Internet of Things Wireless System Release (I-WSR) 1.4

Release Notes

MKG-16687 Ver. 2.0

August 15, 2011

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Revision history

Revision	Date	Description
Ver. 1.0	June 2011	Initial document for release 1.3
Ver. 2.0	August 2011	Document for release 1.4

Contents

1 Overview

This document serves as the release notes for the I-WSR 1.4 general availability (GA) release. The release includes:

- Source code for the host WLAN driver for Freescale™ MQX 3.6.2 or MQX 3.7
- MQX wireless interface documentation
- Host reflash elf image to (re)flash firmware corresponding to the host driver for this release

2 Supported Hardware and Software

2.1 Hardware Support

- The reference hardware includes a host platform and a WiFi card
- The supported WiFi card is:
  - TWR-WIFI-AR4100 Rev. C from Freescale; detailed hardware information can be found in the *TWR-WIFI-AR4100 Hardware Reference Guide*
  - TWR-WIFI-AR4100 Rev. C consists of the Qualcomm Atheros AR4100G 802.11n System in Package (SiP); information can be found in the *AR4100 System in Package 802.11n* data sheet
- I-WSR 1.4 supports 2 primary MCU families in a Tower System platform: ColdFire™ and Kinetis™. These specific MCUs have been used in the system integration:
  - ColdFire 52259 MCU (TWR-MCF5225X), 512 KByte Flash and 64 KByte RAM
  - Kinetis K60 MCU (e.g. TWR-K60N512), 512 KByte Flash and 64 KByte RAM
- MCU memory selection:
  When choosing an MCU from the ColdFire™ or Kinetis™ family, it is recommended to select a device with 256 KByte of Flash and 32 KByte or higher of RAM to enable the application and demos

2.2 Software Support

- AR4100 I-WSR1.4 host driver memory requirements:
  - Flash: 38 KByte
  - RAM: 10 KByte
- The host MCU runs with Freescale MQX™ Operation System version 3.6.2. The IDE environments that have been tested for this version of the OS are:
  - CodeWarrior™ v7.2 for the ColdFire 52259 system running MQX 3.6.2
  - IAR Embedded Workbench v6.10.5 for the Kinetis K60 system running MQX 3.6.2
  - Codewarrior 10.1 for the Kinetis K60 system running MQX 3.7

2.3 Power Supply Requirements

Table 1 shows the power supply requirements. See the *Measuring AR4100 Power Consumption on the TRW-WiFi-AR4100 Board application note* for actual power performance.

Supply Rail	Maximum Current Required
3.3 V	260 mA
1.8 V	110 mA

Table 1 Power Supply Requirements

Table 2 shows typical wakeup and connect times. Typical wakeup times are defined as the time it takes to wake in a typically loaded home network. Highly loaded and congested networks can incur a longer wake time.

Condition	Typical Wake Time
Time required from "off" until ready to transmit when STA connection is maintained on wakeup	160 ms
Time required from "off" until ready to transmit when STA connection loses connection on wakeup (and re-associating to the same AP on the same channel)	190 ms
Time required from "off" until ready to transmit when STA connection loses connection on wakeup (and a complete rescan is required)	500 ms

Table 2 Typical Wakeup and Connect Performance

I-WSR 1.4 has been tested using 3.3 V and 1.8 V supply voltages to the AR4100 SiP, as shown in the *TWR-WIFI-AR4100 Hardware Design Guide*.

2.4 System Release 1.4 Features

- Small host driver 38 KByte flash and 10 KByte RAM
- Store and Recall Feature allowing fast wake up-transmit-sleep functionality
- Firmware store and load from direct flash connection , increasing battery life of the overall system, enabling lower Flash foot print MCU, and faster wake up time
- Offload of Wireless Protected Setup (WPS) 2.0 enrollee functionality to AR4100
- Complete offload of WEP, WPA-PSK, WPA2-PSK, AES, and TKIP security to AR4100
- Full MAC support of infrastructure and ad hoc mode on the AR4100
- Support for extensive connect rates at 2.4 GHz (per 802.11 specification)
  - 802.11b at 1, 2, 5.5, and 11 Mbps
  - 802.11g at 6, 9, 12, 18, 24, 36, 48, and 54 Mbps
  - 802.11n at 6.5, 13.0, 19.5, 26.0, 39.0, 52.0, 58.5, 65.0, 72.2 Mbps
- Supports connectivity with 802.11n access points (APs) in HT20 (802.11n) mode in the 2.4 GHz band
- Supports connectivity with 802.11g and 802.11b access points
- Support for a new WFA-approved 802.11n ASD 0795 targeted for battery and sensor markets (http://www.wi-fi.org/getfile.php?file=WFA_Techops_ASD0795_Aug-08-2011.pdf)

2.5 Certifications

2.5.1 Hardware Certification

- System release 1.4 has received modular certification with the FCC, IC, CE, and other regulatory agencies. Specific guidelines, layouts, and other critical information is available in the AR4100 FCC certification packet.
- System release 1.4 has been submitted to the WiFi Alliance for application-specific device (ASD) certification.

2.5.2 Software Certification

- This release is certified to pass the WFA WPS2.0 certification suite for a STA device
- This release is certified to pass a new 802.11n ASD for battery and sensor based devices approved by WFA (0795) (http://www.wi-fi.org/getfile.php?file=WFA_Techops_ASD0795_Aug-08-2011.pdf)

2.6 AR4100 WiFi Firmware Management

- I-WSR1.4 supports firmware load from this flash only
- The SPI flash device must have a minimum of 256 KB words and be byte-oriented
- These devices have been tested and verified as working with the AR4100:

Vendor	Part Number
Spansion LLC	S25FL016KOXMFI010
Windbond	W25X20BVSNIG
Micron/Numonyx	M25P20-VMN6TPB
Micron/Numonyx	M25P40-VMN6TPB

2.7 References

- *AR4100 System in Package 802.11n* data sheet
- *AR4100 Power Consumption on the TRW-WiFi-AR4100 Board application note*
- *TWR-WIFI-AR4100 Hardware Reference Guide*

3 Testing

This release has undergone quality assurance (QA) test from the Qualcomm Atheros Solutions Product Engineering (SPE) test group using the TWR-WIFI-AR4100 AR4100-based board and the Freescale™ Tower system. Both the ColdFire™ and Kinetis™-host MCU were tested. A bulk of the testing was done using Netgear® WNR 854T APs, Cisco® 1200 series legacy APs, and Qualcomm Atheros reference APs.

Interoperability with other APs was covered as per the WiFi 802.11n and WPS requirements.

Testing covered these areas:

- Regression tests
  - Basic IP application support; TCP, UDP
  - Security (WPA-PSK, WPA2-PSK, WEP 40 bits and 104 bits)
  - Ad hoc
  - Sleep to wake up patterns of the target
  - 802.11b/802.11g/802.11n (HT20 + 2.4G band only)
  - Characterizing throughput performance over varying data payloads sizes.
  - Channel testing
  - Rate versus range: by varying the attenuation in a 1x1 802.11n cabled setup. Attenuation is varied in both directions.
- Certification tests
  - This release is certified to pass a new 802.11n ASD certification suite for battery and sensor based devices approved by WFA (0795) (http://www.wi-fi.org/getfile.php?file=WFA_Techops_ASD0795_Aug-08-2011.pdf)
  - WPS2.0 certification for station (STA) devices is certified to pass for this release
- Feature tests
  - Ultra low power store-recall
  - Power consumption (this suite has a separate test report)
    - Tests: disabled, enabled, disconnected (sleep + network scan state), associated idle state, associated sleep state, and power off states
    - Tests: Power consumption varying RSSI
  - Sleep to wake up state time
  - Beacon mode tests: testing to ensure the AR4100 has the capability to transmit raw data frames as both Unicast frames and Broadcast frames.

