Advance Line Following Sensor Bar
LSA08

User's Manual

V1.1

June 2012

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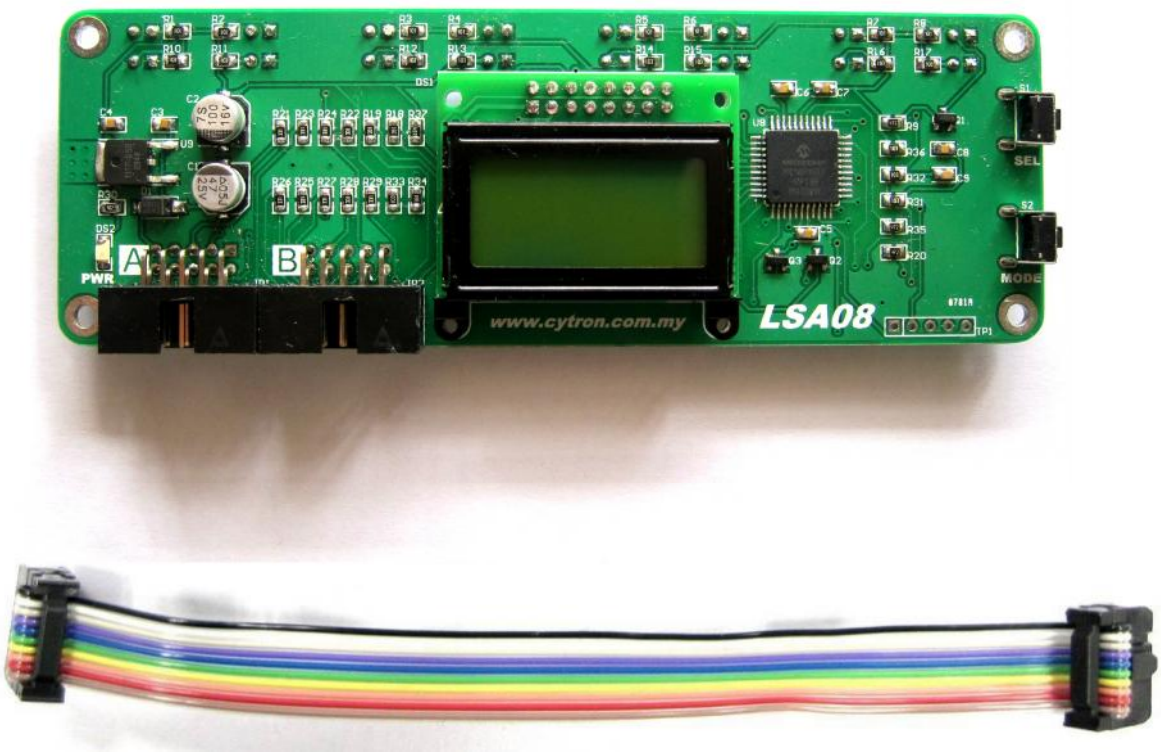
1. INTRODUCTION AND OVERVIEW

LSA08 (Advance Line Following Sensor Bar) consists of 8 sensors pair. 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. LSA08 is capable to operate on surface with color of **Red, Green, Blue, White, Black, Gray** and possibly other colors which are not listed.

LSA08 has some special features which give advantages to the user. LSA08 has low current consumption, typically around 26mA. Power polarity protection on LSA08 prevents damage by applying reversed voltage. LSA08 provides multiple interface methods, namely serial (UART), analog output and direct digital outputs (parallel output). LSA08 has total of 8 sensors spaced at 16mm. This minimizes the user effort of setup the sensor system for the line following robot. Besides, LSA08 has LCD which displays the sensors and line information. This LCD together with setting buttons (SEL and MODE) also enables instant setting up of LSA08. Auto calibration feature of LSA08 calibrates the sensors to the line and background surface easily. Furthermore, LSA08 with special selected transmitters and receivers sensor is capable to work on reflective or **glossy surface** which is difficult to normal infrared (IR) sensor.

2. PACKING LIST

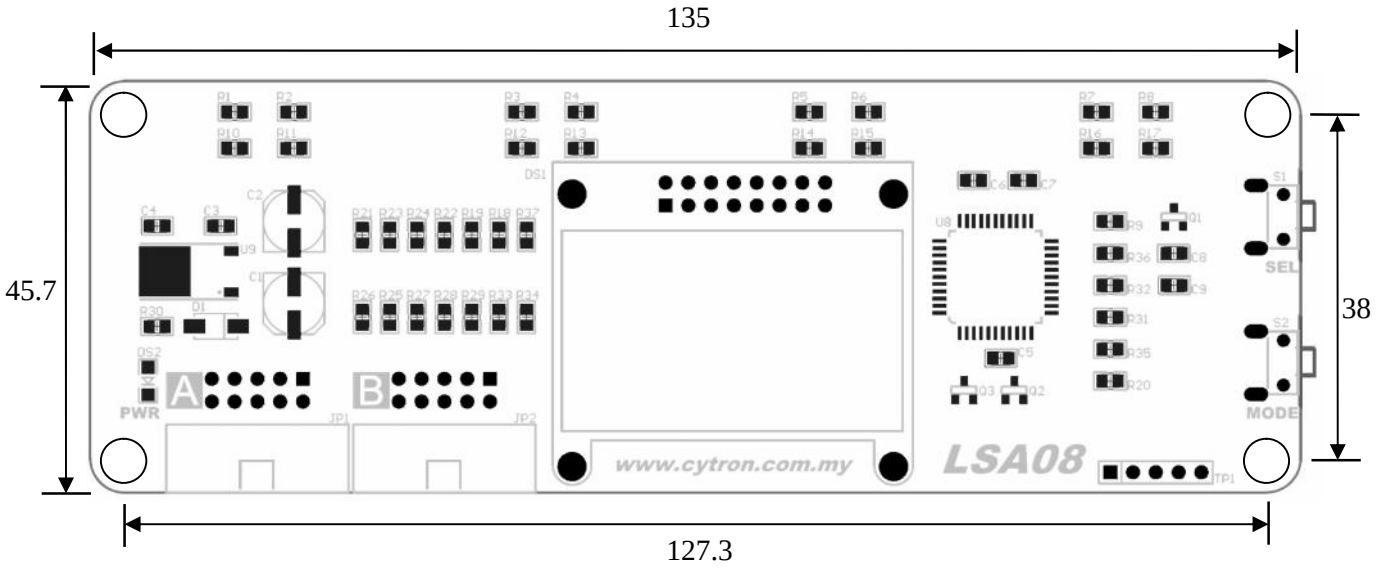
Please check the parts and components according to the packing list. If there is any part missing, please contact us at sales@cytron.com.my immediately.

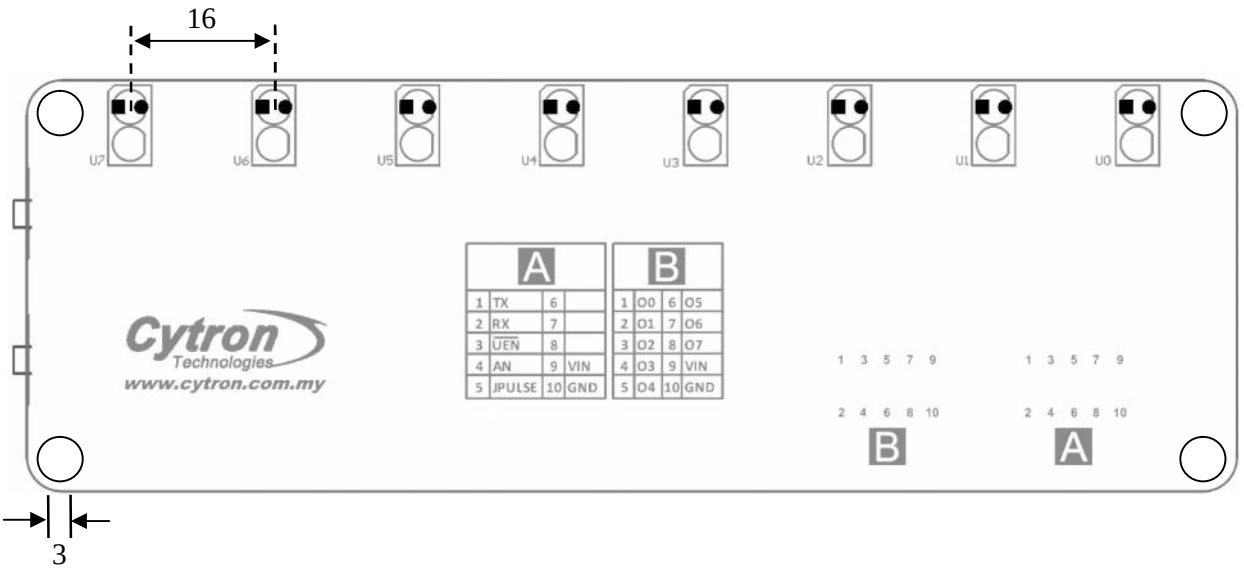


1. LSA08 PCB with every component soldered properly.
2. LSA08 cable connector

3. PRODUCT SPECIFICATION AND LIMITATIONS

3.1 Dimensions (mm):





3.2 Electrical Specifications:

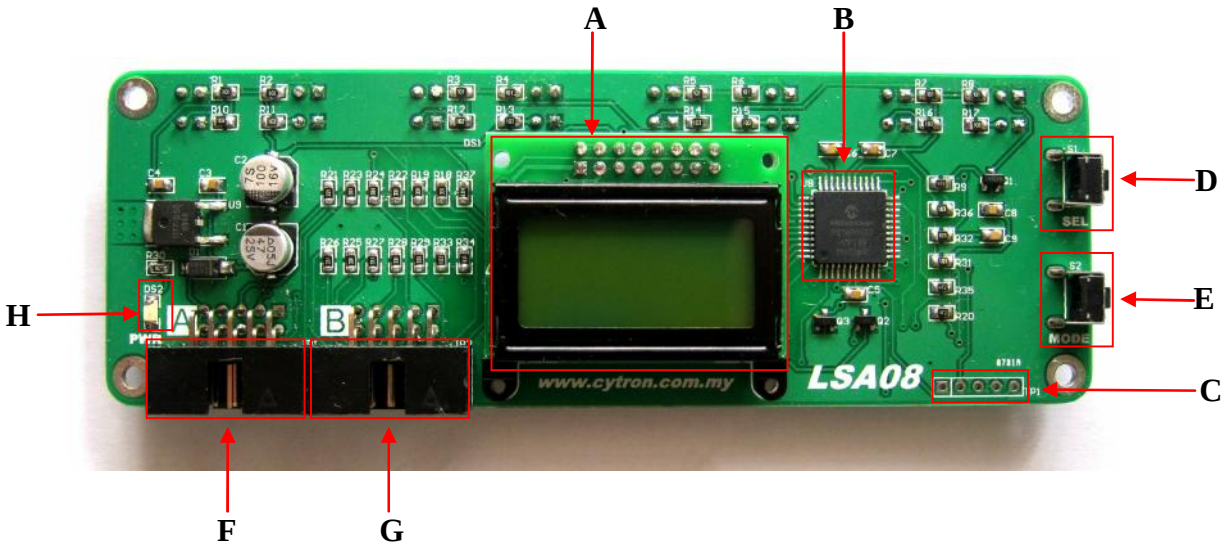
Parameter	Min	Typical	Maximum	Unit
Current Consumption (12V)	25.3	25.5	130	mA
Input signal, V_{IH}	2		5	V
Input signal, V_{IL}	0		0.8	V
Output Signal			5	V

Absolute Maximum Rating

Parameter	Minimum	Typical	Maximum	Unit
Operating voltage	7.5	12	20	V
Maximum Current (I/O signal pins)			20	mA
Sensing distance (from board)	1	3	5	cm
Minimum Line width	15			mm
Refresh Rate	100			Hz

4. BOARD OR PRODUCT LAYOUT

4.1 Top:



Label	Function	Label	Function
A	2x8 LCD display	**F**	Port A (UART and Analog port)
B	Main Controller	**G**	Port B (Digital port)
C	Manufacturing Points	**H**	Power LED (PWR)
D	SEL button		
E	MODE button		

A – 2x8 LCD unit to display the line information and setting menus.

