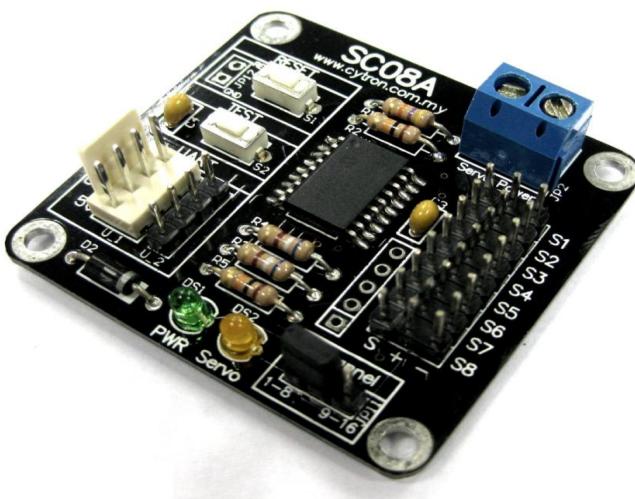




# SC08A

## SERVO CONTROLLER



## User's Manual

V1.0

June 2011

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## 1. INTRODUCTION AND OVERVIEW

SC08A offers reliable yet user friendly RC Servo motor controller to hobbyist and students. Different with SC16A, SC08A is designed to control 8 independent standard RC (Remote Control) servo motors simultaneously in a single board. Each servo signal pin is able to generate servo pulses from 0.5 ms to 2.5 ms, which is greater than the range of most servos, further allows for servos to operate 180 degrees. SC08A comes with small size and different protocol compare to SC16A. Through serial communication, SC08A can be daisy chain in 2 boards to offer independent control over 16 RC servo motors simultaneously. The host of SC08A can either be a PC desktop/Laptop with USB to serial(UART) converter, or microcontroller with UART interface. UART interface present a flexible, fast and easy to use feature.

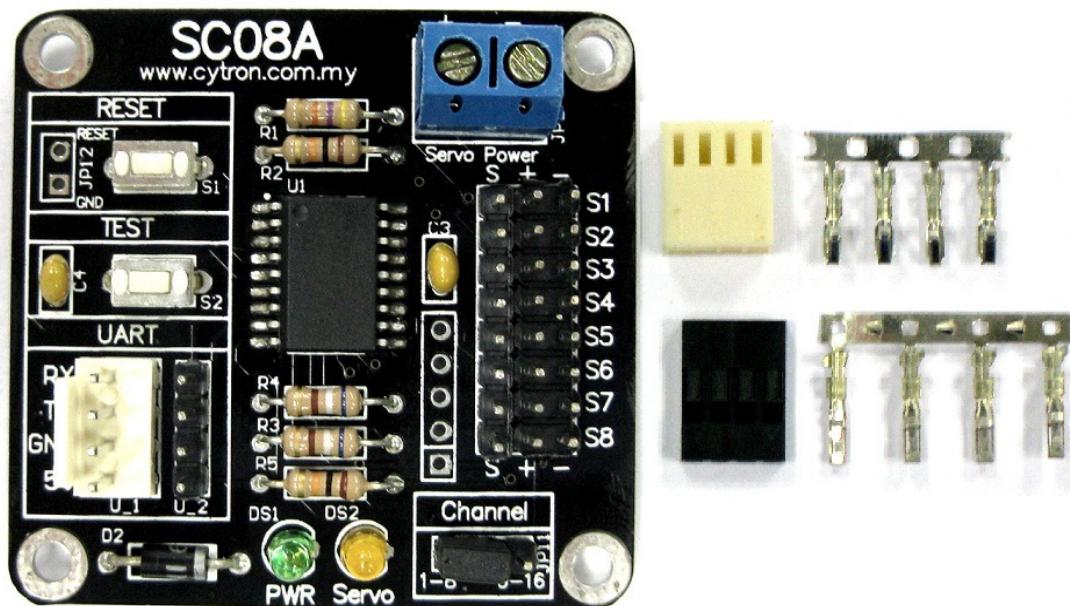
It is designed with capabilities and features of:

- **8 channels:** Servo driven independently
- **Extendable to 16 Channels:** Two controller linked together to drive 16 servos
- **Optional Position Reporting:** User may request position of an individual servo.
- **Servo Activation for each channel:** User may deactivate or activate any channel of servo.
- **Independent Starting Position Command for each channel:** User may set the initial position of any channel at the next start-up.
- **Optional Servo Ramping:** Choose one of 100 ramp rate for each servo.
- **Resolution:** 8000 steps = 0.25us.
- **UART:** 9600 baud rate
- **Servo pulse range:** 0.5ms to 2.5ms.

This document explains the method to use SC08A.

## 2. PACKAGING LIST

Please check the parts and components according to the packing list. If there are any parts missing, please contact us at [sales@cytron.com.my](mailto:sales@cytron.com.my) immediately.



1. 1 x SC08A main board
2. 1 x 2510H-04 connector (with terminal pins)
3. 1 x 2561-04 connector (with terminal pins)
4. 1 x mini jumper for JP11
5. User's Manual and other necessary softcopy should be downloaded from  
[www.cytron.com.my](http://www.cytron.com.my)

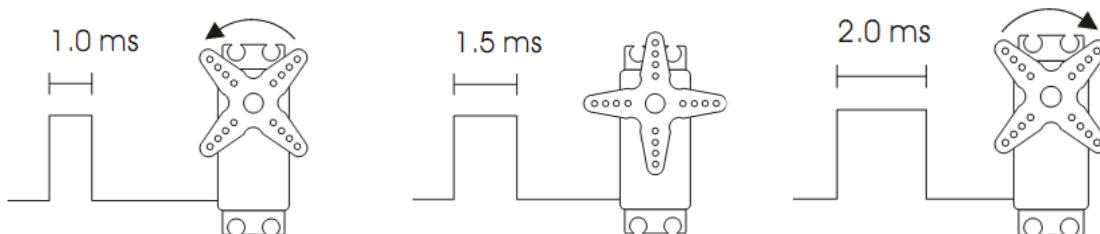
### 3. How RC Servo Motor works

Radio Control (RC) hobby servos are small actuators designed for remotely operating model vehicles such as cars, airplanes, and boats. Nowadays, servos have become more popular in robotics, creating humanoid robot, biologically inspired robot, robotic arm and etc. This is because its' ability to rotate and maintain a certain location, position or angle according to control pulses from a single wire. Inside a typical servo contains a small motor and gearbox to do the work, a potentiometer to measure the position of the output gear, and an electronic circuit that controls the motor to make the output gear move to the desired position. Because all of these components are packaged into a compact, low-cost unit, servos are great actuators for robots.

Besides signal wire, a RC servo has other two leads: power and ground. The control signal is a continuous stream of pulses that are 1 to 2 milliseconds long, repeated approximately fifty times per second, as shown below.