  - WPS as an Enrollee
    - Tests both PIN and push-button methods
    - Tests the WiFi WPS certification tests for an enrollee
    - These APs were tested successfully with WPS with both PIN mode and push-button mode: DLINK DIR 825, Netgear WNDR3300, Linksys WRT610N, Linksys WRT54G2, TRENDnet TEW432BRP
- Stress
  - Bi-directional traffic
  - Very long idle time stability
- Interoperability testing as defined by the WiFi WPS and 802.11n certification requirements
- Performance
  - Throughput in the transmit and receive direction
  - TCP and UDP
- The following were not tested:
  - WiFi Direct
  - Enterprise security: no enterprise security supplicant is available for the Freescale host
  - Fixed rate: API-to-fix rates not ported to Freescale reference host for size optimization

4 Performance

Performance is affected by many factors. Bottlenecks exist at different parts of the system, the largest of which determines the peak throughput rates that are achievable. The firmware used on the AR4100 is known to get at least 802.11g rates (mid 20 Mbps). The main bottle necks are:

- The bus interface:
  - The speed of the SPI bus
  - Support for DMA – a lack of DMA support causes more of the host CPU to be consumed feeding the bus. Additionally, a lack of DMA is further affected by the following:
    - Wait states between bursts, that is, the time it takes to fill up the FIFOs
    - Time between units of bus activity; e.g. time between each byte transmitted on the bus
- The host system:
  - The host MCU's CPU bandwidth affects rates that data can be generated or consumed at
  - The CPU bandwidth required to maintain the SPI bus further affects the available CPU bandwidth for other tasks
  - The amount of available memory to buffer data will affect how much parallelism and locality related efficiency (e.g., aggregation support) can be achieved in the system
  - The host OS system service efficiency and speed
  - The host's IP stack architecture
- The firmware:
  - Amount of memory headroom for buffers
    - To receive a burst over the air
    - To aggregate frames in the transmit direction to get better MAC level efficiencies due to aggregation
  - Protocol used between the host and the SoC; requiring more transactions causes the bus to turn around multiple times for potentially shorter bursts, affecting overall efficiency

The ColdFire 52259 system is constrained by the SPI interface. The SPI runs at 20 MHz, does not support DMA, has a 1.6 µs delay between each byte on the bus, and has a 16 byte FIFO with a delay of 30 µs between bursts. The performance measured on the ColdFire 52259 reference platform running MQX 3.6.2 for 1400 byte packets is:

	Uplink (AR4100→AP)	Downlink (AP→AR4100)
UDP	1.9 Mbps	1.0 Mbps
TCP	1.2 Mbps	1.4 Mbps

The current versions of MQX do not support DMA on the Kinetis K60 reference platform. The performance measured on a Kinetis K60 reference system running MQX 3.6.2 is as follows:

	Uplink (AR4100→AP)	Downlink (AP→AR4100)
UDP	1.9 Mbps	1.4 Mbps
TCP	1.4 Mbps	1.4 Mbps

Performance on MQX3.7 has been improved as shown below for a Kinetis K60:

	Uplink (AR4100→AP)	Downlink (AP→AR4100)
UDP	2.6	2.4
TCP	2.1	1.7

5 Known Issues and Limitations

- The application is expected to explicitly disconnect from one AP before it will be successful in connecting to another AP. This is even in the case of WPS. This is the expected behavior.
- WEP keys are required to be in HEX characters of 10 to 26 digits. Passphrases are not supported at this time.
- The Store-Recall feature to achieve low power should not be used along with the traditional IEEE power-save mode.
- The RTCS stack has been configured with re-assembly enabled in the demos. This is done by enabling RTCSCFG_ENABLE_IP_REASSEMBLY. This allows receiving packets larger than 1500 bytes.
- The installers for MQX3.6.2 and MQX3.7 currently do not install on top of each other. To use the second installer, the first installer must be removed. If it is desired to have both installations (MQX 3.6.2 and MQX 3.7) present at the same time on a machine, use the workaround of manually copying the first installation to a new area before using the installer to remove it.

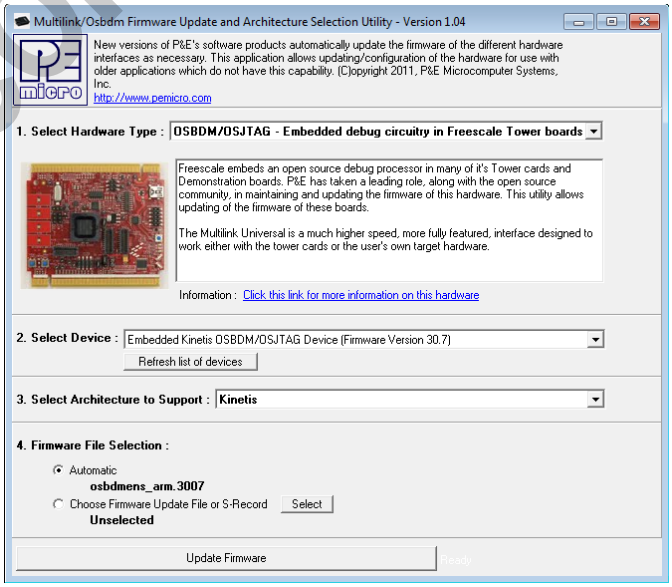
6 Installation

6.1 Working with CodeWarrior (CW) 10.1 and MQX 3.7

1. Download and install CodeWarrior™ 10.1.
2. To build applications for Kinetis platforms, a compiler patch will be required.
   Detailed steps for patching are available at this Freescale site. Use the online update tool.
   http://cache.freescale.com/files/soft_dev_tools/doc/support_info/CW_MCU_v10.1_Update_Procedure.pdf?fpsp=1

6.1.1 OSBDM Firmware Upgrade

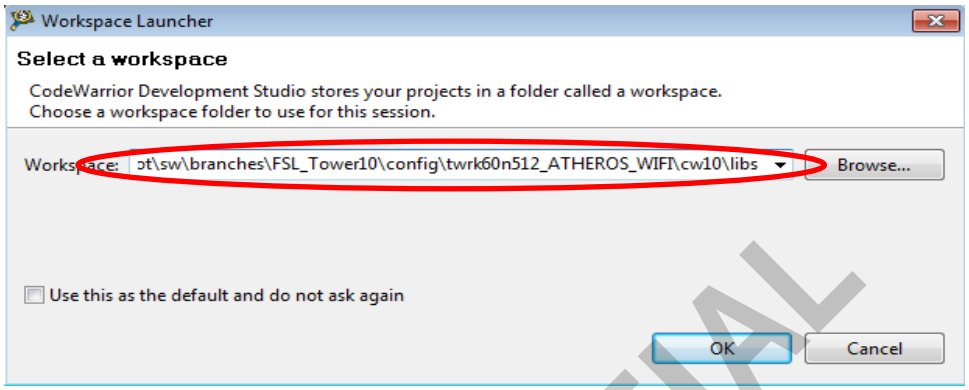
1. CW 10.1 requires OSBDM Firmware version 30 or above. In most cases for Kinetis boards, the firmware must be updated. To update the firmware, download the Firmware updater utility from PE Micro website at: http://www.pemicro.com/osbdm/index.cfm. This website may require registering an account. The utility updates to the latest firmware by default.
2. On the Kinetis K60, place a jumper on the boot pin (J10) to put the board in bootloader mode.
3. Run **PEFirmwareUpdater.exe**.
4. From the drop box labeled "1. Select Hardware Type", select "**OSBDM/OSJTAG – Embedded debug circuitry in Freescale Tower boards**".
5. From "2. Select Device", select the board that needs the firmware updated. If the device is not listed, choose "**Refresh list of devices**".
6. From "3. Select Architecture to Support", select the OSBDM board design type. This field may be auto populated after selecting the device.
7. From "4. Firmware file selection", check **Automatic**.
8. Click on the **Update Firmware** button and follow the instructions to update the firmware.
9. Once the firmware updates, unplug the USB cable and remove the jumper from the boot pin (J10).



