



EM250 User Guide

**For the EM250 Development Kit and
JumpStart Edition for the EM250**

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New in this Revision

Rebranding to Silicon Labs.



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About This Guide

Purpose

This document describes the Ember Development Kit and explains how to set up its hardware and use the Ember InSight Adapter.

- For information on developing and debugging applications with InSight Desktop, see its online documentation.
- For information on designing and debugging an application based on Silicon Labs' EmberZNet PRO software stack, refer to documents 120-3029-000, *Application Development Fundamentals*, and 120-0082-000, the *EM250 Datasheet*.
- Other documents of interest include:

Document	Part No.
Quick Start Guide	120-4023-000
EM250 Breakout Board Technical Specification	120-2003-000
EM250 RCM Technical Specification	120-2001-000
InSight Adapter Technical Specification	120-2002-000

Audience

This document is intended for embedded software engineers who are responsible for developing wireless applications with the Ember Development Kit.

This document assumes that the reader has a solid understanding of embedded systems design and programming in the C language. Experience with networking and radio frequency systems is useful but not expected.

Documentation Conventions

Notation	Meaning	Example
<i>Italics</i>	Identifies on-screen software menu options.	<i>Connect</i>
UPPERCASE	Identifies a keyboard key.	ENTER
Right-angle bracket	Delimits a series of software program menu options to be clicked.	<i>Open > Save</i>
Courier	Identifies software code and, in body text, variables.	<code>void Main(String[] argv) the buffer variable</code>
<i>Courier Italics</i>	Identifies a variable name.	<i>ipAddress</i>

Getting Help

Development Kit customers are eligible for training and technical support. You can use the Silicon Labs web site www.silabs.com/zigbee to obtain information about all Ember products and services. You can also contact Customer Support at www.silabs.com/zigbee-support.

If you have any questions about your Development Kit, contact your account representative at one of the following locations:

United States	25 Thomson Place Boston, MA 02210 Telephone: 617-951-0200 Fax: 617-951-0999
Asia/Pacific	HK Spinners Industrial Bldg, Phase 5 5/F Flat D 760-762 Cheung Sha Wan Rd Kowloon Hong Kong Telephone: +852-8120-5375
Europe	Unit 300 Science Park Milton Road Cambridge CB4 0XL, UK Telephone: 44 (0) 1223 423322 Fax: 44 (0) 1223 423390

2 Introducing Ember Development Kits

The Ember Development Kit is used for application design and development. The kit contains a variety of hardware for quickly creating a prototype of the customer's hardware, EmberZNet PRO, Silicon Labs' implementation of the ZigBee Pro stack software specification, and various development tools which enable the development of the customer's application software.

EmberZNet PRO runs on top of IEEE 802.15.4-compliant radio and link layer software. EmberZNet PRO is a self-organizing, self-healing mesh networking protocol stack. Combined with the powerful IEEE 802.15.4 compliant Ember radios, the EmberZNet PRO network stack provides complete networking services from the physical layer up to a reliable application profile support layer. The stack produces networks that are reliable, flexible, secure, and easy to use.

Note: If you have not yet read document 120-4023-000, the *EM250 Quick Start Guide*, please do so before reading further in this User Guide.

EmberZNet PRO¹ provides a common application programming interface (API) that utilizes the underlying layers. This API provides support for the following layers of the OSI model:

- **PHY:** radio control
- **MAC:** medium access
- **LINK:** route discovery
- **NETWORK:** routing, association
- **APPLICATION:** Application Profile Support for reliable message delivery

The EmberZNet PRO stack can be used to build ZigBee-based applications. Applications that are built on this stack benefit from the following features:

- PHY and MAC layers comply with the IEEE 802.15.4-2003 standard
- LINK and NETWORK layers comply with the latest ZigBee specification
- The APS layer provides the interface to the application for data transfer and management, including reliable transport and binding.

The Ember Development Kit includes InSight Desktop, which facilitates application development and debugging. InSight Adapters incorporate Power-over-Ethernet capability, which can simplify node deployment in the test environment. The boards also provide a direct connection for debugging customer-designed hardware. For detailed information about the Ember customer hardware debug interface, see document 120-2003-000, the *EM250 Breakout Board Technical Specification*.

¹ The release version of EmberZNet PRO as of the time of this writing is 4.6.

Development Kit Contents

Depending on your Ember development kit, you will have the specified count for each component as summarized in Table 1.

Table 1. Quick Start components for EM250 Development Kit and JumpStart Edition for EM250

Component	EM250 Development Kit	JumpStart Edition for EM250
Breakout boards	8	3
InSight adapters	8	3
Radio communication modules	8	3
Battery packs	8	3
12V DC power supplies	8	3
Power-over-Ethernet switch	1	1
6-foot USB cable	1	1
InSight Data Emulation Interface (DEI) interfaces	8	3
InSight Port cables	8	3
2-foot category 5e cables	8	3
Murata-to-SMA adapter cable	1	1

Hardware

- **Breakout boards** serve as test beds for network hardware and applications. Each breakout board has an associated radio communication module (RCM), which can be deployed as a node within a network application. Each breakout board connects with its InSight Adapter (ISA) through two communication links: the InSight Port and the ISA's debug port. This allows the breakout board's RCM to interface with InSight Desktop (ISD) through the ISA's InSight Port and its wired Ethernet connection. These interconnections are described later in this chapter. The Breakout Boards also have a prototype breadboard area for application-specific hardware development.
- **Radio communication modules (RCMs)** contain the Ember EM250 System-on-Chip solution providing a complete radio and microcontroller solution.
- **InSight adapters** that each connects a breakout board to the Ethernet. Each adapter transmits network data collected via its InSight Port and conveys it over its Ethernet connection to InSight Desktop. It also picks up any messages or new software that is addressed to this breakout board.
 - The InSight Port is a cabled communication link between the ISA and the EM250 RCM mounted on the breakout board.
- **InSight Port cables** that connect each RCM to an InSight adapter.
- **Battery packs** that attach to RCMs, enabling deployment of battery-operated nodes.
- **AC power adapters** for powering breakout boards and / or InSight Adapters from wall sockets.
- **Ethernet cables** for connecting InSight Adapters to an Ethernet subnet.
- **Data Emulation Interface (DEI) cables** that provide a peripheral interface connection between the ISA and breakout board. The DEI cable supports UART functionality.
- **Power-over-Ethernet injector** for powering InSight Adapters via the Ethernet.

Software

The Ember Development Kit contains one CD, with the following installation components and associated documentation:

- EmberZNet PRO network stack library and APIs: debug and release builds (see Table 3)
- HAL library
- InSight Desktop
- Sample programs (see Table 4)

For more information on development kit software components, see “Development Kit Contents.”

xIDE for EM250 development environment

Full license is sent via email after initial setup and execution. For more information on installation requirements and process, see “Install xIDE for EM250.”

Documentation

All documents are delivered as Adobe PDF files or as on-line HTML help. See Chapter 3, “Documentation” for more information.

Hardware Requirements

- Workstation with Ethernet connectivity
- Network hub with DHCP server

Software Requirements

- Microsoft Windows XP
- Java Runtime Environment, version 1.5 or higher
- Adobe Acrobat Reader (available free from <http://www.adobe.com/products/acrobat/readstep2.html>)

Before You Begin

The Ember Development Kit is designed only for the operating conditions and interfaces that are described in document 120-2003-000, *EM250 Breakout Board Technical Specification*. Any modifications or alterations to the hardware are liable to cause irreparable damage to the Development Kit, and shall render its warranty null and void.

If you wish to use the Ember Development Kit in a non-standard fashion, consult with Customer Support or Sales before starting development. This is especially true if you are embarking on an aggressive development cycle, plan to use custom hardware, or wish to use alternate software configuration files, images, or hardware configurations. Contact us and describe your plan, so we can help you minimize the risk of delays in your development cycle.