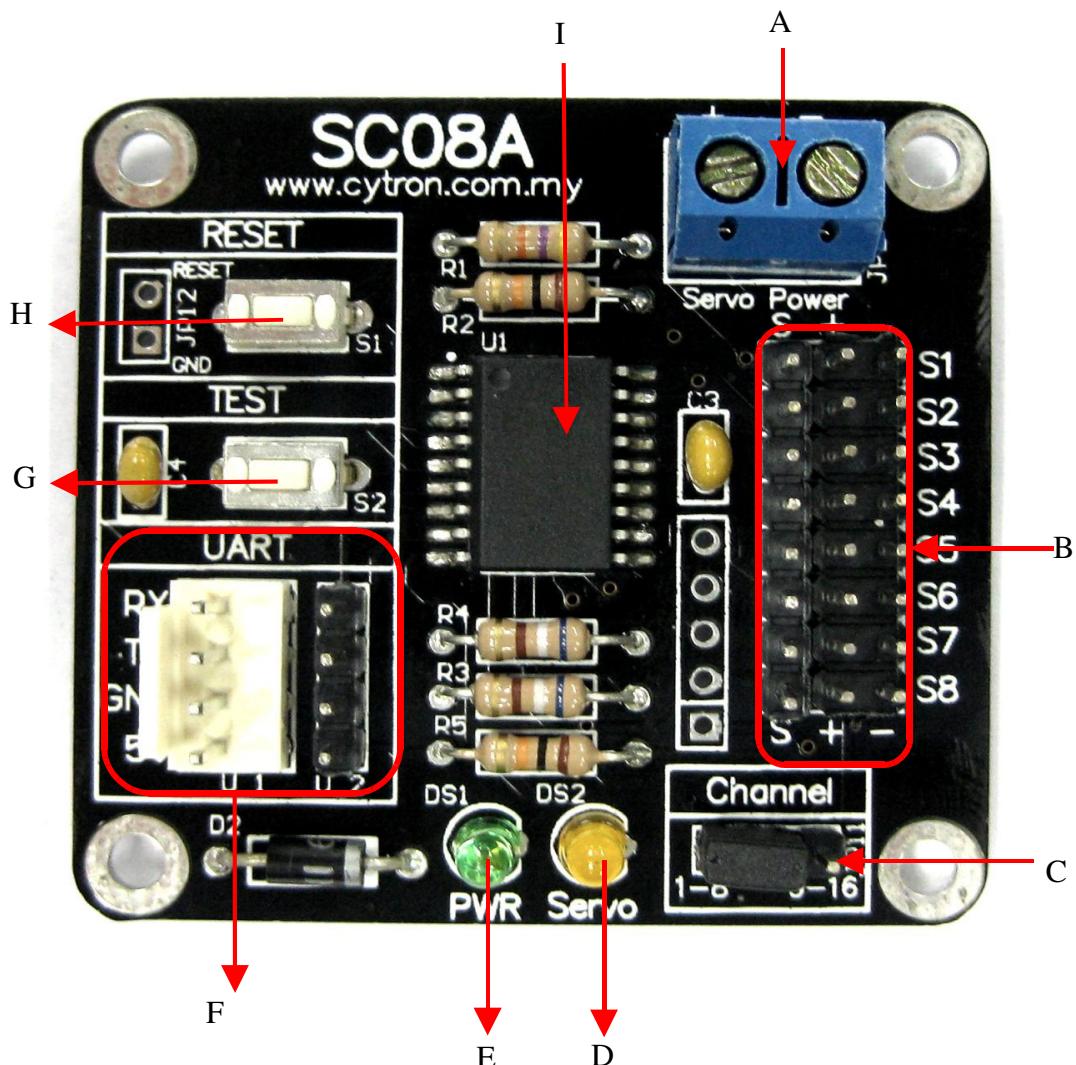


The width of the pulses determines the position to which the servo moves. The servo moves to its neutral, or middle, position when the signal pulse width is 1.5 ms. As the pulse gets wider, the servo turns one way; if the pulse gets shorter, the servo moves the other way. Typically, a servo will move approximately 90 degrees for a 1 ms change in pulse width. However, the **exact correspondence between pulse width and servo varies from one servo manufacturer to another.**



SC08A is designed to simultaneously generate 8 independent servo control signals. The servo controller can generate pulses from 0.5 ms to 2.5 ms, which is greater than the range of most servos, and which allows for a servo operating range of over 180 degrees.

#### 4. BOARD LAYOUT



Label	Function	Label	Function
<b>A</b>	Servo motor power source connector	<b>F</b>	UART/expansion pin connectors
<b>B</b>	Servo motor channels	<b>G</b>	Servo test button
<b>C</b>	SC08A selection channels	<b>H</b>	Reset button
<b>D</b>	Servo power indicator LED	<b>I</b>	PIC16F1827
<b>E</b>	Power indicator LED		

**A** – Blue terminal block for servo motor power source. Please connect correct power to the provided connector and check the polarity before plug in. Normally, rated voltage to drive servo motors is in between 4.8V and 6V. Some may need 7.2V. It is depending on the type of servo motor used. **Over supply voltage may spoil the servo motor!**

**B** – 8 channels of servo motor. Each channel consists of 3 header pin. Servo motor channels t are labeled at the top. Please follow the label for connecting servo port to SC08A, 'S' is for signal line.

**C** – Header pin to configure SC08A for expansion mode. For single board usage, a mini jumper should be put on '1-8'. If SC08A is used in expansion, one of SC08As must be configure to expansion board, the mini jumper should be put on '9-16'.

**D** – A small orange LED to indicate power for servo motor. It should illuminate if power source is connected properly.

**E** – A small green LED to indicate 5V for PIC operation.

**F** – 4 ways header pin and connector for UART communication (using UC00A) and for user to connect SC08A to microcontroller host or another SC08A board. Please be cautions during making connection to this header, **wrong polarity will damage servo controller.**

**G** – Servo test button. Press the test button and the pulses generated will drive servos to the end of position. It is useful to test if the servo controller is working.

**H** – 18 pin of PIC16F1827

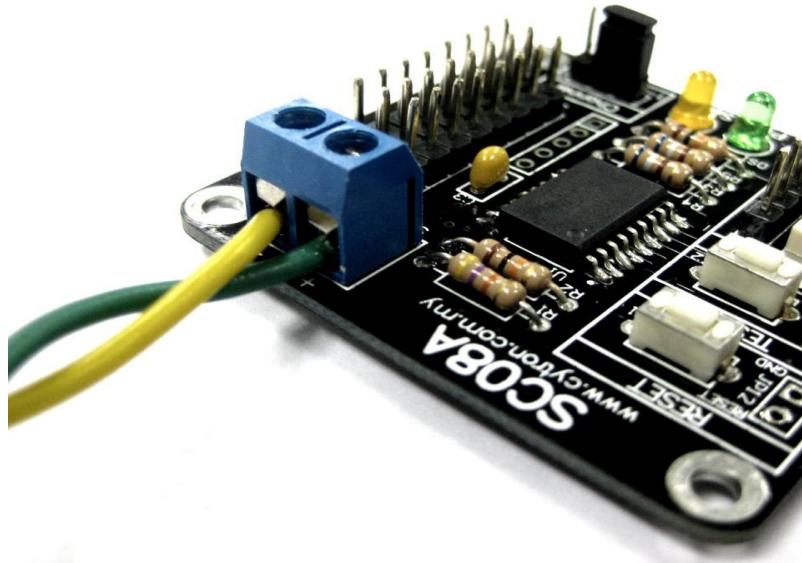
**I** – Reset button for SC08A. Pressing this button will stop all pulses generation and return SC08A to initial stage if after released. Without pulses generation, all servo connected to SC08A will not rotate, is free run.

## 5. INSTALLATION (HARDWARE)

SC08A is designed to control 8 channels of RC servo motor. Following steps will guide user in using SC08A. The controller can either be a microcontroller with UART interface or PC desktop/Laptop with UC00A.

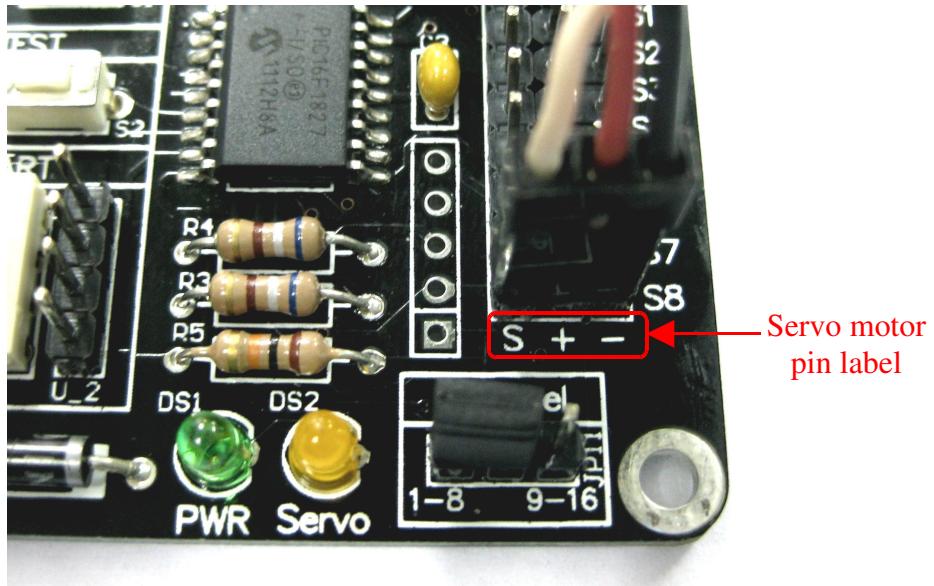
### 5.1 Setting up SC08A

1. Servos are typically powered by independent power source ranging from 4.8V to 9V (standard is 4.8V to 6.0V). The power source should be connected to blue terminal block shown as figure below. **Over supply voltage may spoil the servo motor!**

