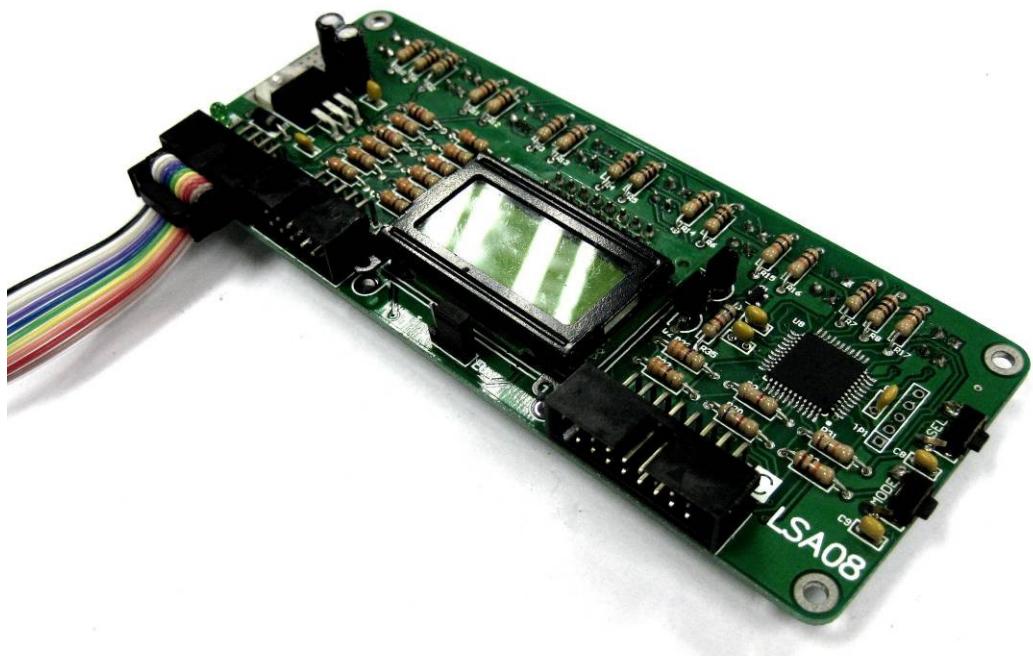




Advance Line Following Sensor Bar LSA08



User's Manual

V1.0

September 2011

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1. INTRODUCTION AND OVERVIEW

LSA08 (Advance Line Following Sensor Bar) consist of 8 IR transmitter and IR receiver pairs. LSA08 is typically used for embedded system or robots for line following task. LSA08 can detect any color of line which has brightness different with the background.

The IR transmitters on LSA08 are pulsed to allow the transmitter to off at certain idle period of sensor. This minimizes the current consumption of LSA08 to at least half of the current consumption compared to a normal unregulated IR line sensor. Power polarity protection is available on LSA08 in case the user accidentally applies a reverse voltage.

LSA08 has several different output modes, for the convenience of use for any system. Namely, the digital output port (8 parallel output line), the serial communication port (UART) and the analog output port.

Output	Description
Digital Port	8 bits for 8 sensors
UART	Retrieve digital value, line position or sensor raw value
Analog	Position value in the form of analog voltage.

LCD on the LSA08 displays the different menu for setting up the operation setting.

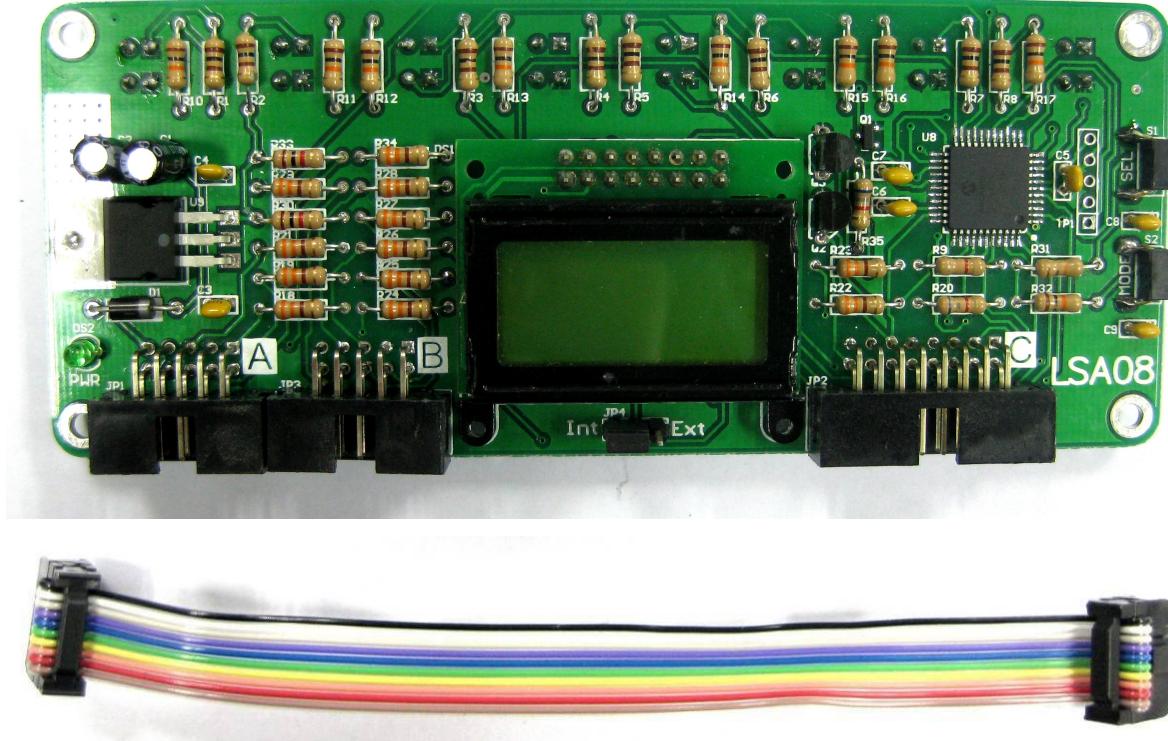
LSA08 have 8 digital outputs to user indicating the existence of the line. The dark and bright value of the line and background will be saved to non-volatile memory when the user calibrate the sensor to the surface that it will recognize. The line existence threshold is set by the Threshold menu of the sensor. Each sensor of the 8 sensors on LSA08 is independent of each other. The refreshing rate of the sensors is more than 100Hz.

LSA08 has a manual mode and select button. User can choose different mode/settings using MODE button and SEL button to enter the mode/settings.

Note: Red color is very bright to IR sensor, thus LSA08 has difficulties in red – white pair color line follow.

2. PACKING LIST

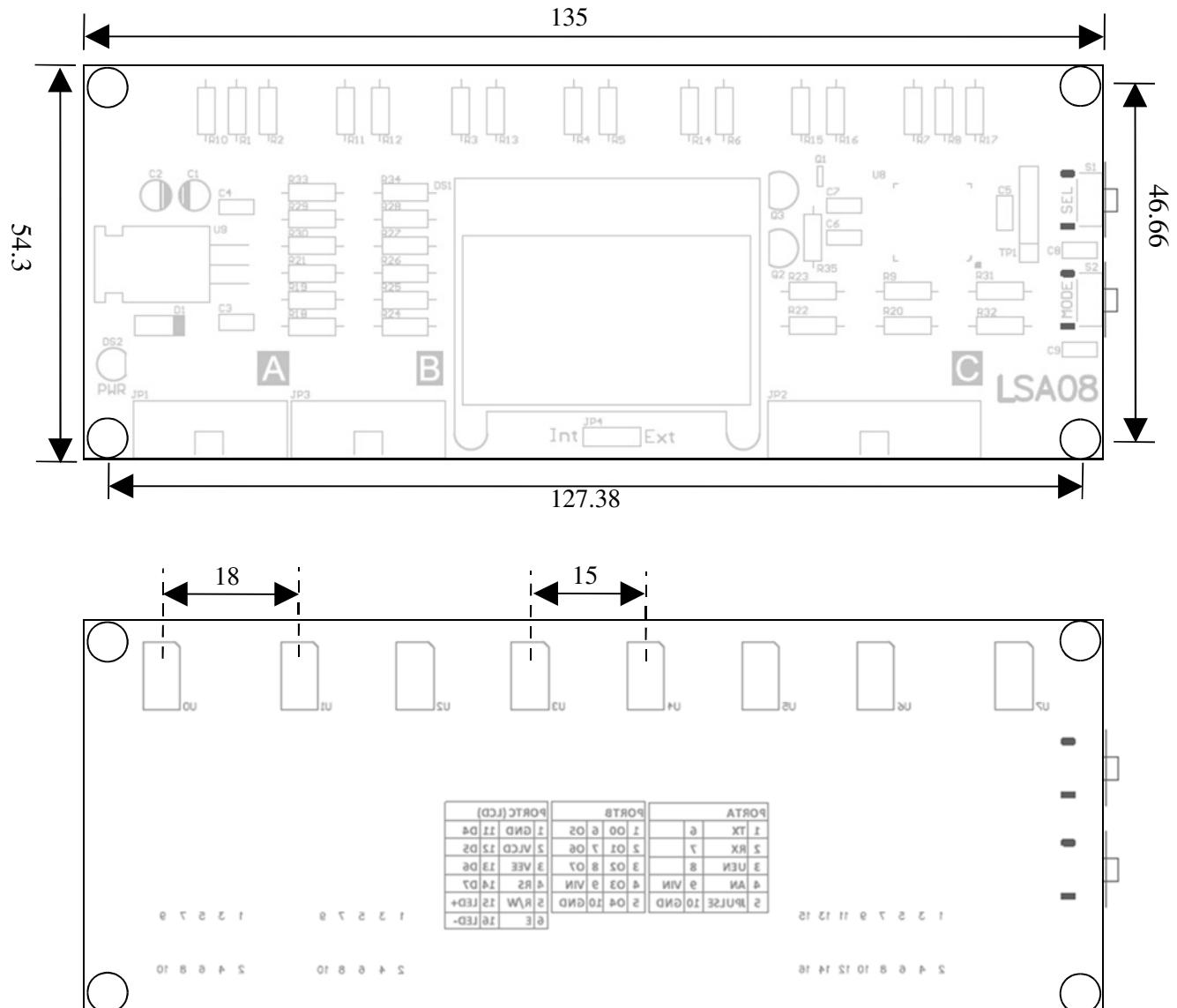
Please check the parts and components according to the packing list. If there is any part missing, please contact us at sales@cytron.com.my immediately.



