Freescale Semiconductor
Application Note

Document Number: AN2825
Rev. 1.1, 02/2006

Handling MAC Address Erasure

Solutions for Avoiding Erasure and for Restoration of MAC Address and Functional Values

1 Introduction

This application note provides recommendations on how to avoid erasing the MAC address and other functional values. This note also provides some recommendations on how to restore the MAC address and functional values should they be erased when a user builds and uploads an application with a Background Debug Module (BDM).

All devices that comply with the IEEE® 802.15.4 standard must have a unique MAC address that individually identifies the device. The MAC address located in the Non-Volatile Memory (NVM) is an integral part of an application with an IEEE 802.15.4 MAC/PHY layer.

The NVM data section is delivered in source files to allow customers to add their own application specific values. The NVM data must be included in the application because the Physical (PHY) layer uses values from the NVM section. Any application built on top of the 802.15.4 MAC/PHY can add its own data to the NVM data structure. The MC908HCS08GB60/GT60 MCU NVM data structure has a maximum size of 512 bytes.

Contents

2 NVM Data Sections

The NVM data is divided into six sections:

1. Application Software Component Information — Contains the version numbers and build dates for different parts of the application. (Keeps track of the different versions.)
2. Application Configuration Values — Holds crucial HCS08 setup values for the MC1319x CLKO output, ICG module register values, self clock mode filter values, and UART baud rate values.
3. Production Data - MAC Address and Functional Values — Contains the unique 64 bit IEEE MAC address, Antenna Select, Sleep Mode, hardware name, serial number, and production information.

NOTE

> The MAC Address and Functional Values as shown in Figure 2 contain vital information used by the code.
>
> The Production Specific Information as shown in Figure 2, is used only by the Test Tool as non-vital tracking information and is not used by any embedded applications.

4. Production Data, RF Chip Parameters — Keeps Crystal trim, bias Setting, and Channel PA's.
5. Application Specific Section — Store application specific NVM data.
6. Flash System Flag — Holds a flash module system flag.

The MAC address and functional values contained in the MAC Address and Functional Values Section, are combined with the Production Specific Information Section and all of these are written into the NVM data section when the evaluation boards are produced. The current valid evaluation boards are:

- 13192-EVB (DIG528)
- 13192-SARD (DIG536)
- AXM0308C
- 13213-NCB
- 13213-SRB

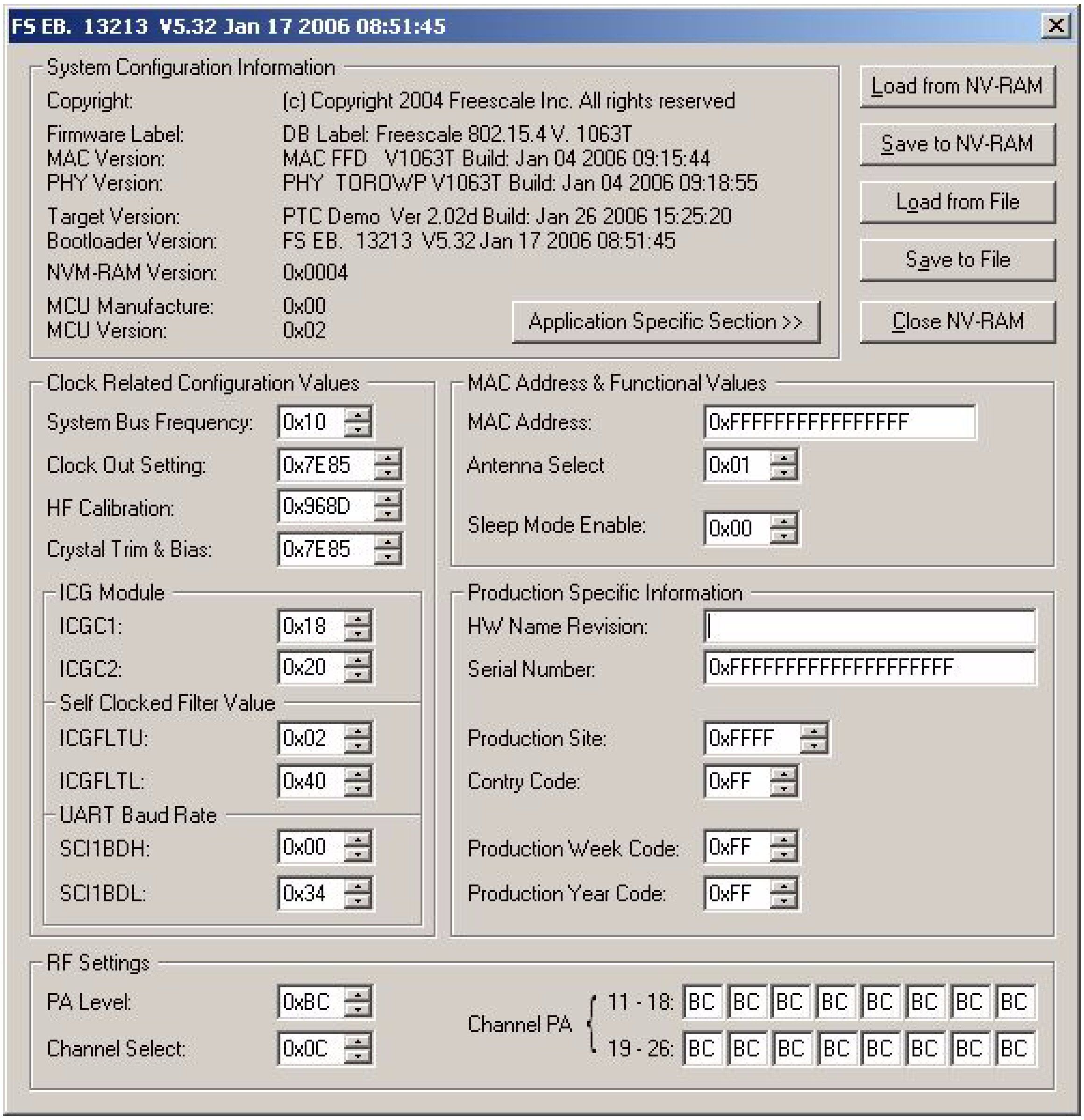
The evaluation boards are produced with the Freescale Embedded Bootloader pre-programmed into them to allow users to evaluate different demonstration applications. However, some of the demonstration applications are delivered as source files in a CodeWarrior MCP-project. The MCP projects use the Freescale BDM flash programmer to upload a new application built under the Integrated Development Environment (IDE).

