

Instruction Manual for IEEE p1451.2 Prototyping Kit

1st Edition



Esensors Inc
Amherst NY

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PRINTING HISTORY

March 2004

First Edition

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Warranty

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About the IEEE p1451.2 Prototyping Kit

The IEEE 1451.2 (Dot 2) smart transducer interface standard is being revised by a working group and is expected to utilize the standard RS232 and RS485 serial buses as the main options (replacing the TII). Also the Transducer Electronic Data Sheet (TEDS) format is being changed. The prototyping kit consists of an Internet compatible Network Capable Application Processor (NCAP) and a Smart Transducer Interface Module (STIM) which can be reprogrammed to suit various applications. It is intended for engineers who are considering future Dot 2 applications.

Introduction to the EM04 (NCAP) and EI02 (STIM)

The EM04 (NCAP)

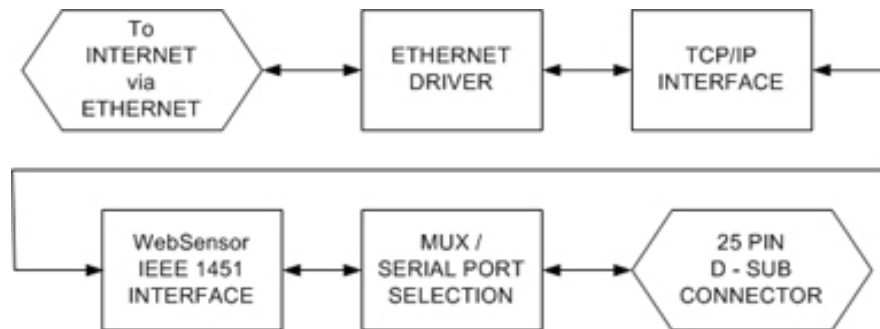
The EM04 interface exchanges digital data between an RS232 and the Internet through Ethernet. Using the TCP/IP format, commands from a website (browser) are sent to the EM04 NCAP which converts the commands to standard IEEE1451.2 format and retransmits them to a STIM through the serial port. Received sensor digital data from the STIM is reformatted within the NCAP (h-command set) and sent through the Internet, via Ethernet, back to the originating website. The NCAP supports several forms of the Transducer Electronic Data Sheet (TEDS).

The EI02 (STIM)

The EI02 is a prototype STIM with three inputs and two outputs. The input consists of two sensors (photodiode and Hall effect) and an analog input. The output consists of a relay output and a D/A voltage output. A standard RS232 serial connection is used with power provided over the 9-pin sub D connector. An internal PIC16F873 microcontroller can be reprogrammed by the user. Source code (PIC C) is provided but because the standard is not finalized, the data formats and TEDS are provisional and subject to change.

EM04 Block Diagram

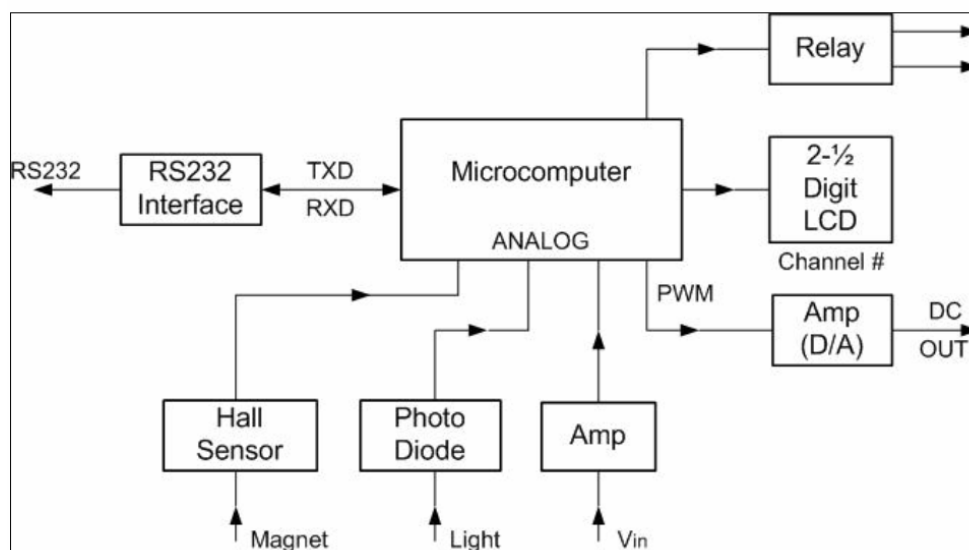
A block diagram of the EM04 interface is shown below. The program for the PIC microcontroller (16F877) is written in C and may be modified by the user.



EM04 Block Diagram

EI02 Block Diagram

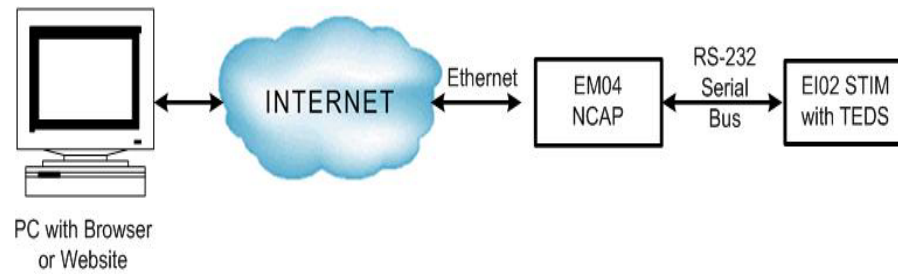
A block diagram of the EI02 STIM is shown below. The program for the PIC microcontroller (16F873) is written in C and may be modified by the user.



EI02 Block Diagram

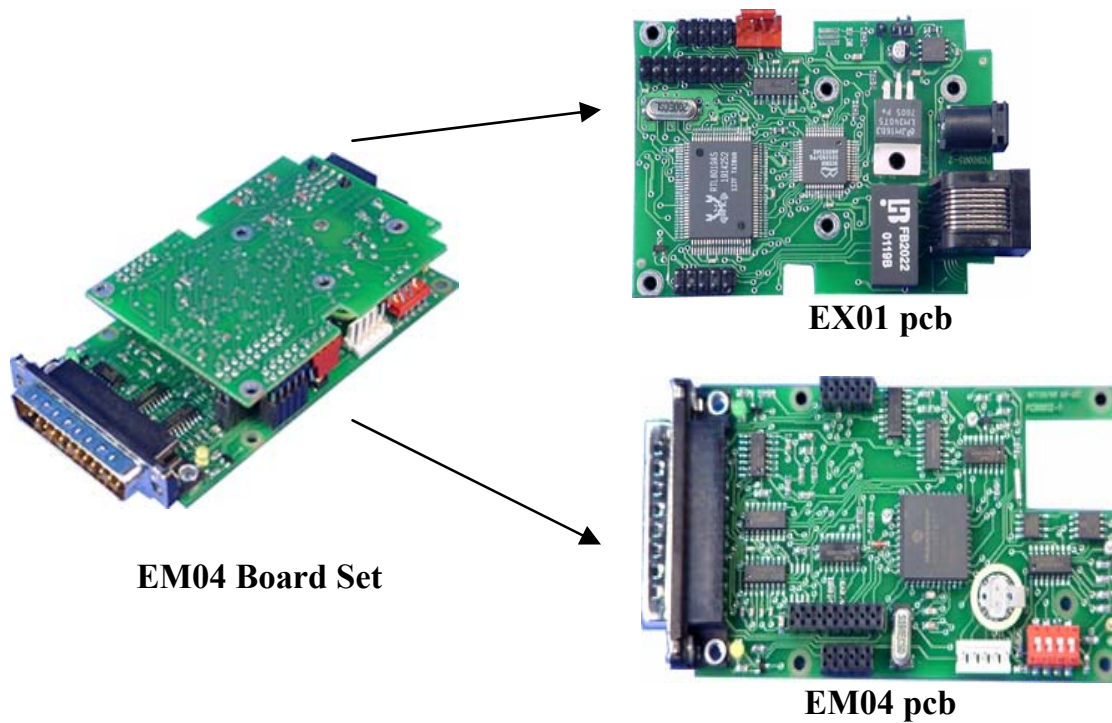
System Block Diagram

A system block diagram is shown below. It shows the relation between the computer, Internet, Ethernet, EM04 (NCAP), serial bus and EI02 (STIM).



