down to the pwm value specified. If the time interval is 0 then the pwm value is immediately updated.

3.1.3 Set PWM Time (0xA3)

Step 1: Write the command value 0xA3 to the device(PIC16F1825).

Setp 2: Write time duration byte to the device.

The total time is:

$\text{time} = \text{timeByte} * 20 \text{ ms}$

So the step value is 20ms.

The maximum time is $255 * 20 = 5100\text{ms}$ or 5.1s

This is an important parameter. Controlling the rate at which the present PWM (location) approaches the final PWM (location) is important for precision and over shoot avoidance as well as for example Robot stability.

3.1.4 Read ADC Value (0xA2)

Step 1: Write the command value 0xA2 to the device(PIC16F1825).

Step2 : Read the measured ADC value as a Byte.

3.1.5 Read Mean (ADC) Value (0xA5)

Step 1: Write the command value 0xA5 to the device(PIC16F1825).

Step2 : Read the measured mean current as a Byte (this is ADC value).

3.1.6 Set ADC Sample Period (A6)

Step 1: Write the command value 0xA6 to the device(PIC16F1825).

Step2 : Write the ADC Sample Period Byte to the device.

The ADC sampling interval for measuring the current is the value (8 bit) multiplied by 100us.

So $\text{adcSamplingInterval} = \text{value} * 100 \text{ us}$.

Example: $\text{value} = 100$ (0x64) then interval is $100 * 100\text{us} = 10\text{ms}$.

The mean value is computed using 10000 samples.

4 UltraSonic Mode

4.1 Introduction

The MK-24316 can be used to convert an Ultrasonic sensor into an I2C based sensor. This is shown in the Figures below.

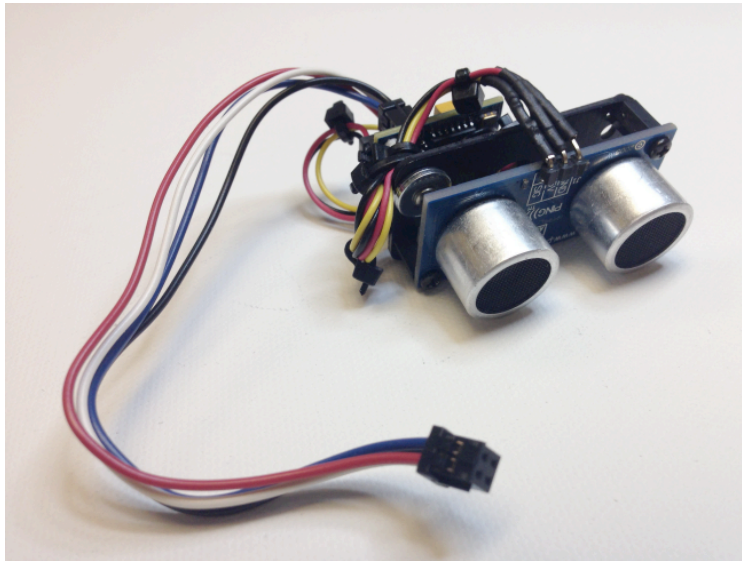


Figure 4 MK-24316 converting ultrasonic sensor into I2C based sensor.

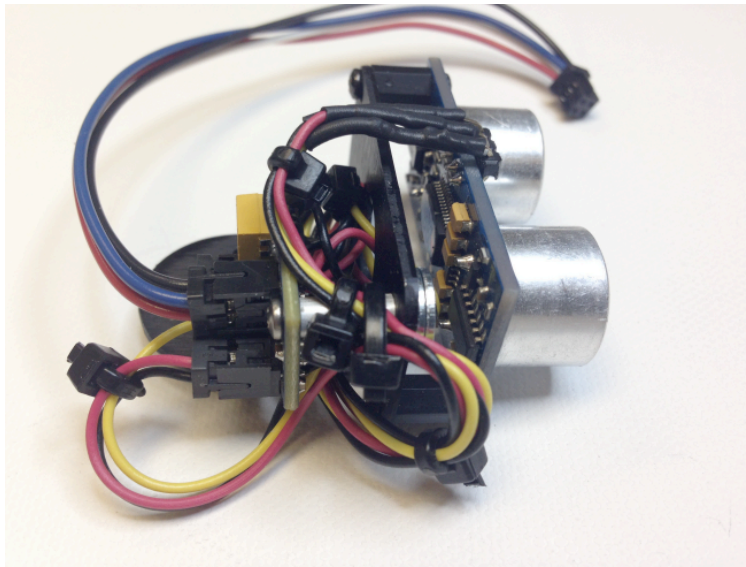


Figure 5 MK-24316 Side view with ultrasonic sensor.

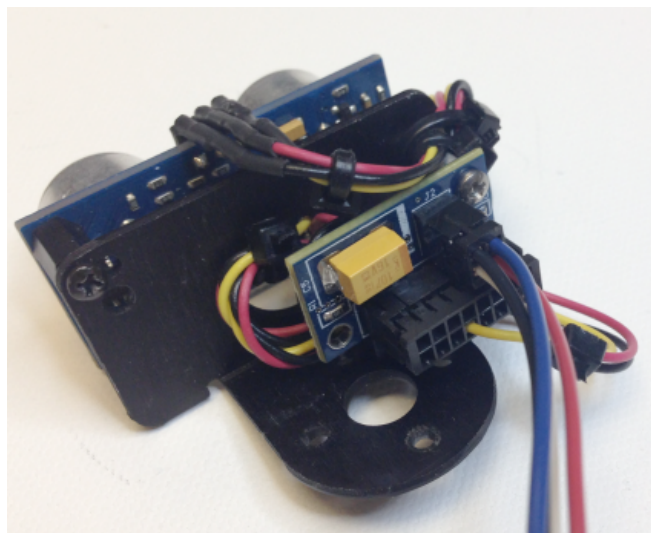


Figure 6 MK-24316 with board connected to I2C bus through 4 pin connector. Also ultrasonic sensor supplied with 5V, Ground and GPIO.