When users build and upload an application with a Background Debug Module (BDM), such as the P&E BDM Multilink Debugger for HCS08 using the default CodeWarrior CPROG (HiWave) flash programmer from P&E, the flash is completely erased, and with it, the NVM and Embedded Bootloader sections. This means that the Production Specific Section, the MAC Address Section and Functional Values and the Embedded Bootloader sections are erased.

NOTE

> At production, the MAC address is printed on a label located on the back side of the boards.

Figure 1 shows the Embedded Bootloader window with the MAC Address and Functional Values and Production Specific Information erased. Figure 2 shows this same information restored.



FS EB. 13213 V5.32 Jan 17 2006 08:51:45

System Configuration Information

Copyright:	(c) Copyright 2004 Freescale Inc. All rights reserved
Firmware Label:	DB Label: Freescale 802.15.4 V. 1063T
MAC Version:	MAC FFD V1063T Build: Jan 04 2006 09:15:44
PHY Version:	PHY TOROWP V1063T Build: Jan 04 2006 09:18:55
Target Version:	PTC Demo Ver 2.02d Build: Jan 26 2006 15:25:20
Bootloader Version:	FS EB. 13213 V5.32 Jan 17 2006 08:51:45
NVM-RAM Version:	0x0004
MCU Manufacture:	0x00
MCU Version:	0x02

Clock Related Configuration Values

System Bus Frequency:	0x10
Clock Out Setting:	0x7E85
HF Calibration:	0x968D
Crystal Trim & Bias:	0x7E85

ICG Module

ICGC1:	0x18
ICGC2:	0x20

Self Clocked Filter Value

ICGFLTU:	0x02
ICGFLTL:	0x40

UART Baud Rate

SCI1BDH:	0x00
SCI1BDL:	0x34

MAC Address & Functional Values

MAC Address:	0xFFFFFFFFFFFFFFFF
Antenna Select	0x01
Sleep Mode Enable:	0x00

Production Specific Information

HW Name Revision:	
Serial Number:	0xFFFFFFFFFFFFFFFFFFFF
Production Site:	0xFFFF
Contry Code:	0xFF
Production Week Code:	0xFF
Production Year Code:	0xFF

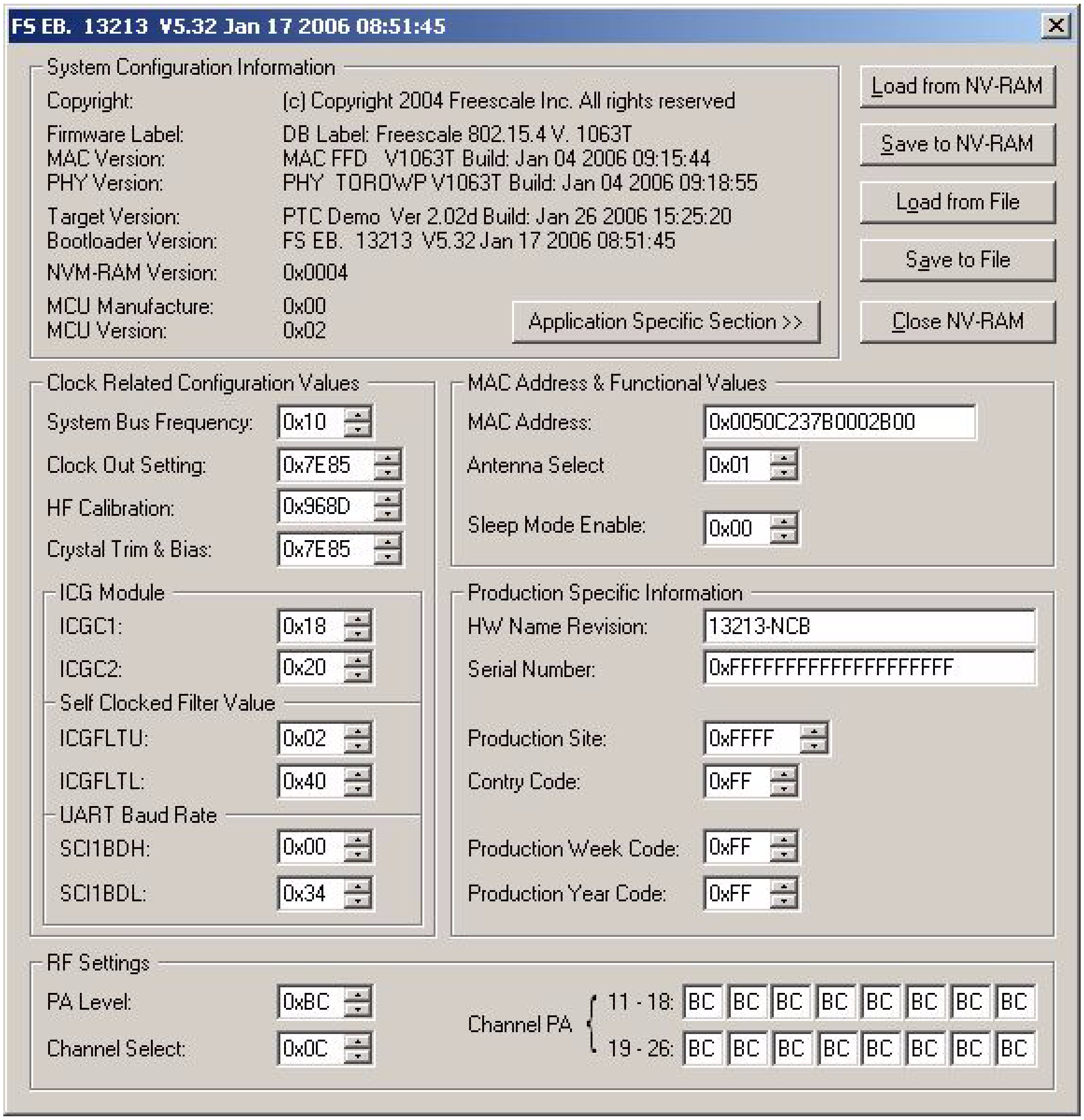
RF Settings

PA Level:	0xBC
Channel Select:	0x0C

Channel PA

11 - 18:	BC	BC	BC	BC	BC	BC	BC	BC
19 - 26:	BC	BC	BC	BC	BC	BC	BC	BC

Figure 1. Embedded Bootloader Window (Information Erased)



