Stamp BOX
i-Stamp Microcontroller
Robotic Controller Board

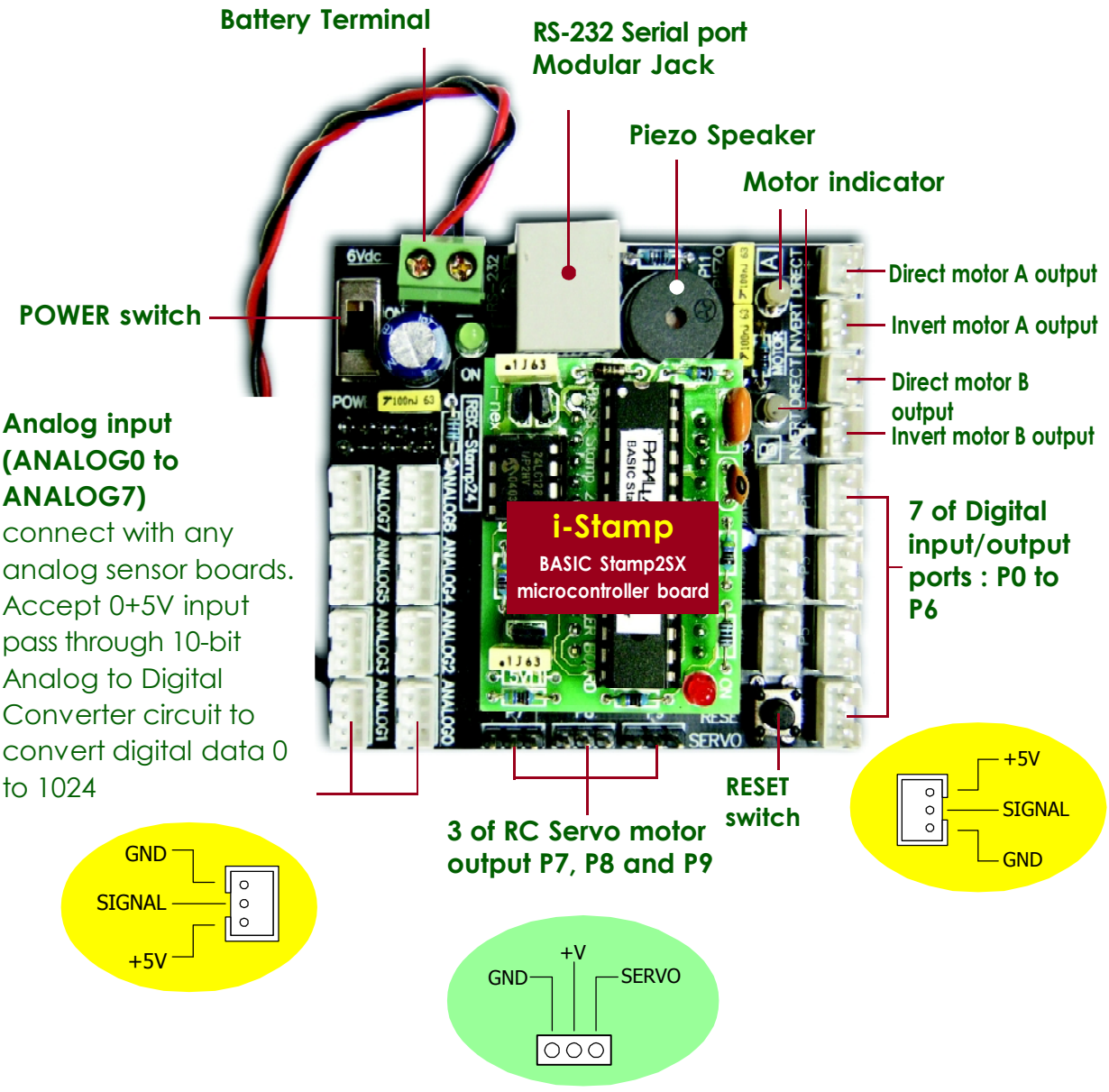
Stamp-BOX
i-Stamp Microcontroller Robotic Controller Board

The Stamp-BOX consists of the i-Stamp Basic Stamp2SX OEM microcontroller board, RBX-Stamp24 board and a CX-4 cable to download programs. It has a 16KB memory (divided into 8 parts, each of 2 KB), 8 analog input channels, 7 digital input/output channels, and it drives two DC motors and three RC servo motors.

1. Stamp-BOX features

- Use i-Stamp as the main microcontroller
- 16 KB memory. Separate 8 of 2KB page and can access to work together.
- Capability to write-erase the memory 100,000 times
- Two DC motor drivers including status indicators to show motor direction
- 3 of RC servo motor connectors
- 8-ch. Analog connector with a 10-bit A/D converter that can accept up to +5V.
- 7-ch. Digital input/output port connector
- Piezo Speaker
- RS-232 Serial port for downloading and communication *(UCON-232S the USB to Serial converter required if using with USB port)*
- Uses PBasic 2.5 programming
- Uses 4 AA batteries support both Alcaline and Rechargeable battery (recommended 1500mAH or higher)
- Small size in 2.75x2.50x1.75 Inches
- Interface many modules and application boards such as : **SRF04/05/08/10** Ultrasonic ranger, **CMPS03** Digital compass sensor, **iV-CAM/CMUcam1** CCD image tracking, **SHT11** Humidity sensor, **Memsic2125/H48C** Accellerometer sensor, **SLCD16x2** the serial LCD 16x2, **ZX-17** Serial Real time clock, **ZX-19** Sound smart board, **ZX-44** the 4x4 Matrix switch board, **ZX-Tilt** 2-outputs Tilt sensor, **ZX-SOUND** the Sound detector board, **ZX-SERVO16** Serial servo controller board, **ESD02** Embeded Bluetooth module, **GP2D120/GP2D12** distance sensor and many types of analog sensor modules.