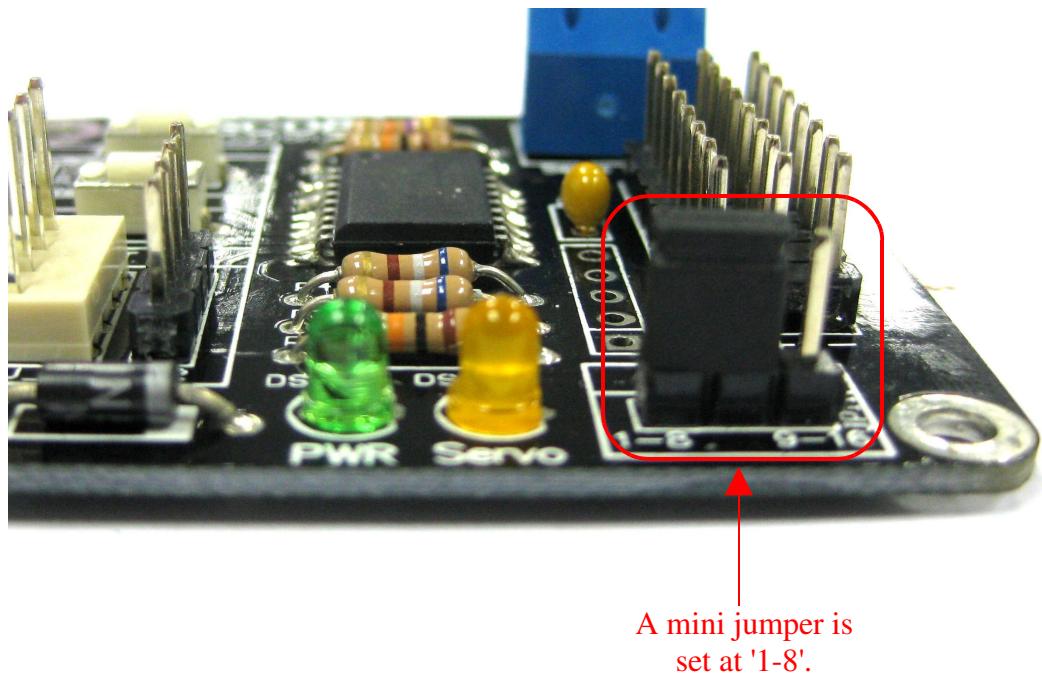


- Servo power indicator LED (orange) will light on if the power source is connected correctly.
  - The power source should be able to provide several ampere of current if many servos are expected to have loading simultaneously.
2. User must ensure the power source is connected correctly before plug-in servo to SC08A. Servo cable may be plugged to any servo channel on SC08A. When connecting servos, be careful because the servo header pins (connector) are not polarized and it is possible to plug in a servo backwards. **ENSURE** the connection of servo is correct; else the servo may destroyed. The function of each pin is being label

at the top of servo motor port, please follow the label to connect the servo.

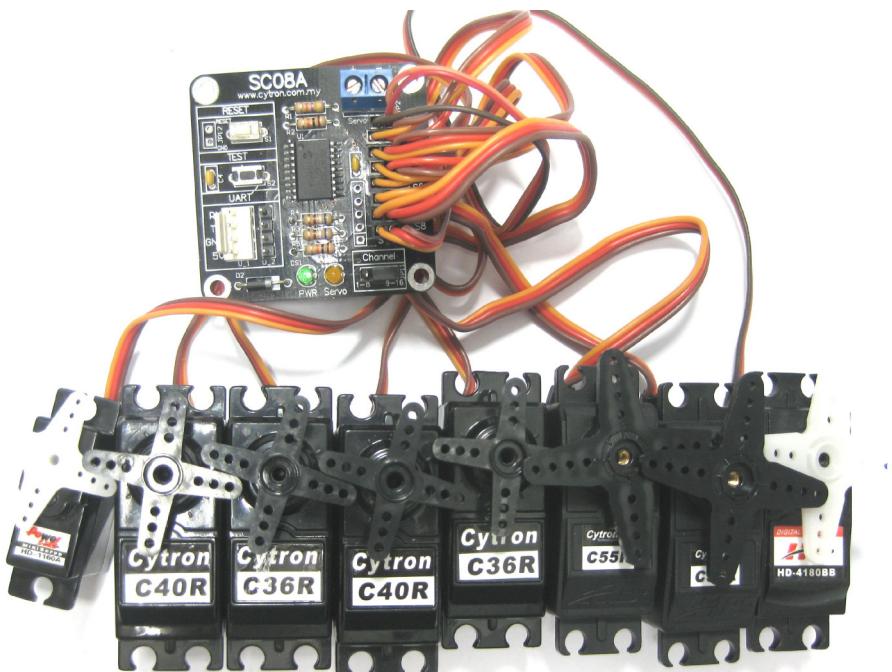


3. For basic connection (8 servos maximum), At JP11, please ensure a mini jumper is set at 1-8.



4. SC08A needs its own power to power up the circuit;. The standard power source is 5V for SC08A.
5. Following steps will further explain the hardware setup for PC desktop/Laptop, Microcontroller and also expansion mode.

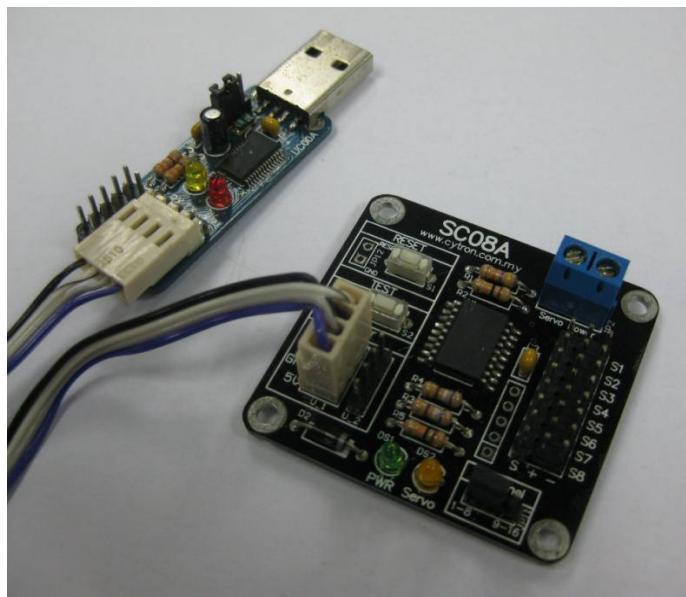
**Caution:** Always ensure the Power source for servo is connected correctly before servo motor is connected to SC08A, else all servo motor will be damaged.



## 5.2 Connecting SC08A to Computer

One of the main concerns in controlling servo is the hard work needed to get start. However, with SC08A, getting start is easy as 1 2 3. Since USB was removed from the board, user can use any USB to UART converter/devices to communicate SC08A with PC or laptop. Cytron offers a USB to UART converter named UC00A, no RS232 (serial port, DB9) is needed. This will save tremendous work and time. Simply plug the converter UC00A (in this case) to SC08A and (PC or Laptop) and there is an extra virtual COM port. Only power source for servo motor is needed if SC08A is connected to PC.

1. Connect UC00A to SC08A and PC/laptop as shown in following figure. The driver will installed automatically (1<sup>st</sup> time user only for Win 7) and there is an extra virtual COM port.