FS EB. 13213 V5.32 Jan 17 2006 08:51:45

System Configuration Information

Copyright:	(c) Copyright 2004 Freescale Inc. All rights reserved
Firmware Label:	DB Label: Freescale 802.15.4 V. 1063T
MAC Version:	MAC FFD V1063T Build: Jan 04 2006 09:15:44
PHY Version:	PHY TOROWP V1063T Build: Jan 04 2006 09:18:55
Target Version:	PTC Demo Ver 2.02d Build: Jan 26 2006 15:25:20
Bootloader Version:	FS EB. 13213 V5.32 Jan 17 2006 08:51:45
NVM-RAM Version:	0x0004
MCU Manufacture:	0x00
MCU Version:	0x02

Clock Related Configuration Values

System Bus Frequency:	0x10
Clock Out Setting:	0x7E85
HF Calibration:	0x968D
Crystal Trim & Bias:	0x7E85

ICG Module

ICGC1:	0x18
ICGC2:	0x20

Self Clocked Filter Value

ICGFLTU:	0x02
ICGFLTL:	0x40

UART Baud Rate

SCI1BDH:	0x00
SCI1BDL:	0x34

MAC Address & Functional Values

MAC Address:	0x0050C237B0002B00
Antenna Select	0x01
Sleep Mode Enable:	0x00

Production Specific Information

HW Name Revision:	13213-NCB
Serial Number:	0xFFFFFFFFFFFFFFFFFFFF
Production Site:	0xFFFF
Contry Code:	0xFF
Production Week Code:	0xFF
Production Year Code:	0xFF

RF Settings

PA Level:	0xBC
Channel Select:	0x0C

Channel PA

11 - 18:	BC	BC	BC	BC	BC	BC	BC	BC
19 - 26:	BC	BC	BC	BC	BC	BC	BC	BC

Figure 2. Embedded Bootloader Window (Information Restored)

3 Avoiding MAC Erasure

This section describes some recommended solutions to avoid erasing the MAC address and functional values. While four solutions are described, Freescale recommends using one of the following two solutions to avoid erasing the MAC address and functional values.:

- Avoiding Erasure Solution One — Demonstrates the use of the Freescale BDM flash programmer. This solution is employed when the uploading of new firmware, preservation of the MAC address and functional values, and full debug features are required.
- Avoiding Erasure Solution Two — Demonstrates the use of the Freescale Embedded Bootloader (a part of the Freescale Test Tool). This solution is employed when only the uploading of new firmware and preservation of the MAC address and functional values are required.

3.1 Avoiding Erasure Solution One

The Freescale BDM flash programming tool (`Bootloader.exe`) is a PC command line version program which can be called with different options from a script file. It can program an application into the flash and preserve the production data in the NVM for a Freescale 802.15.4/ZigBee application. It uses the BDM interface with the P&E BDM Multilink Debugger. It programs the application with NVM parameters and preserves all the vital production data such as the MAC address located in the NVM on the board. The P&E BDM Multilink Debugger is used for full debugging capability. See the Freescale Test Tool documentation for more details.

The Freescale Switch Demonstration Application (`EVK_Switch_Demo.MCP`) contains three (3) software targets that demonstrate different ways to build an application. All of these software targets show how to build and program the application to flash with the Freescale BDM flash programming tool without erasing the MAC address, functional values, and production data.

See the *Switch Demonstration Application Note*, AN2773 for more details.

3.2 Avoiding Erasure Solution Two

The MAC address and functional values are also preserved if the application is downloaded with the Freescale Embedded Bootloader on the board. The application must be downloaded using the Embedded Bootloader application found in the Freescale Test Tool.

NOTE

> User hardware must comply with the Freescale MC1319x, MC1320x, and MC1321x HCS08 Reference Design I/O layout to have a working Embedded Bootloader. If hardware other than the prescribed boards are used, the Embedded Bootloader can be ported to other I/O layouts as described in the *802.15.4/ZigBee Embedded Bootloader Reference Manual*, 802154EBRM.
>
> In order for the Embedded Bootloader to function, a UART or USB interface must be available on the target hardware (PCB).

The application must also be built to support the Embedded Bootloader interface. The Freescale Switch Demonstration Application (`EVK_Switch_Demo.MCP`) Software Target Three (3) demonstrates how to make an application which supports the Embedded Bootloader interface.

See the *Switch Demonstration Application Note*, AN2773 for more details.

The Embedded Bootloader does not support any debug features. However, the P&E HiWave debugger with the P&E Multilink BDM debugger attached, can be launched afterwards and the application symbols from the `*.elf` or `*.abs` files can be downloaded using that debugger. Make sure to select load symbols only. The application, with the exception of the Embedded Bootloader, can now be fully debugged.

See the *802.15.4/ZigBee Embedded Bootloader Reference Manual*, 802154EBRM for more details.

3.3 Avoiding Erasure Solution Three

The MAC address and Functional Values can be written directly into the application. However, this requires that an application is built for each unique MAC address.

NOTE

> This solution is only for users who do not have the Freescale Test Tool installed. Because this solution is only recommended for small development and test setups, Freescale does not recommend using this method for production systems.

The MAC address is written into the `NV_Data.c` C source code file. An example is located in the Switch Demonstration Application (`EVK_Switch_Demo.MCP`) `.\src\code\sys` folder. Default values for the other functional values are already present.

New application data members must first be added to the `NV_Data.h` file. An example is located in the `.\src\code\sys` folder. This file contains the NVM layout.

NOTE

With this solution, the application can be downloaded along with the CodeWarrior IDE using the default BDM CPROG flash programmer, even though the other production data is erased.

3.4 Avoiding Erasure Solution Four

The MAC address and functional values can be written through an application that supports a communication interface (UART/USB). The application image is built with an empty MAC address (0xFFFFFFFFFFFFFFFF) but with default values for the other functional values. See the `NV_Data.c` file for more information. An example is located in the Switch Demonstration Application (`EVK_Switch_Demo.MCP`) `.\src\code\sys` folder. Default values for the other functional values are already present.

NOTE

Freescale recommends this solution only if none of the other solutions apply. However, this solution could be used if the MAC address is kept in a separate host system running a ZigBee stack with its own NVM. The unique MAC address would then be written to the 802.15.4 MAC/PHY NVM at power up through the communication interface.

The Freescale EVK_PTC_Demo_w_Embedded_Bootloader demonstration application provides an example on how to write the MAC address to NVM through a UART or USB communication interface.