1. LSA08 PCB with every component soldered properly.
2. LSA08 cable connector

3. PRODUCT SPECIFICATION AND LIMITATIONS

Dimensions



Electrical Specifications

Parameter	Min	Typical	Maximum	Unit
IR Emission (peak wavelength)		940		nm
Input signal, V _{IH}	2		5	V
Input signal, V _{IL}	0		0.8	V
Output Signal			5	V

Absolute Maximum Rating

Parameter	Minimum	Typical	Maximum	Unit
Operating voltage	7.5	12		V
Maximum Current (I/O signal pins)			20	mA
Sensing distance (from board)	1	3	5	cm

LSA08 Setting Menu:

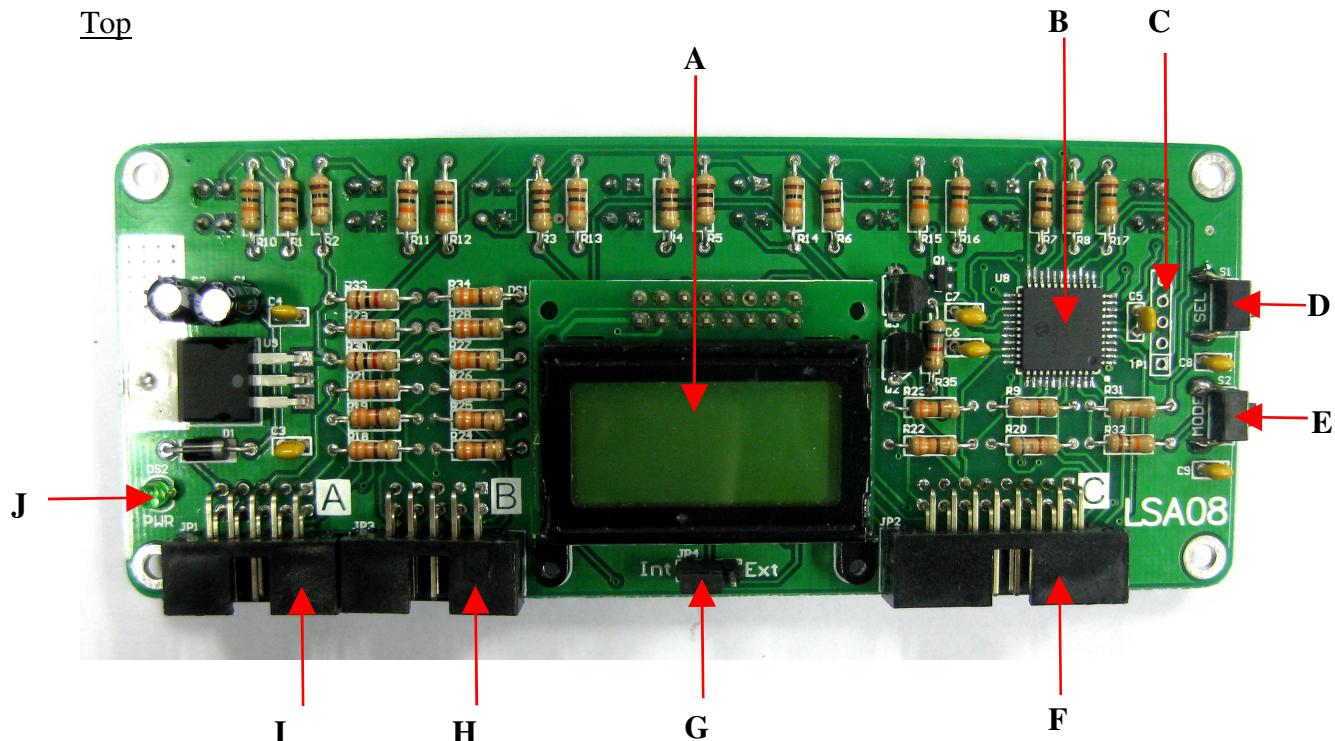
Menu	Description
LCD Contrast (LCD CON)	Setting the contrast of LCD
Calibration (CALB)	Calibrate LSA08 to the colour brightness of the line and background
Line Mode (LINEMODE)	Setting LSA08 to be Dark On (for dark line and bright background) or Light On (for bright line and dark background)
Threshold (THRES)	
Offset (OFFSET)	Maximum and minimum reading of sensor adjustment to eliminate small fluctuation on the bar chart. (set to zero if not used)
Junction Width (J WIDTH)	Junction width, the number of bar chart on LCD for LSA08 to treat it as a junction crossing.
UART Address (UART ADD)	Unique UART address for the LSA08.
UART Baudrate (BAUDRATE)	Setting the baudrate of the UART Communication
UART Mode (UARTMODE)	Setting the UART output mode
LCD Backlight (LCD B/L)	Setting the LCD backlight brightness
Exit (EXIT)	Exit menu
Exit Menu shortcut	Press and hold Mode button on any main menu will exit the menu

LSA08 default setting

Menu	Default setting
Line Mode	Dark On
Thres	2
Offset	0
J_width	5
Uart Add	1
Baudrate	0
Uart Mode	0
LCD BL	6

4. BOARD OR PRODUCT LAYOUT

Top



Label	Function	Label	Function
A	2x8 LCD display	F	Port C (External LCD port)
B	PIC16F1937	G	LCD Selector
C	Manufacturing Test Points	H	Port B (Digital port)
D	SEL button	I	Port A (Analog and UART port)
E	MODE button	J	PWR LED

A – 2x8 LCD display to display the different menu for setting up the operation setting.

B – PIC16F1937 PIC microcontroller for data processing.

C – It is reserved for Manufacturing Test Point. Please **DO NOT** short or connect wire to any of these pins.

D – SEL button is use to select modes or setting.

E – MODE button is use to enter different modes/setting.

F – Port C is provided for external LCD port.

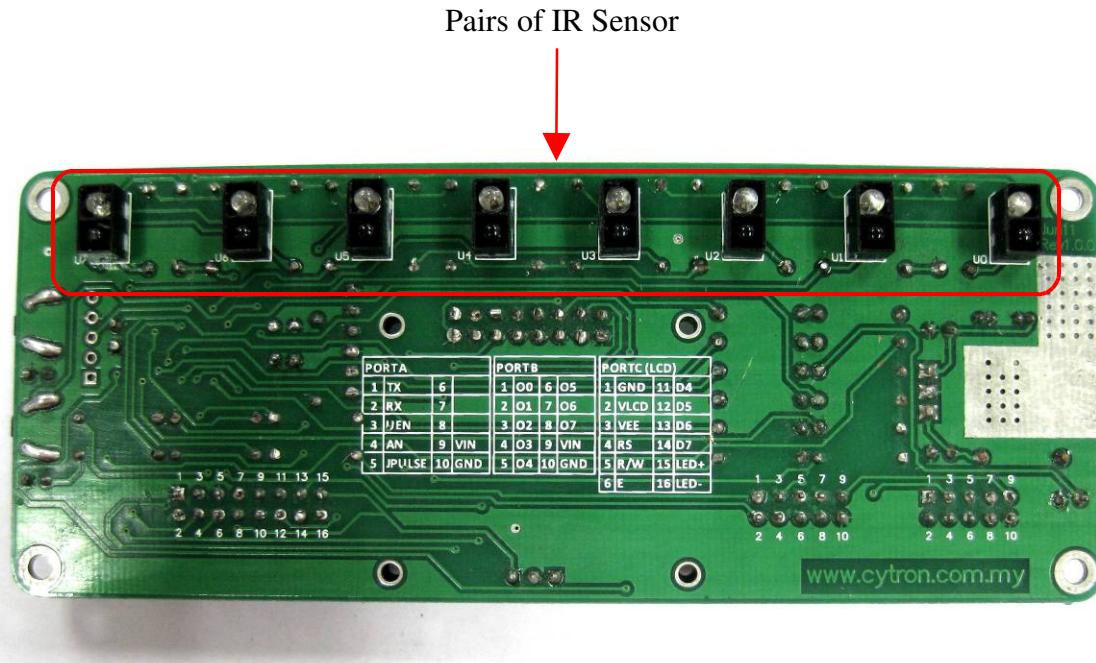
G – LCD selector to select either internal or external LCD used. A jumper needs to be set to Ext for the External LCD to operate.

H – Port B provided for digital output port.

I – Port A provided for analog and UART port.

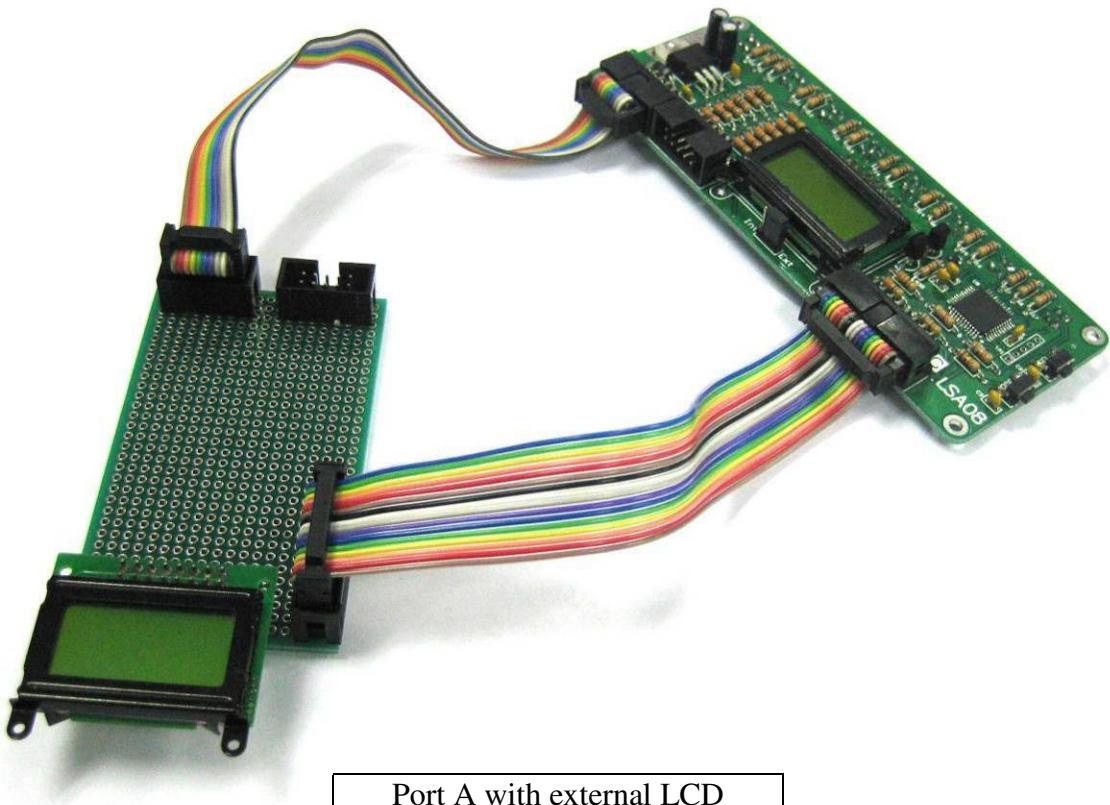
J – Power indicator LED (green) showing the board is supplied with power. Maximum input power is 5V.

