ember

EmberNet Developer Kit User's Guide

120-0002-210 December 2002

FCC Compliance for the EmberNet Node

Compliance Statement (Part 15.19)
The EmberNet Node complies with Part 15 of the FCC Rules and with RSS-210 of Industry Canada.
Operation is subject to the following two conditions:
--This device may not cause harmful interference, and
--This device must accept any interference received, including interference that may cause undesired operation.

Warning (Part 15.21)
Changes or modifications not expressly approved by the party responsible for compliance could void the userís authority to operate the equipment.

RF Exposure (OET Bulletin 65)
To comply with FCC RF exposure requirements for mobile transmitting devices, this transmitter should only be used or installed at locations where there is at least 20cm separation distance between the antenna and all persons.

The EmberNet Node is intended for installation in mobile devices, and is not intended for installation in portable devices.

Contents

Preface

About This Guide

This guide introduces you to the components of the EmberNet Developer Kit and provides basic instruction for their use.

Associated EmberNet Documentation

EmberNet Overview

EmberNet Application Development Guide

EmberNet View User's Guide

EmberNet Node Technical Specification

EmberNet Gateway Technical Specification

Getting Help

Documentation, customer service, and support are available at support.ember.com or by contacting your account representative at Ember.

CHAPTER 1

EmberNet Developer Kit Overview

Overview

There are three versions of the EmberNet Developer Kit, a Standard, Advanced and a Premium version. Each Kit contains a number of hardware and software components to assist you in building an Ember Enabled application. This chapter provides a listing of components and their functions.

EmberNet Developer Kit Components

The following table outlines the components for each EmberNet Developer Kit.

Table 1-1: EmberNet Developer Kits

	Standard	Advanced	Premium
Hardware	8 - EmberNet Nodes 8 - EmberNet Breakout Boards 1 - EmberNet Gateway 1 - USB Programmer 1 - 6ft. Ethernet patch cable 9 - 9V power supplies	12 - EmberNet Nodes 12 - EmberNet Breakout Boards 12 - EmberNet/Ethernet connection boards 1 - EmberNet Gateway 1 - USB Programmer 1 - 6ft. Ethernet patch cable 13 - 9V power supplies	12 - EmberNet Nodes 12 - EmberNet Breakout Boards 12 - EmberNet/Ethernet connection boards 1 - EmberNet Gateway 1 - USB Programmer 1 - 6ft. Ethernet patch cable 13 - 9V power supplies
Software and Documentation	1 - EmberNet Developer Kit CD 1 - AVR-GCC 3.2.C Compiler (Win 32) 1 - EmberNet Node Binary 1 - EmberNet Host API Specifications & Libraries 1 - Sample Application 1 - EmberNet View EmberNet Documentation	1 - EmberNet Developer Kit CD 1 - AVR-GCC 3.2.C Compiler (Win 32) 1 - EmberNet Node Binary 1 - EmberNet Host API Specifications & Libraries 1 - Sample Application 1 - EmberNet View 1 - EmberNet Simulator v1.0 (Linux) 1 - EmberNet Node Binary for EmberNet Simulator 1 - EmberNet/Ethernet Debug Application EmberNet Documentation	1 - EmberNet Developer Kit CD 1 - AVR-GCC 3.2.C Compiler (Win 32) 1 - EmberNet Node Binary 1 - EmberNet Host API Specifications & Libraries 1 - Sample Application 1 - EmberNet View 1 - EmberNet Simulator v1.0 (Linux) 1 - EmberNet Node Binary for EmberNet Simulator 1 - EmberNet/Ethernet Debug Application EmberNet Documentation
Training and Support	1 year - Web based support	Annual Support 1 - Training Seat Telephone, email and web support	Premium Support • 3 days - custom engineering(*T&E excluded) • 2 days (up to 5 students) - Onsite training (*T&E excluded) • Telephone, email and web support.
Optional Upgrades for additional fee	Discounted first seat training ***Per incident support:*** • $750 per three incidents • First three incidents free upon completion of training ***EmberNet Debug Kit includes:*** 8 - EmberNet/Ethernet Connection Boards 1 - EmberNet Simulator 1 - EmberNet/Ethernet Debug application Additional training seats Annual support Custom engineering	• Additional Training seats • Custom Engineeringz	• Additional Training seats • Additional Custom Engineering
* Travel and Entertainments			