6.1.2 Creating the Workspace

CW 10.1 requires a valid workspace to build applications. Before creating the workspace, please ensure that MQX 3.7 source tree is installed on the system and the Qualcomm Atheros Driver patch has been applied to it.

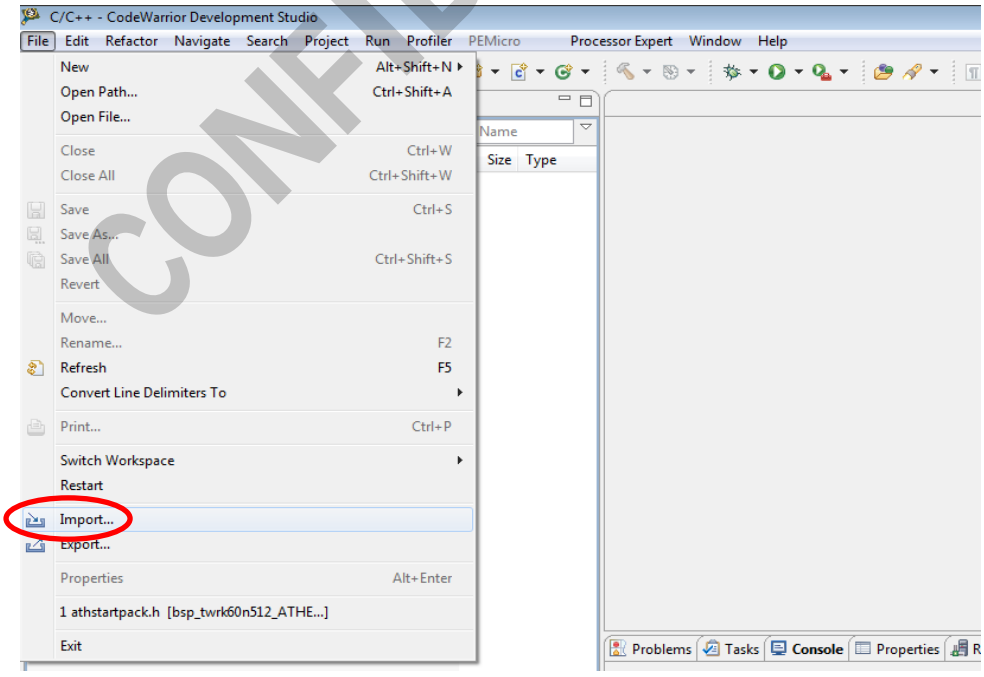
Open CW 10.1. A prompt asks users to select a workspace; Qualcomm Atheros advises creating the workspace in the folder **config\ twrk60n512_ATHEROS_WIFI\cw10**.



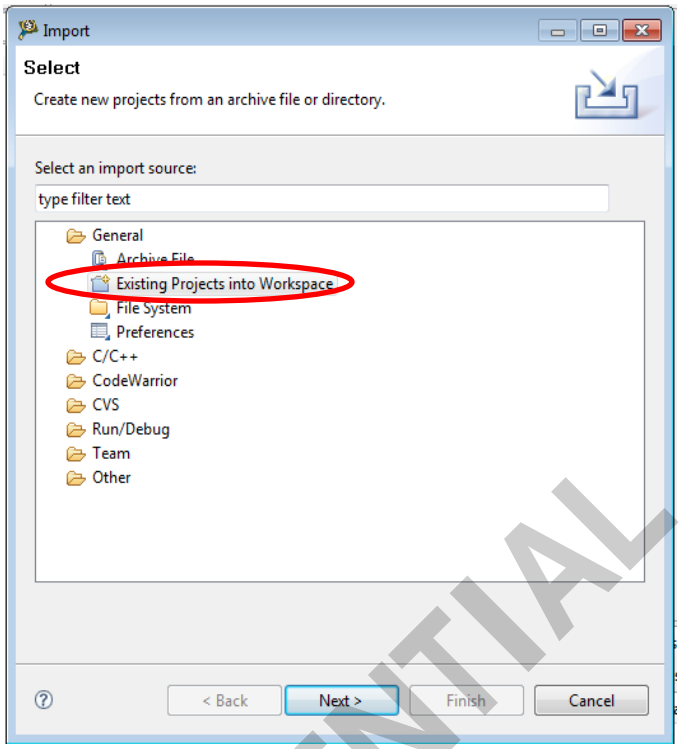
6.1.3 Building Libraries

All MQX-based applications use certain libraries that must be built before building any applications or demos.

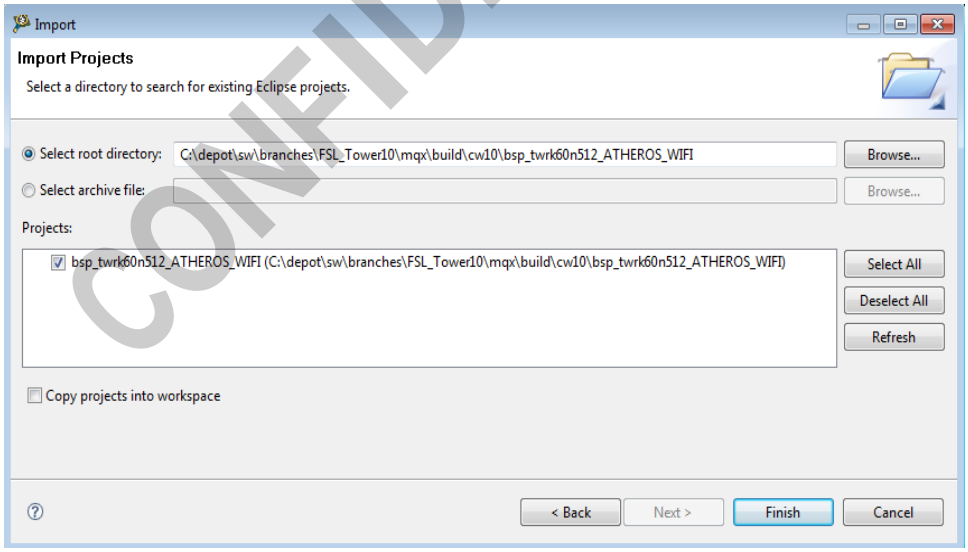
1. To build a library, first add the corresponding project file to the workspace. Click **File > Import**.