4 Restoring MAC Information

This section describes the recommended solution to restore the MAC address should it be erased. Freescale recommends using the following restoration solution to restore the erased MAC address, Functional Values and hardware name. Other production data is lost and cannot be restored.

This solution demonstrates the use of the Freescale Embedded Bootloader (part of the Freescale Test Tool). Users have the option to use the BDM interface (where users can use the application they need) or the UART or USB interface. The NVM can be configured by restoring the MAC address. The MAC address is printed on a label on the back of the board.

4.1 Performing the MAC Restoration

The MAC Restoration Solution uses the Freescale Embedded Bootloader (part of the Freescale Test Tool) along with the communications interface required by the user. (BDM, UART, or USB) If using the BDM, any application that is compliant with the Freescale 802.15.4 NVM layout can be used. If using the UART or USB, only the EVK_PTC_Demo_w_Embedded_Bootloader can be used. The actual application users want to run can be uploaded afterwards by following the standard upload procedure.

The Embedded Bootloader can be restored should it be erased by following the steps in the *802.15.4/ZigBee Embedded Bootloader Reference Manual*, 802154EBRM.

To perform the MAC Restoration, perform the following steps.

1. Connect the P&E Multilink BDM debugger to the BDM port or attach the appropriate cable from a PC to the UART or USB port on the target board.
2. Launch the Freescale Test Tool. The Test Tool window appears as shown in Figure 3.

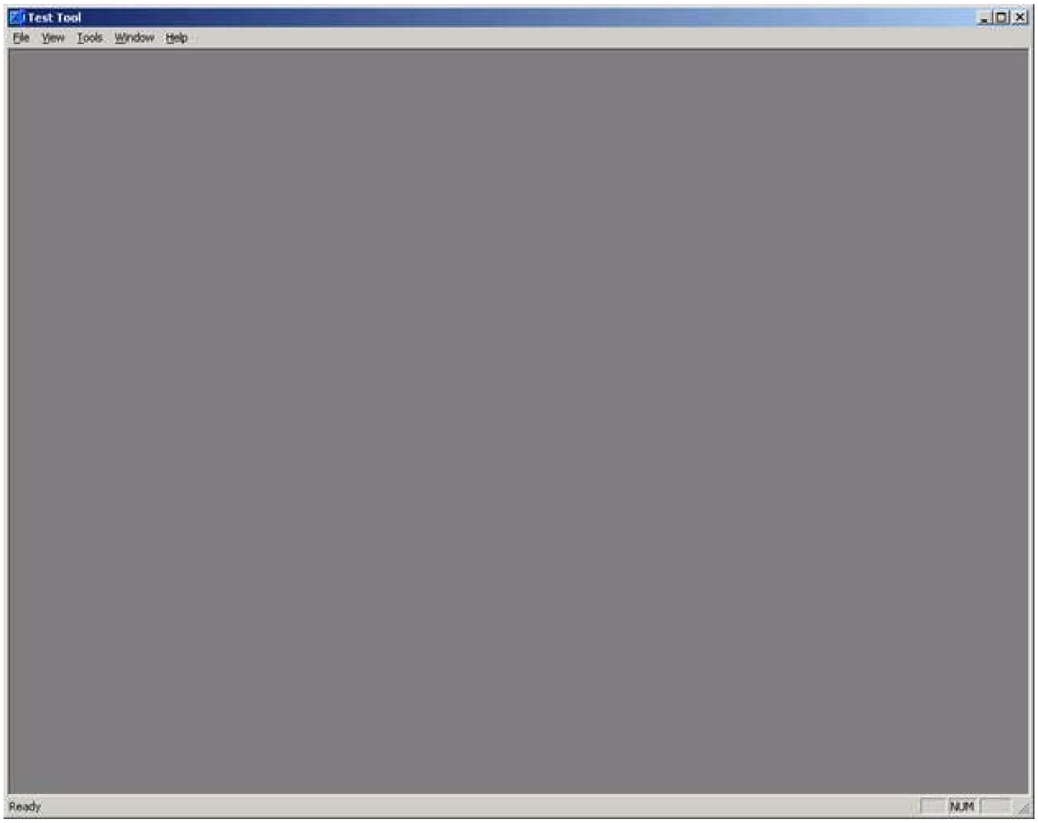


Figure 3. Test Tool Window

3. The devices must be added manually. From the Tools menu as shown in Figure 3, select Communication Settings. The List of Devices window appears as shown in Figure 4.

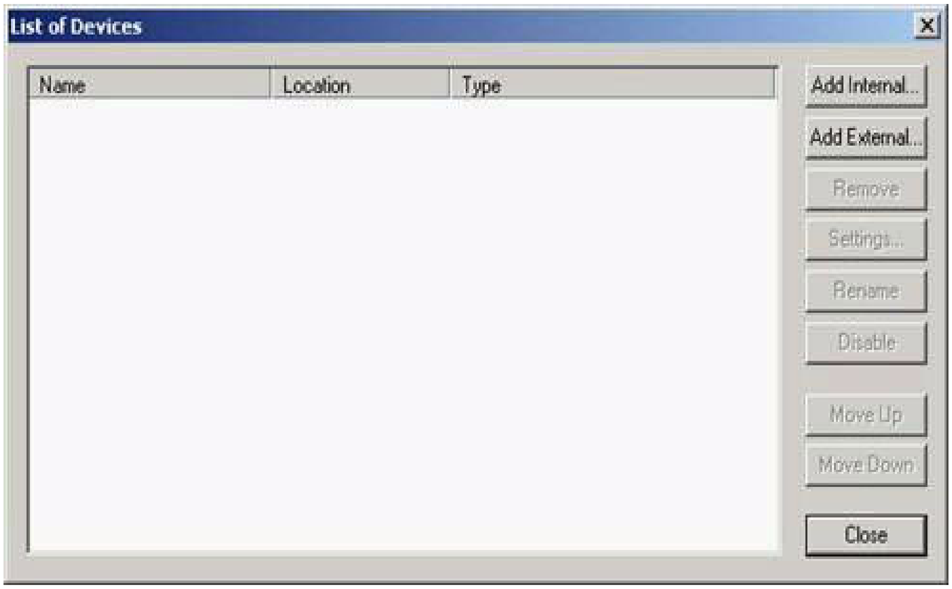
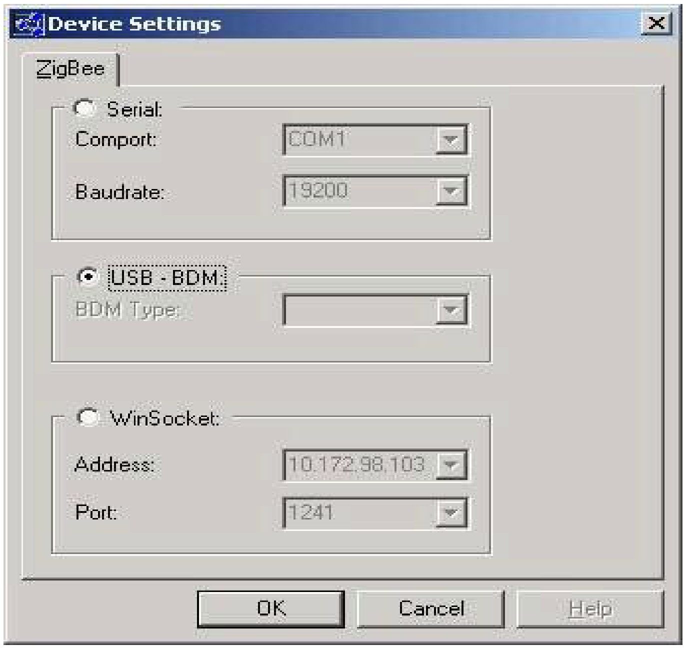


