

Configuring a Wireless Sensor Network

Using a Development Kit for battery-less,
wireless sensors

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Abstract:

The purpose of this application not is to teach how to setup the hardware and software of the P2110-EVAL-01 Lifetime Power® Energy Harvesting Development Kit for Wireless Sensors jointly developed by Powercast and Microchip. This is useful for others that would like to configure their own wireless sensor network for RF energy and wireless sensor network tests and research.

Keywords: Wireless, Sensor, Powercast, Network, Battery-less

Introduction:

Wireless sensor networks have become very important and abundant today. A lot of wireless sensors run off of batteries and in today's "Green" world batteries are just not the ideal solution. The P2110-EVAL-01 is a part of the future. The P2110-EVAL-01 allows for wireless sensor network development and testing using no batteries.

The P2110-EVAL-01 uses RF energy to power up all of its hardware. This technology is on the rise and will soon be the future of powering electronics. Once it is possible to configure the network and be able to communicate with it there are many opportunities with this kit to learn of the new technology of harvesting RF Energy.

Objective:

Discuss the benefits of using Powercast Development kit for wireless sensors as well how to configure a wireless sensor network using RF energy.

Procedure:

Parts required:

P2110-EVAL-01 Lifetime Power® Energy Harvesting Development Kit for Wireless Sensors (jointly developed by Powercast and Microchip) – 1

Kit Includes - Verify that you have all the parts that are needed.

Item	Description	Qty
Power and Data Transmitter (TX91501-3W-ID)	3-watt, 915 MHz transmitter for power and data with integrated 8dBi antenna and two power jacks. Sends a pre-programmed transmitter ID that is received by the P2110 Powerharvester component and is decoded by the MCU on the Wireless Sensor Board	1
P2110 Evaluation Board (P2110-EVB)	Evaluation board (Rev. B) for P2110 Powerharvester Receiver. This board has an SMA connector to connect the antennas and a 10-pin connector for the Wireless Sensor Board	2
Patch antenna	915MHz directional antenna with 120-degree reception pattern (included with the P2110 evaluation board)	2
Dipole antenna	915MHz omni-directional antenna with 360-degree reception (included with the P2110 evaluation board)	2
Wireless Sensor Board (WSN-EVAL-01)	Sensor for Temp/Humidity/Light and an external input. Plugs into P2110 evaluation board, and sends data to the access point (Microchip 16-bit XLP Development Board)	2
Microchip 16-bit XLP Development Board (DM240311)	Development platform featuring Microchip's PIC24F MCU that is preprogrammed to operate as an access point for receiving data from the Wireless Sensor Boards. USB cable included in box.	1
Microchip MRF24J40 PICtail/PICtail Plus Daughter Board (AC164134-1)	2.4GHz, IEEE 802.15.4 radio that plugs into the 16-bit XLP Development Board for receiving data from the Wireless Sensor Boards	1
PICkit™ programmer/debugger (PG164130)	Programming tool for updating code on the Wireless Sensor Boards and the 16-bit XLP Development Board. USB cable included in package.	1

Installation Guide:

This Installation guide is for Windows 7.

- 1) First and most important step, make sure you have all the necessary tools to complete this project. Second check the development kit to make sure everything was included.
- 2) Download and install a terminal emulator program on your PC. A terminal emulator is a program that will emulate a video terminal within some other display architecture. Although there are plenty of terminal emulators available for download, Powercast recommends HyperTerminal. A downloadable copy of HyperTerminal is located on the resources page at Powercast's website. See Appendix A. Once you have downloaded HyperTerminal or the emulator Terminal of your choice please locate the ".exe" file but do not open it yet. Also there will be a ".dll" file as well that will be downloaded. Please keep both files in the same directory. For the rest of this application note, HyperTerminal will be used.
- 3) This step includes hardware. Please take out the Microchip 16-bit XLP Development Board (DM240311) as well as the Microchip MRF24J40 PICtail/PICtail Plus Daughter Board (AC164134-1).
 - a. First connect the Microchip MRF24J40 to the 16-Bit XLP Development board via connection J7 (see Figure 1.)
 - b. Make Sure the following settings on the 16-Bit XLP Development board are as follows (See Figure 2)
 - i. S4: PIC24FK
 - ii. S7: ON
 - iii. J12: Jumper set to EXT PS/USB
 - iv. JP6: Jumper On
 - v. JP9: Jumper On
 - vi. JP10: Jumper On
- 4) Once the development board is set up, the USB-to-Serial driver file will need to be installed. The USB-to-Serial driver file can be downloaded from Powercast's website. See Appendix A. This driver file will allow the computer to communicate with the Microchip 16-bit Development Board. After the driver is downloaded connect your development board mini-USB connector J9 to your computer using the given USB cable. Once the development board is connected to the computer a "Hardware Successfully Setup" window will pop up on the bottom right side of your screen. This setup the Communications Port for the computer.

