Freescale MQX ETHERNET BOOTLOADER User's Guide

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Revision History

To provide the most up-to-date information, the revision of our documents on the World Wide Web will be the most current. Your printed copy may be an earlier revision. To verify you have the latest information available, refer to http://www.freescale.com/mqx.

The following revision history table summarizes changes contained in this document.

Revision Number	Revision Date	Description of Changes
Rev. 1.0	01/2011	Draft coming with MQX 3.6
Rev. 1.1	04/2011	Prototype coming with MQX 3.7.0 official release
Rev. 1.2	06/2011	Update Bootloader commands and Bootloader example
Rev. 1.3	07/2011	Update Bootloader for Nor flash devices

Chapter 1 Before You Begin

1.1 About This Book

This book is a guide and reference manual for using the FSLMQX NAND Bootloader, which is a part of Freescale MQX Real-Time Operating System distribution.

1.2 Where to Look for More Information

- The release notes document accompanying the Freescale MQX release provides information that was not available at the time this user's guide was published.
- The *MQX User's Guide* describes how to create embedded applications that use the MQX RTOS.
- The *MQX Reference Manual* describes prototypes for the MQX API.

1.3 Product Names

In this book, we use BLD as the abbreviation for the Freescale MQX Bootloader Embedded File System.

1.4 Typographic Conventions

Throughout this book, we use typographic conventions to distinguish terms.

Font style	Usage	Example
Bold	Function families	The **_io_mfs** family of functions.
Bold	Function names	**_io_mfs_install()**
Italic	Data types (simple)	*uint_32*
	Data types (complex)	See following example.
Constant-width	Code and code fragments	—
	Data types in prototype definitions	See following example.
	Directives	#include "*mfs.h*"
	Code and code fragments	
Italic	Filenames and path names	*part_mgr.h*
Italic	Symbolic parameters that you substitute with your values.	See following example.
UPPERCASE Italic	Symbolic constants	*MFS_NO_ERROR*

1.5 Other Conventions

1.5.1 Cautions

Cautions tell you about commands or procedures that could have unexpected or undesirable side effects or could be dangerous to your files or your hardware.

CAUTION	If an application calls read and write functions with the partition manager, the file system will be corrupted.

Chapter 2 Using Ethernet Boot Loader

2.1 Ethernet Boot Loader at a glance

Ethernet Boot Loader provides an easy and reliable way to load new user applications to the device that available Nand or Nor flash memory. After loaded, the new user applications will be able to run in the device. However, Ethernet boot loader support user to load more than one application to flash memory and specify booting image. The Ethernet boot loader needs an TFTP server running on PC.

This Ethernet boot loader was specifically written for several families of Freescale microcontrollers that have MQX RTOS support NAND or NOR flash driver and enough memory to store more than one applications.
Tested development boards:

- TWR-MPC5125 with NAND flash support
- TWR-MCF54418 with NAND flash support
- M5329EVB with NOR flash support
- M53015EVB with NOR flash support
- M54455EVB with NOR flash support

Tested operating systems:

- Windows XP Pro with Service Pack 2

Tested development tool:

- Code Warrior 10.1
- Code Warrior 9.2
- Code Warrior 7.2

This document intends to help you gain an insight into the Ethernet boot loader and capabilities to develop your own applications. The document targets to firmware application developers who would like to develop the applications using Ethernet boot loader.

2.2 Ethernet boot loader flow

The Boot loader is integrated with an application that performs the product's main functions. At beginning, the boot loader executes and does some simple checks to see which the application should start after a timeout value. The Boot loader should go to main application where user can setup own network and get image from server in first time. The Boot loader supports firmware image in S-record, Code warrior binary and raw binary file formats.

- S-record files are common ASCII files used to specify the program data stored in devices. Freescale's software tool chain called Code warrior generates S-record files and Code warrior binary files automatically when projects are compiled. S-record files have the extension .S19 and Code warrior binary files have the extension .bin.
- Raw binary file is the image file of flash memory.

After the image file has been transferred, the Boot loader will store in a specific area.

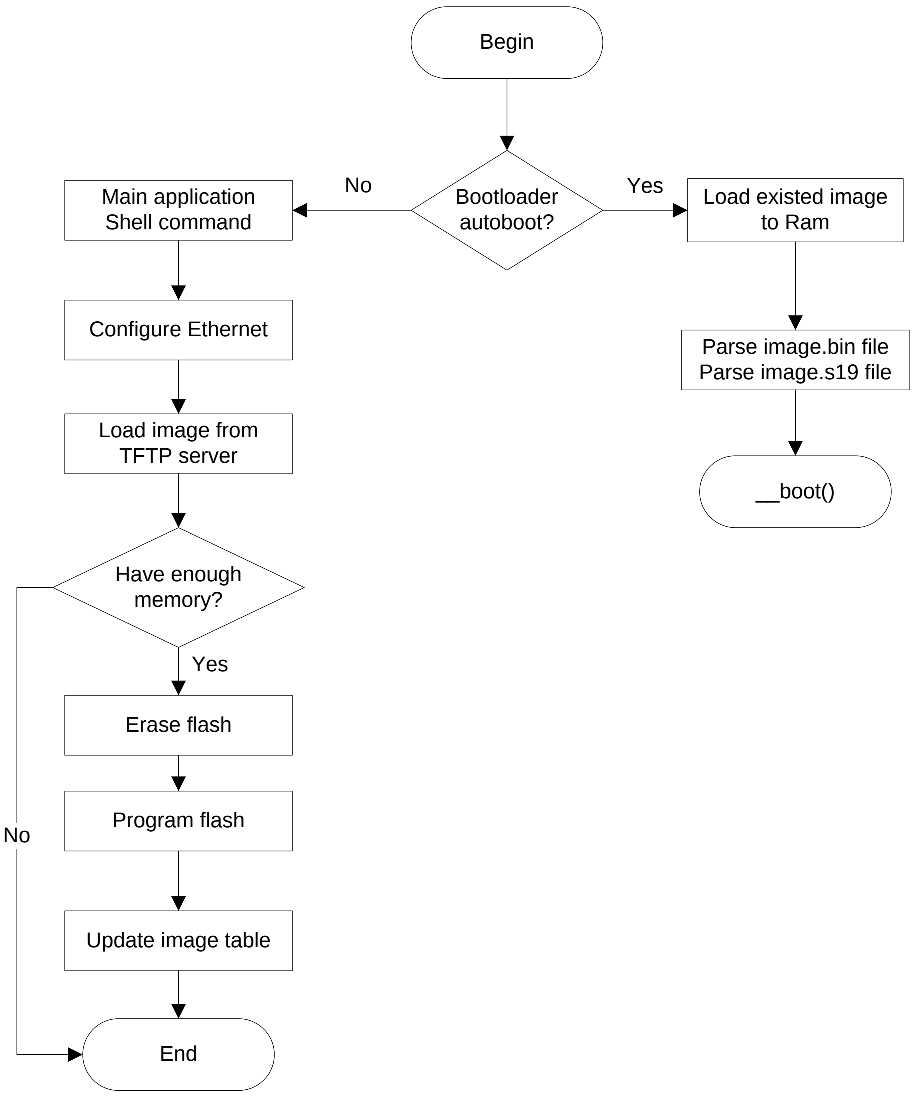


Figure 2-1 Boot loader functional follow chart

When entering to auto boot mode, the Boot loader will parse image file to Ram memory and execute booting from Ram.

2.3 Boot loader Memory Maps

The following sections show the memory maps for the different device examples. The memory map for both the boot loader and application are show to see how the RAM overlaps. Notice the application has access to all RAM and overlaps the bootloader RAM. All other memory sections are identical between the two.