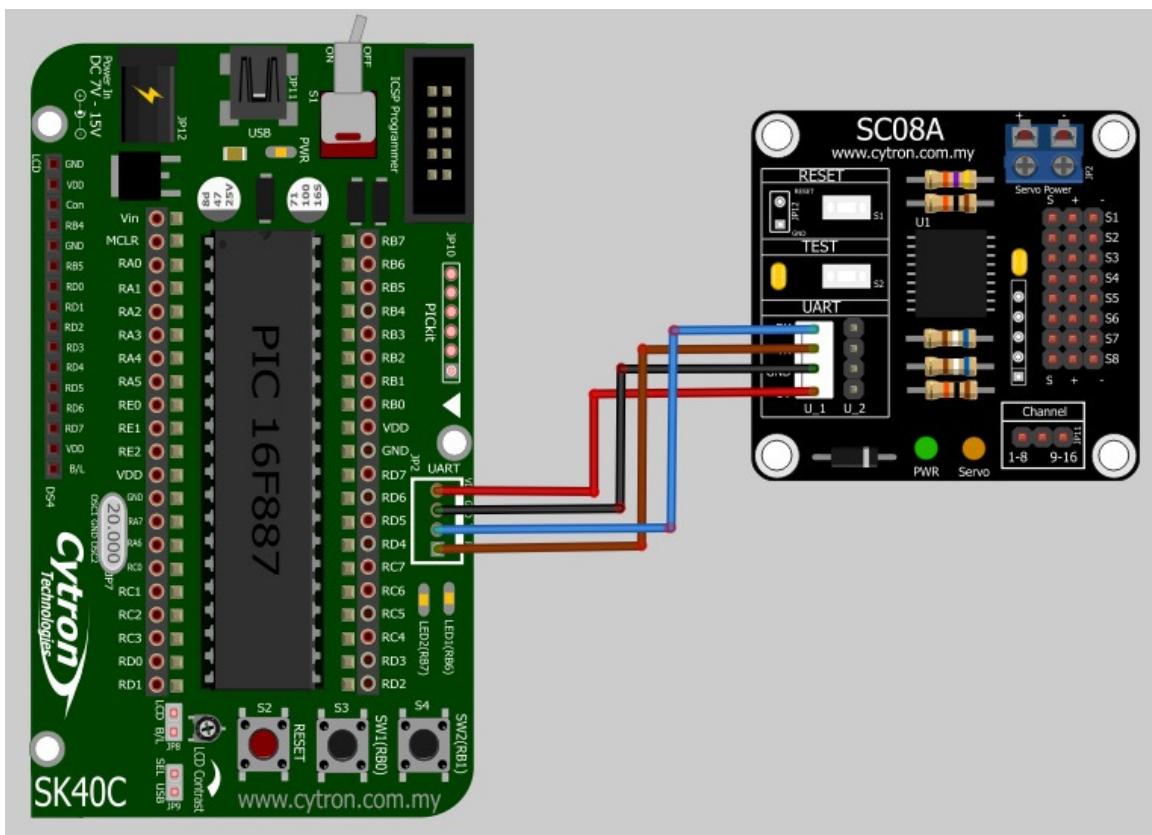


2. Connect servo power source at JP2(blue terminal block). SC08A get it power from UC00A.
3. Please beware that, only one host can be connected to SC08A at a moment. Either computer or a microcontroller. DONOT connect two hosts (computer and microcontroller) to a SC08A at the same time.

**Caution:** Only one host should be connected to SC08A, either computer (through UC00A) or microcontroller (through UART).

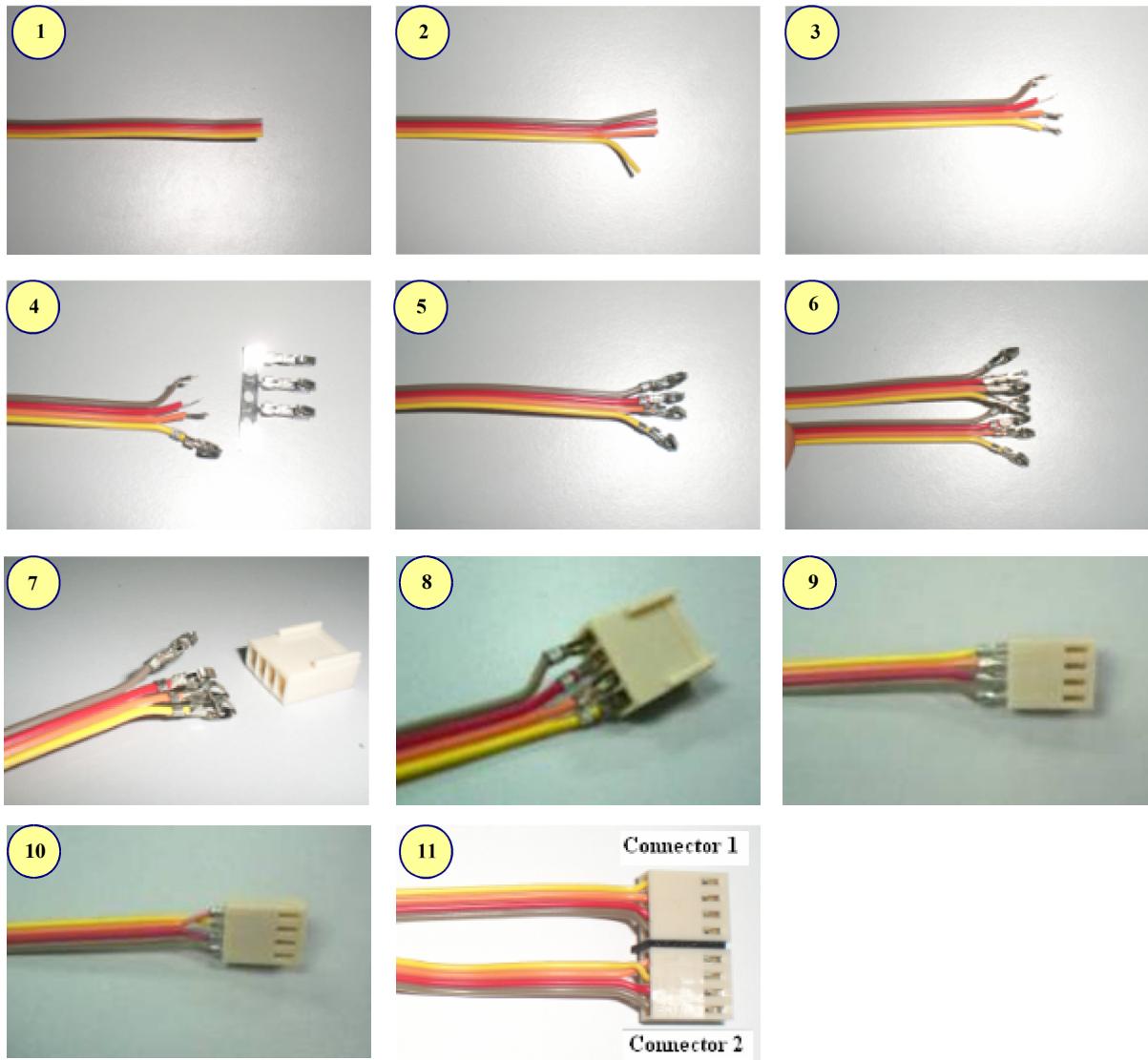
### 5.3 Connecting SC08A to Microcontroller

Another concern of user is for embedded system to control servo motors. For microcontroller to interface with SC08A, the minimum requirement will be TTL UART (Universal Asynchronous Receiver and Transmitter) and 5V supply. 5V will not be an issue since most of embedded or microcontroller system is 5V powered, tapping the 5V from host system will be reasonably easy. As for UART, a minimum of Transmit pin is required to send command to SC08A.



1. Please refer to the sample schematic to interface SC08A to microcontroller. Following sample schematic shows PIC16F877A interface to SC08A. No restriction to what type or brand of microcontroller can be used, as long as it has UART peripheral. Schematic above show sample schematic to interface SC08A to SK40C.
2. Although SC08A come with Tx pin, it is an alternative for user to connect if positioning report is needed. Thus minimum wires from the host, microcontroller to SC08A are 3 wires. Please use proper connector to connect the wires. Following figure show an example of wire interface to SC08A. It uses 4 ways 2561 socket. Please ensure the cable

is not connected in wrong direction, wrong connection will spoilt SC08A and worst the host or microcontroller. Tx and Rx pin of SC08A should be cross connected to Tx and Rx pin of SK40C. In other words, Rx of SC08A should be connected to SK40C's Transmitter pin (Tx), while Tx of SC08A should be connected to SK40C's Receiver pin (Rx).