B – Main controller for data processing.

C – Reserved for Manufacturing purpose.

D – SEL button is used to enter the selected mode or setting.

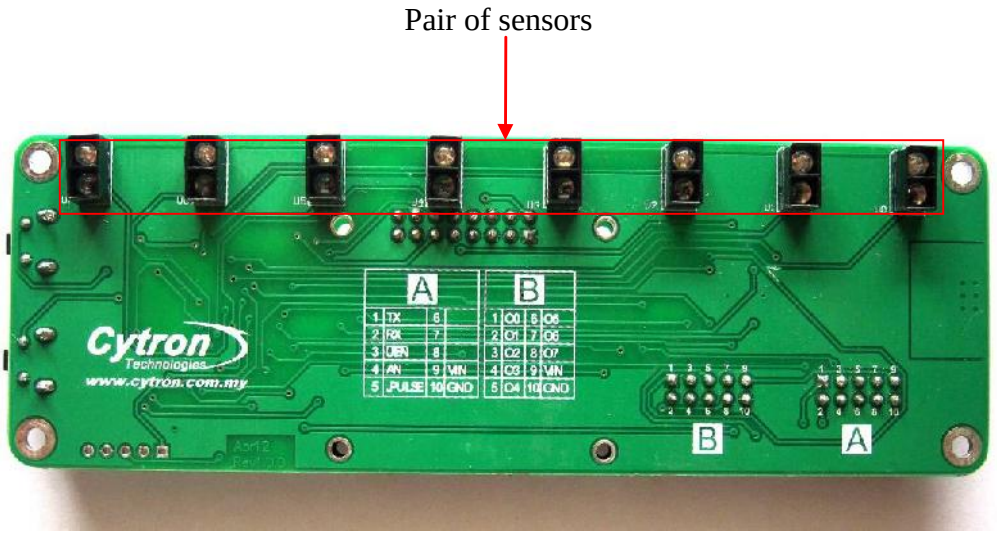
E – MODE button is used to select mode or setting.

F – Port A is UART and Analog port

G – Port B is digital parallel output port

H – Power indicator LED (green) for indication of power supplied to LSA08.

4.2 Bottom:


Pair of sensors
A
B
1 TX 6
2 RX 7
3 OEN 8
4 AN 9 VIN
5 PULSE 10 GND
1 O0 6 O6
2 O1 7 O5
3 O2 8 O7
4 O3 9 VIN
5 O4 10 GND
Cytron
Technologies
www.cytron.com.my
B
A

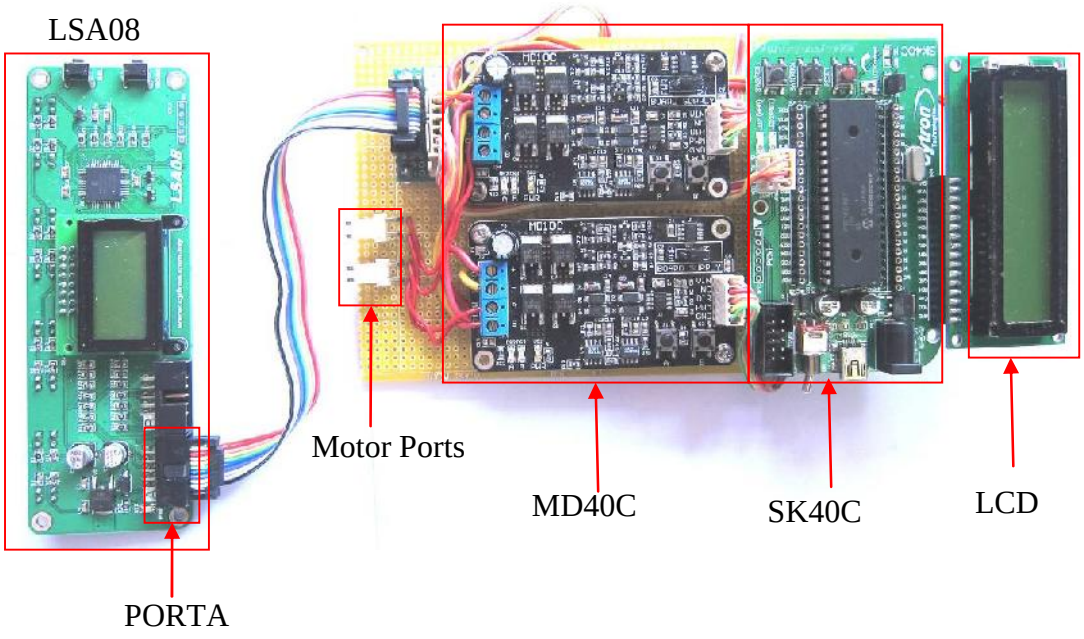
5. INSTALLATION (HARDWARE)

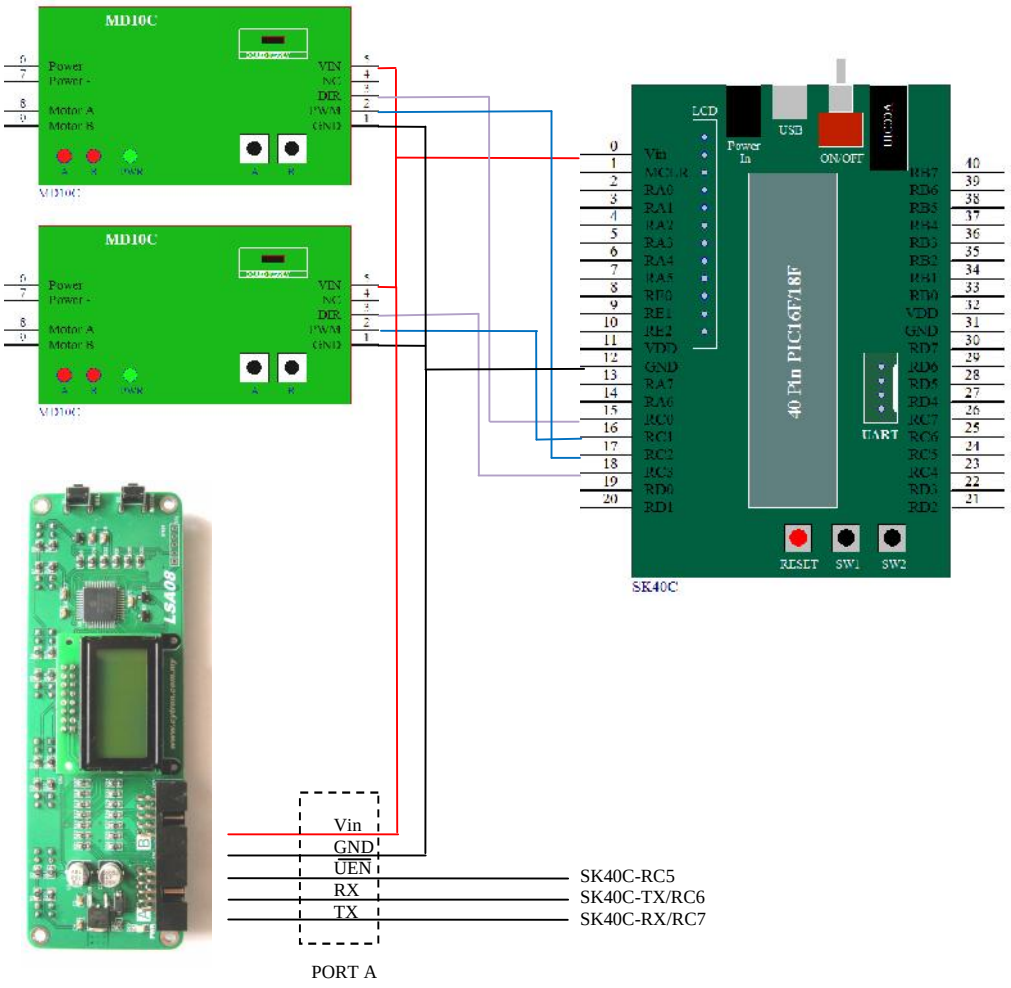
LSA08 is powered from VIN and GND pin of either PORT A or PORT B. sections below are example of hardware connection setup for LSA08. User may use either PORT A or PORT B or both PORTs at the same time.

5. 1 Sample connection with SK40C +MD10C

5.1.1 PORT A UART:

SK40C can be used as the main controller for a line following task. Motor driver is needed to drive the motors. This example uses 2 unit of MD10C to drive the left and right motors. MD10C requires very simple control signals which are the PWM signal and Direction signal (Sign-Magnitude PWM). PWM signal (pulse width) determines the speed of the motors and DIR signal determines the direction of rotation of the motors.

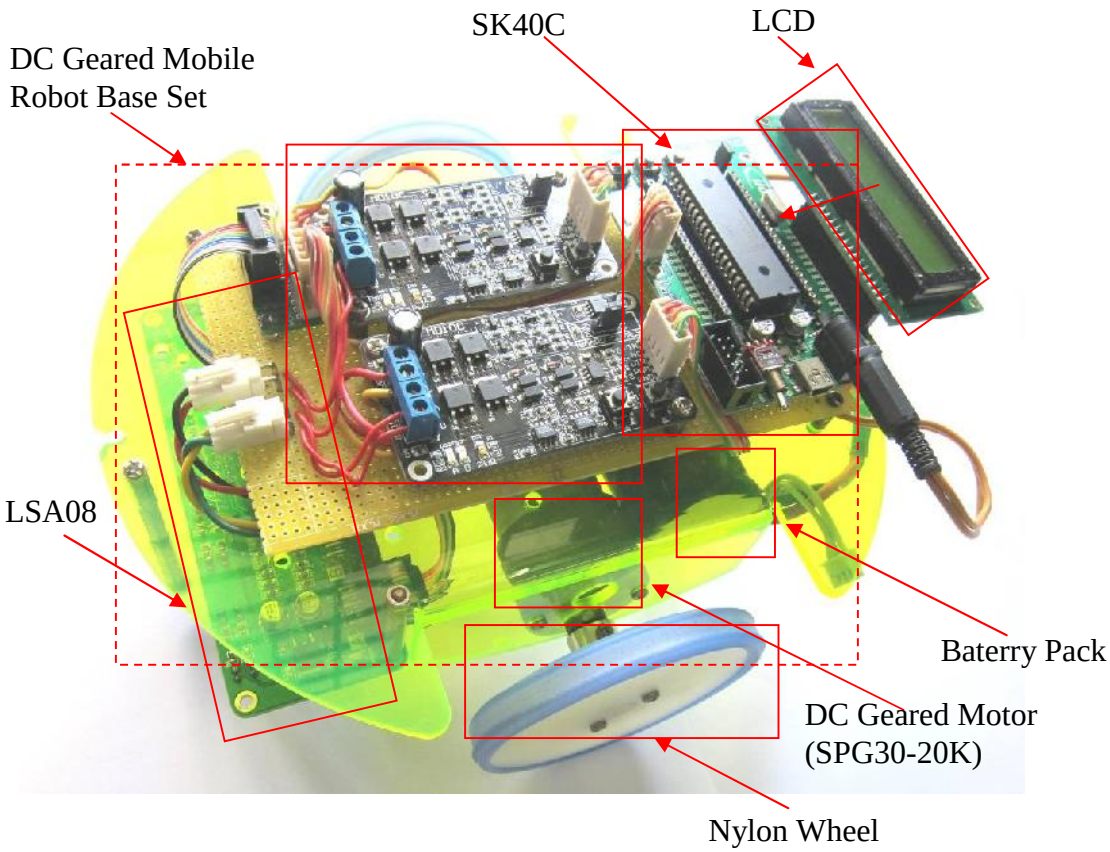




Figures above show the schematic of the connections for the PORTA of LSA08 to SK40C and also the MD10C to SK40C. This sample uses the serial UART communication with LSA08 to retrieve the line position from LSA08. JPULSE connection is trivial in this case since user can retrieve the cross junction count information using UART command. The Sample source code can be downloaded from Cytron's official website. Figure below shows the complete setup using DC Geared Mobile Robot Base set. All the parts needed as listed below can be found from Cytron's product range.

