

Hookup guide for Line Follower Array

- **Introduction:**

The Line Follower Array is an array of eight IR sensors (**QRE1113**) that are configured and read as digital bits. We have designed the Line Follower Arrays to follow a dark line of about **18mm** width or smaller on a light background. This product is designed as an add-on for any robot. The array features visible LEDs, so you can see what the robot sees, with brightness control right on the board, and an I2C interface for reading and power control.

- **Features:**

1. 8 sensor eyes ([QRE1113](#))
2. [I2C](#) interface
3. Adjust IR brightness on the fly with a knob
4. Switch IR on and off with software
5. Switch visual indicators on and off with software
6. Invert dark/light sight with software
7. Based on the [MCP23017 I/O Expander](#).

- **Hardware Overview:**

The Line Follower Array PCB has few points to be noted.

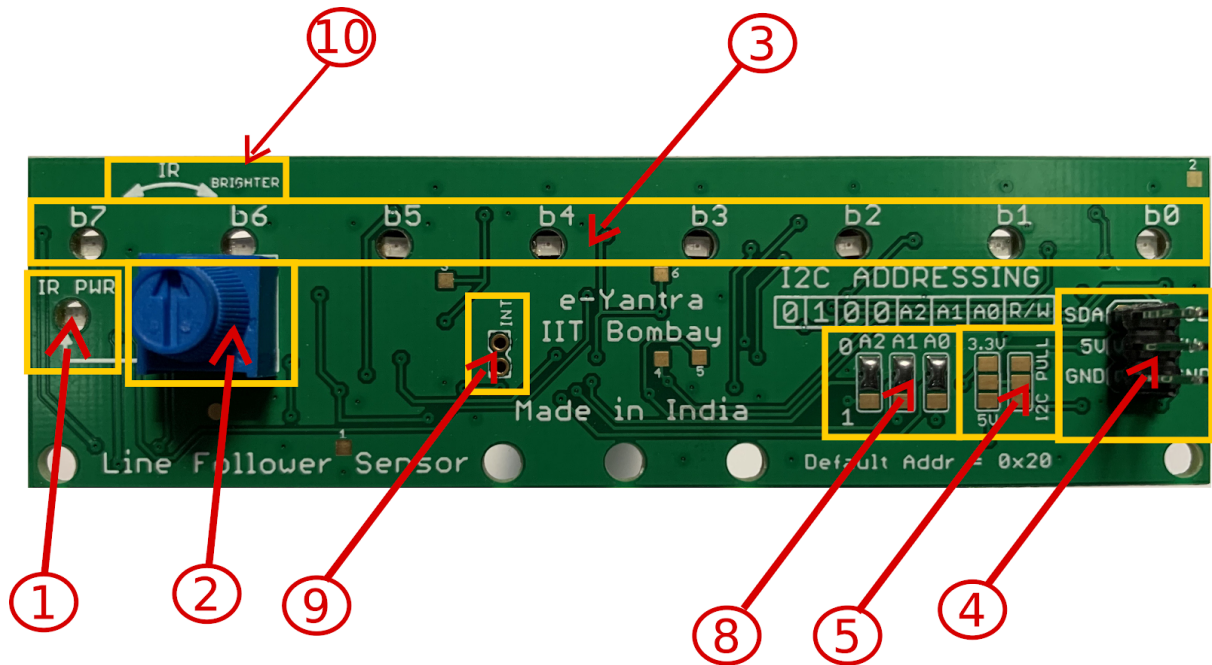


Fig.1: Top Side

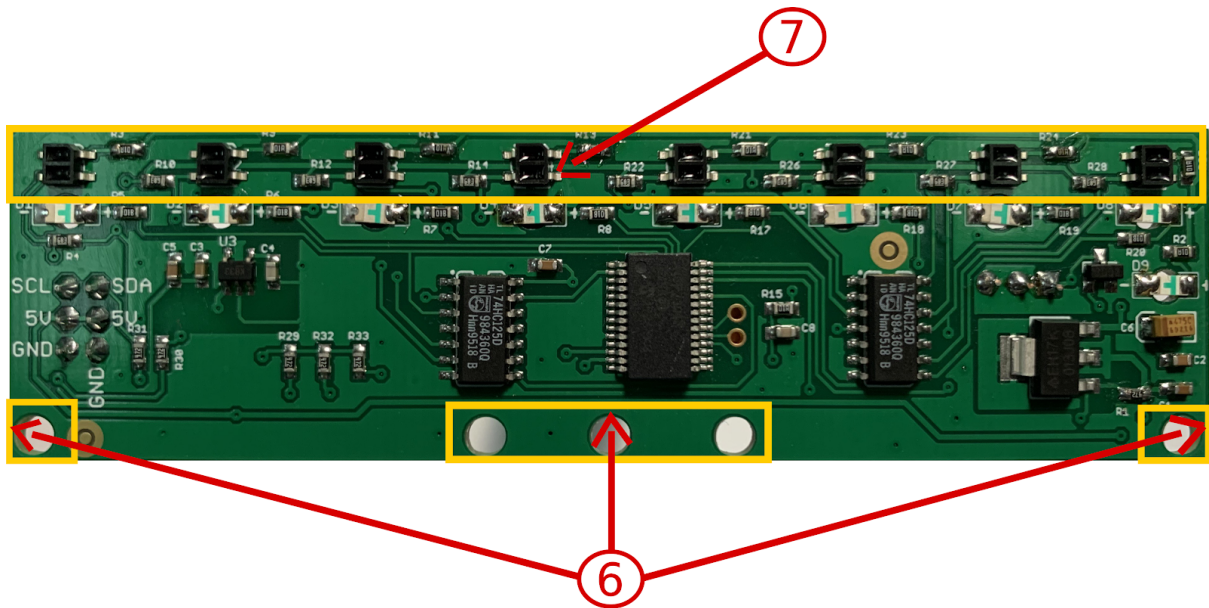


Fig.2 : Bottom Side

1. **IR brightness indicator** : The IR PWR led shows the strength of the IR LEDs. More brightness, more the IR emission.
2. **IR brightness control** : The potentiometer is used to change the brightness of IR LEDs, Knob direction is given on PCB(refer Fig.1 “10”) for IR brightness control.
3. **IR Led status indicator** : There are total 8 Sensor eyes which has there own status indicator named from b0 to b7, (i.e. This LEDs helps user to know which Sensor eye is picking up black surface and other white surface).
4. **Digital interface** : Described in the Connections with Controller.
