Modern Robotics Inc.
Sensor Documentation

Version 1.0.1 September 9, 2016

Contents

1. Document Control

Revision History			
Version	Date	Description	By
1.0.0	6/29/16	Initial Document	Modern Robotics
1.0.1	9/9/16	Minor corrections and text fixes	Modern Robotics

Specifications subject to change without notice.

Modern Robotics, Inc
13335 SW 124th St
Miami, FL 33186

Phone: (786)393-6886
Email: support@modernroboticsinc.com
Web: www.modernroboticsinc.com

2. Introduction

The following document is a guide for the use and implementation of all Modern Robotics Sensors. Modern Robotics Sensors are built in a robust plastic housing with either a three or four wire connector for easy connection to various Modern Robotics Controllers. These sensors are designed for work, play and education with a housing tailored to fit the Matrix Robotics System's 8mm grid.

3. Three-Wire Analog & Digital Sensors

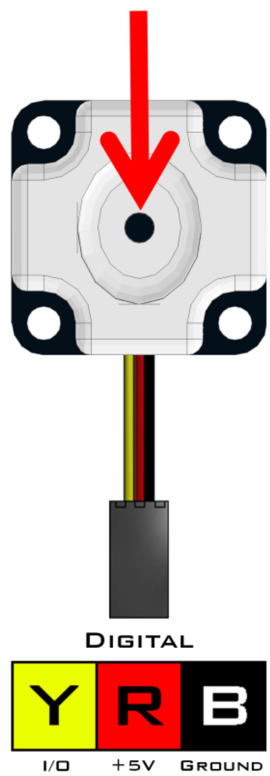
All three-wire sensors connect to either a digital port or an analog port. Therefore, if it is a digital sensor, it produces a value of either 0 or 1. If the sensor is analog, it produces a value between 0 and 255. The sensors consist of a black, red and yellow wire.
The black wire is the ground wire and must line up with the black bar on the right side of the port.
The red wire is the power wire that connects to 5V for all of the sensors to operate on.
The yellow wire is the input/output signal line that ranges from 0V-5V.

3.1. Program Control Button (45-2002)

The Program Control Button (PCB) is used to provide the user the ability to interact with the running program. It can be used to stop and start programs without having to intercept the power. This sensor is designed to work with the Core Spartan Controller.

http://modernroboticsinc.com/program-control-button

Sensor Type: Three Wire Digital Sensor
Dimensions: 32 x 32 x 12 millimeters
Mounting Holes: 24 x 24 millimeters
Power: 5 volts DC, 20 mA max.
Signal Logic Levels: Logic 0 – 0 volts, Logic 1 – 5 volts

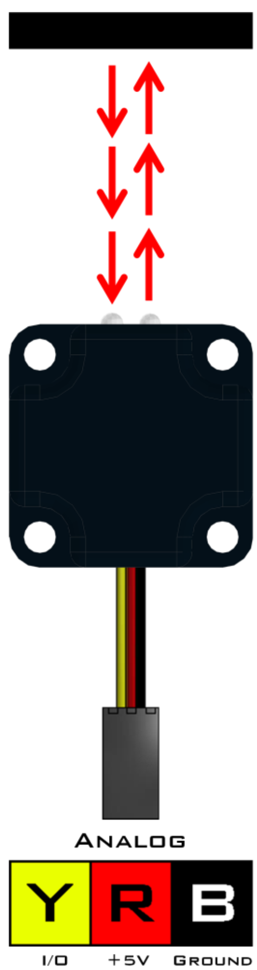


3.2. Optical Distance Sensor (45-2006)

The Optical Distance Sensor (ODS) is an analog sensor that uses electro optical proximity detection to calculate distance from an object based on the intensity of the light. This sensor can accurately calculate distances between 1 cm and 15 cm. Lighter colored objects will return a more accurate and consistent reading. Try different colors and materials to see what works best for you. The ODS can be used for object detection, line detection and the difference between light and dark.

http://modernroboticsinc.com/optical-distance-sensor-2

Sensor Type: Three Wire Analog Sensor
Dimensions: 32 x 32 x 12 millimeters
Mounting Holes: 24 x 24 millimeters
Power: 5 volts DC, 20 mA max.
Signal Logic Levels: Analog 0 – 5 volts

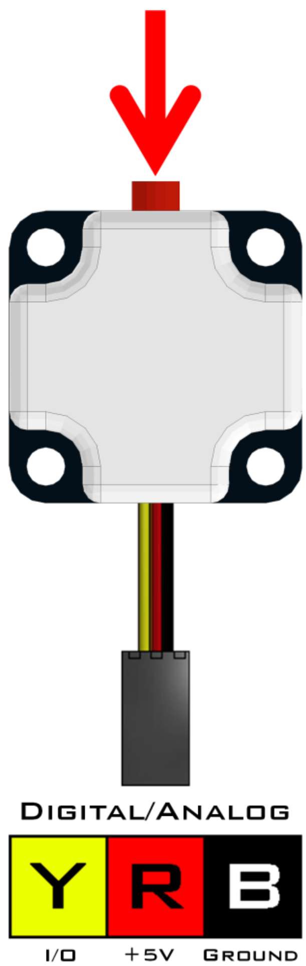


3.3. Touch Sensor (45-2007)

The Touch Sensor can be used for an array of different tasks including object detection, counter, standard push button and many more. The sensor can be attached to either an analog or digital port and contains a built in LED which indicates when the sensor is activated.