Figure 4. List of Devices Window

4. Click on the Add Internal button. The Device Settings windows appears as shown in Figure 5.



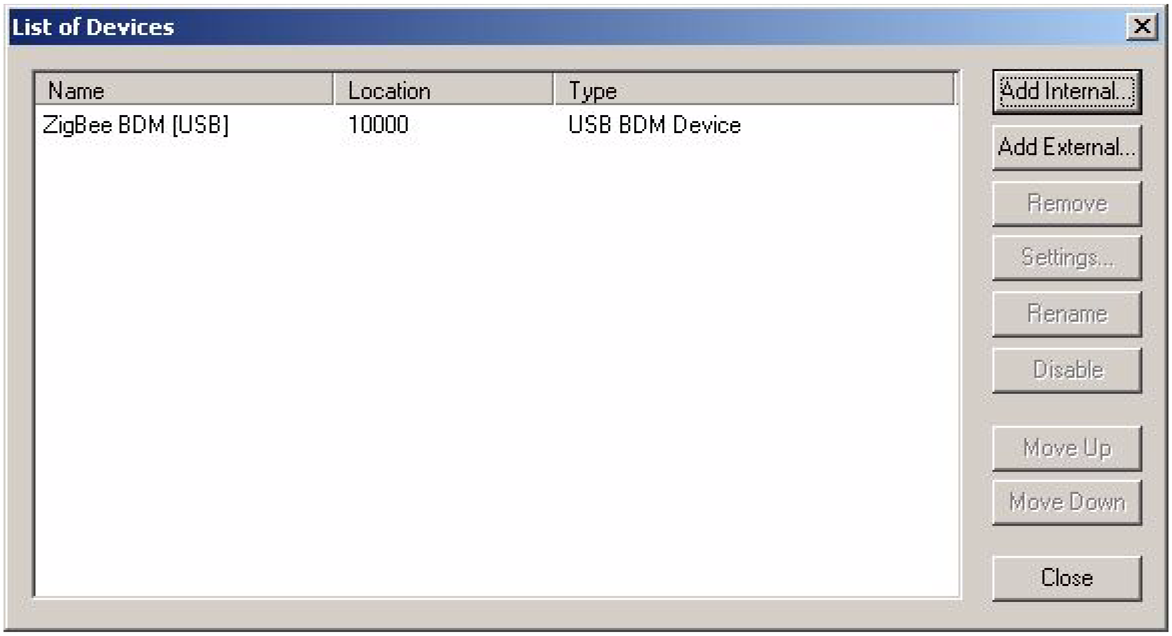
○ Serial:
Comport: COM1
Baudrate: 19200

● USB - BDM
BDM Type:

○ WinSocket:
Address: 10.172.98.103
Port: 1241

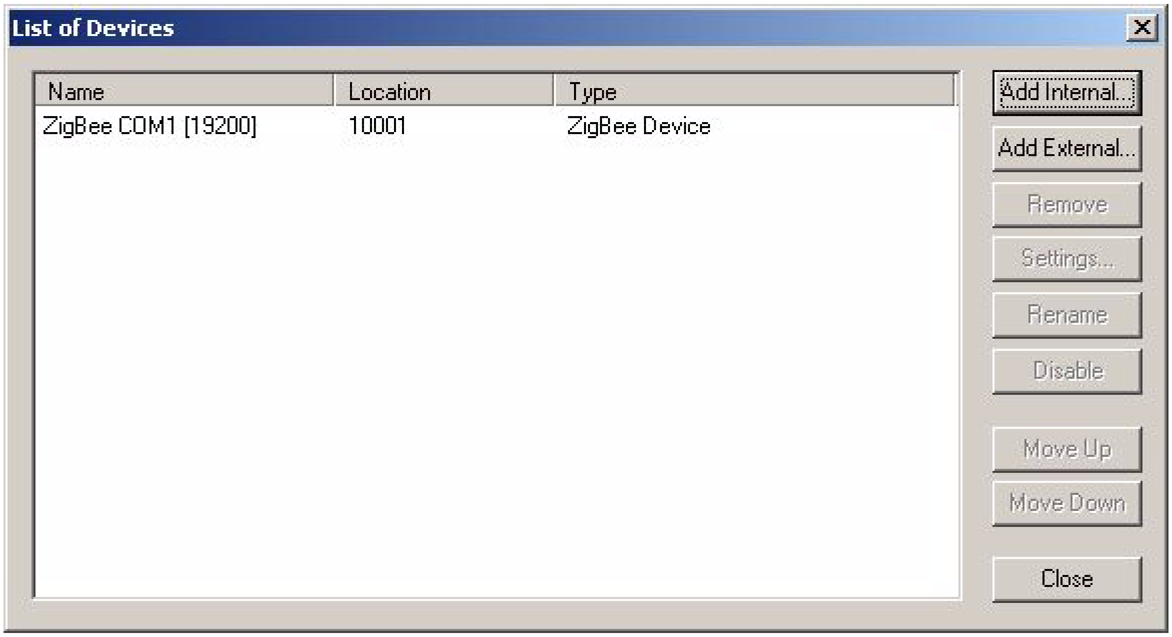
Figure 5. Device Settings

5. If using the BDM, select the USB-BDM option. If using the USB or UART connection, select the correct Comport and Baud Rate (default is 19,200). Then click the OK button.
If using the BDM, the List of Devices window appears as shown in Figure 6.
If using the USB or UART, the List of Devices window appears as shown in Figure 7.