5. **I2C pull option jumper** : By default it is left unconnected as the provided eYFI-Mega board has its I2C lines pulled up to 5V. If interfaced with some other development board depending on its nominal voltage the I2C lines has to be pulled up to 3.3V or 5V. See Setting the Jumpers.
6. **Mounting holes** : These holes are provided for mounting the Line Follower Array as an add-on module on robot. Here standard M3 holes screw can be used.
7. **The IR transducers(Sensor eye)** : These emit and detect IR radiation.
8. **I2C address selection** : Here the Line Follower Array comes with its default address **0x20**, this particular sensor can be configured to have 8(eight) different I2C addresses which can be set using Solder joints in accordance with the table given on PCB to set desired address. [Refer MCP23017 for more info](#)
9. **Interrupt Configuration** : Interrupt output for PORTA/PORTB of MCP23017 .

- **Electrical Specifications**

Parameter	Min	Typ	Max	Unit
Supply Voltage	4.5	5	5.5	V
Supply Current	50	--	200	mA

- **Setting the Jumpers**

The Line Follower Array has two configurable options: **I2C address** and **I2C pull-up voltage**.

- 1. I2C address**

The MCP23017 is a slave I2C interface device that supports 7-bit slave addressing, with the read/write bit filling out the control byte. The slave address contains four fixed bits and three user-defined hardware address bits (pins A2, A1 and A0). If you need to change the address of the Line Follower Array, move the solder jumper to set A0, A1 and A2 as indicated in Fig.3. The table on Top Side of PCB "I2C ADDRESSING" gives the reference of same(refer Fig. 3). As given on the silk screen(Top side of PCB), the default address is 0x20. For example, if you want to use address 0x26, move A2, A1 to the '1' position and leave A0 at '0'.