2. Stamp-BOX Anatomy



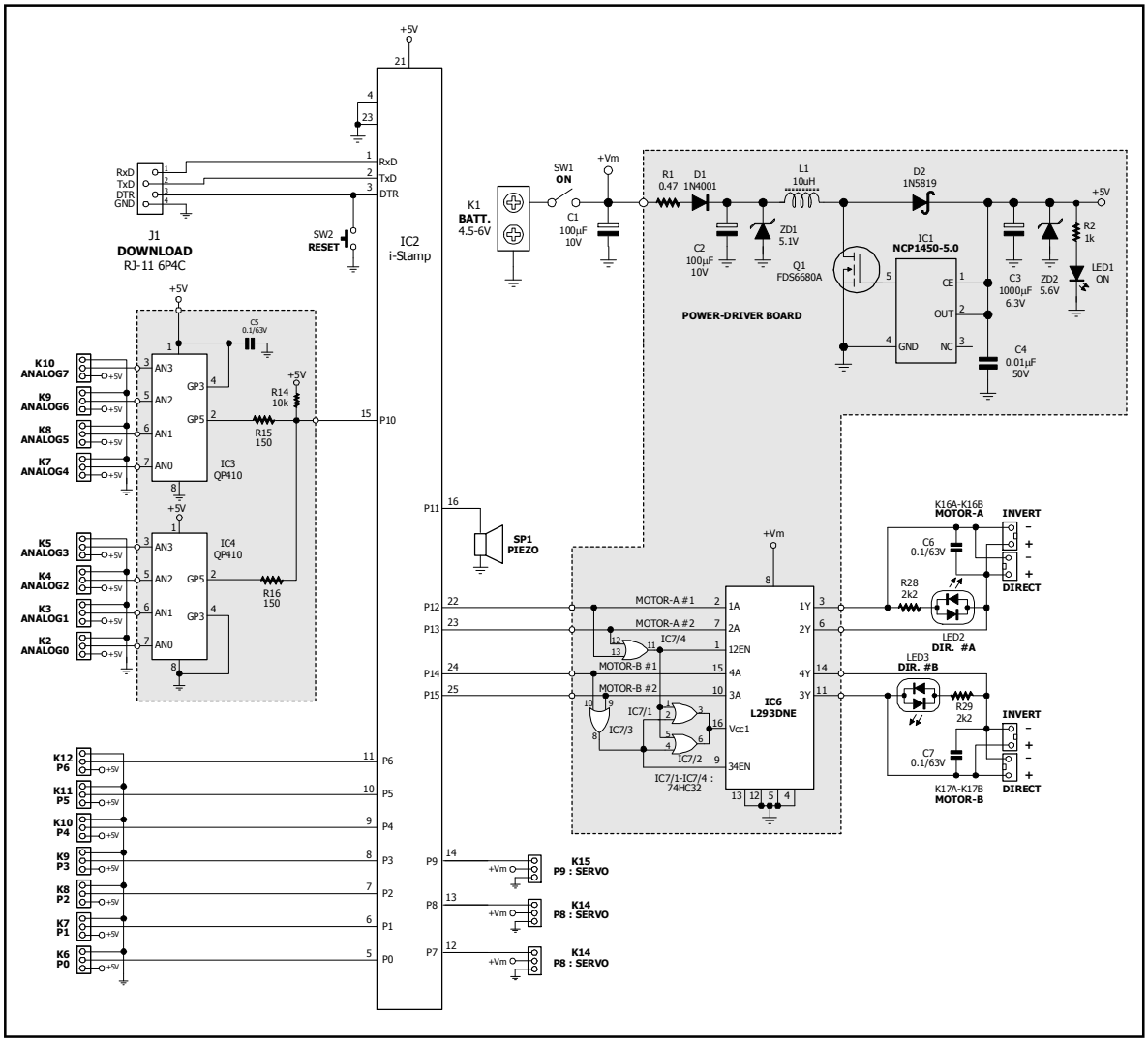
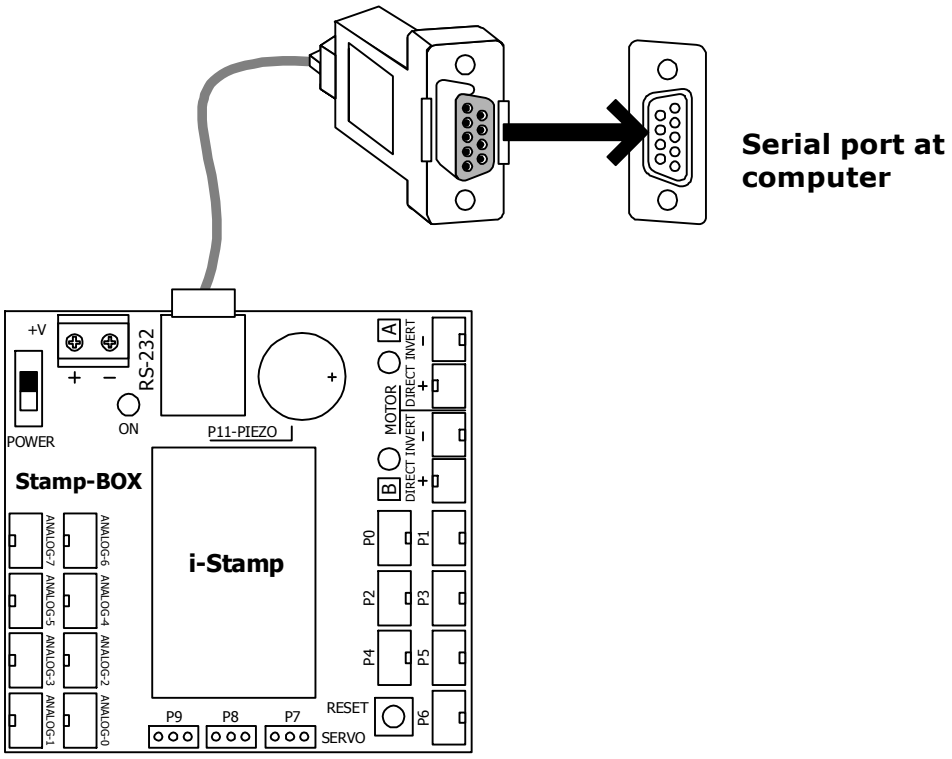


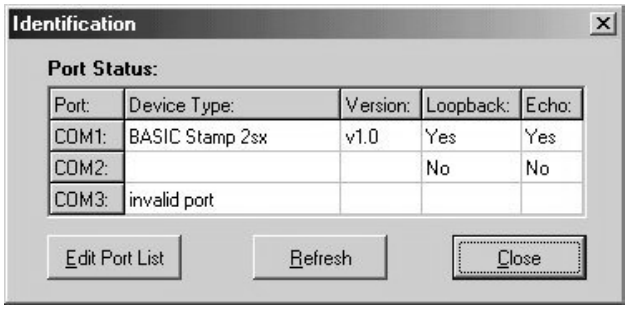
Figure 1 Stamp-BOX schematic : Circuit diagram in shade box is contained on the power control board

3. Tesing Stamp-BOX

3.1 Connect the Stamp-BOX with serial port. *If computer has only USB port, the USB to Serial port converter isrequired. UCON-232S is recommended*. Turn on the power switch.

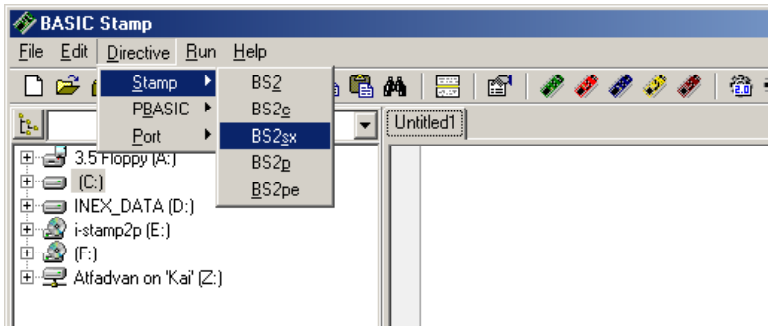


3.2 Open the BASIC Stamp editor software (Version 2.2.6 or higher is recommended. Free download at www.parallax.com). Press the Ctrl + I button on keyboard for identification testing. The identification window will show the status below. It means the Stamp-BOX ready to work.

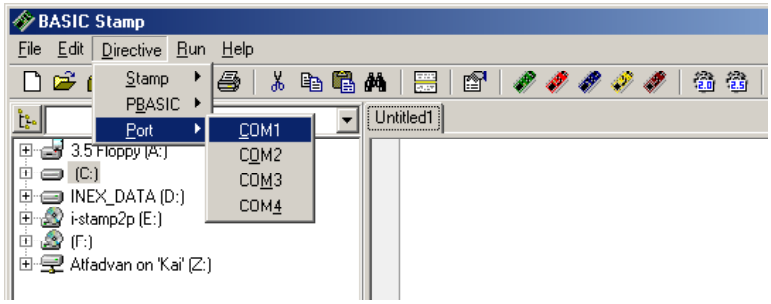


3.3 Write the simple program following this steps :

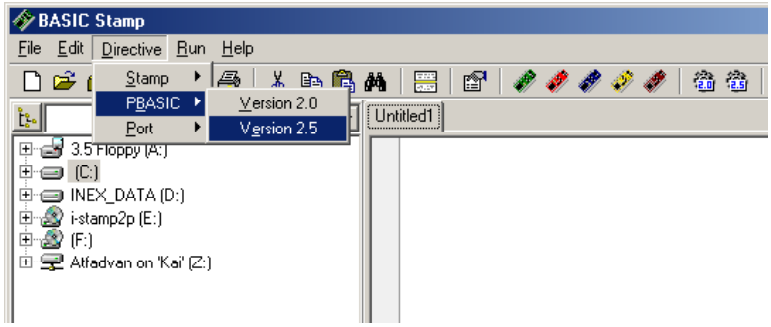
3.3.1 Select BASIC Stamp directive by go to Directive menu, select ***Stamp → BS2SX*** It shows **`'{$STAMP BS2SX}`** on first line. Press the **Enter** key.



3.3.2 At **Directive** menu, select download port by ***Port → Com1*** (or any com port) It shows **`'{$PORT COM1}`** on second line. Press the **Enter** key.



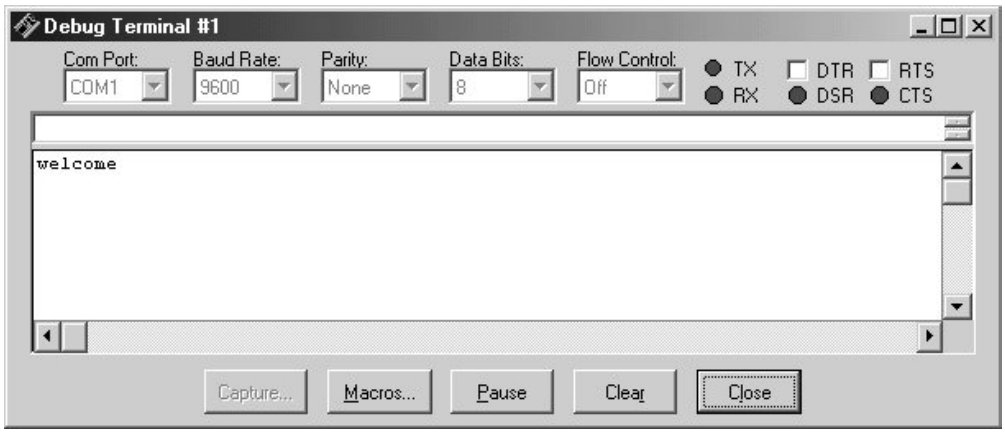
3.3.3 At **Directive** menu, select BASIC Stamp directive by ***PBASIC → Version2.5***. It shows **`'{$PBASIC 2.5}`** on the third line. Press the **Enter** key.