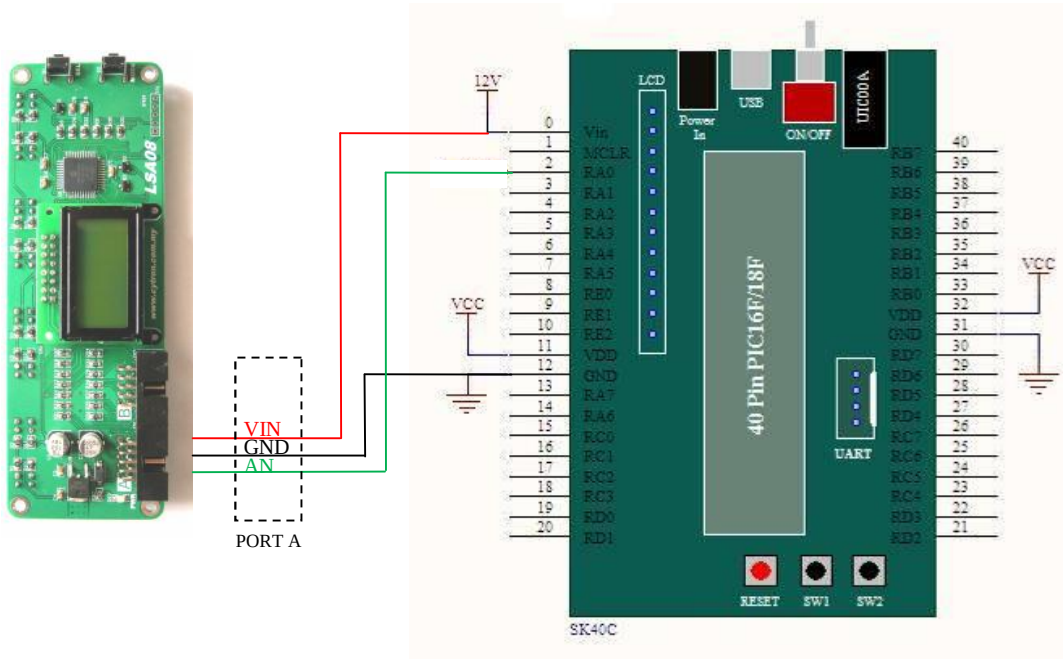
1. DC Geared Mobile Robot Base Set (HD-BSC-SPG-G), inclusive of robot base, DC geared motors, Nylon wheels, DC motor Couplings and Castors.
2. Enhanced 40 pins PIC Start-UP kit (SK40C) with LCD (optional)
3. Enhanced 10Amp DC Motor Driver (MD10C)

4. Advance Auto-Calibrating Line Sensor (LSA08)
5. Battery pack



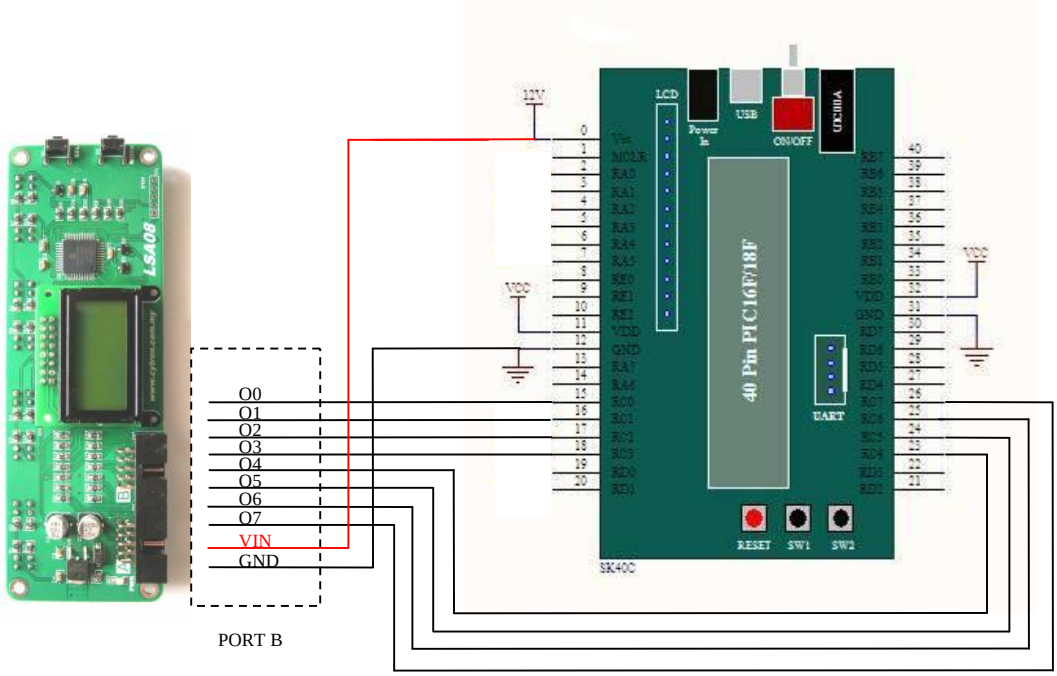
5.1.2 PORTA Analog:

Analog pin (Pin 4) of LSA08 PORT A can be used to retrieve line position also. Voltage on this pin represents the line position. The setup connection using this method is simple. Only 3 wires connections are required i.e. VIN, GND and AN pin. If user needs to do cross junction counting, then 4th connection is required to the **JPULSE** pin. Any digital IO port pin can be used for JPULSE pin connection. Figure following shows the sample connection to SK40C.



5.1.3 PORT B Parallel Digital:

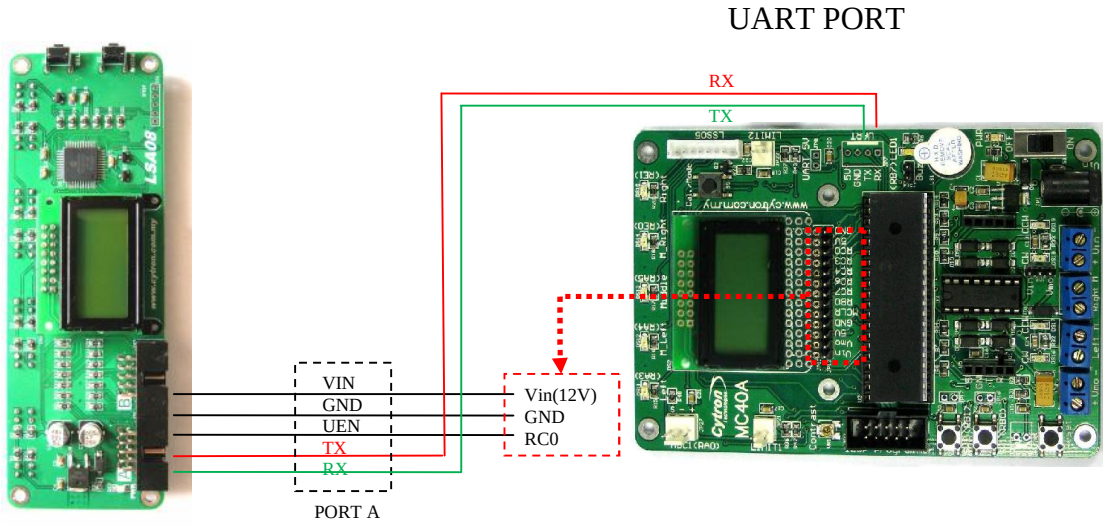
If user wants to use LSA08's Port B on SK40C, the schematic below shows the sample connection. This method is easy but requires more wiring. LSA08's PORT B's output is parallel digital output. Every pin on LSA08's Port B represents each of the sensor, where '1' represents line detected and '0' represent no line detected on that particular sensor.



5.2 Sample connection with Mini Mobile Robot Controller (MC40A)

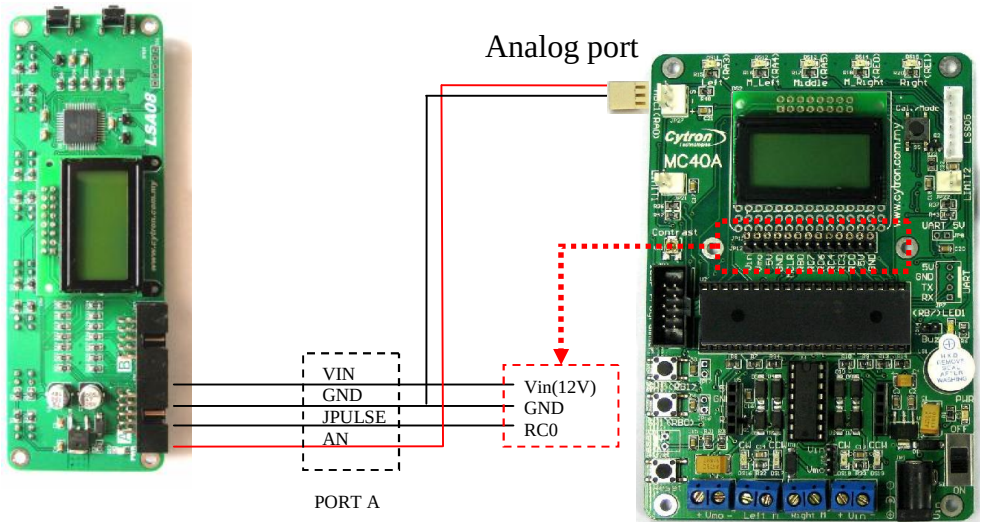
5.2.1 PORTA UART:

Mini Mobile Robot Controller (MC40A) is a convenient robot controller for line following purpose since the board has the motor driver integrated on board (motor driver peak current is 1.2A). It was actually designed to be used with Auto-Calibrating Line Sensor (LSS05) for line following. However, LSA08 can be used instead. User can use either Port A's UART or Port A's Analog on LSA08 for the line position retrieval. Connection below shows Port A's UART setup for LSA08 to MC40A. TX pin of LSA08 is connected to RX pin of MC40A and RX pin of LSA08 is connected to TX pin of MC40A for the communication.



5.2.2 PORTA Analog:

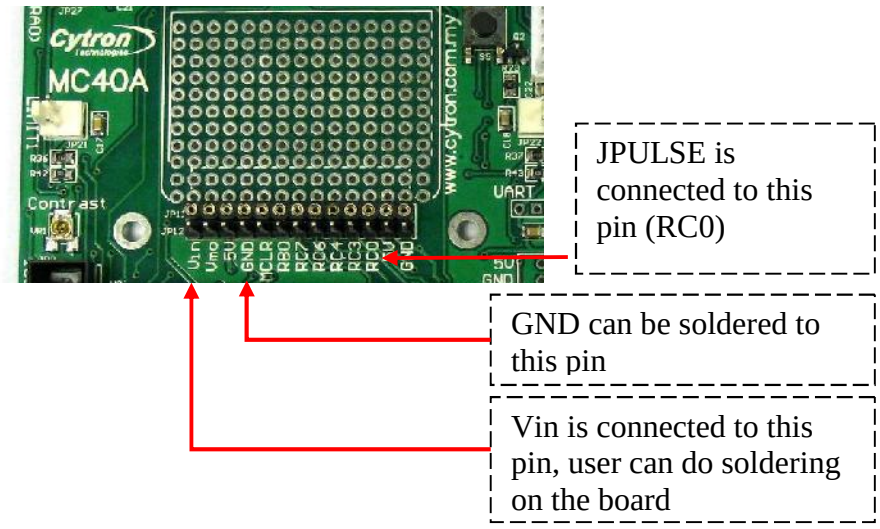
Figure below shows setup of MC40A to use LSA08 Port A's Analog for line following. JPULSE pin is for cross junction counting and is optional if the line following task does not requires the junction counting.