Developer Kit Requirements

Most modern PCs provide the necessary requirements for developing Ember Enabled applications. Refer to the GCC documentation for specific details on the compiler's requirements, but in general, the following should be sufficient:

- Windows 98 and later
- An available USB port for downloading images to the EmberNet Node or application code to the processor.
- Adobe Acrobat reader (available via free download from www.adobe.com) for viewing the documentation.

Additionally you may require these optional components

- if you would like to connect and manage your EmberNet Gateway directly from your PC
  - •Ethernet connection port on your PC
  - •cross-over cable
- if you would like to connect and manage your EmberNet Gateway via your local area network
  - •local area network connection
  - •standard serial cable
  - •HyperTerminal (a Windows Accessory component)

Developer Kit Components

The components of the EmberNet Developer Kit include both hardware and software components, as well as support services.

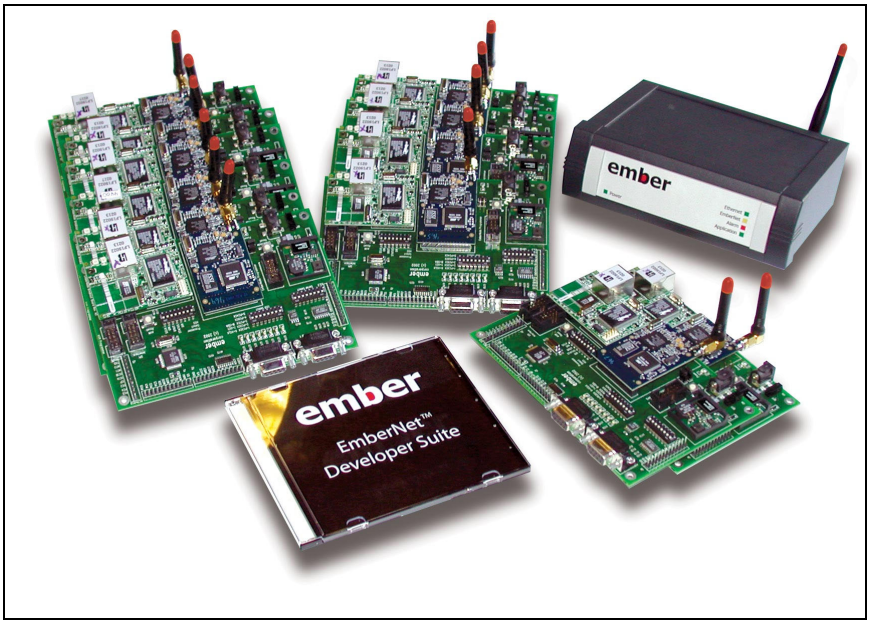


Figure 1-1: EmberNet Advanced Developer Kit

NOTE: An Implementer ID number was included in your EmberNet Developer Kit. This ID number MUST be used as described in Chapter 3 in order to ensure that your application will not interfere with other EmberNet networks.

Hardware Components

The hardware components of the development kit include the following:

- Either 8 or 12 EmberNet Nodes (attached to Breakout Boards)
- Either 8 or 12 EmberNet Breakout Boards (including pre-mounted RabbitCore boards for debugging, and 9V power supplies)
- One EmberNet Gateway and 9V power supply
- Either 8 or 12 medium profile antennae for the EmberNet Nodes

- One medium profile antenna for the EmberNet Gateway
- One USB Programmer with cable, programming applications, and documentation
- One 6-foot Ethernet patch cable

Software Components

The software in the EmberNet Developer Kit includes the following:

- EmberNet Developer Suite CD, which includes:
  - EmberNet Host API
    - Source code
  - EmberNet Node binary for EmberNet Node hardware
  - EmberNet Debug Logging Utility
  - Application template
  - Sample applications
  - GNU/GCC compiler

    NOTE: If you are interested in purchasing a commercial compiler, we recommend the IAR Embedded Workbench from IAR Systems. Refer to www.iar.com for more information and pricing, or to download a free demo copy.

