

Start-up commissioning and binding using Ember's EM250 and the Daintree Networks Sensor Network Analyzer

Application Note AN022



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Sensor Network Analyzer Release 2.3 (2009-06-03)

About commissioning

Commissioning is the physical deployment, addressing, and logical binding of nodes to form a functional network. You commission all types of networks including those used for testing and field trials, and live deployed networks.

In its broadest sense, commissioning encompasses a wide range of tasks, including a survey of the radio and physical environment, the placement of devices, configuration of parameters, application binding, optimization of network and device parameters, and testing and verification of correct operation.

Often, non- and semi-technical issues need to be considered, including the skills and workflow practices of the installer, ease and identification and accessibility of devices, and interoperability and coexistence with other wireless or wired systems.

While consideration for commissioning is often focused on the installer, the ability to easily configure and commission ZigBee systems during development and testing, as well as field trials, can also significantly speed up the development and product delivery to market.

This application note provides instructions of how to perform start-up commissioning of the Ember EM250 SoC using Daintree's Sensor Network Analyzer.

About Daintree's Sensor Network Analyzer (SNA)

The SNA combines a powerful protocol analyzer with network visualization, measurements and diagnostics for IEEE 802.15.4™ and ZigBee® applications. It provides automatic display of network formation, topology changes, and router and coordinator state changes allowing rapid detection of incorrect network behavior and identification of device or network failures.

It also provides a powerful commissioning tool that helps to hide the complexity of the underlying technology, and provides straight-forward configuration, testing and troubleshooting capabilities. Its graphical representations makes it fast and easy for installers to monitor network formation and measure key parameters such as link quality and bindings.

Visit www.daintree.net to find out more about Daintree's SNA.

About Ember's EM250 SoC

The EM250 from Ember is a true ZigBee system-on-chip, combining a 16-bit microprocessor, Flash, RAM, a 2.4GHz 802.15.4 radio, and numerous debugging and development features. Application development is supported by a C-language development environment that includes the EmberZNet stack.

Visit the Ember web site at www.ember.com/products_zigbee_chips_e250.html to find out more.

How does start-up commissioning work?

This is the initial configuration of a device that tells it which network to join and the way in which it should join that network. It typically consists of the following steps:

1. If required, load the required firmware to all devices.
2. Use the SNA to start a Commissioning Network with an active device such as Daintree's 2400E or Ember's EM250 breakout board (together with the EM250 RCM) as the network coordinator.
3. Turn on the remaining devices, and then commission each device by setting all parameters required to start, and then join, the new live network.
4. Use the SNA to monitor the new live network.
5. This application note also describes how to add bindings as required.

Loading firmware to devices

Daintree provides sample firmware files specifically for use with Ember's EM250. You can find full details in the [SNA Firmware Appendix](#) of this application note.

This firmware was compiled using xIDE_EM250_1.4b2 and requires revision 2.3b2 of em2xx_load.exe. (See your Ember documentation to find out more if required.)

1. From the Windows **Start** menu, select **Run**.
2. Type **cmd** and then click **OK** to open a command window.
3. Enter the following commands in the command window to check whether your version of em2xx_load.exe is compatible with the Daintree firmware:
 - o **cd \Program Files\Ember\xIDE_EM250\SIF\bin** to select the required directory.
 - o **em2xx_load.exe** to display your current version of this file (the firmware requires revision 2.3 Build 2). Refer to your Ember documentation to find out how to access other versions of em2xx_load.exe if required.
4. Create a sub-directory in the bin directory in which to copy the firmware files.
5. Run the following commands to download the firmware:
 - o **em2xx_load.exe -Run <newdir>\EM250-ZBv2sp2-RC-HA-OnOff[Light|Switch]-20080613r2.hex -sid "IP address/Host name"**

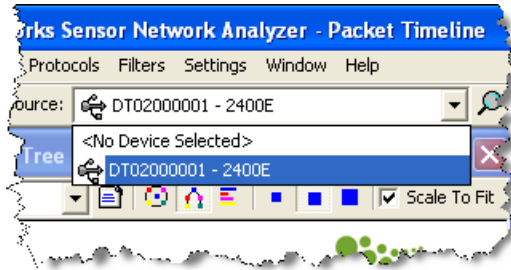
The following notes apply to these firmware files:


- After loading "coordinator-capable" firmware to a device, you first need to commission it before it will behave as a coordinator. Prior to commissioning, it will behave as a router and attempt to join an existing network.
- The Light and Switch firmware have been designed to join a network with an Extended Pan ID (EPID) of 00:50:c2:77:10:00:00:00. Therefore, you must configure your intended coordinator to use this EPID.