4.2 Commands

4.2.1 Perform Measurement (0xF1)

Once the Byte 0xF1 is sent to the I2C device, an ultrasonic measurement is initiated. The GPIO pin C5 is used. First it is set as an output. A 100 uS pulse is generated. This triggers the Ultrasonic Device. The GPIO pin C5 is then setup as an input. A timer is initiated. When the received pulse goes low, the timer value is captured. The timer value is the measurement.

4.2.2 Read LSB of 16 bit Measurement (0xF4)

To read the Least Significant Byte send the command 0xF4. Follow this by a read. The LSB is returned.

4.2.3 Read MSB of 16 bit Measurement (0xF5)

To read the Most Significant Byte send the command 0xF5. Follow this by a read. The LSB is returned.

4.2.4 Read ADC Value Byte (0xFD)

To read the ADC Byte send the command 0xFD. Follow this by a read. The ADC Byte is returned.

The ADC is Pin C3.

5 Connections

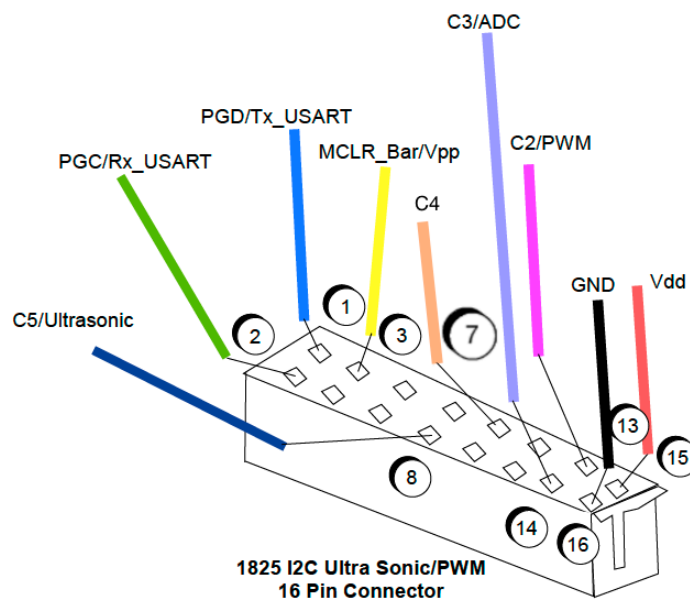


Figure 7 Cartoon of 16 pin Connections

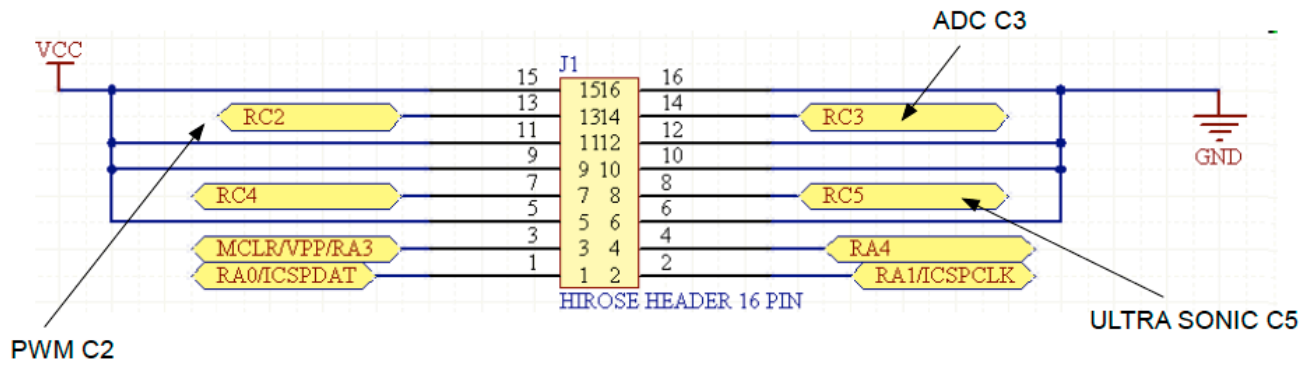


Figure 8 16 pin connector signals and power. Also used for programming (ICS)

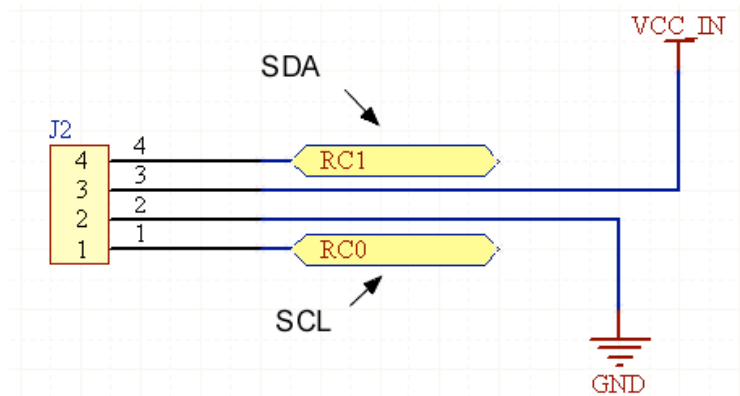


Figure 9 I2C 4 pin connector.