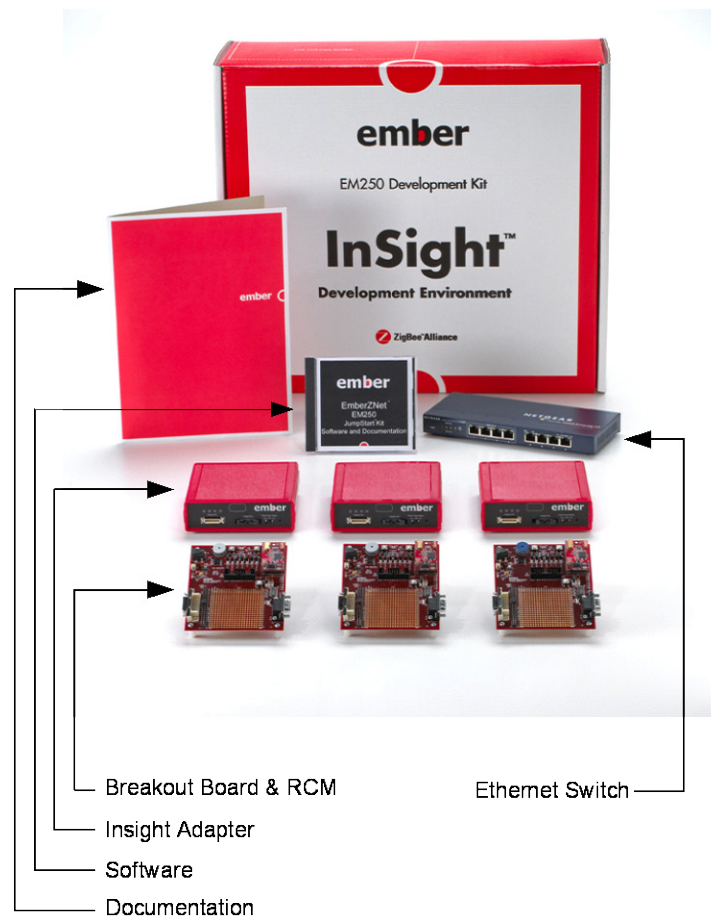
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Development Kit Components

Overview

Figure 1 shows the components in the EM250 Development Kit.

Figure 1. EM250 Development Kit (Typical)



This chapter describes the EM250 Development Kit components in three sections:

- Hardware
- Software
- Documentation

Hardware

The EM250 Development Kit development board set has eight (8) pieces each of three major components:

- Breakout Board
- Radio Communication Module
- InSight Adapter

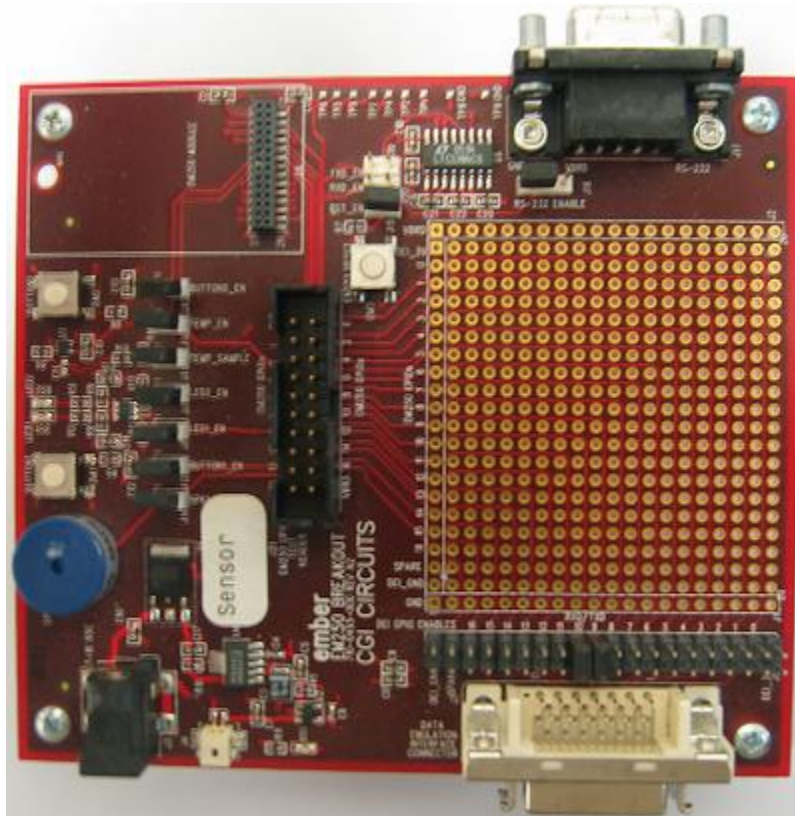
The JumpStart Edition for the EM250 development board set has three (3) pieces each of the same major components.

The EM250 Development Kit also includes the following hardware components:

- AC Power Adapter
- Power-Over-Ethernet (PoE) Switch

Breakout Board

Figure 2. Breakout Board



The breakout board (Figure 2) has the following components:

- External power supply connectors
- One DB-9 serial port connector for RS-232 serial communication
- One header with TTL-compliant UART signals for SPI serial communication
- A buzzer, two buttons, four LEDs, and a temperature sensor for application development purposes

- Hardware reset buttons for the radio communication module
- Prototype or breadboarding area (20 x 20, 0.1" pitch array) for application-specific hardware development
- One InSight data emulation interface connector

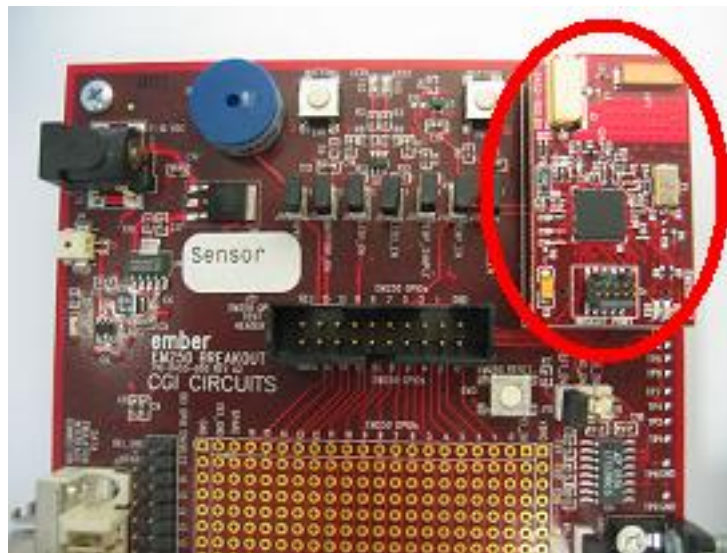
Warning: In order to use the InSight data emulation interface, you must power the radio communication module from an InSight Adapter that is powered by its Ethernet connection or from the development kit's 12V DC power supply. Powering the radio communication module from the battery pack when the InSight data emulation interface is in use can damage the InSight Adapter.

For detailed information about the breakout board, see document 120-2003-000, *EM250 Breakout Board Technical Specification*.

Radio Communication Module

The Ember Development Kit Radio Communication Module (RCM) pictured in Figure 3 is used together with the Development Kit breakout board to prototype customer hardware and to develop and debug application software. Its low-power design represents a good starting point for your own product design. Full details of the RCM circuit and PCB design are supplied as part of the development kit's online documentation.

Figure 3. EM250 breakout board with EM250 RCM installed



The radio communication module includes these components:

- Ember IEEE 802.15.4-compliant, 2.4 GHz radio transceiver (EM250)
- EM250 microcontroller
- External antenna connection
- Two LEDs
- InSight Port connector

For detailed information about the radio communication module supplied with your kit, see document 120-2001-000, the *EM250 Radio Communication Module Technical Specification*.

Once the developer moves away from the RCM and toward application-specific hardware, they should refer to Ember's extensive reference design library at www.silabs.com/zigbee-support. Each reference

design provides a schematic, bill of material (BOM), and layout files. They are designed and delivered in a manner that reduces both time to market and hardware implementation risk. For assistance in locating the best design for your needs, contact Customer Support at www.silabs.com/zigbee-support.

InSight Adapter

InSight Adapter provides an efficient and configurable Debug Interface to the Development Kit breakout board for processing emulation and debug commands, as well as providing an interface to InSight Desktop for monitoring and managing network data. See Figure 6 and Figure 7.

The InSight Adapter has the following components:

- Debug Port interface to the breakout board's Extended Debug Interface Connector.
- InSight Port interface to the radio communication module, providing programming and debugging services.
- TCP/IP 10/100 Ethernet interface with Power-over-Ethernet functionality.
- USB Interface.