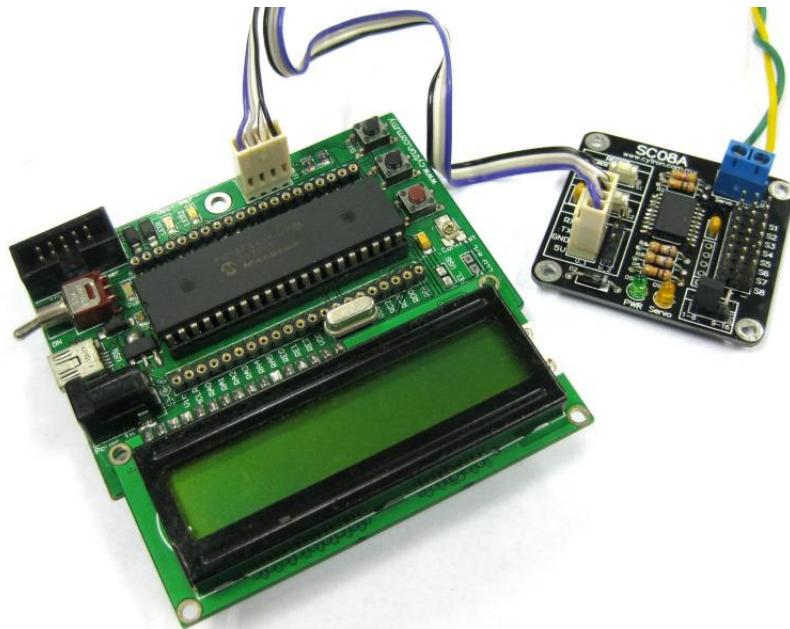


\* For step 6, please repeat step 1 – 5 for other end of rainbow cable.

\*\*For step 10, Tx and Rx should cross connected.

3. In this setup, SC08A will share 5V power source from host or microcontroller board. If 5V power source is ON and connection is correct, the small green LED (5V) will light ON to indicate controller is powered.

4. The hardware interface for SC08A to microcontroller host is ready. However in order to control servo from microcontroller, user is require to write program for microcontroller sending command according to protocol in software section.

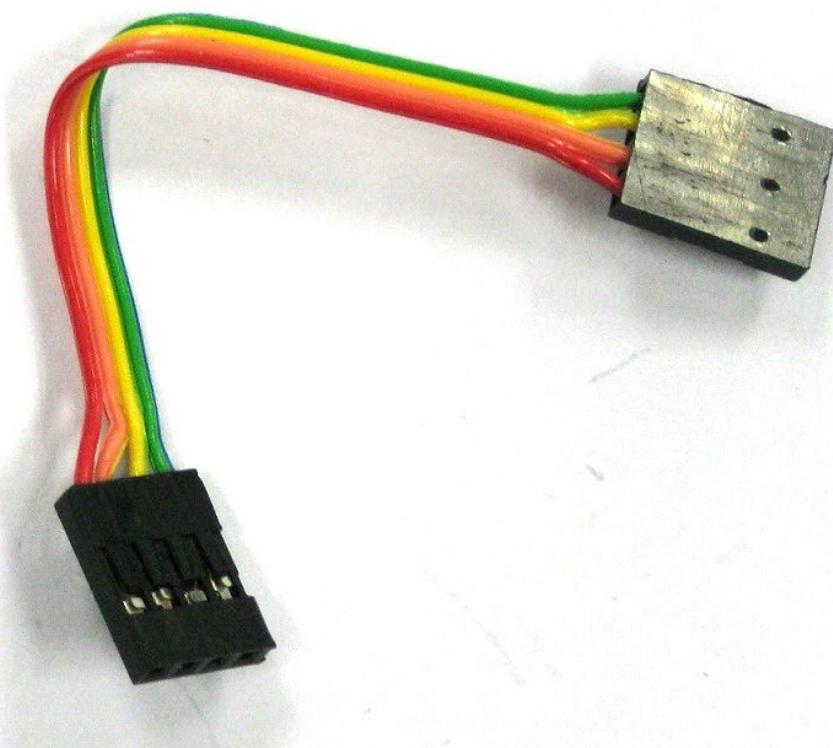


Hardware connection between SK40C and SC08

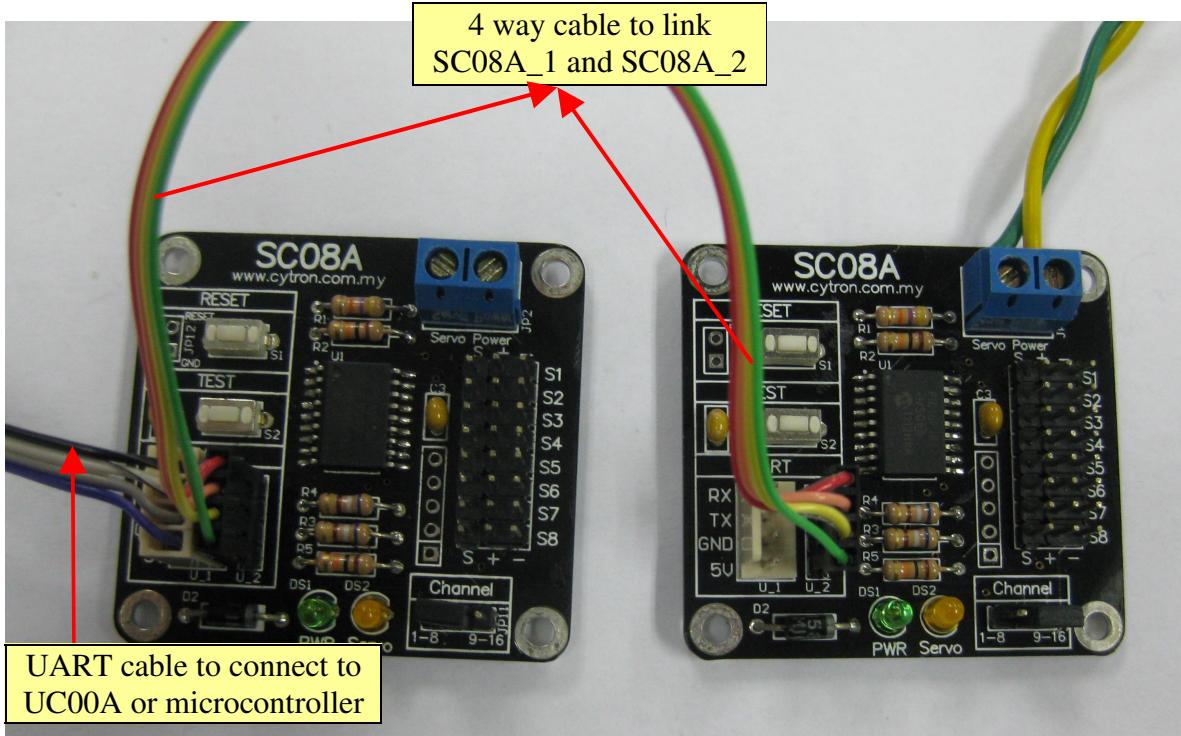
## 5.4 Expanding SC08A for 16 Channels

SC08A provides the flexibility to be expanded and control 16 channels of servo motor simultaneously. In some application, more than 8 servos are required. No worries, 2 units of SC08A can be combined for expansion mode to control 16 servos. Following steps will guide user to setup SC08A for expansion mode.

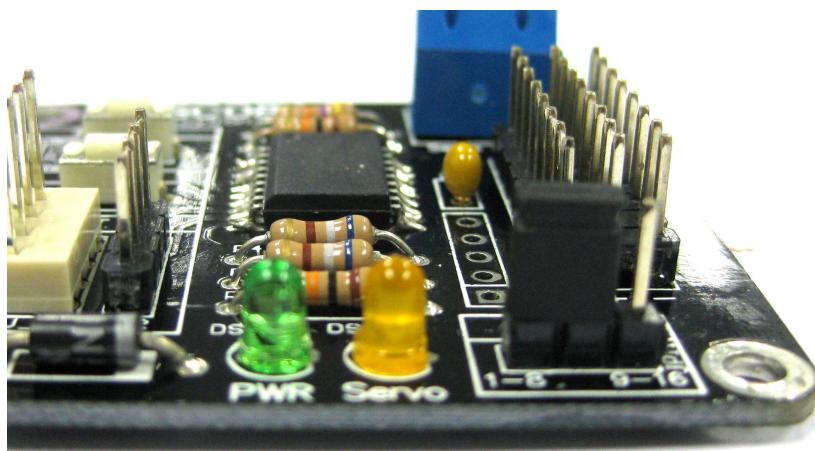
1. Two units of SC08A are needed.
2. Setup both SC08A according to steps in section 5.1. User may share the same power source for servo motor. However, please ensure power source is capable to supply higher current since more servos are used.
3. Create a 4 ways cable for interlink between two SC08As. Following figure shows the cable connection. Please ensure the polarity is correct. This cable connection is not same with cable in previous section. Do not use this cable to connect SC08A with microcontroller.