http://modernroboticsinc.com/touch-sensor-2

Sensor Type: Three Wire Digital Sensor
Dimensions: 36 x 32 x 15 millimeters
Mounting Holes: 24 x 24 millimeters
Power: 5 volts DC, 20 mA max.
Signal Logic Levels: Logic 0 – 0 volts, Logic 1 – 5 volts
Actuator Length: 5 millimeters
Actuator Depression Force: 150 grams



4. Four-Wire Digital I2C Sensors

All four-wire sensors are I2C sensors. I2C stands for Inter-Integrated Circuit and is used for communication between two or more devices. All Modern Robotics I2C sensors have four wires: Black, Red, Yellow and White.
The black wire is the ground wire and must line up with the black bar on the right side of the port.
The red wire is the power wire that connects to 5V for all of the sensors to operate on.
The yellow wire is the serial data (SDA) which is responsible for the transfer of data between the master and the slave devices.
The white wire is the serial clock (SCL) which is very important as I2C communication relies on the clock signal for sending out and receiving in data on the yellow wire.
Each sensor has its own I2C address associated with it. If you intend to use two of the same sensor, you must change the address of one of the sensors. Core Device Discovery is a tool that can be found at http://modernroboticsinc.com/coredevicediscovery and it is used to test Modern Robotics modules and controllers. Core Device Discovery may also be used to change the I2C address of a sensor through a Core Device Interface Module. The I2C ports are connected to the same I2C bus. Therefore whichever I2C port the sensor is connected to is arbitrary.

Note:
The fields shown as fsb/lsb are 16 bit values with a notional binary point between bits 7 and 8. Thus, the value 0x0100 represents the decimal value 1.00 whereas 0x0180 represents decimal value 1.50.

Standard I2C Memory Map for 4 Wire Sensors

Address	Function
0x00	Sensor Firmware Revision
0x01	Manufacturer Code
0x02	Sensor ID Code
0x03	Command Register (optional)
0x04-0x6F	Data Registers
0x70-0xFF	Unavailable

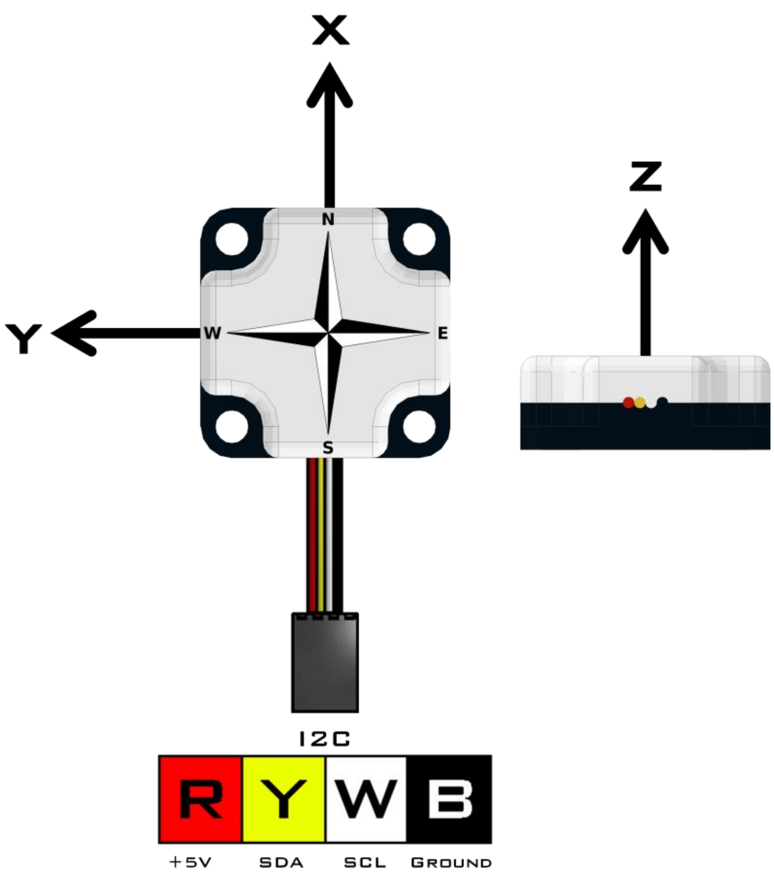
Sensor Codes
Location 0x00 will contain the major and minor firmware revision numbers as two hex nibbles. Location 0x01, the manufacturer code byte, will contain 0x4D (“M”). Location 0x02, the sensor ID code, will contain an ID code as defined above.