2.3.1 TWR-MPC5125 Memory Map

Table 2-1 TWR-MPC5125 Boot loader and application memory map

Addresses	Boot loader	Application
0x0001_0000 to 0x0040_0000	Reserved	- Interrupt and exception vectors - Code and Const data
0x0040_0000 to 0x0081_0000	Reserved	RAM available for application
0x0081_0000 to 0x0100_0000	- Interrupt and exception vectors - Code and Const data	Reserved
0x0100_0000 to 0x0200_0000	RAM available for application	Reserved

2.3.2 TWR-MCF54418 Memory Map

Table 2-2 TWR-MCF54418 Boot loader and application memory map

Addresses	Boot loader	Application (Ram target only)
0x4000_0000 to 0x4000_0600	Vector table, due to the uboot the start address shifted by 0x100000	Reserved
0x4000_0600 to 0x4010_0000	Code + Const data (cached)	Reserved
0x4010_0000 to 0x4010_0600	Reserved	Vector table, due to the uboot the start address shifted by 0x100000
0x4010_0600 to 0x4300_0000	Reserved	Code + Const data (cached)
0x4300_0000 to 0x4400_0000	RW data cached	Reserved
0x4400_0000 to 0x4500_0000	Reserved	RW data cached
0x4500_0000 to 0x4600_0000	RW data uncached	Reserved
0x4600_0000 to 0x4800_0000	Reserved	RW data uncached

2.3.3 M5329EVB Memory Map

Table 2-3 M5329EVB Boot loader and application memory map

Addresses	Boot loader	Application (Ram target only)
0x4000_0000 to 0x4000_0600	Reserved	Vector table
0x4000_0600 to 0x4100_00000	Reserved	Code + Const data (cached)
0x4100_0000 to 0x4190_0000	Reserved	RW data cached
0x4190_0000 to 0x4190_0600	Vector table	Reserved

0x4190_0600 to 0x41A0_0000	Code + Const data (cached)	Reserved
0x41A0_0000 to 0x41B0_0000	RW data cached	Reserved
0x41B0_0000 to 0x41B0_0000	RW data uncached	Reserved
0x41f0_0000 to 0x4200_0000	Reserved	RW data uncached

2.3.4 M53015EVB Memory Map

Table 2-4 M53015EVB Boot loader and application memory map

Addresses	Boot loader	Application (Ram target only)
0x4000_0000 to 0x4000_0600	Reserved	Vector table
0x4000_0600 to 0x4200_00000	Reserved	Code + Const data (cached)
0x4200_0000 to 0x4200_0600	Vector table	Reserved
0x4200_0600 to 0x4280_0000	Code + Const data (cached)	Reserved
0x4280_0000 to 0x4300_0000	RW data cached	Reserved
0x4200_0000 to 0x43F0_0000	Reserved	RW data cached
0x43F0_0000 to 0x4400_0000	RW data uncached	Reserved
0x41F0_0000 to 0x4200_0000	Reserved	RW data uncached

2.3.5 M54455EVB Memory Map

Table 2-5 M54455EVB Boot loader and application memory map

Addresses	Boot loader	Application (Ram target only)
0x4000_0000 to 0x4000_0600	Reserved	Vector table
0x4000_0600 to 0x4100_00000	Reserved	Code + Const data (cached)
0x4100_0000 to 0x4100_0600	Vector table	Reserved
0x4100_0600 to 0x4110_0000	Code + Const data (cached)	Reserved
0x4110_0000 to 0x4120_0000	RW data cached	Reserved
0x4120_0000 to 0x4130_0000	RW data uncached	Reserved
0x4800_0000 to 0x4C00_0000	Reserved	RW data cached
0x4C00_0000 to 0x5000_0000	Reserved	RW data uncached

Chapter 3 Reference: Functions

3.1 _bootloader_init_table

Initialize image table

Synopsis

```
int_32 _bootloader_init_table(void)
```

Description

- Initialize image table. Create a blank table if does not exists.
- Calculate check sum all image. Image stored in NAND Flash may be deleted by another application, therefore it should calculate checksum before using.

Return Codes

MQX_OK	– No error occurs
IO_ERROR	– IO error occurs

3.2 _bootloader_check_image

Synopsis

```
boolean _bootloader_check_image
(    boolean autoboot,
     uint_32 index)
```

Description

Checking autoboot image

Return Codes

TRUE	- If image index is set to autoboot image
FALSE	- If image index not set to autoboot image

3.3 _bootloader_del_image

Synopsis

```
uint_32 _bootloader_del_image(uint_32 index)
```

Description

Delete image with index specified

Return Codes

MQX_OK	– No error occurs
IO_ERROR	– IO error occurs

3.4 _bootloader_del_table

Synopsis

```
int_32 _bootloader_del_table(void)
```

Description

Delete all images

Return Codes

MQX_OK	– No error occurs
IO_ERROR	– IO error occurs

3.5 _bootloader_store_image_data

Synopsis

```
int_32  _bootloader_store_image_data
(
     uint_32   addr,
     uint_32   size,
     uchar_ptr buff,
     uchar_ptr name
)
```

Description

Store image in NAND Flash. Bootloader find images was masked delete, overwrite this one if new image size equal or smaller than old image. Otherwise store new image in the end of table.

Addr	-	[IN] Start address refer
Size	-	[IN] Image size
Buff	-	[IN] Pointer to image data
Name	-	[IN] Name of image will be store in table.

Return Codes

MQX_OK	– No error occurs
IO_ERROR	– IO error occurs

3.6 _bootloader_list_image

Synopsis

```
     void _bootloader_list_image(void)
```

Description

Print out all images stored in NAND Flash

Return Codes

NA

3.7 _bootloader_set_default

Synopsis

```
int_32 _bootloader_set_default(uint_32 index)
```

Description

Set image as autoboot image after bootloader startup with timeout value.

Return Codes

MQX_OK	– No error occurs
IO_ERROR	– IO error occurs

3.8 _bootloader_get_timeout

Synopsis

```
int_32 _bootloader_get_timeout(void)
```

Description

Get timeout value of autoboot image

Return Codes

-1 – No image found or no timeout value found.

3.9 _bootloader_set_timeout

Synopsis

```
     int_32 _bootloader_set_timeout(uint_32 index, uint_32
timeout)
```

Description

Set image timeout value

Return Codes

MQX_OK	– No error occurs
IO_ERROR	– IO error occurs

Chapter 4 Reference: Commands

4.1 ipconfig

This command used to setup Ethernet network. Flow the command instruction to set you board IP address.

4.2 imgload

This command used to load a file type .bin or .s19 from TFTP server and store to NAND flash immediately.
This image is set as auto boot when transfer success.

Usage

```
imgload  <host>  <source>  <addr> [<name>]
```

<host> - TFTP server ip address
<source> - Source file name
<add> - Start address in Ram
[<name>] - Name of image will be stored in table (optional). Default source file name is stored in table.

Examples

```
imgload 10.207.215.40 hello.s19 0x400048f8 helloworld
```

4.3 imglst

This command has no argument.This command used to list all images in NAND flash.

Usage

This command doesn't have argument

4.4 imgdel

This command used to delete a image in memory of NAND flash.

Usage

```
imgdel <index>
```

<index> - Index of image to delete

4.5 tbldel

This command used to delete all images in memory NAND flash.

Usage

This command doesn't have argument

4.6 autoboot

This command used to select image auto boot when reset or power on.

Usage

```
autoboot  [<index>]
```

<index> - Image index to boot.

4.7 imggo

This command jumps to image and runs application of this image.
Usage

```
imggo <index>
```

<*index*> - Image index in memory table.

4.8 imgtimeout

This command sets autoboot timeout expire in second.
Usage

```
atbtmo <index> <timeout>
```

<*index*> - Image index to set timeout
<*timeout*> - Time out in second value.