6 Applications

The following are examples of the MK-24316 PIC16F1825 used in a Pan and Tilt system with UltraSonic and a Humanoid Robot (Based on the Lynxmotion BRAT). The servos for the Pan and Tilt are controlled using 16F1825 PIC chips programmed with the firmware. The UltraSonic device is also controlled with a 16F1825. In both examples, we also illustrate the Pyraptor USB/I2C Bridge and the Pyraptor Java Graphical Interface.

6.1 Pan and Tilt with Sonar

In this application an MK-24316 is used for Pan and another is used for Tilt. A third is used to interface an Ultrasonic sensor into the I2C bus. The pan and Tilt are controlled through the I2C bus by an I2C Master. See the figures below. Also visit the IONOTRONICS WEB site.

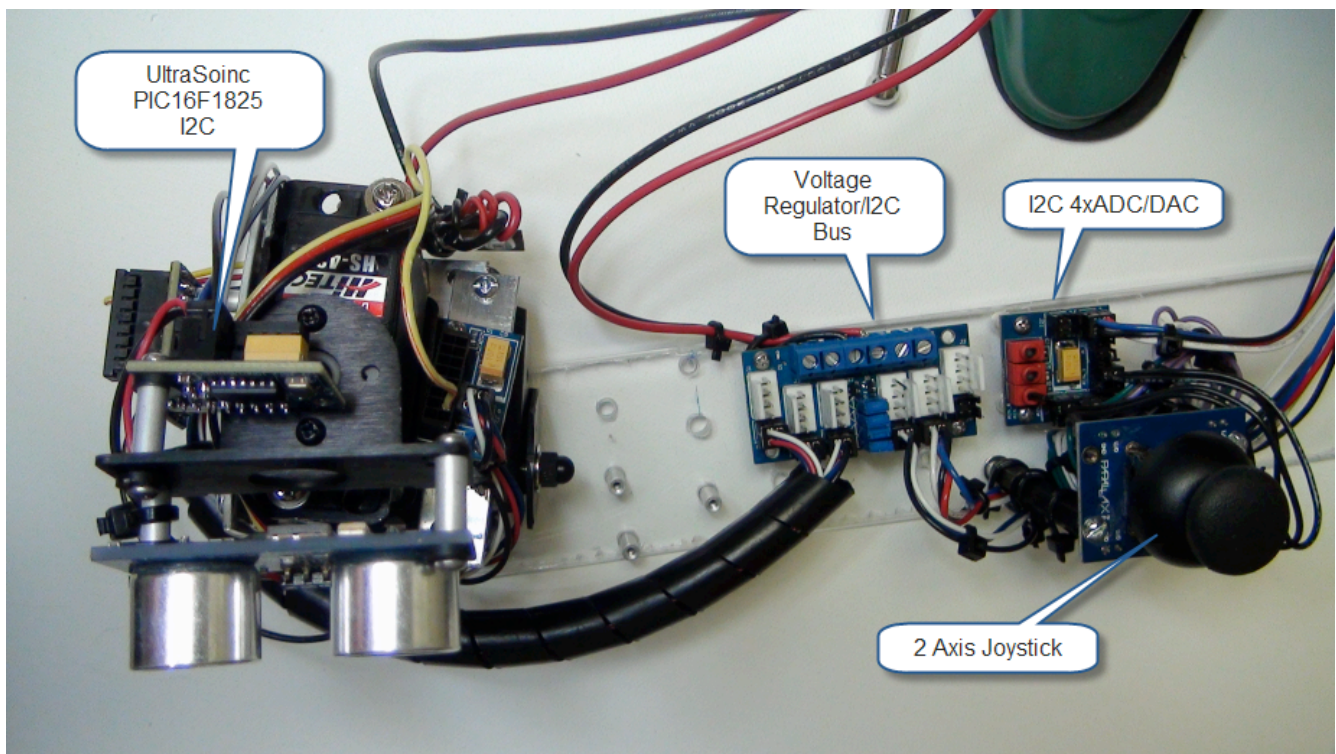


Figure 10 Pan and Tilt Application with Ultrasonic Sensor

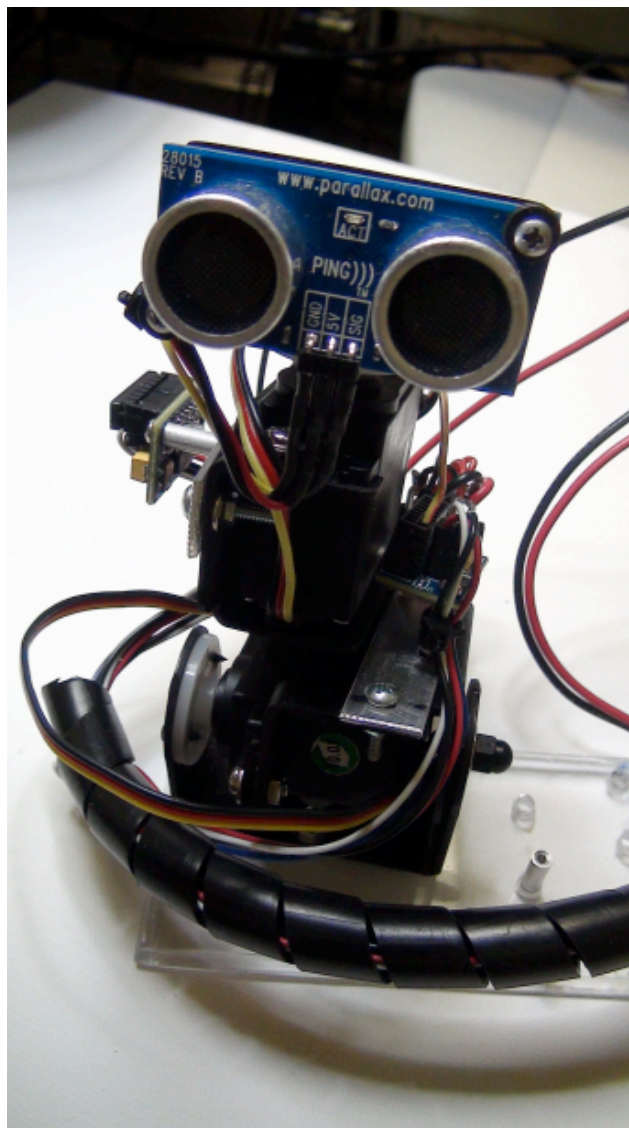


Figure 11 Front View Pan and Tilt Application with Ultrasonic Sensor

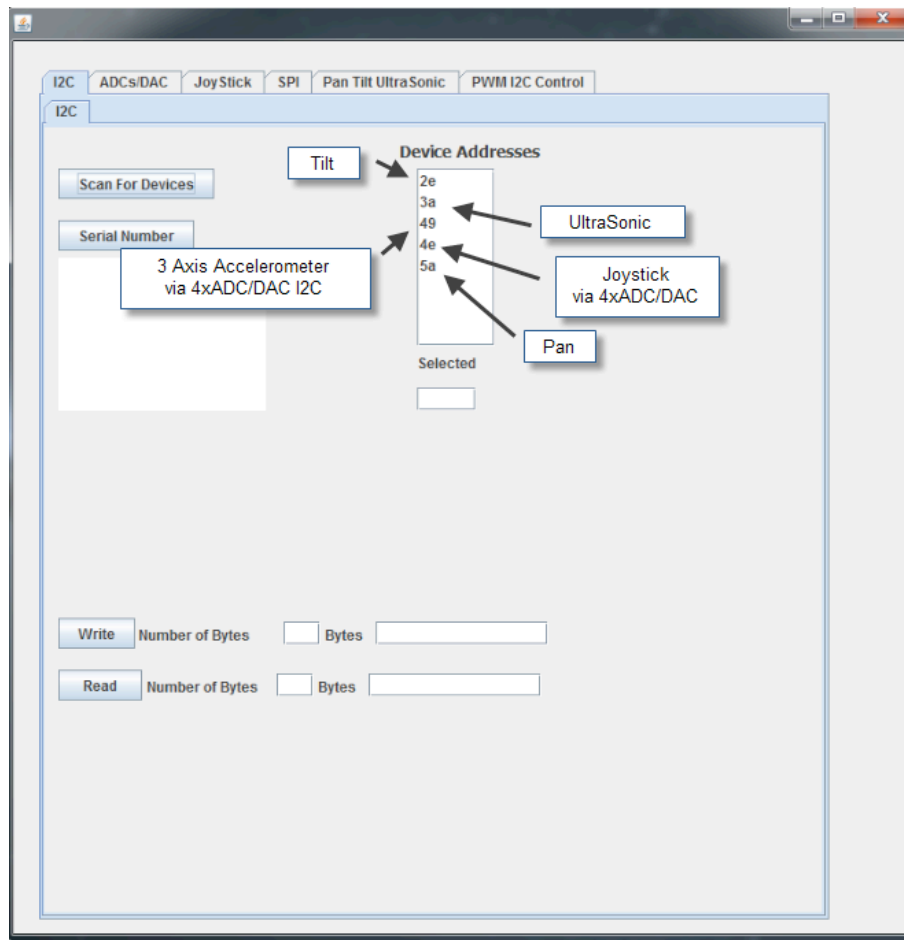


Figure 12 I2C Bus Scan with Pyraptor Java Graphical Interface of the Pan and Tilt Application with Ultrasonic Sensor

6.2 Humanoid Robot with Hip,Knee and Ankle Control Through I2C

The BRAT Biped Humanoid has 6 PWM Servos. In the design by IONOTRONICS, they are controlled using PIC16F1825 I2C PWM Slaves (MK-24316). A PIC16F1947 is the I2C Master. It receives commands for the I2C based PWM Servos from the Java Application via the Wireless TCP/IP link. In some of the Videos (BRAT Getting Up), the Java Application is running in autonomous mode where it is continuously checking the status of the accelerometers. Based on the reading, it determines whether the BRAT is on its back or standing. If it is on its back, it sends servo commands for the BRAT to getup. If the BRAT is put on its back, it will detect it and get up. The key is that the code providing the intelligence is written in Java with the full powers of Java and speed of a multi-GHz clocked CPU. The BRAT has a PIC16F1947 which has remote control firmware. It provides the status of all sensors to the Java application. It receives servo position, and time to move, commands from the Java Application via Wireless TCP/IP. The PIC16F1947 also has GPIO to control, for example an RGB LED, for status (e.g.

Green LED for Standing and Red for when the BRAT is on its back). The Videos demonstrate these capabilities. All code for the Java Application and PIC16F1947 firmware are available as Open Source. Visit the IONOTRONICS web site to view the videos.

