SOLUTIONS CUBED

ICON Interface Module – BASIC Stamp Prototyping Kit (AN600 Kit)

Revision 1

February 27th, 2002

AN600 Kit
ICON Interface Module – BASIC Stamp Kit

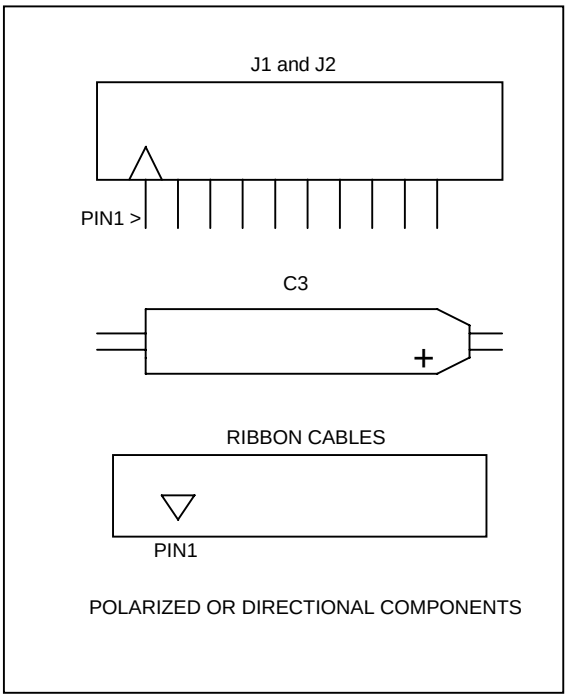
FEATURES
- Control and Interface to 1 or 2 ICON Interface Modules with ICON H-Bridges
- BASIC Stamp 2, 2SX, 2P24, 2E compatible
- Large prototyping area
- BASIC Stamp powered by ICON Interface Module at J1

DESCRIPTION:
This kit and documentation package provide a road map for successfully interfacing one or two ICON Interface Modules and ICON H-Bridges to a BASIC Stamp 2. This hardware can be used for robotic drive systems utilizing skid steering of 2 DC motors up to 12A. This prototyping kit can also be used for single motor control applications by omitting the second ICON Interface Module and ICON H-Bridge normally connected to J2.

ASSEMBLY:
Assembly of the kit can be accomplished by placing the components on the silk-screen (white lettering and outlines) of the PCB, and soldering the components from the backside of the PCB. It is useful to solder on the parts with the smallest profile first. For instance, start by soldering the socket associated with U1, then add the discrete components R1, C1, C2, and C3, then J1 and J2, and finally add J3 the BASIC Stamp programming connector.

Some of the connectors are polarized or have pin locations designated as pin 1. These are detailed in figure 1.

Figure 1: Polarized or Directional Components



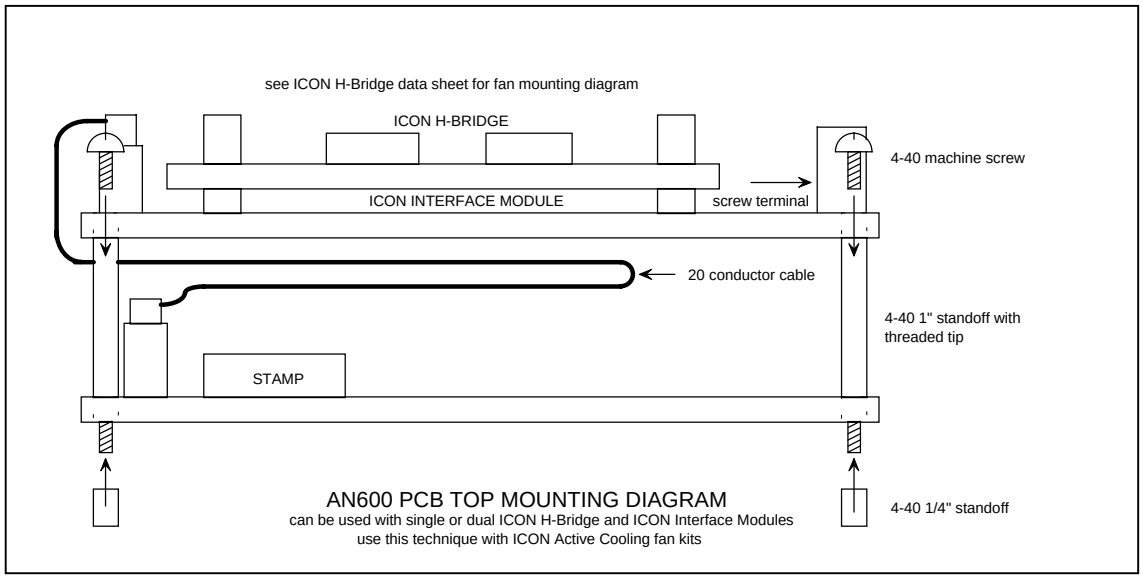
ASSEMBLY (continued):
Your kit should contain the following hardware.