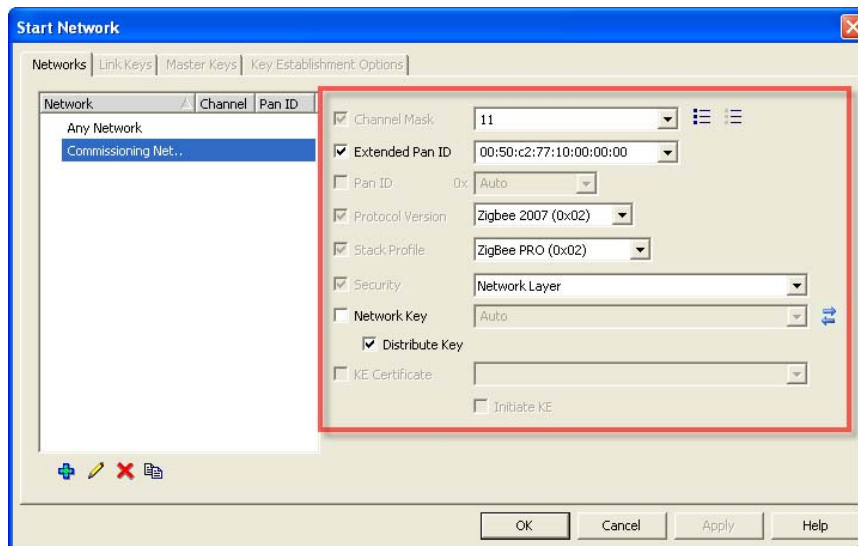
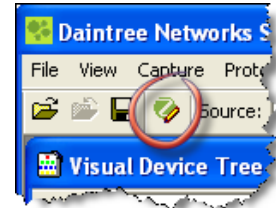
Starting a commissioning network

The following example uses Daintree's 2400E Sensor Network Adapter as the network coordinator. You can also use Ember's EM250 breakout board (together with the EM250 RCM) in its place.

1. Start the SNA application and connect the 2400E Sensor Network Adapter to your computer via USB.
2. Select the 2400E from the **Source** list.



3. From the **Settings** menu, select **Device Manager**, or click the Device Manager icon from the main SNA toolbar. This opens the Device Manager dialog box.
4. On the Device Manager dialog box, click the **Commission** tab. Then click your active device (to select it) and click  to start a new network.
5. On the Start Network dialog box **Start Network** tab, click **Commissioning Network** to select it. Then enter the settings for this network, which must include the following if you are using the Daintree-Ember firmware:
 - o **EPID** of 00:50:c2:77:10:00:00:00
 - o **Protocol Version** of Zigbee 2007 (0x02)
 - o **Stack Profile** of Zigbee PRO (0x02)
 - o **Security Level** of Network Layer



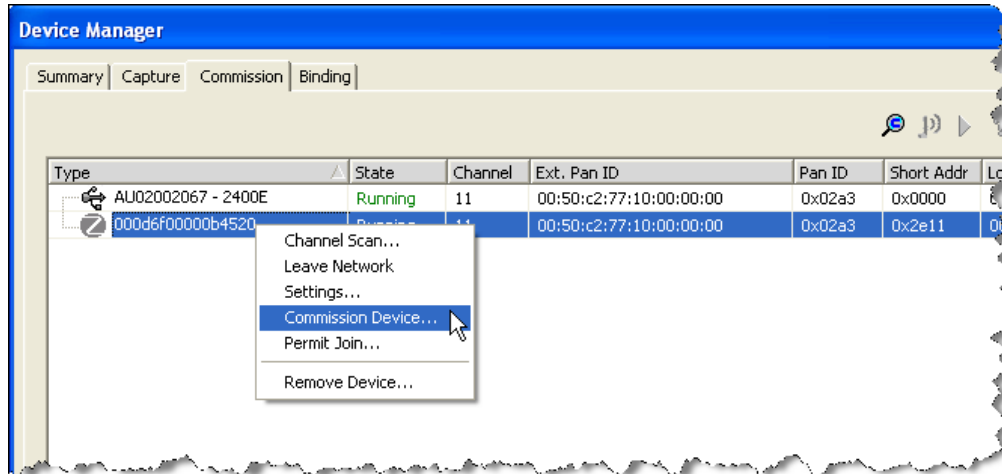
6. Click **OK** to start the network using the specified settings.