AC Power Adapter

Caution: Use only the AC power adapter provided in your Development Kit. Any other power adapter is liable to severely damage the radio communication module microprocessor

The AC power adapter (Figure 4) is a linear regulated wall plug power supply with 12V DC at 1600mA regulated output. It has a six-foot output cord and a power supply. Four interchangeable snap-in input plugs are provided with various port configurations suitable for various locales: North America, Europe, United Kingdom, and Australia. The Development Kit cable complies with local regulations.

Figure 4. AC power adapter with interchangeable AC plugs



Table 1 in Chapter 1 lists all of the components and the acceptable combinations of power sources that yield normal operation. Potential power sources include the following:

- Power-over-Ethernet (PoE)
- External AC adapter
- Battery pack (3VDC)
- Power over Insight Port on ISA (the RCM Power Select switch on the front panel must be set to *Int.*)
- USB cable
- From RCM dedicated power

Table 2. Safe combination of operating power

	PoE	Ex AC Adapter	Battery	ISA Switch	USB	Breakout Board
ISA	X	X	N/A	N/A	N/A	N/A
EM250 RCM	N/A	N/A	X ²	X	N/A	X
EM250 Breakout Board	N/A	X	X	X ³	N/A	N/A

Power-Over-Ethernet (PoE) Switch

The EM250 Development Kit contains a Netgear 16-port Power-over-Ethernet (PoE) switch that supplies power to an InSight Adapter over a standard TIA/EIA-568 category 5 cable. (The JumpStart Edition for the EM250 contains a Netgear 8-port (PoE) switch.) The InSight Adapter can, in turn, supply power to an Ember development board and the radio communication module that is mounted on it. Thus, you can place breakout boards wherever an Ethernet cable connection is available.

The DC operating power for data terminal units is fed through unused pairs 7/8 and 4/5. For more information about the Netgear switch, see its online technical specifications.

The Netgear switch that is supplied in the EM250 Development Kit is certified by Silicon Labs. If you wish to use a different PoE switch, please consult with Customer support: www.silabs.com/zigbee-support.

Software

The Ember Development Kit contains the following software components:

- Network Stack
- Hardware Abstraction Layer
- Sample Applications
- InSight Desktop
- xIDE for EM250

Network Stack

The EmberZNet PRO network stack is an advanced implementation of the ZigBee Pro wireless protocol stack which provides mesh routing algorithms for creating reliable, flexible, and secure networks. The stack's APS layer provides interfaces for delivering messages reliably. The network stack API is documented in document 120-3029-000, *Application Development Fundamentals*, 120-3031, *Advanced Application Programming with the Stack and HAL APIs*, and the API References for the EM250, available in HTML and PDF versions.

The network stack is delivered as a collection of libraries that you can link to your applications. The libraries are available in both release and debug build versions:

- **Debug build** implements features that facilitate application debugging, such as error checking and an interface to InSight Desktop, which provides information about traffic flow, API traces, error conditions, and more.

² There is no dedicated power connector available. Power must be hard-wired to the RCM interface connector.

³ Power is sourced from the RCM module via the InSight Port connected to the ISA with its RCM Power Switch set to *Int*.

- **Release build** omits debugging functionality, so it is smaller and runs more efficiently. Use this build in your application after it is fully debugged and ready for product release.
- **Stub library** is a library used for resolving references but which has no functionality. For those libraries which are not needed by the application, the stub library must be linked in order for the stack to build properly.

Table 3 list the EmberZNet PRO stack and associated libraries.

Note: Table 3 shows the base library directory name, but it does not duplicate entries for the debug and stub libraries because they are self explanatory.

Table 3. EmberZNet PRO stack and associated libraries

Library name	Directory Name	Description
Alarm Library	/build/Alarm-library-xap2b-em250	Library containing the non-ZigBee standard alarm code.
Binding Table Library	/build/Binding-table-library-xap2b-em250-em250	Device bind library
End Device Bind Library	/build/end-device-bind-library-xap2b-em250-em250	End device bind library
Core Security Library	/build/security-library-core-xap2b-em250	Core ZigBee Pro security library
Core Security Library for End Devices	/build/security-library-core-end-device-xap2b-em250-em250	Core ZigBee Pro security library for end devices. This library is smaller than the full core security library.
Link Key Security Library	/build/security-library-link-keys-xap2b-em250-em250	Library to handle optional link keys
Core ZigBee Pro Stack	/build/zigbee-pro-stack-em250-em250	Core ZigBee stack functionality

Hardware Abstraction Layer

The hardware abstraction layer (HAL) acts as a conduit between the network stack and the node processor and radio. Separating network stack functionality from the specific hardware implementation enables easy portability. HAL code is provided as a library that you can alter in order to customize, extend, or reduce device functionality across various hardware platforms. The HAL API is documented in document 120-3016-000, *EmberZNet Stack API Reference*.

Sample Applications

The Ember Development Kit contains sample applications. These demonstrate aspects of the network stack that show the breadth of stack functionality. Silicon Labs provides an IAR project and workspace file for each application. Table 4 lists the sample applications that are in the current distribution. All applications are in the `app` directory.

Table 4. Development Kit sample applications

Application name	Filename	Description
Application Bootloader	app-bootloader-demo	Example application that shows how to use the application bootloader.
Standalone Bootloader	standalone-bootloader-demo	Example application that shows how to use the standalone bootloader.
Manufacturing Library	mfglib	Example of how to use the manufacturing library co-resident with your application.
Home Automation	ha	The home automation example shows how to use the HA- related clusters and build a basic HA application framework.
Sensor/sink	sensor	Aggregation example that shows how a single device collects data from multiple device. In this simple application, sensor nodes collect data and send it periodically to a sink node. The default application preloaded on kit hardware.
Rangetest	rangetest	Precompiled (non-stack) application for RF testing.
Token utility	token-utility	Non-stack example for accessing and writing tokens.
Template	template	A template to use as a starting point for developing an application.
ZigBee Device Object	zdo	Sample application showing how to use the ZDO.

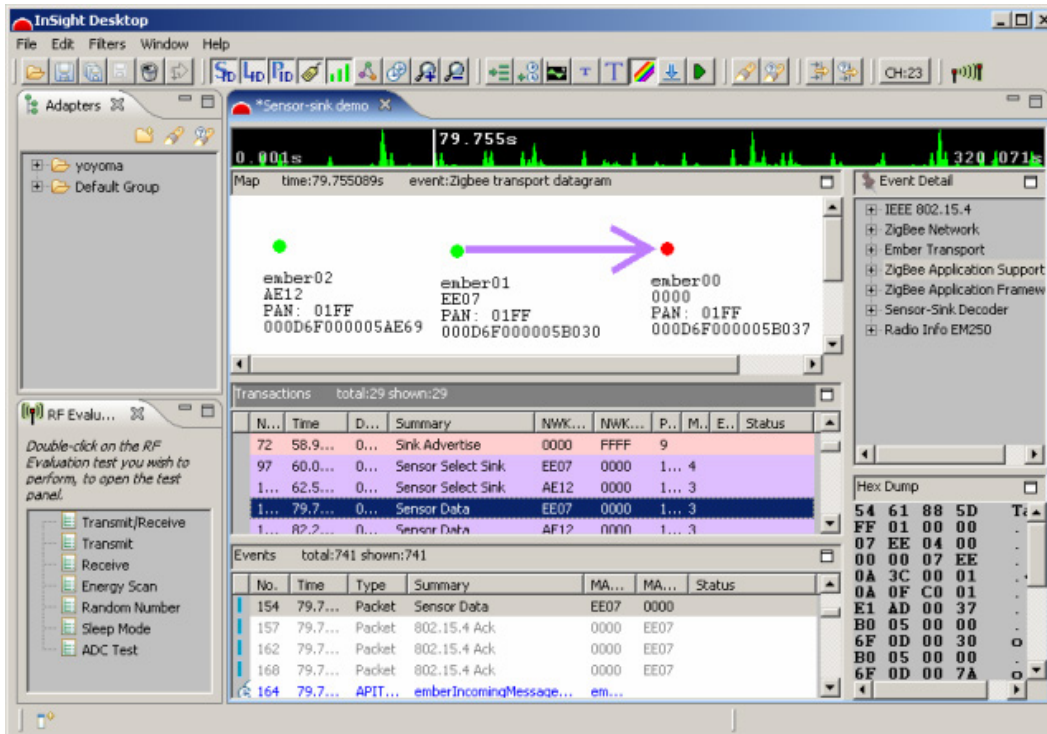
InSight Desktop

InSight Desktop (ISD) is a graphical tool that manages the Development Kit hardware and displays network and node activity in real time (see Figure 5). It provides a rich and flexible interface to Ember embedded networks, which helps you develop and debug new network applications. InSight Desktop includes these features:

- And Integrated Development Environment with Multiple editor panes that provide tiered views of network activity, letting you drill down fro a high-level map of node interactions to the details of each packet.
- Customizable filters that let you specify exactly which network activities to display.
- Log files that save captured data, so you can step through transactions and events for detailed analysis.
- A file browser that lets you easily upload new applications to any connected node.