3.3.4 Write PBASIC command **`debug "welcome"`** Press the **Enter** key.

3.3.5 Click **Run** button on the screen.

This program will run and the debug terminal will appear and show ***"welcome"*** *message on the screen.*



4. Simple example code

```
'{$STAMP  BS2SX}     'STAMP directive (specifies a BS2SX)
'{$PBASIC 2.5}
i   VAR  Byte        ' Counter for position in tune.
f   VAR  Word        ' Frequency of note for FREQOUT.
C   CON  839         ' C note
D   CON  939         ' D note
E   CON  1054        ' E note
G   CON  1254        ' G note
R   CON  3           ' Silent pause (rest).

FOR i = 0 TO 28      ' Play the 29 notes of the LOOKUP table.
   LOOKUP  i,[E,D,C,D,E,E,E,R,D,D,D,R,E,G,G,R,E,D,C,D,E,E,E,E,D,D,E,D,C],f
  FREQOUT 11,563,f,(f-8) MAX 32768
NEXT
STOP
```

Listing #1 Sound generation on P11 of Stamp-BOX. Stamp-BOX will sing "Mary has a little lamb" song.

```
'{$STAMP  BS2SX} 'STAMP directive (specifies a BS2SX)
'{$PBASIC 2.5}

i  VAR  Byte        ' Counter for position in tune.
f  VAR  Word        ' Frequency of note for FREQOUT.
C  CON  839         ' C note
D  CON  939         ' D note
E  CON  1054        ' E note
G  CON  1254        ' G note
R  CON  3           ' Silent pause (rest).

DO UNTIL IN0=0
LOOP

FOR i = 0 TO 28    ' Play the 29 notes of the LOOKUP table.
   LOOKUP  i,[E,D,C,D,E,E,E,R,D,D,D,R,E,G,G,R,E,D,C,D,E,E,E,E,D,D,E,D,C],f
  FREQOUT 11,563,f,(f-8)  MAX 32768
NEXT
STOP
```

Listing #2 Music box. Stamp-BOX will sing a song if switch at P0 is pressed.
Hardware connection : Connect the switch module (ZX-SWITCH) at P0

5. Driving DC motor with Stamp-BOX

Stamp-BOX can drive 2 of DC motors. The motor functions when it receives a direct current. Figure 2 shows how the direction of the motor is controlled when electric current is supplied into the DC motor.

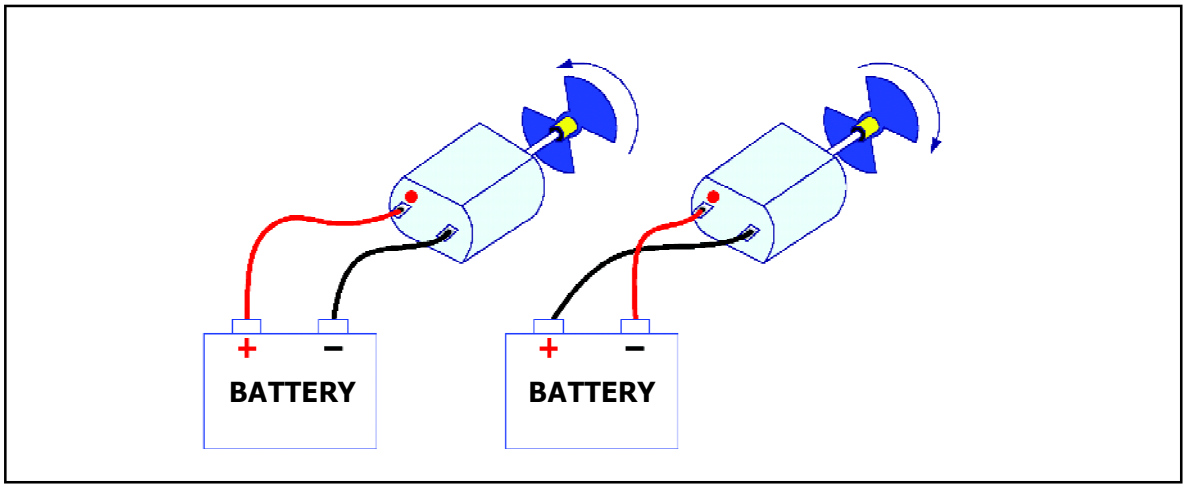


Figure 2 Shows electric current being supplied to the motor.
(a) The motor rotates clockwise when positive current is sent to the red end (+) and negative current to the black end (-).
(b) The motor rotates counter-clockwise when positive current is sent to the black end (-) and negative current to the red end (+).

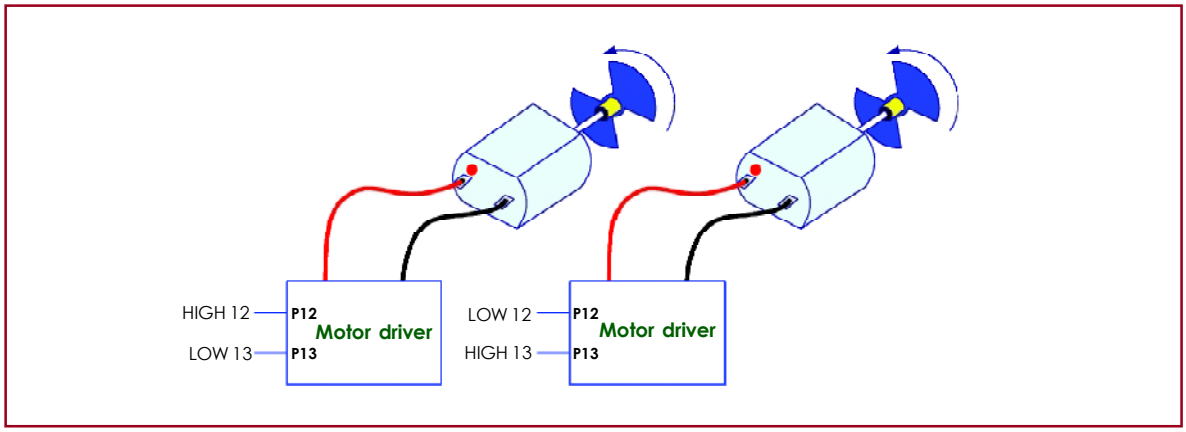


Figure 3 Using BASIC commands to control how the motor.

5.1 The motor module in the Stamp-BOX

Stamp-BOX can drive two DC motors. The first one or Motor A is controlled from P12 and P13 of i-Stamp. The second motor or Motor B is controlled by P14 and P15. Figure 3 shows the flow of the electric current into the motor as well as the BASIC commands used to control the motor module for motor A. For motor B, change the commands for P14 and P15 instead.

You can order the motor to stop running by setting P12 and P13 to either both LOW or HIGH. However, setting both to LOW will also stop the flow of electric current to the motor and would therefore help save power, unlike setting both to HIGH.

5.2 Position of the Motor Polarity

Stamp-Box has 4 connection points for the 2 motors as shown in figure 4. As you can see, the connection point for DIRECT and INVERT are the same except for the difference in polarity. If the motor is connected to INVERT, the motor will spin in the opposite direction as when connected to DIRECT.