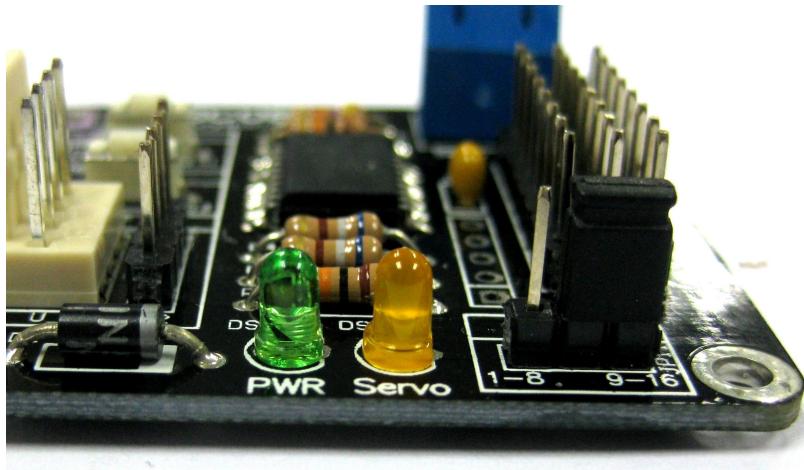
4. Link up both SC08A with the cable. Following figure shows the sample connection. Please ensure the 2510 connector is being connected. Users may use either U\_1 or U\_2 to connect SC08A to another SC08A board.



5. For SC08A\_1(board 1), a mini jumper should be put at “1-8” while for SC08A\_2(board 2) a mini jumper should be at “9-16”.



SC08A\_1 : a mini jumper is set to '1-8'



SC08A\_2 : A mini jumper is set to '9-16'

6. For SC08A\_2, servo connected at “S1” will be recognized as “S9” in software. This applied to the rest of servo port on SC08A\_2. Every label should be added with 16 during software development.

## 6. INSTALLATION (SOFTWARE)

Cytron Technologies has provided two sample program for users understanding. One of sample programs is using SK40C and PIC16F877A to control servo through SC08A. Another simplest way is use to the sample GUI Control Panel program which installer has provided by Cytron Technologies Website.

### 6.1 Sample program for PIC16F877A

Most servo motor is being used as actuator for humanoid, legged mobile robot and many other applications. All these developments are based on embedded controller, which is microcontroller or microprocessor. Considering this reason, Cytron Technologies has also developed a sample embedded program using PICC Lite for PIC16F877A. Following steps will guide user to use the sample program.

1. The sample program (SK40C\_16F877A\_SC08A.zip) can be downloaded from Cytron website ([www.cytron.com.my](http://www.cytron.com.my)), the link under SC08A page.
2. Extract the file into hard disc.
3. Ensure the hardware interface for microcontroller to SC08A is setup properly. Besides, the power for servo motor is also needed. Please refer to section 5.3 for example of schematic.
4. There are 2 files available for user, SK40C\_16F877A\_SC08A.c and SK40C\_16F877A\_SC08A.hex. For fast testing, user may load SC08A+16F.hex to PIC16F877A and plug into microcontroller board that was being completed in step 3.
5. The sample program is based on SK40C startup kit. Power up the board, it will further power the SC08A.
6. If all connections and setups are correctly done, press SW1 to activate all servo motor channel. Press SW2 and every servo on SC08A will turn from left to right and return to left.
7. Please refer to SK40C\_16F877A\_SC08A.c for details on method to send command to SC08A.
8. Sample source code for PIC16F877A is compatible for PIC16F876A. Cytron Technologies developed based on PIC16F877A is because PICC Lite does not support PIC16F876A.

## 6.2 Sample Program for Computer

To ease for user using SC08A, Cytron Technologies has develop a GUI (Graphic User Interface) 8 or 16 Servo Control Panel. User can use this GUI control panel to control SC08A with USB to UART Converter (UC00A) or other UART port devices. Following steps will guide user to install SC08A Servo Control Panel and how to use it.

1. Extract the zipped file named “SC08A Servo Control Panel.zip ”. This file can be download from Cytron website ([www.cytron.com.my](http://www.cytron.com.my/)).
2. Double click on “setup.exe” to install the GUI SC08A Servo Control Panel.
3. A shortcut will be created at Window's start up menu or Desktop. To active the GUI, go to start-->All Programs-->SC08A VB project1.
4. Before any setup at SC08A Servo Control Panel, please ensure hardware installation of SC08A is being setup correctly, UART connection and power to servo motor is connected.
5. After SC08A Servo Control Panel is activated, a window will pop out, following figure show on the window.



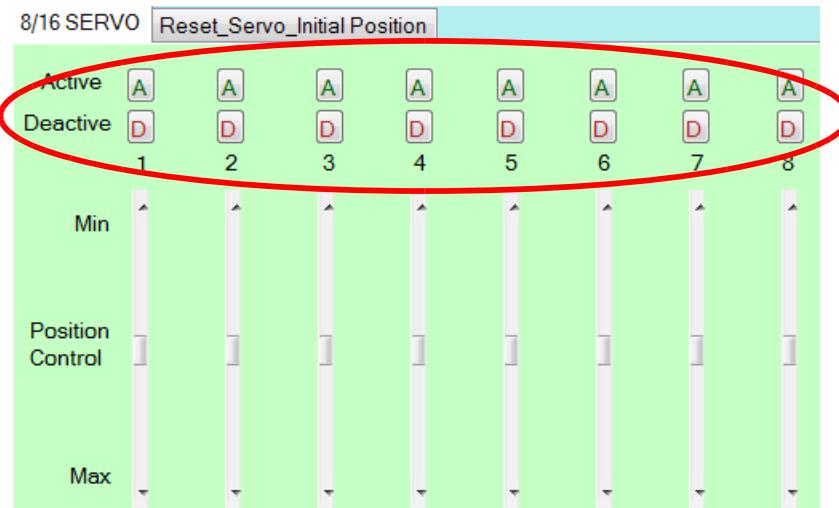
7. Ensure the UART port device connect to computer, click the “Search” icon for refresh the COM Port searching. Choose the COM Port by clicking the side bar, choose the last COM Port. Normally, the extra virtual COM port will be largest number port after drive installation. Click on it.
8. Click the “Connect” icon and the SC08A Servo Control Panel will show “COM XX connected” and the baud rate value will show out.
9. If user click the “cancel” icon, text box will show “Com XX disconnected”.



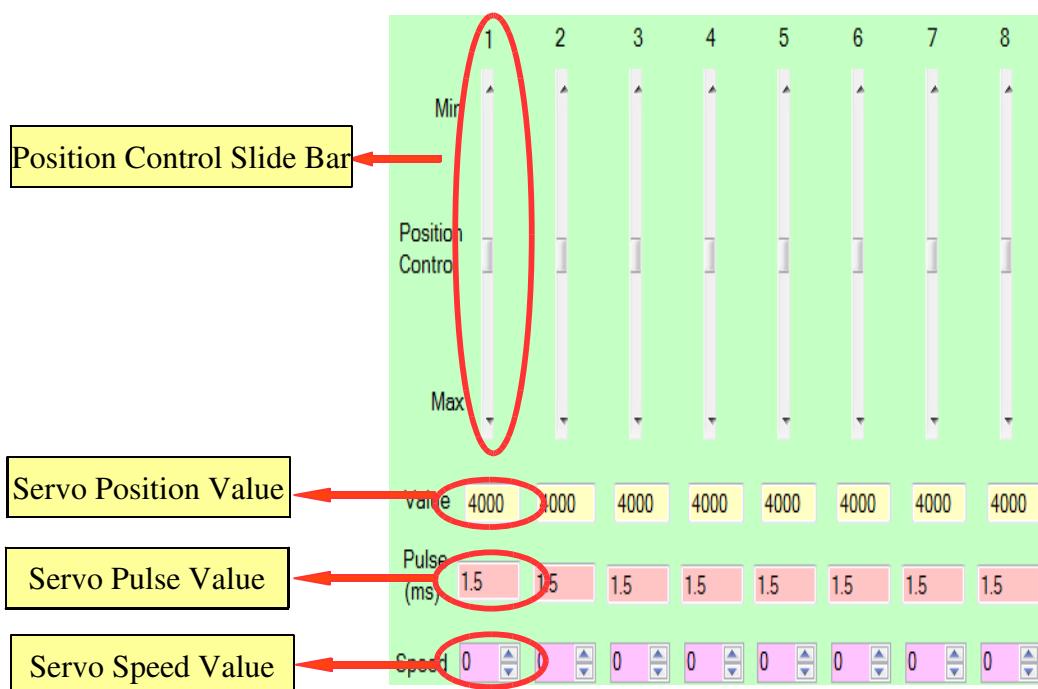
10. SC08A servo controller can be control 8 servo motors, but user also can expand another SC08A for control maximum 16 servo motor. So that, SC08A Servo Control Panel provide two icon which is “Active 8 Servo” and “Active 16 servo” for user select one of them.