4.9 imgren

This command used to rename the image in table.
Usage

```
imgren <index> <name>
```

<*index*> - Image index to be renamed.
<*name*> - New image name.

4.10 imgaddr

This command used to set the boot address of image.
Usage

```
imgren <index> <address>
```

<*index*> - Image index to set boot address.
<*name*> - New image boot address.

4.11 nandcheck

This command used to check bad blocks of Nand flash
Usage

```
nandcheck
```

4.12 nandef

This command is used to force erase specific block of Nand flash
Usage

```
nandef <block>
```

<*block*> - Block force erased.

4.13 Reset

This command is used to soft reset the board.
Usage

```
reset
```

Chapter 5 MQX Bootloader Examples

5.1 Introduction

This chapter gives you insight on how to use the Boot Loader example. The example use TWR-MPC5125 board and Code Warrior version 9.2 and TWR-MCF54418 board and CodeWarrior version 10.1. The following sections described in this chapter:

- Preparing the setup
- Preparing image file (CodeWarrior 9.2 and CodeWarrior 10.1)
- Running the application

5.2 Preparing the setup

5.2.1 Software Setting up

This demo uses the following software:

- Code Warrior version 9.2
- Code Warrior version 10.1
- Hyper terminal on Windows XP
- NetBurner TFTP Server Version 1.0

5.2.2 Hardware Setting up

Make connection as shown in this following picture

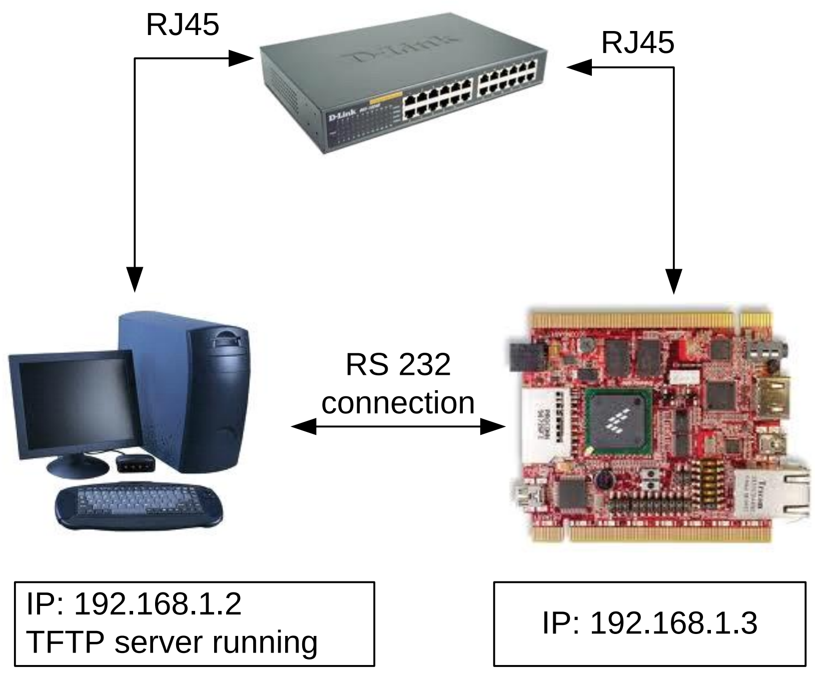


Figure 5-1 Hardware Setting up

This demo uses the following hardware:

- A personal computer
- A TWR-MPC5125 board and power supply for it

Follow these steps to setup the hardware

1. Connect the power supply to the board.
2. Connect the USB TAP to the COP jumper of the board TWR-MPC5125.
3. Connect to virtual com J19 of TWR-MPC5125 board.
4. Turn board power on.

5.3 Preparing image file

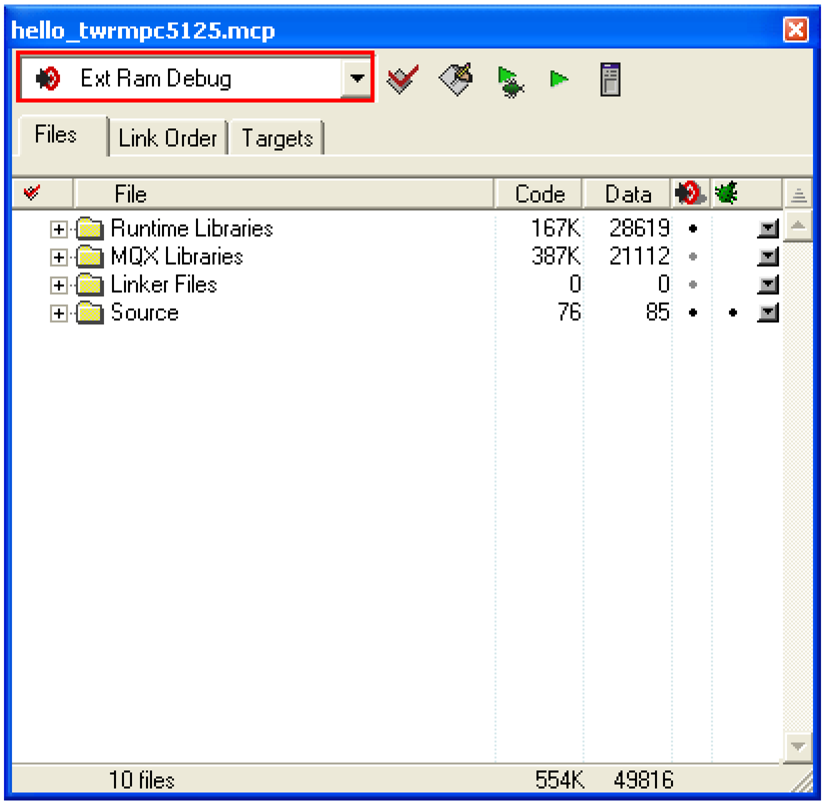
This section describes steps to create a MQX image, which will be loaded and executed in RAM by Boot loader.

5.3.1 Preparing image file for TWR-MPC5125

Step1. Build libraries of MQX by running
`[MQX_PATH]\config\twrmpc5125\cwmpc92\build_twrmpc5125_libs.mcp`

Step2. Compile an application that will be run by Boot loader. For examples, we chose “Hello World”

`[MQX_PATH]\mqx\examples\hello\cwmpc92\hello_twrmpc5125.mcp`
There should be chose Ram target for compiling because boot loader will copy image for Flash memory to Ram memory and execute program.