Commissioning devices

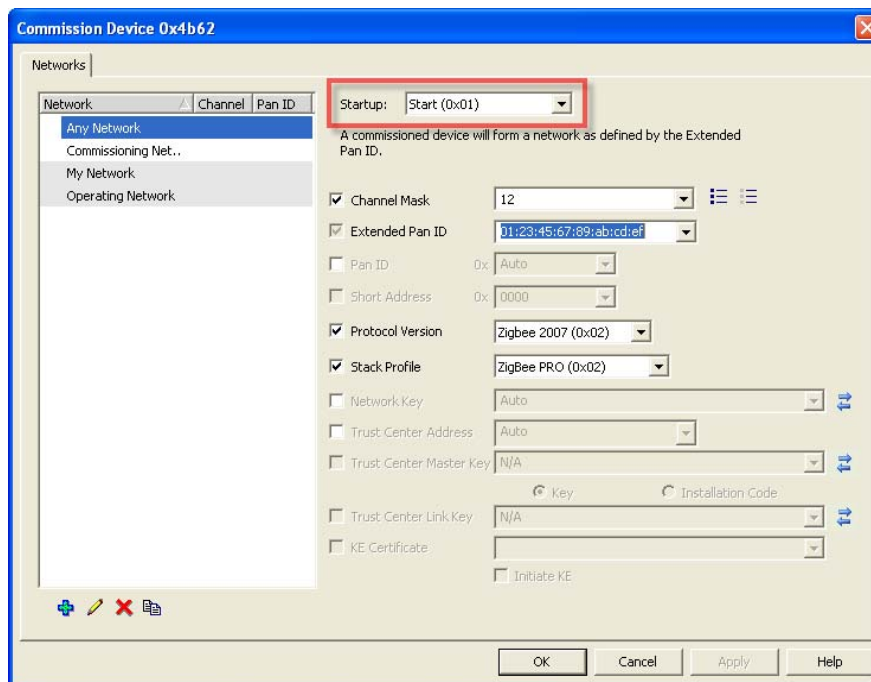
1. Turn on the remaining devices.

As each device joins your commissioning network, you will see it appear on both the Visual Device Tree window and the Commission tab of the Device Manager dialog box.

2. On the Device Manager > Commission tab, right-click the device that will act as the coordinator in your new network, and then select **Commission Device**.



3. On the Commission Device dialog box, click  and enter a name under which to save the settings for the new "live" network (called Operating Network in the example below). Then enter the settings for the new coordinator:
 - o **Startup** must be **Start (0x01)** to start the new network with the device as coordinator.
 - o **Extended Pan ID** should be unique to ensure that subsequent devices join this new network correctly.



4. Click **OK** to save the settings.

This causes the device to leave the Commissioning Network, and go off to start the new Operating Network as coordinator. When that is complete, the device will disappear from the Visual Device Tree and Device Manager for the Commissioning Network.

5. Commission each remaining device as described in steps 2 through 4, with the following exceptions:
 - o Select **Operating Network** from the list of available networks as a fast way to commission all devices with the same parameters.
 - o **Startup** should be set to **Join**, which causes the device to join a network using the specified channel and EPID.