11. However, if user want to control 8 or 16 servo motors by individual so user can click “A” icon for activate or “D” icon for deactivate any servo motor.



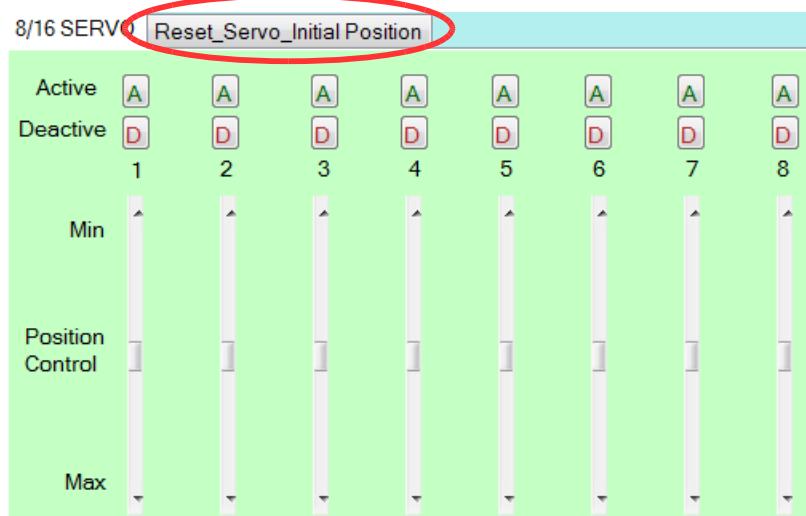
12. After activate servo motor, SC08A Servo Control Panel is ready to control the servo motors on SC08A. Please ensure the power supply for servo motor is connected properly.



13. Furthermore, user may set the speed at bottom of pulse value at each slide bar.

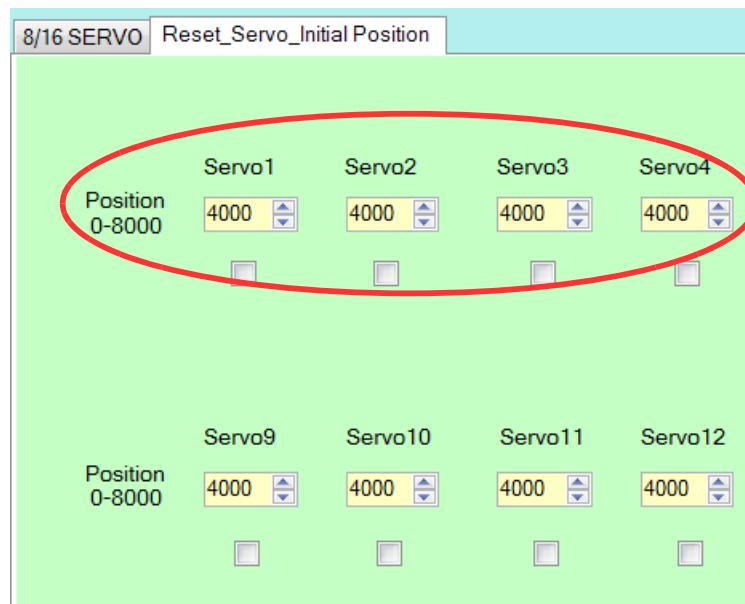
The default value of speed is “0” which represent fastest speed for servo motor. For further details of speed, please refer section 7.1 Servo Position and Speed Command.

14. For user to initialize the starting position of servo motors, SC08A Servo Control Panel has provided “Reset\_Servo\_Initial Position”. User just need to click this section for entry another tab.

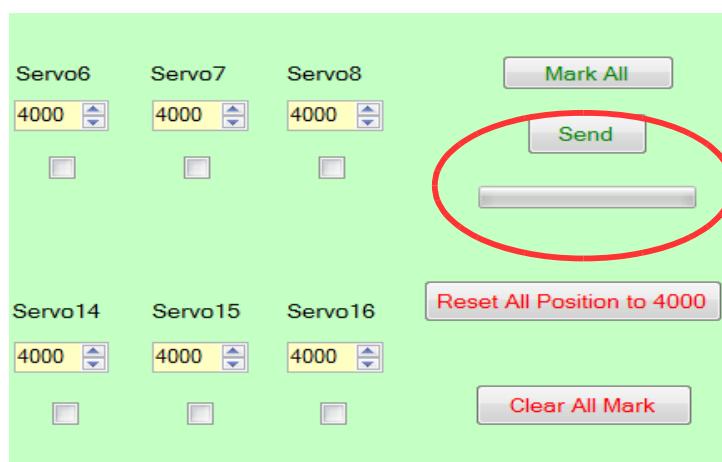


15. User can change the value of position from 0 to 8000 to setting servo motor initial position.

16. After changed the value of position, user can mark any small box (show on below position value box) for each servo motor.



17. After user finish mark and select the servo motor, user may click “Send” icon and waiting the processing done in moment.



\

18. Below the “COM PORT” section, a “RESET” icon is provide for reset all position adjustable bar, position value, servo motor pulse and speed to original value. So that, user can start to use SC08A Servo Control Panel again without close window.



19. Extra information, User can directly click the link provided on SC08A Servo Control Panel for visit Cytron Technologies Website page. Other information also provided on Text Box which show on top of control panel.



## 7. GETTING STARTED

### 7.1 Protocol of SC08A

Like SC16A, SC08A has two types of protocol but the protocols are different with SC16A.

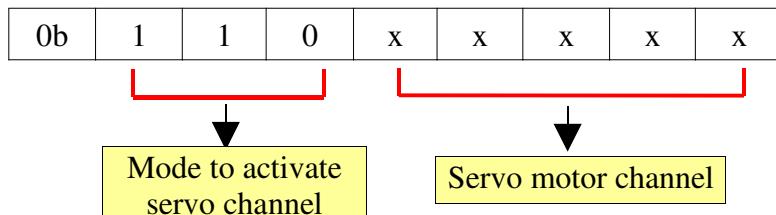
The 1<sup>st</sup> protocol is important which is used to send command to SC08A, further control a particular servo to a position with a defined speed. 2<sup>nd</sup> protocol is for host to request the current position of servo. The 2<sup>nd</sup> protocol is alternative to user, if position reporting is not requirement, it can be ignored. If position reporting is required, please do remember to connect the Tx pin of SC08A to Rx pin of host.

#### **Activate Servo Channel Command**

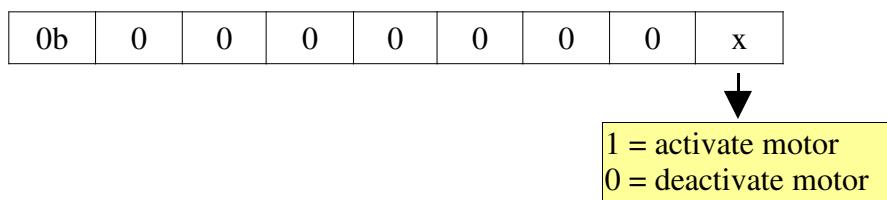
The initial status for servo motor is deactivate. Users need to send this command to SC08A to activate selected channels or all channels before running the servo motor.

- a) The command is being sent in packet format. Each packet consists of 2 bytes. Servo motor channel is from 0-16. Select '0' to activate/deactivate all servo motor from channel 1 to 8(if single SC08A used) or 1 to 16 (if double SC08A used).

- i. 1<sup>st</sup> byte: Mode + Servo motor channel



- ii. 2<sup>nd</sup> byte: On/Off



### Position and Speed Command

Both computer and microcontroller actually send command to SC08A serially. This section explains the protocol to send command.