2. In the Import window, select **General > Existing Projects into Workspace**. Click **Next**.

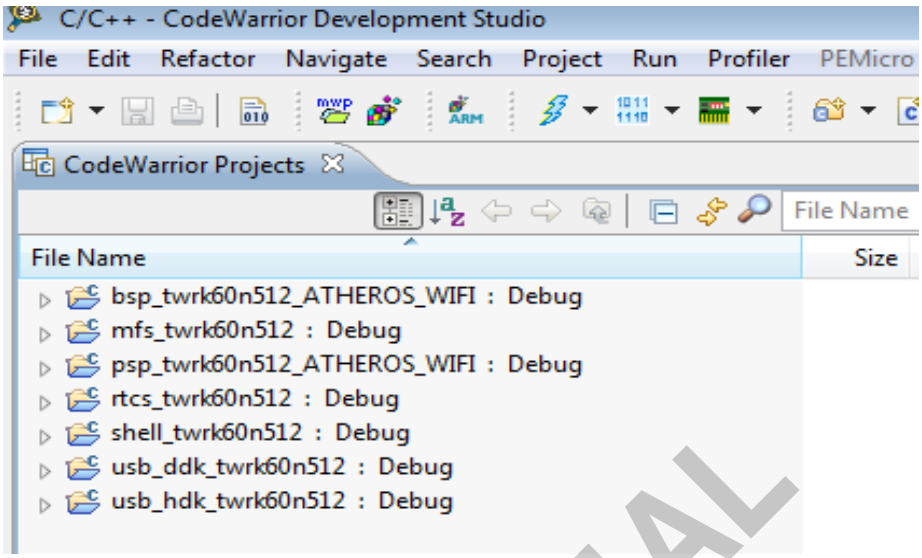


3. Browse to the corresponding root directory for the project. For example, for the BSP project, browse to **mqx\build\cw10\bsp_twrk60n512_ATHEROS_WIFI**.

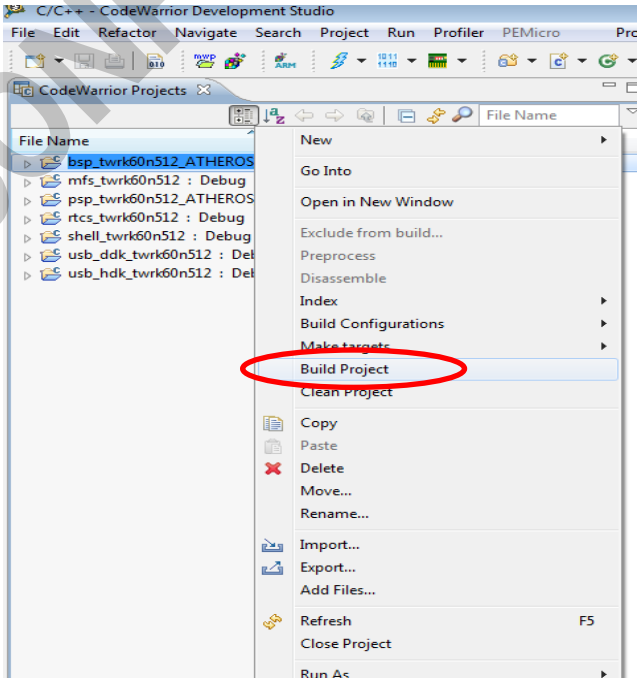


4. Click **Finish**. BSP project is added to the workspace.

Repeat steps 1 to 4 to add the PSP, MFS, RTCS, Shell, and USB library projects. After all library projects are added, the structure looks like this:



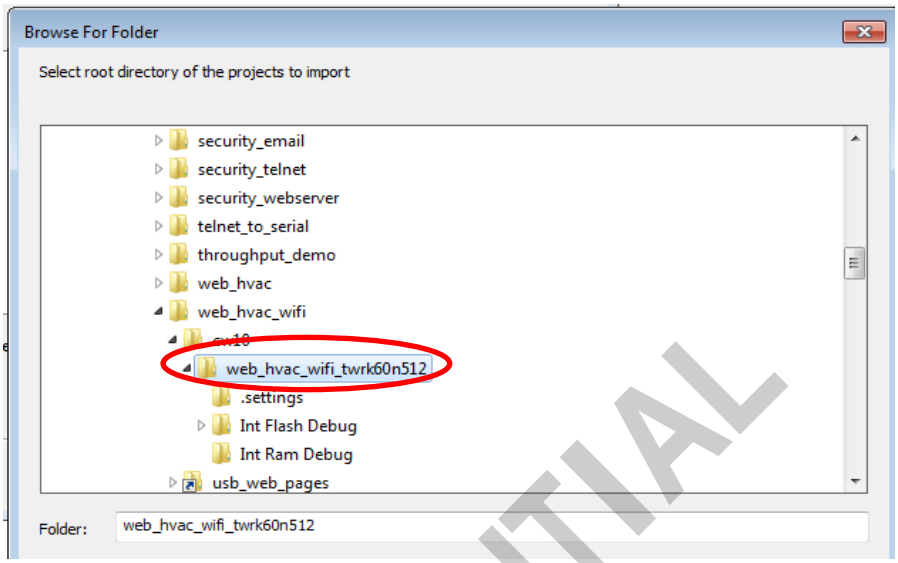
5. Build all the libraries:
   a. Right-click on project in the CodeWarrior Projects Pane and click **Build Project**. The libraries have inter-dependencies, so they must be built in this order:
      i BSP
      ii PSP
      iii MFS
      iv RTCS
      v Shell
      vi USB



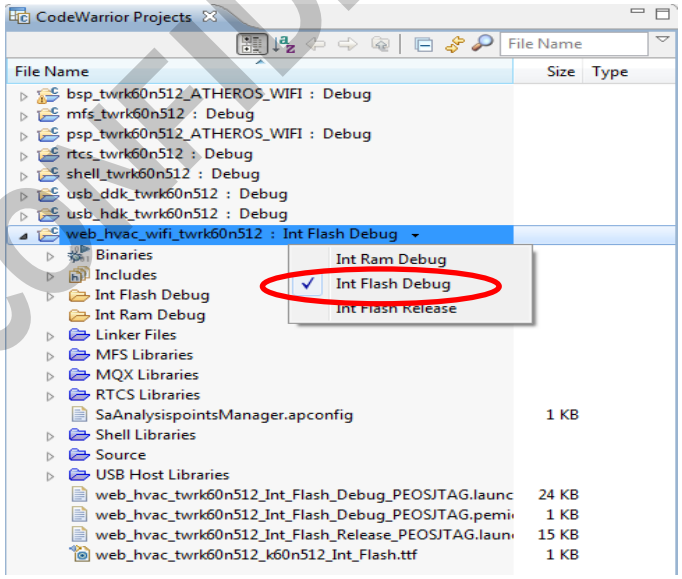
6.1.4 Building Demo Applications

Once all libraries are built, build the demo applications. These steps are similar to building the library project.