An Adapters view shown in Figure 5 allows you to interact with the InSight Adapters and RCM in order to download new firmware, reset, and manage each of the devices.

Figure 5. InSight Desktop



For detailed information about InSight Desktop, refer to the *InSight Desktop User's Guide* (120-4005-001), available online, and ISD's online help.

xIDE for EM250

xIDE for EM250 provides a compiler, IDE and debugger tool chain that you can use to program the EM250's XAP2B microprocessor. For more information about xIDE for EM250, see Chapter 5.

Documentation

References to many documents occur throughout this guide. These documents, and others, are located on the software CD supplied with your Development Kit. Many of these documents are provided in Adobe Acrobat (.PDF) format. You can view these documents online or you can print them out as needed. Any version of the Acrobat Reader V6 or later can be used for this purpose. A copy of the free Acrobat Reader can be downloaded at <http://get.adobe.com/reader/>.

Documentation supplied with this Development Kit includes the following documents and more:

- *EM250 Datasheet* (120-0082-000)
- *Application Development Fundamentals* (120-3029-000)
- *Testing and Debugging Applications* (120-3030-000)
- *Advanced Application Programming with the Stack and HAL APIs* (120-3031-000)
- *EM250 RF Communication Module Technical Specification* (120-2001-000)
- *EM250 Breakout Board Technical Specification* (120-2003-000)
- *InSight Adapter Technical Specification* (120-2002-000)
- *EmberZNet Stack API Reference* (120-3013-000)

- *EM250/EM260 Quick Start Guide* (120-4023-000)
- *InSight Desktop User's Guide* (120-4005-000 and on-line HTML help)
- Application notes
- ISD Online Help
- xIDE online help and user manuals (PDF)
- Sample applications and hardware designs
- Product licensing information

4

Setting Up Hardware Components

This chapter contains the following sections:

- InSight Adapter Settings
- Hardware Connections
- EUI-64 Assignments
- Attaching and Removing Breakout Board Modules
- Powering the Breakout Board
- Resetting InSight Adapters
- Connecting the External Antenna Connector to the RCM
- Configuring the Serial Communication Path

InSight Adapter Settings

As shipped, InSight Adapters are configured with DHCP mode enabled and a pre-assigned hostname is assigned:

- `ember00 ... ember07` (EM250 Development Kit)
- `ember00 ... ember02` (JumpStart Edition for the EM250)

Each InSight Adapter carries a label with its hostname. Hostnames for all InSight Adapters in the kit also appear on a printed hardware ID list, which are mapped to their MAC-ID identifiers, and the EUI-64 identifiers of the matching radio communication modules.

Caution: InSight Adapters are accessible through their assigned hostnames only if your DHCP system populates DNS records automatically. Otherwise, you must access them through their IP addresses. Alternatively, you can set up a hosts file on your local computer that maps host names to IP addresses. If you are using static IP addresses, make sure that they do not conflict with other network addresses.

Hardware Connections

To avoid communication problems, verify that each radio communication module is firmly seated in its breakout board connector, and its InSight port cable is properly seated.

EUI-64 Assignments

Each radio communication module in the development kit has a serial number, which you can use to identify its IEEE EUI-64 assignment. The serial number is printed on a label affixed to the back of the module. To see the label, remove the module from the breakout board. Then look up the serial number in the printed table (enclosed in your development kit) that matches each serial number to the module's EUI-64.

Attaching and Removing Breakout Board Modules

Two hardware modules attach to the EM250 breakout board:

- Radio communication module
- InSight Adapter

Caution: Observe electrostatic discharge (ESD) precautions when removing, handling, or replacing RF communication modules.

To attach the radio communication module:

Align the radio communication module to its footprint outline on the breakout board, then press it into place. Make sure that the radio communication module sits firmly in its mating connector.

To remove the radio communication module:

- Carefully pull the module away from the breakout board.

To attach the InSight Adapter:

1. Plug the InSight port cable into the InSight Adapter.
2. Plug the InSight port cable into the radio communication module.
3. Verify that the InSight Adapter's RCM Power Select switch is set to *Int* (Internal).

To remove the InSight Adapter:

1. Unplug the InSight port cable from the radio communication module.
2. Unplug the InSight port cable from the InSight Adapter.

Powering the Breakout Board

You can power the breakout board from an InSight Adapter, or directly from the supplied AC adapter. Refer to Figure 2 for power connector location information. Table 2 provides a list of safe operating power sources for the Breakout Board and other kit hardware.

Powering the Breakout Board from an InSight Adapter

InSight Adapter can obtain its power from the supplied AC adapter (Figure 4) or the PoE switch. In either case, you can set up the breakout board and its radio communication module to obtain power from the InSight Adapter as follows:

1. Make sure that the RCM Power Select switch on the front of the InSight Adapter is set to *Int*.
2. Plug one end of the supplied InSight Port cable into the InSight Adapter's InSight Port interface.
3. Plug the other end of the InSight Port cable into the radio communication module's InSight Port connector.

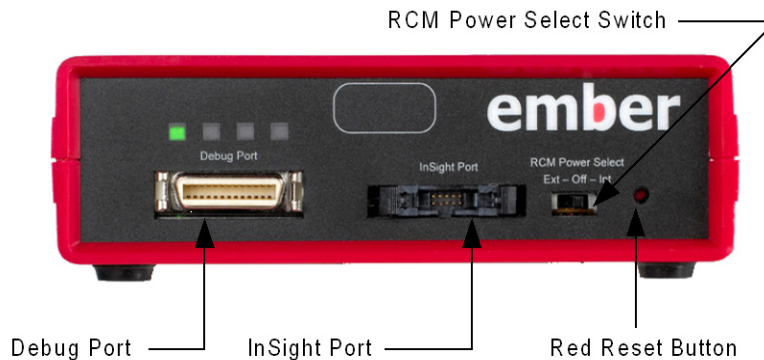
Powering the Breakout Board Directly

1. Snap an input plug into the Development Kit's AC power adapter.
2. Plug the power adapter into a wall outlet.
3. Plug the power adapter into the 12V power jack on the board.

Resetting InSight Adapters

To perform a hardware reset of an InSight Adapter, use a pen or pencil point to press the red reset button through the front panel.

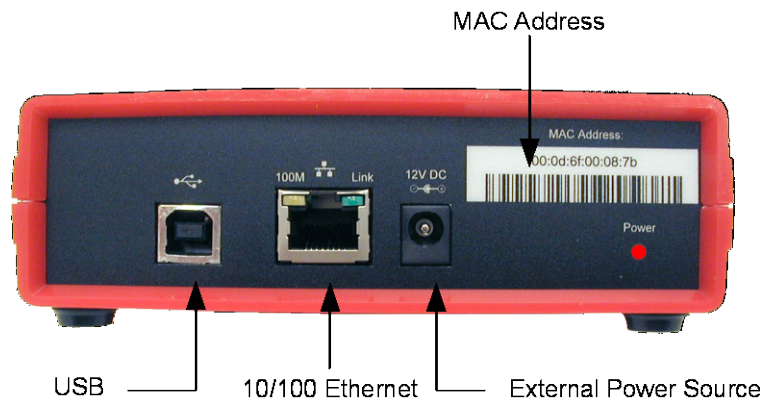
Figure 6. InSight Adapter Front Panel



You can reset the InSight Adapter's network settings as follows:

- Connect or disconnect an Ethernet cable from the ISA.