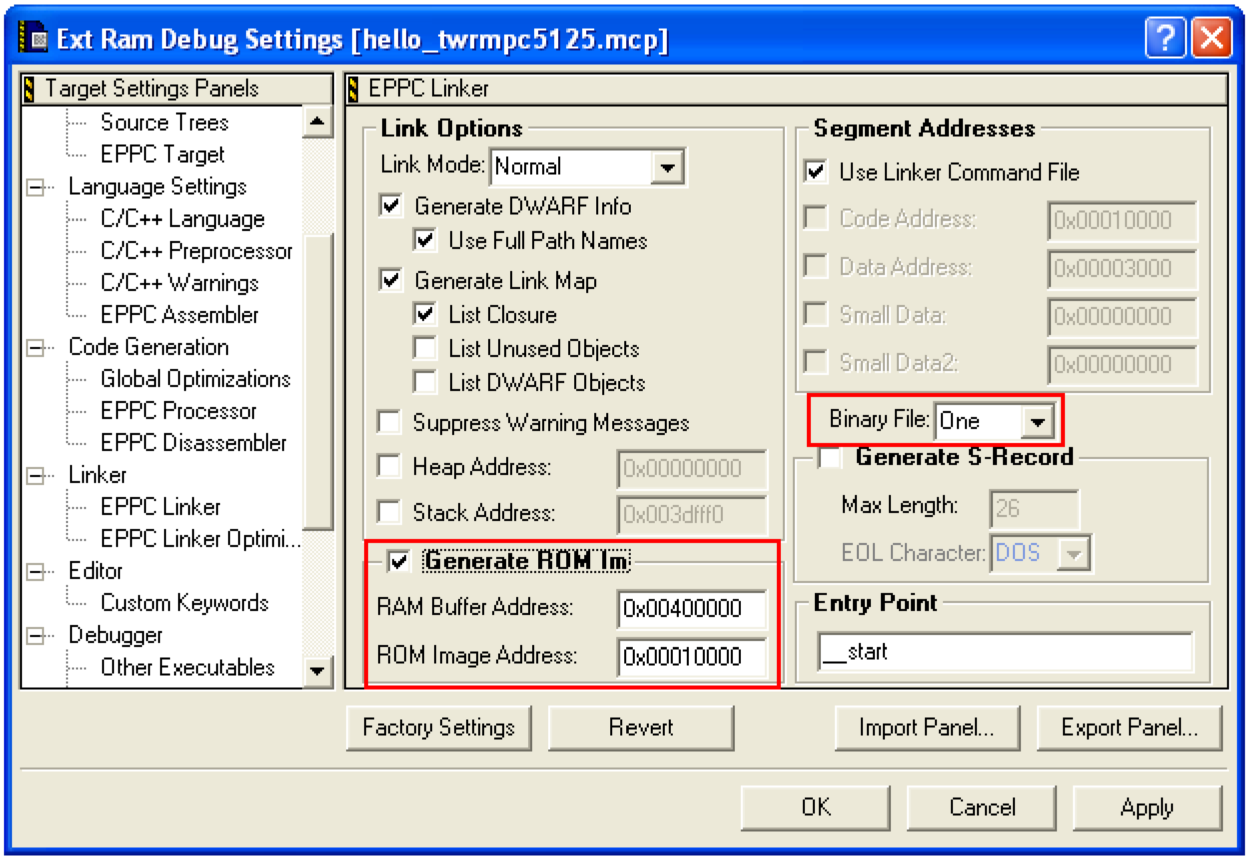

hello_twrmpc5125.mcp

Ext Ram Debug

File	Code	Data
Runtime Libraries	167K	28619
MQX Libraries	387K	21112
Linker Files	0	0
Source	76	85
10 files	554K	49816

Figure 5-2 Select Ram Target

Step3. Configured the target settings



Ext Ram Debug Settings [hello_twrmpc5125.mcp]

EPPC Linker

Link Options
- Link Mode: Normal
- [✓] Generate DWARF Info
- [✓] Use Full Path Names
- [✓] Generate Link Map
- [✓] List Closure
- [ ] List Unused Objects
- [ ] List DWARF Objects
- [ ] Suppress Warning Messages
- [ ] Heap Address: 0x00000000
- [ ] Stack Address: 0x003dfff0
- [✓] Generate ROM Im
- RAM Buffer Address: 0x00400000
- ROM Image Address: 0x00010000

Segment Addresses
- [✓] Use Linker Command File
- [ ] Code Address: 0x00010000
- [ ] Data Address: 0x00003000
- [ ] Small Data: 0x00000000
- [ ] Small Data2: 0x00000000
- Binary File: One
- [ ] Generate S-Record
- Max Length: 26
- EOL Character: DOS

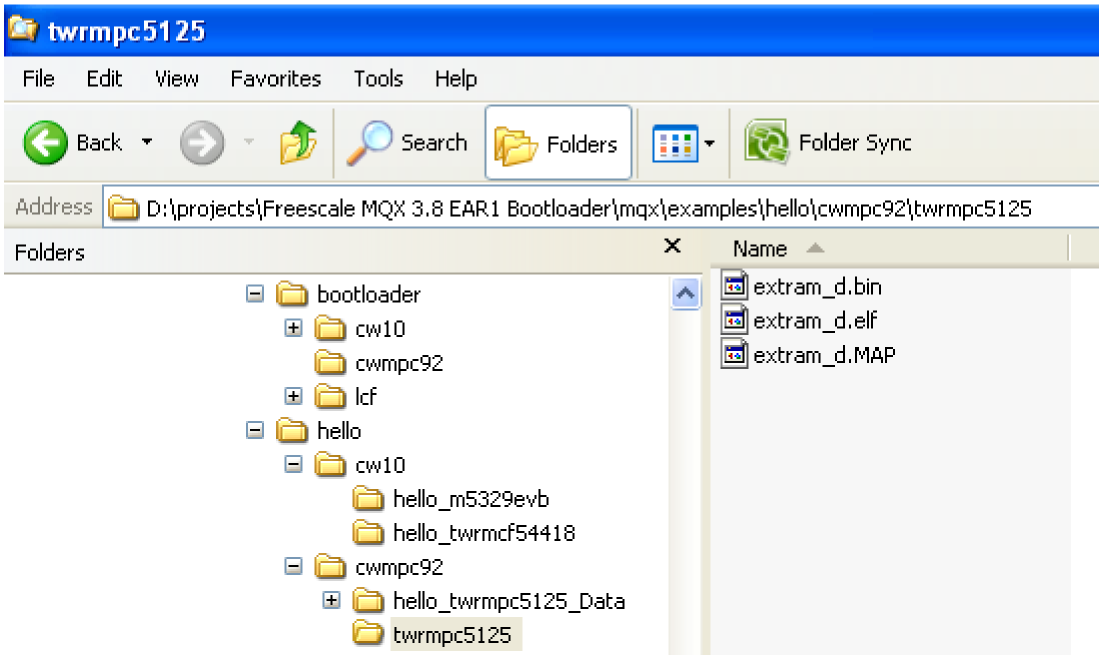
Entry Point
- __start

Figure 5-3 Setting Rom and Ram address

Chose Binary File is One and set the start address in Generate ROM Image check box.
RAM Buffer Address is Ram address in Linker file.
ROM Image Address is Rom address in Linker file.

```
    rom:                org = 0x00010000, len = 0x003EFF00
    ram:                org = 0x00400000, len = 0x01c00000
    kernel_data:        org = 0x02000000, len = 0x06000000
```

Step4. Compile the project and then *extram_d.bin* is generated.



D:\projects\Freescale MQX 3.8 EAR1 Bootloader\mqx\examples\hello\cwmpc92\twrmpc5125

```
bootloader
    cw10
    cwmpc92
    lcf
hello
    cw10
        hello_m5329evb
        hello_twrmcf54418
    cwmpc92
        hello_twrmpc5125_Data
        twrmpc5125
```

```
extram_d.bin
extram_d.elf
extram_d.MAP
```

Figure 5-4 Generated file

Step5. Copy *extram_d.bin* to the TFTP root folder. For example *D:\projects\tftp_root\twrmpc5125*
Rename *extram_d.bin* to *helloworld_extram_d.bin*
Remember that Start address is Rom address. In this examples Start address = 0x00010000.