Note : I2C Address is only of 7 bits the **R/W** bit is not to be considered for address formation.

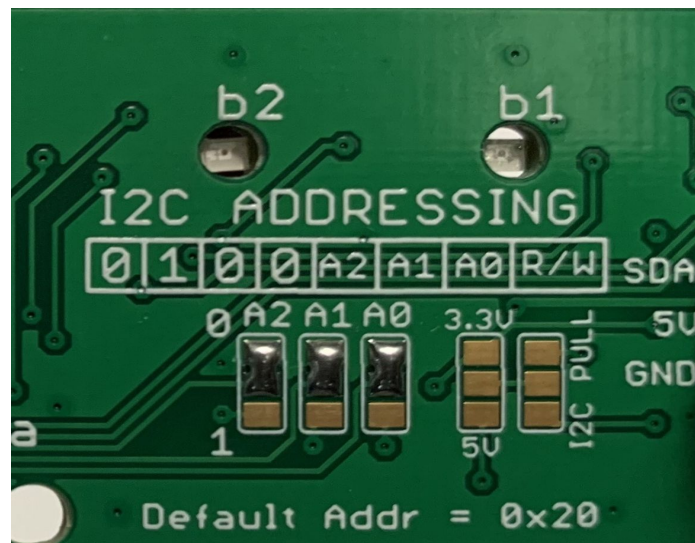


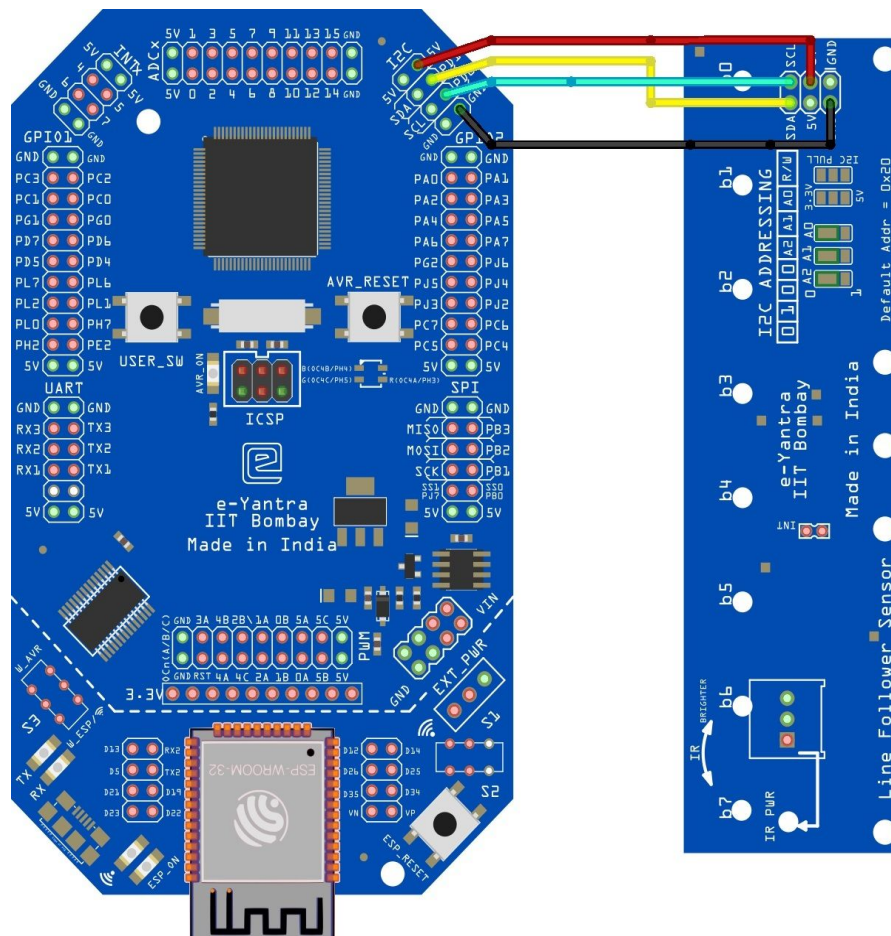
Fig.3: I2C Addressing

2. I2C pull-up voltage

By Default it is left unconnected as the provided eYFi-Mega board has its I2C lines pulled up to 5V. If interfaced with some other development board depending on its presence of I2C pull up resistor and nominal voltage, the I2C lines has to be pulled up to 3.3V or 5V. To do so, add a solder jumper to the "3.3V/5V" side and short all the three pads of I2C pull with solder jumper.