  - EmberNet Documentation

    NOTE: The EmberNet documentation is provided in Adobe Acrobat format (pdf). To view the documentation, you need the Adobe Acrobat reader, available free from www.adobe.com.

Support Services

The EmberNet Developer Kit also provides you with access to Ember's Technical Support resources, including training, phone and e-mail support, and the Ember Support web site. Refer to www.ember.com for more details on these services.

Hardware Components

EmberNet Node

An EmberNet Node is a small-footprint module (2.2" x 1.5") that connects to a carrier board (the EmberNet breakout board for development and the customized board for integration into an OEM product) and the EmberNet Gateway.

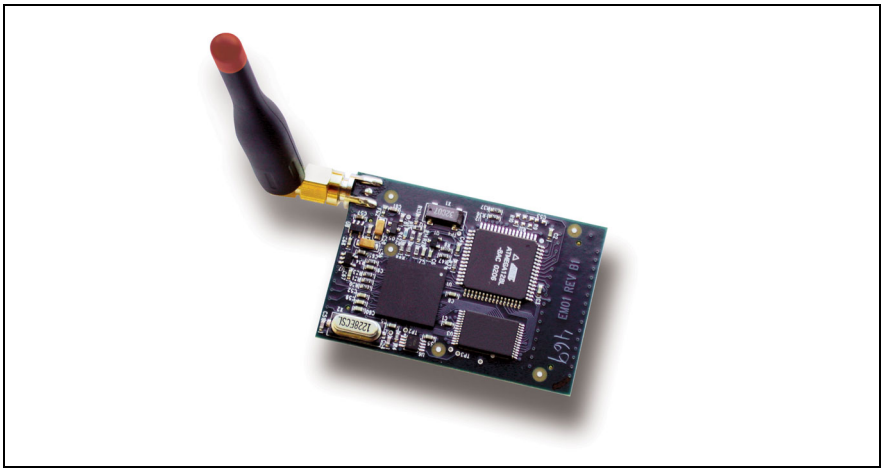


Figure 1-2: EmberNet Node, top view

An EmberNet Node is the primary component of an EmberNet network—it implements the protocols that enable EmberNet networks to organize themselves and route messages across the network on behalf of the applications.

EmberNet Node Components

The following block diagram represents the components of an EmberNet Node.

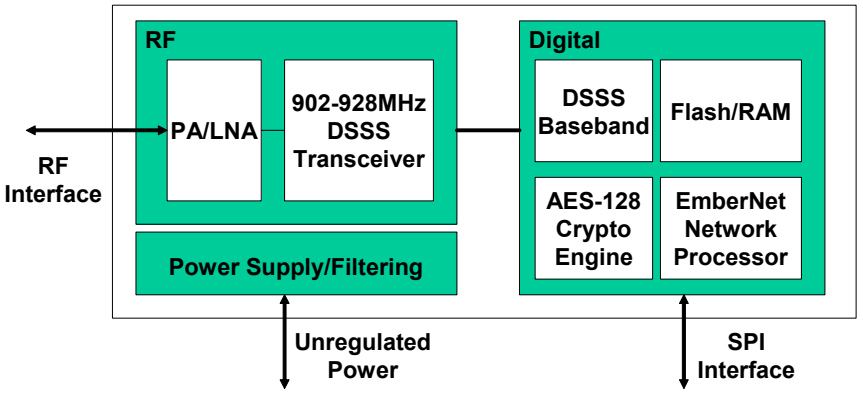


Figure 1-3: Block diagram of EmberNet Node

The main components of an EmberNet Node include:

- An **8-bit micro controller** which runs the EmberNet Protocol Stack and any application code you may wish to develop. In most cases, the EmberNet Node is embedded into a larger system, where the application code runs on the host processor and communicates with the EmberNet Node via the high-speed serial interface using the SPI or the EmberNet Host API commands.