5.3.2 Preparing image file for TWR-MCF54418

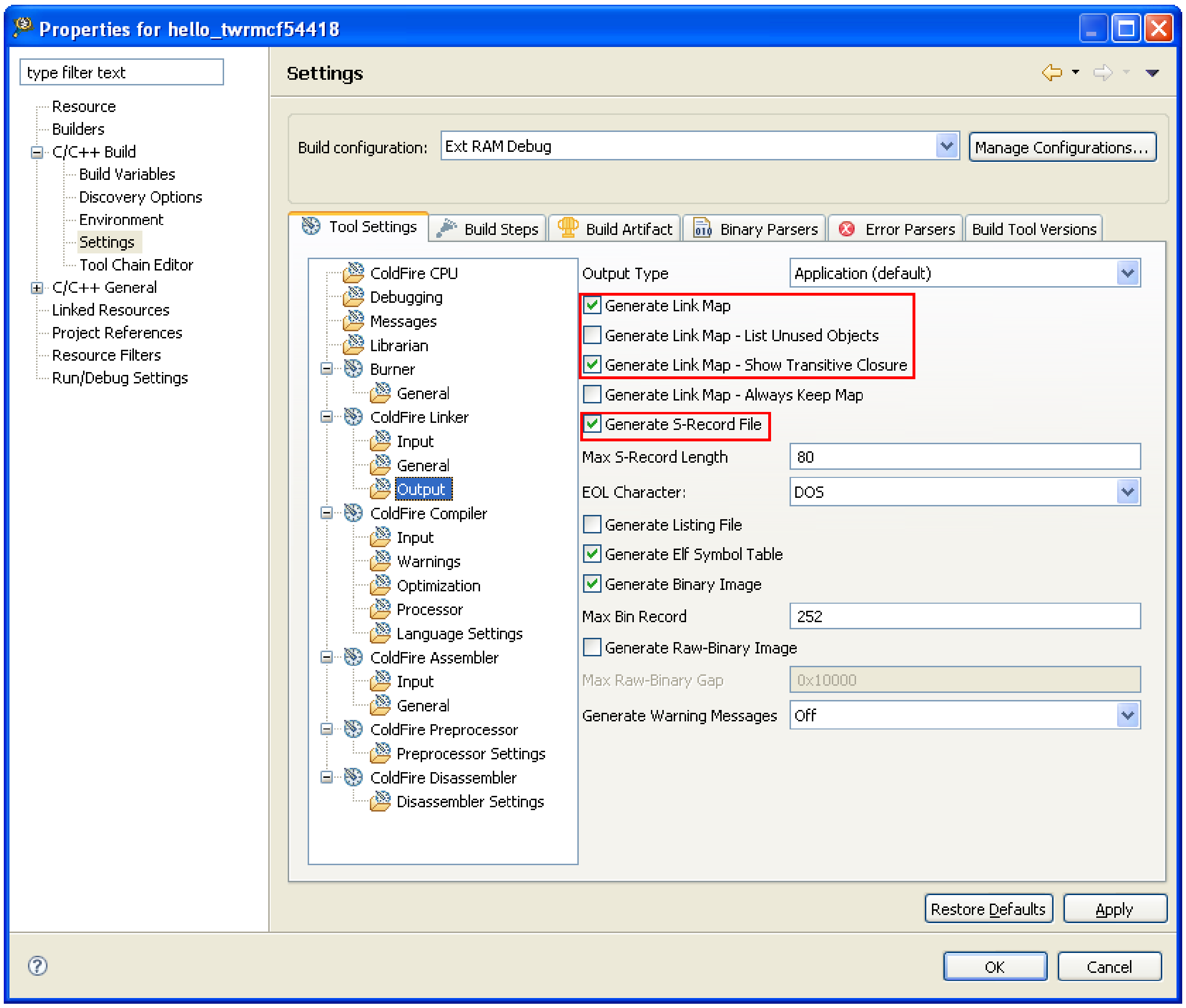
Step1. Build libraries of MQX by running

```
[MQX_PATH] \mqx\build\cw10\bsp_twrmcf54418
[MQX_PATH] \mqx\build\cw10\psp_twrmcf54418
```

Step2. Compile an application that will be run by Boot loader. For examples, we chose "Hello World"

```
[MQX_PATH]\mqx\examples\hello\cw10\hello_twrmcf54418
```

There should be chose Ram target for compiling because boot loader will copy image for Flash memory to Ram memory and execute program.
Step3. Configured the target settings


Properties for hello_twrmcf54418

Settings

Build configuration: Ext RAM Debug

Tool Settings > ColdFire Linker > Output

Output Type: Application (default)

- [✓] Generate Link Map
- [ ] Generate Link Map - List Unused Objects
- [✓] Generate Link Map - Show Transitive Closure
- [ ] Generate Link Map - Always Keep Map
- [✓] Generate S-Record File

Max S-Record Length: 80

EOL Character: DOS

- [ ] Generate Listing File
- [✓] Generate Elf Symbol Table
- [✓] Generate Binary Image

Max Bin Record: 252

- [ ] Generate Raw-Binary Image

Max Raw-Binary Gap: 0x10000

Generate Warning Messages: Off

Figure 5-5 Target settings

Step4. Compile project

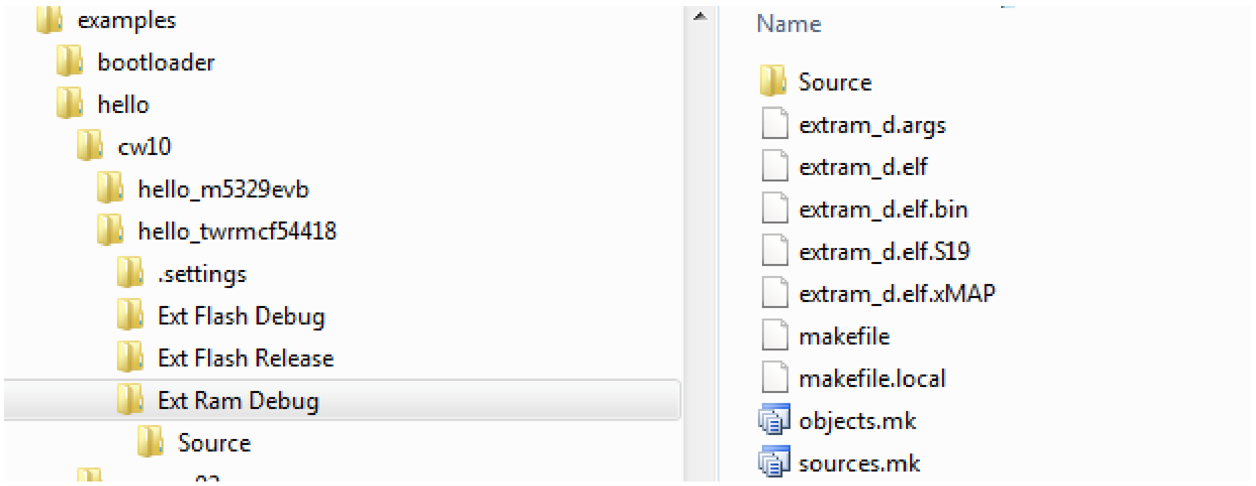


Figure 5-6 Generated files

Step5. Determine start address – Entry point in CodeWarrior setting.
Open extram_d.elf.xMAP by a text editor and find **boot** address. The format will be same with following line:

```
4010A60A 00000058 .text    __boot (bsp_twrmcf54418_d.a boot_c.o       )
```

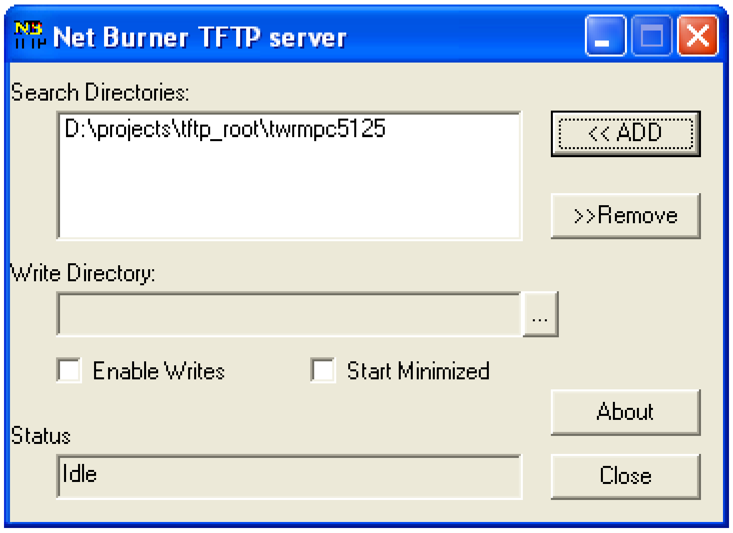
0x4010A60A is start address, remember that will be a argument of *imgload* command

Step6. Copy *extram_d.elf.s19* to the TFTP root folder. For example *D:\projects\tftp_root\twrmcf54418*
Rename *extram_d.elf.s19* to *helloworld_extram_d.s19*

5.4 Running Boot loader

This section describes step by step running Boot loader application with assumption your PC had installed Net Burner TFTP server or other kind of TFTP server.