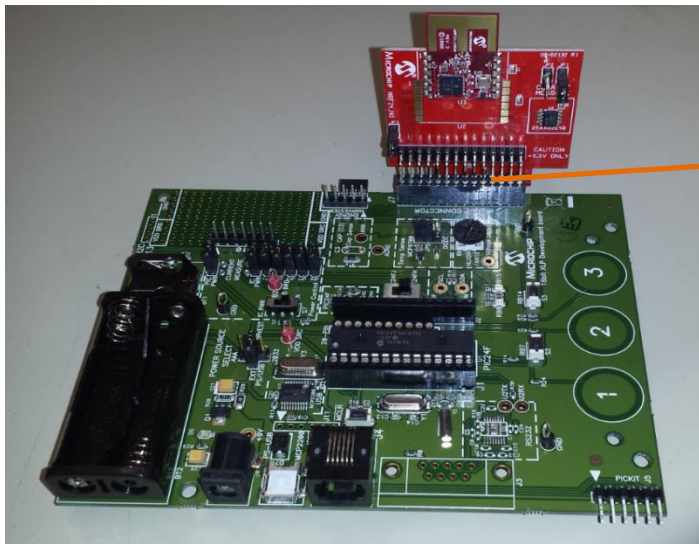


Figure 1 Connector J7

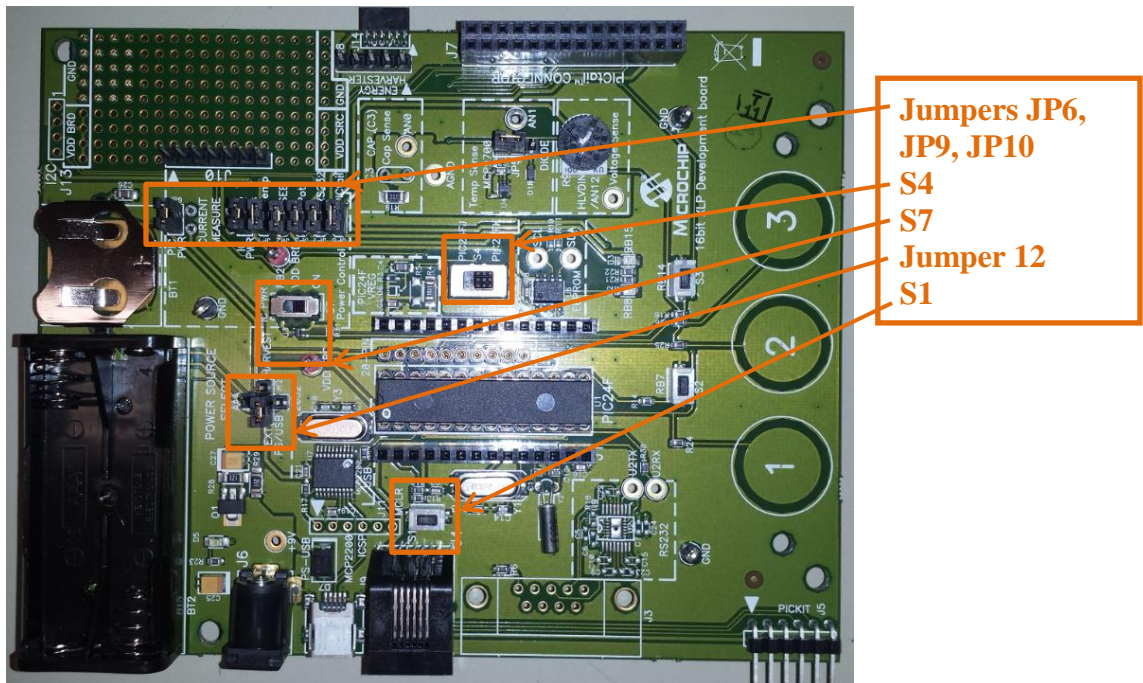
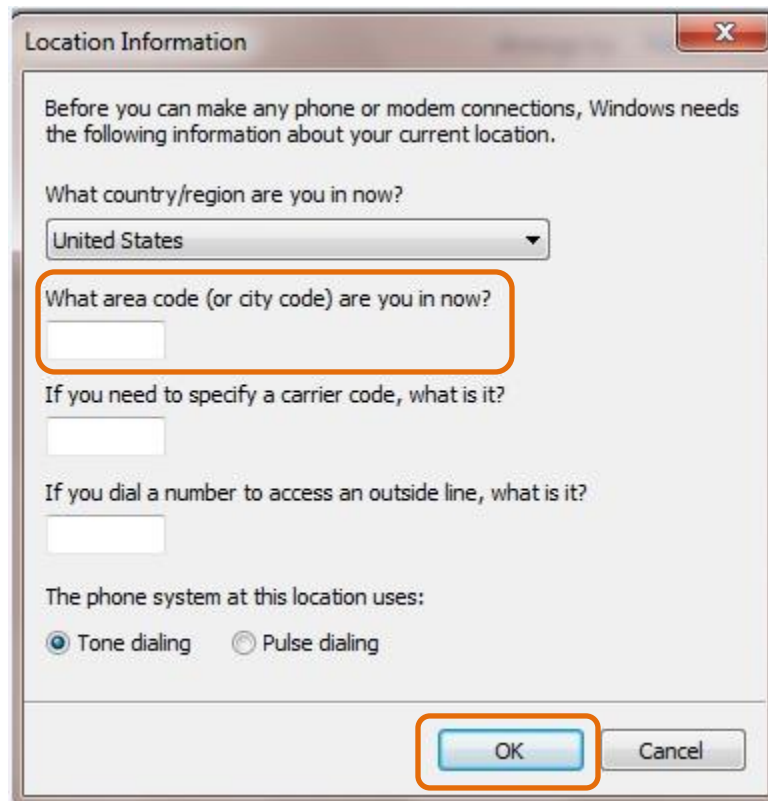


Figure 2 Jumper and Switch Locations for Initial Setup

- 5) It is now time to go back to HyperTerminal that was downloaded in step 2. In this step you will configure HyperTerminal to see data from the wireless sensor network. Locate the directory that HyperTerminal was downloaded to and open up "hypertrm.exe" A window asking if you want HyperTerminal to be the default telnet program will pop up. This is your preference, so answer yes or no to continue.

Next a dialog box will appear asking information about your current location. Enter in your area code and select "OK" to proceed.

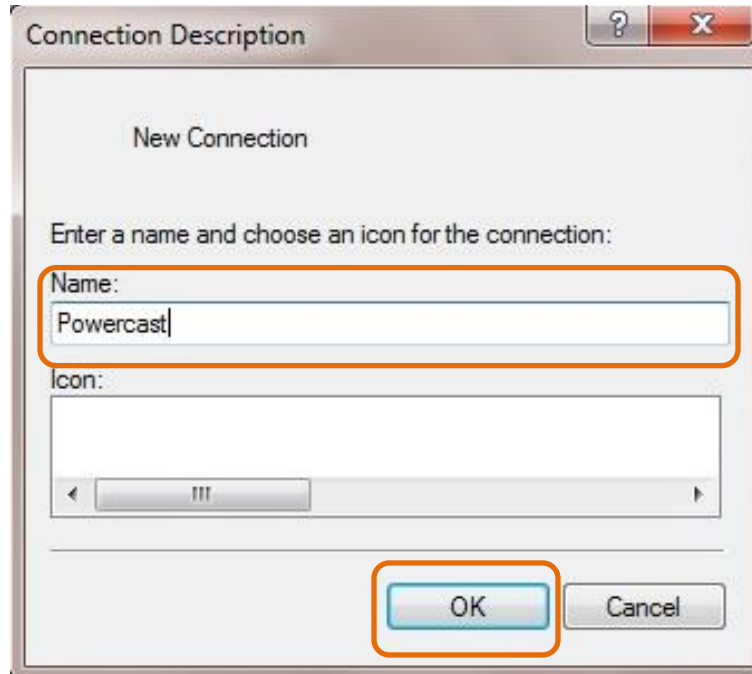


The image shows a Windows dialog box titled "Location Information". The dialog box contains the following text and controls:

- Text: "Before you can make any phone or modem connections, Windows needs the following information about your current location."
- Text: "What country/region are you in now?"
- Dropdown menu: "United States" (with a downward arrow)
- Text: "What area code (or city code) are you in now?"
- Text input field: (empty)
- Text: "If you need to specify a carrier code, what is it?"
- Text input field: (empty)
- Text: "If you dial a number to access an outside line, what is it?"
- Text input field: (empty)
- Text: "The phone system at this location uses:"
- Radio buttons: "Tone dialing" (selected) and "Pulse dialing"
- Buttons: "OK" and "Cancel"

The "OK" button is highlighted with an orange border.

After you click “OK” the following dialog box will pop up asking you to describe your connection. Enter in a name for the connection. In this application note “Powercast” was used for the name but if you would like any name can be used. Once a name is entered click “OK” to proceed.



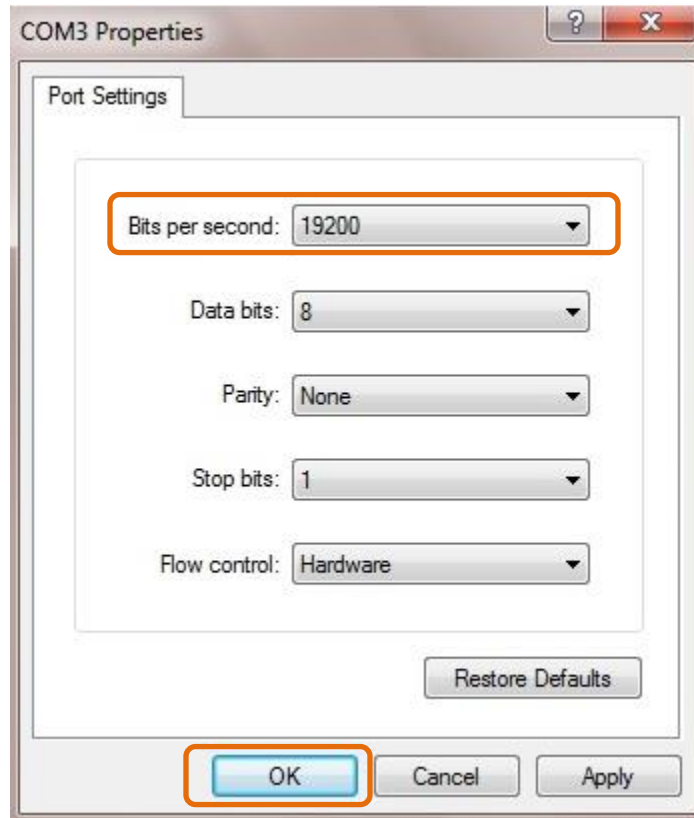
The "Connection Description" dialog box is shown. It has a title bar with a question mark and a close button. The main area is titled "New Connection". Below this, it says "Enter a name and choose an icon for the connection:". There is a text field labeled "Name:" containing the text "Powercast". Below the text field is an "Icon:" section with a large empty box and a small icon selection area. At the bottom right, there are "OK" and "Cancel" buttons. The "Name:" text field and the "OK" button are highlighted with orange rectangles.

The next dialog box below will pop up to help you select the COM port you would like to be used for the 16-Bit XLP Development board access point. COM3 is chosen in this example. Typically there is only one COM port available. Choose the COM port and click “OK”.