4.1. Compass (45-2003)

The Compass uses a magnetometer and an accelerometer to calculate heading data based on Earth's magnetic field. The compass can return the heading data, accelerometer data and magnetometer data to the user. Anything that generates a magnetic field must be moved away from the sensor like power cables, motor or magnetic material. This must happen because during calibration the sensor will add an offset to account for other magnetic sources in the area.

http://modernroboticsinc.com/compass-acceleration-tilt-sensor

Sensor Type: Four Wire I2C Sensor
Default I2C Address: 0x24
Dimensions: 32 x 32 x 12 millimeters
Mounting Holes: 24 x 24 millimeters
Power: 5 volts DC, 20 mA max.
Signal Logic Levels: Logic 0 – 0 volts, Logic 1 – 5 volts
I2C Bus Speed: 100kHz max
I2C Address Change Option: yes



Address	Function
0x00	Sensor Firmware Revision
0x01	Manufacturer Code
0x02	Sensor ID Code
0x03	Command
0x04/0x05	Heading Data (lsb/msb)
0x06/0x07	Accelerometer X Value (lsb/msb)
0x08/0x09	Accelerometer Y Value (lsb/msb)
0x0A/0x0B	Accelerometer Z Value (lsb/msb)
0x0C/0x0D	Magnetometer X Value (lsb/msb)
0x0E/0x0F	Magnetometer Y Value (lsb/msb)
0x10/0x11	Magnetometer Z Value (lsb/msb)
0x12/0x13	Accelerometer X Offset (lsb/msb)
0x14/0x15	Accelerometer Y Offset (lsb/msb)
0x16/0x17	Accelerometer Z Offset (lsb/msb)
0x18/0x19	Magnetometer X Offset (lsb/msb)
0x1A/0x1B	Magnetometer Y Offset (lsb/msb)
0x1C/0x1D	Magnetometer Z Offset (lsb/msb)
0x1E/0x1F	Magnetometer Tilt Coefficient (fsb/lsb)
0x20/0x21	Accelerometer Scale Coefficient (fsb/lsb)
0x22/0x23	Magnetometer X Scale Coefficient (fsb/lsb)
0x24/0x25	Magnetometer Y Scale Coefficient (fsb/lsb)

Command	Operation	EEPROM Auto-Update
0x00	Normal measurement mode	
0x43	Hard Iron Calibration mode	✓
0x58	Accelerometer X axis null	✓
0x59	Accelerometer Y axis null	✓
0x5A	Accelerometer Z axis null	✓
0x47	Accelerometer sensitivity/gain adjust	✓
0x55	Measure tilted up accelerometer value	
0x44	Measure tilted down accelerometer value	✓
0x57	Write EEPROM data	✓

During normal operation the LED will blink briefly at 1Hz. During Hard Iron Calibration the LED will blink at ½Hz. During tilt up and tilt down calibration the LED will be on during a period of calibration measurement.

Hard Iron Calibration:
Hard Iron Calibration is entered by setting the command location to 0x43. Once Hard Iron Calibration is active rotate the Compass 360°, making sure it does not tilt, for a period of 5 seconds. Once the rotation procedure is complete, the command location must be set to 0x00 to signal that calibration is complete. If the data collected during the rotation was good, the Compass will enter Normal Measurement Mode using the new calibration data. If the data collected during the rotation was not good, the command value will change to 0x46 and the Compass will enter Normal Measurement Mode using the previous calibration data.

Tilt Compensation:
Tilt compensation is performed in two steps, tilt up and tilt down in that order.
The first step is tilt up. To set the Compass up for tilt up measurement, the Compass should be pointed due North and set with the front of the device tiled up by approximately 20°. Then the command location should be set to 0x55 while the Compass is held perfectly still. Once the LED extinguishes itself, the command location will return to 0x00, indicating that tilt up data has been captured.
The second step is tilt down. To set the Compass up for tilt down measurement, the Compass should be pointed due North and set with the front of the device tilted down by approximately 20°. Then the command location should be set to 0x44 while the compass is held perfectly still. Once the LED extinguishes itself, the command location will return 0x00, indicating that tilt down data has been captured and the tilt compensation coefficient has been acquired.
If the two tilt steps are not performed in the correct order, or some other error is detected, the command location will be set to 0x46 and the Compass will enter Normal Measurement Mode using the previous tilt compensation coefficient.

Accelerometer Nulling:
Accelerometer axis nulling is performed using the three axis null commands. For both the x and y axis nulling should be performed with the device set perfectly level. Setting the command location to 0x58 will update the accelerometer X axis offset. Setting the command location to 0x59 will update the accelerometer Y axis offset. For the Z axis nulling, the device should be set to be perfectly vertical. Setting the command location to 0x5A will update the accelerometer Z axis offset

Accelerometer Sensitivity:

The accelerometer sensitivity is adjusted to be approximately 1mg/count. If greater measurement accuracy is required, the Accelerometer Scale Coefficient (fsb/lsb) may be set by the user. This can be simply done by setting the device perfectly vertical and obtaining the accelerometer X value. If the value read were to be 850, then the Accelerometer Scale Coefficient would have to be set to 1.176 or 0x012D (1.176 x 256). If the value read were to be 1050, then the Accelerometer Scale Coefficient would have to be set to 0.952 or 0x00F3 (0.952 x 256).