Step1. Setting up “Search Directories” to the folder of image file, refer to section 5.3.1 Step 5.



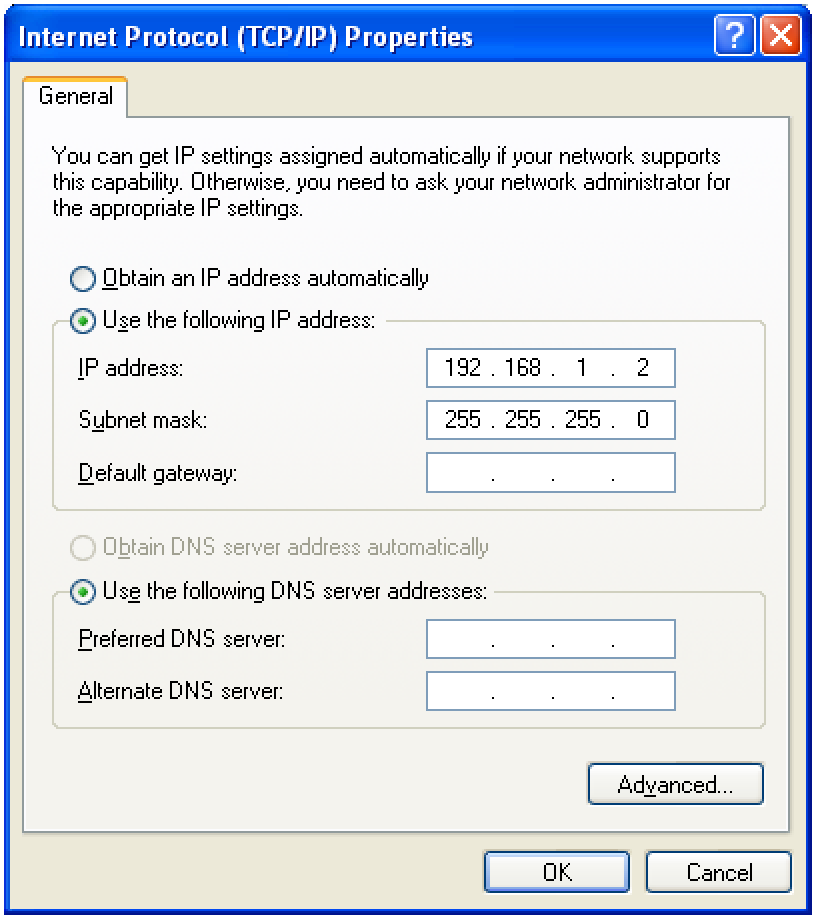
D:\projects\tftp_root\twrmpc5125

Enable Writes [ ] Start Minimized [ ]

Status: Idle

Figure 5-7 TFTP server settings

Step2. Manual configure your IP address as figure bellow:



You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

Obtain an IP address automatically [✓ Use the following IP address:]

IP address: 192 . 168 . 1 . 2

Subnet mask: 255 . 255 . 255 . 0

Default gateway: . . .

Obtain DNS server address automatically [✓ Use the following DNS server addresses:]

Preferred DNS server: . . .

Alternate DNS server: . . .

Figure 5-8 IP configure manual settings

Step3. Setting up HyperTerminal

To ensure that applications run correctly, the HyperTerminal is used on your computer to get events from the device that running the application. These steps are used to configure the HyperTerminal program:

1. Open HyperTerminal applications as shown in **Figure 5-9**

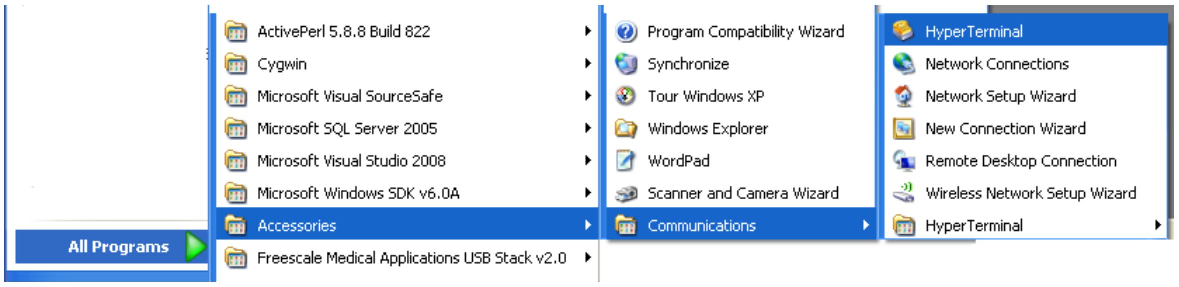
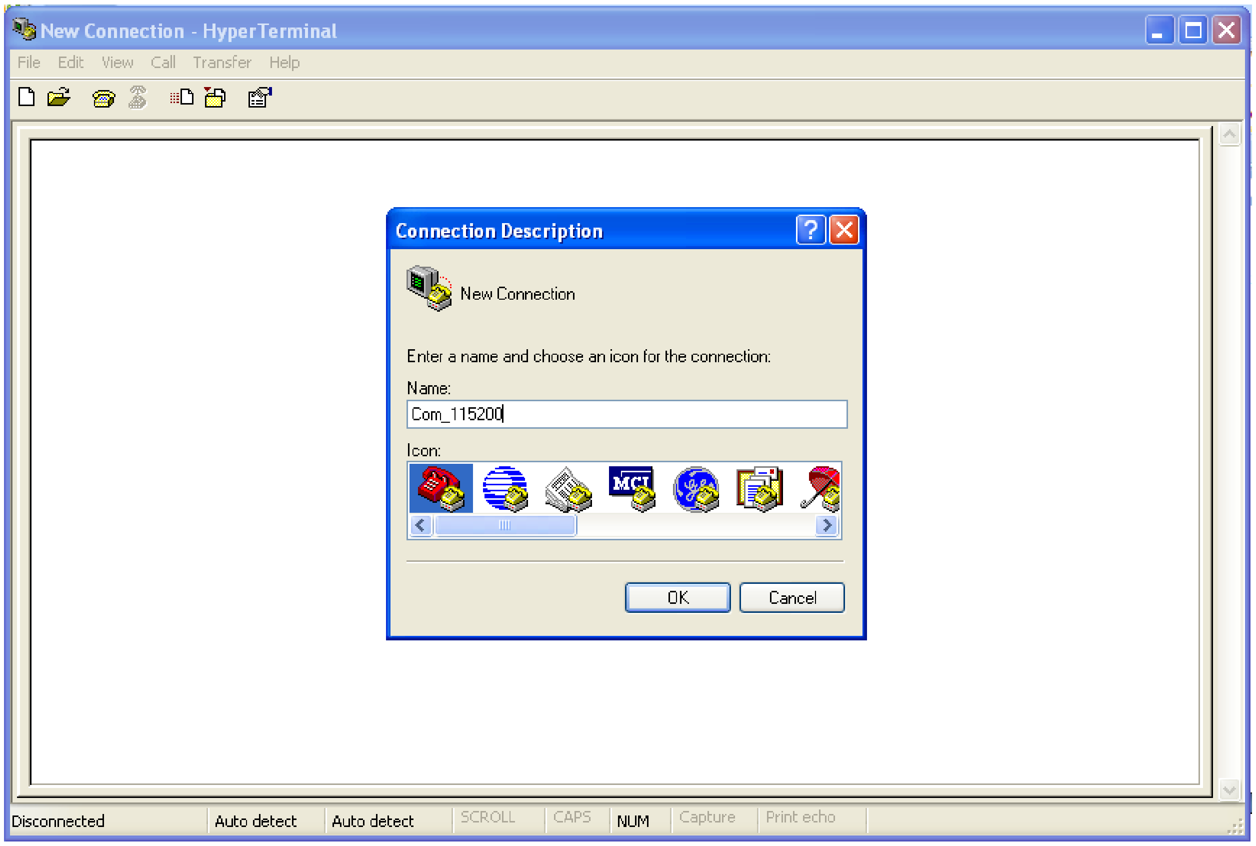