Figure 2: AN600 Kit Bill of Materials

Item Number	Qty.	Part Reference	Description	Manufacturer	Manufacturer Part Number
1	2	C1 C2	0.1uF 50V X7R CERAMIC CAP TH	Panasonic	A104K20X7RFVVWN
2	1	C3	10uF 10V AXIAL TANTALUM CAP TH	Kemet	T322B106K010AS
3	2	J1 J2	DUAL 0.1" ROW 20 POS SHROUDED	Tyco-AMP	103308-5
4	1	J3	D-SUB 0.318 DB9 FEMALE	Amp	747844-4
5	1	R1	2 OHM 1/4W 5% RESISTOR	Panasonic	2.0QBK-ND
6	1	U1	24 PIN 0.6" SOCKET	Mill-Max	110-99-624-41-001
7	2		6" SCKT-SCKT 20 CONDUCTOR CABLE	CW Industries	C3AAT-2006G-ND
8	8		4-40 x 1/4" PHILLIPS STAINLESS STEEL SCREW	IDXMART	6F1004-30827
9	8		4-40 x 1" MALE/FEMALE ALUM. THREADED STANDOFF	IDXMART	6F1396-67387
10	4		4-40 X 1/4" ALUM. STANDOFF	IDXMART	6F1388-68137
11	1		4x4 12 ROUTE POINT PCB	RSC	AN600_2

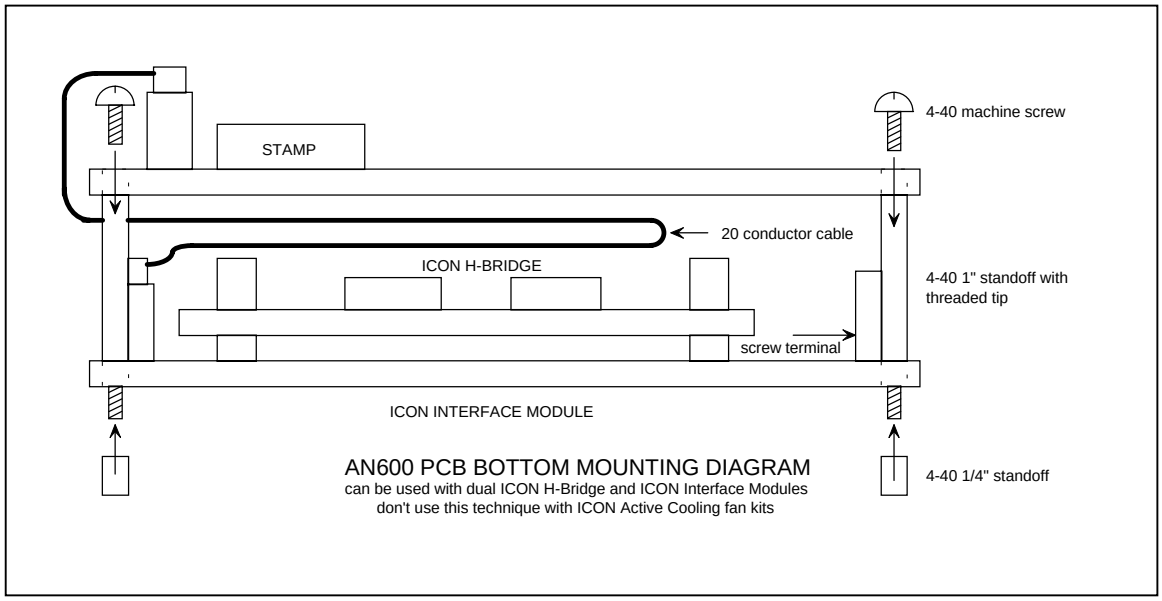
The ICON Interface Modules and ICON H-Bridges may be mounted above or below the AN600 PCB. When using the ICON Active Cooling (fan) kits the ICON products should be mounted above the AN600 PCB. Additionally, if interfacing to only one ICON Interface Module, the module should be connected to J1 with the 6" ribbon cable and should be mounted above the AN600 PCB.

Figure 3: AN600 PCB Top Mounting Diagram



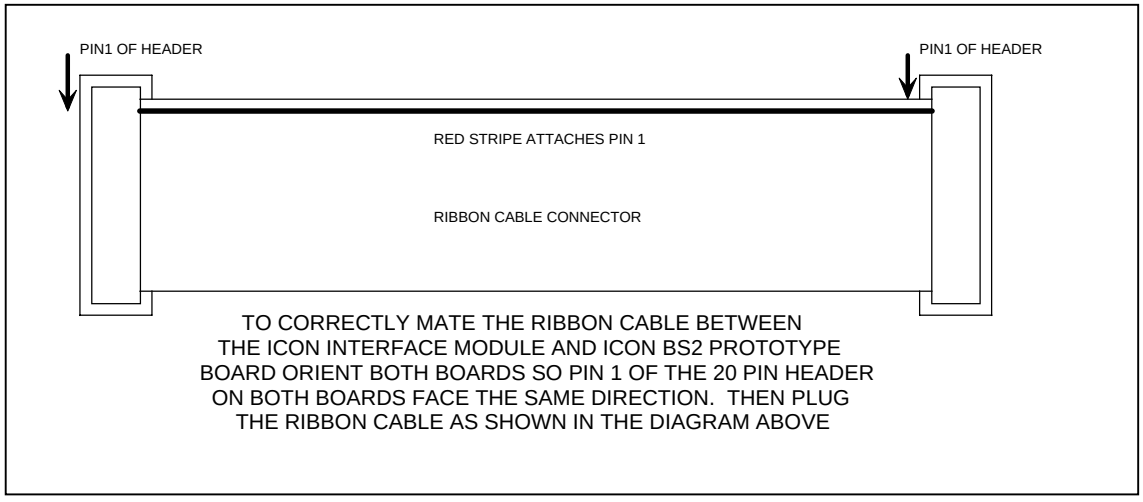
You may also mount the ICON products beneath the AN600 PCB. Cutouts have been routed on the AN600 PCB to allow access to the screw terminals of each ICON Interface Module.