- Connections with Controller

Signal/Description	Line Follower array	eYFi-Mega
Power	5V	5V
Ground	GND	GND
I2C Data	SDA	SDA/PD1
I2C Clock	SCL	SCL/PD0



- **Setting the Brightness**

The knob (refer Fig.1 “2”) on the sensor array is used to set the brightness of the sensor eye (IR LEDs). Because human naked eyes can't see IR, the "IR PWR" LED is provided to give feedback for how bright LEDs are operating, and to indicate that the regulator is functioning.

Follow these four steps to configure the Sensor eye (IR brightness):

Step 1 : Place the Line Follower Array at a particular height (close to ground) with black strip underneath (black strip approx 1 - 1.5cm)

Step 2 : Turn the brightness down to the lowest using Knob present on Line Follower Array and observe that all the LEDs are turned ON. (refer Fig.4)

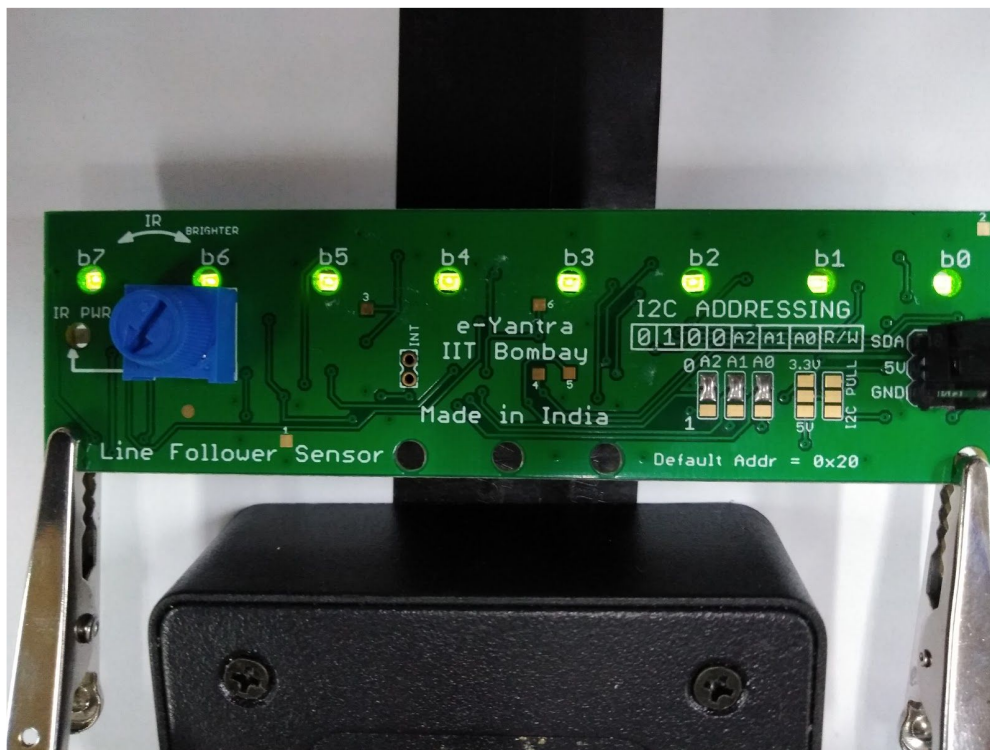


Fig.4: All LEDs are turned ON

Step 3 : Turn the brightness up, so that light area (white surface) LEDs starts turning OFF and only Dark area LEDs are ON.(refer Fig. 5)