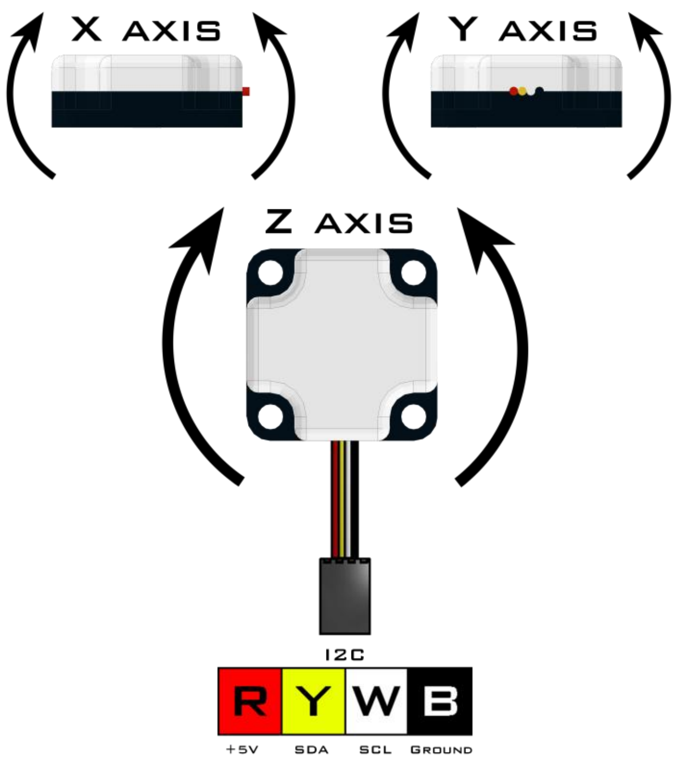
Once the Accelerometer Scale Coefficient has been adjusted, the 0x57 command should be issued to ensure the new value is recorded in EEPROM.

4.2. Integrating Gyro (45-2005)

The Integrating Gyro uses a 3-axis chip to obtain X, Y and Z coordinates as well as an integration of the Z-axis to provide heading data. The integrated Z value is an integration of the Z-axis over time and this value is used for both internal calculations and to provide an Absolute heading (-∞ - ∞) as opposed to the Cartesian heading (0 – 359).

http://modernroboticsinc.com/integrating-3-axis-gyro

Sensor Type: Four Wire I2C Sensor
Default I2C Address: 0x20
Dimensions: 32 x 32 x 12 millimeters
Mounting Holes: 24 x 24 millimeters
Power: 5 volts DC, 20 mA max.
Signal Logic Levels: Logic 0 – 0 volts, Logic 1 – 5 volts
I2C Bus Speed: 100kHz max
I2C Address Change Option: yes



Address	Function
0x00	Sensor Firmware Revision
0x01	Manufacturer Code
0x02	Sensor ID Code
0x03	Command
0x04/0x05	Heading Data (lsb/msb)
0x06/0x07	Integrated Z Value (lsb/msb)
0x08/0x09	Raw X Value (lsb/msb)
0x0A/0x0B	Raw Y Value (lsb/msb)
0x0C/0x0D	Raw Z Value (lsb/msb)
0x0E/0x0F	Z Axis Offset (lsb/msb)
0x10/0x11	Z Axis Scaling Coefficient (fsb/msb)

Command	Operation	EEPROM Auto-Update
0x00	Normal measurement mode	
0x4E	Null gyro offset and reset Z axis integrator	✓
0x52	Reset Z axis integrator	
0x57	Write EEPROM data	✓

During normal operation the LED will blink briefly at 1Hz. During Null gyro the LED will be on for the period of calibration.

Gyro Null:
Gyro null is entered by setting the command register to 0x4E. The sensor must be kept still for 3 seconds while the sensor calibrates. Once the gyro offset has been measured, the Z axis integrator will be reset to 0 and the command location will reset to 0x00. The Z axis offset field is used to record the offset value and will be automatically recorded in EEPROM.

Gyro Raw Values:
The tree fields X, Y and Z are the unprocessed values being obtained from the sensor element. These values are updated at approximately 760Hz.

Heading Data:
The heading data is obtained by dividing the integrated gyro Z value by 360 yielding a remainder which is then forced to lie between 0° - 359° as the current heading value. If rotated in a CW direction, the value increases from 0°. If rotated in a CCW direction, the value decreases from 359°.

Integrated Z Value:

The integrated gyro Z value returns the current value obtained by integrating the Z axis rate value, adjusted by the Z axis offset continuously. This integrated value can be reset to 0 by issuing command 0x52.

This value can also be used as a signed heading value where CW is in the positive direction and CCW is in the negative direction.

The integrated Z value is subject to scaling based on the Z axis scaling coefficient. This value defaults to 0x0100 which has a binary "decimal point" between bits 7 and 8. Thus the 0x0100 represents a value of 1.0. This value may be adjusted to ensure that a reading of 360° corresponds to one exact revolution of the sensor. The Z axis scaling coefficient must be calculated using the below formula. Once the value is entered into the Z axis scaling coefficient register, a command of 0x57 must be made to the command register to save the value to the EEPROM.