Figure 4: AN600 PCB Bottom Mounting Diagram

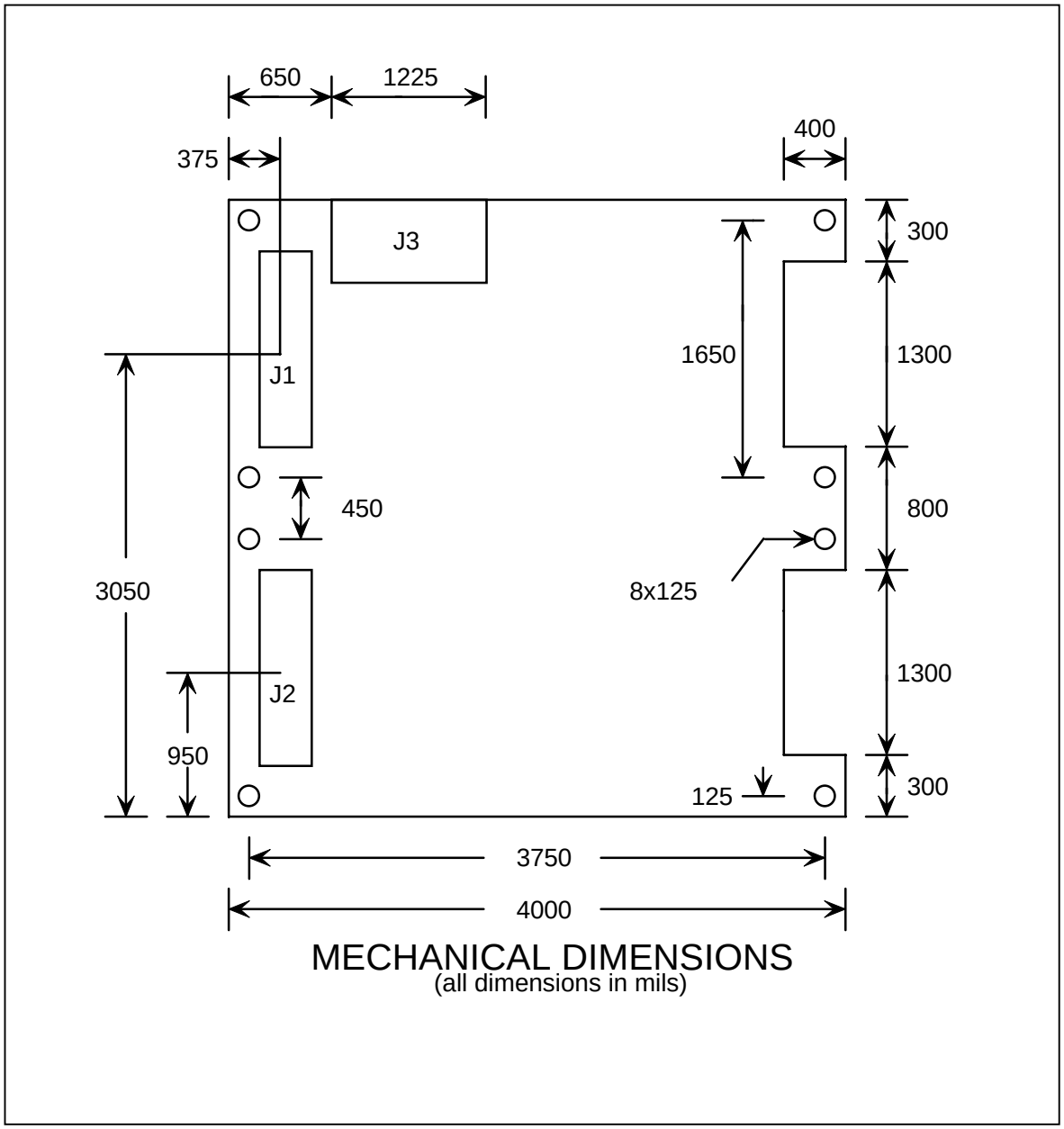


When connecting the ribbon cables between the ICON Interface Modules and the AN600 PCB verify that the devices are connected correctly. Pin 1 of each end of the ribbon cable should be connected to pin1 of the 20 pin headers. Both the header and the ribbon cable have pin 1 designated in the manner displayed in figure 1 of this data sheet. Figure 5 describes one method to ensure that connectivity is accomplished correctly.

Figure 5: Ribbon Cable Connections



MECHANICAL DIMENSIONS:



AN600:
Application note 600 is included in its entirety on the following pages. The source code for the BASIC Stamp 2 that is displayed in this application note can be downloaded from www.solutions-cubed.com.