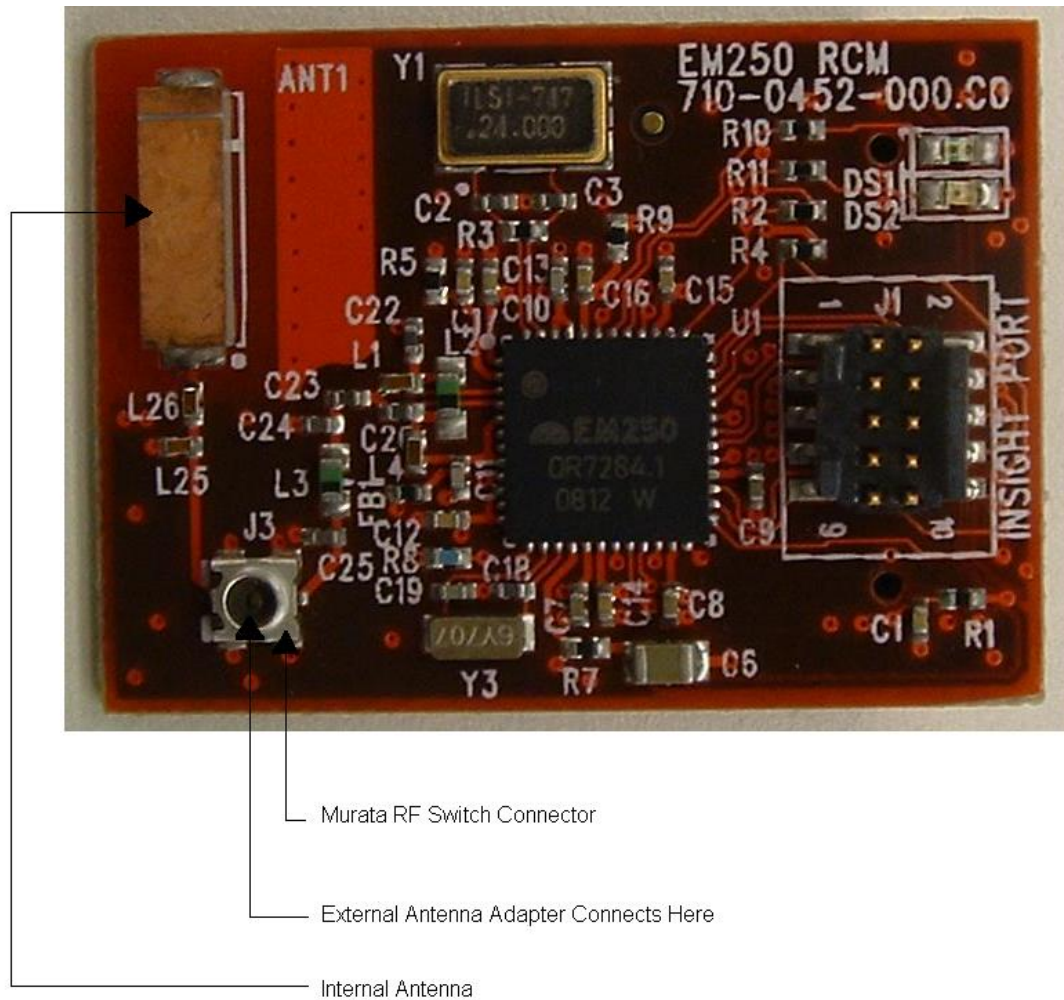
Figure 7. InSight Adapter Rear Panel



Connecting the External Antenna Connector to the RCM

The RCM can be used with its internal antenna or using an external antenna. The external antenna may also be used for testing. Some versions of the RCM use a Murata RF Switch Connector that requires a special mating connector. The Development Kit equipped with these RCMs contains SMA adapter cables that plug into the Murata RF Switch Connector.

Figure 8. External Antenna Connection



Other versions of the RCM may use a different External Antenna Connector. If this is the case, the appropriate adapter cables will be provided in the kit.

Note: The external antenna connector contains a switch that will automatically remove the internal antenna from the circuit when an external antenna connector is attached. This provides a stable impedance at the output.

Battery Powering Modules

Caution: Observe electrostatic discharge (ESD) precautions when handling RF communication modules that have been removed from the breakout board.

To increase deployment options for your application, use the supplied battery pack (with two AAA batteries) to power the radio communication module via the breakout board. You must connect the module to the breakout board. To locate the battery pack connector, see Figure 2.

To connect the battery pack:

1. Insert two AAA batteries into the battery pack.

2. Make sure that the external 12VDC power is disconnected from J3 on the breakout board (see Figure 2).
3. Plug the battery pack into the battery pack port (J4) on the breakout board.

Configuring the Serial Communication Path

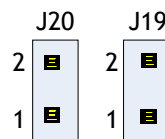
In order to communicate with the radio communication module's serial port via port 4901 (see Table 5), you must set up a serial communication path as follows:

1. Make sure that the target development board is powered only from InSight Adapter. Make sure that the RCM Power Select switch on the front of the InSight Adapter is set to `Int.`

Caution: Using the data emulation interface cable with hardware not powered from the InSight Adapter can cause in permanent hardware malfunction.

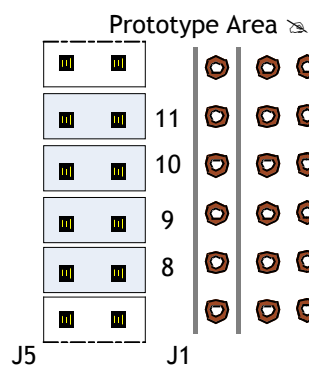
2. Plug one end of the data emulation interface cable into the InSight Adapter's Debug Port.
3. Plug the other end of the data emulation interface cable into the breakout board's Extended Debug Connector (see Figure 2).
4. Make sure the InSight Port cable is connected between the InSight Adapter and the radio communication module.
5. Confirm that RS-232 jumpers are properly set as shown in Figure 9. Note that J19 and J20 should be removed.

Figure 9. RS-232 Serial Jumpers



6. Confirm jumpers are placed on header J5 at pins 9 and 10 as shown in Figure 10. This enables the TXD and RXD UART functions through the Extended Debug Connector (J7), allowing the ISA to communicate with the Breakout Board's serial port.

Figure 10. RS-232 GPIO Jumpers



This completes the hardware setup.

5

Installing the Development Environment

Installation of xIDE is a two-stage procedure:

- Install xIDE for EM250
- Obtain a License

Install xIDE for EM250

In order to install xIDE for EM250:

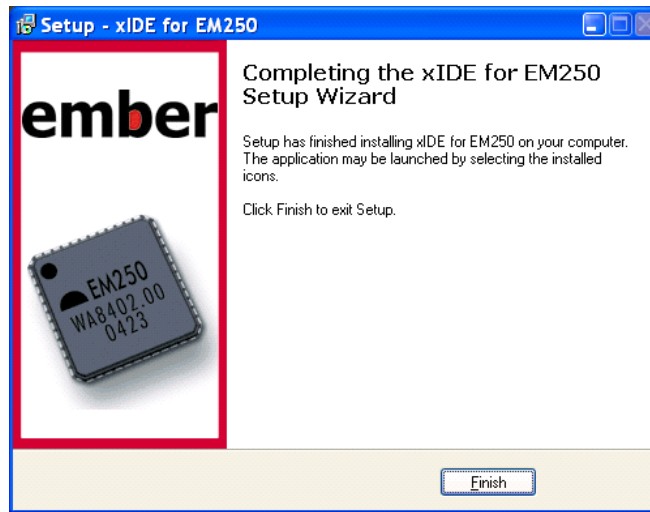
1. From the Ember installation CD, click on `xIDE_EM250.exe` to start the setup wizard.

Figure 11. xIDE Setup Wizard



2. Follow the installation steps to completion.

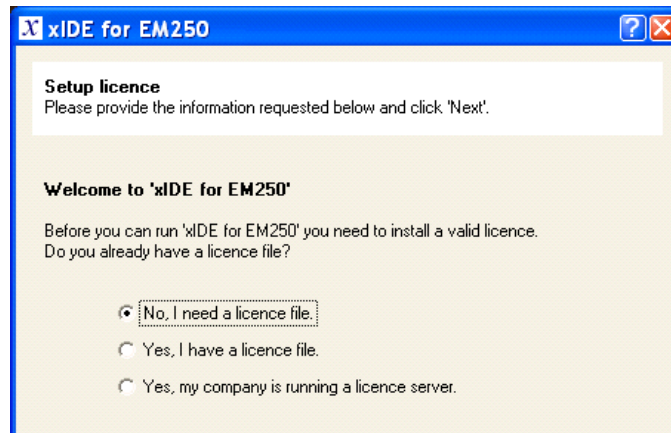
Figure 12. xIDE Setup Wizard



Obtain a License

When you start xIDE after installation, it asks whether you have a license.