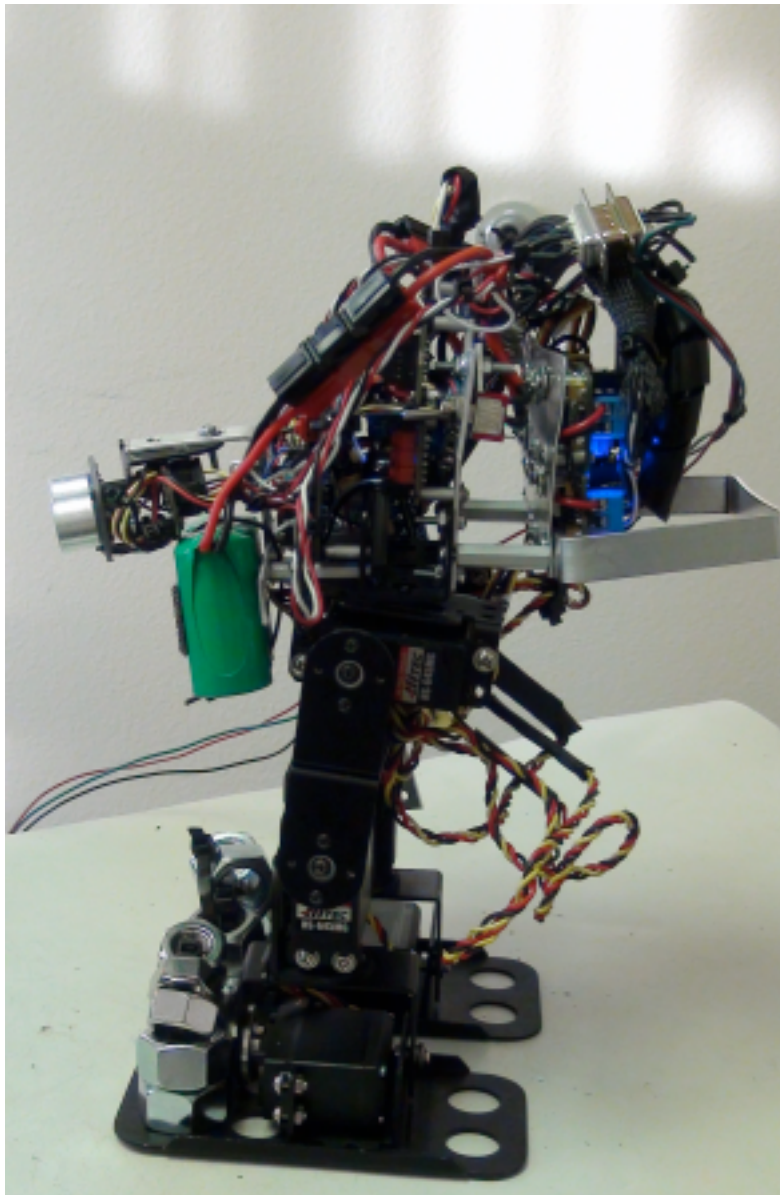


Figure 13 Side View of Humanoid with All I2C Based PWM Servo Control with PIC16F1825 (MK-24316)

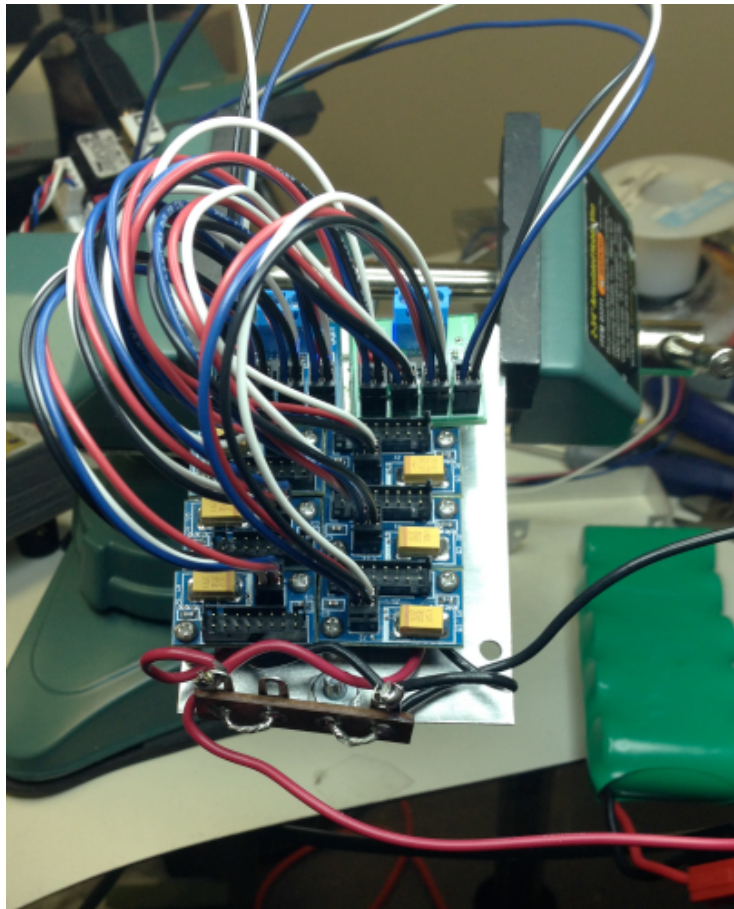


Figure 14 Six MK-24316 PIC16F1825 I2C PWM for Hip, Knee and Ankle Control. Note two 6V LDO to 5V boards are used each providing 4 I2C bus 4-pin Hirose connectors and supplying 5V to Each MK-24316s.