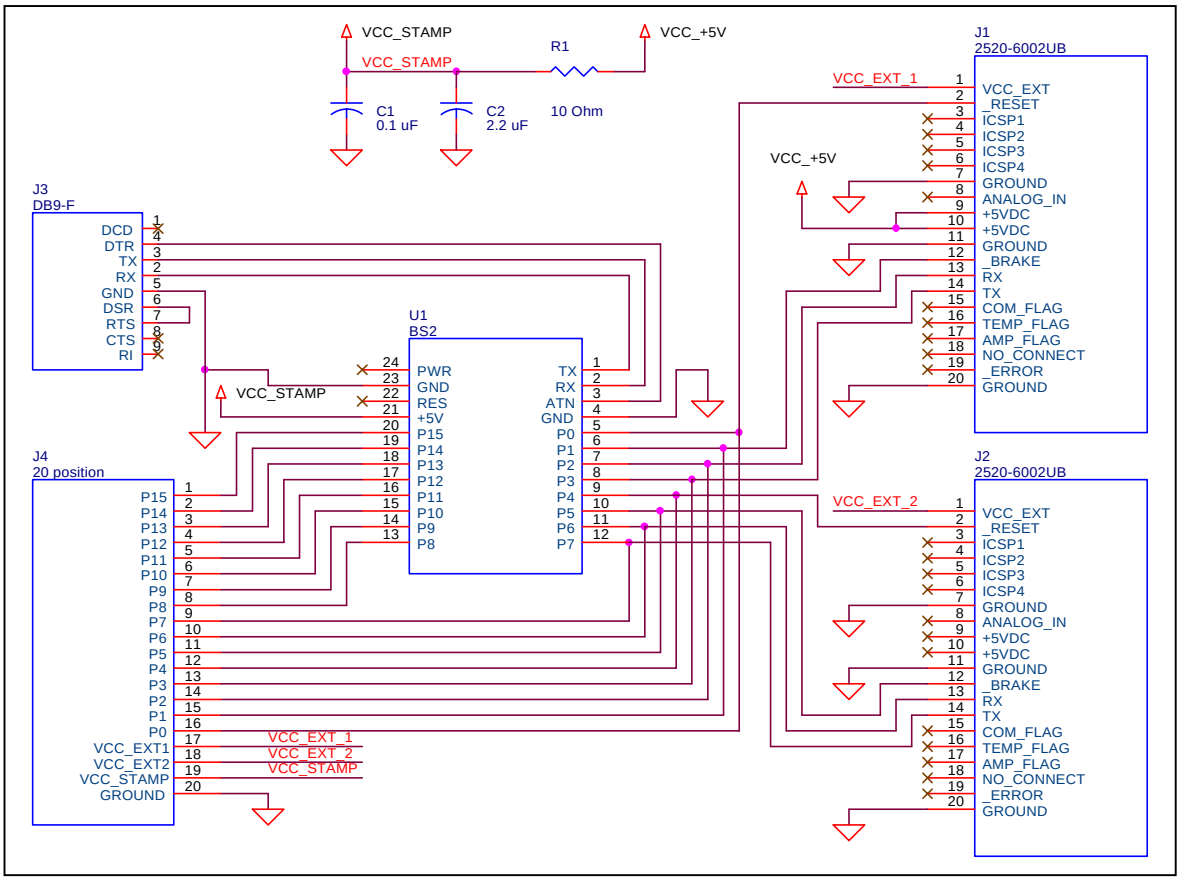
Technical support for this design can be reached at solcubed@solutions-cubed.com.

AN600 – INTERFACING THE ICON INTERFACE MODULE TO THE BASIC STAMP2

HARDWARE:

Connectivity and control of the ICON Interface Module and ICON H-Bridge can be simplified to a 38,400BPS N,8,1 serial interface. While the ICON Interface Module possesses five modes of operation, the BASIC Stamp in this application will use just the serial control mode. A DB9-female connector is used to program the BS2, while a 20-pin header provides access to each BS2 I/O pin, and various power connections. It is assumed that the BS2 is powered by the +5VDC output available on the 20-pin connector connected to ICON Interface Module #1 (connected to J1).

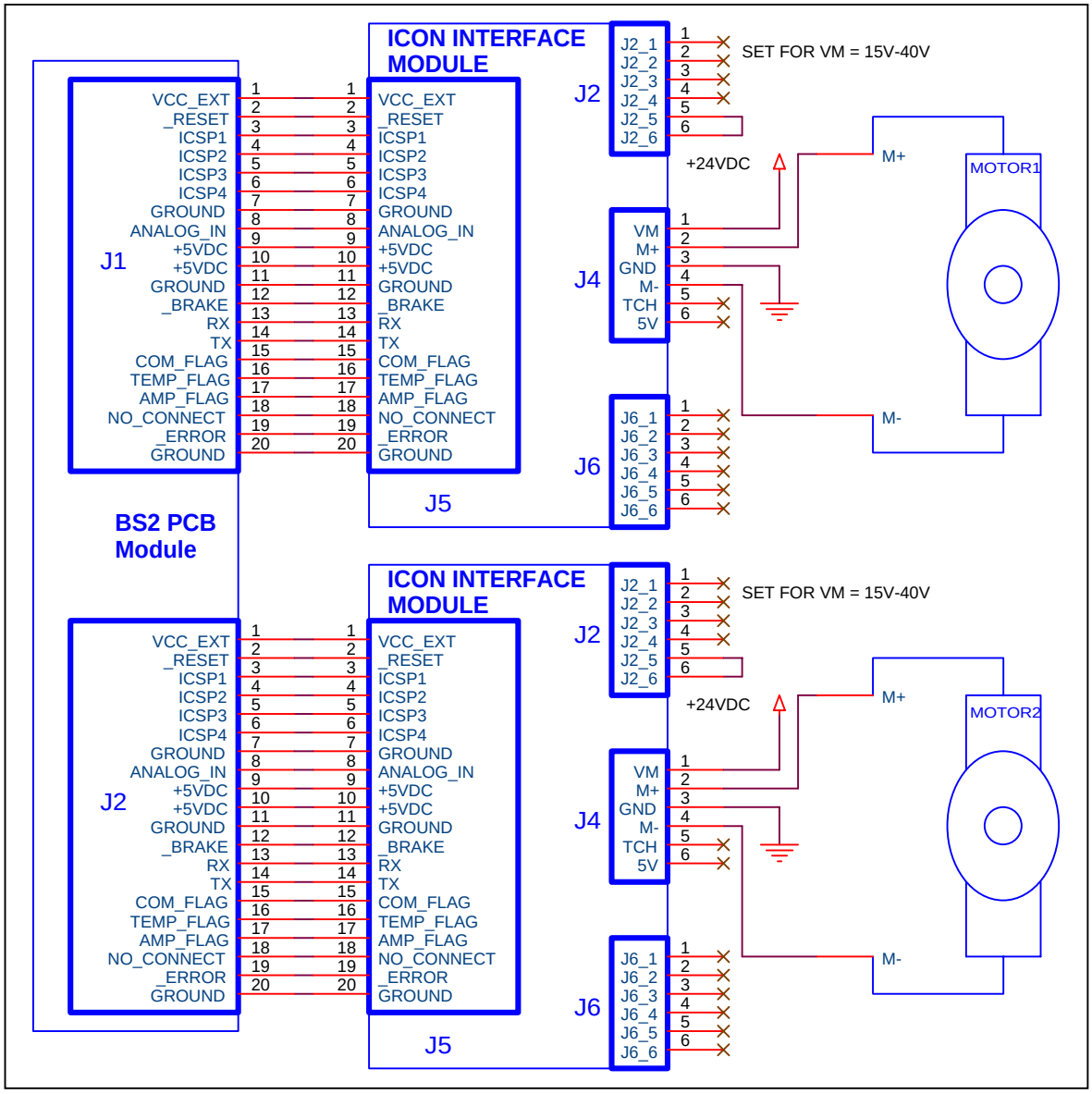
Figure 6: BS2 Connectivity to 2 ICON Interface Modules