Figure 13. xIDE License Dialog



1. When queried for your license, choose this option:

No, I need a license file

Note: IDE for EM250 does not support floating licenses.

2. Complete all license-related information, including your email address.

Figure 14. License Information Screen

xIDE for EM250

Setup licence
Please provide the information requested below and click 'Next'.

Please provide the details below. These will be used to automatically generate the text for an email to us requesting a licence file.

Name: Ember Preferred Customer

Company: Insert Company Here

Address: Insert Address Here

email: Insert e-mail here (required)

< Back Next > Cancel

- At the prompt, specify that you will send email manually.

Figure 15. License Email Screen

xIDE for EM250

Setup licence
Please provide the information requested below and click 'Next'.

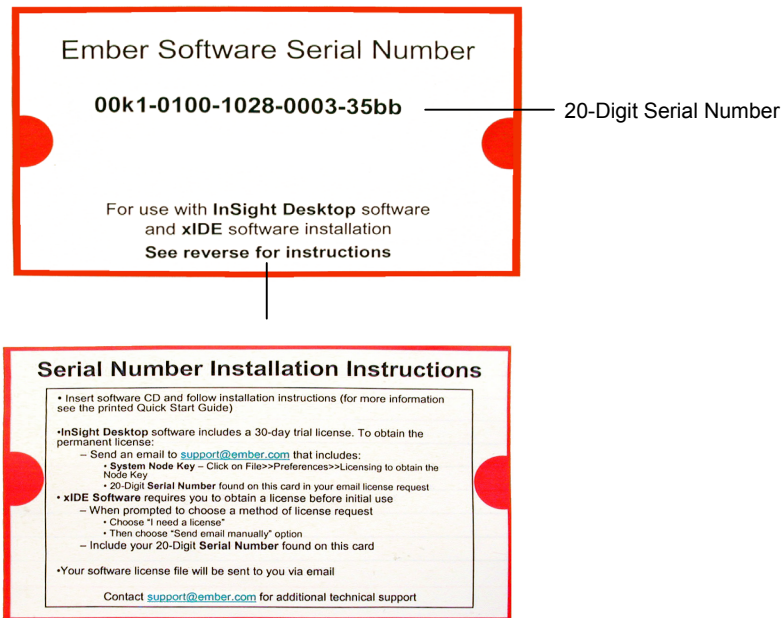
'xIDE for EM250' can automatically send us an email requesting a licence. You will also receive a copy of the email. If you chose not to send an email, the contents of the message will be copied to the clipboard so you can paste it into your email program. Would you like to send the email now?

Yes, send the email now

No, I will send the email manually

- Locate the Ember Software Serial Number card supplied with your kit (see. You will need to include the 20-digit serial number with your license request.

Figure 16. Software Serial Number Card



After you email your license request, Silicon Labs will send you a license file within two business days. If you have questions, contact Customer Support at www.silabs.com/zigbee-support.

5. When you receive the reply email with a license file, save it to this location on your computer:

Program Files/Ember/xIDE_EM250_x.x/license

6

Setting Up an InSight Network

With the Development Kit, you typically set up an InSight network that you use while developing and debugging applications. All nodes in this InSight network are connected to the Ethernet via their InSight Adapters. An Ethernet-connected workstation that is running InSight Desktop uses the InSight Adapters to monitor network node data and manage node behavior.

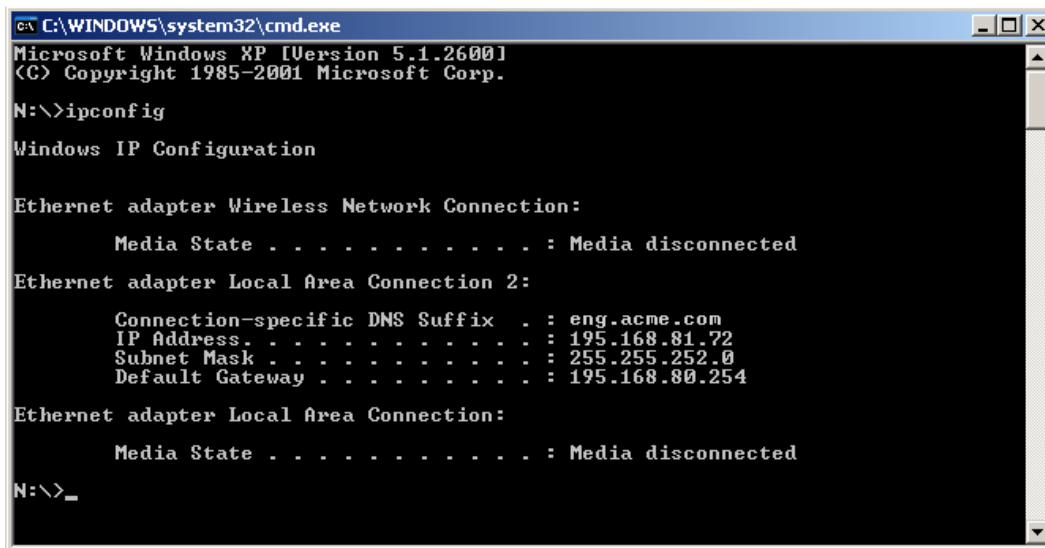
Two types of Ethernet networks can be used: static IP or DHCP

Setting Up a Standalone InSight Network

To set up an InSight network using static IP:

1. Install InSight Desktop on a computer that is connected to your network.
2. Open a command window and type `ipconfig` (Figure 17). Make note of the IP, subnet and gateway addresses for your computer.

Figure 17. Determining IP Address of PC



```
ca C:\WINDOWS\system32\cmd.exe
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.
N:\>ipconfig

Windows IP Configuration

Ethernet adapter Wireless Network Connection:

    Media State . . . . . : Media disconnected

Ethernet adapter Local Area Connection 2:

    Connection-specific DNS Suffix . : eng.acme.com
    IP Address. . . . . : 195.168.81.72
    Subnet Mask . . . . . : 255.255.252.0
    Default Gateway . . . . . : 195.168.80.254

Ethernet adapter Local Area Connection:

    Media State . . . . . : Media disconnected

N:\>_
```

3. Connect all InSight Adapters to the Ethernet.
4. Power up the ISA and the nodes (see “Powering the Breakout Board”).
5. Check the configuration of the ISA and change it to static IP using the same Subnet Mask and Gateway address determined in Step 2. This procedure is detailed in Configuring Your ISA for DHCP or Static IP.

6. Repeat Steps 4 & 5 for each ISA.
7. **(Optional)** In order to establish a serial port connection to a node so that you can interact with the node's application:
 - Telnet to the ISA administrative port 4902
 - Issue the InSight Adapter command `port 1` to check the settings for UART1
 - Configure the InSight Adapter serial port settings to match the application settings. For example: `port 1 115200 8-n-1`
 - Quit the Telnet session
 - Then, Telnet to serial port 4901 (UART1)

For detailed information, see “Configuring the Serial Communication Path.”
8. Distribute nodes in the test environment, following the guidelines in “Positioning Network Nodes.”

Setting Up on a DHCP Network

To set up an InSight network using a DHCP Ethernet network:

1. Install InSight Desktop on a computer that is connected to your network.
2. Connect all InSight Adapters to the Ethernet.
3. Power up the nodes (see “Powering the Breakout Board”).
4. Check the configuration of the ISA and turn on DHCP if necessary. This procedure is detailed in Configuring Your ISA for DHCP or Static IP.
5. Repeat Steps 3 and 4 for each ISA.
6. **(Optional)** In order to establish a serial port connection to a node:
 - Telnet to the ISA administrative port 4902
 - Issue the InSight Adapter command `port 1` to check the settings for UART1
 - Configure the InSight Adapter serial port settings to match the application settings. For example: `port 1 115200 8-n-1`
 - Quit the Telnet session
 - Then, Telnet to serial port 4901 (UART1)

For detailed information, see “Configuring the Serial Communication Path.”
7. Distribute nodes in the test environment, following the guidelines in “Positioning Network Nodes.”

Configuring Your ISA for DHCP or Static IP

The InSight Adapter can be configured to connect to a network using a DHCP server or a static IP address to determine its IP address. The default is DHCP. For more information, see Chapter 7, “Using the InSight Adapter.”

Positioning Network Nodes

You can position radio communication modules in any spatial orientation (for example, horizontally, vertically, or upside-down), but for optimal performance all should be positioned with their antennas in the same orientation. Observe the operating temperature limits described in the technical specification for the radio communication module in your Development Kit.