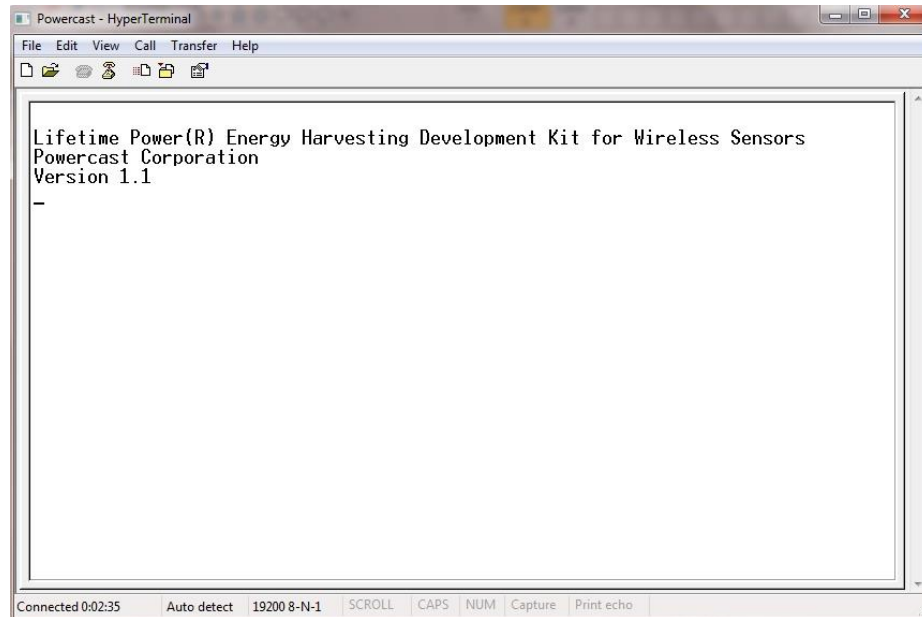


The "Connect To" dialog box is shown. It has a title bar with a question mark and a close button. The main area is titled "Powercast". Below this, it says "Enter details for the phone number that you want to dial:". There are three text fields: "Country/region:" with a dropdown menu showing "United States (1)", "Area code:" with the text "419", and "Phone number:". Below these is a "Connect using:" dropdown menu showing "COM3". At the bottom right, there are "OK" and "Cancel" buttons. The "Connect using:" dropdown menu and the "OK" button are highlighted with orange rectangles.

Now it is time to choose the COM port properties. For this setup the bits per second also known as the baud rate will be set to 19200. Keep everything else as the default. Once the baud rate is set to 19200, click “OK”.



Congratulations the hard part is over; now all that needs to be done is to setup up the wireless sensor boards, the power transmitter and read data. But before that is done, check to make sure that your access point is configured correctly. Press S1 on the development board. (See Figure 2) This switch will reset the system. The HyperTerminal should look like this if it was setup successfully.



- 6) It is now time to setup the hardware which includes the following:
 - a. Power and Data Transmitter (TX91501-3W-ID)[Qty. 1]
 - b. P2110 Evaluation Board (P2110-EVB) [Qty. 2]
 - c. Dipole antenna Wireless Sensor Board (WSN-EVAL-01)[Qty. 2]
 - d. Wireless Sensor Board (WSN-EVAL-01)[Qty. 2]

Items, b, c, and d all connect. The sensor board will connect to the evaluation board via a keyed connection called J2 on the evaluation board. (See Figures 3 and 4)

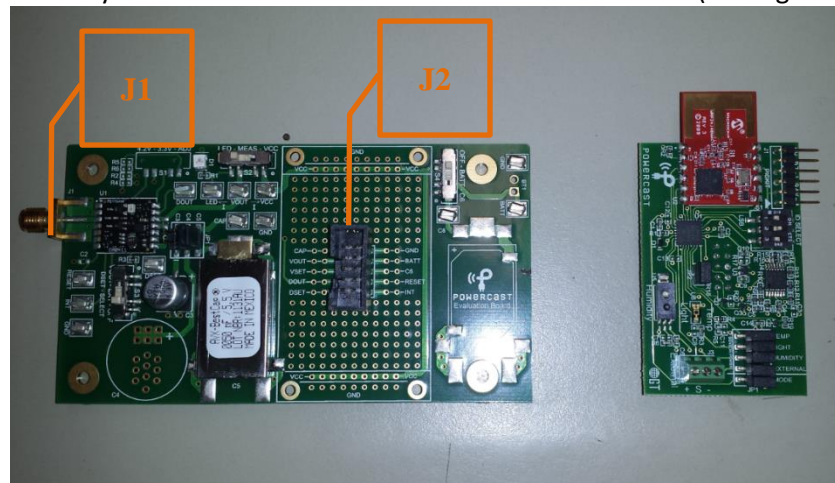


Figure 3 Evaluation Board(Left) and Sensor Board(Right)