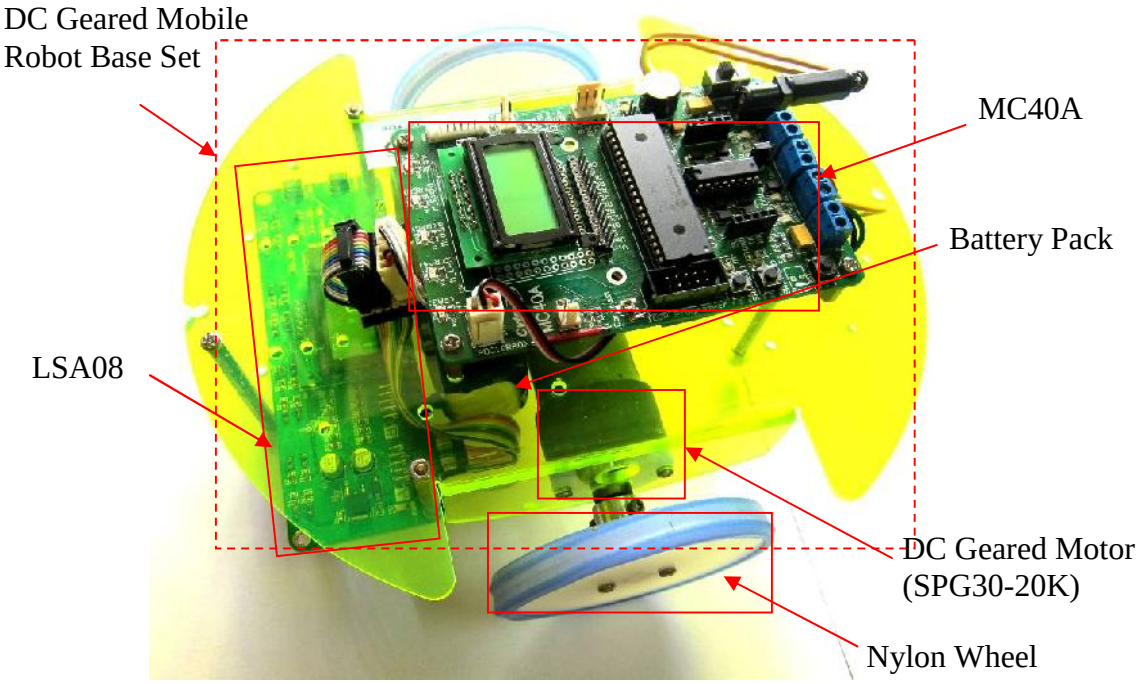


Vin of LSA08 is connected to the VIN (12V) of MC40A. Soldering of wires to the board is needed for connecting the VIN, GND and JPULSE wire. JPULSE wire is connected to any available digital input pin for example RC0 pin in this sample. This example uses Analog to Digital converter (ADC) of the microcontroller to read the Analog pin of LSA08. The Sample source code can be downloaded from Cytron's official website. Figure below shows the complete setup using DC Geared Mobile Robot Base set. All the parts needed as listed below can be found from Cytron products range.

1. DC Geared Mobile Robot Base Set (HD-BSC-SPG-G), inclusive of robot base, DC geared motors, Nylon wheels, DC motor Couplings and Castors.

2. Mini Mobile Robot Controller (MC40A) with LCD (optional)
3. Advance Auto-Calibrating Line Sensor (LSA08)
4. Battery pack

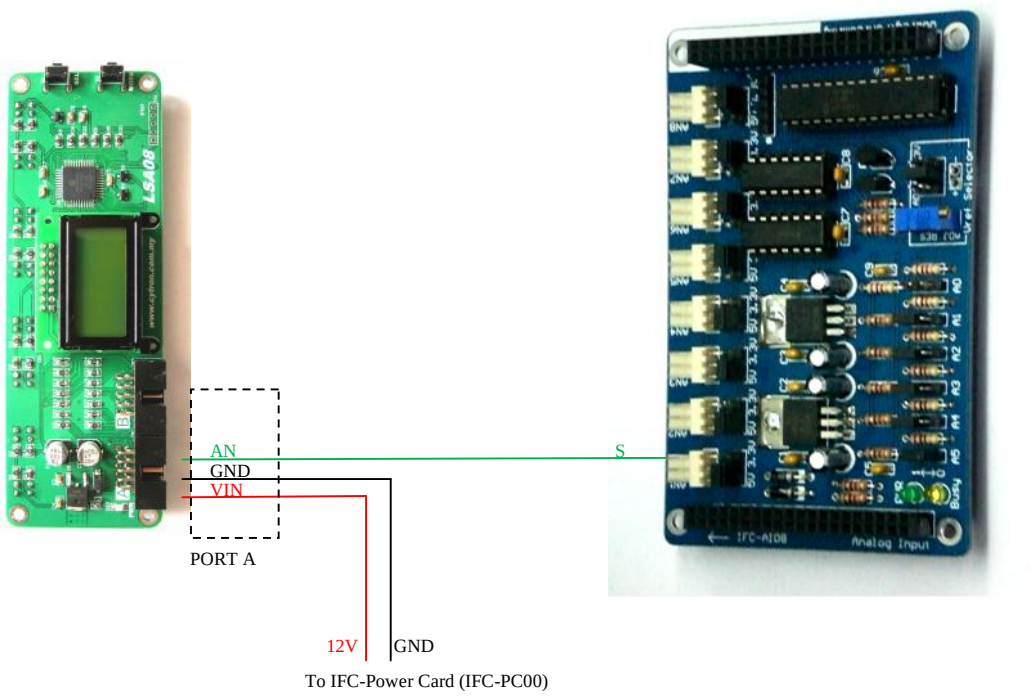




5.3 Sample connection with Interface Free Controller System (IFC)

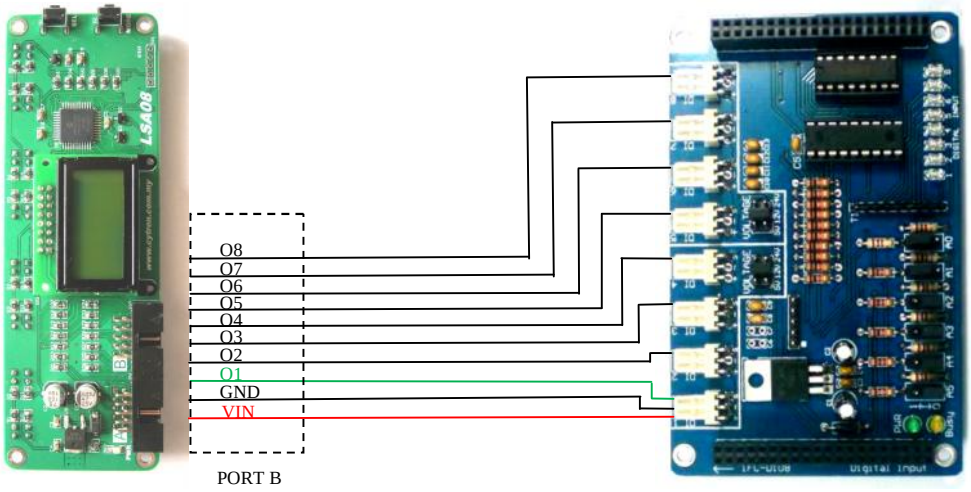
5.3.1 Port A Analog:

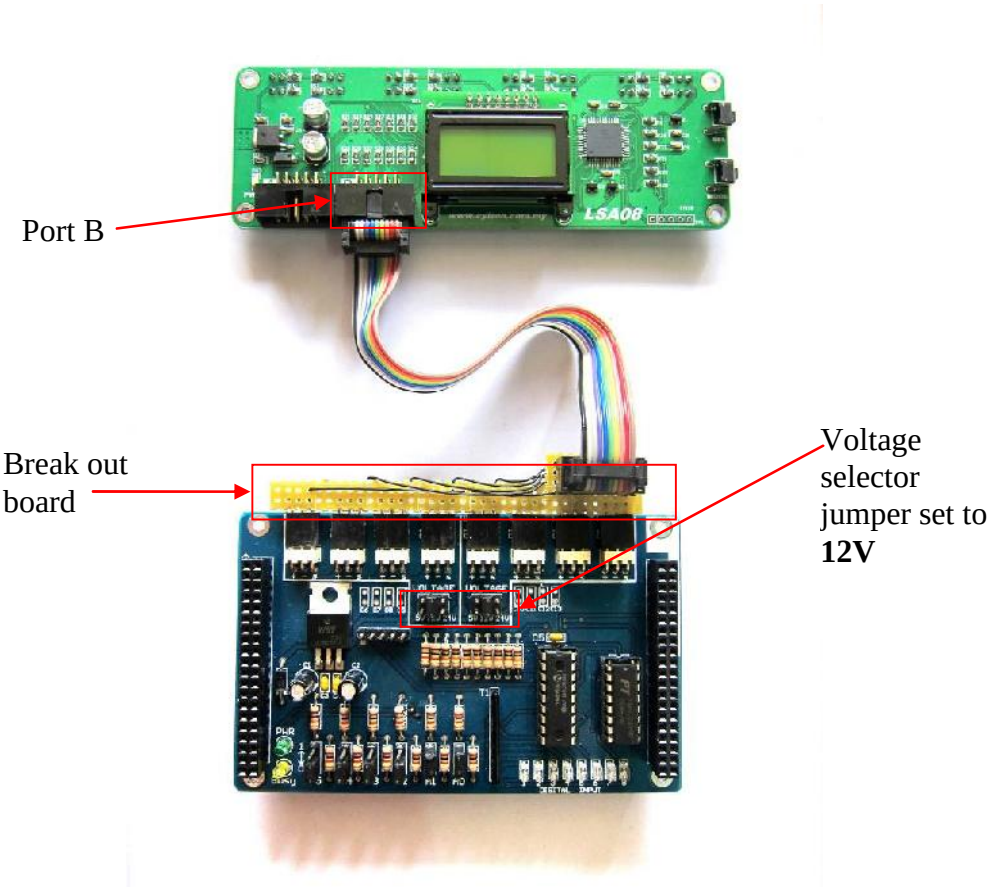
IFC-AI08 can be used to retrieve line position from LSA08 using analog method. Sample connection is shown in the figure below. IFC-Main Board retrieves the analog value from the IFC-AI08 and processes it to get the line position to do line following task. The reference voltage jumper on IFC-AI08 is set to 5V.



5.3.2 Port B Parallel Digital:

IFC-DI08 card can be used for LSA08. The **voltage selector jumper** is set to **12V** to provide suitable voltage to LSA08. The sample connection from LSA08 to IFC-DI08 is shown in the figure below. Port B of LSA08 which is the digital parallel port is used for this setup. User can choose to connect the Vin of LSA08 from any of the positive voltage 12V of IFC-DI08 sensor ports. Only one single connection is needed for the VIN and GND pin of LSA08 from IFC-DI08.