All Programs
ActivePerl 5.8.8 Build 822
Cygwin
Microsoft Visual SourceSafe
Microsoft SQL Server 2005
Microsoft Visual Studio 2008
Microsoft Windows SDK v6.0A
Accessories
Freescale Medical Applications USB Stack v2.0
Program Compatibility Wizard
Synchronize
Tour Windows XP
Windows Explorer
WordPad
Scanner and Camera Wizard
Communications
HyperTerminal
Network Connections
Network Setup Wizard
New Connection Wizard
Remote Desktop Connection
Wireless Network Setup Wizard
HyperTerminal

Figure 5-9 Launch HyperTerminal Application

2. The HyperTerminal opens as shown in*Error! Reference source not found.*. Enter the name of connection and click on the **OK** button.

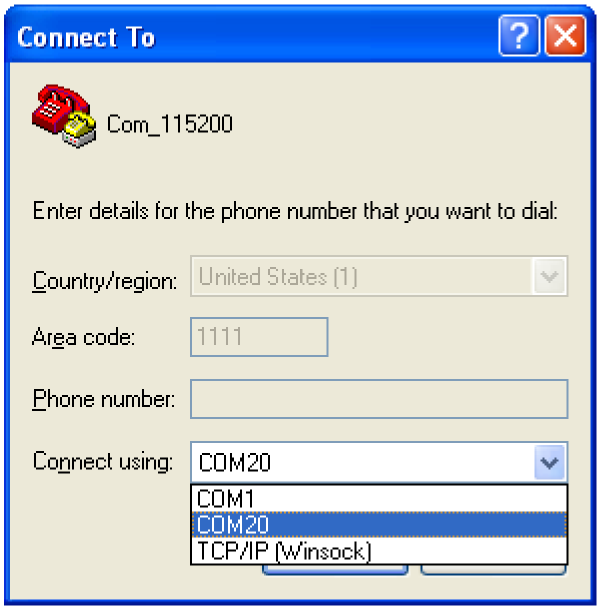


Enter a name and choose an icon for the connection:

Name: Com_115200

Figure 5-10 HyperTerminal GUI

3. The window shown in the **Figure 5-11** appears. Select the COM port appropriates with the COM port that you connect to the board.



Connect To

Com_115200

Enter details for the phone number that you want to dial:

Country/region: United States (1)

Area code: 1111

Phone number:

Connect using: COM20

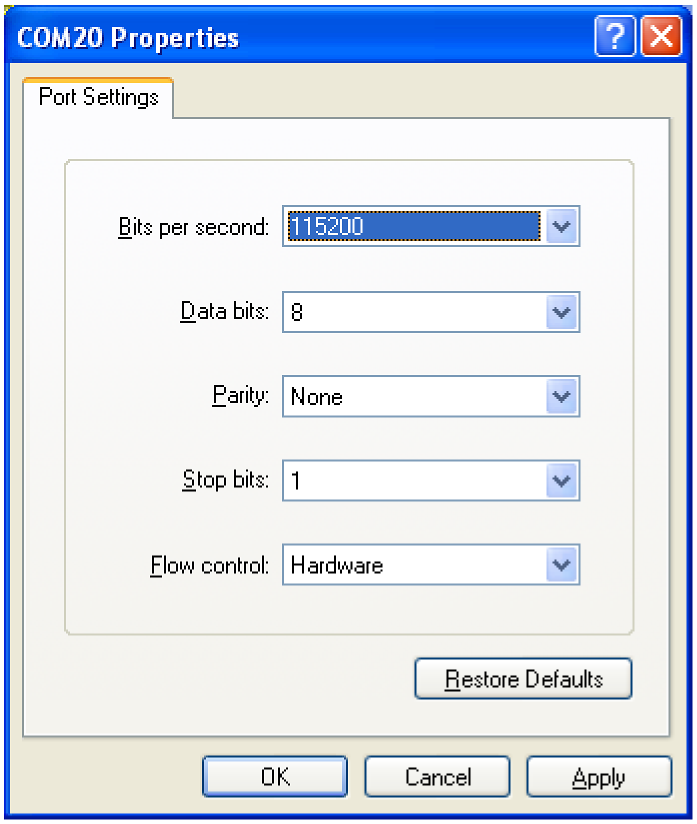
COM1

COM20

TCP/IP (Winsock)

Figure 5-11 Connect using COM8

4. In the next window set the communication baud rate to 115200, data length to 8, no parity, one stop bit and no flow control, then click **OK** to complete the HyperTerminal configuration. Configure the virtual COM port baud rate and other properties as shown in **Figure 5-12**