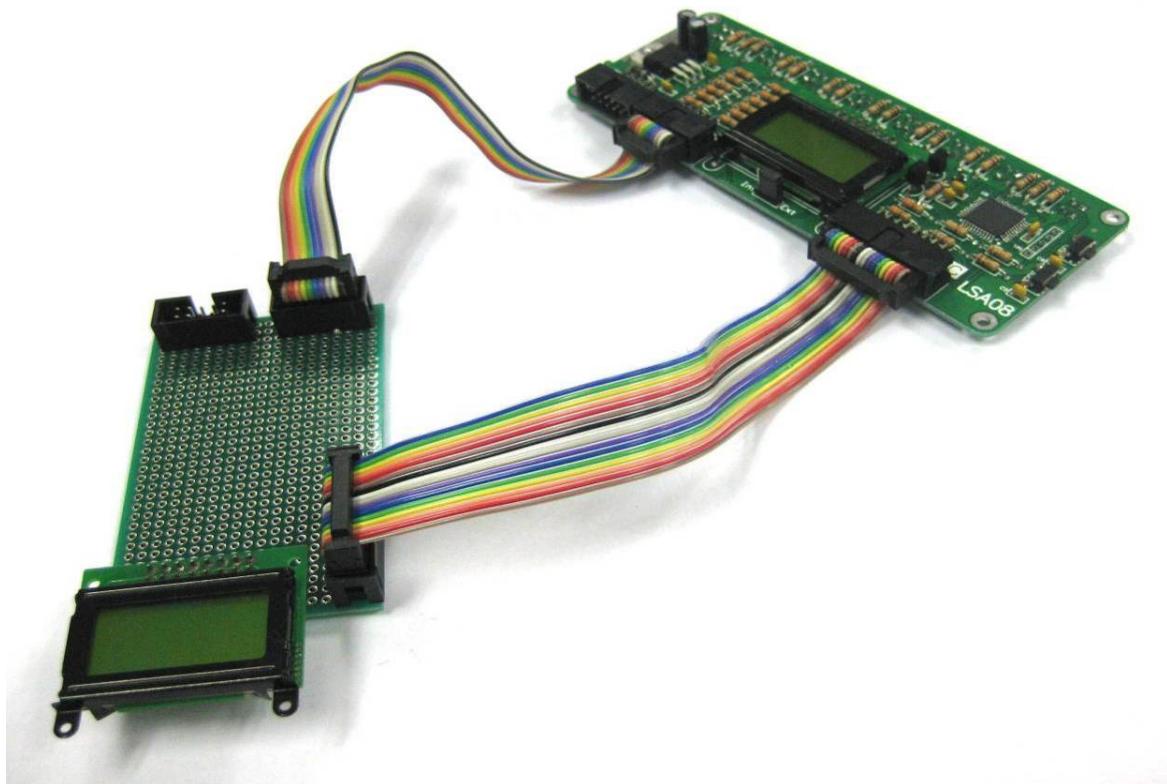
Bottom



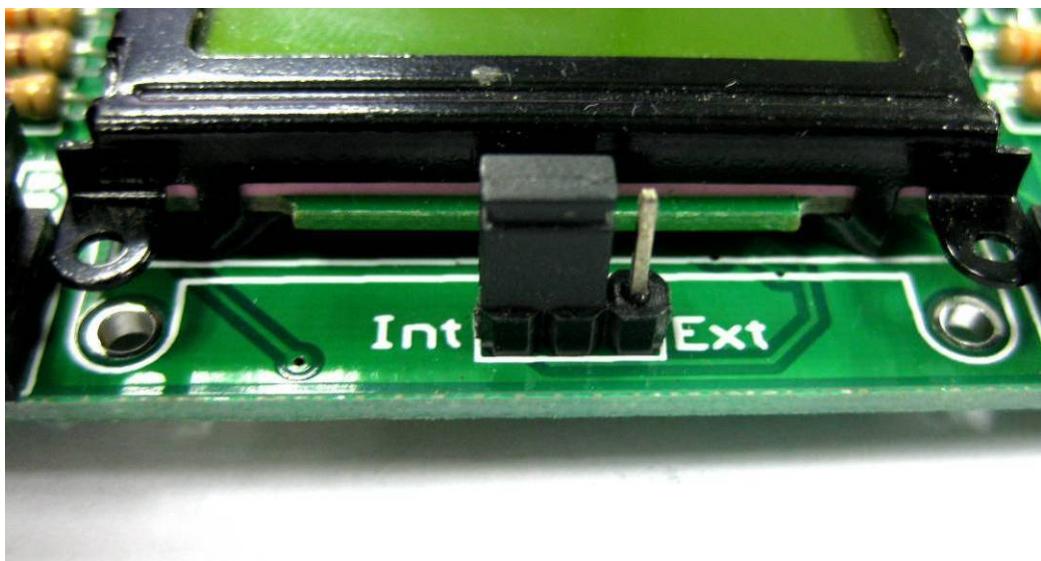
5. INSTALLATION (HARDWARE)

LSA8 has its power from Vin and Gnd pin of PORT A and PORT B. Vin voltage is 12V. The picture below is an example of hardware connection setup for LSA08. User may use either PORT A or PORT B or both PORTS at the same time. If PORT C is used for the external LCD, please ensure that mini jumper is set to “Ext” at JP4.

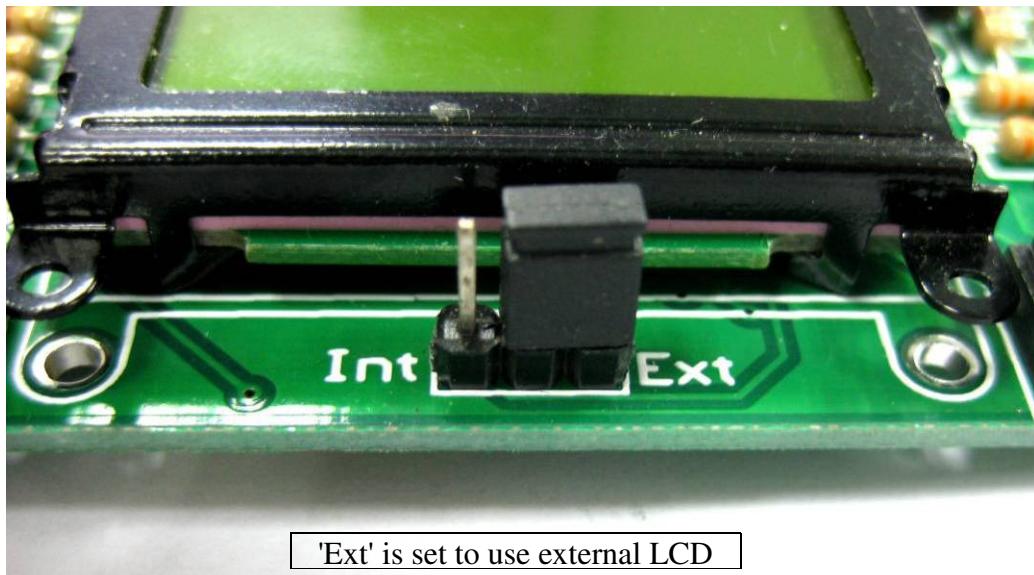




Port B with external LCD

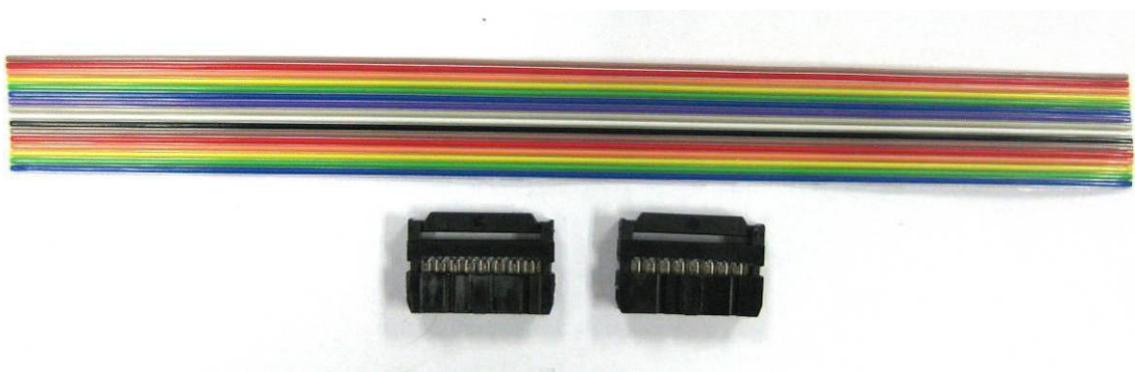


'Int' is set to use internal LCD



Cable connector for PORT C is not included in LSA08 packing list. Users need to create the cable if needed. Below are the steps to create cable for PORT C using rainbow cable.

The items that user needs to create the cable are:

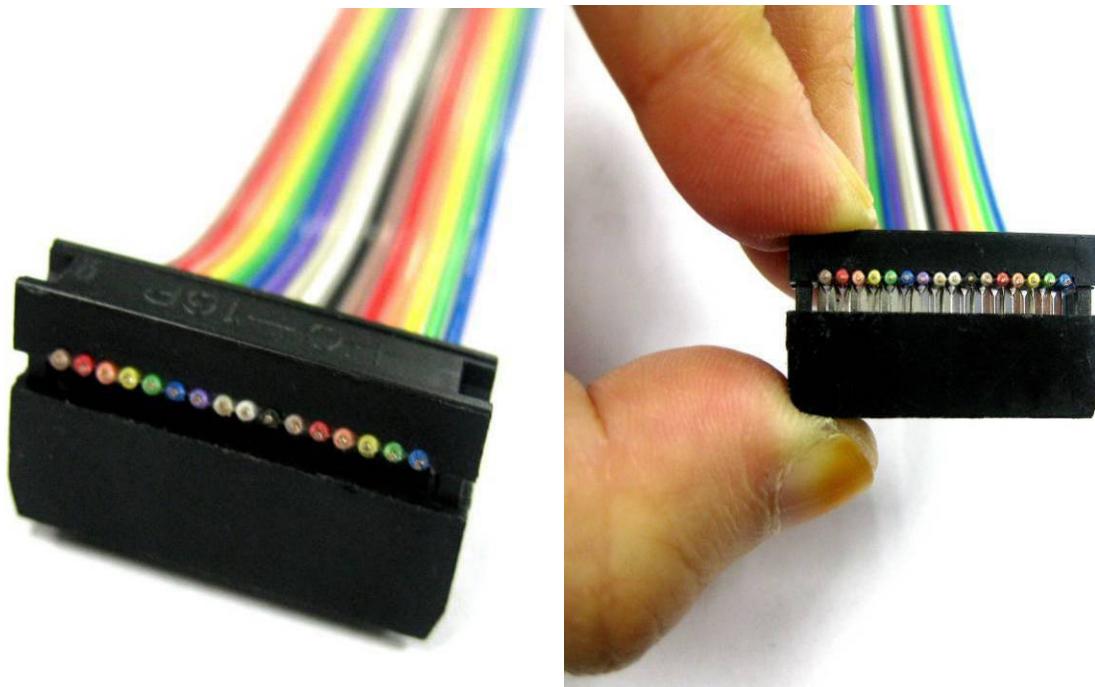


- Rainbow cable
- 2x 16 ways IDC Socket

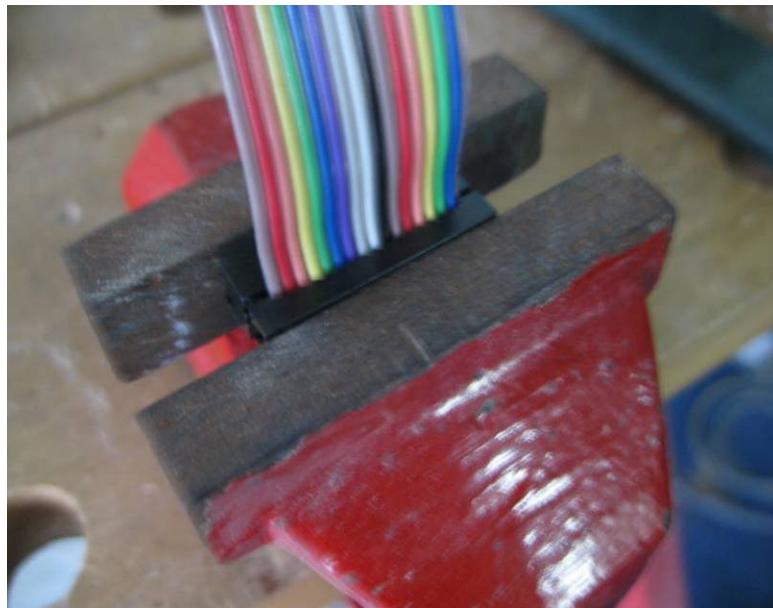
- a) Remove the clip from IDC socket



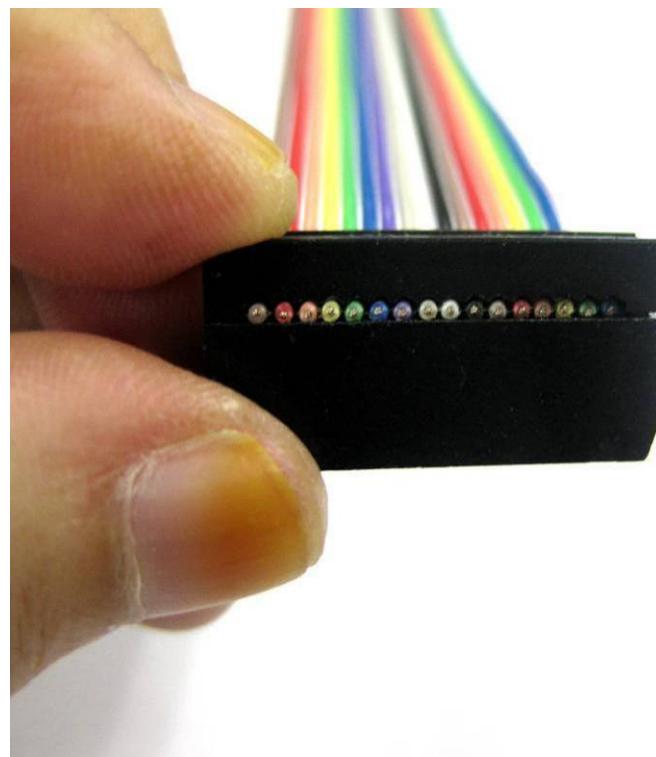
- b) Insert rainbow cable into IDC socket shown as figure below.