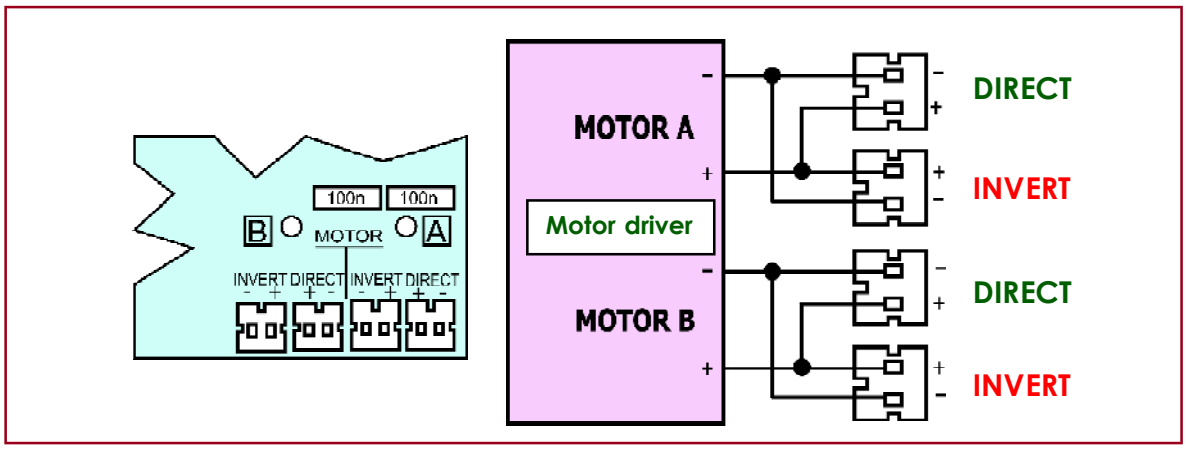


Figure 4 Motor output postion on Stamp-BOX

5.3 Testing the Polarity Connection of the Motor

5.3.1 Open the BASIC Stamp Editor and type in the following program. Download it to the Stamp-BOX and turn off the POWER switch on the Stamp-BOX.

```
'{$STAMP BS2sx}
'{$PBASIC 2.5}
' +++++++++ FORWARD & BACKWARD EVERY 2 SECOND ++++++++++++++
  DO
    LOW 12 : HIGH 13 : LOW 14 : HIGH 15    ' Motor Forward
    PAUSE 2000                             ' Delay 2 Sec
    HIGH 12 : LOW 13 : HIGH 14 : LOW 15    ' Motor Backward
    PAUSE 2000                             ' Delay 2 Sec
    HIGH 12 : LOW 13 : LOW 14 : HIGH 15    ' Motor A Backward ,
                                           ' Motor B Forward
    PAUSE 2000
    LOW 12 : HIGH 13 : HIGH 14 : LOW 15    ' Motor A Forward ,
                                           ' Motor B Backward
    PAUSE 2000
  LOOP
```

5.3.2 Connect both DC motors at DIRECT outputs

5.3.3 Remove the download cable (CX-4). Turn on the power switch and observe the motor.

The motor will turn clockwise for 2 seconds and then turn counter-clockwise for another 2 seconds. Motor A and Motor B will then spin in the opposite direction for another 2 seconds. It will repeat these steps continuously.

6. Serial Data Communication

Downloading the program written from the Basic Stamp Editor to the Stamp-BOX can be considered as a form of communication in which the computer acts as the sender and the Stamp-BOX is the receiver. Two-way communication can be done through the Debug Terminal window as shown in Figure 5 When the Stamp-BOX sends data to the computer, the data will appear on the blue display screen (color can change). Data can be sent to the Stamp-BOX by typing it into the input box above the blue display screen

6.1 Using the DEBUG command to send data from Stamp-BOX to the computer

6.1.1 Connect the CX-4 (download cable) between the Stamp-BOX and the serial port (If the computer doesn't have an serial port use the USB port converter to convert it into a RS-232 port or COM port).

6.1.2 Connect ZX-SWITCH module with P1 port on Stamp-BOX.

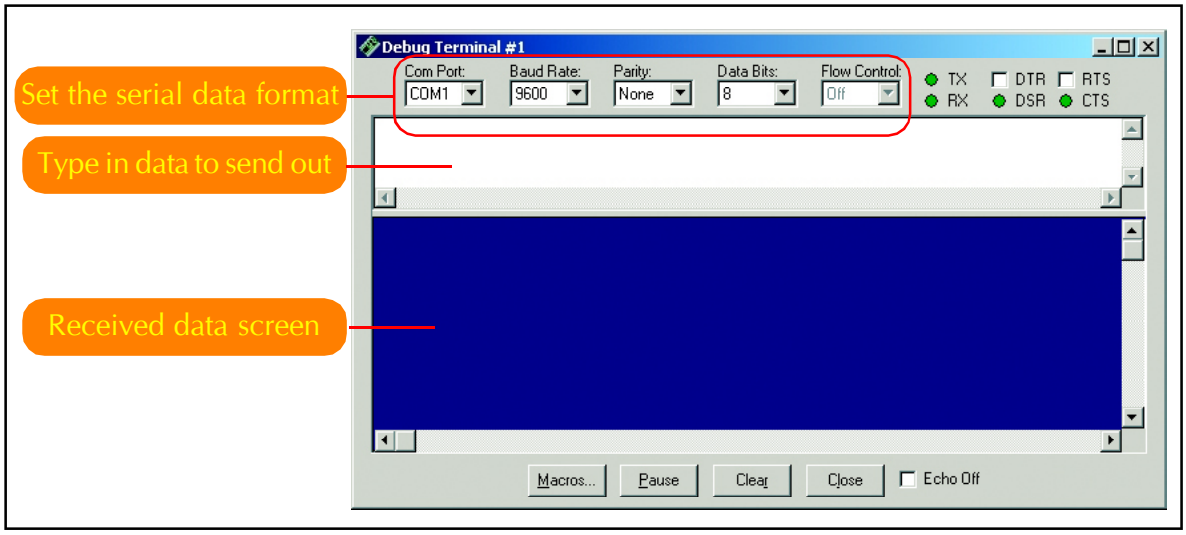


Figure 5 Component of Debug Terminal that use in serail data communication

6.1.3 Open the Basic Stamp Editor program and type in the following program. Download the program to the Stamp-BOX.

```
'{$STAMP BS2sx}
'{$PBASIC 2.5}
Main:    IF (IN1 = 0) THEN      ' Test Switch
           DEBUG "Stamp-BOX"    ' Show ASCII
           PAUSE 1000           ' Delay 1 Sec
         ENDIF
         GOTO Main              ' Again
```

6.1.4 The Debug Terminal window will appear with no data on the display screen yet. With the download cable still connected, press the switch connected to P1 of the Stamp-BOX. Observe the changes that occur on the Debug Terminal window.

*This test program shows how data sent from the Stamp-BOX will be displayed on the Debug Terminal window. When the switch connected to P1 is pressed, the robot will send the text "**Stamp-BOX**" to be displayed on the Debug Terminal window.*

7. Reading the Analog Signal

Since the i-stamp or Basic Stamp 2SX, which is the main micro-controller in the Stamp-BOX, does not have an analog to digital converter module (A/D converter), an external converter must be connected in order to communicate with components that send out voltage signals, such as Module GP2D120. Therefore, IC QP410 will be used to convert and send digital signals to the main micro-controller. Figure 6 displays the circuit schematic when connected with the Stamp-BOX.

7.1 Communicating with IC QP410

Communicating with the IC QP410 A/D converter can be done through a program, as shown in Listing 3 . The program reads the data value from ANALOG1 of the Stamp-BOX (while connected to Module GP2D120), then displays it onto the Debug Terminal window. The program works according to the following steps.