In general, objects near modules do not significantly affect radio transmission. Very large solid objects, such as walls and metal objects, can diminish the radio range of modules positioned within a few inches of them. Placing a module within a metal box can completely isolate the module from the

network. Repositioning the module 20 to 30 cm from any obstructions will usually restore full range. You can also reconfigure the network to work around a radio obstacle.

Other IEEE 802.15.4 networks may compete for available bandwidth. Changing channels usually takes care of any conflicts.

7

Using the InSight Adapter

The Development Kit InSight Adapter provides an Ethernet connection to networked radio communication modules and to development tools on the breakout board—for example, programmable buttons. You can use the InSight Adapter to perform the following tasks:

- Debug hardware.
- Monitor application or debugging data over radio communication module serial ports.
- Monitor radio data packets.

For detailed information on InSight Adapter commands, see “InSight Adapter Commands.”

InSight Adapter Default Configuration

InSight Adapters are shipped in the following state:

- DHCP mode with pre-assigned hostnames:
 - `ember00 ...ember07` (EM250 Development Kit)
 - `ember00 ... ember02` (JumpStart Edition for the EM250)
- Serial port settings of 115200 baud and 8-n-1

You can reconfigure the modules to use static mode (see “Configuring Your ISA for DHCP or Static IP”).

Connecting to an InSight Adapter Port

You can telnet via Ethernet into the InSight Adapter ports listed in InSight Adapter Ports, using either the hostname or the IP address of the InSight Adapter (your network must be configured appropriately).

Caution: The administrative port (4902) is also available from the standard telnet port (23).

Table 5. InSight Adapter Ports

Port	Definition	Use
4900	Radio communication module virtual serial port.	Monitor output for application development or serial port debugging. These ports also let users simulate external input.
4901	Radio communication module serial port 1, accessible only via a connection to the InSight data emulation interface.	
4902	Administrative	InSight Adapter command line interface
4903	InSight Adapter reset	InSight Adapter reset
4911	Radio communication module serial port 1	Monitors input for application development or serial port debugging.

Monitoring Radio Communication Module Data

You can monitor or simulate real-time traffic between a radio communication module and external devices via either of the module's serial ports. You can drive these serial ports from Ethernet ports 4900 or 4901, from the breakout board serial ports, or from the TTL header. To do this, you must configure port settings for the breakout board serial ports to match those being used by the application running on the radio communication module.

Note: Port 4901 is only accessible over an InSight data emulation interface connection.

To configure a breakout board serial port for radio communication module monitoring:

Issue the InSight Adapter command `port` and specify the port settings that are used by the application running on the radio communication module. For example, if your application uses breakout board serial port 1 and settings 115200 8-n-1, issue this command:

```
port 1 115200 8-n-1
```

Setting Up Serial Communication with InSight Adapter

To issue commands to the InSight Adapter through a USB port:

1. Connect a USB cable from your workstation to the InSight Adapter's USB connector.
2. From your workstation, run a standard terminal emulator (for example, Hyperterm, TeraTerm, PUTTY) to connect to the InSight Adapter (the InSight Adapter appears as a COM port).
3. Configure your terminal emulator with these settings:
 - 115200 (baud)
 - 8 (data bits)
 - n (no parity)
 - 1 (stop bit)
 - Flow Control = None

Resetting an InSight Adapter port

If an Ethernet port become inaccessible, issue the `port_reset` command on the InSight Adapter administrative port 4902.

Resetting the InSight Adapter

If you cannot connect to port 4902, the InSight Adapter administrative port, or if the `port_reset` command does not work, you can force a reset in one of the following ways:

- Connect to the InSight Adapter administrative socket (port 4902), then issue the `reboot` command.
- Press the InSight Adapter's red RESET button in front.
- If the first two methods fail, power cycle the breakout board by disconnecting the external power supply or the PoE cable.

Terminating a Connection to the Administrative port

To terminate a connection to the administrative port, issue the `quit` command.

Configuring the InSight Adapter

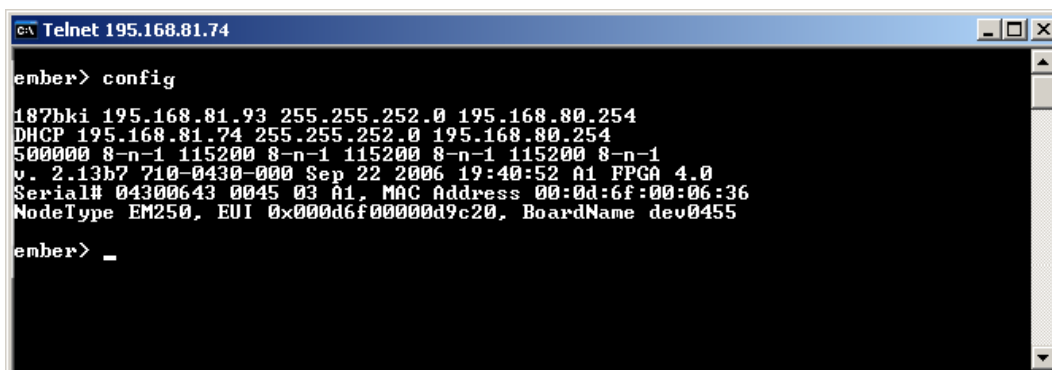
You can configure the InSight Adapter in several ways:

- Change from DHCP to static IP address mode (see Chapter 5).
- Change the host name
- Configure serial port settings

You can also view current configuration settings by issuing the `config` command via telnet to the InSight Adapter administrative port 4902. This command returns all non-volatile configuration information for the InSight Adapter:

- hostname
- serial port information
- static IP settings
- date and time of the last compile of the module's software
- whether DHCP is in effect

Figure 18. ISA Configuration via Telnet



```

c:\ Telnet 195.168.81.74
ember> config
187bki 195.168.81.93 255.255.252.0 195.168.80.254
DHCP 195.168.81.74 255.255.252.0 195.168.80.254
500000 8-n-1 115200 8-n-1 115200 8-n-1 115200 8-n-1
v. 2.13b7 710-0430-000 Sep 22 2006 19:40:52 A1 FPGA 4.0
Serial# 04300643 0045 03 A1, MAC Address 00:0d:6f:00:06:36
NodeType EM250, EUI 0x000d6f0000d9c20, BoardName dev0455
ember> _

```

If DHCP mode is in effect, the command also outputs its current dynamic IP settings.

To determine the version of the InSight Adapter firmware, issue the `version` command on the InSight Adapter administrative port (4902).

Changing to static IP address mode

InSight Adapter is preconfigured for DHCP. You can change this configuration to implement static IP address mode. To do this, you must put breakout board serial port 1 into administrative mode and issue two InSight Adapter commands.

To configure the Ethernet connection for static mode:

1. Connect a USB cable from your workstation to the InSight Adapter's USB connector.
2. From your workstation, run a standard terminal emulation program like Hyperterminal to connect to the InSight Adapter (the InSight Adapter appears as a COM port).
3. Configure your terminal emulator with these settings:
 - 115200 (baud)
 - 8 (data bits)
 - n (no parity)
 - 1 (stop bit)
 - Flow Control = None
4. Issue the following InSight Adapter commands through the terminal emulator:


```
ip_static <ipaddress> <netmask> <gateway> ip_dhcp off
```
5. Reboot the ISA by entering the command `reboot` or by pressing the red RESET button on the front of the InSight Adapter.

Changing the hostname

If you purchase two Development Kits, you might need to change the hostnames assigned to the InSight Adapters in one of the kits in order to avoid network conflicts. You can change a hostname by issuing the `hostname` command to the InSight Adapter in two ways:

- Telnet into port 4902 (Connecting to an InSight Adapter Port).
- Connect breakout board serial interface DB-9A to the InSight Adapter administrative port and issue the command over a serial connection.

To change the hostname via an InSight Adapter USB connection:

1. Connect a USB cable from your workstation to the InSight Adapter's USB connector.
2. From your workstation, run a standard terminal emulation program to connect to the InSight Adapter (the InSight Adapter appears as a COM port).
3. Configure your terminal emulator with these settings:
 - 115200 (baud)
 - 8 (data bits)
 - n (no parity)
 - 1 (stop bit)
 - Flow Control = None
4. Issue the InSight Adapter command `hostname` through the terminal emulator, giving it the new hostname. For example:


```
hostname set <new-hostname>
```
5. To verify the new host name, issue the InSight Adapter command `config`, which returns with the new hostname.