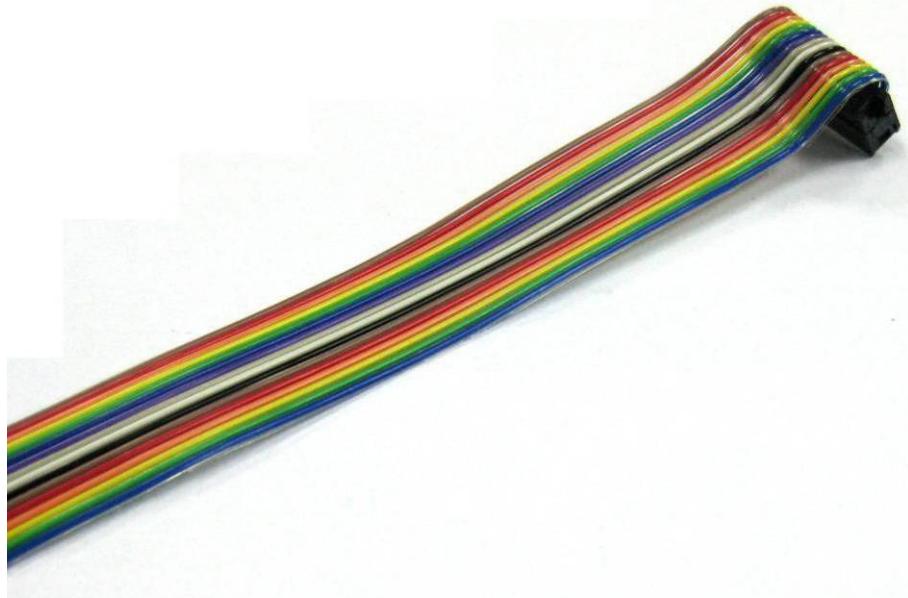
- c) Clamp the rainbow cable to IDC socket using clamper.



- d) Figure above shows the rainbow cable with connector after clamp by the clamper.



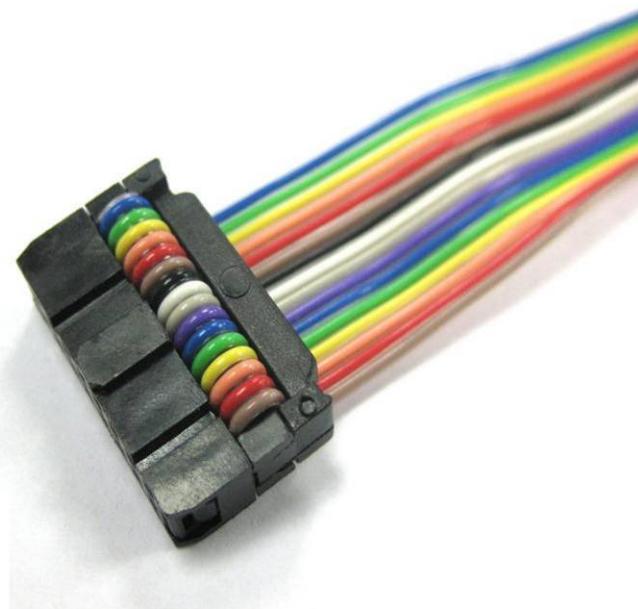
- e) The rainbow cable is fold to front as show in figure below.



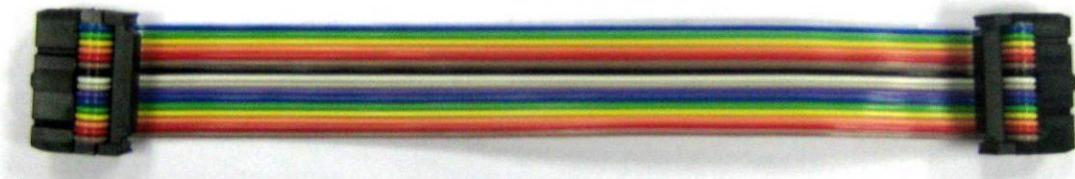
f) The last step is to plug on the clipper to the connector.



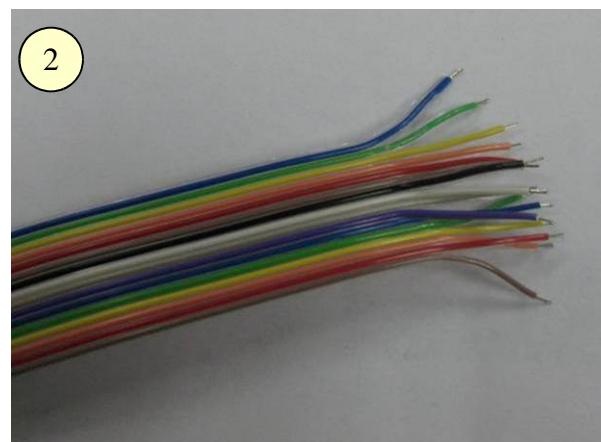
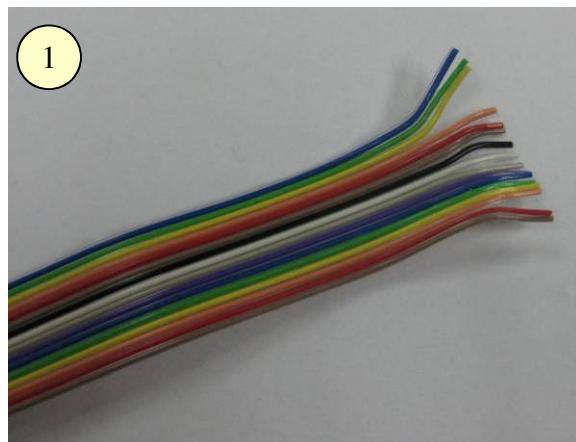
g) Figure below show the completed cable with IDC socket.

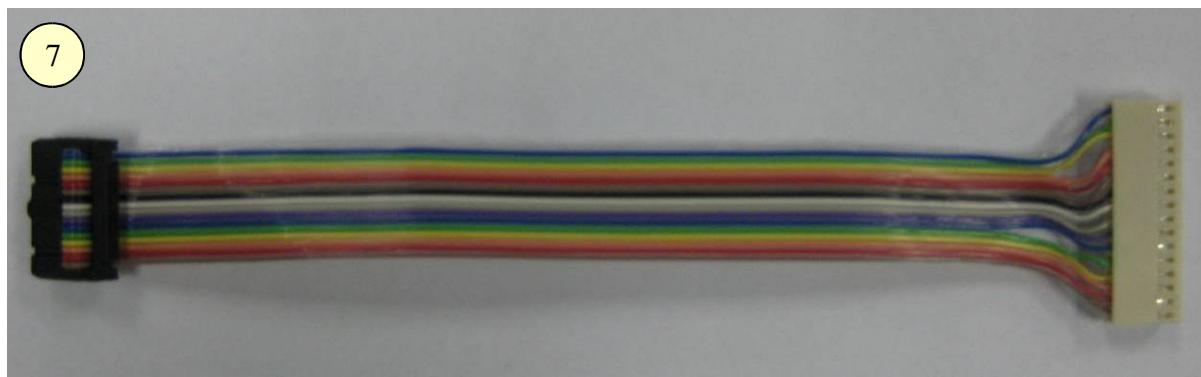
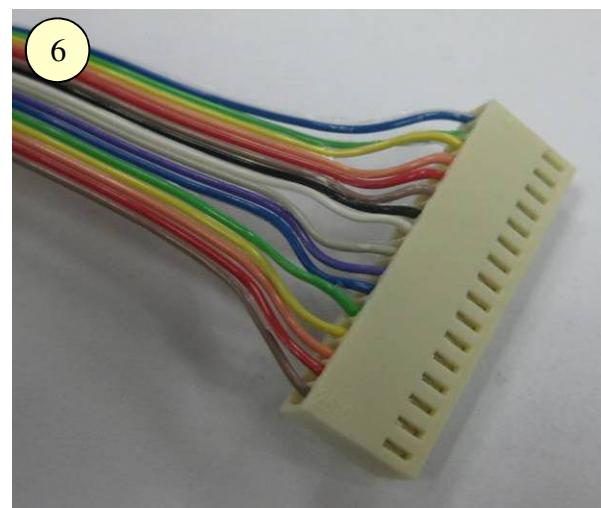
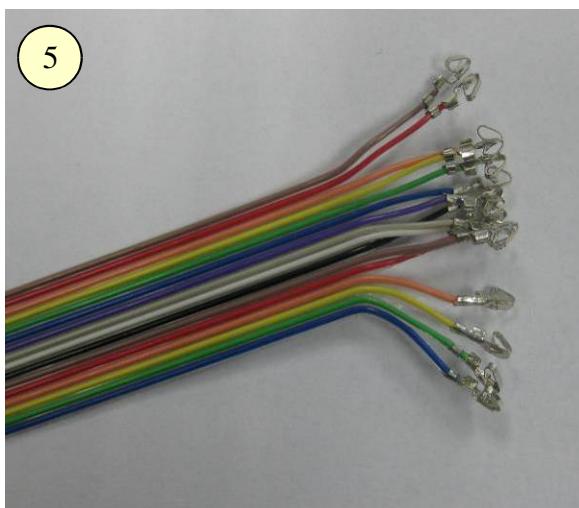
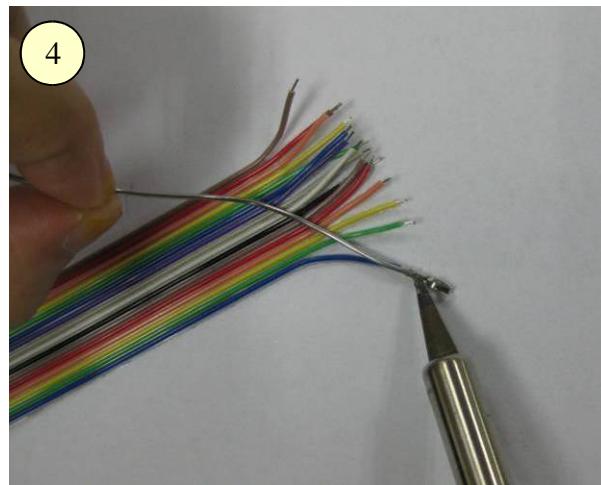
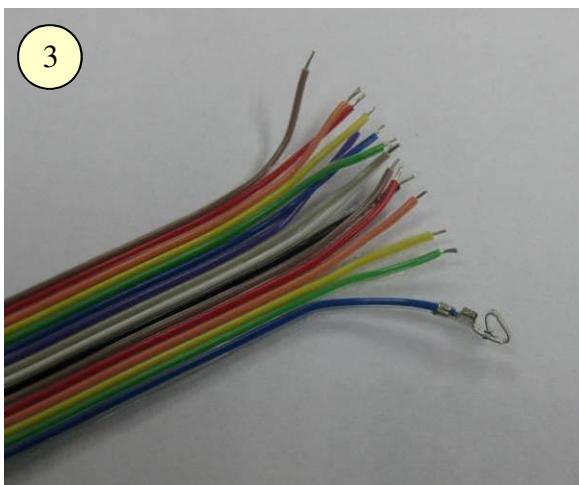


- h) To connect LSA08 to main controller, user may use IDC socket for other end of rainbow cable. It depends on the connector at the main controller side, modifications can be done to the cable as needed.