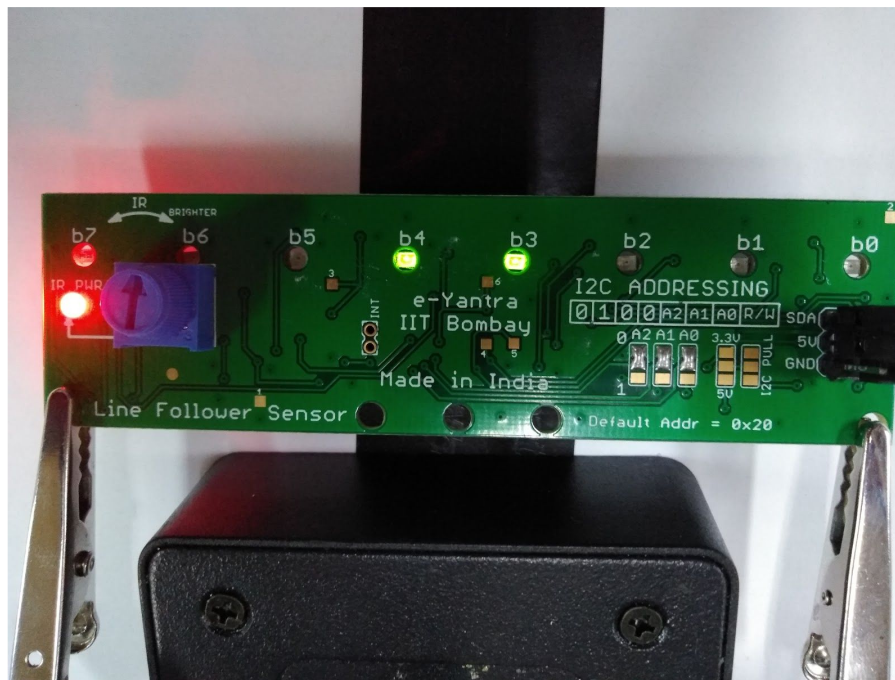


Fig.5: Dark area LEDS are ON

Step 4 : Set the brightness a little higher than **Step 3** (Setting it too high might result in improper calibration and reading will change). It's done the sensor is now calibrated for that particular height.

- **Important insights of LFA HARDWARE**

1. The Line Follower Array is based on I2C Protocol, which means it will communicate with the outside world through its SDA/SCL lines.
2. To do so the MCP23017 is used as an I/O Expander. MCP23017 has 2 Eight bit ports named as GPA/GPB.
3. As mentioned in Hardware Overview, LFA has 8 sensor eyes whose output is connected to GPA port of MCP23017. (**HINT**: To get the reading of sensor eye we have to configure GPA port as INPUT).
4. LFA also has a buffer IC (74HC125) which acts as a bridge between the eight Sensor eyes and MCP23017. This bridge is controlled by **GPB.1** pin of MCP23017

(**HINT**: To make a connection between sensor eye and MCP23017 set the **GPB.1** pin as an OUTPUT and set it to logic Low(0)).

5. LFA reading(output) is a single 8 bit word where each bit represents an IR sensor, Where b0 resembles the LSB and b7 resembles the MSB. If the IR Led status indicator show: ON, ON, ON, ON, ON, ON, ON, ON, the output will be 255(in decimal system).

Referring to Fig. 4, IR Led status indicator shows: ON, ON, ON, ON, ON, ON, ON, ON, the output will be 255 (in decimal system) or 0xFF (in Hex system).

Referring to Fig. 5, IR Led status indicator shows: OFF, OFF, OFF, ON, ON, OFF, OFF, OFF, the output will be 24 (in decimal system) or 0x18 (in Hex system).

Let's look at a few more examples:

- 1) If the IR Led status indicator show: OFF, ON, ON, ON, ON, ON, ON, ON, the output will be 127 (in decimal system).
- 2) If the IR Led status indicator show: OFF, OFF, OFF, ON, ON, OFF, OFF, OFF, the output will be 24 (in decimal system).

Note : Always set **GPB.0** as OUTPUT and set it to logic Low(0).

Revision History

Date	Version	Release notes
December 14, 2019	v0.1	First release of the document
December 16, 2019	v0.2	Updated the “ Important insights of LFA HARDWARE ” Section. GPB.2 Changed to GPB.1 & GPB.1 Changed to GPB.0