  An EmberNet Node can also be used in stand-alone fashion (attached to an EmberNet Breakout Board or another carrier board for power) as a repeater. You can choose to run application components or whole applications in the EmberNet Node.
- The direct sequence spread spectrum **baseband** controls the radio and mediates communications between the radio and the Node's processor. Because the EmberNet Node's processor is small, some of the work, such as encryption, is given to the baseband.
- The **radio** communicates by way of the main RF channel.

Information is transmitted into and out of the EmberNet Node in two ways. The primary communications channel is a RF channel, which uses a 900MHz frequency-hopping spread-spectrum radio by which the EmberNet Node communicates with its neighboring nodes. In addition, a high-speed synchronous serial interface (SPI) is used for the EmberNet node to communicate with its host processor on the embedded device.

EmberNet Node Connections

The EmberNet Node has the following connections:

- The **J1 and J3 connectors** are used to attach the node to the EmberNet breakout board or your customized carrier board. These connections allow the EmberNet Node to communicate with the host processor on the carrier board. For pinout information on these connectors, refer to the EmberNet Node Technical Specification.
- The **J2 antenna controller SMA connector** connects the antenna to the EmberNet Node. Refer to Chapter 2 for more information about the antennae and how to connect them to nodes.
- **Power** is supplied to the node via DC power through the carrier board

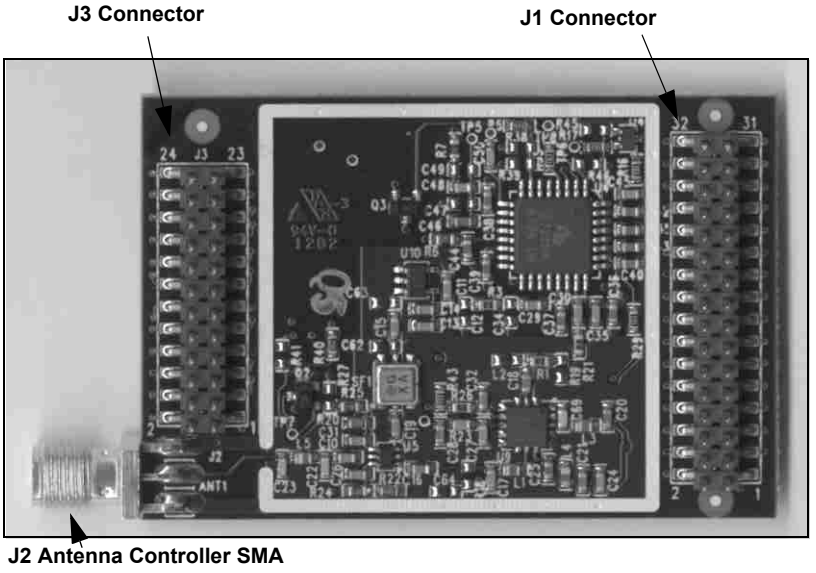


Figure 1-4: EmberNet Node connections

EmberNet Breakout Boards

The EmberNet breakout boards are the carrier boards on which an EmberNet Node resides for development only; a custom carrier board will be designed to specifically fit the equipment for which the application is being developed. The following illustration shows the breakout board with an attached EmberNet Node.