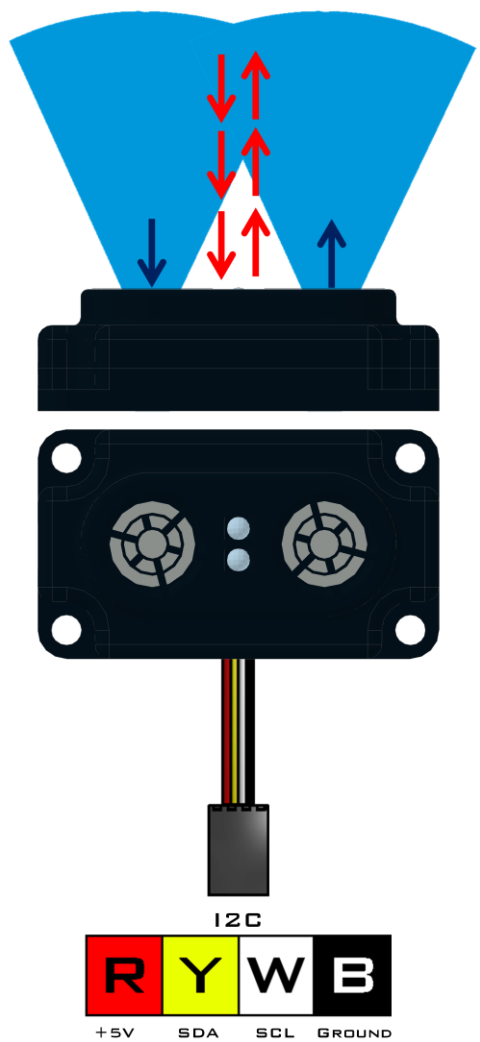
$$\frac{\text{Angle Rotated}}{\text{Heading Value}} \times 256 = \text{scale\_value}$$

4.3. Range Sensor (45-2008)

The Range Sensor combines ultrasonic and optical measuring elements to obtain a reading between 1cm and 255cm. The ultrasonic accurately measures distance to a target up to 255cm away, but it losses accuracy if the object is closer than 5cm. This is where the optical sensor comes into play as it can measure from 1cm out to about 7cm. The target shape and surface material will influence to detectable range.

http://modernroboticsinc.com/range-sensor

Sensor Type: Four Wire I2C Sensor
Default I2C Address: 0x28
Dimensions: 56 x 32 x 17 millimeters
Mounting Holes: 48 x 24 millimeters
Power: 5 volts DC, 20 mA max.
Signal Logic Levels: Logic 0 – 0 volts, Logic 1 – 5 volts
I2C Bus Speed: 100kHz max
I2C Address Change Option: yes



Address	Function
0x00	Sensor Firmware Revision
0x01	Manufacturer Code
0x02	Sensor ID Code
0x03	Not Used
0x04	Ultrasonic reading (cm)
0x05	Optical reading

Ultrasonic:
The ultrasonic element works by one of the transducers emitting a sound wave and the other receiving the sound wave. This reading is accurate between 5cm and approximately 255cm. Since the value returned is in units of centimeters, the return is linear.

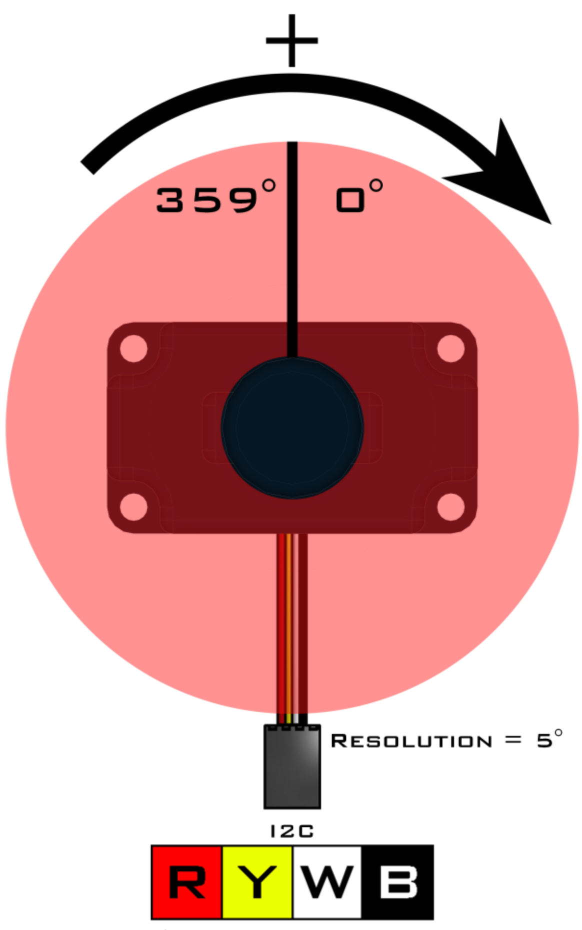
Optical:
The optical element works by emitting infrared light from on LED and receiving infrared light to the other LED. The optical value can detect objects within 15cm. As an object approaches the optical element the returned value will increase at an exponential rate.