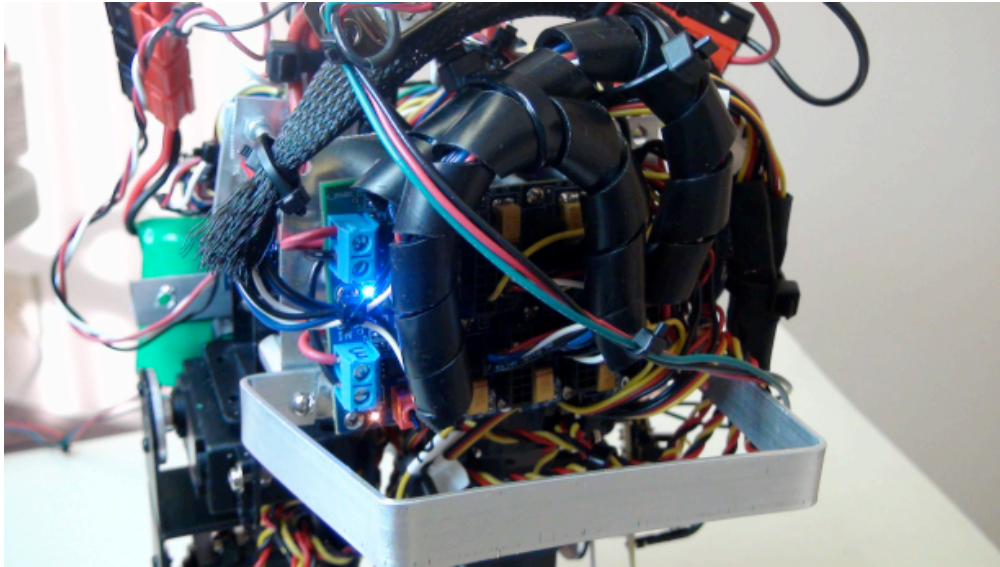


Figure 15 Back View of I2C Based Humanoid Robot.

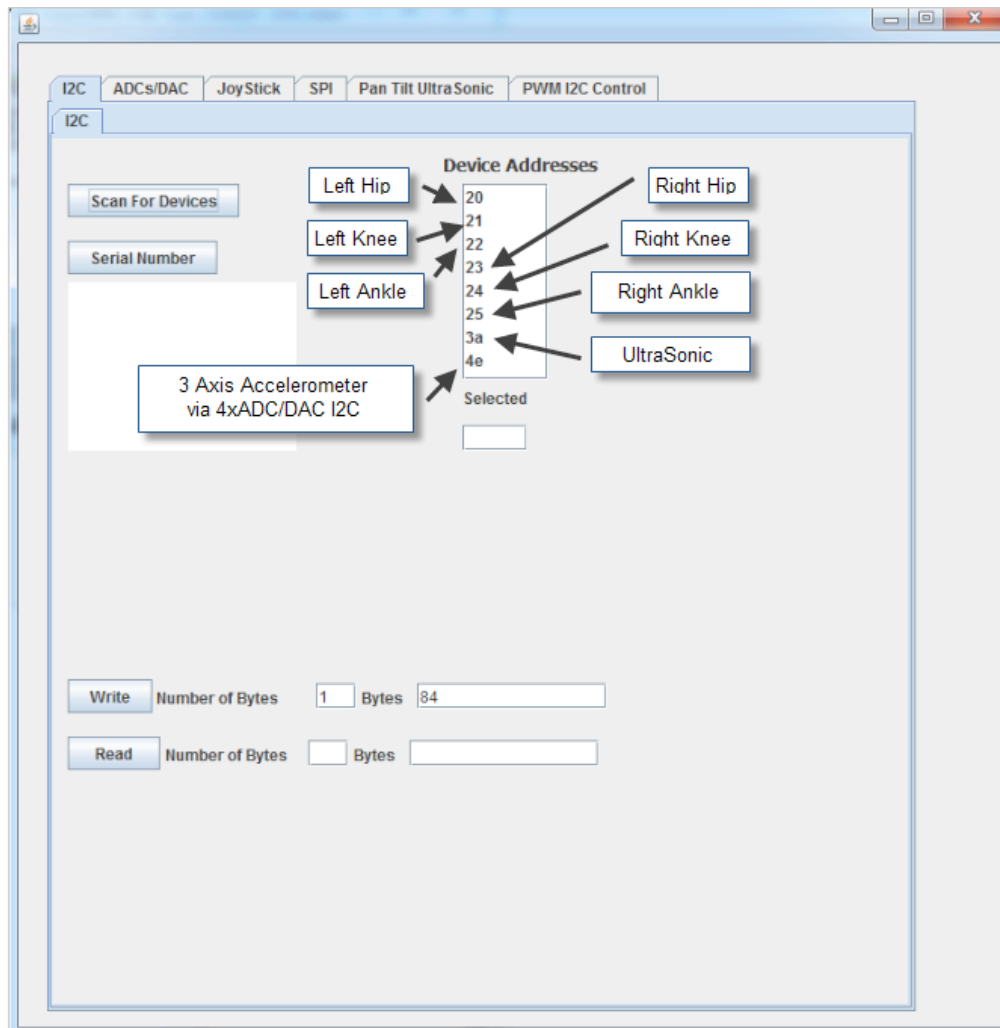


Figure 16 Pyraptor I2C Bus Scan of I2C Based Humanoid Robot Showing MK-24316s and Sensors and LCD Display

6.3 Rover with I2C SaberTooth Motor Control

In section we show a Rover in which the Sabertooth Dual Channel Motor Controller is controlled by two MK-24316 devices so that the Rover motion (Tanking, Forward, Reverse and Speed) cfan be controlled using the I2C protocol. The Rover also has integrated I2C based sensors as well as I2C LCD Display. The Rover also has an I2C based Pan/Tilt and Ultrasonic Sensor (All based on MK-24316).