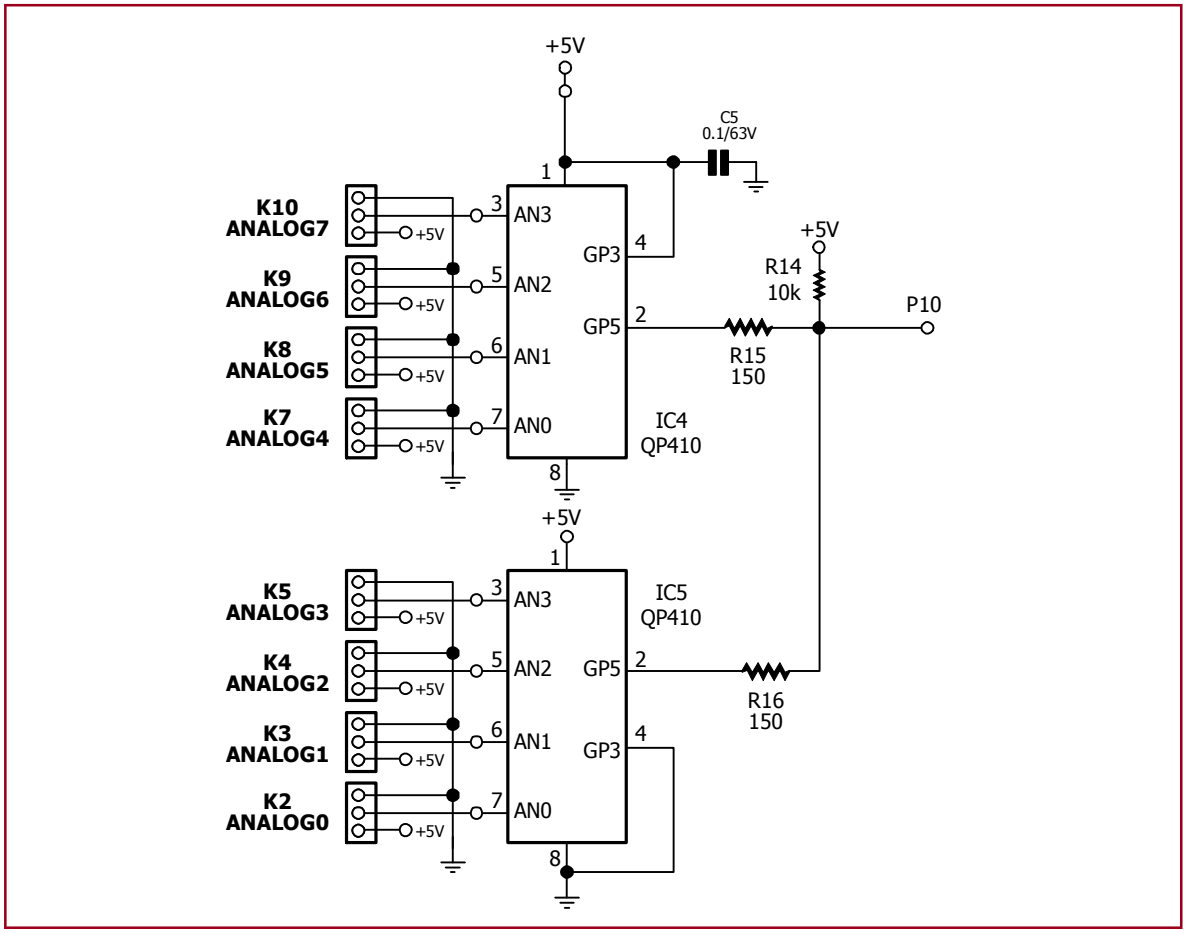


Figure 6 The analog receiver circuit of the Stamp-BOX has 2 IC QP410 connected to connection point P10 of the i-Stamp, resulting in an analog input of 8 channels.

Listing 3

```
'{$STAMP BS2sx}
'{$PBASIC 2.5}
'********************************
' Read Data From Analog Input (CH1)
'********************************
ADC  VAR   Word
PAUSE 1000
Init:   HIGH 10                                 ' Idle chip ADC
        DO
           LOW 10:PAUSE 1:HIGH 10               ' Send acknowledge
           SEROUT 10,240,[1]                    ' Select channel 1
           SERIN 10,240,[ADC.BYTE0,ADC.BYTE1]   ' Read ADC
           DEBUG DEC STREAM,CR                  ' Show data on Debug Teminal
           PAUSE 1000
        LOOP
```

(1) Pauses or delays for 1 second so that the IC QP410 is ready to operate.

(2) Sends a pulse signal so that the IC QP410 can acknowledge and get ready to communicate with the Stamp-BOX

(3) The i-Stamp sends the value of the channel to be read to the IC QP410. From Listing 3 the value is 1 which means that it will be communicate with ANALOG1

(4) The i-Stamp reads the value from channel ANALOG1 of the IC QP410 and stores it in the variable ADC. The variable is defined as type word, which can store up to 16 bits of data, therefore easily storing the 10 bit data from the IC QP410.

(5) i-stamp sends the value that it reads to be displayed on the Debug Terminal.

7.1.1 Connect GP2D120 Infrared distance sensor at ANALOG1 connector.

7.1.2 Download the Listing 3 program to the Stamp-BOX and do not remove the download cable yet. The Debug Terminal window will appear automatically.

7.1.3 Observe the values displayed on the Debug Terminal .

7.1.4 Use your hand or a piece of paper to block in front of the GP2D120 module. Observe the number that appears on the Debug Terminal

The numbers that appear on the Debug Terminal window will increase.

7.1.5 Move your hand or the paper back and forth to change the distance between the GP2D120 module. Observe the changes that occur.

The numbers that appear on the Debug Terminal window will change according to the distance. But the data that the QP410 IC reads from the GP2D120 module is raw data, and not the final distance value.

7.1.6 To make it more convenient to write programs that can call upon the A/D converter QP410 when needed, asubroutine called **RD_ADC** is created as shown in Listing 4.

Listing 4

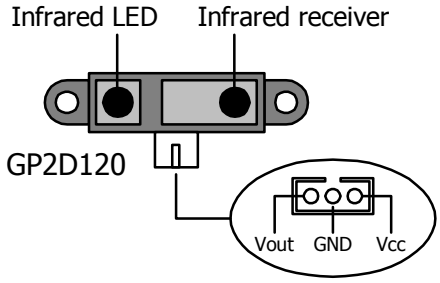
```
RD_ADC: LOW 10:PAUSE 1:HIGH 10      ' Send acknowledge

        SEROUT 10,240,[1]           ' Select channel 1
        SERIN 10,240,[STREAM.BYTE0,STREAM.BYTE1]  ' Read ADC
         RETURN
```

8. GP2D120 distance sensor with Stamp-BOX

The GP2D12/GP2D120 Infrared Ranger module has 3 terminals: Power input (Vcc), Ground (GND) and voltage output (Vout). To read the voltage values from the GP2D120, you must wait till after the acknowledgement period which is around 32 to 52.9 ms.

The output voltage of GP2D120 at a range of 30 cm and +5V power supply is between 0.25 to 0.55V, with the mean being 0.4V. At the range of 4-30 cm, the output voltage will change at 2.25V± 0.3V.



The output from Module GP2D120 is voltage. When connected to the Stamp-BOX, it must be connected to ports ANALOG0 to ANALOG7 so that the values can be read through IC QP410. In the previous activity, the GP2D120 module was connected to ANALOG1, so we can proceed on with this activity.

The value received from GP2D120 must be displayed in the form of range. This can be done by converting the voltage value using a comparison graph between voltage and range. For convenience, a line equation with the following formula has been created.

$$R = \frac{2914}{V+5} - 1 \quad \text{for GP2D120}$$

Thus, R Range measured in centimeters

V Data Received from the A/D converter

8.1 Procedure

8.1.1 Type in Listing 5 and download it to the Stamp-BOX. After finished, turn off the switch. Do not remove the download cable yet.

8.1.2 Connect GP2D120 to ANALOG1

8.1.3 Turn on the power switch of the robot. Hold the robot near the wall, with the side that has the GP2D120 module installed facing the wall. Observe the range value that appears on the Debug Terminal window.

8.1.4 Use a ruler to measure the distance from the robot to the wall and compare it to the value shown on the Debug Terminal window.

Listing 5

```
'{$STAMP BS2sx}
'{$PBASIC 2.5}
ADC  VAR   Word
R    VAR   Word

PAUSE 1000
HIGH 10
DO
  GOSUB RD_ADC
  R = (2914 /(ADC+5))-1       ' Convert Voltage to Range (CM)
                              ' Show Range On Debug Terminal
  DEBUG "ADC = ",DEC ADC,TAB, "Range = ",DEC R ,"  CM" ,CR
  PAUSE 200
  LOOP                        ' Read Again

RD_ADC: LOW 10: PAUSE 1: HIGH 10               ' Send Acknowledge
        SEROUT 10,240,[1]                      ' Send Select Chip
        SERIN 10,240,[ADC.BYTE0,ADC.BYTE1]     ' Read ADC
        RETURN
```

How the Program works:

(1) Pause 1 second for the A/D converter to get ready

(2) Call subroutine **RD_ADC** to read the value from the A/D Converter

(3) Take the value and use it in the equation $R = (2914/(V + 5) - 1$ to find the range value. The resulting number is a whole number, unit in centimeters, and is stored in the variable **R**.

(4) Display the measured range value on the Debug Terminal window, both the raw value that was measured and the value in centimeters after the conversion.

8.1.5 Test at different ranges to see if the actual distance and the range on the Debug Terminal window is the same. Notice the range from Module GP2D120 starts being inaccurate.

8.2 Modifications:

From Listing 5, it is seen that the value read often changes or shifts from the actual value. Therefore, modifications to the Listing 5 are made to find the average after reading the value several times, as seen in Listing 6.

8.2.1 Type in Listing 6 and download it to the Stamp-BOX. After finished, turn off the switch. Do not remove the download cable yet.

8.2.2 Repeat the test again from steps 8.1.3 and 8.1.4 . Compare the results.

Listing 6

```
'{$STAMP BS2sx}
'{$PBASIC 2.5}
ADC   VAR   Word
R     VAR   Word
I     VAR   Byte
X     VAR   Word

PAUSE 1000
HIGH 10                                    ' Initial ADC
DO
   X = 0
   FOR I = 1 TO 5                          ' Mean Off ADC 5 Time
      GOSUB RD_ADC
      X = (ADC+X)
   NEXT
   X = X/5
    R = (2914 /(X+5))-1                    ' Convert voltage to distance(CM)

' Show Range On Debug Terminal
   DEBUG "ADC = ",DEC X,TAB, "Range = ",DEC R ,"  CM" ,CR
   PAUSE 200
   LOOP                                                ' Read Again

RD_ADC: LOW 10: PAUSE 1: HIGH 10                       ' Send Acknowledge
        SEROUT 10,240,[1]                              ' Select channel
         SERIN 10,240,250,Error,[ADC.BYTE0,ADC.BYTE1]  ' Read ADC
        RETURN

Error:   DEBUG "Error Reading",CR
         RETURN
```

How the program works:

This program uses the **FOR...NEXT** command to loop back 5 times to read the data value from the GP2D120. Then the values will be divided by 5 to find a more stable value. In addition, this program also adds a check line in the subroutine **RD_ADC** by adding a parameter in the **SERIN** command to check the time data is received. If no data is sent by the QP410 IC within 0.1 seconds, the program will go back to the main program. This is to prevent the program from remaining at the **SERIN** command awaiting data.