COM20 Properties

Port Settings

Bits per second: 115200

Data bits: 8

Parity: None

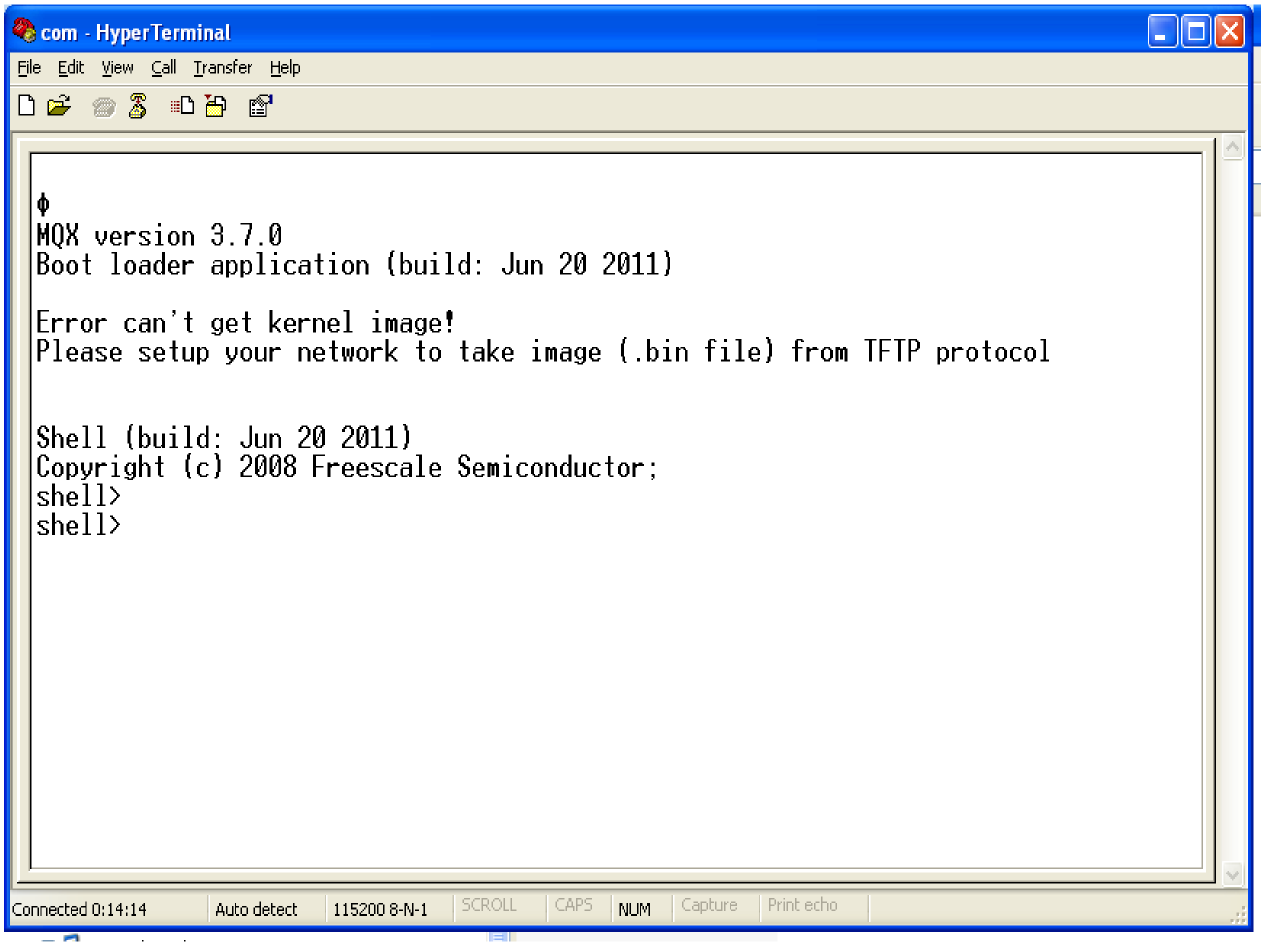
Stop bits: 1

Flow control: Hardware

Figure 5-12 COM8 Properties

5. The HyperTerminal is configured now.

Step4. Run Boot loader application.



```
ϕ
MQX version 3.7.0
Boot loader application (build: Jun 20 2011)

Error can't get kernel image!
Please setup your network to take image (.bin file) from TFTP protocol


Shell (build: Jun 20 2011)
Copyright (c) 2008 Freescale Semiconductor;
shell>
shell>
```

```
Connected 0:14:14   Auto detect   115200 8-N-1   SCROLL   CAPS   NUM   Capture   Print echo
```

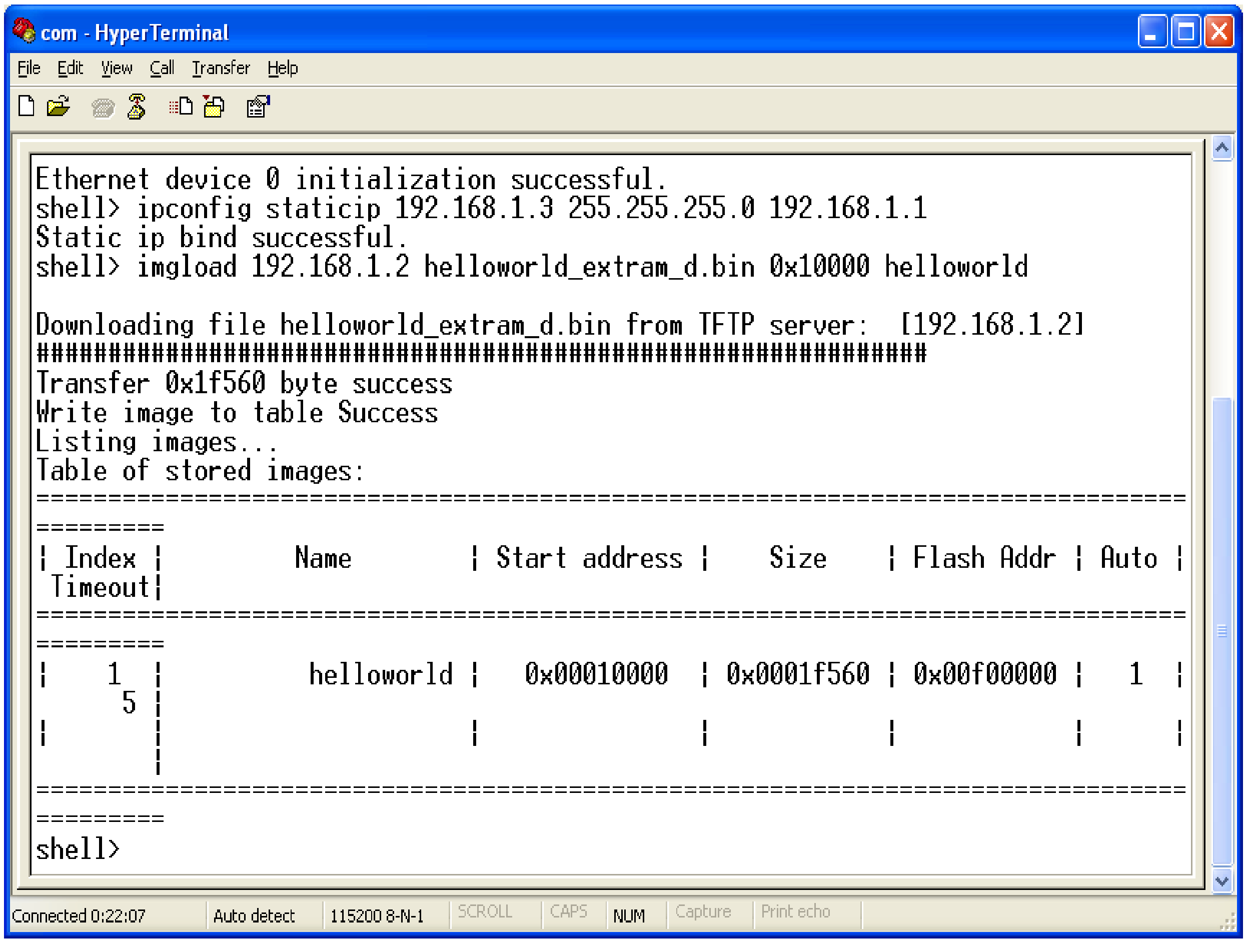
Figure 5-13 Bootloader started with no image

Step5. Configure board net IP address

```
shell> ipconfig 0 init
Ethernet device 0 initialization successful.
shell> ipconfig staticip 192.168.1.3 255.255.255.0 192.168.1.1
Static ip bind successful.
shell>
```

Step5. Load image to Flash

```
shell> imgload 192.168.1.2 helloworld_extram_d.bin 0x10000 helloworld
```



```
Ethernet device 0 initialization successful.
shell> ipconfig staticip 192.168.1.3 255.255.255.0 192.168.1.1
Static ip bind successful.
shell> imgload 192.168.1.2 helloworld_extram_d.bin 0x10000 helloworld

Downloading file helloworld_extram_d.bin from TFTP server:  [192.168.1.2]
##############################################################
Transfer 0x1f560 byte success
Write image to table Success
Listing images...
Table of stored images:
================================================================================
=========
| Index |          Name         | Start address |    Size     | Flash Addr | Auto |
 Timeout|
================================================================================
=========
|    1  |           helloworld |    0x00010000   | 0x0001f560 | 0x00f00000 |   1  |
     5  |
|       |                       |               |            |            |      |
        |
================================================================================
=========
shell>
```

Figure 5-14 Image is stored successful in flash

Step6. Run image

```
shell> imggo 1
```

If the Boot loader application is flash to Nand Flash memory by using Ext Nand Download targets, you can boot image from hard reset.