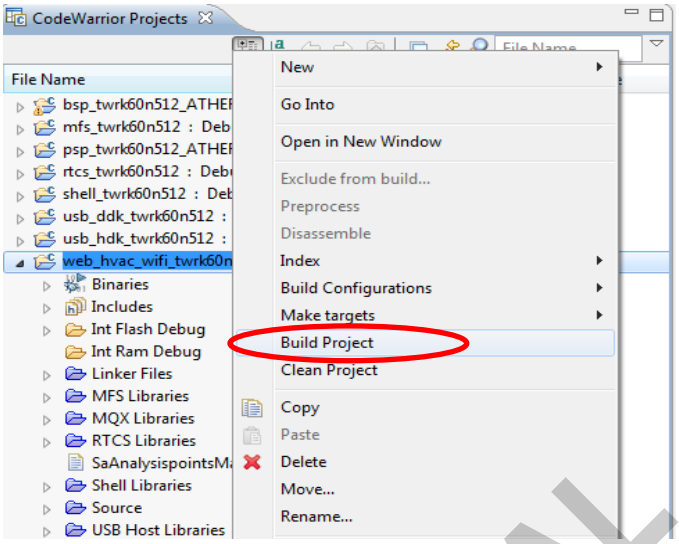
1. Import a demo project to the workspace.



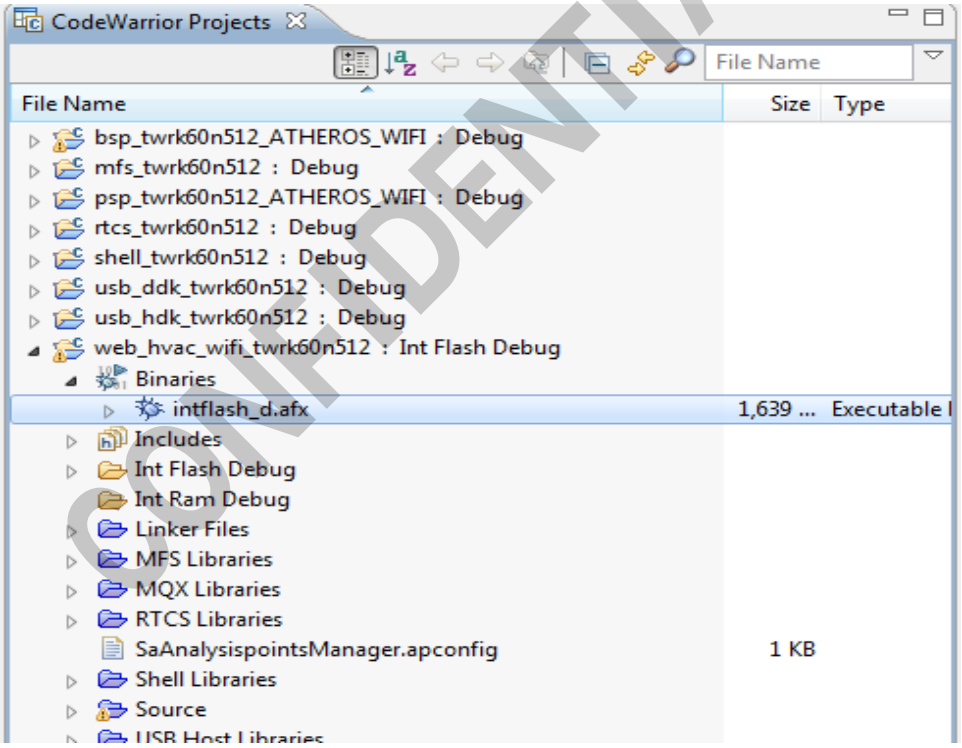
NOTE: Make sure that either the **Int Flash Debug** or **Int Flash Release** build configuration option is selected for demo projects.



2. Build the demo application by right-clicking on the project and choosing **Build Project**.

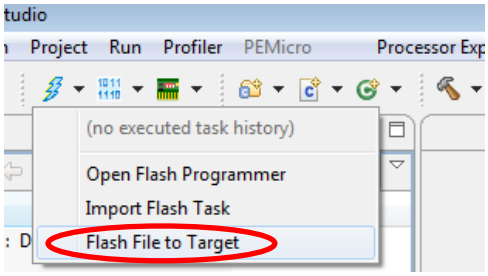


3. If the project is built successfully, an output file (**.afx**) shows up in the **Binaries** directory.

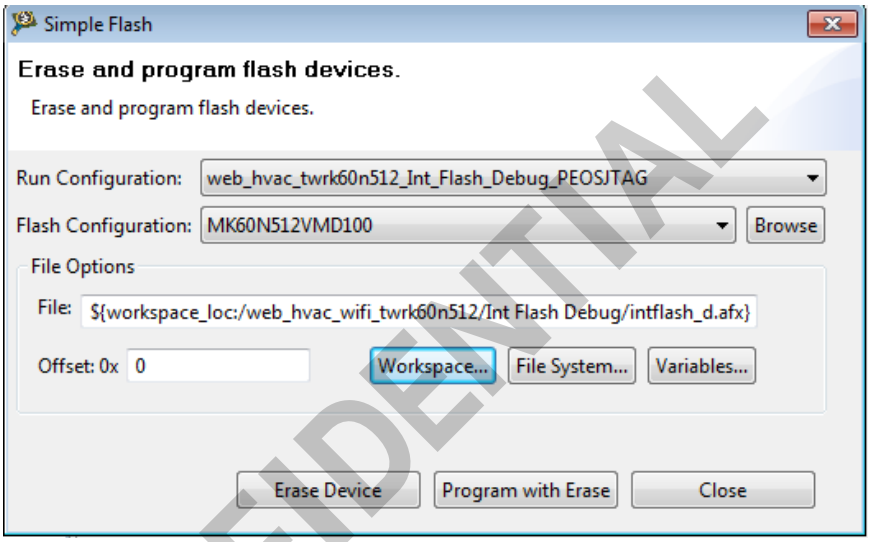


6.1.5 Downloading an Image to the Kinetis Platform

1. From the drop-down list next to the Flash programmer Icon, choose **Flash File to Target**.

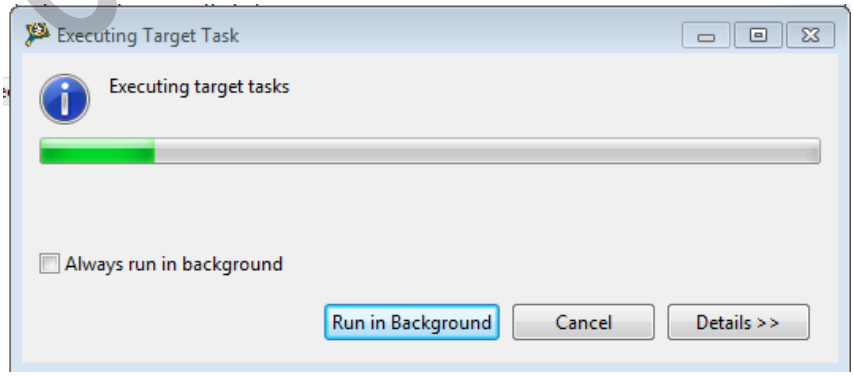


2. The Flash Programmer window opens.



Make sure that "Run Configuration" corresponds to the correct configuration (Debug or Release).

3. Select the file to download from the workspace (click **Workspace**), or specify a previously built file by browsing the File System (click **File System…**).
4. Click **Program with Erase**. The process takes some time to finish.



The board is now programmed and ready for use.

5. Power cycle the board.

6.2 Working with MQX 3.6.2

This section shows the steps used to install the reference host driver. These installation steps use CodeWarrior (CW).