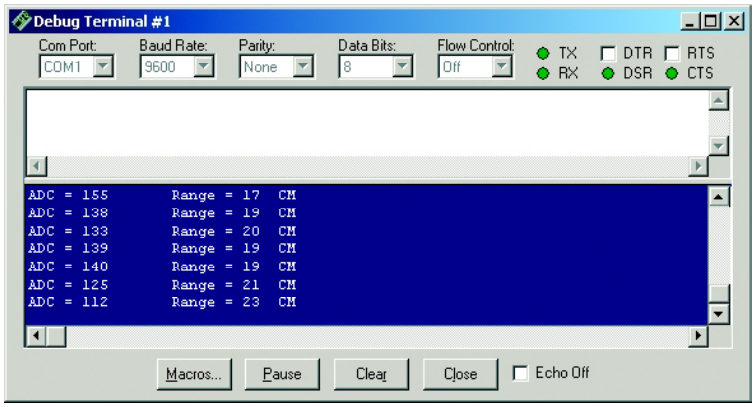


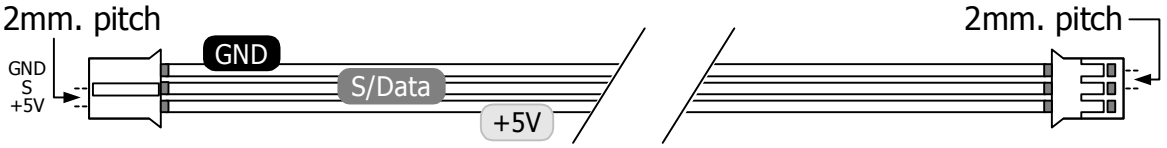
Figure 7 The Debug Terminal window displays the value read from Module GP2D120 from Listing 6

9. Stamp-BOX cable assignment

The Stamp-BOX use some signal cables for the interfacing between the controller board, sensor module and the computer. They includes the PCB3AA-8 cables for interconnection to the sensor module and a Serial port cable (CX-4) for interfacing with the computer.

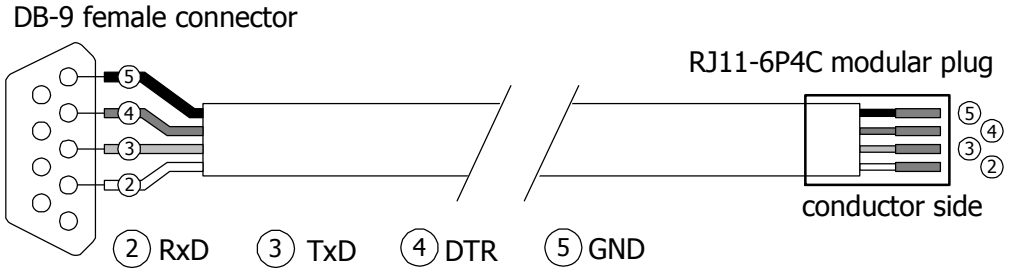
9.1 PCB3AA-8 cable

This is an INEX standard cable, 3-wires combined with 2mm. The PCB connector is at each end. 8 inches (20cm.) in length. Used for connecting between microcontroller board and all the sensor modules in MicroCamp kit. The wire assignment is shown in the diagram below.

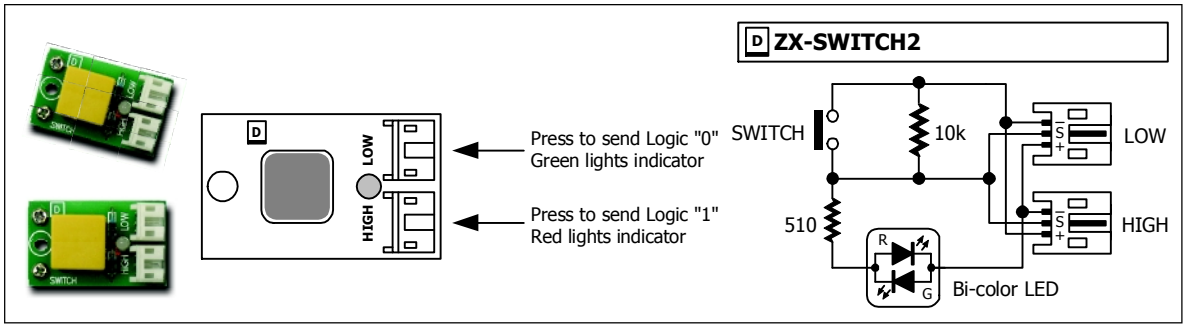


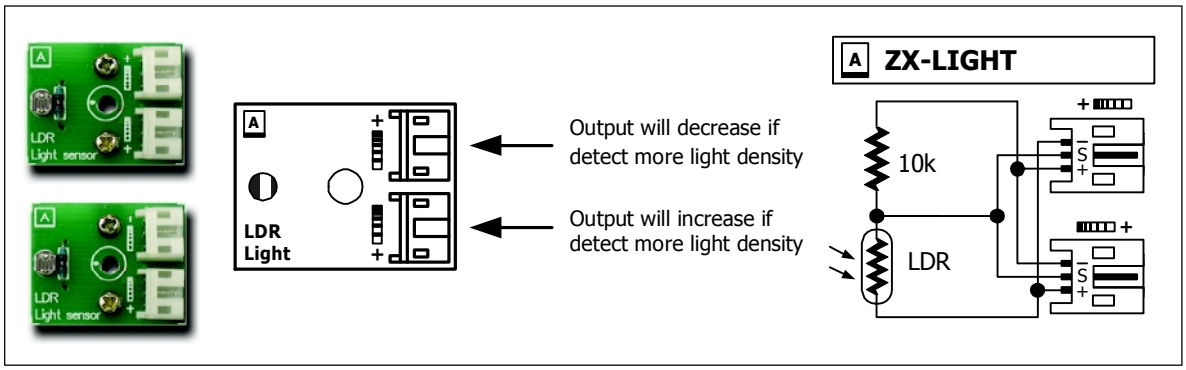
9.2 CX-4 serial port cable

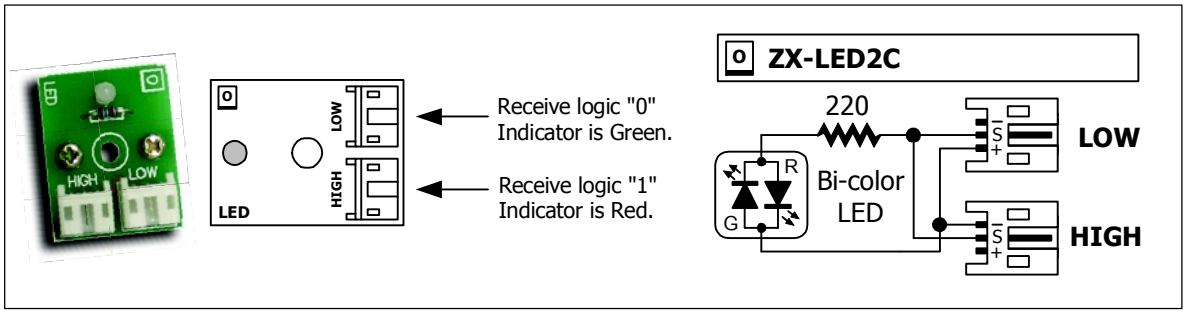
This is used to connect between the computer's RS-232 serial port and the target or external device such as a Microcontroller board, eg. The MicroCamp controller board. The connector's end uses a DB-9 female connector, and the other end uses a Modular plug RJ-11 6P4C (6-pins form and 4-contacts) Its Length is 1.5 meters. In the kit, this cable is used to connect between RS-232 serial port and PX-400 programmer box. The wire assignment is shown in the diagram below.