Connectivity to each ICON Interface Module is accomplished with a ribbon cable (CW Industries PN: C3AAT-2006G) available through Digi-Key. The shrouded 20-pin headers on the BS2 module match those on the ICON Interface Modules (Tyco-Amp PN: 103308-5) which is also available from Digi-Key.

It is assumed that power is supplied to the BS2 module from the ICON Interface Module #1, that both ICON Interface Modules are being powered by a 24VDC supply, and that J2 on each ICON Interface Module has its jumper selected appropriately.

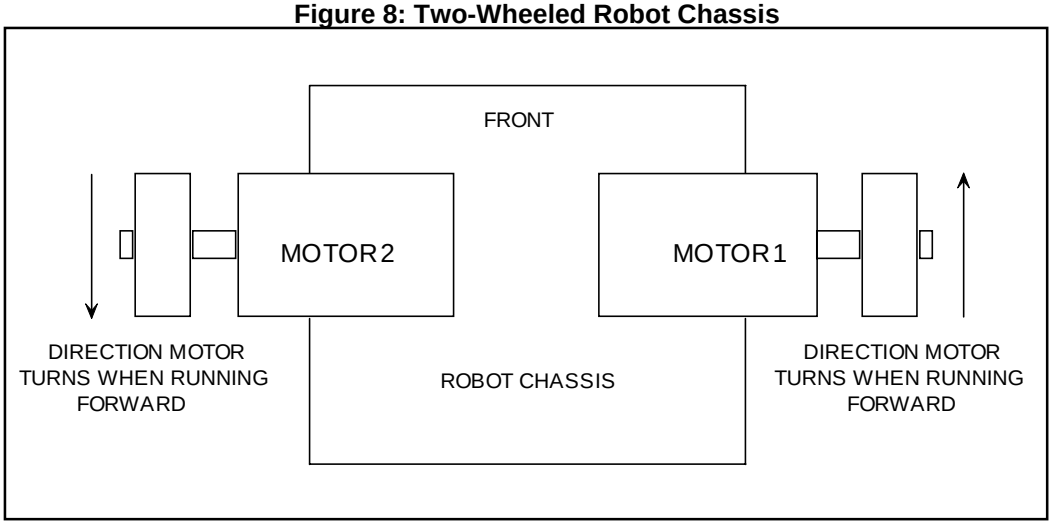
Figure 7: ICON Interface Module and BS2 PCB Module Connectivity Diagram



For motor voltages between 10VDC and 15VDC the voltage selection header (J2) on each ICON Interface Module should be jumped at J2_3 and J2_4. For motor voltages less than 10VDC the user will have to supply an external 12VDC signal at the BS2 module and place a jumper across J2_1 and J2_2 of J2 on each ICON Interface Module. The 12VDC signal would then be connected to the VCC_EXT_1 and VCC_EXT_2 connection on the BS2.

SOFTWARE:
AN600 was designed to display a simple method for controlling a two-wheeled robot. It is assumed that the software would have to be modified to account for the particular idiosyncrasies of any mechanical systems. The software describes a method that may be used to ramp motor speed up or down to prevent over current conditions that can occur by rapidly changing speeds in large motors. It also describes methods for implementing slow and fast turns, and reversing a two-wheeled robot. The software is relatively simple and well commented. But for clarification a diagram of the envisioned mechanical system is included here.