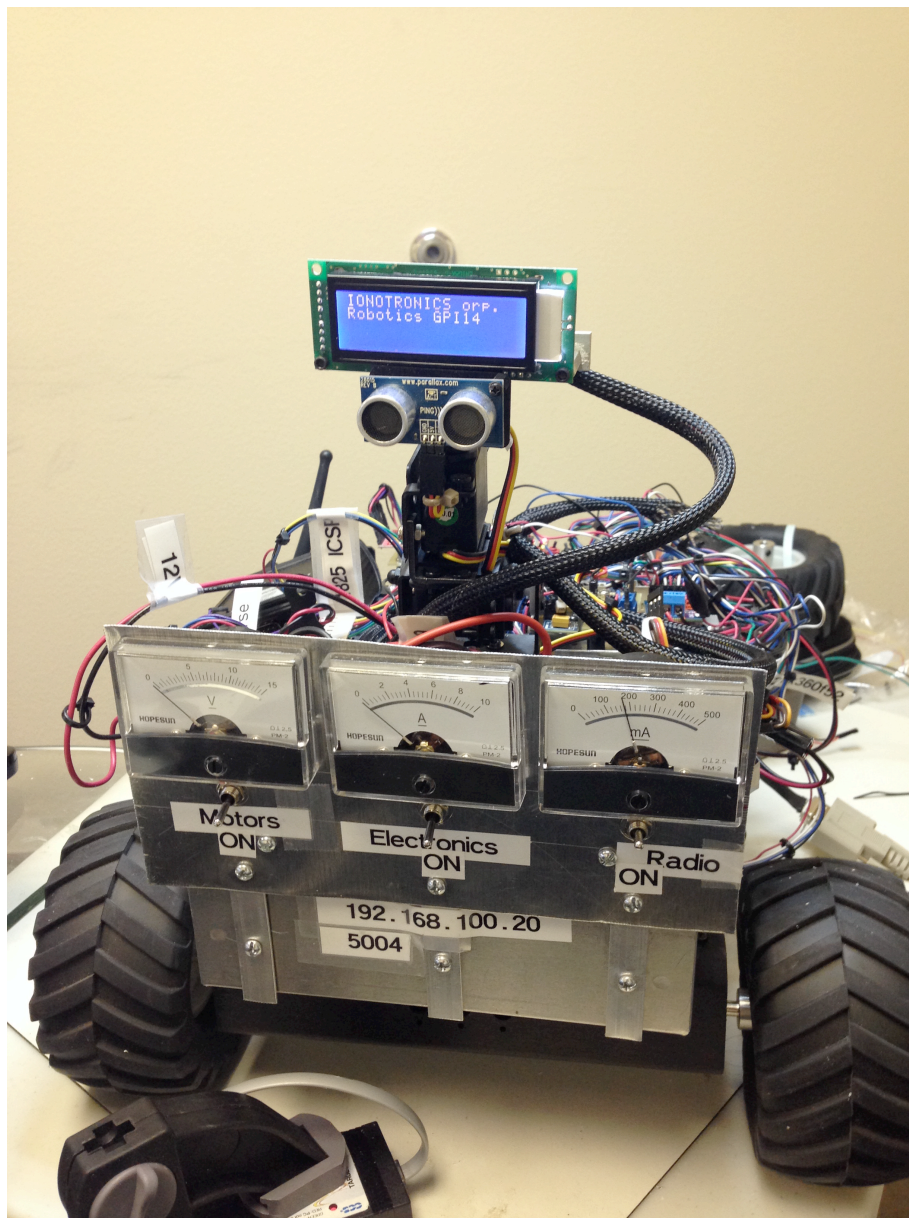


Figure 17 Front View of Rover with I2C based Motor Control. Two MK-24316's Control the Sabertooth Servo Controller via PWM.

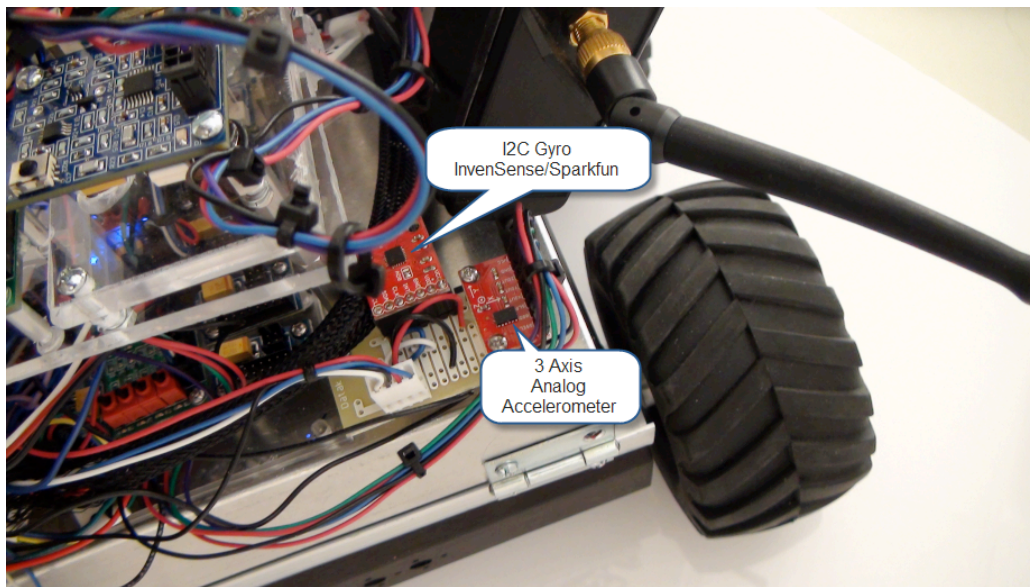


Figure 18 Rover Showing Accelerometer (Analog through I2C 4xADC) and I2C Gyro Sensors.