To setup a complete working IFC system for line following with LSA08, user will need:

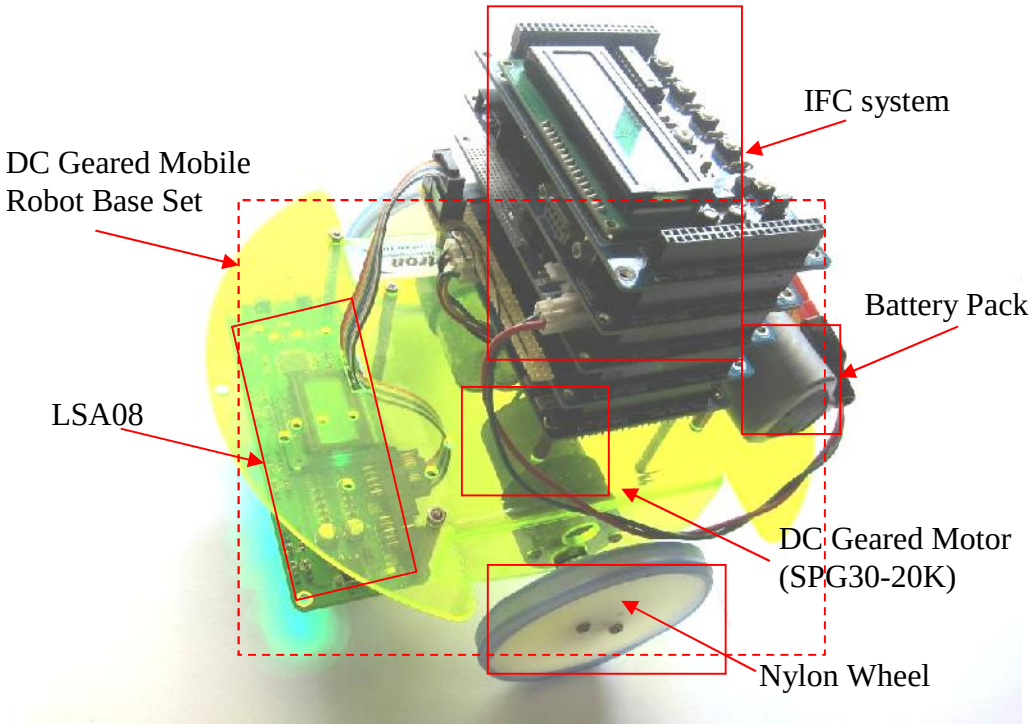
1. IFC-Main Board (IFC-MB00),
2. IFC-Power Card (IFC-PC00),
3. IFC-Digital Input Card (IFC-DI08) **or**

4. IFC-Analog Input Card (IFC-AI08)
5. IFC-Dual Brush Motor Card (IFC-BH02) **or**
6. IFC-Brushless Motor Card (IFC-BL02)
7. IFC-Control Panel Card (IFC-CP04) (optional)

Example setup shown below used the following parts which can be found from Cytron's product list. All the parts used are listed as following.

1. DC Geared Mobile Robot Base Set (HD-BSC-SPG-G), inclusive of robot base, DC geared motors, Nylon wheels, DC motor Couplings and Castors.
2. Interface Free Controller (IFC)
3. Advance Auto-Calibrating Line Sensor (LSA08)
4. Battery pack

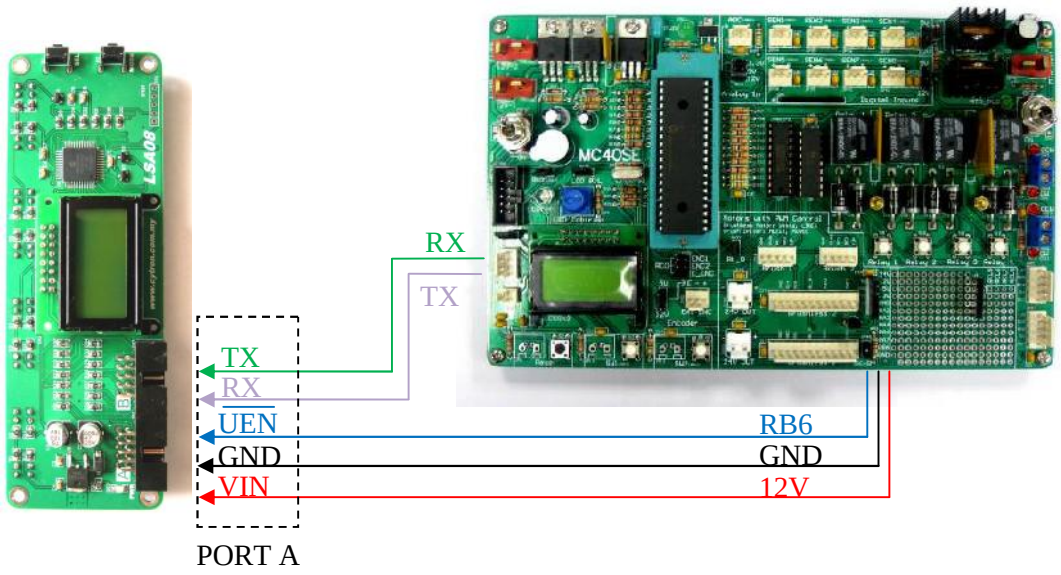
IFC system is a convenient robot controller to use. Simply stacking up all the required cards and the system is ready to be programmed for the line following task. IFC system requires user to program IFC-Main Board (IFC-MB00) only, other slave cards are preloaded with ready-use firmware already. Sample source code for simple PID controlled line following can be downloaded from Cyton's official website (www.cytron.com.my).



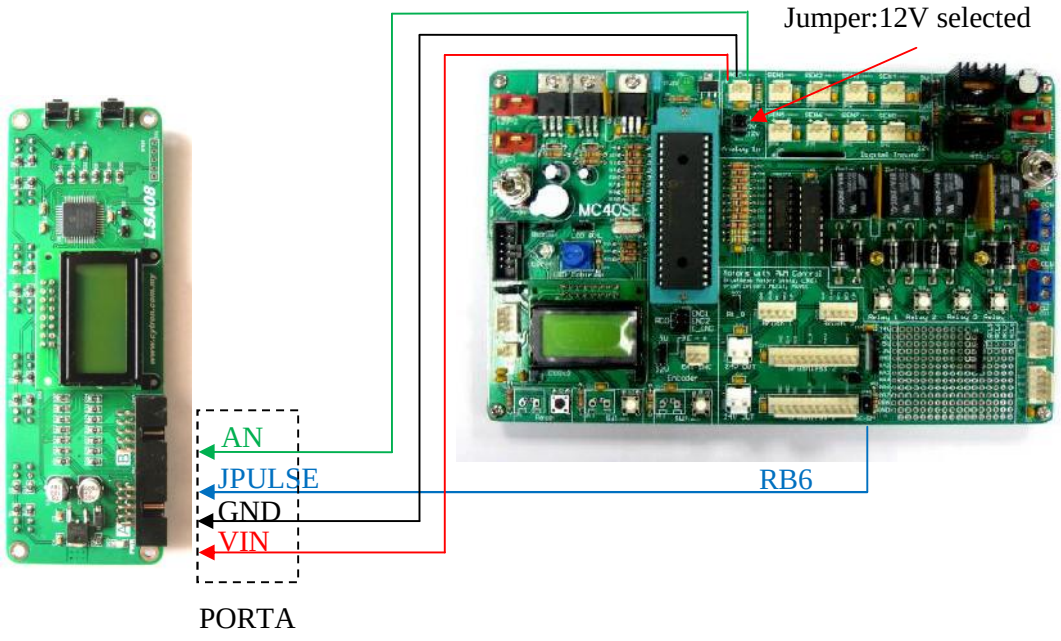
5.4 Sample connection with MC40SE:

LSA08 Connection with MC40SE is similar to other controller described previously. Following sections show the connection to LSA08 using UART, analog and digital parallel method.

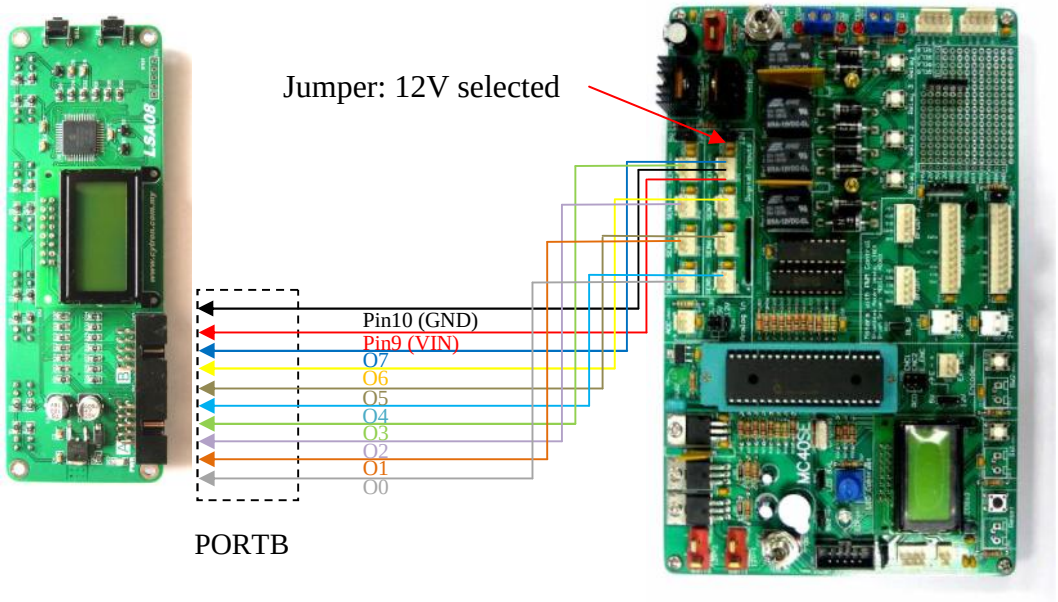
5.4.1 PORT A UART:



5.4.2 PORTA Analog

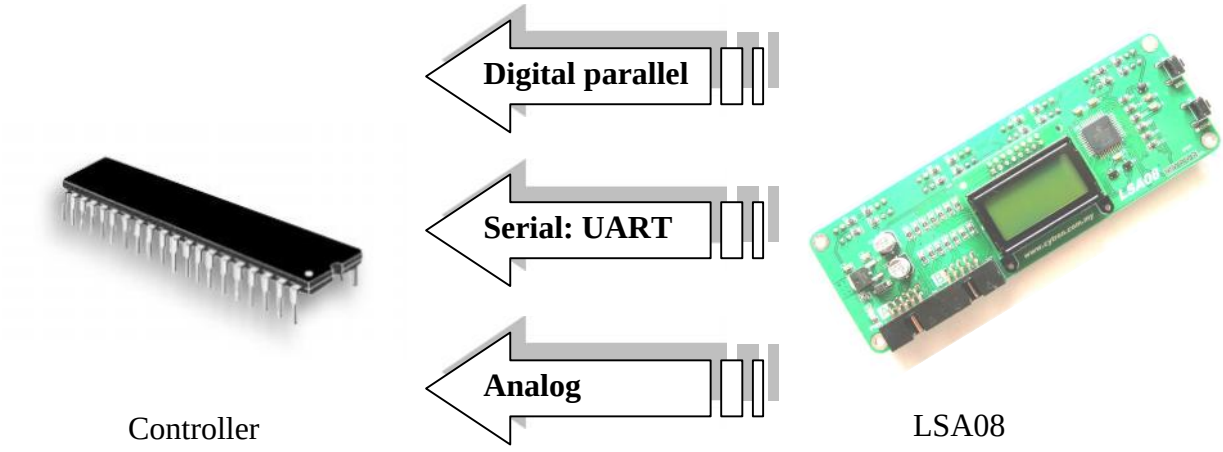


5.4.3 PORT B Parallel Digital:



5.5 Connection with other controllers:

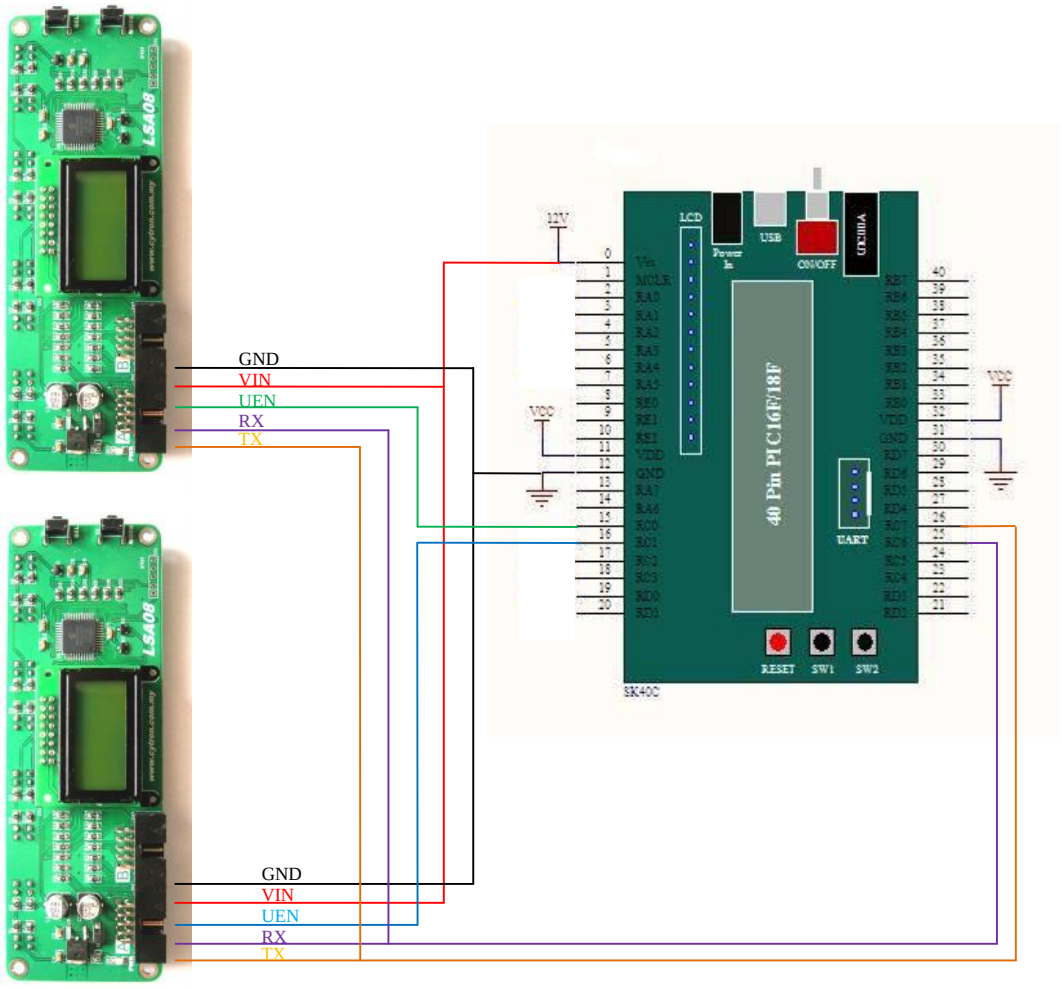
LSA08's user can choose any methods of connection or communication to retrieve the line position and information from LSA08. Figure below shows the main methods for line position or information retrieval from LSA08. Details of methods will be explained in later section.



5.6 Multiple LSA08 to a Single Controller

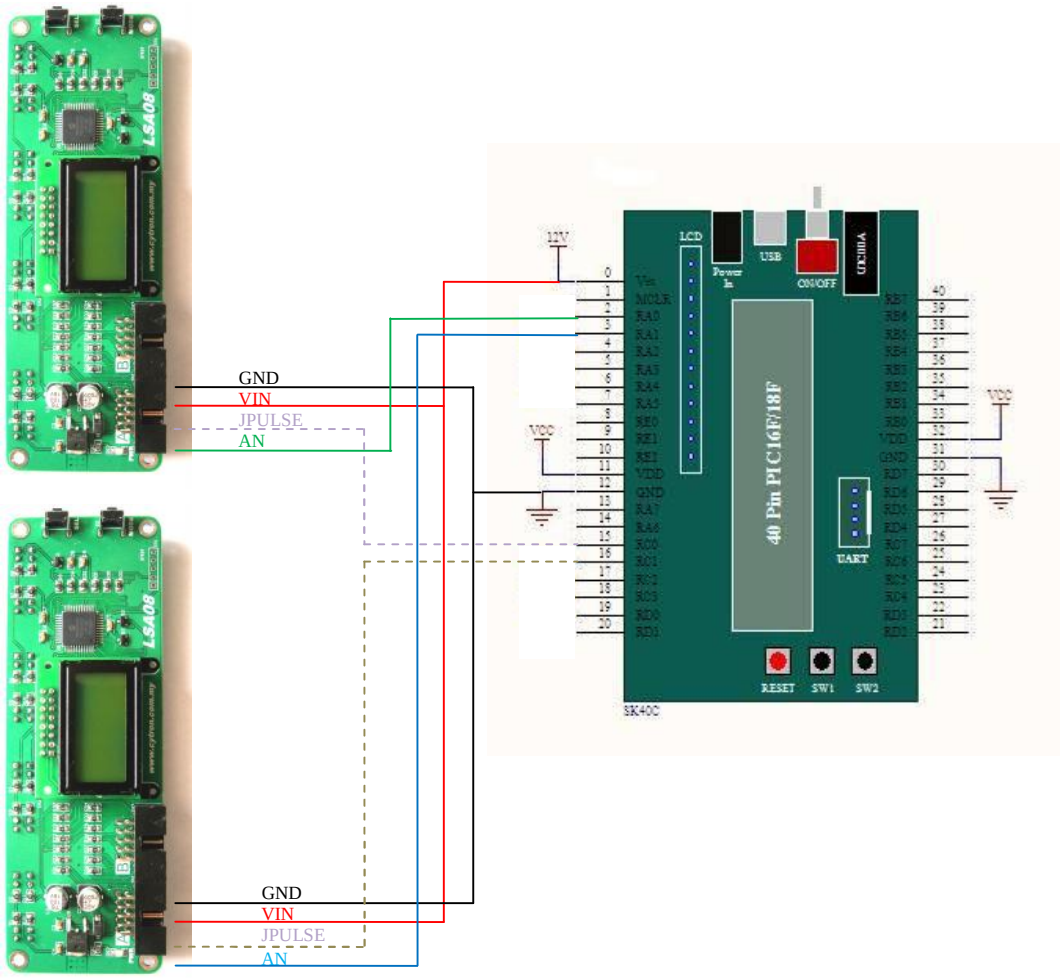
5.6.1 UART Connection:

Connection for multiple LSA08 to a single controller is shown in figure below. For UART communication, user is reminded to set **different UART Address** for each connected unit of LSA08. This is for the main controller to differentiate between each connected LSA08, since the TX and RX pin can be shared for multiple LSA08.



5.6.2 Analog Connection:

Figure below shows the connection of multiple LSA08 to a single main controller. Two analog channels on main controller are needed. Extra wiring for JPULSE pin is needed if the user needs to perform junction counting.

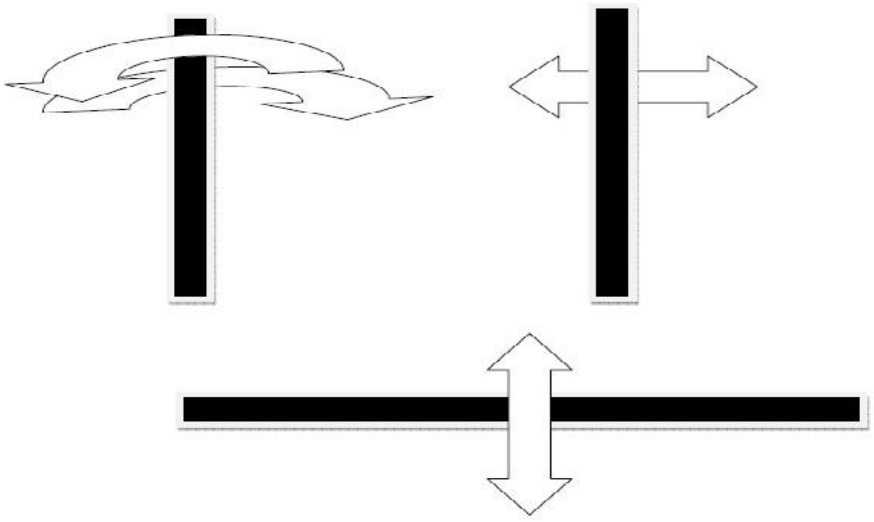


6. GETTING STARTED

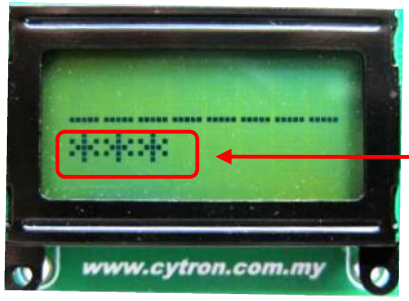
6.1 LSA08 Calibration:

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 sensor pairs** need to be exposed to the dark and bright surface for LSA08 to read and save the value. The surfaces brightness value will be saved to non-volatile memory of LSA08. 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 the setting menu by pressing MODE button twice. Choose CALB menu and enter the mode using SEL button. Calibration is started and user needs to exposing each of sensors to the bright surface and then to the dark surface of the line or background. LSA08 will save the brightest and darkest value from the calibration process. User can calibrate by simply swinging the sensors across the dark and bright surface. Example motions of calibration are show in the figure below. Same method applies for both Dark-On and Light-On mode. If the surface has several colours, choose the pair of colour which has less brightness different to calibrate for a better performance. For Example, line colour is white and there are 3 background colours, red, green and blue. Choose to calibrate on white line green background. Calibration of LSA08 can also be started by LSA08's command packet which will be discussed in later section.



Once the power is supplied to LSA08, LCD will display the line position detection and bar chart. Line position detection is a value to show the line position with respect to the leftmost sensor of LSA08. The line position shown on LCD display is ranging from 0 to 70. When there is no line detected, the position value will be shown as "****". If sensor S0 detected a line, the line position shown on LCD will be "0". Likewise if a line is detected on sensor S7 the position shown will be "70". The line position value varies **linearly from 0 to 70** according to the line detected by the sensors. If a line is at the middle of the LSA08 (S3 and S4), the LCD display will show the position as 35.



No line detected

Position 0 – sensor 0 detects the line

Position 70 – sensor 7 detects the line

Position 35 – sensor 3 and sensor 4 detect the line

6.2 Setting Menu of LSA08:

Selection of different Setting Menu can be done by pressing the **MODE** button. The desired Setting Menu is entered by pressing the **SEL** button. The respective setting value can be adjust using the SEL button after the entering the selected menu. Press on MODE button after done adjusting the desired setting value to go back to the Menu selector. Press again the MODE button to select other modes or Press and hold the MODE button to exit the Setting Menu. All the settings of LSA08 are listed in the table.

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)	
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

6.2.1 LCD CON

Press MODE button once will bring user to 1st Setting Menu: **LCD CON**. User can set appropriate LCD Contrast with the **SEL** button. Press and hold the SEL button for fast increment of contrast value.

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** once to enter the LCD Contrast Menu and **press and hold** the Select button to adjust the contrast.

6.2.2 CALB

Press Mode button twice will bring user to the Calibration Menu which allows user to calibrate the LSA08's sensor to the line and background surface that it will do line following. Press **SEL** button to start the sensor calibration and start swing the sensor across the different colours or brightness surface.