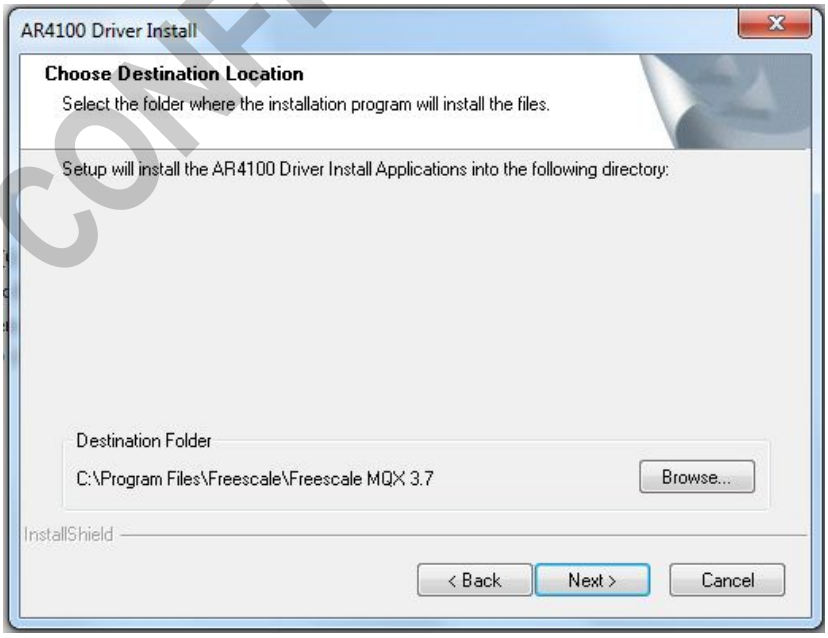
NOTE: Refer to the tool chain/development tool documentation on building, loading, and testing the driver.

6.2.1 Install the IOT Package

Install MQX 3.6.2 first. IOT setup will patch IOT-specific changes to the MQX tree:

1. Open **setup.exe** and read the click-through license.

2. Browse to the destination folder of the installed MQX package, then click **Next**.



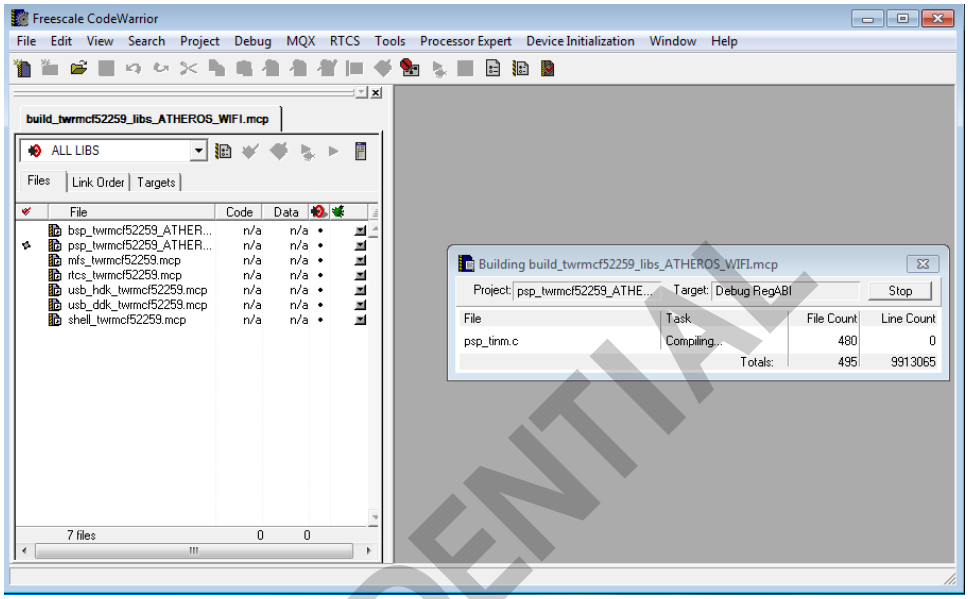
3. Once the package is installed, two new demo applications will be installed in the demo folder (**hvac_wifi** and **web_hvac_wifi**).

6.2.2 Building and Installing Demo Applications

The libraries must be built first.

6.2.2.1 ColdFire

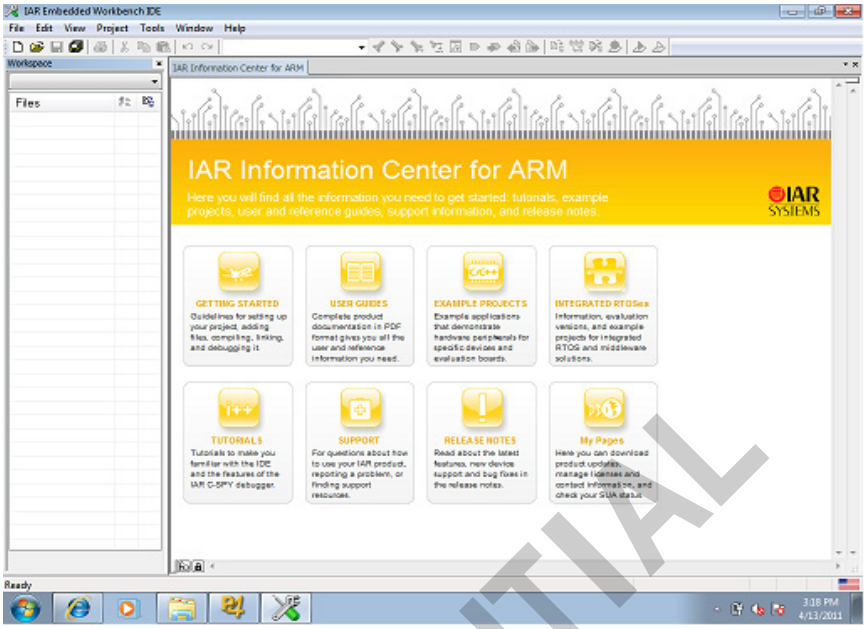
1. Browse to **mqx\config\twrmcf52259_ATHEROS_WIFI\cwcf72**.



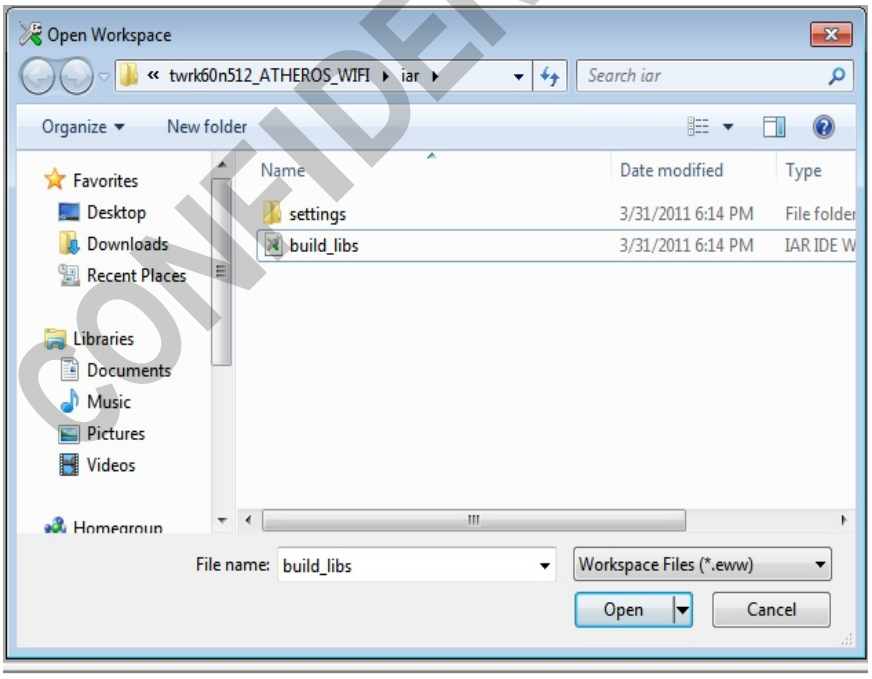
2. Click on the project file (.mcp) to open the project in CW.
3. Click **Make** to build the libraries.