Figure 8: Two-Wheeled Robot Chassis



Some aspects of the software require explanation. When implementing a command and waiting for a response from the ICON Interface Module the SERIN command is loaded with a 150ms timeout. In most cases the ICON Interface Module will respond within 5-10ms to a command. But the ICON Interface Module is regularly polling the ICON H-Bridge (about 5 times per second) to check the ICON H-Bridge's status. The communication between the ICON H-Bridge and the ICON Interface Module occurs at 2400BPS. If the ICON Interface Module is in the process of communicating with the ICON H-Bridge it may not be able to reply to a command for up to 150ms. You may reduce this timing or eliminate waiting for an ACK to speed up your program flow. If this is the route you take you should periodically check the status of each ICON Interface Module to verify that it is operating. This can be done with the READ_STATUS subroutine that is included in the software listing but is not called during program run time as AN600 is currently written.

If modifying AN600 for use with a BS2SX you should modify the BAUD constant to decimal 45, and change the timeout used with the SERIN commands to 500 (from 150). The software used for this application note (AN600.BS2) may be downloaded at www.solutions-cubed.com.

Finally, when interfacing to a large motor the resulting voltage and current spikes can destroy electronic circuits or reset processors. It is usually a good idea to avoid dramatic changes in motor speed or direction. If you find you have spurious failures check your power supply for glitches and try ramping motor speeds up and down to avoid dramatic speed changes.