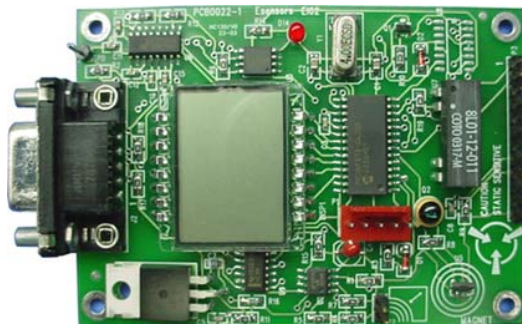
System Block Diagram

EM04 Board Set



NOTE: The EX01 Ethernet Communications board is used in both the EM04 and EM01 (Websensor product). An EX01 programmed to work with EM04 “will not” work with an EM01 and vice versa.

EI02 Board Set

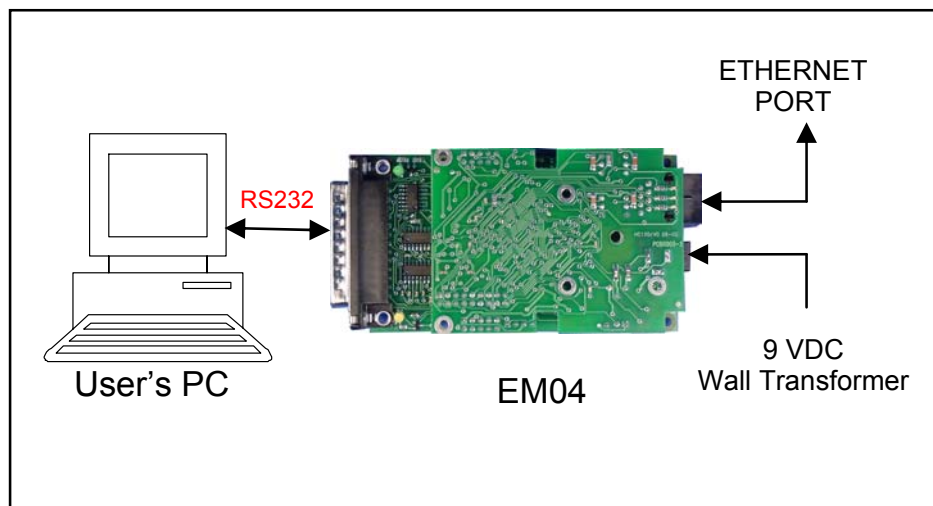


EI02 pcb

Basic Set-Up and Configuration for EM04

Before the EM04 can be used, it must be assigned an IP address.

Begin by configuring the PC and EM04 as depicted in the *EM04 Configuration Block Diagram*.



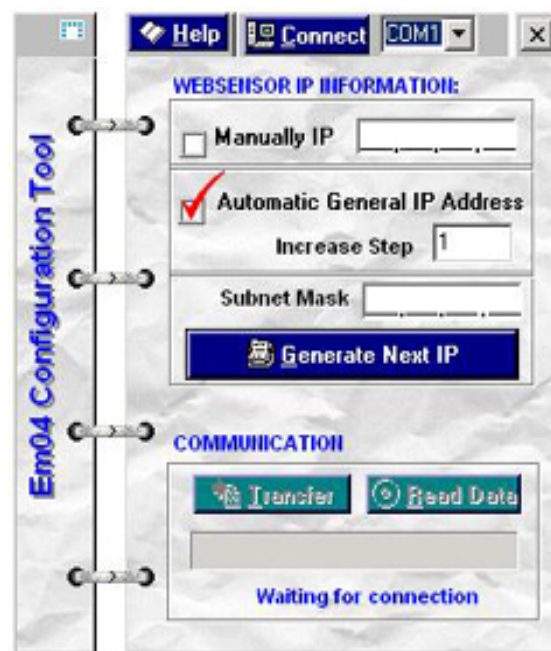
EM04 Configuration Block Diagram

Basic Set-Up and Configuration for EM04

After the equipment is connected as shown in the “EM04 Configuration Block Diagram” (see previous page), place the EM04 Configuration CD into the CD drive of the computer. Through either My Computer or Windows Explorer, locate the program “Com2Em”.



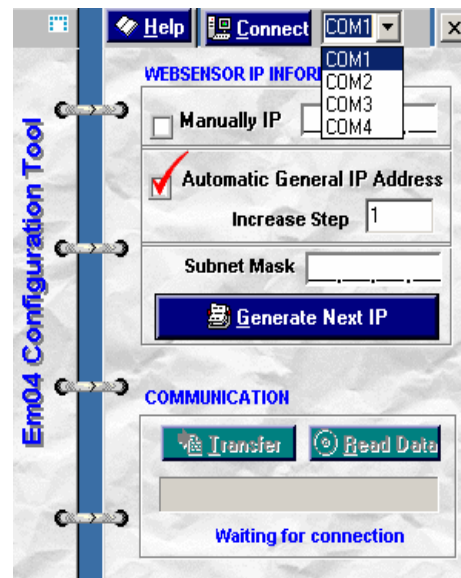
Double-Click on “Com2EM04” to start [EM04 Configuration Tool](#) program. The start-up screen is shown below.



[EM04 Configuration Tool START-UP screen.](#)

Basic Set-Up and Configuration for EM04

Establish serial communication by clicking on the drop down menu and select the correct serial port being used by PC and then click on CONNECT.

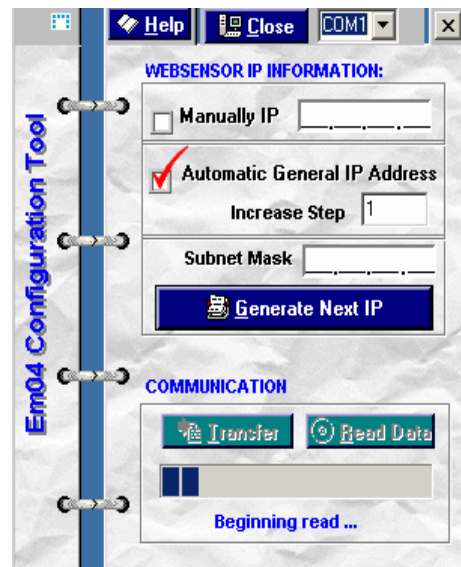


Configuration Screen showing Connection established

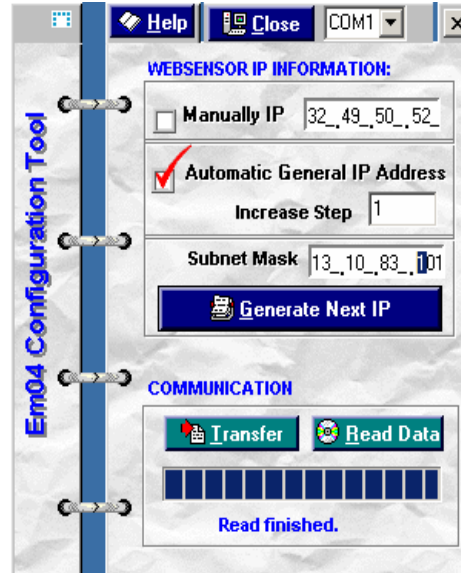


Basic Set-Up and Configuration for EM04

Once communication is established, click on “Read Data” to load the configuration information that has been stored in the EM04.



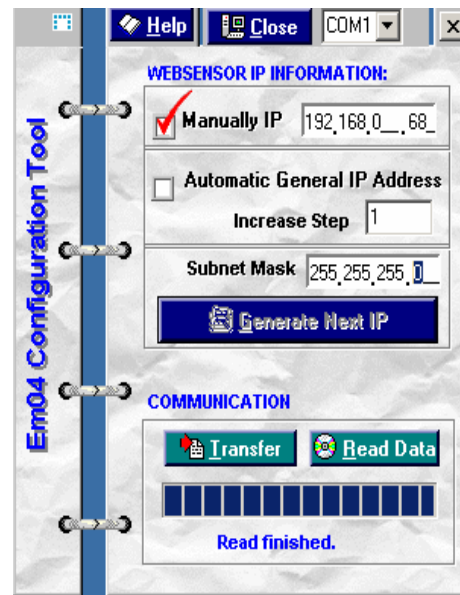
This screen shows that the Configuration Tool has completed READING the data stored in the EM04.