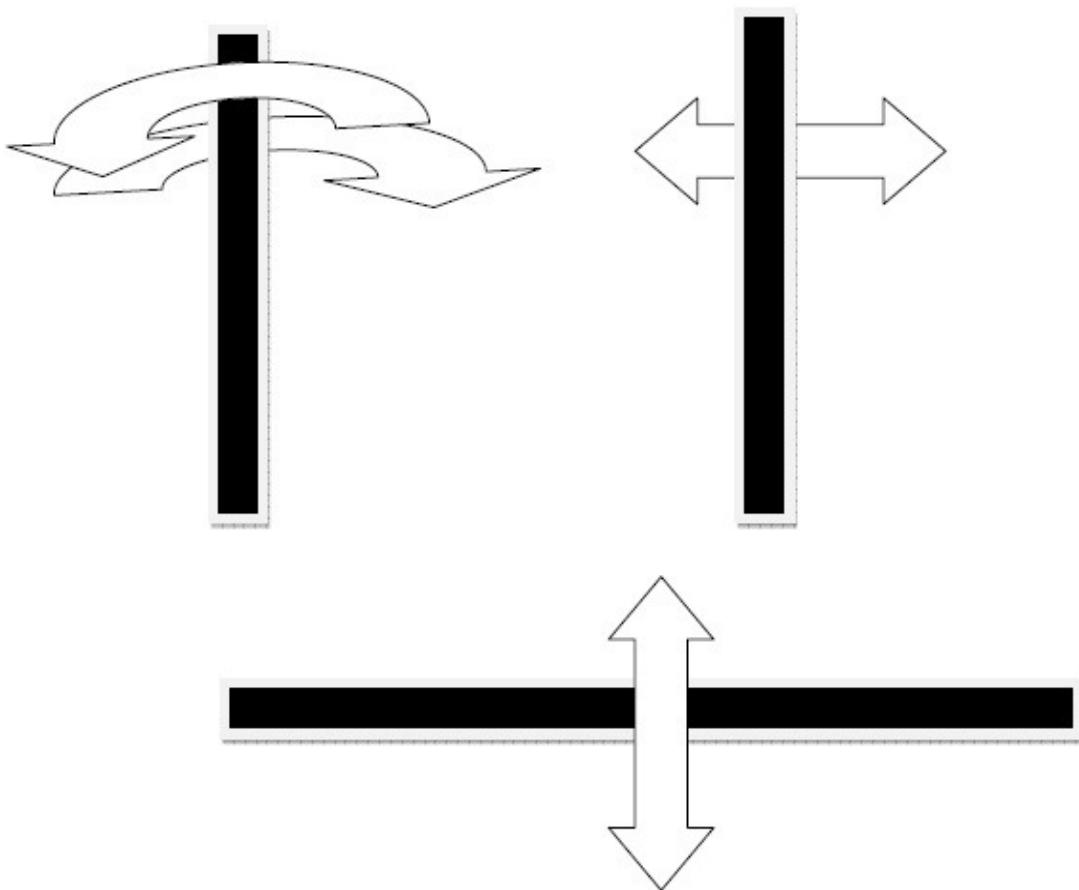
Below are example steps for setting up LSA08 cable to connect to main controller using 2510 connector.





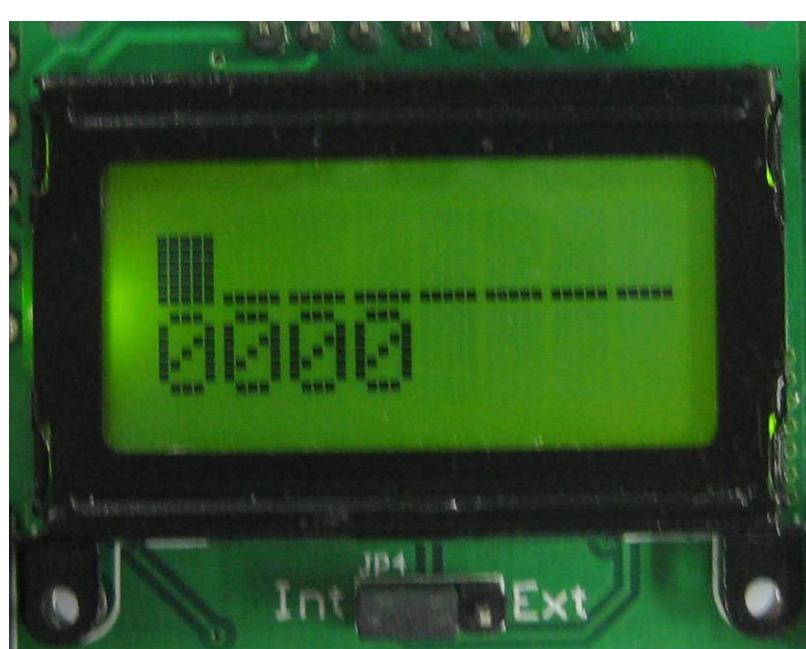
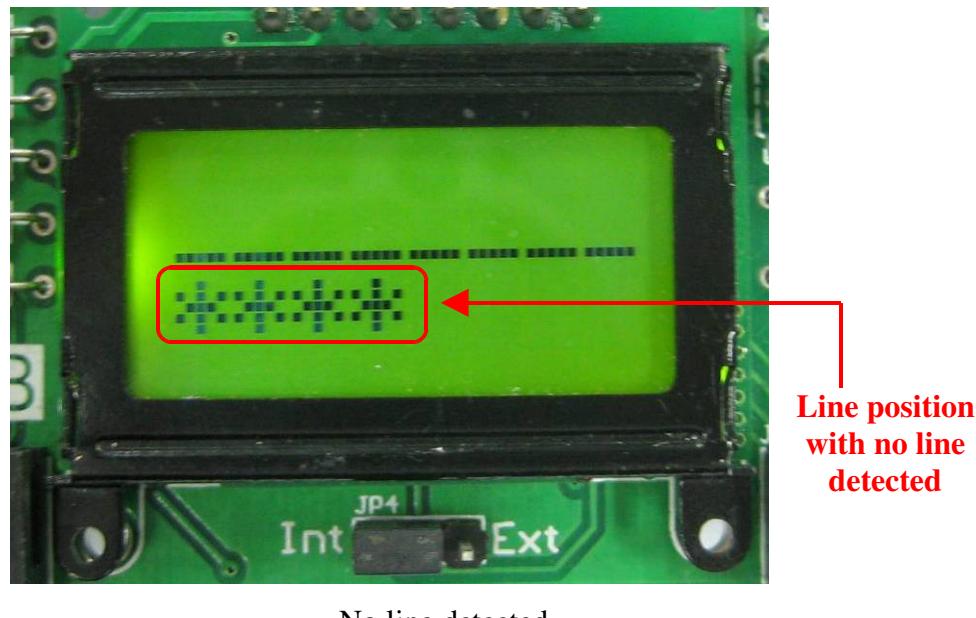
6. GETTING STARTED

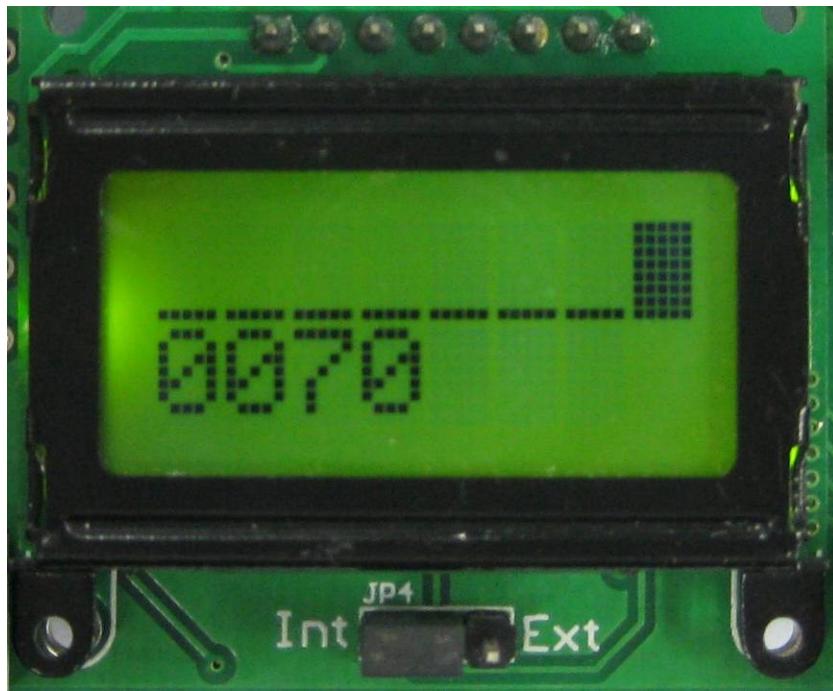
LSA08 need to be calibrated to retrieve the dark and bright value of the surface that it will do the line follow. **Every of the IR sensor pairs** need to be exposed to the dark and bright surface for it to read the value and save it. LSA08 will save the value in EEPROM, it will retrieve back the data from the EEPROM every time its switch on. Hence, only one time calibration is needed for the same background and line unless the background and the line changed, then recalibration is needed. To calibrate LSA08, go into menu setting using MODE button. Choose CALB and enter the mode using SEL button. Calibration is started by exposing the sensor to the bright surface and then to the dark surface of the line and background in the allocated time. Restart the calibration if missed the timing. LSA08 will save the brightest and darkest value in from the calibration process. User can calibrate by simply swinging the sensors across the dark and bright surface of the line in order to expose every sensor to the dark and bright surface. Calibration of every sensor is independent and value of each sensor will be saved.



Example motions of calibration by crossing the sensor between the lines.

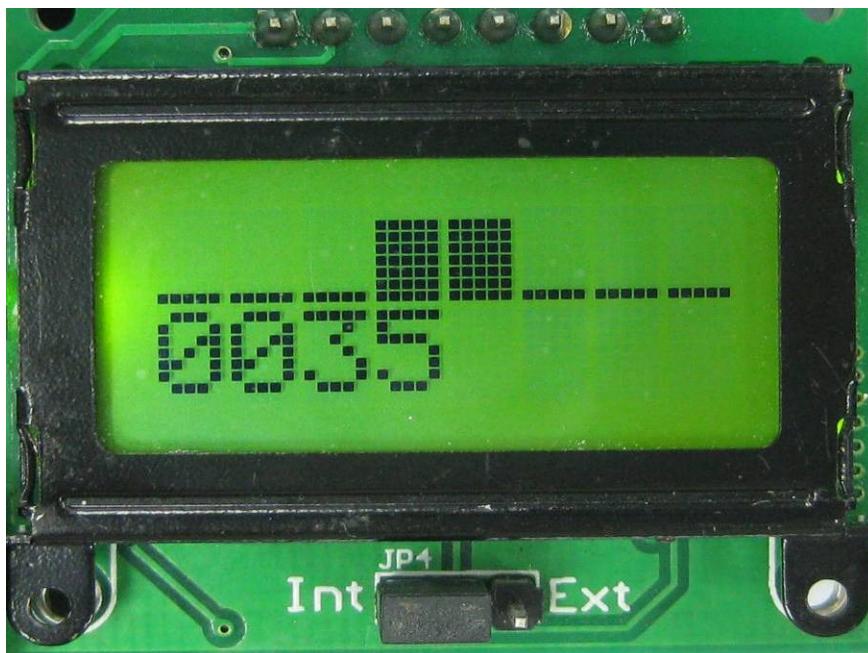
Once power is supply to LSA08, LCD will display the line position detection and bar chart. Line position detection is a value to shown which sensor is detect the line. The position on LCD display is ranging from 0 to 70. When there is no line detected on LCD, the position value will be shown as “****”. If sensor U0 detected a line, the line position reading shown on LCD will be “0000”. Likewise if a line is detected on sensor U7 the position shown will be “0070”. The position value varies in between linearly.