Name	Location	Type
ZigBee BDM [USB]	10000	USB BDM Device

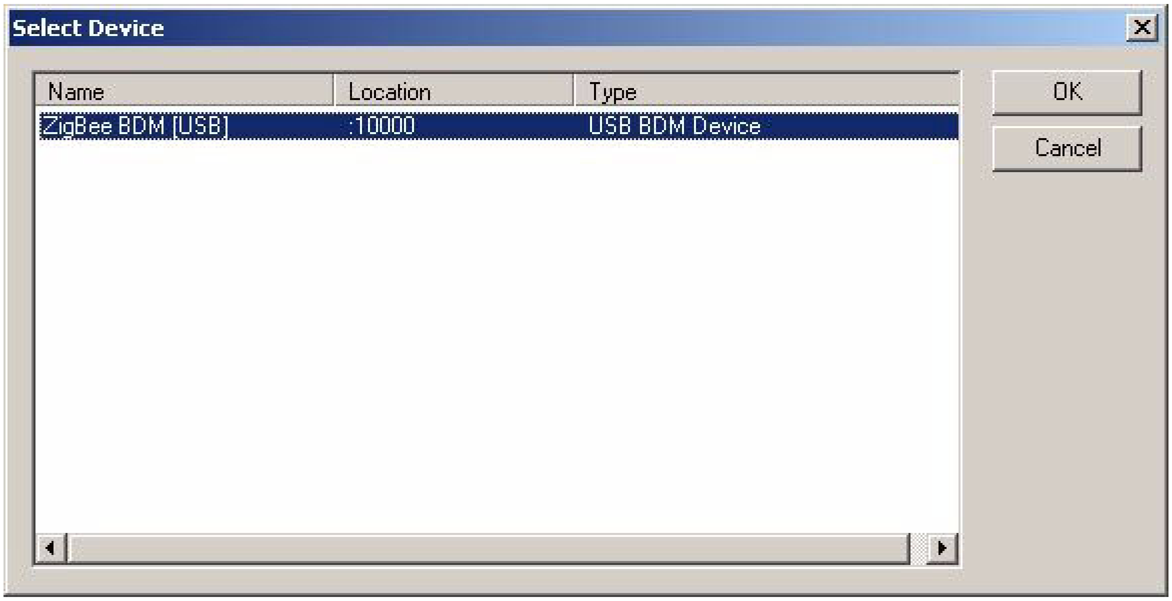
Figure 6. List of Devices Window (BDM)



Name	Location	Type
ZigBee COM1 [19200]	10001	ZigBee Device

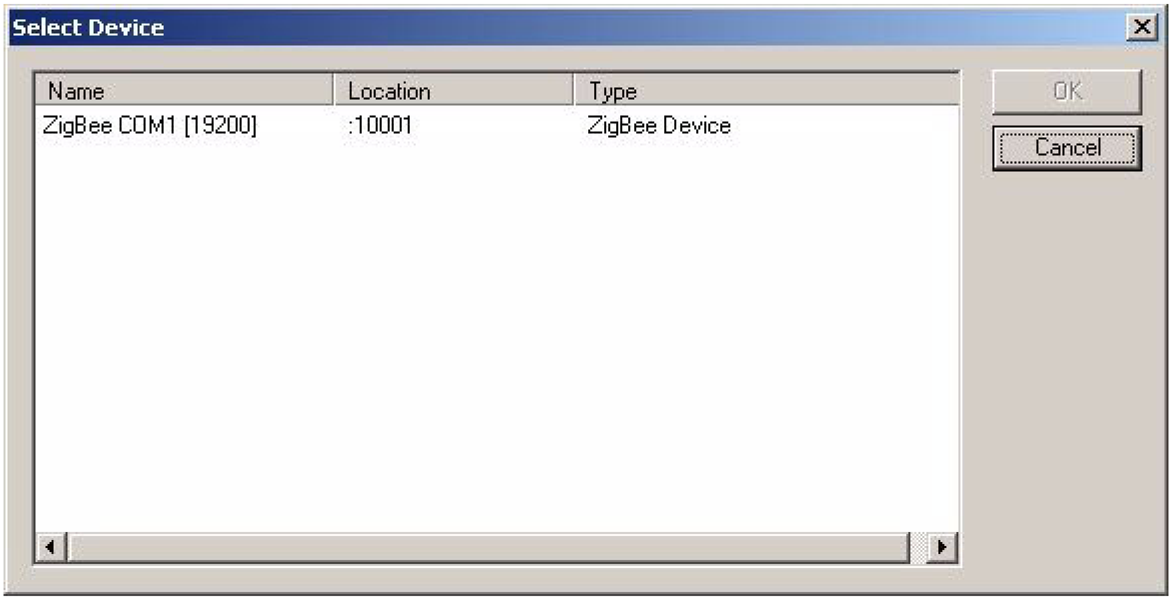
Figure 7. List of Devices Window (USB or UART)

6. Click the Close button.
7. From the Test Tool window, click on View, then click on Embedded Bootloader.
   If using the BDM, the Select Device window appears as shown in Figure 8.
   If using the USB or UART, the Select Device window appears as shown in Figure 9.



Name	Location	Type
ZigBee BDM [USB]	:10000	USB BDM Device

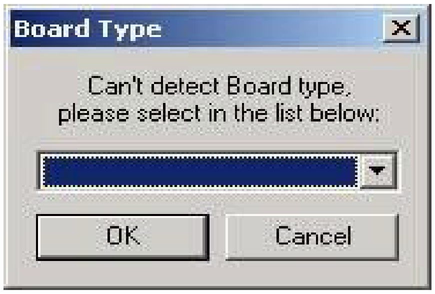
Figure 8. Select Devices Window (BDM)



Name	Location	Type
ZigBee COM1 [19200]	:10001	ZigBee Device

Figure 9. Select Devices Window (USB or UART)

8. Highlight the appropriate device, then click on the OK button.
9. The system tries to detect the board type by reading the hardware name from the NVM through the chosen interface. If the MAC address is erased, the hardware name is also missing and the detection fails. The Board Type window appears as shown in Figure 10.