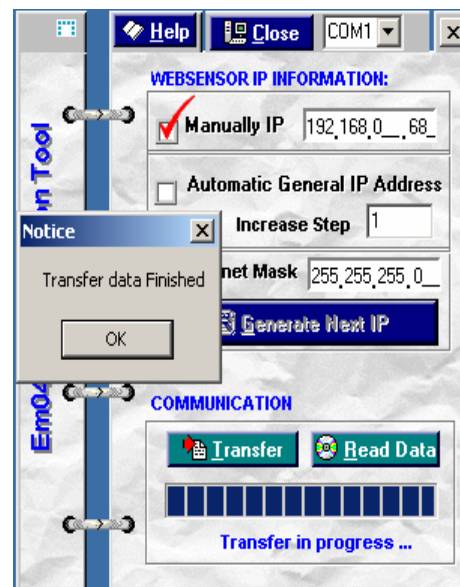
Basic Set-Up and Configuration for EM04

At this point a new IP address can be entered by clicking on the Manually IP box, and then placing the cursor in the octet that will be changed and then enter the new value.

(Note: the IP address shown in this example may be very different than the IP address actually entered by the USER)

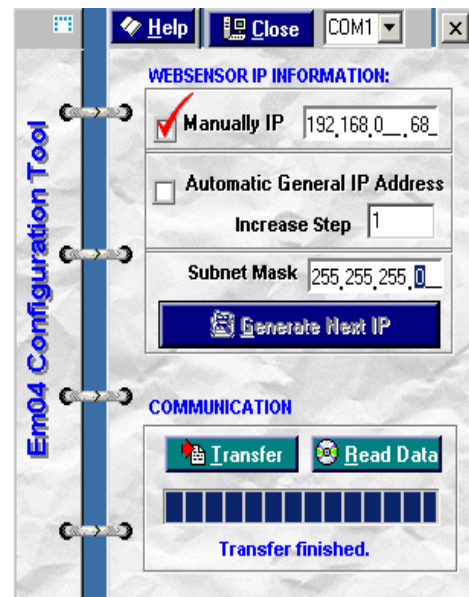


Once the transfer of the new data has completed, click on the OK box.



Basic Set-Up and Configuration for EM04

Once the OK Box has been clicked on, the message at the bottom of the Configuration Tool screen shows “Transfer finished”.



RESET the EM04 by removing the wall-transformer from the receptacle and wait for a moment before the wall-transformer is plugged-in to the receptacle again.

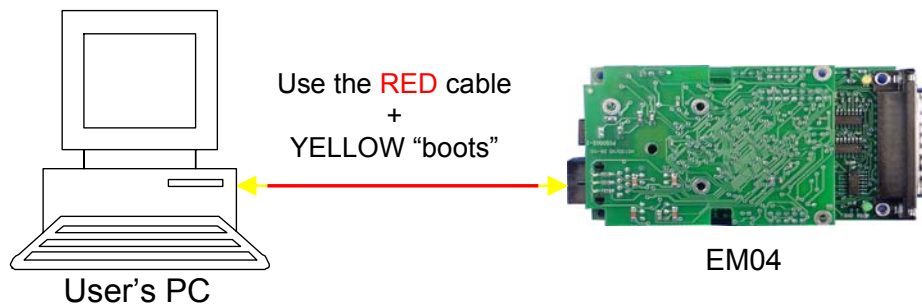
NOTE: The new values for the IP address and email address become effective when power is once again applied to the EM04.

Testing the EM04: To Confirm the Configuration of the IP Address

Once the EM04 has been successfully set up, it is important to confirm that the IP address is properly configured before using the EM04. One way to confirm the configuration is to “ping” the IP address.

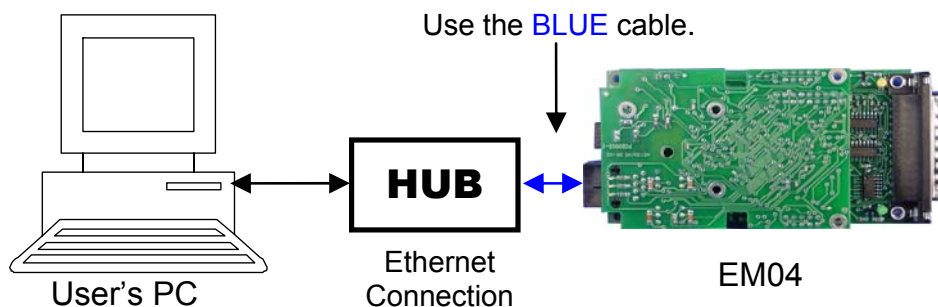
Before the IP address is “pinged”, connect the EM04 to a PC via an Ethernet cable according to either figure below.

If connecting directly to a PC, a crossover type Ethernet patch cable must be used. A crossover type Ethernet cable has been included with the EM04. It is the RED cable with YELLOW boots.



EM04 connected directly to the NIC in a PC

If connecting to a PC through a HUB, a “straight” type Ethernet patch cable must be used between the HUB and the EM04. A “straight” type Ethernet patch cable is also included with the EM04; it is the BLUE patch cable.



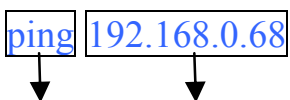
EM04 connected through a HUB to the NIC in a PC

Testing the EM04:

To Confirm the Configuration of the IP Address

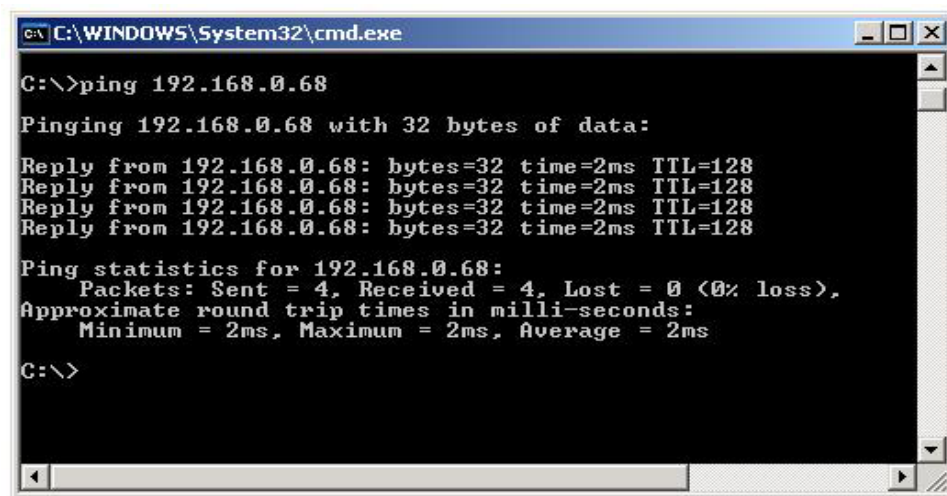
To “ping” the IP address, open a Window with “Command Prompt”.
START > ACCESSORIES > COMMAND PROMPT

In the “Command Prompt” Window, type in the following IP address with the “ping” command and hit the “ENTER” key:


“ping” command IP Address

NOTE: For purposes of explanation, the example IP address 192.168.0.68 is being used. However, the USER should enter the IP address that was programmed into the EM04 during the configuration step.

If the IP address has been properly configured, the replies should look like the “Command Prompt” Window as shown below:



```
C:\WINDOWS\System32\cmd.exe
C:\>ping 192.168.0.68
Pinging 192.168.0.68 with 32 bytes of data:
Reply from 192.168.0.68: bytes=32 time=2ms TTL=128
Reply from 192.168.0.68: bytes=32 time=2ms TTL=128
Reply from 192.168.0.68: bytes=32 time=2ms TTL=128
Reply from 192.168.0.68: bytes=32 time=2ms TTL=128
Ping statistics for 192.168.0.68:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 2ms, Maximum = 2ms, Average = 2ms
C:\>
```

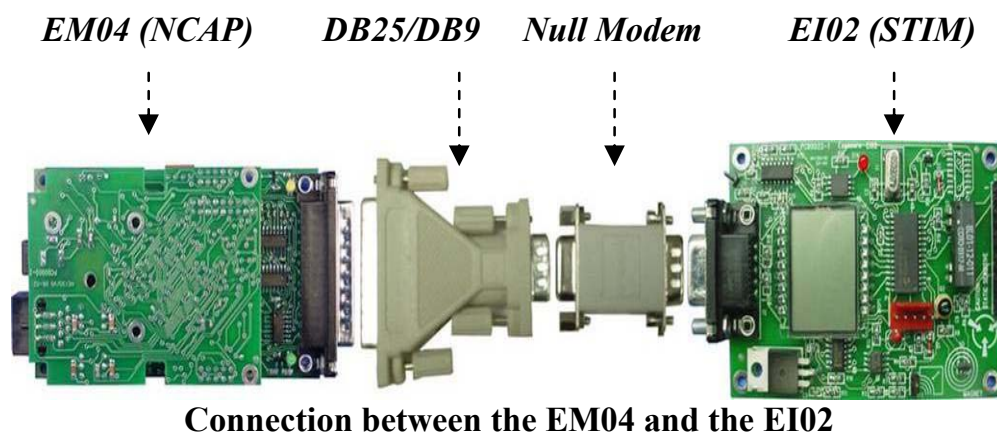
“Command Prompt” Window

If the response shown in the command prompt screen is “not received”, please refer to “Troubleshooting the EM04” section in the appendices.