6.2.2.2 Kinetis

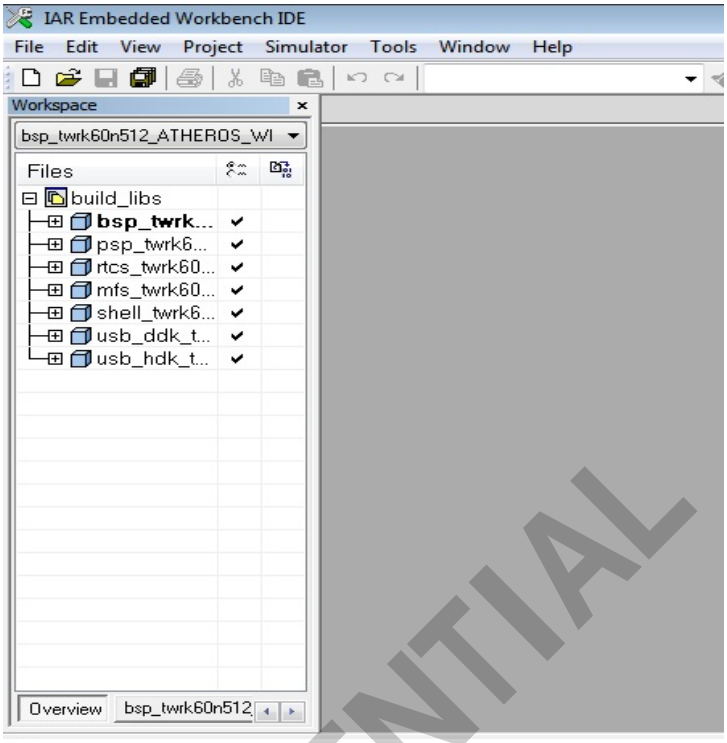
1. Click **File > Open > Workspace** to open the IAR Embedded workbench IDE.



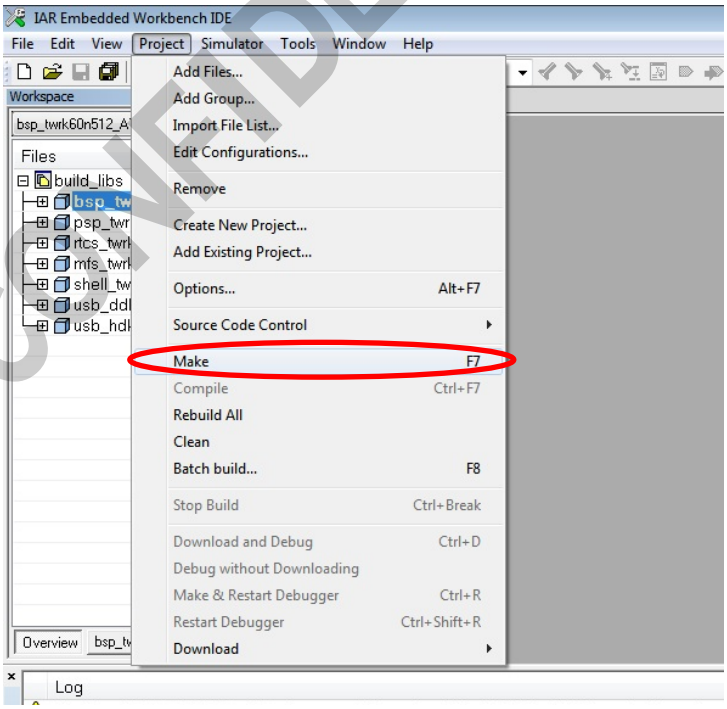
2. Browse to the folder mqx\config\twrf60n512_ATHEROS_WIFI\iar and select build_libs.



3. Click **View > Workspace** to see all the library projects in the workspace pane.



4. Select the first project in workspace, then click **Project > Make** or press **F7**.

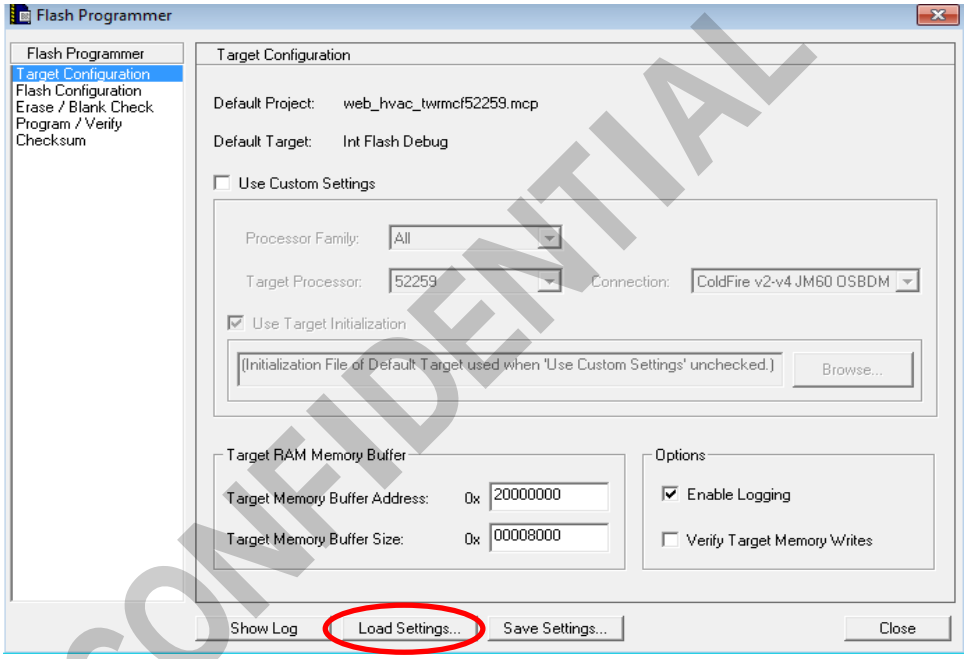


   a. Repeat for all libraries.