Can't detect Board type,
please select in the list below:

Figure 10. Board Type Not Found

10. Select a board from the list as shown in Figure 11 and then click on the OK button.

    Valid board/hardware names are as follows (See the label on board):

    The current valid evaluation boards are:

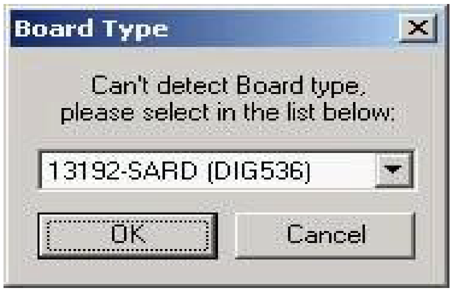
    — 13192-EVB (DIG528)

    — 13192-SARD (DIG536)

    — AXM0308C

    — 13213-NCB

    — 13213-SRB



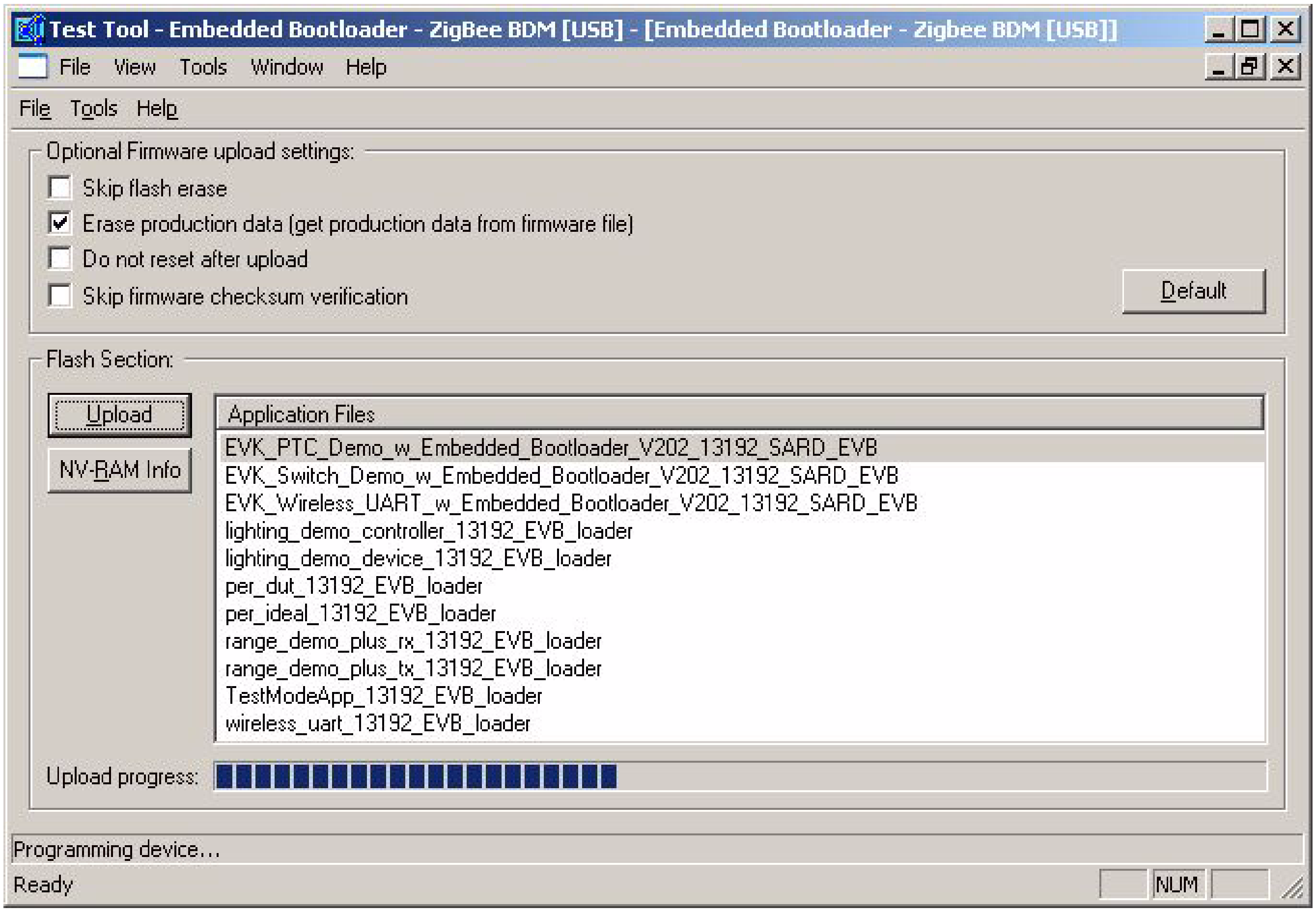
Board Type

Can't detect Board type, please select in the list below:

13192-SARD (DIG536)

Figure 11. Board Type Selected

11. Choose the Erase Production Data (get production data from firmware) option located in the Optional Firmware upload settings area of the Embedded Bootloader window as shown in Figure 12. The functional values are restored with the values found in the application file.



Test Tool - Embedded Bootloader - ZigBee BDM [USB] - [Embedded Bootloader - Zigbee BDM [USB]]

Optional Firmware upload settings:

□ Skip flash erase
☑ Erase production data (get production data from firmware file)
□ Do not reset after upload
□ Skip firmware checksum verification

Flash Section:

Application Files

EVK_PTC_Demo_w_Embedded_Bootloader_V202_13192_SARD_EVB
EVK_Switch_Demo_w_Embedded_Bootloader_V202_13192_SARD_EVB
EVK_Wireless_UART_w_Embedded_Bootloader_V202_13192_SARD_EVB
lighting_demo_controller_13192_EVB_loader
lighting_demo_device_13192_EVB_loader
per_dut_13192_EVB_loader
per_ideal_13192_EVB_loader
range_demo_plus_rx_13192_EVB_loader
range_demo_plus_tx_13192_EVB_loader
TestModeApp_13192_EVB_loader
wireless_uart_13192_EVB_loader

Upload progress:

Programming device...