Testing the EM04: To Confirm the Initialization of the EM04

Once the EM04 has been successfully “pinged”, it is important to confirm that the EM04 is properly initialized before using it. One way to confirm the initialization is to issue a “http: request”.

Before a “http: request” is issued, connect the EI02 to the EM04 using the figure as shown below.



*NOTE: The confirmation on the initialization of the EM04 is **ONLY** required whenever the EM04 has been **RESET**.*

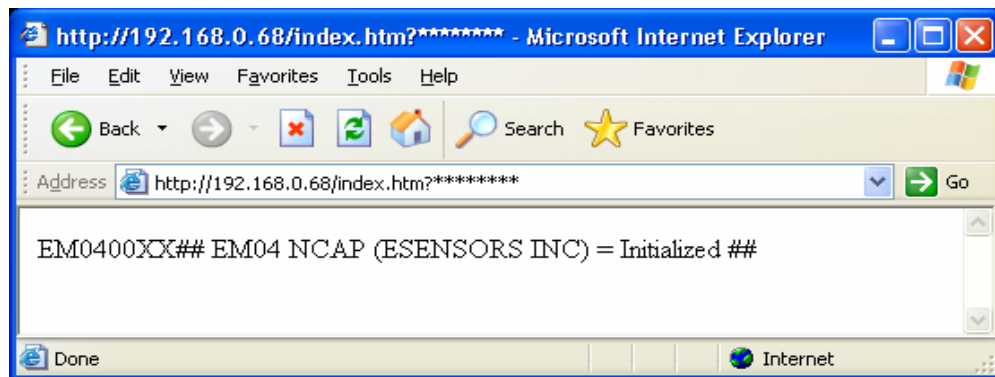
To issue a “http: request”, start up an internet browser (Internet Explorer / Netscape) and type the following address in the URL address field:

http://192.168.0.68/index.htm?*****
↓
IP Address

NOTE: For purposes of explanation the example IP address 192.168.0.68 is being used. However, the USER should enter the IP address that was programmed into the EM04 during the configuration step.

Testing the EM04: To Confirm the Initialization of the EM04

Once the address is entered, press the “ENTER” key. If the EM04 has been properly initialized, the internet browser window will show a response similar to the one as shown in figure below.



Internet Browser Window with a “http: request”

If the response shown in the browser screen is different, please refer to Appendix A, “Troubleshooting the EM04” section in the appendices.

Using the EM04: To Read Data from the EI02 – TEDS Data

Once the EM04 has been properly initialized, it is ready to be used to read the TEDS data from the EI02. One way to read the TEDS data is to issue a “http: request + command”.

Before the “http: request + command” can be issued, a 4 bytes (8 hex) provisional IEEE 1451.2 standard command must be configured using the table as shown below.

<i>Byte No</i>	<i>Byte</i>	<i>Descriptions</i>
1	<i>Address</i>	To locate the STIM in a multi-STIM system
2	<i>Function</i>	To select the read/write for transducer/TEDS
3	<i>Channel</i>	To select the channel in a STIM
4	<i>Data</i>	To indicate the data to be written to actuator

Table of Provisional Standard Commands with Detailed Description

Referring to the detail descriptions above, a series of 4 bytes command with their corresponding function was configured and listed in the table below.

<i>Command</i>	<i>Function</i>
01A00000	Read Meta TEDS
01A00100	Read Channel TEDS 1
01A00200	Read Channel TEDS 2
01A00300	Read Channel TEDS 3
01A00400	Read Channel TEDS 4
01A00500	Read Channel TEDS 5
01A10000	Read Meta-Id TEDS

Table of command and Its Corresponding Function

Note: Commands are subject to change pursuant to the IEEE 1451 established protocol.

Using the EM04: To Read Data from the EI02 – TEDS Data

To issue a “http: request +command”, press on the URL address field in the same internet browser and replace the asterisks (*) with one of the 4 byte commands:

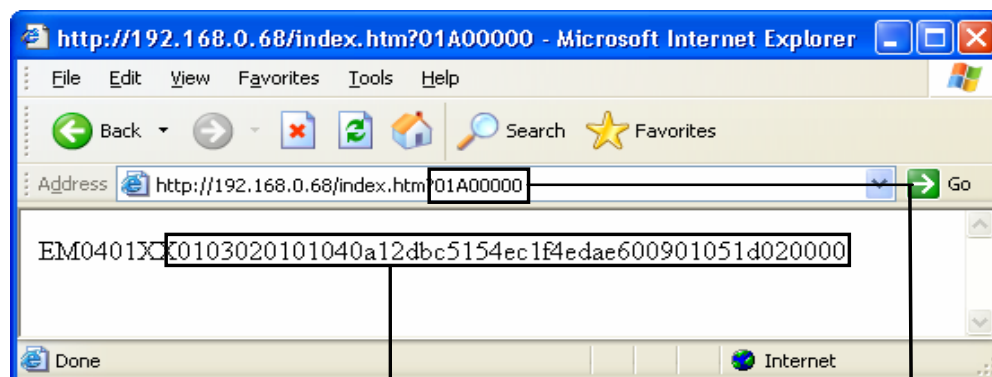
http://192.168.0.68/index.htm?*****

IP Address

Replace with 4 Bytes Command

NOTE: For purposes of explanation the example IP address 192.168.0.68 is being used. However, the USER should enter the IP address that was programmed into the EM04 during the configuration step.

Once a 4 byte command (Example: 01A00000) is included in the URL address, press the “ENTER” key. If a valid “http: request + command” was issued, the internet browser window will show a response similar to one as shown in figure below.



EI02 TEDS's Data (48 hex values)

4 Bytes Command (8 hex values)

Internet Browser Window with “http: request + command”

Using the EM04: To Read Data from the EI02 – TEDS Data

Referring to the internet browser window, the selected 4 byte command (8 hex values) will returned a TEDS data (48 hex values) similar to the one listed in the table as shown below.

<i>Command</i>	<i>TEDS Data</i>
01A00000	0103020101040a12dbc5154ec1f4edae600901051d020000
01A00100	0103020201080101090e0001808080808082808080010101
01A00200	0103020201080101090e0001808080808082808080020202
01A00300	0103020201080101090e0001808080808082808080030303
01A00400	0103020201080101090e0001808080808082808080040404
01A00500	0103020201080101090e0001808080808082808080050505
01A10000	01030203011111-IEEE-1451.2-STIM*****

Table of Simulated TEDS Data and Its Corresponding Command

If the command was read and returned an unmatched TEDS data from the EI02, please refer to Appendix B, “Troubleshooting the EI02” section in appendices.

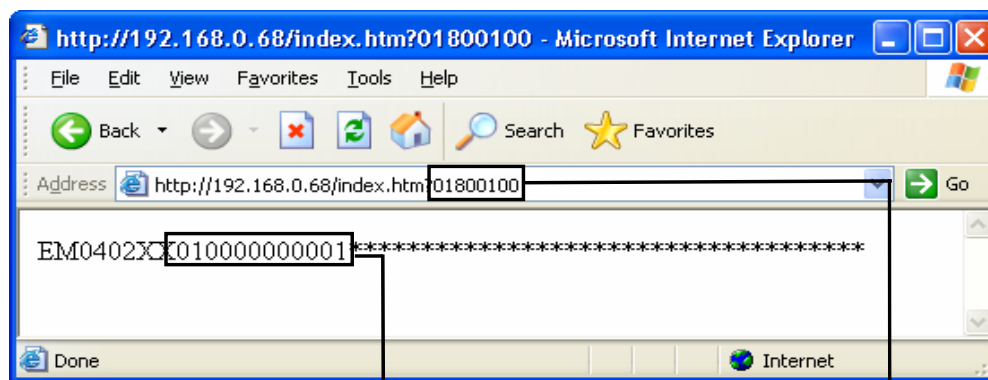
Using the EM04: To Read Data from the EI02 Input

Once the EM04 is able to read the TEDS data, it will also be able to read the data from the EI02 input. To read data from the EI02 input, a “http: request + command” is issued using the 4 byte command as shown in the table below:

<i>Command</i>	<i>Function</i>
01800100	Read Data from EI02 Input - Hall Effect Sensor
01800200	Read Data from EI02 Input - Illumination Sensor
01800300	Read Data from EI02 Input - A/D Input Voltage

Table of command and Its Corresponding Function

Once a 4 byte command (Example: 01800100) is included in the URL address, press the “ENTER” key. If a valid “http: request + command” was issued, the internet browser window will shown a response similar to the one shown below.