6.2.3 LINEMODE

The third setting menu is Line Mode menu which allows user to set whether the line following is Dark-On or Light-On. Dark-On means the line following is performed on a darker line compare to background colour (example, black line on white background surface). Light-On means line following is performed on brighter line compare to background colour (example, white line on blue or green or red or black background surface).

6.2.4 THRES

Threshold Menu is the 4th setting menu. User can set the desired setting value according to the surface condition of the line. Threshold (THRES) value of LSA08 is the number of bars shown by the bar chart on LCD which LSA08 assumes as a valid line detected. The threshold value can be set from 0 to 7 through the setting menu by using the MODE and SEL button.

For example, the threshold is set to 4. In the figure on left, S3 and S4 will detect the dark line because the bar chart is more than 4. On the other hand (Figure on right), if the bar chart is less than 4, LSA08 assume no line because the threshold value is 4.

LSA08 detect the line the bars are more than the threshold

LSA08 detects no line because the bars are less than the threshold.

6.2.5 J WIDTH

Junction Width menu is for setting the junction width of the junction, the numbers of sensors on LSA08 detect line which LSA08 will assume as a valid junction. This is special feature on LSA08 for the ease of cross junction counting. The valid Junction Width value is from 3 to 8.

6.2.6 UART ADD

UART ADD menu is for UART addressing. User can set **identical** UART address for each LSA08 connected to the robot system. This enables multiple LSA08s connected to a single UART line on main controller. Only LSA08 that matches the address called by main controller will respond. The address value can be from 0 to 255. Press and hold the SEL button for fast increment of address.

6.2.7 BAUDRATE

Baudrate menu is for setting the desire baudrate for UART serial communication. There are several baudrate can be set as listed below. User can choose the desire baudrate according to the table. Higher baudrate is more prone to error if the wiring is not good.

Baudrate No.	Baudrate
0	9600
1	19200
2	38400
3	57600
4	115200
5	230400

6.2.8 UARTMODE

UARTMODE menu is for setting the desired data output format from LSA08 on TX pin of PORT A when **$\overline{\text{UEN}}$** is pulled **low**. There are 4 available formats in the menu indicated by number 0 to 3. Each format is described in the table below.

Output Format	Description
0	No UART data output
1	Digital format. Each byte represents digital value of sensor. Each bit in the byte represents a sensor. LSB represents sensor 0 and MSB represents sensor 7.
2	Line position with respect to the leftmost sensor (sensor 0). Value from 0 to 70. No line is represented by value of 255.
3	Raw analog value for each sensor in a packet of 9 bytes. First byte is header (0x00) followed by 8bytes of the analog value of each sensors.

6.2.9 LCD B/L

LCD Backlight Menu is for the user to set suitable backlight for the LCD unit on LSA08. Current consumption of LSA08 is affected by the backlight value of the LCD. Brighter backlight will consume more current. The backlight value can be set from value of 0 to 10. Value 0 means the backlight is OFF.

6.2.10 EXIT

Exit menu is to exit the setting menu. Press SEL button to exit the setting menu when in this menu. Another exit method as mention before is by press and hold on mode button while in setting menu selector screen. The "Exit…" string will appear and LSA08 will exit to normal line display screen.

6.2.11 Debug Mode:

This is a special mode for debug purpose. User can see the sensor raw value on LCD unit of LSA08. This mode is not shown in the setting menu. To enter this mode, press and hold the SEL button for few seconds and release. Value of 1st sensor or sensor 0 will be displayed. This value is 10 bits value. To display value of other sensors, press the SEL button again to switch between the sensors. To exit the debug mode, reset LSA08 by power off and on.

6.3 LSA08 default settings:

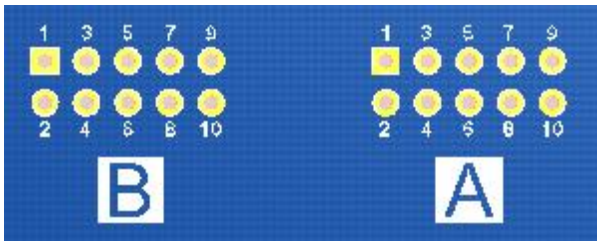
Table below shows the default setting of LSA08.

Menu	Default setting
Line Mode	Light On
Thres	4
J_width	5
Uart Add	1
Baudrate	0
Uart Mode	0
LCD BL	2

6.4 Output Port:

LSA08 has 2 output ports (Port A and Port B) for 3 types of output mode. The 3 outputs modes for LSA08 are serial communication (UART) output, Analog output and digital output (8 parallel output line). Port A includes UART and Analog output mode and port B is for digital parallel output mode. User may choose to use either Port A or Port B or both. Vin and Gnd pins on both Port A and B are for providing power to LSA08. LSA08 can be powered by either Port A or B. All the pin information is labeled clearly on the back surface of LSA08's PCB. Figures below show the pin labeling of LSA08.

Port A and Port B's Pin function



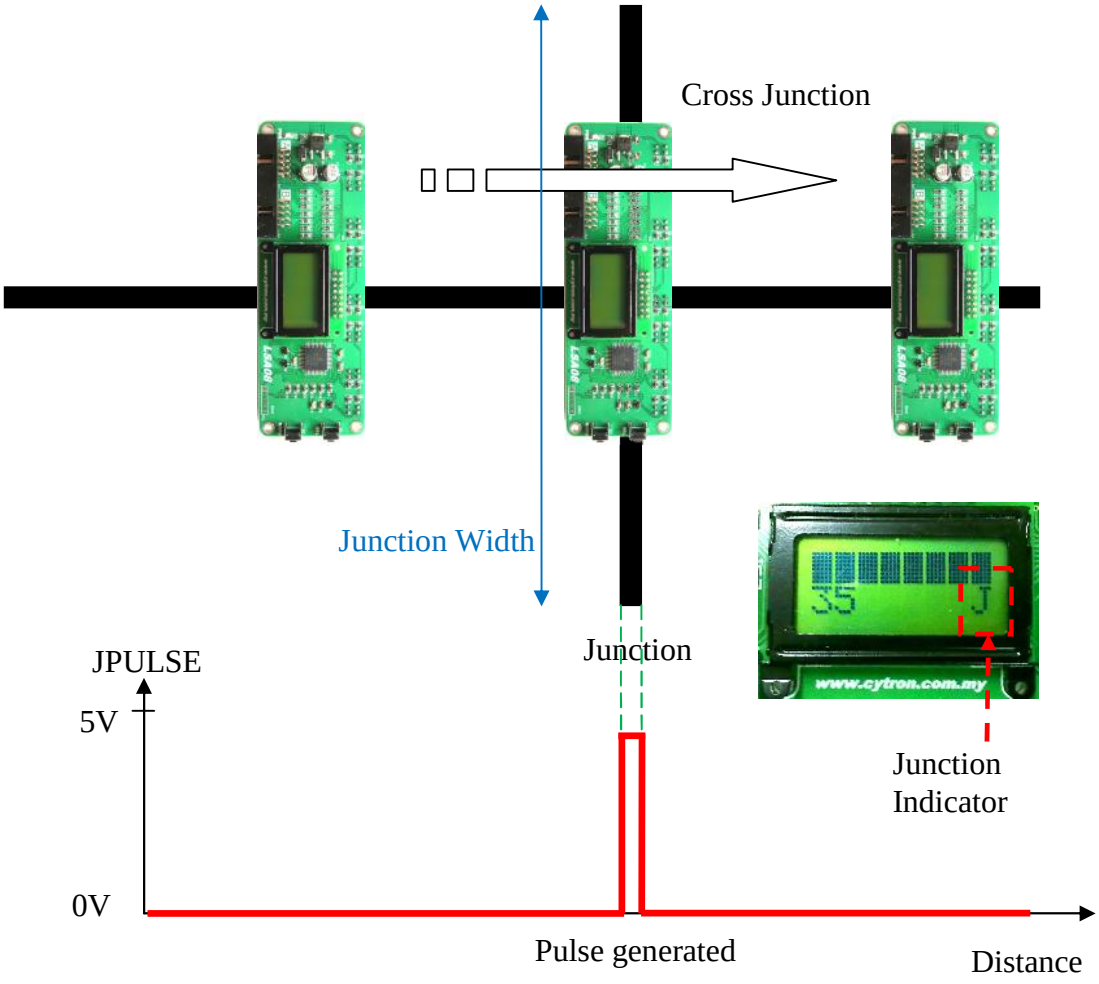
Port A and Port B's Pin numbering. Pin with square shaped soldering pad is pin 1.

6.4.1 PORT A – UART and Analog Output

Table below shows pinning information for PORT A:

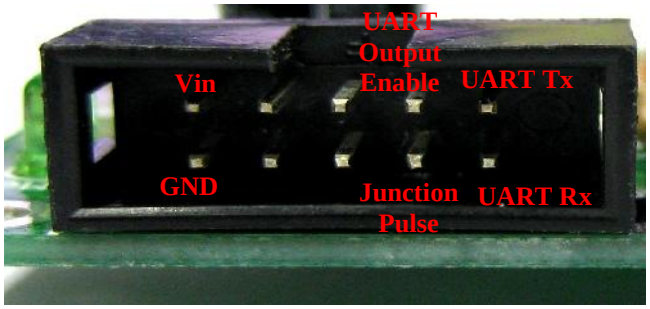
Pin	Description	Symbol
1	UART TX (Transmit)	TX
2	UART RX (Receive)	RX
3	UART Output Enable	$\overline{\text{UEN}}$
4	Analog Output	AN
5	Junction Pulse	JPULSE
6	Not used	-
7	Not used	-
8	Not used	-
9	VIN (12V)	VIN
10	GND	GND

LSA08's UART TX pin becomes floating and high impedance when it is not sending any data i.e. when $\overline{\text{UEN}}$ pin is not pull down and there is no UART command response from LSA08. LSA08's RX pin is weakly pulled up. $\overline{\text{UEN}}$ pin is an active low pin which is used to enable stream of data out of the LSA08's TX pin. AN pin of LSA08 give relative position of line detected by LSA08 in term of voltage level. This pin will be described in Analog output mode section. JPULSE pin is for junction detection, pulse will be generated every time LSA08 crossing a junction with a minimum width determined by Junction Width setting. Figure below illustrates the pulse generated on JPULSE pin when LSA08 cross a junction. User can use this feature to detect and count the junction cross. However, user can also choose to use the LSA08's command packet to obtain the junction count if the UART communication is available on main controller. LSA08's command packet will be discussed in later section. VIN and GND needs to be connected to a power supply. The power supply limitations and requirements are described previously in Product specification and limitations section. Typically user can connect a 9 to 12V supply to LSA08.



6.4.1.1 UART Output mode

Figure below shows pin defined for UART communication. UART and Analog pin shared same port which is PORT A.



PORT A

UART output enable signal pin ($\overline{UEN}$) is for controlling the flow of data from the LSA08 board. Data stream is sent out of the TX pin only when $\overline{UEN}$ pin is **pulled low**. This pin is functioning as the flow control of the UART output data. The main controller requests the data by pulling low the pin. The data output streams can be in 4 different formats which is set by UART Mode setting menu.

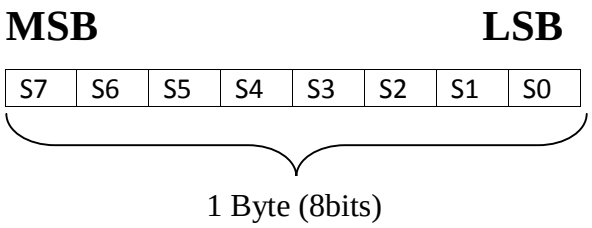
Different UART mode will set LSA08 to send different data type out of the TX pin. There are 3 data modes available in LSA08. All 3 types of UART modes are described below.