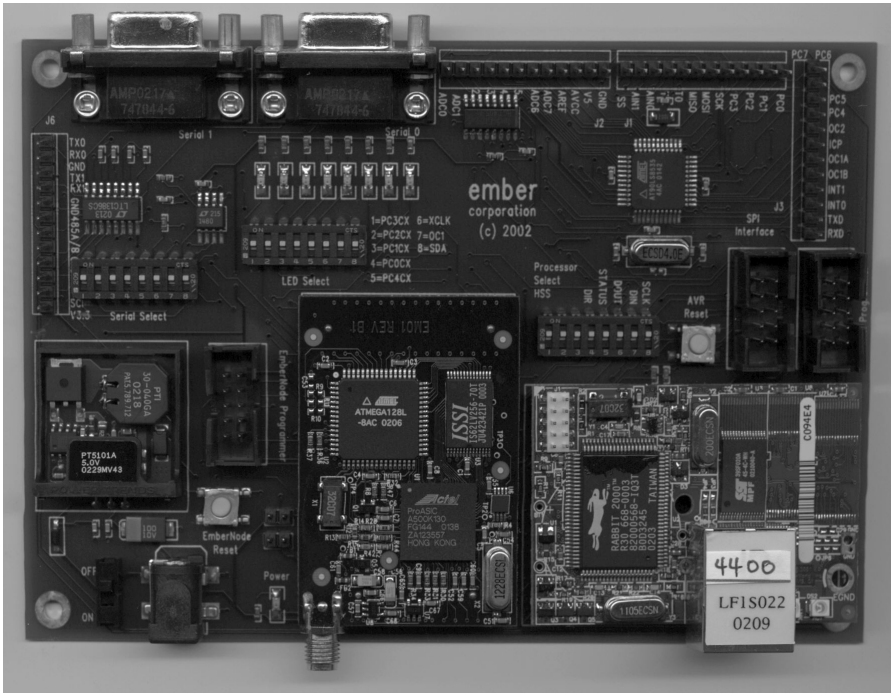


Figure 1-5: EmberNet Breakout Board with attached EmberNet Node

Breakout board components and connections

The breakout board consists of several components and connections. The Atmel 8535 processor provides on-board processing capabilities. The SW1 dip switch and offboard processor connector allows the use of an alternative processor. The RabbitCore board provides an Ethernet connection for debugging. Two serial connections and four other connections provide communications with the devices under development. For a complete listing of EmberNet Breakout Board components, refer to Chapter 2.

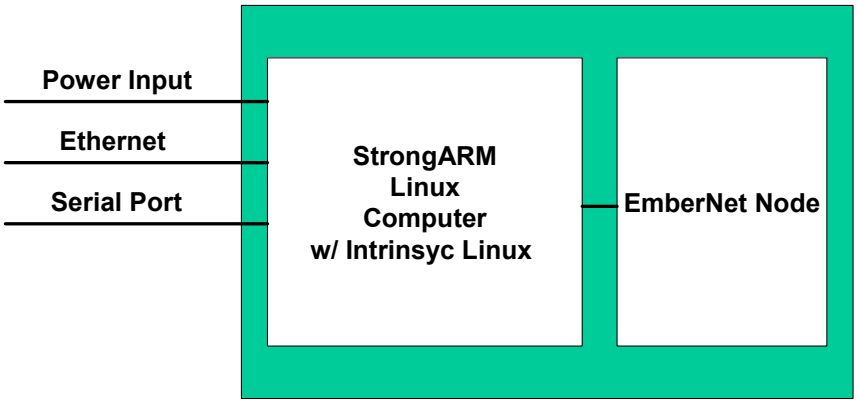
EmberNet Gateway

The EmberNet Gateway provides a link between an EmberNet network and a TCP/IP Ethernet network, allowing you to collect data, monitor network status, and perform limited management, configuration, and debugging of your network.

Figure 1-6: EmberNet Gateway

EmberNet Gateway Components

The following block diagram represents the components of an EmberNet Gateway.