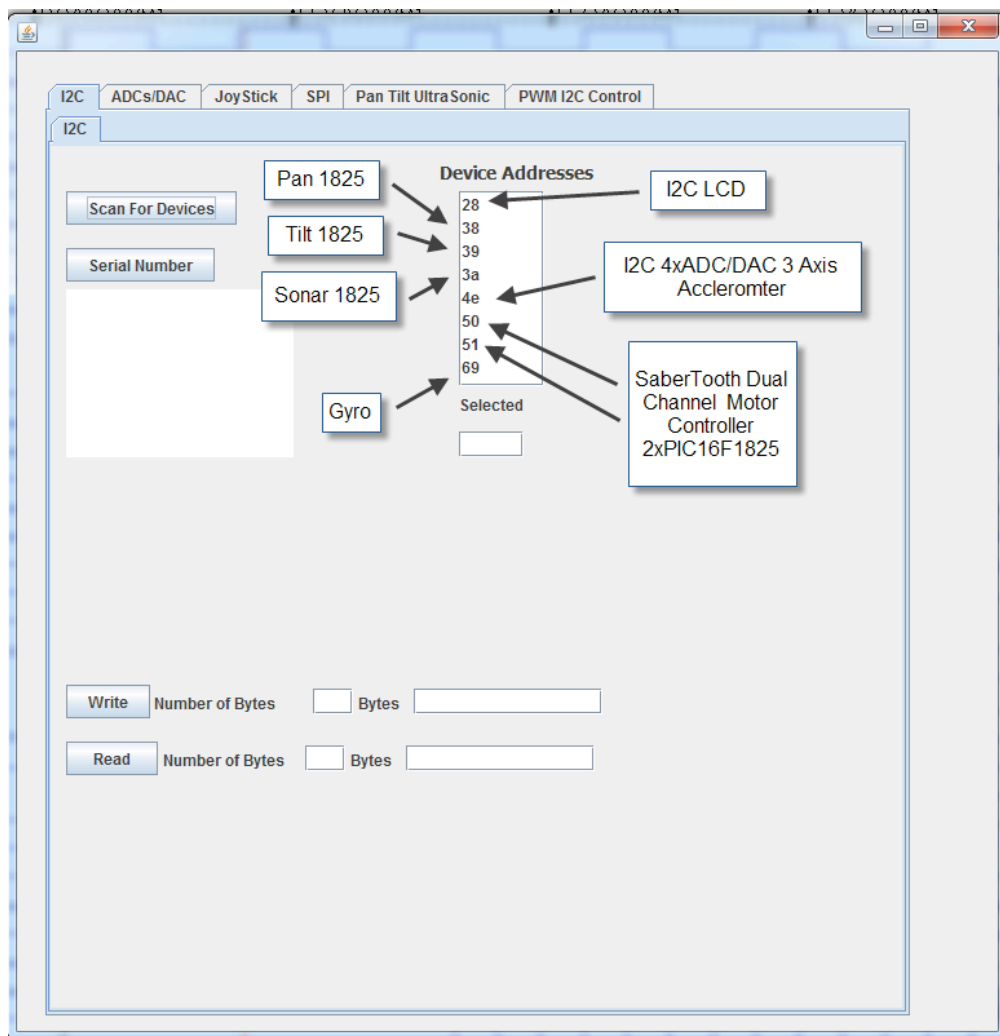


Figure 19 I2C Scan of the Rover I2C Bus Using the Pyraptor USB/I2C Bridge. Note the I2C Addresses of the MK-24316s for Motor Control (0x50 and 0x51)

7 Hirose DF11 Series Connector

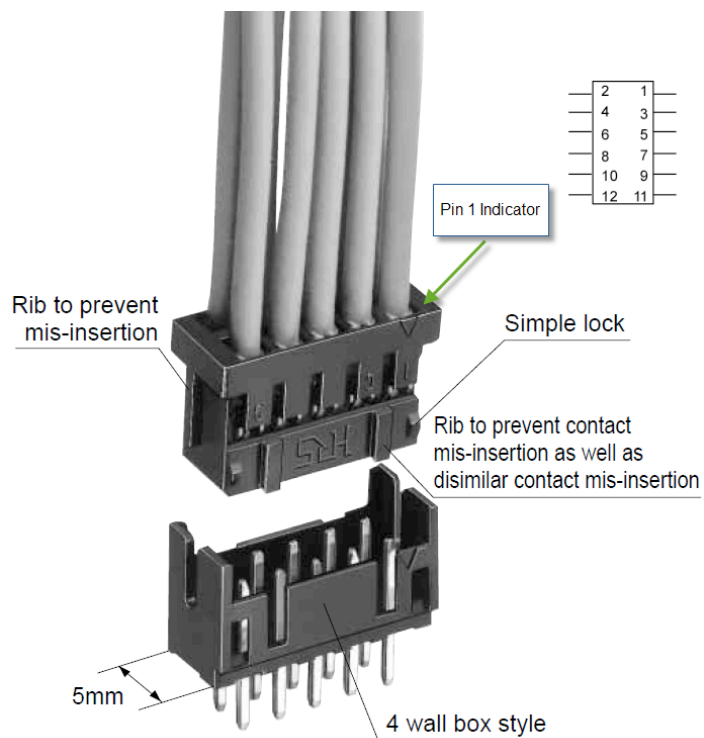


Figure 20 Guide to the Hirose DF11 series connector

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