Ready

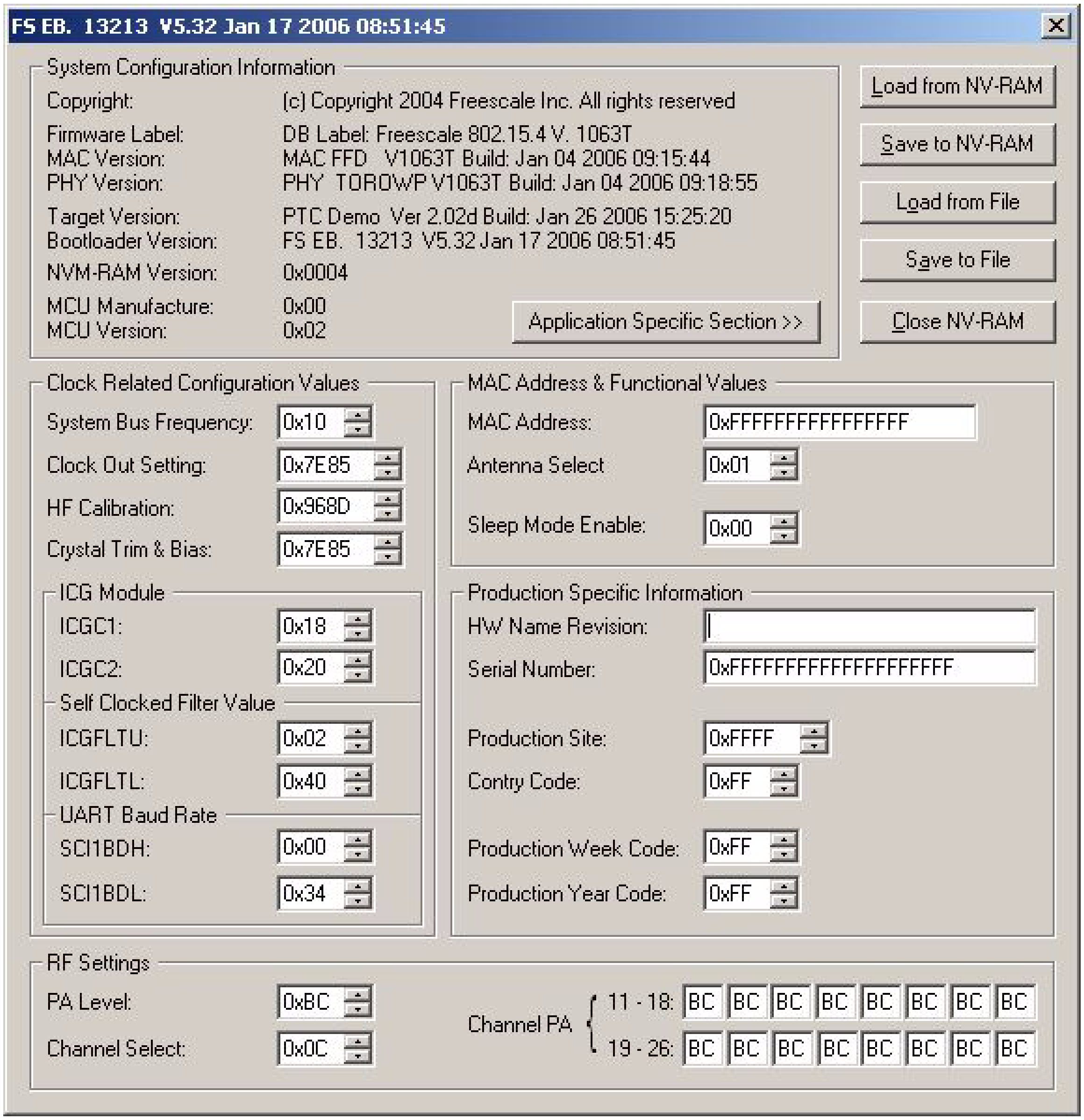
Figure 12. Test Tool (Embedded Bootloader Window)

NOTE

In Step 12, if using the UART or USB, users must select the EVK_PTC_Demo_w_Embedded_Bootloader.

If using the BDM, users can select any application.

12. In the Flash Section of the Embedded Bootloader window, select the appropriate application to run then click on the Upload button. Users can also click on the lower of the two Tools options from the menu as shown in Figure 12, then click on Upload and browse for the appropriate application to run. The application will then begin to upload. Wait for the application to be completely uploaded to the board before performing the next step.
13. Deselect the Erase Production Data (get production data from firmware) option located in the Optional Firmware upload settings area of the Embedded Bootloader window.
14. Click the NV-RAM Info button to open the NV-RAM section. The NV-RAM window appears as shown in Figure 13.
15. Click the Load from NV-RAM button to readout all NVM parameters. The NV-RAM parameters are read.



FS EB. 13213 V5.32 Jan 17 2006 08:51:45

System Configuration Information

Copyright: (c) Copyright 2004 Freescale Inc. All rights reserved
Firmware Label: DB Label: Freescale 802.15.4 V. 1063T
MAC Version: MAC FFD   V1063T Build: Jan 04 2006 09:15:44
PHY Version: PHY TOROWP V1063T Build: Jan 04 2006 09:18:55
Target Version: PTC Demo Ver 2.02d Build: Jan 26 2006 15:25:20
Bootloader Version: FS EB. 13213 V5.32 Jan 17 2006 08:51:45
NVM-RAM Version: 0x0004
MCU Manufacture: 0x00
MCU Version: 0x02

Clock Related Configuration Values

System Bus Frequency: 0x10
Clock Out Setting: 0x7E85
HF Calibration: 0x968D
Crystal Trim & Bias: 0x7E85

ICG Module
ICGC1: 0x18
ICGC2: 0x20

Self Clocked Filter Value
ICGFLTU: 0x02
ICGFLTL: 0x40

UART Baud Rate
SCI1BDH: 0x00
SCI1BDL: 0x34

MAC Address & Functional Values

MAC Address: 0xFFFFFFFFFFFFFFFF
Antenna Select: 0x01
Sleep Mode Enable: 0x00

Production Specific Information

HW Name Revision:
Serial Number: 0xFFFFFFFFFFFFFFFFFFFF
Production Site: 0xFFFF
Contry Code: 0xFF
Production Week Code: 0xFF
Production Year Code: 0xFF

RF Settings

PA Level: 0xBC
Channel Select: 0x0C

Channel PA
11 - 18: BC BC BC BC BC BC BC BC
19 - 26: BC BC BC BC BC BC BC BC

Figure 13. NV-RAM Window After Loading from NV-RAM

16. Enter the MAC address as it is shown on the label on the back of the board into the MAC Address field.
17. Enter a valid hardware name into the HW Name Revision field. This information allows the system to detect the board type on subsequent start ups.
    (See valid board/hardware names shown in Step 10.)
18. When finished, click the Save to NV-RAM button to flash the NVM.

    The MAC address and Functional Values and the Hardware Name Revision are now restored (as shown in Figure 2) and another application can be uploaded by following the normal upload procedures or the current application can be restarted.