EI02 Response (12 hex values) ***4 Bytes Command (8 hex values)***

Internet Browser Window with “http: request + command”

Using the EM04: To Read Data from the EI02 Input

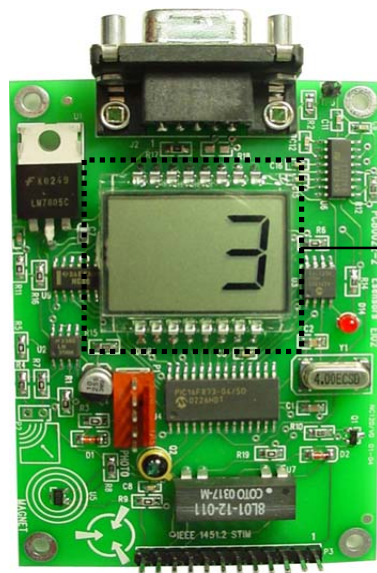
The data returned from the EI02 input to the internet browser window is a 6 byte provisional IEEE 1451.2 standard data, configured using the table as shown below.

<i>Byte No</i>	<i>Byte</i>	<i>Data Descriptions</i>
1	<i>Channel</i>	The channel number of the input/output data
2	<i>Data</i>	The return data from the read/write
3		
4		
5		
6	<i>Status</i>	The status for the read/write confirmation

Table of Provisional Standard Data with Detail Description

Note: Data are subject to change pursuant to the IEEE 1451 established protocol.

The LCD display on the EI02 will also indicate the channel selected as shown in the diagram below .

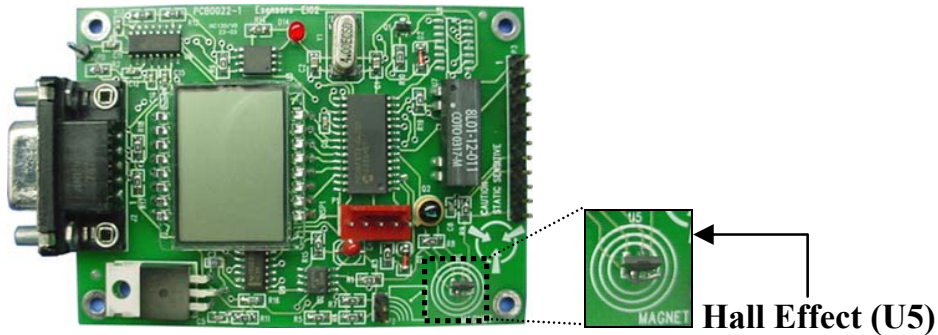


**LCD Display
(With Channel Selected)**

Using the EM04:

To Read Data from the EI02 Input – Hall Effects Sensor

Once the read Hall Effect sensor command is included in the “http: request + command”, the EI02 will return data that represents the polarity of the magnetic field detected by U5.



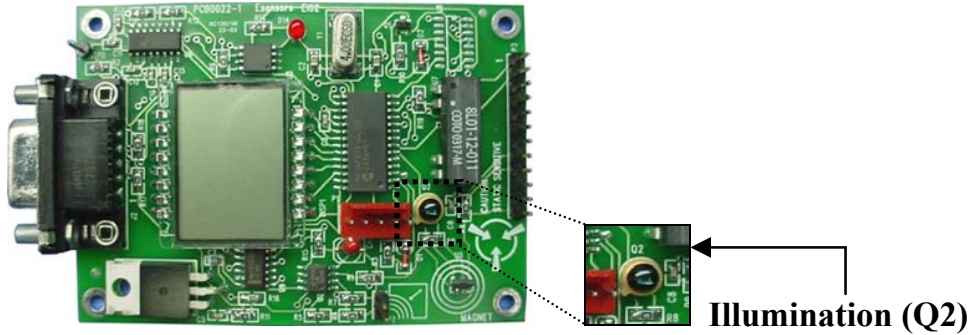
After the EM04 reads the Hall effect sensor data from the input of the EI02, it will display one of the 6 byte responses as shown in table below, in the internet browser window.

<i>EI02Responses</i>	<i>Data Representation</i>
010000000001	North Pole detected at Hall Effect Sensor (U5)
010000000101	South Pole detected at Hall Effect Sensor (U5)

Using the EM04:

To Read Data from the EI02 Input – Illumination Sensor

Once the read Illumination sensor command is included in the “http: request + command”, the EI02 will return data that represents the light level detected by Q2.



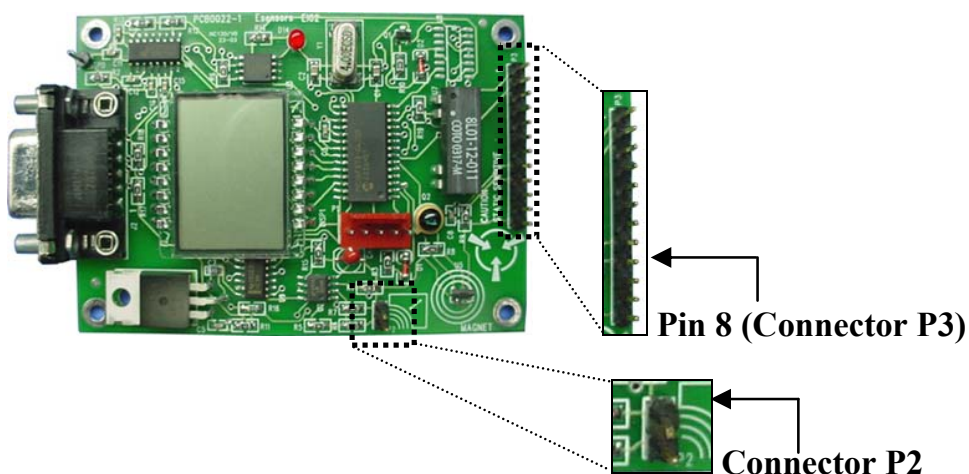
After the EM04 reads the illumination sensor data from the input of the EI02, it will display one of the 6 byte responses as shown in table below, in the internet browser window.

<i>EI02 Responses</i>	<i>Data Representation</i>
0200000000001	No light detected at Illumination Sensor (Q2)
0200000xxx01	$\left(\frac{xxx(hex)}{3ff(hex)} \cdot 100\% \right)$ = Light's level detected at Illumination Sensors (Q2)

Using the EM04: To Read Data from the EI02 Input – A/D input Voltage

Once the read A/D input voltage command is included in “http: request + command”, the EI02 will return data that represents the voltage level measured at pin 8 of connector P3.

*Note: An **open** at the connector P2 will amplify the measured voltage by a gain of 2. A **short** at the connector P2 will amplify the measured voltage by a gain of 10.*



After the EM04 reads the voltage level from the input of the EI02, it will display one of the 6 byte responses as shown in table below, in the internet browser window.

<i>EI02 Responses</i>	<i>Connector P2</i>	<i>Data Representation</i>
0300000000001	Open	No voltage measured at pin 8 (Connector P3)
0300000xxx01	Open	$\left(\frac{xxx(hex)}{3ff(hex)} \cdot 5 Volts \right)$ = 2 * voltage measured at pin 8(Connector P3)
0300000000001	Short	No voltage measured at pin 8 (Connector P3)
0300000xxx01	Short	$\left(\frac{xxx(hex)}{3ff(hex)} \cdot 5 Volts \right)$ = 10* voltage measured at pin 8(Connector P3)

Using the EM04: To Write Data to the EI02 Output

The EI02 has 2 output channels. The first is a simple relay contact closure. The second is a digital to analog output.