Position 70 - U7 detect the dark line

If a line is at the middle of the LSA08(U3 and U4), the LCD display will show the position as 35.



Position 35 – U3 and U4 detect the dark line

Threshold is the value of bar chart on LCD for LSA08 to treat as a valid line. The threshold value is from 0 to 7. If threshold is set to 7 for example, LSA08 will not detect the line if the bar chart on LCD is less than 7 LCD also will only display “****” means no line detect.

For this example, the threshold is set to 2 and U1 is detect the dark line because the bar line is more than 2.

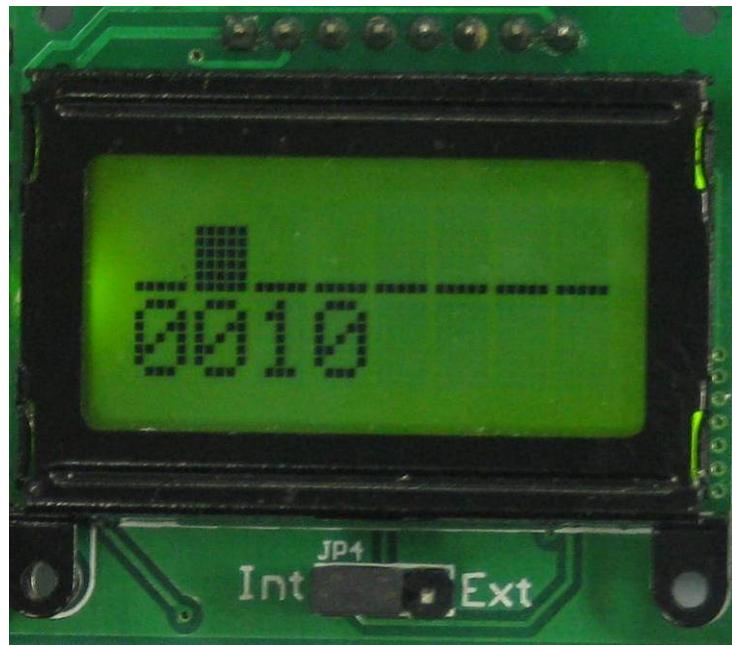
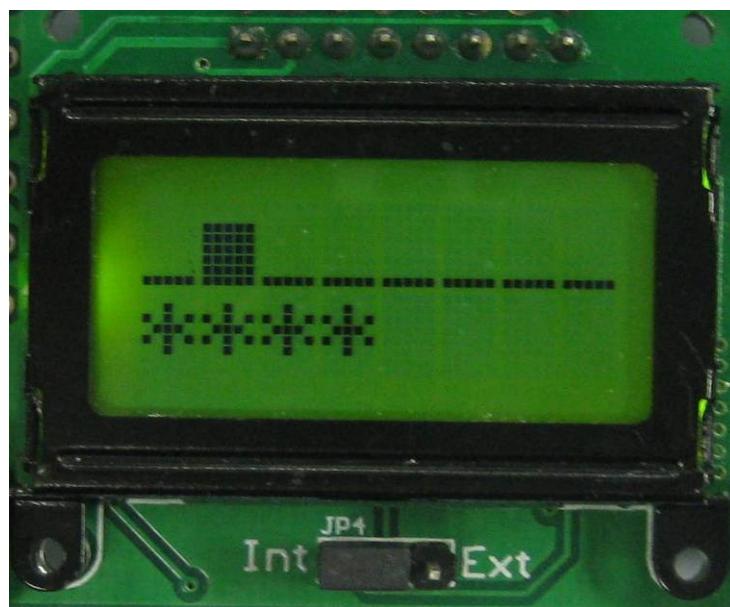
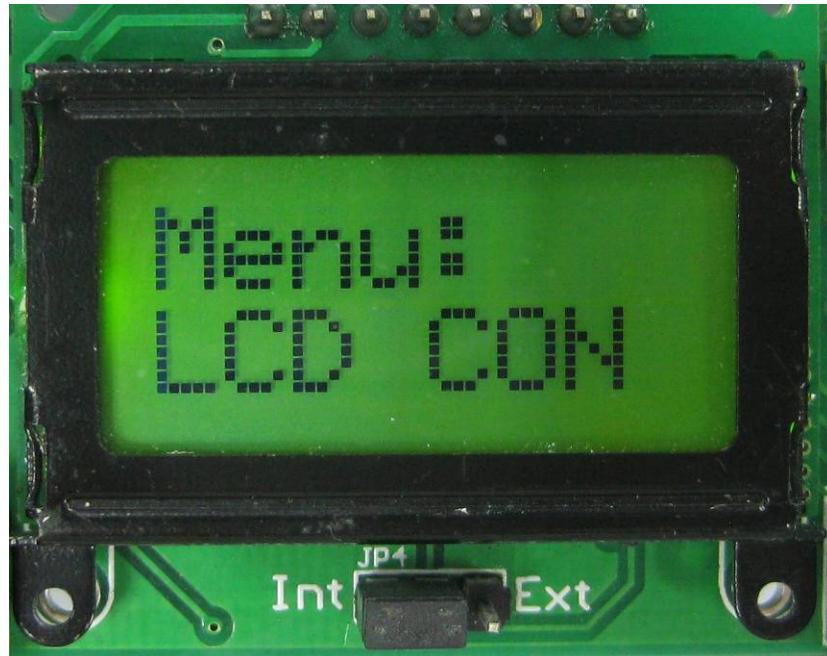


Figure below shown LSA08 cannot detect the line because the threshold value is 7 and the bar line display on LCD is less than 7.

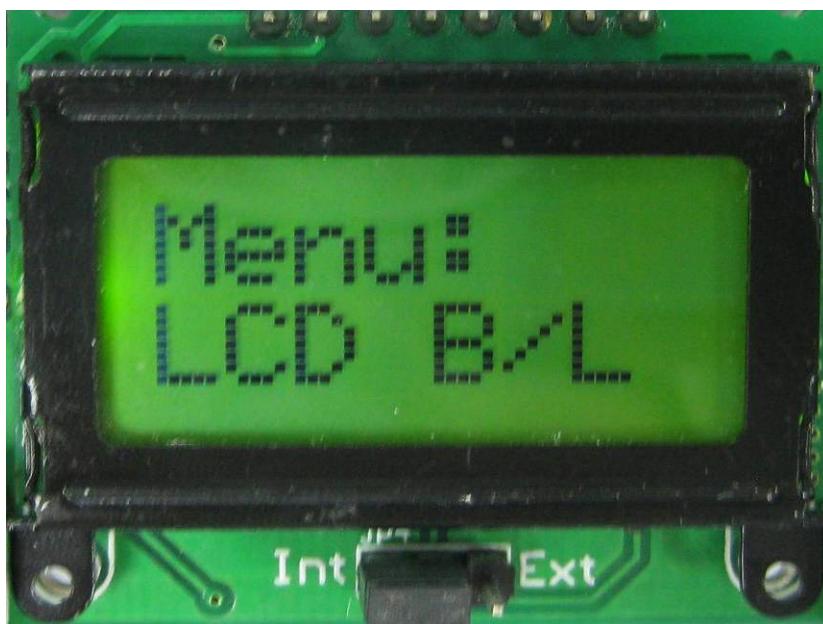


LCD on the LSA08 will displays the different menu for setting up the operation setting. There are 10 setting for LSA08. Users may refer page 6 for menu setting description. For example, user want to set LCD Backlight for LSA08. To enter menu setting:

1. Press MODE button once. It will bring user to 1st menu setting which is LCD CON.



2. Change the menu by more presses on Mode button until the desired menu appeared, for example "LCD B/L".



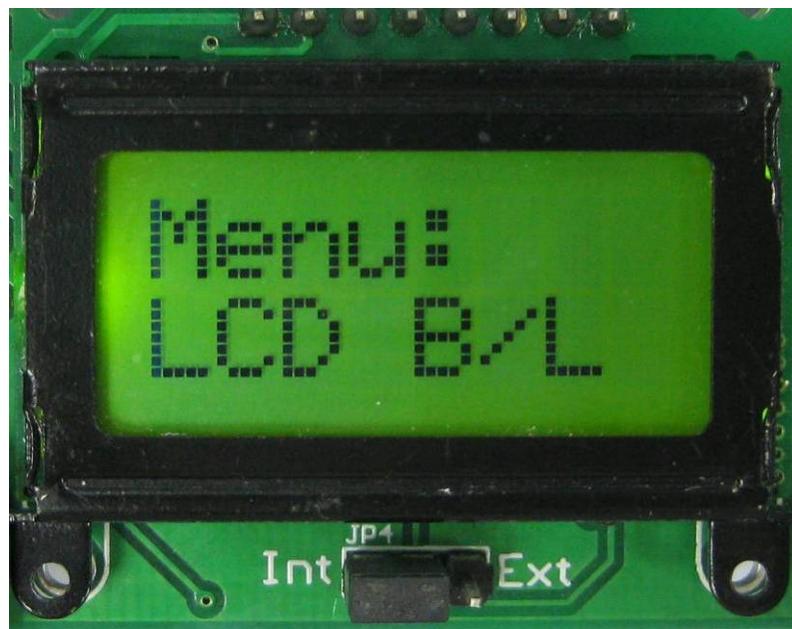
3. Press SEL button to enter the desired menu (LCD B/L). LCD will display current value of LCD backlight.



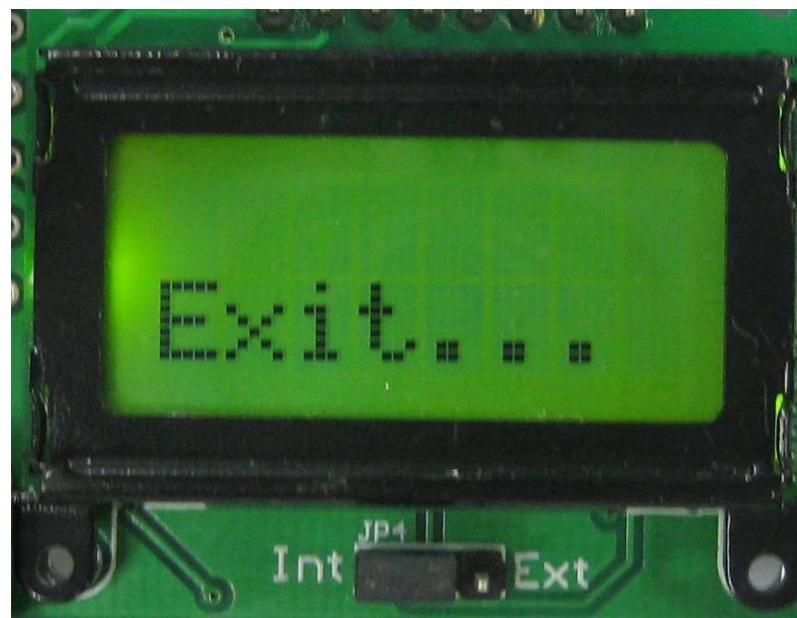
4. Press SEL button to change the value.