The EmberNet Gateway is comprised of two main components:

- A **StrongARM single board computer (SBC)** that runs LINUX and runs an http server. It includes:
  - The Apache web server provides access to data from the network.
  - A CGI server so that external applications can query data from the network.
  - The EmberNet Protocol Stack server allows the Gateway to use the same host API running on the EmberNet Node.
  - The EmberNet View application provides the ability to use a web browser to monitor and configure your EmberNet. For more information, refer to the EmberNet View User's Guide (document 120-0004-100).
- An **EmberNet Node** to provide access to the EmberNet network.

The SBC and the EmberNet node communicate using the EmberNet Host API over the SPI high-speed serial interface, just as an EmberNet Node communicates with a host processor on a carrier board.

EmberNet Gateway Connections

- Power is supplied to the EmberNet Gateway via a 9V power supply.
- An RJ-45 Ethernet connection provides access to the TCP/IP Ethernet network.
- A (DB-9) serial connection (RS-232) allows you to connect the Gateway to any serial device for configuration.

Radio antenna

Your development kit includes 12 medium profile antennae to be attached to the EmberNet Nodes and one medium profile antenna to attach to the EmberNet Node that resides in the EmberNet Gateway. Refer to Chapter 2 for details.

USB Programmer with cable

The USB programmer (including the programmer itself, USB cable, software, and documentation) is used to:

- download an image from your development system into flash memory on an EmberNet Node via a programming port on the breakout board.
- download application code to the host processor on the breakout board.

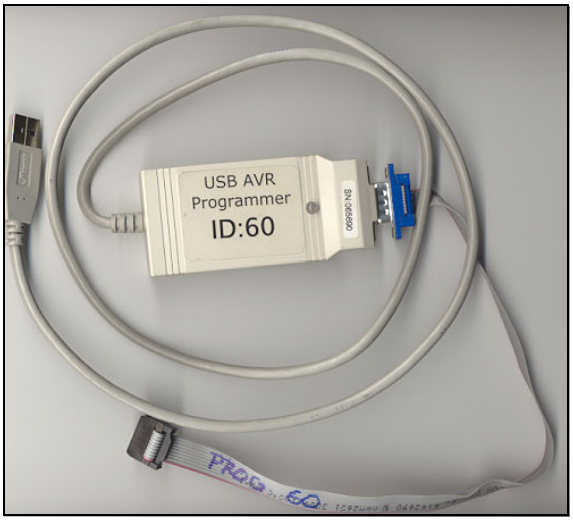


Figure 1-7: Serial Device Programmer with cable

The software files associated with the USB Programmer (for Windows only) are included on the Setup and Installation CD-ROM included in the USB kit. For more information on installing and using the USB Programmer, refer to Chapter 4.

Software Components

A number of EmberNet software tools are used in the development of Ember Enabled devices.

GCC Compiler

The EmberNet Developer Kit includes the Win32 build of avr-gcc 3.2, the GCC Compiler for a Windows development environments. The AVR-GCC C compiler is made available under the GNU general public license. There are a number of web sites, including www.avrfreaks.com and gcc.gnu.org, that offer documentation and support via discussion boards for this compiler.

Alternate Compiler

If you are interested in purchasing a commercial compiler, we recommend the IAR Embedded Workbench from IAR Systems. Refer to www.iar.com for more information and pricing, or to download a free demo copy.

EmberNet Node Binary for EmberNet Node Hardware

The EmberNet Node binary contains the software image for the EmberNet Node. This image is provided in the event that you need to reload it onto the EmberNet Node.

EmberNet Host API and EmberNet SPI Protocol (ESP) Command Set

The EmberNet Host API is a set of commands that allows the EmberNet Node and the host processor to communicate across the high-speed SPI interface. The API should be used if you are using the ATMel 8535 processor on the breakout board for application development. For more information on the API, refer to the EmberNet Application Development Guide (document 120-0003-100).

For development using another processor, you should use the API source code and the EmberNet SPI Protocol (ESP) command set to port the API to the processor of your choice.