AN600.BS2 Software Listing

```
'AN600 Interfacing a BASIC Stamp 2 to 2 ICON Interface Modules

'Communication string variables
        CMMD            VAR     BYTE                    'Command byte storage
        ADDR            VAR     BYTE                    'Address byte storage
        LENG            VAR     BYTE                    'Length byte storage
        CKSUM           VAR     BYTE                    'Checksum byte storage
        DAT1            VAR     BYTE                    'Data byte registers
        DAT2            VAR     BYTE
        DAT3            VAR     BYTE
        DAT4            VAR     BYTE
        DAT5            VAR     BYTE
        DAT6            VAR     BYTE
        DAT7            VAR     BYTE
        DAT8            VAR     BYTE
        ERROR1          VAR     BYTE                    'Communication error counters
        ERROR2          VAR     BYTE
        LOOP            VAR     WORD                    'For next loop word
        SPEED           VAR     WORD                    'Speed value storage
        STRT_SPD        VAR     WORD                    'Start speed used in ramp up and ramp down
        END_SPD         VAR     WORD                    'End speed used in ramp up and ramp down
'PWM storage registers
        PWM_REG1        VAR     WORD                    'PWM storage register for ICON Module 1
                P1HI    VAR     PWM_REG1.HIGHBYTE
                P1LO    VAR     PWM_REG1.LOWBYTE
        PWM_REG2        VAR     WORD                    'PWM storage register for ICON Module 2
                P2HI    VAR     PWM_REG2.HIGHBYTE
                P2LO    VAR     PWM_REG2.LOWBYTE

'Program constants
'       BAUD            CON     45                      'Use BAUD = 45 for BS2SX
        BAUD            CON     6                       'Use BAUD = 6 for BS2

'ICON Interface Module #1 control lines
        RESET1          CON     0                       'Causes hardware reset when pulled low
        BRAKE1          CON     1                       'Implements braking function when pulled low
        DOUT1           CON     2                       'TTL serial data to ICON Interface Module
        DIN1            CON     3                       'TTL serial data from ICON Interface Module

'ICON Interface Module #2 control lines
        RESET2          CON     4                       'Causes hardware reset when pulled low
        BRAKE2          CON     5                       'Implements braking function when pulled low
        DOUT2           CON     6                       'TTL serial data to ICON Interface Module
        DIN2            CON     7                       'TTL serial data from ICON Interface Module

'Set BS2SX i/o direction and level
        DIRS            =%0000000001110111              'Set P0,P1,P2,P4,P5,P6 as outputs
        OUTS            =%1111111111111111              'Set all outputs high

        LOW             RESET1                          'Reset ICON Interface Modules
        LOW             RESET2
        PAUSE           5
        HIGH            RESET1
        HIGH            RESET2
        PAUSE           750                             'Wait 750ms for Interface Modules to power up
        DEBUG           CLS                             'Clear debug screen

        GOSUB           INIT_IM                         'Initialize the ICON Interface Modules
```

```
START:

'The "ramp-up forward" portion of this code ramps up the speed of both motors.  This technique
'may be used to increase motor speed in large motors without abruptly changing motor speed
'and therefore tripping the over current fuse in either of the attached ICON H-Bridges.

RAMP_UP_FORWARD:
        DEBUG           CR,"FORWARD RAMP UP",CR
        STRT_SPD        =$0
        END_SPD         = $3E8
        FOR     SPEED = STRT_SPD TO END_SPD STEP ((END_SPD - STRT_SPD)/10)
                GOSUB   FORWARD
                PAUSE   20
        NEXT
        PAUSE           2500

'The "ramp-down forward" portion of this code ramps down the speed of both motors.  This technique
'may be used to decrease motor speed in large motors without abruptly changing motor speed
'and therefore tripping the over current fuse in either of the attached ICON H-Bridges.

RAMP_DN_FORWARD:
        DEBUG           CR,"FORWARD RAMP DOWN",CR
        STRT_SPD        =$3E8
        END_SPD         = $0
        FOR     SPEED = STRT_SPD TO END_SPD STEP ((STRT_SPD - END_SPD)/10)
                GOSUB   FORWARD
                PAUSE   20
        NEXT
        PAUSE           500
        SPEED           = $200                  'Set motor speed to 50%

        DEBUG           CR,"BACKWARD",CR
        GOSUB           BRAKE                   'Brake motors before changing direction
        GOSUB           BACKWARD                'Run robot in reverse
        PAUSE           2000

        DEBUG           CR,"SLOW LEFT",CR       'Make a slow left turn
        GOSUB           BRAKE                   'Brake motors before changing direction
        GOSUB           SLOW_LEFT               'Perform a slow left turn
        PAUSE           2000

        DEBUG           CR,"SLOW RIGHT",CR      'Make a slow right turn
        GOSUB           SLOW_RIGHT              'Perform a slow right turn
        PAUSE           2000

        DEBUG           CR,"FAST LEFT",CR       'Make a fast left turn
        GOSUB           FAST_LEFT               'Stop left motor (2) and run right motor (1)
        PAUSE           2000

        DEBUG           CR,"FAST RIGHT",CR      'Make a fast right turn
        GOSUB           FAST_RIGHT              'Stop right motor (1) and run left motor (2)
        PAUSE           2000

        LOW             BRAKE1
        LOW             BRAKE2
        PAUSE           2000                    'Assert brake pins to stop the motors from turning
        HIGH            BRAKE1
        HIGH            BRAKE2

        GOTO            START                   'Return to start of program
```

```
'************************************ Subroutines ***********************************

'****************************************************************************************
'INIT_IM:       This subroutine initializes the ICON Interface Modules by ensuring that the
'               ADDRESS registers are programmed to "1" and programming the IM_FUNCTION
'               registers to binary %10100000.  The IM_FUNCTION value enables dynamic
'               braking and amps retry settings (see the communication protocol for
'               more information on these functions).  The ADDRESS and IM_FUNCTION registers
'               are written to using the universal address of "0", therefore no ACK will be
'               be received from the ICON Interface Modules.  The BS2 then sends the STORE
'               command to each ICON Interface Module and waits for the ACK.  This process
'               occurs every time the circuit is powered up, but in reality it only needs to
'               occur once since the settings are stored in EEPROM with the STORE command.
'****************************************************************************************
INIT_IM:
        CMMD            = $D2                                   'WRITE command
        ADDR            = $00                                   'Universal address
        LENG            = $04                                   'Message length
        DAT1            = $0E                                   'ADDRESS register index value
        DAT2            = $01                                   'Write "1" to ADDRESS register
        DAT3            = $0F                                   'IM_FUNCTION register index value
        DAT4            = $A0                                   'Write %1010000 to IM_FUNCTION register
        CKSUM           = CMMD+ADDR+LENG+DAT1+DAT2+DAT3+DAT4
        SEROUT          DOUT1,BAUD,[CMMD,ADDR,LENG,DAT1,DAT2,DAT3,DAT4,CKSUM]
        SEROUT          DOUT2,BAUD,[CMMD,ADDR,LENG,DAT1,DAT2,DAT3,DAT4,CKSUM]

        PAUSE           20
        CMMD            = $D3                                   'STORE command
        ADDR            = $01                                   'ICON Interface Module address of "1"
        LENG            = $00                                   'Length of 0, no data in command
        CKSUM           = CMMD+ADDR+LENG
        SEROUT          DOUT1,BAUD,[CMMD,ADDR,LENG,CKSUM]
        SERIN           DIN1,BAUD,150,NA_INIT1,[DAT1]