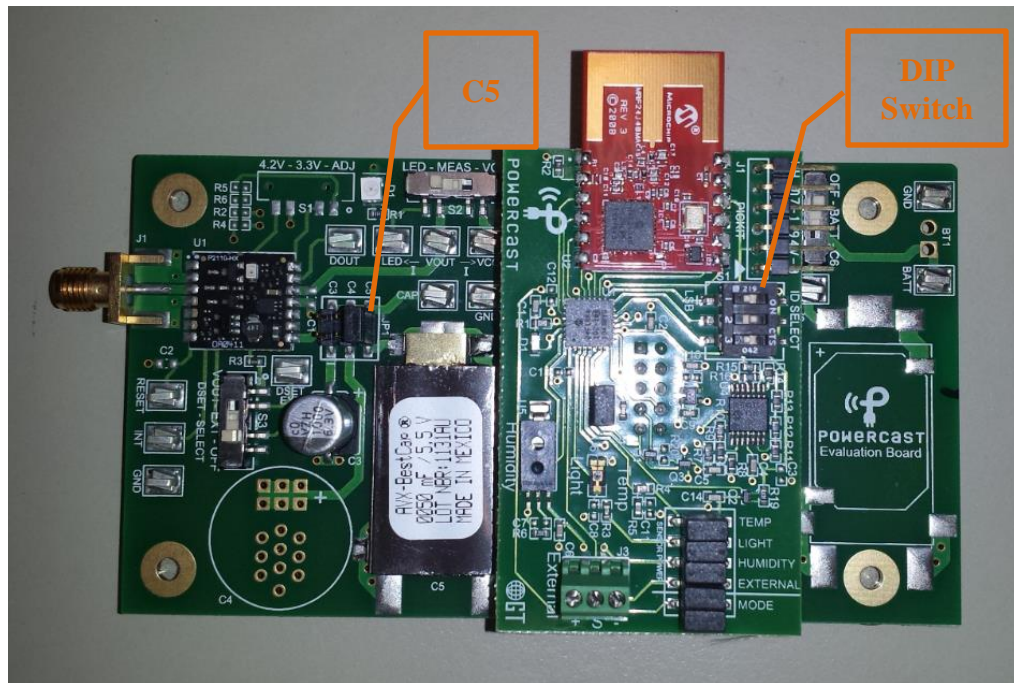


Figure 4 Evaluation Board with attached Sensor Board

Next, the dipole antenna (See Figure 5) will be attached via connector J1 (See Figure 3). Once the dipole antenna is attached you have a complete wireless node (See Figure 6) with three sensors which include light, humidity, and temperature. Now build the next one. Start at step 6.