UART MODE 0:

This mode causes the LSA08 stops sending data out from UART port.

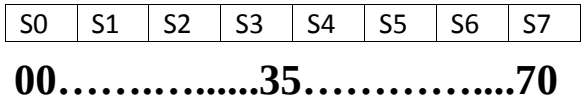
UART MODE 1:

UART Mode 1 sends out a byte of digital value of sensors. Every bit in the byte of the value represents the value of each sensor. Bit value 1 represents line detected and bit value 0 represents no line.



UART MODE 2:

UART Mode 2 sends out the detected line position. The value of line position is between 0 to 70. Value of **255** represents **no line** detected.



UART MODE 3:

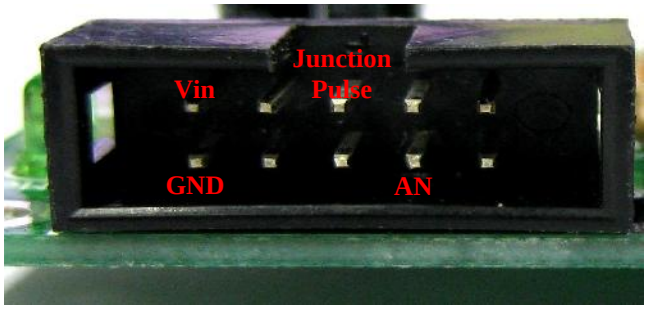
UART Mode 2 sends continuous bytes of sensors' raw value. This is for debug purposes if the user needs. The packet starts with header 0x00 and following eight bytes are the eight sensors raw values.

Packet format:

0x00	S0	S1	S2	S3	S4	S5	S6	S7

6.4.1.2 Analog Output mode

Figure below shows the pin used in analog output mode. Junction Pulse pin can be used if the user needs to do cross junction counting or else it can be eliminated.



PORT A

Voltage on analog output pin represents the relative line position detected by LSA08. 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 S3 and S4. The LCD on LSA08 will show the position as 35 and the analog pin voltage reading will be around 2.25V. The linear equation for conversion of analog value on Analog Output pin to the position is shown below:

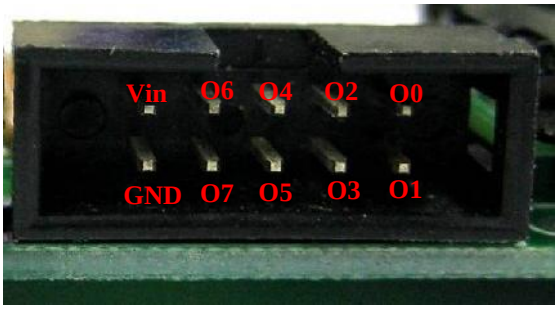
$$Position = \frac{Analog\ Pin\ Voltage)}{4.5V} \times 70$$

6.4.2 PORT B – Digital Output port

The digital port consists of 8 signal pins and 2 pins for power supply to LSA08. Every signal pin represents a sensor on LSA08 board. A 5V or high digital value "1" shows line detected while 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 sensor 0 and sensor 1 sensor give high digital value, this means that the line is in between the two sensors.

LSA08's Port B requires very simple setup. User can connect the digital port which consist 8 signals from LSA08 directly to main controller's digital input port (general purpose IO port). The user program will read the digital port value to determine the line position. Example setup with IFC-DI08 was shown previously in Installation section. Table below shows the pins defined for digital output port.

Pin	Description	Symbol
1	Digital Output 0 (Sensor 0)	O0
2	Digital Output 1 (Sensor 1)	O1
3	Digital Output 2 (Sensor 2)	O2
4	Digital Output 3 (Sensor 3)	O3
5	Digital Output 4 (Sensor 4)	O4
6	Digital Output 5 (Sensor 5)	O5
7	Digital Output 6 (Sensor 6)	O6
8	Digital Output 7 (Sensor 7)	O7
9	Vin (12V)	VIN
10	GND	GND



PORT B

6.5 LSA08 UART Commands:

6.5.1 Command Packet Format:

User can send UART commands to setup and retrieve information or data from LSA08. UART Serial Communication specifications of LSA08 are shown as following:

Baudrate	Depending on UART baudrate setting
Start bit	1
Stop bit	1
Data bit	8
Parity bit	0

Baudrate setting table of LSA08:

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

LSA08 UART Command Reference Table:

Command (ASCII)	Hexadecimal Value	Description	Data (decimal value)
C	0x43	Calibration	0
L	0x4C	Mode (Dark On/Light On)	0 -1
T	0x54	Line Threshold	0 - 7
J	0x4A	Junction Width	3 - 8
A	0x41	UART Address	0 - 255
B	0x42	LCD Backlight	0 - 10
S	0x53	LCD Contrast	0 - 255
R	0x52	UART Baudrate	0 - 5
D	0x44	UART Data Output Mode	0 - 3

X	0x50	Junction information	0 -1
P	0x4F	Line position/sensor information	1-2

UART Command Packet Format (4 bytes):

ADDRESS	COMMAND	DATA	CHECKSUM

Table above shows the command packet used to setup LSA08 or retrieve information from LSA08. ADDRESS is the Address of the LSA08 which the value can be from 0 to 255 set by user in UART Address Menu. This Address together with UART Output Enable features allows the user to control more than one unit of LSA08 from a single main controller. 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

In order to successfully send a command to LSA08, user will need to continuously send the 4 bytes value in the packet. LSA08 will only wait for a maximum of **20ms** for a continuous byte in a packet. After the wait period, LSA08 will discard the incomplete packet.

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 expose the LSA08 sensors to the line and background for the calibration period.

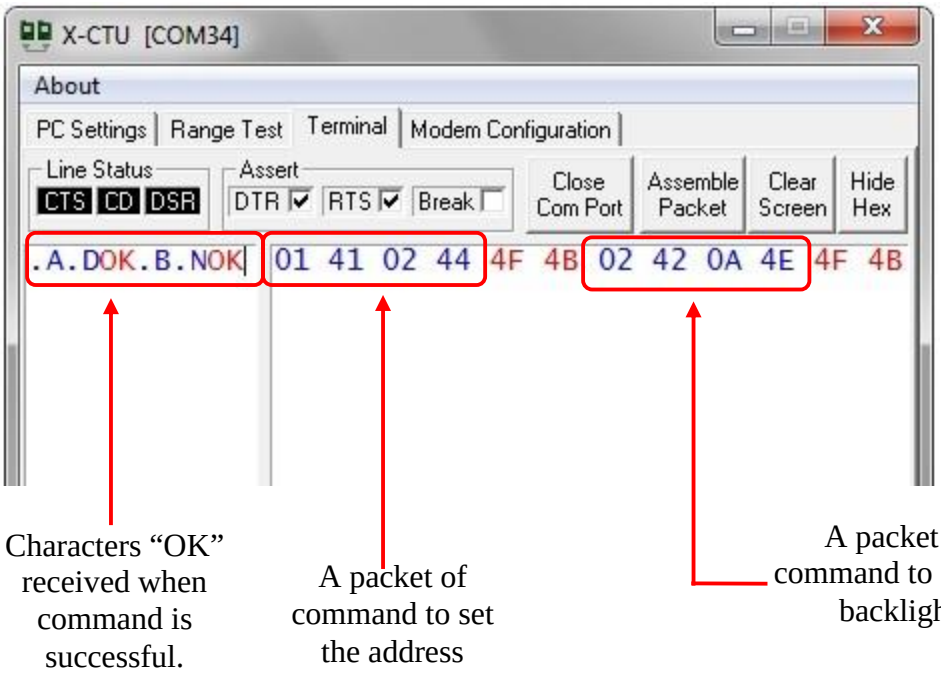
Address	Command	Data	Checksum
0xF0	0x44	0x03	0x37

The above command will set the LSA08's UART data mode to mode 3 which is the raw data 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 the correct address of LSA08. 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 setting type command received by the LSA08 with correct address, command and checksum value will be responded by LSA08 with a pair of ASCII characters "**OK**" immediately upon successful execution of the command. If in case there is no response from LSA08, this means that the packet is being ignored by LSA08 because of the wrong address, command, checksum or communication error which may be due to incorrect baudrate or poor signal line.

Figure below is examples of packet command sent to LSA08 using terminal on a computer. 1st command packet sent is to set the address to 02 from the current address (01). The 2nd command packet is to set the LCD backlight to maximum backlight (10).



For the command which acquire data or information from LSA08, LSA08 will not respond with "OK". Instead, LSA08 will send out the data requested immediately. For example, the command 'P' and command 'O'.

6.5.2 Description of commands:

Calibration :'C'

Example packet:

Address	Command	Data	Checksum
0x01	0x43	0x00	0x44

This packet is sent to LSA08 with address of 1 to command the LSA08 to perform calibration immediately. User will need to control the robot to start rotate robot against the surfaces that it will perform line following.

Line Mode: 'L'

Example packet:

Address	Command	Data	Checksum
0x01	0x4C	**0x00**	0x4D

This packet will command the LSA08 to set the line mode to Light-On line following mode.

Address	Command	Data	Checksum
0x01	0x4C	**0x01**	0x4E

This packet will command the LSA08 to set the line mode to Dark-On line following mode.

Line Threshold: 'T'

Example packet:

Address	Command	Data	Checksum
0x01	0x54	**0x04**	0x59

This packet will command LSA08 to set the line threshold value to 4.

Junction Width: 'J'

Example packet:

Address	Command	Data	Checksum
0x01	0x4A	**0x08**	0x53

This packet will set the minimum junction width as 8 which mean that LSA08 will assume a junction is crossed if 8 sensors detected line.

UART Address: 'A'

Example packet:

Address	Command	Data	Checksum
0x01	0x41	**0x01**	0x43

This packet will set the Address of LSA08 as 1. This address will be used for UART communication.

Backlight: 'B'

Example packet:

Address	Command	Data	Checksum
0x01	0x42	**0x02**	0x45

This packet will set LSA08's LCD backlight brightness to level 2.

Contrast: 'S'

Example packet:

Address	Command	Data	Checksum
0x01	0x53	**0x50**	0xA4

This packet will set the LSA08's LCD contrast to 80.

Baudrate: 'R'

Example packet:

Address	Command	Data	Checksum
0x01	0x52	**0x00**	0x53

This packet will set the LSA08's UART baudrate to 9600bps according to the baudrate setting table shown previously.

UART Data Mode: 'D'

Example packet:

Address	Command	Data	Checksum
0x01	0x44	**0x02**	0x47

This packet will set LSA08's UART data mode to mode 2 which LSA08 will send out line position through the TX pin when $\overline{\text{UEN}}$ pin is pulled low.

Junction Information: 'P'

Example packet:

Address	Command	Data	Checksum
0x01	0x50	**0x00**	0x51

This packet will clear the internal junction counter of LSA08.

Address	Command	Data	Checksum
0x01	0x50	**0x01**	0x52

This packet will cause LSA08 to send out the internal junction counter value. User can retrieve the internal junction counter value by sending this command and use this value to determine how many junctions had the LSA08 crossed.

Line/Sensor Information: 'O'

Example packet:

Address	Command	Data	Checksum
0x01	0x4F	**0x01**	0x51

Sending this packet to LSA08 will return a byte of sensor's digital value. MSB is sensor 7's value and LSB is sensor 0's value.

Address	Command	Data	Checksum
0x01	0x4F	**0x02**	0x52

Sending this packet to LSA08 will return a byte of relative line position detected by LSA08. The returned value is from 0 to 70.

This method to retrieve the line position using command packet is relatively slower compared to streaming the line position out of LSA08's TX by pulling down $\overline{\text{UEN}}$ pin. User who needs fast refresh rate of line position, especially for fast moving robot is advised to use the $\overline{\text{UEN}}$ to stream out the line position.

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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