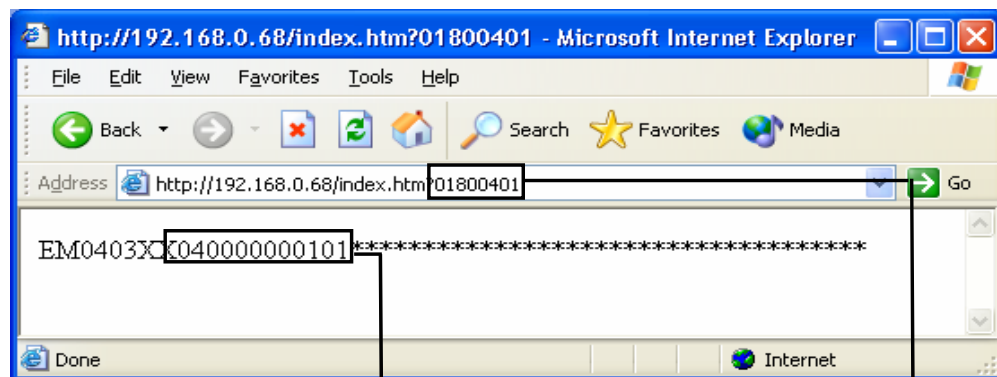
Once the EM04 is able to read data from the TEDS and EI02 inputs, it will be able to write data to the EI02 output. To write data to the output of the EI02, a “http: request + command” is issued using the 4 byte commands as shown in the table below:

<i>Command</i>	<i>Function</i>
01800400	Write Data to EI02 Output – To Turn Relay Off
01800401	Write Data to EI02 Output – To Turn Relay On
01800500	Write Data to EI02 Output – To Turn D/A Output Voltage Off
018005xx	Write Data to EI02 Output – To Turn D/A Output Voltage On

Table of command and Its Corresponding Function

*Note: The **xx** in the command is an 8-bit variable digital data value which can be used to generate a variable D/A output voltage, the value of which is determine by the equation, $[\text{xx (hex)} / \text{ff (hex)}] * 5 \text{ volts} = \text{D/A output}$.*

After a 4 byte command (Example: 01800401) is appended to the URL address, press the “ENTER” key. If a valid “http: request + command” was issued, the internet browser window will show a response similar to the one shown below.



EI02 Response (12 hex values)

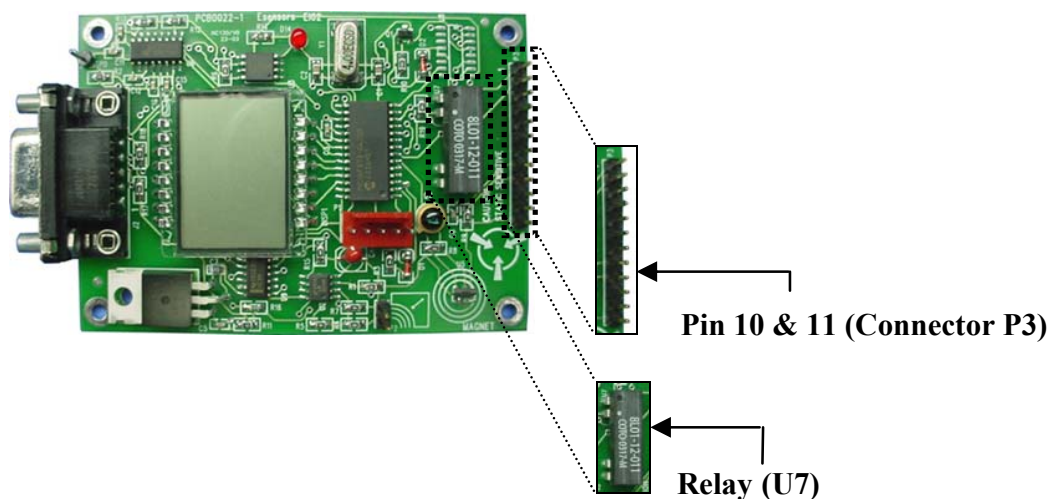
4 Bytes Command (8 hex values)

Internet Browser Window with “http: request + command”

Using the EM04: To Write Data to the EI02 Output - Relay

Once the turn relay On/Off command is included in the “http: request + command”, the EM04 will send a message to the EI02, which in turn will either energize or de-energize Relay U7.

*Note: A relay receiving an **On** command will **Short** pin 10 and pin 11 of connector P3. A relay receiving an **Off** command will **Open** the path between pin 10 and pin 11 of connector P3.*



The EI02 will return a message to the EM04 indicating that an On or Off function command executed. Once the EM04 reads the return data from the EI02, it will display one of the 6 byte responses as shown in table below, in the internet browser window.

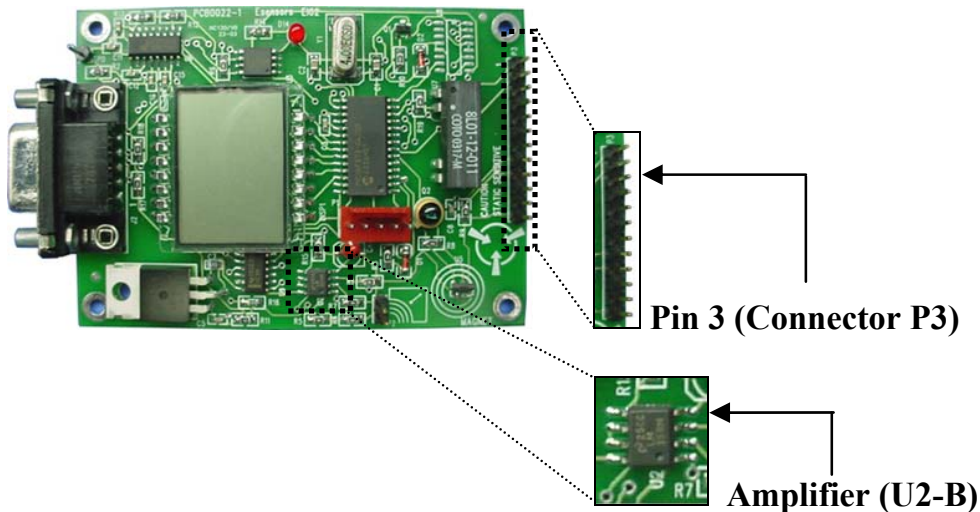
<i>EI02 Responses</i>	<i>Data Representation</i>
040000000001	Relay had disconnected pin 10 from pin 11(Connector P3)
040000000101	Relay had connected pin 10 to pin 11 (Connector P3)

Using the EM04:

To Write Data to the EI02 Output – D/A Output Voltage

Once the turn D/A output voltage on/off command is included in the “http: request + command”, the EM04 will send a command to indicates the type of function that will be executed by the U2-B (part of the D/A circuit).

*Note: An amplifier enabled by an **On** command will use the two hex values in the command to determine the D/A voltage output to Vout, (Pin3 at connector P3). The **Off** function is indicate by a zero (replacing two hex values) in the command, which causes the D/A to generate 0 volts at Vout.*



The EI02 will return a message to the EM04 confirming that an On/Off command was executed. Once the EM04 reads the message returned by the EI02, it will display one of the 6 byte responses as shown in table below, in the internet browser window.

<i>EI02 Responses</i>	<i>Data Representation</i>
050000000001	Amplifier had generated $\left(\frac{00(hex)}{ff(hex)} \cdot 5 Volts \right)$ = D/A voltage (0 Volts) to pin 3
05000000xx01	Amplifier had generated $\left(\frac{xx(hex)}{ff(hex)} \cdot 5 Volts \right)$ =D/A voltage to pin3

Modifying the EM04 and EI02 Program:

The program supplied with the Dot2 Prototyping Kit was done so with the intent of providing a basic platform for the user / 1451.2 developers.

Modifications will be necessary to the EM04 and EI02 program to support the user's 1451 sensor application.

In order to program the EM04 and EI02, it will be necessary to obtain the following items:

- PIC C compiler and Manual
CCS, Inc. (Custom Computer Services, Inc.). The CCS, Inc. website can be found at <http://www.ccsinfo.com>.