4.4. IR Locator 360 (45-2009)

The IR Locator 360 is a 360° infrared detecting sensor. There are 4 IR photo diodes that are arranged to provide an accurate reading of the IR source. The sensor provides 600Hz and 1200Hz readings that produce results at a resolution of 5°.

http://modernroboticsinc.com/ir-locator-360

Sensor Type: Four Wire I2C Sensor
Default I2C Address: 0x1C
Dimensions: 56 x 32 x 31 millimeters
Mounting Holes: 48 x 24 millimeters
Power: 5 volts DC, 20 mA max.
Signal Logic Levels: Logic 0 – 0 volts, Logic 1 – 5 volts
I2C Bus Speed: 100kHz max
I2C Address Change Option: yes



Address	Function
0x00	Sensor Firmware Revision
0x01	Manufacturer Code
0x02	Sensor ID Code
0x03	Not Used
0x04	1200 Hz Heading in 5° increments
0x05	1200 Hz Signal Strength
0x06	600 Hz Heading in 5° increments
0x07	600 Hz Signal Strength

The frequencies are channels that the IR Locator 360 uses to tell the difference between IR emitting sources. Both 600Hz and 1200Hz IR signals may be present at the same time which results in two identifiable IR sources.

Heading:
The heading value is returned in degrees and ranges from 0° to 359° at a resolution of 5°. If an object were to circle the sensor in a clockwise direction, the value of degrees will increase. If the object were to circle in a counter clockwise direction, the value of the heading will decrease.

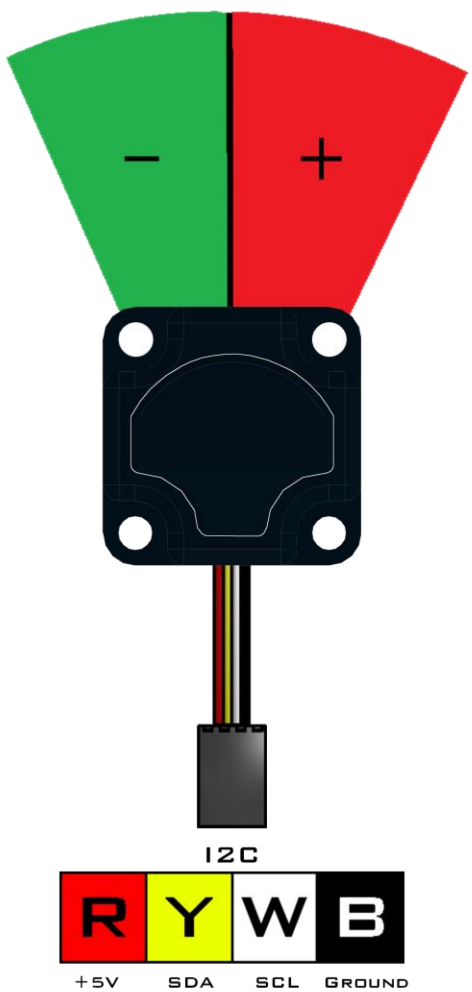
Strength:
The strength value represents the distance of the IR source out to a range of about 3m. When no IR source is detected the value of the strength approaches 0. As an IR source get closer to the sensor the value of the strength goes to 255.

4.5. IR Seeker V3 (45-2017)

The IR Seeker V3 consists of two IR detectors used to locate an IR source and calculate it's heading relative to the front of the sensor. The sensor can read incoming infrared light at 600Hz and 1200Hz. The sensor has a range of 2.75m. It is primarily intended to provide head-on resolution when locating an IR source.

http://modernroboticsinc.com/ir-seeker-v3-2

Sensor Type: Four Wire I2C Sensor
Default I2C Address: 0x38
Dimensions: 32 x 32 x 19 millimeters
Mounting Holes: 24 x 24 millimeters
Power: 5 volts DC, 20 mA max.
Signal Logic Levels: Logic 0 – 0 volts, Logic 1 – 5 volts
I2C Bus Speed: 100kHz max
I2C Address Change Option: yes



Address	Function
0x00	Sensor Firmware Revision
0x01	Manufacturer Code
0x02	Sensor ID Code
0x03	Not Used
0x04	Direction Data – 1200Hz
0x05	Signal Strength – 1200Hz
0x06	Direction Data – 600Hz
0x07	Signal Strength – 600Hz
0x08/0x09	Left Side Raw Data – 1200Hz (lsb/msb)
0x0A/0x0B	Right Side Raw Data – 1200Hz (lsb/msb)
0x0C/0x0D	Left Side Raw Data – 600Hz (lsb/msb)
0x0E/0x0F	Right Side Raw Data – 600Hz (lsb/msb)

The frequencies are channels that the IR Seeker V3 uses to tell the difference between IR emitting sources. Both 600Hz and 1200Hz IR signals may be present at the same time which results in two identifiable IR sources.

Heading:
The heading value gives an indication of the source direction. If the value is negative, then the source is to the left of center. If the value is positive, then the source is to the right of center. The magnitude of the values gives an indication of how far off the axis the source is. If the value is zero, then the source is in the center of the field of view.