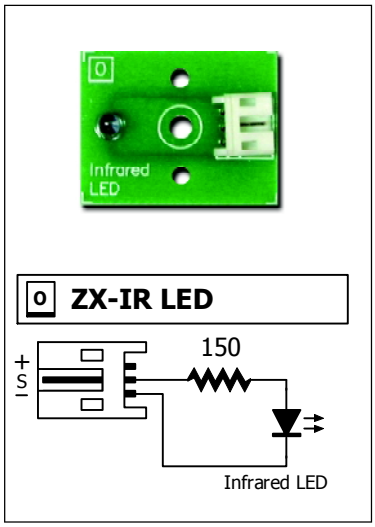


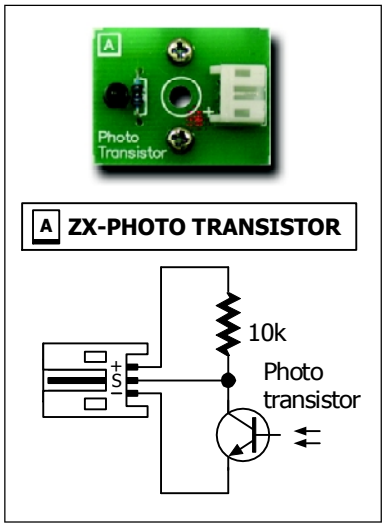
Sample of Application modules for Stamp-BOX