        IF              DAT1 = $6 THEN A_INIT1                  'Wait 150ms for an ACK from module 1
NA_INIT1:
        DEBUG           "NO ACK INIT1",CR
A_INIT1:
        SEROUT          DOUT2,BAUD,[CMMD,ADDR,LENG,CKSUM]
        SERIN           DIN2,BAUD,150,NA_INIT2,[DAT1]
        IF              DAT1 = $6 THEN A_INIT2                  'Wait 150ms for an ACK from module 2
NA_INIT2:
        DEBUG           "NO ACK INIT2",CR
A_INIT2:
        RETURN

'****************************************************************************************
'SETDC_IM1:     This routine sends speed and direction data to the ICON Interface Module
'               number one located on the right hand side of the robot.  The speed and
'               direction data are stored in the PWM_REG1 register.  If an ACK is not
'               received within 150ms then the BS2 will attempt to send the command again.
'               This retry will be attempted up to 5 times.
'****************************************************************************************

SETDC_IM1:
        DEBUG           "PWM1 = ",ISHEX4 PWM_REG1,TAB
        CMMD            = $D0                                   'SETDC command
        ADDR            = $01                                   'ICON Interface Module address of "1"
        LENG            = $02                                   'Length of SETDC is 2
        CKSUM           = CMMD+ADDR+LENG+P1LO+P1HI
        SEROUT          DOUT1,BAUD,[CMMD,ADDR,LENG,P1HI,P1LO,CKSUM]
        SERIN           DIN1,BAUD,150,NA_SDC1,[DAT1]
        IF              DAT1 <> $6 THEN NA_SDC1
        ERROR1          = 0
        RETURN
NA_SDC1:
        ERROR1          = ERROR1+1
        IF              ERROR1 < 5 THEN SETDC_IM1
        ERROR1          = 0
        RETURN
```

```
'*****************************************************************************
'SETDC_IM2:  This routine sends speed and direction data to the ICON Interface Module
'            number two located on the left hand side of the robot.  The speed and
'            direction data are stored in the PWM_REG2 register.  If an ACK is not
'            received within 150ms then the BS2 will attempt to send the command again.
'            This retry will be attempted up to 5 times.
'*****************************************************************************

SETDC_IM2:
        DEBUG           "PWM2 = ",ISHEX4 PWM_REG2,CR
        CMMD            = $D0                           'SETDC command
        ADDR            = $01                           'ICON Interface Module address of "1"
        LENG            = $02                           'Length of SETDC is 2
        CKSUM           = CMMD+ADDR+LENG+P2LO+P2HI
        SEROUT          DOUT2,BAUD,[CMMD,ADDR,LENG,P2HI,P2LO,CKSUM]
        SERIN           DIN2,BAUD,150,NA_SDC2,[DAT1]
        IF              DAT1 <> $6 THEN NA_SDC2
        ERROR2          = 0
        RETURN
NA_SDC2:
        ERROR2          = ERROR2+1
        IF              ERROR2 < 5 THEN SETDC_IM2
        ERROR2          = 0
        RETURN

'*****************************************************************************
'FORWARD:    This subroutine runs motor one in the forward direction and motor two at
'            the same speed but in the reversed direction.  This should move the robot
'            forward.
'*****************************************************************************

FORWARD:
        PWM_REG1        = SPEED
        PWM_REG2        = -SPEED
        GOSUB           SETDC_IM1
        GOSUB           SETDC_IM2
        RETURN

'*****************************************************************************
'BACKWARD:   This subroutine runs motor two in the forward direction and motor one at
'            the same speed but in the reversed direction.  This should move the robot
'            backward.
'*****************************************************************************

BACKWARD:
        PWM_REG1        = -SPEED
        PWM_REG2        = SPEED
        GOSUB           SETDC_IM1
        GOSUB           SETDC_IM2
        RETURN

'*****************************************************************************
'SLOW_LEFT:  This subroutine runs motor one forward and motor two at half the speed of
'            motor one in reverse.  This will cause the robot to veer to the left.
'*****************************************************************************

SLOW_LEFT:
        PWM_REG1        = SPEED
        PWM_REG2        = -(SPEED/2)
        GOSUB           SETDC_IM1
        GOSUB           SETDC_IM2
        RETURN
```

```
'*****************************************************************************
'SLOW_RIGHT:   This subroutine runs motor two reversed and motor one at half the speed of
'              motor two in the forward direction.  This will cause the robot to veer to
'              the right.
'*****************************************************************************

SLOW_RIGHT:
          PWM_REG1        = SPEED/2
          PWM_REG2        = -SPEED
          GOSUB           SETDC_IM1
          GOSUB           SETDC_IM2
          RETURN

'*****************************************************************************
'FAST_LEFT:  This subroutine runs motor one in the forward direction and stops motor two
'             by sending it a speed of $0000.  This causes the robot to pivot to the left.
'*****************************************************************************

FAST_LEFT:
          PWM_REG1        = SPEED
          PWM_REG2        = $0
          GOSUB           SETDC_IM1
          GOSUB           SETDC_IM2
          RETURN

'*****************************************************************************
'FAST_RIGHT:This subroutine runs motor two in the reversed direction and stops motor
'           one by sending it a speed of $0000.  This causes the robot to pivot to the
'           right.
'*****************************************************************************

FAST_RIGHT:
          PWM_REG1        = $0
          PWM_REG2        = -SPEED
          GOSUB           SETDC_IM1
          GOSUB           SETDC_IM2
          RETURN

'*****************************************************************************
'READ_STATUS:   This subroutine reads the IM_STATUS, and IH_STATUS registers from both
'               ICON Interface Modules and displays the information in a binary format.
'*****************************************************************************

READ_STATUS:
          CMMD            = $D1
          ADDR            = $01
          LENG            = $02
          DAT1            = $00
          DAT2            = $01
          CKSUM           = CMMD+ADDR+LENG+DAT1+DAT2
          SEROUT          DOUT1,BAUD,[CMMD,ADDR,LENG,DAT1,DAT2,CKSUM]
          SERIN           DIN1,BAUD,150,NA_RDST1,[DAT1,DAT2,DAT3,DAT4]
          DEBUG           "IM1 STATUS =",BIN8 DAT3,"  IH1 STATUS =",BIN8 DAT4,CR
          GOTO            RDST2
NA_RDST1:
          DEBUG           "NO ACK READ STATUS 1",CR
RDST2:
          DAT1            = $00
          DAT2            = $01
          CKSUM           = CMMD+ADDR+LENG+DAT1+DAT2
          SEROUT          DOUT2,BAUD,[CMMD,ADDR,LENG,DAT1,DAT2,CKSUM]
          SERIN           DIN2,BAUD,150,NA_RDST2,[DAT1,DAT2,DAT3,DAT4]
          DEBUG           "IM2 STATUS =",BIN8 DAT3,"  IH2 STATUS =",BIN8 DAT4,CR
          GOTO            DONE_RDST2
NA_RDST2:
          DEBUG           "NO ACK READ STATUS 2",CR
DONE_RDST2
          RETURN
```

```
'*****************************************************************************
'BRAKE:      This subroutine asserts the /BRAKE pins for both ICON Interface Modules
'           waits 250ms and then releases the /BRAKE pins.
'*****************************************************************************

BRAKE:
        LOW             BRAKE1
        LOW             BRAKE2
        PAUSE           250
        HIGH            BRAKE1
        HIGH            BRAKE2
        RETURN

END:
```

SUMMARY:

As can be seen from AN600 the ICON Interface Module and ICON H-Bridge can simplify connectivity and control of brushed DC motors with the BASIC Stamp. This application note used only the simplest of the ICON Interface Module's capabilities. Additionally, with the 12A continuous current handling capability of the ICON DC Motor Control system larger robotic systems can be envisioned. Furthermore, these systems may be implemented with minimal development time and at a reduced development cost.