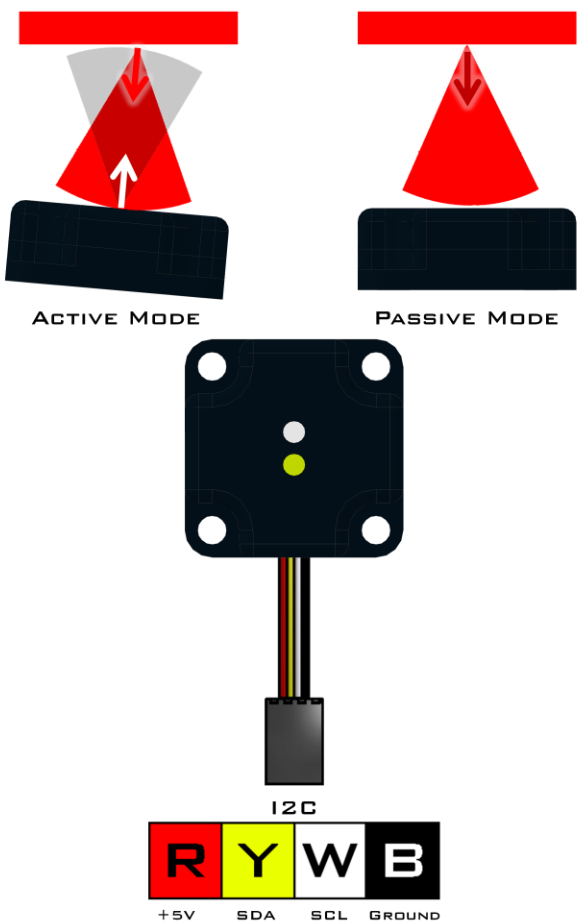
Strength:
The strength value represents the magnitude of the receive signal. If this value is set to 0, it means that not enough IR signal is available to estimate the heading value. The value of the strength will increase as an IR source approaches the sensor.

4.6. Color Sensor (45-2018)

The Color Sensor is used to read the color of an object and returns a handful of useful data using a red/green/blue reading. This data includes a color number that corresponds to the color line in the documentation, as well as raw and adjusted readings. The material of the surface being read and the ambient light in the room will affect the results. Therefore the Color Sensor should be recalibrated for different environments. This sensor has a maximum distance of 7cm.

http://modernroboticsinc.com/color-sensor

Sensor Type: Four Wire I2C Sensor
Default I2C Address: 0x3C
Dimensions: 32 x 32 x 11 millimeters
Mounting Holes: 24 x 24 millimeters
Power: 5 volts DC, 20 mA max.
Signal Logic Levels: Logic 0 – 0 volts, Logic 1 – 5 volts
I2C Bus Speed: 100kHz max
I2C Address Change Option: yes



Address	Function
0x00	Sensor Firmware Revision
0x01	Manufacturer Code
0x02	Sensor ID Code
0x03	Command
0x04	Color Number
0x05	Red Value
0x06	Green Value
0x07	Blue Value
0x08	White Value
0x09	Color Index Number
0x0A	Red Index
0x0B	Green Index
0x0C	Blue Index
0x0D	Undefined
0x0E/0x0F	Red Reading (lsb/msb)
0x10/0x11	Green Reading (lsb/msb)
0x12/0x13	Blue Reading (lsb/msb)
0x14/0x15	White Reading (lsb/msb)
0x16/0x17	Normalized Red Reading (lsb/msb)
0x18/0x19	Normalized Green Reading (lsb/msb)
0x1A/0x1B	Normalized Blue Reading (lsb/msb)
0x1C/0x1D	Normalized White Reading (lsb/msb)

Command	Operation	EEPROM Auto-Update
0x00	Active Mode (LED ON)	✓
0x01	Passive Mode (LED OFF)	✓
0x35	50Hz Operating Frequency	✓
0x36	60Hz Operating Frequency	✓
0x42	Black Level Calibration	✓
0x43	White Balance Calibration	✓

Commands:

The command register may be set to any of the values from the command table. Once a command value is entered into the command register the value will be saved in the EEPROM.

Active Measurement Mode

Command = 0x00

In active measurement mode, the sensor takes a reading by illuminating a surface with a white LED and measuring the reflected light. Active mode is useful in identifying the color of a surface.

Passive Measurement Mode

Command = 0x01

In passive measurement mode, the sensor takes a reading without the white LED on. Therefore passive measurement mode is most useful in determining the color of a light source like an LED.

Operating Frequency

Command = 0x35(50Hz) or 0x36(60Hz)

The operating frequency is provided to enable the sampling to coincide with the normal flickering associated with artificial lighting. This helps to reduce signal noise and other issues. The operating frequency can be set to 50Hz or 60Hz.

Black Level Calibration

Command = 0x42

Black level calibration will run 64 measurement cycles to obtain an average value for each of the 3 color channels.

During black level calibration, the sensor should be placed such that no surface is within 1.5m forward of the sensor elements. The calibration process last about 1.5 seconds and when calibration is complete, the LED will blink briefly and then the command register will be reset to 0x00 or 0x01 depending on the mode save in EEPROM.

Black level calibration must be completed before white balance calibration.