5. Press Mode button to return to menu selection



6. Press and Hold Mode button while in menu selection to exit



6.1 Output Port

LSA08 has 2 output port (Port A and Port B) for 3 types of output mode. The outputs mode for LSA08 are digital output (8 parallel output line), serial communication (UART) and analog output. Port A is provided for UART and analog output mode and port B for digital output mode. User may choose to use either this Port A or Port B or both. Vin and Gnd pin are for the power of the LSA08. Both Port A and Port B has the pins, either of the port can provide the power to LSA08.

6.1.1 PORT A - Analog and UART Port

Table below is pin defined for PORT A- Analog and UART port

Analog and UART Port (PORT A)

Pin	Description	Symbol
1	UART TX (Transmit)	Tx
2	UART RX (Receive)	Rx
3	UART Output Enable	UEN
4	Analog Output	AN
5	Junction Pulse	JPULSE
6	Not used	-
7	Not used	-
8	Not used	-
9	Vin	VIN
10	GND	GND

* Junction Pulse is for junction detection, pulse will be generated every time LSA08 crossing a junction with minimum width determine by Junction Width setting.

Analog Output mode

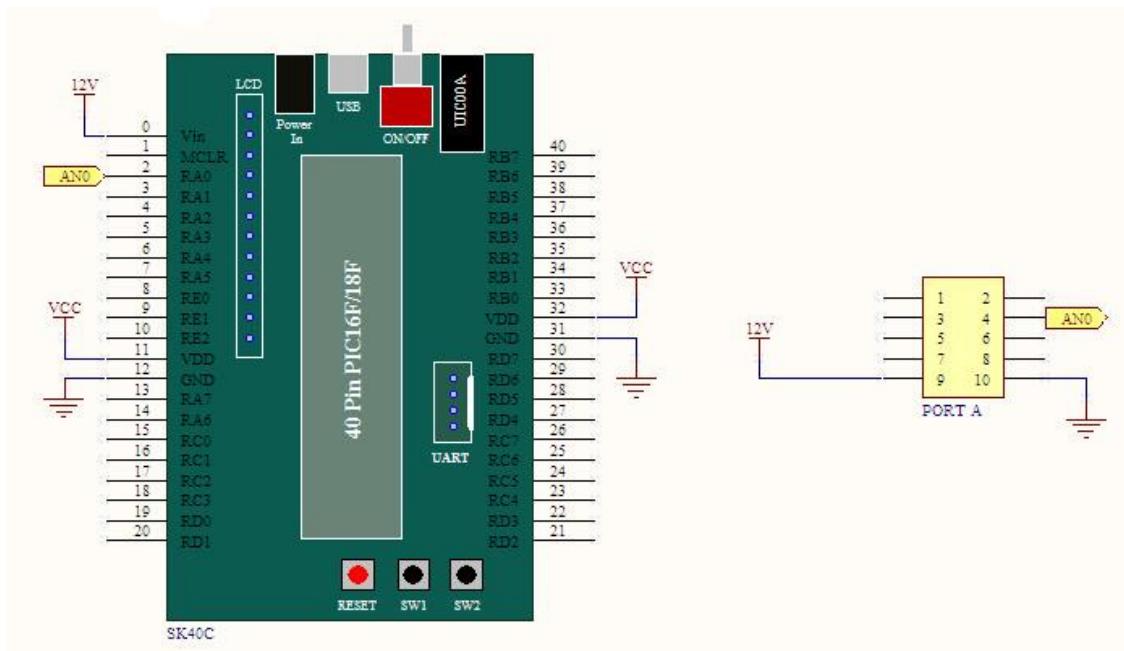
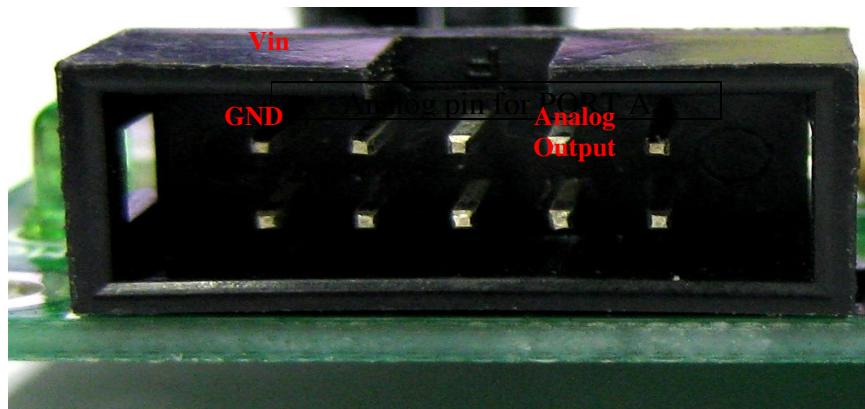
Analog output pin represents the line position detected in the form of analog voltage. User read the analog voltage on the pin using Analog to Digital converter to determine the position of the line. The analog voltage value range from **0 Volt to 4.5 Volt** which represents the line position between sensor 0 to sensor 7. 5 Volt on the analog output pin represents no line detected.

For example if a line is at the middle of the LSA08 which is in between sensor U3 and U4, the LCD on board will show the position as 35. And the analog reading will be

$$\left(\frac{4.5V}{70} \right) * Position = 2.25V$$

The linear equation for conversion of analog value on Analog Output pin to the position is shown below:

$$Position = \left(\frac{\text{Analog pin readings}}{4.5V} \right) * 70$$



Example connection from Analog Output (LSA08) to microcontroller

UART Output mode

UART Output port can be connected to microcontroller or computer. Connection to computer is using UC00A/B. UART TX and RX are the UART transmit and receive pin of LSA08 which Tx and Rx pin from LSA08 must cross connected to Tx and Rx pin of UC00A/UC00B or microcontroller. In others word, Tx pin of LSA08 must connected to Rx pin of UC00A/microcontroller and Rx pin of LSA08 must connected to Tx pin of UC00A/microcontroller.

UART Output Enable (UEN) pin is used to enable the data output streams from the LSA08. This pin needs to be **pulled low** to enable the data output streams. This pin is functioning as the flow control of the UART output data. The main controller request the data by pulling low the UART Output Enable pin. The data output streams can be in 4 different formats which are set in menu of UART Mode.

Mode 0: No Data

Mode 1: Parallel output, digital output of each sensor.

Mode 2: Line Position.

Mode 3: A/D reading of each sensor

Mode	Description
0	No data from UART
1	One byte of data at the refreshing rate of LSA08. 8 bits represent digital value of the 8 sensors. '1' represents the existence of line and '0' means no line. Threshold of the line existence is set in the Threshold Menu.
2	One byte of data which represent the current position of the line. The value is from hexadecimal value of 0x00 to 0x70. 0XFF represents no line detected. 0X00 means the line is detected on the most left of the LSA08 and 0x70 means that the line is detected on the most right of the sensor. This value is also shown on the second row LCD of LSA08.
3	Every raw A/D value readings from the sensor are sent out in packets. Each packet is start with 0x00 as the delimiter, followed by 8 bytes of sensor A/D reading. This mode is for those who want to process the sensor raw data themselves.

UART Serial communication setting need to initialize in user programming (microcontroller) or hyperterminal(computer). UART Serial Communication specification of LSA08 are:

Baudrate : Variable, Set by user

Start bit : 1

Stop bit : 1

Data bit : 8

Parity bit : 0

For LSA08 Serial Communication (UART), a command needs to send to enter menu mode Table below shown command reference table for UART and UART Command Packet Format. Table shows the selectable baudrate for LSA08.

Setting	Baudrate(bps)
0	9600
1	19200
2	38400
3	57600
4	115200
5	230400

Command and data reference table for the UART:

Command (ASCII)	Hexadecimal Value	Description	Data (Hexadecimal value)
C	0x43	Calibration	0x00
L	0x4C	Mode (Dark On/Light On)	0x01(Dark on), 0x00 (light on)
T	0x54	Line Threshold	0x00 - 0x07
O	0x4F	Offset	0x00 - 0x32
J	0x4A	Junction Width	0x01 - 0x08
A	0x41	UART Address	0x00 - 0xFF
B	0x42	LCD Backlight	0x00 - 0x0A
S	0x53	LCD Contrast	0x00 - 0xFF
R	0x52	UART Baudrate	0x00 - 0x05
D	0x44	UART Data Output Mode	0x00 - 0x03

UART Command Packet Format (4 bytes):

ADDRESS	COMMAND	DATA	CHECKSUM
---------	---------	------	----------

ADDRESS is the Address of the LSA08. It can be from 0 to 255 set by user from the UART Address Menu. This Address together with UART Output Enable features allows the user to control more than one LSA08 from a main board. The Checksum byte of the packet is calculated by adding up the Address byte, Command byte and Data byte together and taking only lower byte if more than one byte after addition.

CHECKSUM (1 Byte, Lower Byte) = ADDRESS + COMMAND + DATA

Example packet:

Address	Command	Data	Checksum
0x02	0x43	0x00*	0x45

This packet will cause the LSA08 to start calibration. Thus, the user may need to start rotate the robot to start exposing the LSA08 to the line and background in the predefined time constraint.

*The data byte is set to zero for those commands that do not need of any data value.

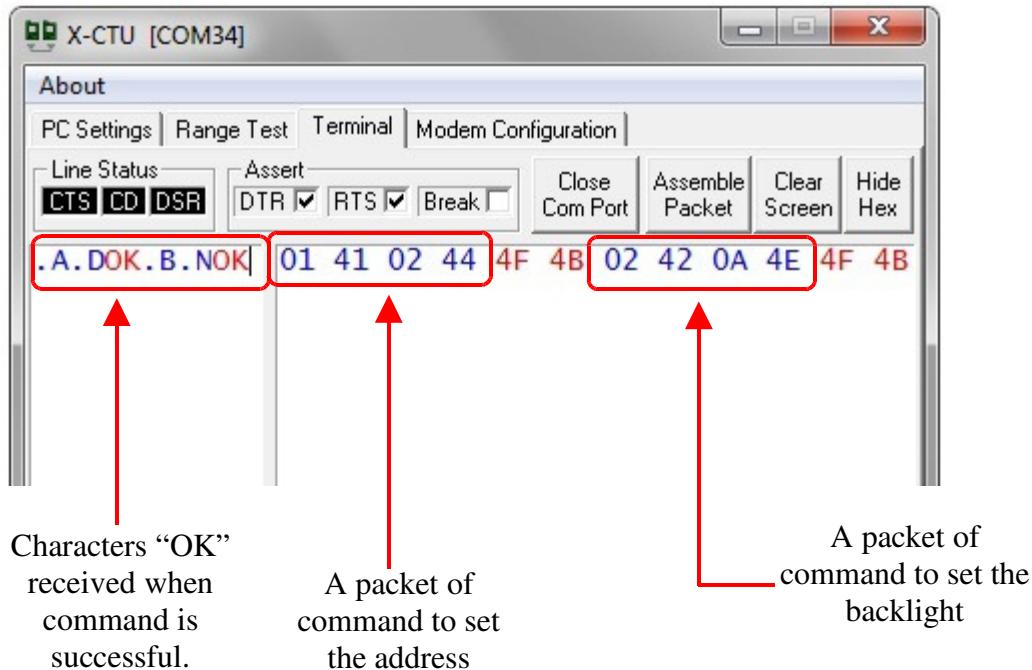
Address	Command	Data	Checksum
0xF0	0x44	0x03	0x37

Please take note that the 4 modes of the UART mode are represented by data value from 0 to 3. The above command will sent the UART data mode to mode 3 which is raw data from A/D converter of the sensors on LSA08.

If there is confusion of UART address of the LSA08, anytime the user can manually go into the LCD menu of the “UART ADD” to check for it. The correct address for the LSA08 board is important to be known if the user wants to use the UART serial communication with the board.