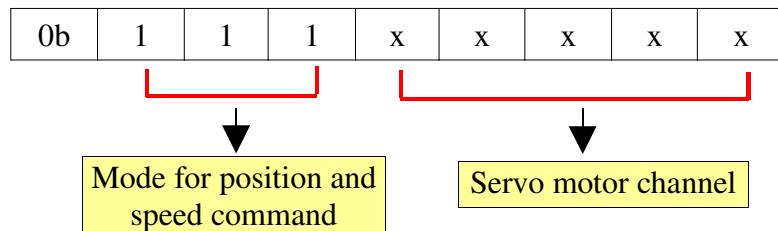
a) The command is being sent in packet format. Each packet consists of 4 bytes.

- i. 1<sup>st</sup> byte: Mode + Servo motor channel
- ii. 2<sup>nd</sup> byte: Position (Higher 7 bit)
- iii. 3<sup>rd</sup> byte: Position (Lower 6 bit)
- iv. 4<sup>th</sup> byte: Speed (0-100)

b) SC08A translate four bytes of data into three parameter:

Byte	Binary	Hexadecimal	Decimal
1st Byte	0b111XXXXX	0xE1 to 0xF0	224 to 240
2nd Byte	0b0XXXXXXX	0x00 to 0x7F	0 to 127
3rd Byte	0b00XXXXXX	0x00 to 0x3F	0 to 63
4th Byte	0b0XXXXXXX	0x00 to 0x64	0 to 100

- i. 1<sup>st</sup> byte is combination of mode and servo motor channel. Servo motor channel is from 0-16. Select '0' to activate all servo motor from channel 1 to 8(if single SC08A used) or 1 to 16 (if double SC08A used).



- ii. 2<sup>nd</sup> and 3<sup>rd</sup> byte combined to provide 13 bit data of servo position, 0-8000. The resolution of SC08A is 0.5us. It will start from 0.5ms and increase the duty cycle of pulses according to value of Position. Thus, following formula show the duty cycle of pulses generated:

$$\begin{aligned}
 \text{Duty cycle} &= (\text{resolution} \times \text{Servo Position}) + 0.5\text{ms} \\
 &= (0.25\text{us} \times \text{Servo Position}) + 0.5\text{ms}
 \end{aligned}$$

2<sup>nd</sup> byte: Higher 7bit

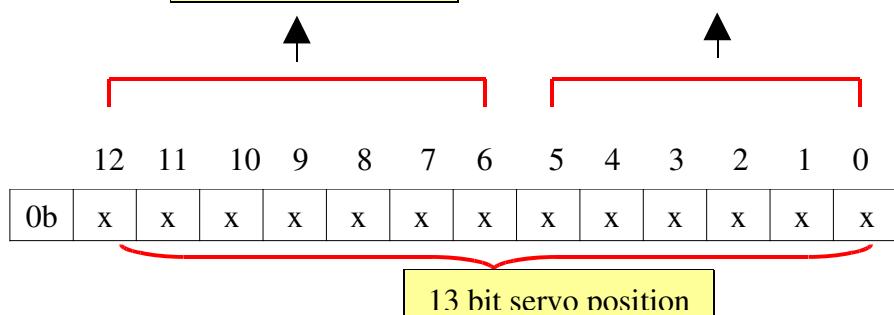
0b	0	x	x	x	x	x	x	x	x
	7	6	5	4	3	2	1	0	

3<sup>rd</sup> byte: Lower 6 bit

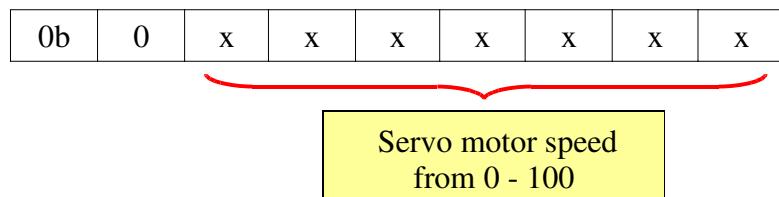
0b	0	0	x	x	x	x	x	x	x
	7	6	5	4	3	2	1	0	

2<sup>nd</sup> byte: Higher 7bit

3<sup>rd</sup> byte: Lower 6 bit



iii. 4<sup>th</sup> byte represents the speed of servo rotation. The speed is from 0 – 100. The higher value, the faster and the lower value is servo will rotate to its position. Decimal value '1' indicates that the servo will run at slowest speed and decimal value '100' will run at fastest speed. However, value '0' is special value. Value '0' is more faster than value '100'.



- c) The speed of servo motor is depending on the brand of servo motors. Therefore, different type of servo would result in different speed. For Cytron C36S servo, the approximate time of speed range from 0 degree to 180 degree of rotation is shown as follows:

Decimal value 0-100 for servo speed.

0 = 0.3 seconds	64 = 3.60 seconds
1 = 2.0 minutes	80 = 2.80 seconds
16 = 14 seconds	96 = 2.2 seconds
32 = 7.0 seconds	99 = 1.9 seconds
48 = 4.14 seconds	

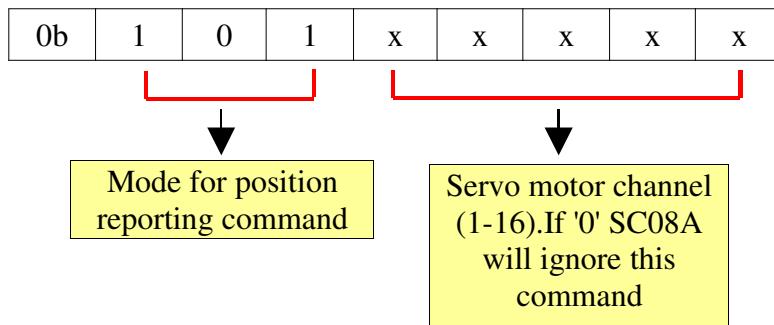
- d) For more details, user may refer to sample source code provided. Comments are being provided in the sample code to help user understanding.

### **Servo position reportingCommand**

This section explains the position reporting command.

- a) If position report is needed, the host (computer or microcontroller) should send this command to SC08A. The command is being sent in packet format. Each packet consists of a byte.

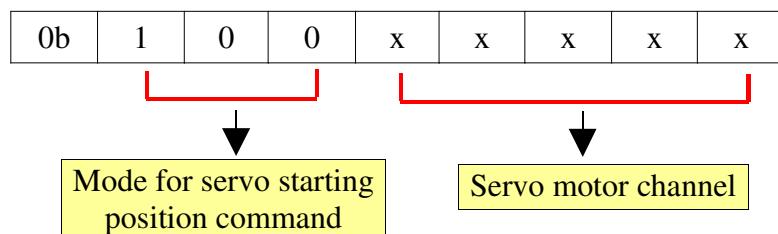
- i. 1<sup>st</sup> byte: Mode + Servo motor channel



- b) After receive reporting command, SC08A will reply the position for the regarding servo channel in 2 bytes. Please refer back to Position and Speed Command section (b)ii for the description of these 2 bytes.
  - i. 1<sup>st</sup> byte: Position (Higher 7 bit)
  - ii. 2<sup>nd</sup> byte: Position (Lower 6 bit)
- c) User is requires to receive and process these 2 bytes. User may refer to sample source code provided. Comments are being provided in the sample code to help user understanding. Please refer to sample program named “SK40C\_16F877A\_SC08A.c”.

### Servo starting position Command

- a) This command useful for users to initialize the starting position for servo motors. To initialize starting position, the command is being sent in packet format. Each packet consists of 3 bytes.
  - i. 1<sup>st</sup> byte: Mode + Servo motor channel
  - ii. 2<sup>nd</sup> byte: Position (Higher 7 bit)
  - iii. 3<sup>rd</sup> byte: Position (Lower 6 bit)
- b) 1<sup>st</sup> byte is combination from mode and servo motor channel. Servo starting position command mode is '100' which is 3 MSB bits from 1<sup>st</sup> byte. Servo motor channel is from 0-16. Select '0' to activate all servo motor from channel 1 to 8(if single SC08A used) or 1 to 16 (if double SC08A used).



- c) 2<sup>nd</sup> and 3<sup>rd</sup> byte is combined to provide 13 bit servo position. Please refer back Position and Speed command section (b)ii for description for these 2<sup>nd</sup> and 3<sup>rd</sup> byte.
- d) After received starting position command, SC08A will reply one byte (0x04) to microcontroller.

## **8.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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