PCM Compiler for 14 bit parts - \$125.00

Manual: \$15.00

Optional: PIC C Tutorial Book, by Nigel Gardner \$29.95
(Note: Tutorial book sold at \$15 with purchased of compiler)

- MPLab IDE (MicroChip, Inc.)
MPLab IDE is available “free of charge” from the MicroChip website: www.microchip.com.
- MicroChip ICD (In Circuit Debugger) programmer.
The MicroChip ICD Programmer is available from DigiKey (www.digikey.com), Mouser (www.mouser.com), or any of the other MicroChip, Inc. distributors.

(Pricing shown for CCS, Inc. & MicroChip, Inc. are estimates and provided as a courtesy. Please contact the associated companies for current pricing.

Included with the Dot2 Prototyping Kit, is a programming cable which connects the EM04 and EI02 to the MicroChip ICD Programmer.

Modifying the EM04 and EI02 Program:

SOURCE CODE

Source code is provided for the program shipped with the dot2 Kit and can be found on the CD provided. The program for the Em04 and EI02 was developed using the “PIC C” compiler offered by CCS, Inc. (Custom Computer Services, Inc.).

Flowchart of the program provided can be found at the appendix C

Appendix A: Troubleshooting the EM04

This section describes some common problems associated with the initial set-up and configuration of the EM04.

COMMON PROBLEMS

Not able to “PING” the EM04.

If you are not able to “PING” EM04 follow these steps:

1. Make sure there is power to the EM04. The EM04 is powered by the 9 volt DC wall transformer included in the “Starter Kit”.
2. Confirm that the NIC (network interface card) is working in the PC being used to configure and test EM04. Proper operation can be verified by opening a “Command Prompt” window and issuing a “PING” command to the IP address of the NIC card. For example: ping 192.168.0.68. A reply should be received almost immediately. If no reply is received, confirm that the NIC card is configured with the desired IP address through the “Control Panel” in Windows.
3. Confirm that the correct “Ethernet patch cable” is being used. When properly connected, the LEDS on the NIC card should “light”.

“No LEDS lit”, may indicate some hardware issue like an incorrect, or a faulty cable is being used. Connecting the EM04 directly to the NIC of a PC requires a crossover type of patch cable. The crossover cable included in the EM04 “Starter Kit” is RED in color with YELLOW boots covering the connectors.

Connecting the EM04 to an Ethernet HUB requires a “straight” type of patch cable. The “straight” type of patch cable included in the EM04 “Start Kit” is BLUE.

Appendix B: Troubleshooting the EI02

This section describes some common problems associated with the read and write data from/to the EI02.

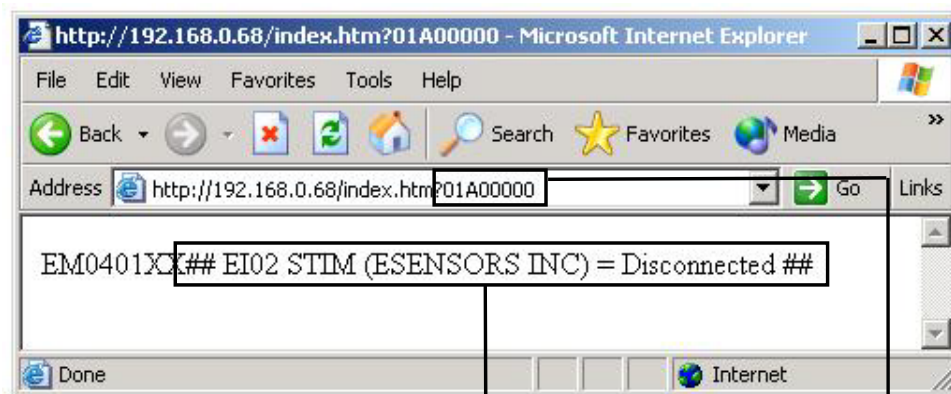
COMMON PROBLEMS

Not able to read the data from EI02.

If you are not able to read data from EI02, follow these steps:

1. Make sure the EI02 was connected to the EM04 properly (using the DB25/DB9 and the null modem as shown in the previous section). If the error message “## EI02 STIM (ESENSORS INC) = Disconnected ##” was shown in the internet window browser, it means the EI02 was connected to the EM04 improperly.

Using the instruction in the previous section as a reference, reconnect the EI02 to the EM04 and resent the “http: request + command”. With a proper connection, the EM04 will read and display the EI02 data on the internet browser window.



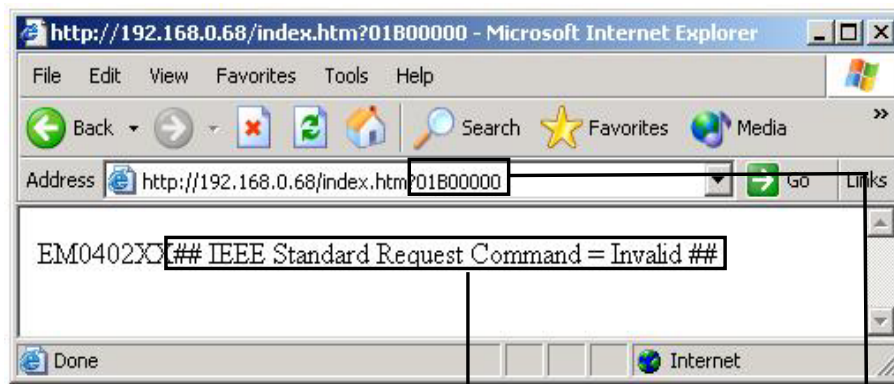
Error Message 4 Byte Command (8 hex values)

Internet Browser Window with an EI02 Disconnected Error Message

Appendix B: Troubleshooting the EI02

2. Make sure the command entered to in the URL address field is a provisional IEEE 1451.2 standard command. If the error message “## IEEE Standard Request Command = Invalid ##” was shown in the internet window browser, it means the command entered is not a provisional IEEE 1451.2 standard command.

Using the table in the previous section as a reference, reenter a command in the URL address field and resend the “http: request + command”. With a valid command, the internet browser window will show the data respond from the EI02.