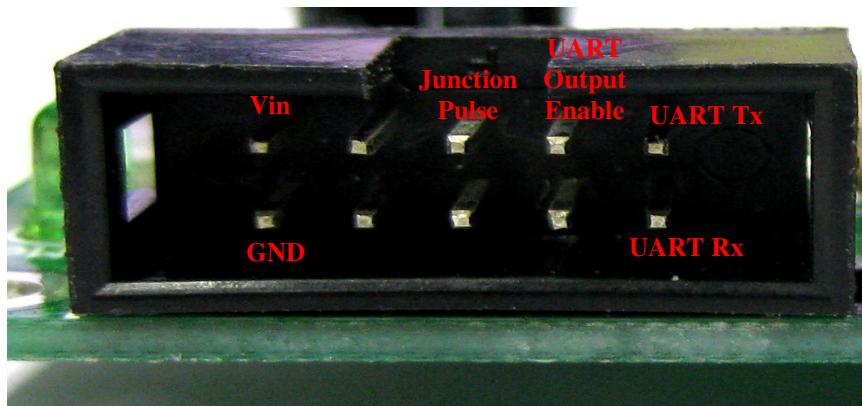
Every successful UART command received by the board with correct address, command and checksum value will be responded by LSA08 with a pair of ASCII characters “OK” immediately upon successful command. If in case there is no response from the board, the packet is being ignored by the board because of the wrong address, command, checksum or communication error which might be caused by the incorrect baudrate or poor signal line. Resend of the command packet is needed if the user still need to change the setting by UART communication.

Figure below is example a packet command send to setting LSA08. 1st packet data send is to set the address to 02 from the current address. Because this is the 1st time to set the address, the current address is the default address (01) of LSA08. The 2nd packet data is to set the LCD backlight with maximum backlight.

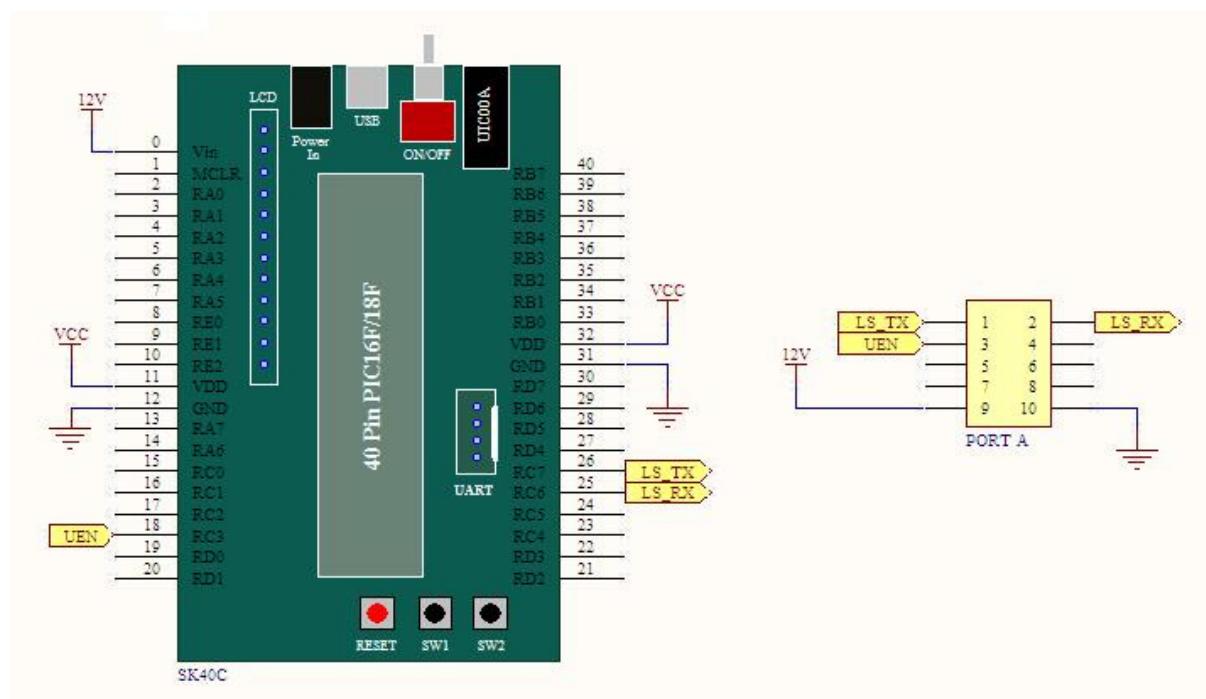


This is different from retrieving data from LSA08. By enabling the UART data sending to the desired setting of data format (refer to table in 6.1.1), the data is always sent out by LSA08 when the flow control signal line (UART Output Enable, UEN) pin is pulled low by the user. This flow control signal line enables the user to have enough time to process the data from LSA08 before any new data coming in by setting a high signal to UEN pin. This will prevent the UART buffer overflow of the user's main board side condition caused by fast flowing of data sent by LSA08.

Below is pin defined for UART pin. UART and Analog pin shared same port which is PORT A.



UART output enable signal pin (UEN) is for controlling the flow of data from the LSA08 board. This line will not affect the commands sent into the LSA08 board and responses of LSA08 to the commands on UART serial communication line. Commands can be sent to the LSA07 regardless the UEN line signal state either low or high and LSA08 will still response accordingly. Commands and responses of command have higher priority than the data output streams. Thus, LSA08 will process the command and response accordingly as soon as it receives the full correct packet command.



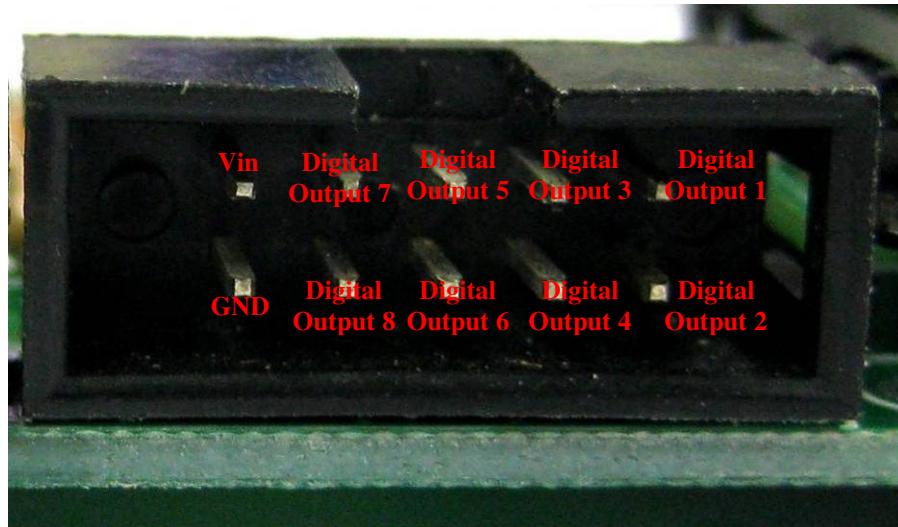
Example connection from UART Output (LSA08) to microcontroller

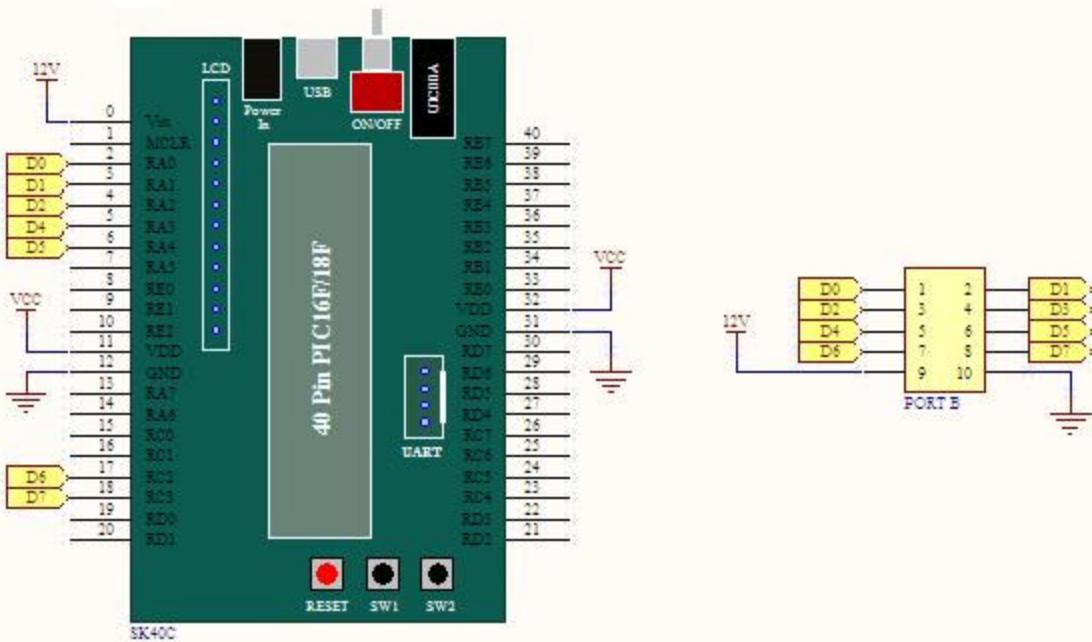
6.1.2 PORT B – Digital Output port

The digital port consists of 8 signal pins. Every signal pin represents a sensor on LSA08 board. A 5V or high digital value “1” shows line detected whilst a 0V or digital value of “0” shows no line detected. The User will need to process the data to determine where the line exists. For example if U0 and U1 sensor give high digital value, this means that the line is in between the two sensors. A simple setup, user can connect the digital port which consists 8 signals from LSA08 directly to the user’s main controller digital port. The user main program can directly read the digital port value to determine the line position. This port actually consumes a lot of port pins (8 pin). If the user main controller is lack of the digital input port pins, the user can choose to use the UART output (3 pins maximum) or Analog output (1 pin) from the LSA08 which minimize the usage of the controller port pins and reserve for other control purposes.

Table below shows the pins defined for digital output port.

Pin	Description	Symbol
1	Digital Output 1 (Sensor 1)	O0
2	Digital Output 2 (Sensor 2)	O1
3	Digital Output 3 (Sensor 3)	O2
4	Digital Output 4 (Sensor 4)	O3
5	Digital Output 5 (Sensor 5)	O4
6	Digital Output 6 (Sensor 6)	O5
7	Digital Output 7 (Sensor 7)	O6
8	Digital Output 8 (Sensor 8)	O7
9	Vin (12V)	VIN
10	GND	GND





Example connection from Digital Output (LSA08) to microcontroller

6.1.3 PORT C – External LCD

Another port provided is PORT C which is for the use of external LCD. Jumper on LSA08 needs to be set to Ext for the External LCD to operate. The contrast value for the LCD need to be readjusted because every LCD has different voltage range for the liquid crystal in order to display properly. The contrast is the second menu of the LSA08.

Table below shows the pins defined for external LCD. User may use only one LCD at a time. Either external or internal LCD which is set by JP4.

External LCD Port (PORT C)

Pin	Description
1	GND
2	LCD VDD(5V)
3	LCD VEE (Controlled by the contrast menu)
4	RS
5	R/W
6	E
11	D4
12	D5
13	D6
14	D7
15	LED+ (Backlight)
16	LED- (Backlight)

In the case of the characters on the LCD is invisible due to the wrong contrast, press the Mode button once, then press Select button to enter the LCD Contrast Menu and **press and hold** the Select button to adjust the contrast.

7. WARRANTY

- Product warranty is valid for 6 months.
- Warranty only applies to manufacturing defect.
- Damage caused by misuse is not covered under warranty.
- Warranty does not cover freight cost for both ways.

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