EmberNet Debug Logging Utility

The EmberNet Debug Logging Utility provides a means for testing and analyzing EmberNet applications. EmberNet Nodes attached to the breakout board can generate a variety of debugging messages (configurable through EmberNet Host API) and send them through the Ethernet connection to the EmberNet Debug Logger Utility, a Java program that collects and formats the raw data.

Sample Applications

A few sample applications are included in the EmberNet Developer Kit so that you can examine sample source code for an Ember Enabled application. For more information on the sample applications, refer to Chapter 3. You can also check support.ember.com for additional sample applications.

Application Template

A template is included for assisting in the development of the application for your Ember Enabled device. Refer to Chapter 3 for information on using the template.

CHAPTER 2

Connecting the Hardware

Overview

In general, when developing an Ember Enabled device with the Developer Kit, use the following steps:

1. Attach the antennae to the EmberNet Nodes and EmberNet Gateways.
2. Attach the EmberNet Breakout Board to the development system PC and to any external devices (sensors, external processor, etc.)
3. Write the application code using the EmberNet Host API. Refer to the EmberNet Application Development Guide.
4. Download the application code to the processor using the USB programmer. Refer to Chapter 4 for information on installing and using the USB programmer.
5. Install the EmberNet Gateway to monitor the application using EmberNet View. Refer to the EmberNet View User's Guide for more details on using this monitoring tool.
6. Use the EmberNet Debug Logging Utility to test and analyze EmberNet applications. Refer to Chapter 5 for information on installing and using the EmberNet Debug Logging Utility.

This chapter discusses attaching antennae to EmberNet Nodes and Gateways, connecting an EmberNet Breakout Board for development, and installing an EmberNet Gateway.

Attaching antennae

The EmberNet Developer Kit includes twelve medium profile antennae for use with the EmberNet Nodes and one medium profile antenna for the EmberNet Gateway. These antennae can be used during the design and development of your EmberNet network.

EmberNet Nodes and EmberNet Gateways are not shipped with pre-installed antennae, so you will need to attach them BEFORE powering on the EmberNet Node or EmberNet Gateway..

CAUTION!

Always connect an antenna to the EmberNet Node or EmberNet Gateway prior to power up. Failure to do so could cause permanent damage to the EmberNet Node, EmberNet Gateway or the EmberNet Breakout Board.

EmberNet antenna

This 916 MHz 1/4-wave medium profile antenna is used on the EmberNet Nodes and EmberNet Gateway. It has a right-angle RP-SMA female connector that is FCC Part 15-compliant.

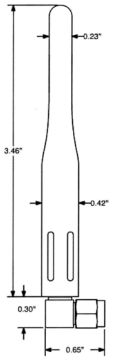


Figure 2-1: EmberNet antenna

Features of this antenna include:

- Medium profile (3.46 inches) whip
- High performance
- Omni-directional pattern
- Rugged construction
- Used with plastic (requires proximity grounding) or metal enclosures

Connecting the antennae

The antennae have FCC Part 15-compliant RP-SMA female connectors that mate with RP-SMA male connectors on an EmberNet Node, which are factory-installed on the EmberNet Breakout Boards and EmberNet Gateways.

CAUTION!

Always connect the antenna to the EmberNet Node prior to power up. Failure to do so could cause permanent damage to the EmberNet Node, EmberNet Gateway or the EmberNet Breakout Board..

To install an antenna on an EmberNet Node, perform the following steps:

1. If attaching an antenna to an EmberNet Gateway, connect a medium profile antenna's RP-SMA connector to the RP-SMA connector of the node in the EmberNet Gateway.
2. If attaching an antenna to an EmberNet Node on the breakout board, connect a medium profile antenna's RP-SMA connector to the EmberNet Node RP-SMA connector.
3. Adjust the antenna, by hand, turning it so it is vertical.
4. Tighten the antenna's RP-SMA connector, not to exceed 8 in-lb. of torque. Use an 8 in-lb. calibrated torque wrench if you are uncertain about the amount of torque you are applying.
5. Repeat steps until you have connected all antennae to all of the EmberNet Nodes.