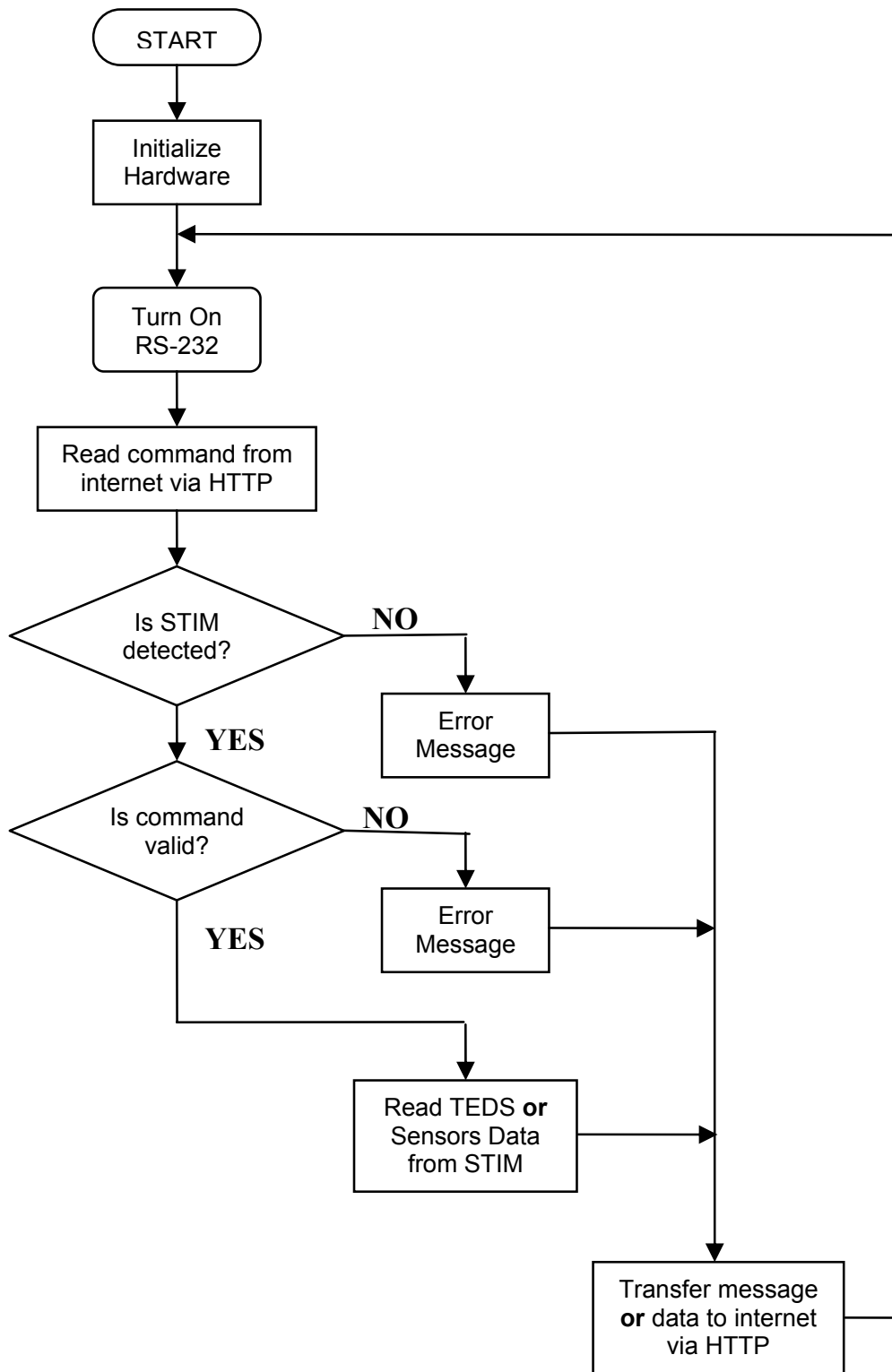


Error Message

4 Byte Command (8 hex values)

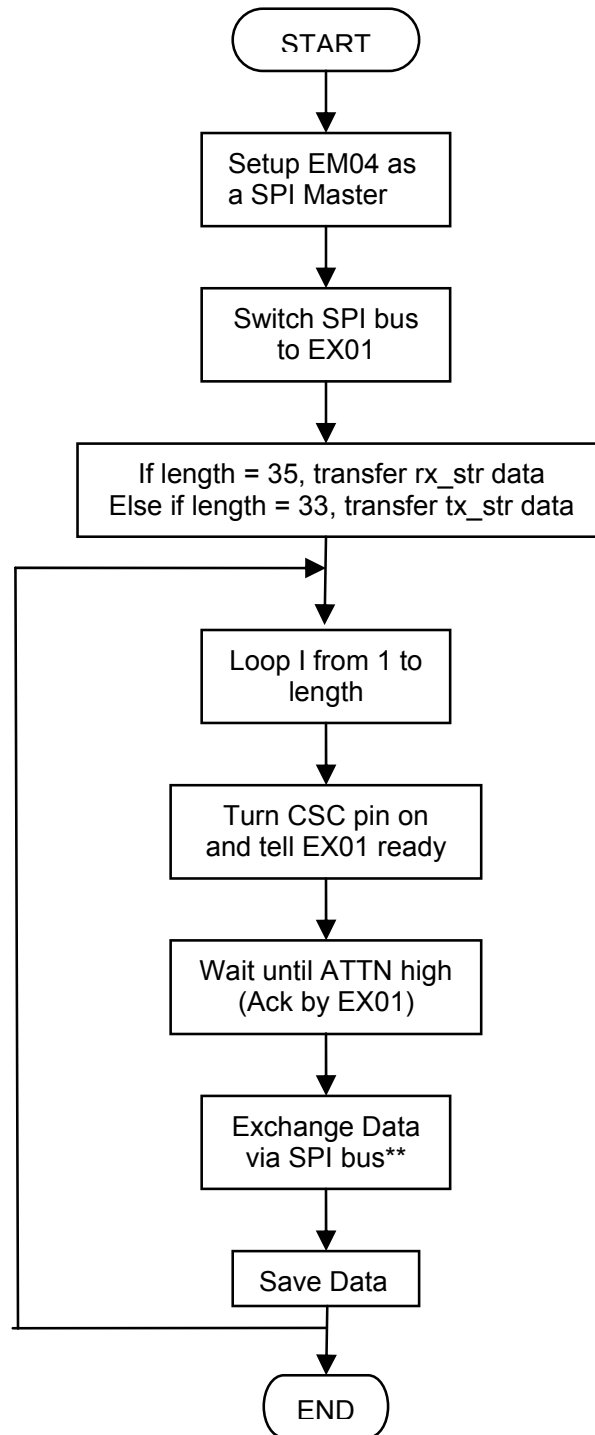
Internet Browser Window with an Error Message

Appendix C: Software Flowchart



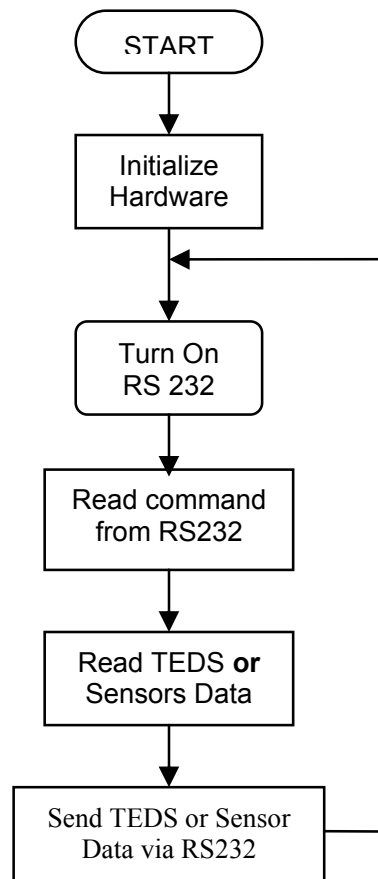
Flowchart for EM04 Main Program

Appendix C: Software Flowchart



Flowchart for Communication between EM04 and EX01

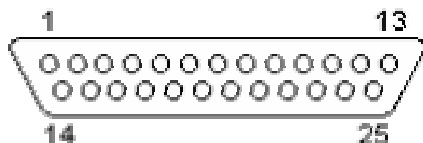
Appendix C: Software Flowchart



Flowchart for the EI02 Main Program

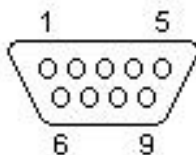
Appendix D: Connector

DB25 PINOUT FROM EM04



<u>No.</u>	<u>Name</u>	<u>No.</u>	<u>Name</u>
1	PGND	14	AN2
2	TXD	15	DOT4
3	RXD	16	SEL0
4	RTS	17	SEL1
5	CTS	18	SEL2
6	--	19	TRIG
7	GND	20	+9/+VCC
8	DOUT	21	EDO
9	DIN	22	NINT
10	DCK	23	NACK
11	RDA	24	+5
12	RDB	25	NSDET
13	AN1		

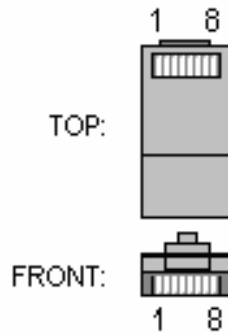
NULL MODEM PINOUT – GOING TO EI02



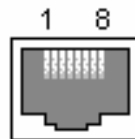
<u>No.</u>	<u>Name</u>	<u>No.</u>	<u>Name</u>
1	+9/+VCC	6	--
2	TXD	7	CTS
3	RXD	8	RTS
4	+9/+VCC	9	--
5	GND		

Appendix D: Connector

RJ 45 PINOUT



Ethernet RJ45 PLUG - 10BaseT



Ethernet RJ45 Socket - 10BaseT

<u>Pin No.</u>	<u>Description.</u>	<u>Color</u>
1	TX +	White w/Orange
2	TX -	Orange
3	RX +	White w/Green
4		Blue
5		White w/Blue
6	RX -	Green
7		White w/Brown
8		Brown

Ethernet RJ45 Pinouts

Appendix E: IEEE p1451.2 Prototyping Kit Software CD

Included on the SOFTWARE CD provided are:

- Copy of EM04 Source code (em04v2.c)
- Copy of EI02 Source code (ei02v2.c)
- Copy of the EM04 Configuration Tool (Com2EM04.exe)
- Copy of the Instruction Manual(Dot2Kit.pdf)
- Copy of EM04 Schematic Diagram
- Copy of EI02 Schematic Diagram

As the IEEE 1451 product and standard mature, check the Esensors website for downloads.

See: www.Eesensors.com

Appendix F: Customer Support

For configuration support,

Contact us at TechHelp@Eesensors.com

OR

Call us at (716) 837-8719
(Eastern Time: 9 AM to 4 PM)

OR

Reference the Esensors website:
www.eesensors.com

IEEE p1451.2 PROTOTYPING KIT

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