Figure 5 Dipole Antenna

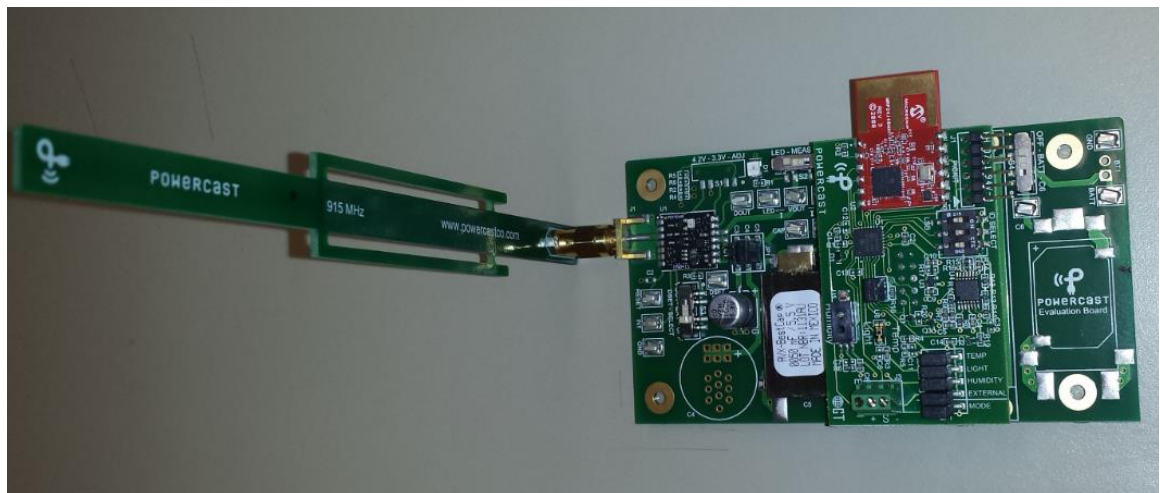


Figure 6 Complete Wireless Sensor Node

There are three last things that need to be done before you have successfully built and configured a wireless sensor network. The first is to configure the Evaluation board. To do this just make sure C5 is connected. (See Figure 4) The next thing that you need to do is to give each node an ID. You can do this by using the DIP switch on the sensor board. (See Figure 4) After both wireless sensor nodes are built you will need to plug the Power and Data Transmitter (TX91501-3W-ID) into a power socket. Make sure the wireless sensor nodes are within 20 ft. of the power transmitter for efficiency. The Red LED light on the evaluation board should be blinking. The faster it blinks the faster packets are being sent.

Look at the HyperTerminal, you should see packets being sent from each wireless sensor node and displayed on the PC. A successful setup should have a very similar HyperTerminal at the end of the configuration. As you can see packets are being sent at about 1-3 seconds.

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Packet # 38 | Node 2 | TX ID --- | Temp 71.8 F | Light 145 lx
Time 00:04:16 | dT 00:00 | RSSI 2.22mW | Humidity 31 % | Extrnl 1728 mV

Packet # 39 | Node 2 | TX ID --- | Temp 71.8 F | Light 138 lx
Time 00:04:17 | dT 00:01 | RSSI 6.82mW | Humidity 31 % | Extrnl 1720 mV

Packet # 40 | Node 2 | TX ID 242 | Temp 71.6 F | Light 153 lx
Time 00:04:18 | dT 00:01 | RSSI 6.40mW | Humidity 31 % | Extrnl 1742 mV

Packet # 41 | Node 2 | TX ID --- | Temp 71.8 F | Light 120 lx
Time 00:04:19 | dT 00:01 | RSSI 7.94mW | Humidity 32 % | Extrnl 1751 mV

Packet # 42 | Node 2 | TX ID --- | Temp 71.8 F | Light 113 lx
Time 00:04:20 | dT 00:01 | RSSI 4.84mW | Humidity 32 % | Extrnl 1711 mV

Packet # 43 | Node 2 | TX ID 242 | Temp 71.8 F | Light 117 lx
Time 00:04:21 | dT 00:01 | RSSI 7.28mW | Humidity 32 % | Extrnl 1668 mV

Packet # 44 | Node 2 | TX ID 242 | Temp 71.8 F | Light 117 lx
Time 00:04:23 | dT 00:02 | RSSI 1.74mW | Humidity 32 % | Extrnl 1736 mV

Packet # 45 | Node 2 | TX ID --- | Temp 71.8 F | Light 117 lx
Time 00:04:26 | dT 00:03 | RSSI 1.74mW | Humidity 32 % | Extrnl 1718 mV

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Results: Upon completion of this project you should be able to configure the P2110-EVAL-01 Lifetime Power® Energy Harvesting Development Kit for Wireless Sensors (jointly developed by Powercast and Microchip) and actually start reading data from 2 wireless battery-less sensor nodes.

Recommendations: Even though the dipole antenna was used in this project. The patch antenna which is included in the kit might give you a better response. Also it is recommended that you take your time and make sure that when you are downloading the software to make sure everything is in the same directory. One last thing, the power transmitter is very sensitive to “line-of-sight” so make sure that the wireless sensor nodes that you built are in “line-of-sight” with the power transmitter.

References:

<http://www.powercastco.com/PDF/P2110-datasheet.pdf>

<http://www.powercastco.com/PDF/P2110-EVB.pdf>

<http://www.powercastco.com/PDF/P2110-EVAL-01-overview.pdf>