Monitoring the new operating network

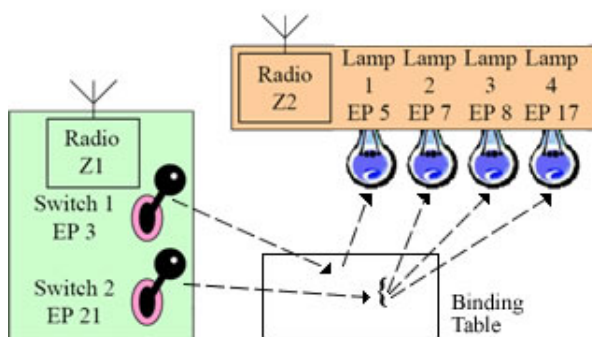
After all devices are commissioned to leave the Commissioning Network and join the new Operating Network, the Visual Device Tree and Device Manager will show only the 2400E Adapter.

1. On the Device Manager > Commission tab, right-click the 2400E, and then select **Leave Network** to leave the Commissioning Network.
2. On the Device Manager > Commission tab, right-click the 2400E, and then select **Join Network**.
3. On the Join Network dialog box, select **Operating Network** (or whatever name you assigned to your network) from the list of available networks.

When the Join is successful, the SNA will update all windows to show details for the new Operating Network.



Adding bindings

Bindings are connections between end devices in a ZigBee network, such as a connection between a light switch and the light that it operates. Each binding supports a specific Application Profile, and each message type is represented by a Cluster (within that profile).

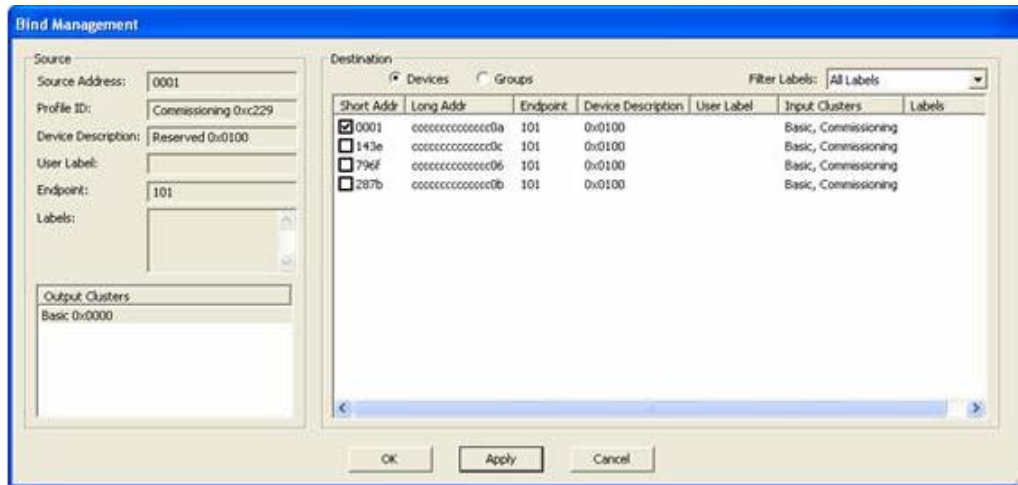


You can create bindings between endpoints that use the same Application Profile and that have associated Output/Input Clusters (for example, one with an On/off Output Cluster, and another one with an On/off Input Cluster).

Start-up commissioning using Ember's EM250 and Daintree's SNA

1. On the Device Manager dialog box, click the **Binding** tab. Then click  to perform a service discovery, during which the SNA will find and display details about each device's application profile and output/input clusters.
2. Select the endpoint for which you want to create a binding, and then click  to open the Bind Management dialog box.
3. On the Bind Management dialog box, select the Output Cluster for which you want to create the bindings. (If the device contains only one Cluster, it is automatically selected for you.)

The SNA lists all of the available endpoints that match the selected Application Profile and Output Cluster.



4. To **add** a new binding, click the box next to its Short Address. You can also **remove** an existing binding, by clearing the box next to its Short Address.
5. Click **OK** to save the bindings and display their details on the Device Manager > Binding tab and also in the Visual Device Tree window.



100	On/Off Switch	HA 0x0104	On/off
0x143e:100	0xcccccccccccc0b		On/off

Appendix: SNA firmware

The SNA provides a number of firmware files that can be used with Ember's EM250 for home automation.