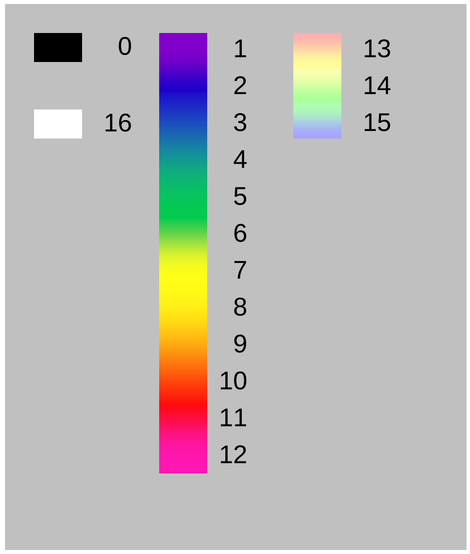
White Balance Calibration

Command = 0x43

White balance calibration will run 64 measurement cycles to obtain and average value for each of the 3 color channels and are adjusted according to the black level calibration values.

During white balance calibration, the sensor must be placed approximately 5cm (2in) from a white target. The target must be very white and not allow light to pass through the material. At least 3 sheets of high quality copy paper will make a satisfactory white surface for calibration. The calibration process last about 1.5 seconds and when calibration is complete, the LED will blink briefly and then the command register will be reset to 0x00 or 0x01 depending on the mode save in EEPROM.

Color Number:
The color number register returns a single number representing the color estimate. The number corresponds to the following figure.



Color Values:
The color values are returned separately as red, green, blue and white. The color value is a measure of the current detection levels for each primary color.

Color Index Number:
The color index number is a single 6 bit number. Bits (5:4) encode the red signal level, bits (3:2) encode the green signal level and bits (1:0) encode the blue signal levels.

D7	*D6*	*D5*	*D4*	*D3*	*D2*	*D1*	*D0*
0	*0*	*Red 1*	*Red 0*	*Green 1*	*Green 0*	*Blue 1*	*Blue 0*

Color Indexes:
The color index will return the current analog signal levels for red, green and blue separately. The color with the greatest intensity is set as 0xFF while the other two colors indexes are set as a proportion of 0xFF.

Color Readings:
The color reading registers return the current analog signal levels as 16 bits values for red, green, blue and white.

Color Normalized Readings:
The color normalized readings will return the current levels for the color components and white channel that are adjusted for gain and offset.

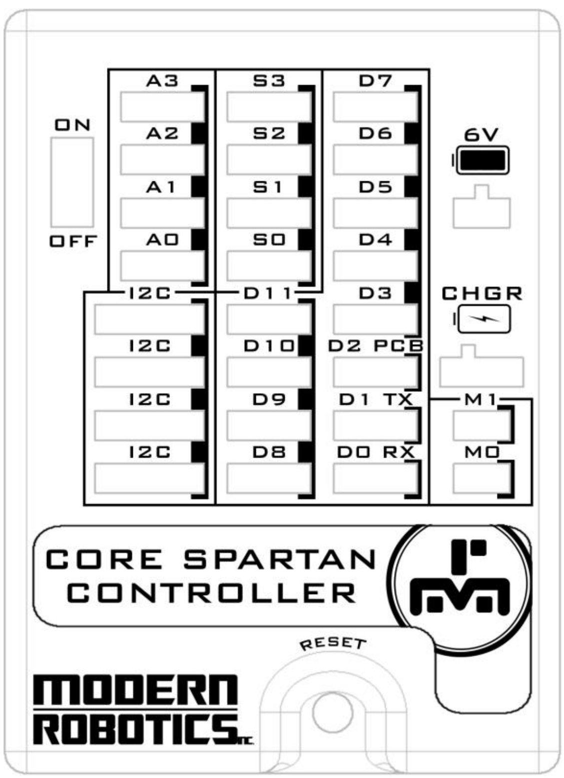
5. Controllers

Modern Robotics sensors are designed to be used on multiple control devices like the Core Spartan Controller or Core Device Interface Module. The sensors may also be used on any Arduino board, Raspberry Pi, BeagleBone as well as most other types of microcontrollers or embedded systems.

5.1. Core Spartan Controller (45-2000)

The Core Spartan Controller makes it easy to connect, control, and program your robot with the use of the Arduino IDE. The Core Spartan Controller is designed to control sensors, servos and motors. The Core Spartan Library must be installed on your computer to have access to all the available functions that are used in controlling the Core Spartan Controller and its sensors. The board's primary use is with the Spartan Robot; however, it can be used as a standalone microcontroller. There are twelve digital ports, four analog ports and four I2C ports for use with external sensors. The Core Spartan Controller also supports DC motors and servos by providing two motor ports and four servo ports. The Core Spartan Controller can be powered by USB for processing and sensors. The main power supply is a 6V 2200mAh NiMH rechargeable battery that can power the board, sensors, servos and motors.

http://modernroboticsinc.com/core-spartan-controller



5.2. Core Device Interface Module (45-2001)

The Core Device Interface Module (CDI) connects external sensors and other devices to an Android device or PC. With a total of 26 ports are divided into five general classes: Digital Input/Output, Analog Input, Analog Output, PWM and I2C. The CDI gives a convenient way to attach a wide range of Modern Robotics sensors or home brewed devices to control your world. The CDI enables the host Android or PC programs to independently access each connected device.

http://modernroboticsinc.com/core-device-interface-module-2