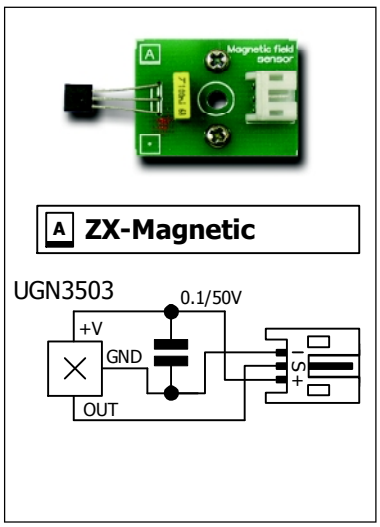


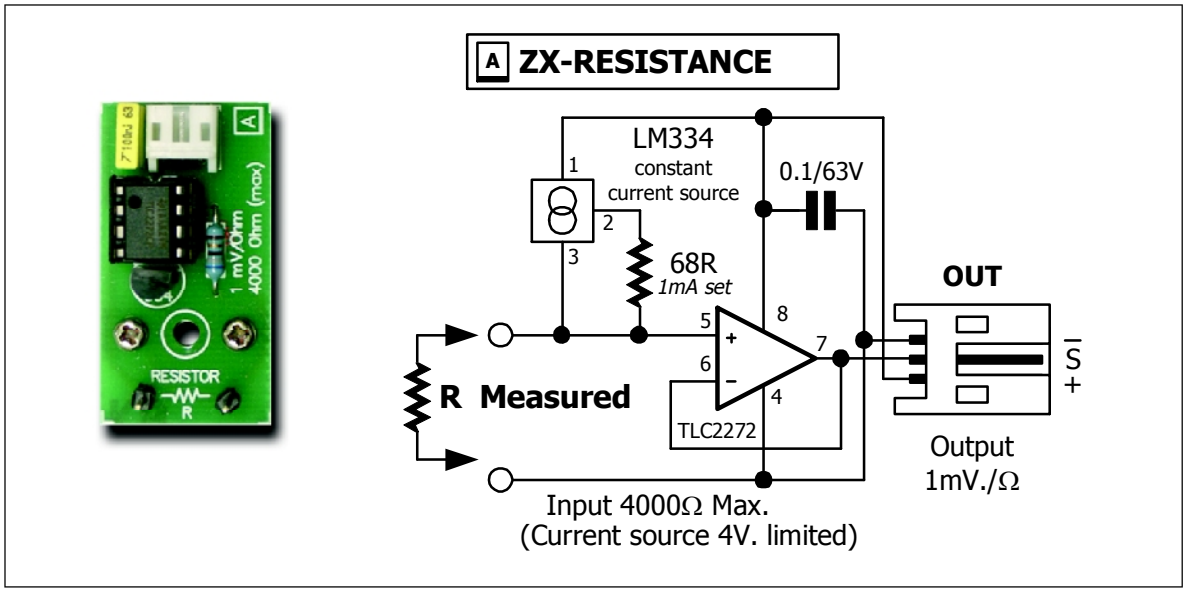


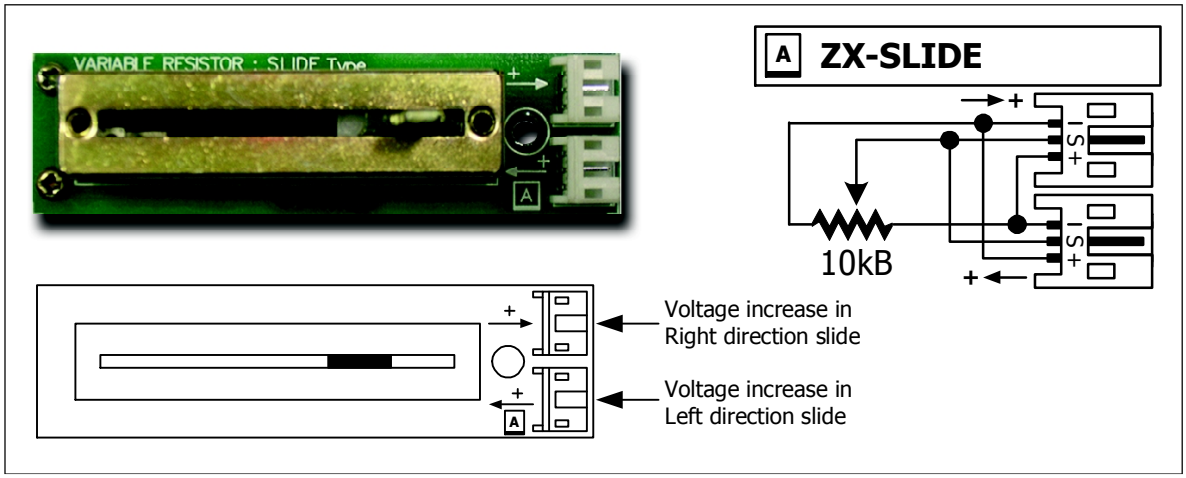


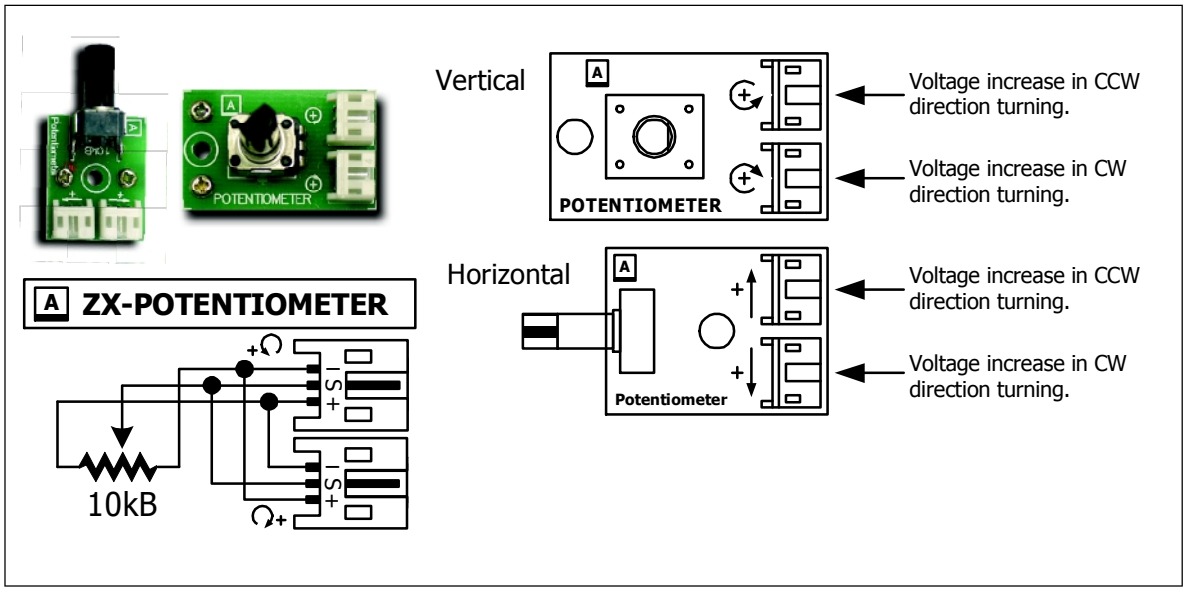


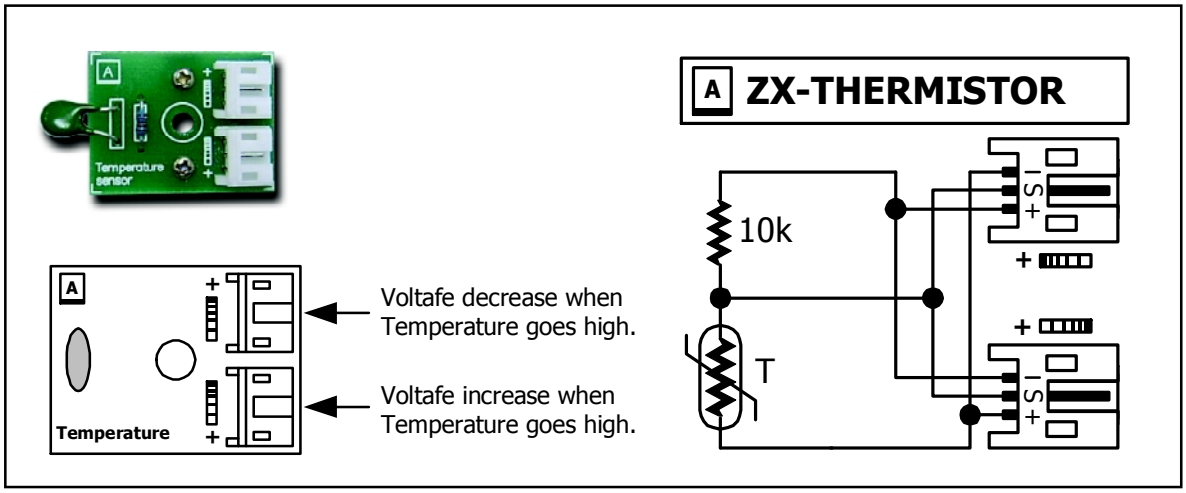


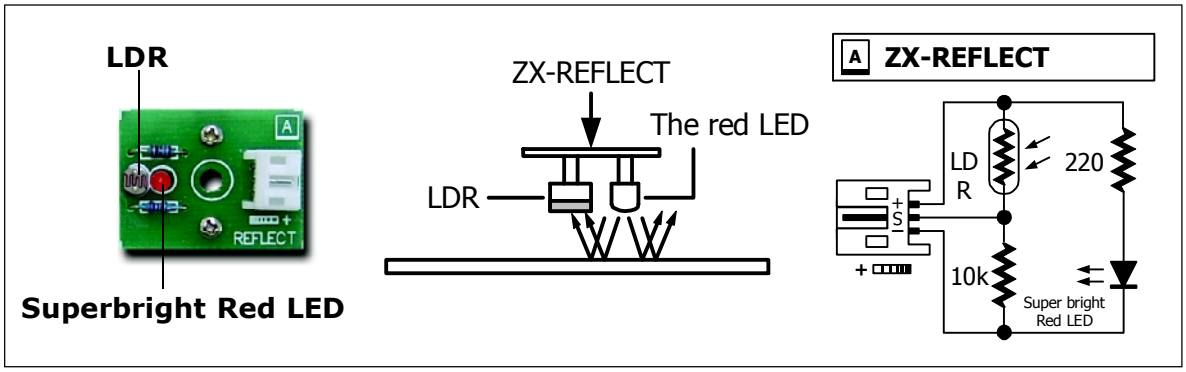


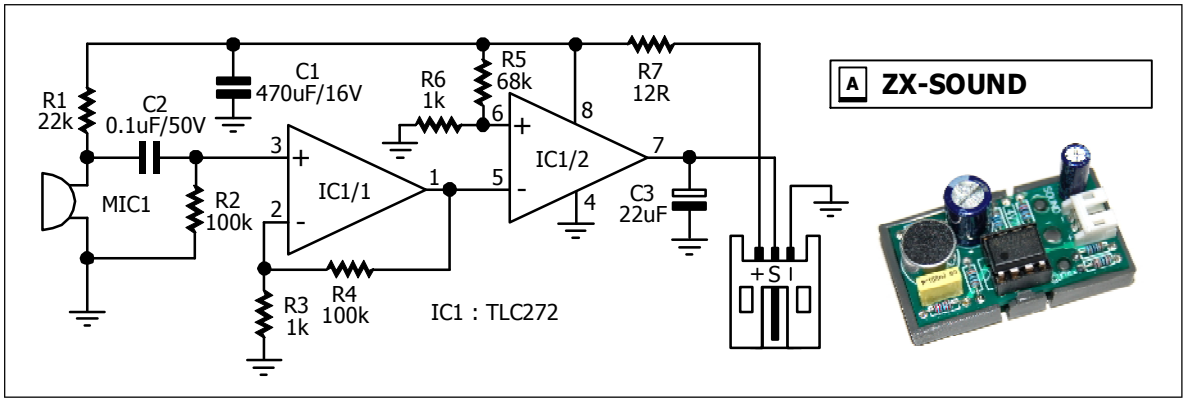

A ZX-RESISTANCE
LM334
constant
current source
0.1/63V
68R
1mA set
OUT
R Measured
TLC2272
Output
1mV./Ω
Input 4000Ω Max.
(Current source 4V. limited)

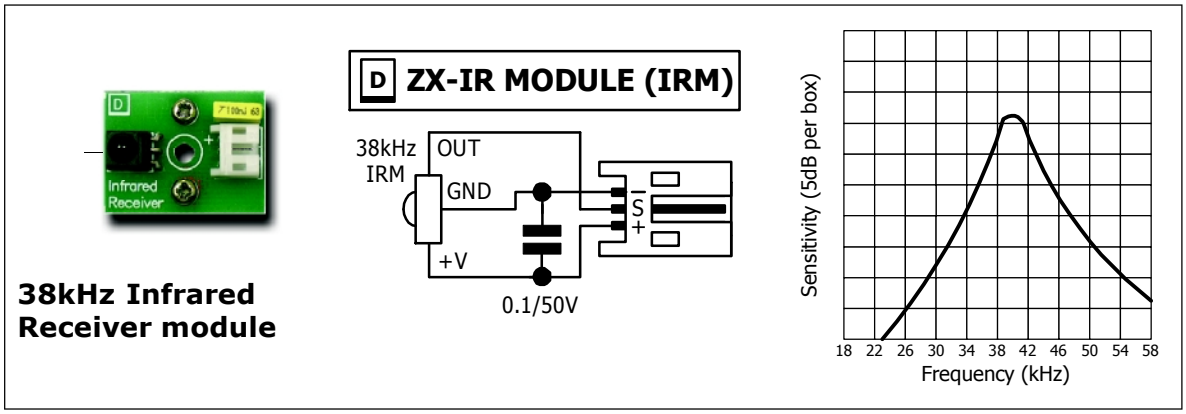

VARIABLE RESISTOR : SLIDE Type
A ZX-SLIDE
10kB
Voltage increase in
Right direction slide
Voltage increase in
Left direction slide


POTENTIOMETER
A ZX-POTENTIOMETER
10kB
Vertical
POTENTIOMETER
Voltage increase in CCW
direction turning.
Voltage increase in CW
direction turning.
Horizontal
Potentiometer
Voltage increase in CCW
direction turning.
Voltage increase in CW
direction turning.


A ZX-THERMISTOR
Temperature sensor
Temperature
Voltafe decrease when Temperature goes high.
Voltafe increase when Temperature goes high.
10k
T
S

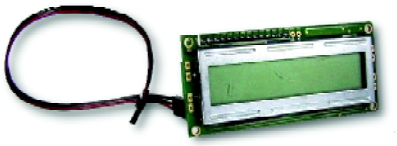

LDR
Superbright Red LED
REFLECT
ZX-REFLECT
The red LED
LDR
A ZX-REFLECT
LD R
220
10k
Super bright Red LED


R1 22k
C2 0.1uF/50V
C1 470uF/16V
R6 1k
R5 68k
R7 12R
MIC1
R2 100k
IC1/1
IC1/2
C3 22uF
R3 1k
R4 100k
IC1 : TLC272
A ZX-SOUND


Infrared Receiver
38kHz Infrared Receiver module
D ZX-IR MODULE (IRM)
38kHz IRM
OUT
GND
+V
0.1/50V
Sensitivity (5dB per box)
18 22 26 30 34 38 42 46 50 54 58
Frequency (kHz)

Serial LCD 16x2 : SLCD16x2

(connect to P0-P7)



SLCD16x2 is the 16 characters 2 lines LCD module that communication by serial interface. It received data serially and display on the LCD. Accept serial data at 2400 or 9600 baudrate and accept either TTL or RS-232 level, by 2 jumpers select. Support on standard LCD controller HITACHI HD44780 or SEIKO EPSON SED1278 compatible. Both 1/8 Duty and 1/16 Duty of 1x16 LCD Module can be used by jumper selection too.

- Serial Input RS-232 or Invert/Non-invert TTL/CMOS logic level.
- 1/8 or 1/16 Duty can be selected by jumper.
- Scott Edwards's LCD Serial Backpack ® command compatible addition with Extended Command that make LCD control easier.
- Easy to interface with microcontroller
- Operation with +5 to 12 Vdc supply

INNOVATIVE EXPERIMENT

www.inex.co.th
www.inexglobal.com