- **Home Automation Light used for flashing from the "em2xx_load.exe" utility:**
 - EM250-ZBv2sp2-RC-HA-OnOffLight-20080613r2.hex (Coordinator-capable Router)
- **Home Automation Switch (with source bindings included) used for flashing from the "em2xx_load.exe" utility:**
 - EM250-ZBv2sp2-RC-HA-OnOffSwitch-20080612r2.hex (Coordinator-capable Router)

Note: The firmware was compiled with **xIDE for EM250, version 1.6.0, build 3** and the em2xx_load.exe file is rev 2.3 Build 2.

Home Automation Light used for flashing from the "em2xx_load.exe" utility

Firmware for Home Automation Light used for flashing from the "em2xx_load.exe" utility. The following firmware file is provided:

- EM250-ZBv2sp2-RC-HA-OnOffLight-20080613r2.hex (coordinator-capable routers)

The table below shows the features and settings for this file.

Home Automation Light	<ul style="list-style-type: none"> • Security = Enabled 'Application Layer(Pre-Shared Link Keys)' • In Clusters <ul style="list-style-type: none"> # Groups # ON/OFF • Hardware = EM250RCM connected to the EM250 Breakout board • Functionality: LED DS1 is turned on and off.
Commissioning	<ul style="list-style-type: none"> • Extended PAN id = 0050c27710000000 • Channels = 0x07FFF800 // all channel <ul style="list-style-type: none"> # Preferred Channels = 11, 14, 15, 19, 20, 24, 25 • In Clusters <ul style="list-style-type: none"> # Commissioning • Functionality: A high-pitched beep indicates the network has been successfully joined, while a low-pitched beep indicates failure. Reset to default settings is done by pressing Button 0, and then the EM250 reset button. When forming a new network, or scanning to join a network, the devices scans the channels using the Preferred Channels before scanning the rest of the channels in order to avoid the most commonly used WiFi channels and to improve the user experience during installation.
ZCL ON/OFF	<ul style="list-style-type: none"> • ON • OFF • TOGGLE
ZCL Groups (Future revision)	<ul style="list-style-type: none"> • Add • View • Get Membership • Remove • Remove All • Add If Identifying
ZDO Optional features	<ul style="list-style-type: none"> • NWK_addr_req • Mgmt_Lqi_rsp • Mgmt_Leave_rsp • Mgmt_Permit_Joining_rsp

Home Automation Switch (with source bindings included) used for flashing from the "em2xx_load.exe" utility

Firmware for Home Automation Switch (with source bindings Included) used for flashing from the "em2xx_load.exe" utility. The following firmware file is provided:

- EM250-ZBv2sp2-RC-HA-OnOffSwitch-20080612r2.hex (coordinator-capable routers)

The table below shows the features and settings for this file.

Home Automation Switch	<ul style="list-style-type: none"> • Security = Enabled 'Application Layer(Pre-Shared Link Keys)' • Out Cluster # ON/OFF • Hardware = EM250RCM connected to the EM250 Breakout board • Source binding • Functionality: When pressing Button 1, unicast toggle HA messages are sent over the air. When pressing Button 1 and Button 2 simultaneously, group toggle HA messages are sent over the air.
Commissioning	<ul style="list-style-type: none"> • Extended PAN id = 0050c27710000000 • Channels = 0x07FFF800 // all channel # Preferred Channels = 11, 14, 15, 19, 20, 24, 25 • In Clusters # Commissioning • Functionality: A high-pitched beep indicates the network has been successfully joined, while a low-pitched beep indicates failure. Reset to default settings is done by pressing the EM250 reset button, and then Button 0. When forming a new network, or scanning to join a network, the devices scans the channels using the Preferred Channels before scanning the rest of the channels in order to avoid the most commonly used WiFi channels and to improve the user experience during installation.
ZCL ON/OFF	<ul style="list-style-type: none"> • ON • OFF • TOGGLE
ZDO Optional features	<ul style="list-style-type: none"> • Bind_req • Bind_rsp • Unbind_req • Unbind_rsp • NWK_addr_req • IEEE_addr_req • Mgmt_Bind_req • Mgmt_Lqi_rsp • Mgmt_Leave_rsp • Mgmt_Permit_Joining_rsp