Configuring serial port settings

To change the breakout board serial port settings, connect to the InSight Adapter administrative port (4902) and issue the `port` command. For example, the following command configures breakout board serial port 1 for 19200 baud rate, 8 bits, no parity, 1 stop bit:

```
port 1 19200 8-n-1
```

Getting Help on Insight Adapter commands

To view a description of an InSight Adapter command, issue the `help` command followed by a command name—for example, `help port`.

Uploading Software to the InSight Adapter

Periodically, Silicon Labs provides software upgrades for the InSight Adapter. You can upload these upgrades using InSight Desktop. To do this, right click on the adapter in the Adapter View window and select **Upload Adapter Firmware**.

8

InSight Adapter Commands

Syntax Conventions

Element	Meaning	Example
Literal	A syntax element—command or argument—that is entered exactly as shown.	<code>ip_dhcp {on off}</code>
Variable	A variable name.	<code>help [command-name]</code>
{ }	Delimits a set of one or more mandatory arguments	<code>{a}</code> <code>{a b}</code>
[]	Delimits a set of one or more optional arguments	<code>[0 1]</code> <code>[rate]</code>
	Delimits options within a list, where only one can be chosen.	<code>{a b c}</code> <code>[red blue green yellow]</code>

Entering Commands

- Commands are not case sensitive.
- Arguments are separated with a single white space.
- To move the cursor on the command line, press the arrow-left or arrow-right key.
- Press CTRL-D to delete all characters to the right of the cursor.
- Press BACKSPACE to delete one character to the left of the cursor.

Note: The interface times out after 10 minutes of inactivity.

Connecting to the InSight Adapter Administrative Port

To connect to the InSight Adapter administrative port, do one of the following:

1. Telnet into port 4902 over the Ethernet.
2. Put the breakout board into administrative mode and connect to its serial port 1 using a serial communication program configured to settings 115200 8-n-1.

To put the breakout board into administrative mode:

1. Unplug the Ethernet cable.
2. Press the breakout board reset button.
3. Connect a serial cable to breakout board serial port 1.

Insight Adapter Commands

- button
- config
- help
- hostname
- ip_dhcp
- ip_static
- port
- port_reset
- power
- quit
- reset
- upload_backchannel
- version

button

```
button {0|1} {on|off}
```

Description

Sets the specified breakout board button to a state of on or off.

You can issue this command only over an InSight data emulation interface connection.

Warning: In order to use the InSight data emulation interface, you must power the radio communication module from an InSight Adapter that is powered by its Ethernet connection, or from the development kit's 12V DC power supply. Powering the radio communication module from the battery pack when the InSight data emulation interface is in use can damage the InSight Adapter.

Arguments

0, 1	Button number, where 0 maps to breakout board button EM1, and 1 maps to EM2.
on, off	The button setting

Example

```
button 1 on
```

config

```
config
```

Description

Outputs all non-volatile configuration information for the InSight Adapter:

- hostname
- static IP settings
- whether DHCP mode is in effect
- serial port information

- date and time of the last compile of the module's software (needed to determine the software version).

If DHCP mode is in effect, the command also outputs its current dynamic IP settings.

You can also view configuration information via InSight Desktop (see document 120-4036-000, the *InSight Desktop User's Guide*).

Arguments

None.

gpio

```
gpio
```

```
gpio {read | monitor}
```

```
gpio {config | set} 0xNNNN
```

Description

Allows reading and writing of GPIO pin states to the attached EM250 or ATmega host MCU. (Only applies to pins configured as GPIO, with no alternate functions.)

If issued with no arguments, reports on config, set, and read. Bits 19:17, 10:9, and 5:4 are 0.

Parameter 0xNNNNN corresponds to a bitmask, specified in big-endian notation, indicating GPIO bits 16-0.

Arguments

set	Report or configure output level high (1) or low (0). Bits 19:17, 10:9, and 5:4 are ignored.
monitor	Report on input changes sampled at 0.1 seconds till key press. Bits 19:17, 10:9, and 5:4 are 0.
read	Report on input. Bits 19:17, 10:9, and 5:4 are 0.
config	Same as <i>set</i>

help

```
help [ command-name ]
```

Description

Provides help on InSight Adapter commands as follows:

- If issued with no arguments, outputs a list of all InSight Adapter commands.
- If issued with a valid command name, outputs a description of that command.

Arguments

The name of any InSight Adapter command.

Example

```
help port
```

hostname

```
hostname set hostname
hostname read
```

Description

Valid only for DHCP mode, use this command to set or obtain the host name of the InSight Adapter. The module tries to set this hostname when it connects to the Ethernet. The host name that you set is used only after you reboot the module.

You can also view the hostname via InSight Desktop (see the *InSight Desktop User's Guide*).

Arguments

<code>set</code>	Specifies that the command identify a host name
<code>hostname</code>	Character hostname, may include up to 20 alphanumeric characters
<code>read</code>	Specifies that the command outputs a hostname

Example

```
hostname set myhost1
```

ip_dhcp

```
ip_dhcp {on|off}
```

Arguments

<code>on</code>	Specifies to use DHCP.
<code>off</code>	Specifies not to use DHCP.

Description

Configures the InSight Adapter to use DHCP. This command is a prerequisite for using the hostname command.

For the command to take effect, you must reboot the InSight Adapter.

You can power cycle a module via InSight Desktop (see the *InSight Desktop User's Guide*).

Example

```
ip_dhcp on
```

ip_static

```
ip_static ipaddress netmask gateway
```

Description

Configures the InSight Adapter statically. This command takes effect only after you reboot the InSight Adapter.

Arguments

<i>ipaddress</i>	IP address of the breakout board
<i>netmask</i>	Netmask for current network
<i>gateway</i>	Gateway for your network configuration

Example

```
ip_static 192.168.168.126 255.255.255.0 192.168.168.1
```

port

```
port {0|1} [ baud-rate [ #bits-parity-stopbits ] ]
```

Description

Configures serial ports on a breakout board. If you supply only the serial port number, the port command returns with that port's current configuration.

Configures serial port settings for the breakout board. You can configure just the rate or the rate plus the data settings, but you cannot configure the data settings alone.

Arguments

0, 1	The emulator/debug module's serial port number
<i>baud-rate</i>	The baud rate for this port.
<i>#bits</i>	Number of data bits per character
<i>-parity</i>	Parity with one of the following characters: <ul style="list-style-type: none"> ▪ N (none) ▪ O (odd) ▪ P (even)
<i>-stopbits</i>	Stop bits with an integer of 1 or 2.

Examples

To configure serial port 1 for a baud rate of 115200, 8 bits, no parity, 1 stop bit:

```
port 1 115200 8-n-1
```

To configure serial port 1 for a baud rate of 57600:

```
port 1 57600
```

To obtain the current configuration information for serial port 1:

```
port 1
```

port_reset

```
port_reset {4900|4901|4911}
```

Description

Forces a port on the InSight Adapter to close. Use this command when port 4900, 4901, or 4911 becomes inaccessible because the port closed incorrectly. (For port definitions, see Table 5.)

Note: Port 4901 is only accessible over an InSight data emulation interface connection.

Arguments

4900	Serial port 0
4901	Serial port 1
4911	Serial port sniff

power

```
power {on|off|read}
```

Description

Controls the power supplied to a radio communication module.

You can also power cycle a module via InSight Desktop (see the *InSight Desktop User's Guide*).

Arguments

on	Powers the module on
off	Powers the module off
read	Outputs the status of radio communication module (on or off)

Examples

```
power on
```

```
power read
```

quit

```
quit
```

Description

Terminates a connection to the administrative port.

Note: This command has no effect on serial port connections to the admin port.

Arguments

None.

reset

```
reset
```

Description

Resets a radio communication module by pulling down its reset line for a millisecond.

You can also reset a module via InSight Desktop (see the *InSight Desktop User's Guide*).

Arguments

None.

upload_backchannel

`upload_backchannel`

Description

Puts the InSight Adapter into FTP server mode to enable software uploads.

Arguments

None.

version

`version`

Description

Outputs the software version number of the InSight Adapter software.

You can also view the version number via InSight Desktop (see the *InSight Desktop User's Guide*).

Arguments

None.