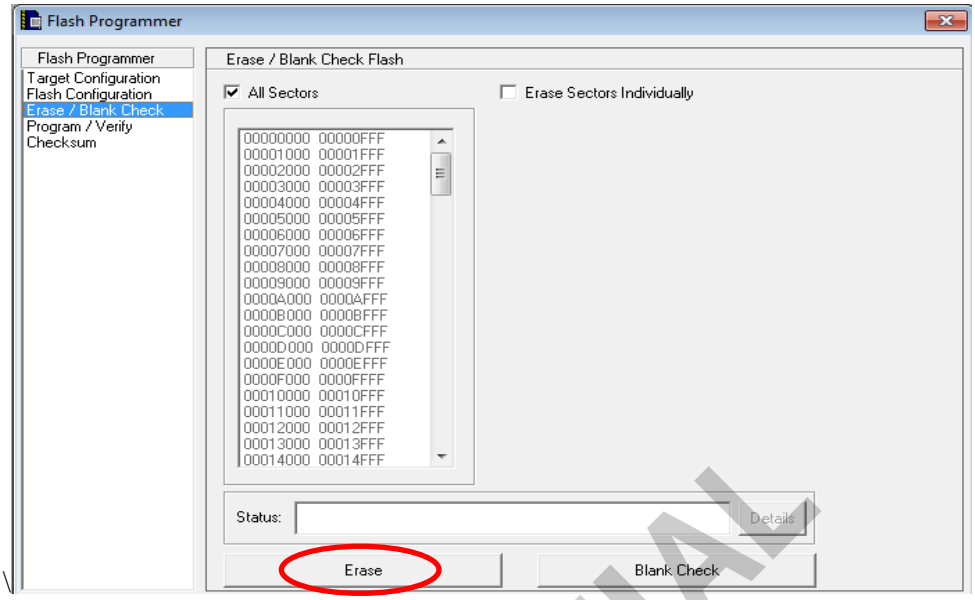
6.2.3 Building the Demos

6.2.3.1 ColdFire

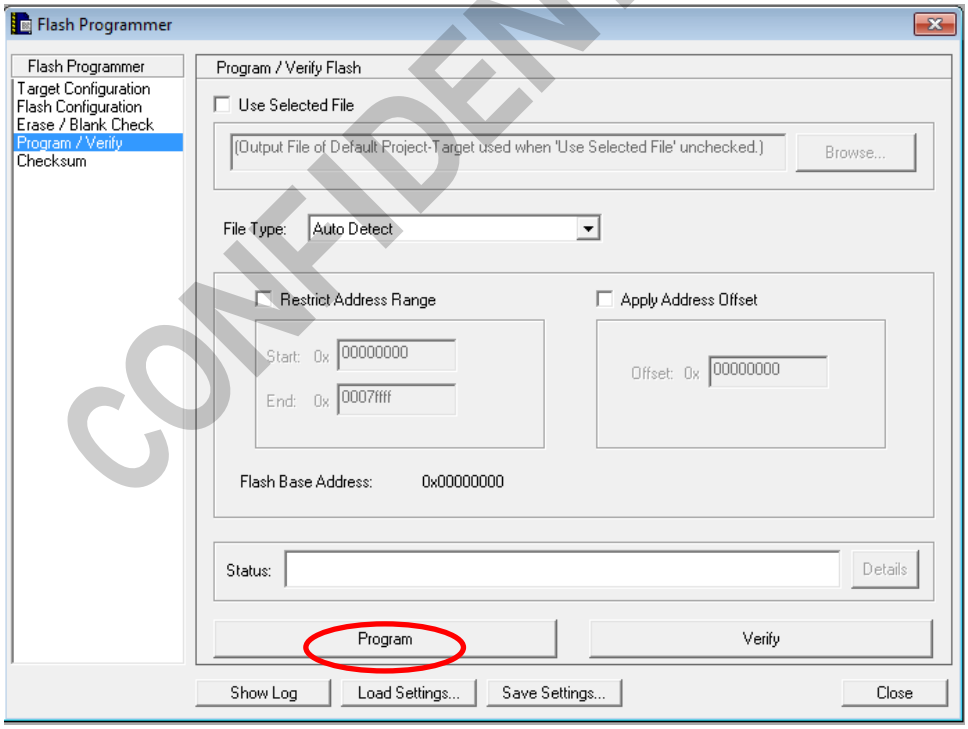
1. Browse to the corresponding **cwcf72** folder in the demo and double-click on the project file (.mcp) to open the project in the CW environment.
2. Click **Make**.
3. Open **Tools > Flash Programmer**.
4. Uncheck the **Use Current Settings** check box.
5. In the Flash Programmer window, ensure that Connection is set to **ColdFire v2-v4 JM60 OSBDM**.
6. Click **Load Settings** and select **MCF52259_INTDLASH.xml.**



7. Choose the **Erase/Blank Check** tab and click **Erase**.

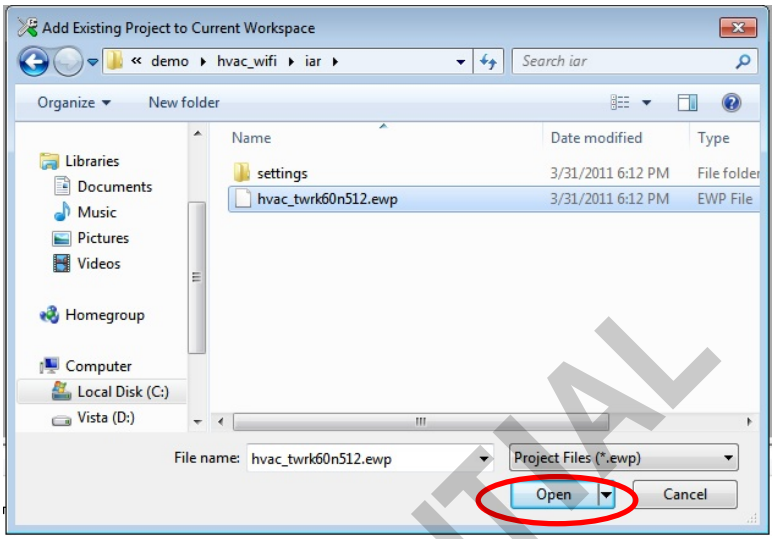


8. Choose the **Program/Verify** tab and click **Program** to download the image to the tower platform. A reset on the microcontroller will initialize the demo application.



6.2.3.2 Kinetis

1. In the IDE, choose Project > Add Existing Project.
2. Browse to the folder mqx/demo/hvac_wifi/iar and select hvac_twr60n512.ewp.
3. Click Open to add the demo project to existing workspace.



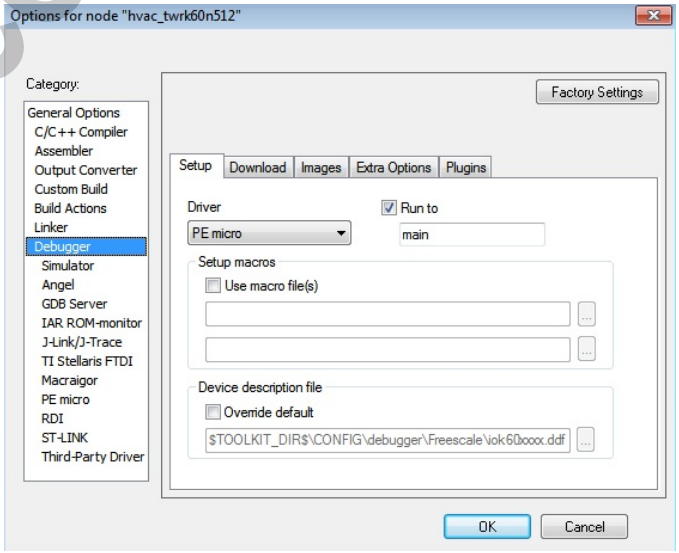
4. Select the demo project in the workspace and choose **Project > Make** or press **F7**.

6.2.4 Downloading to the Flash

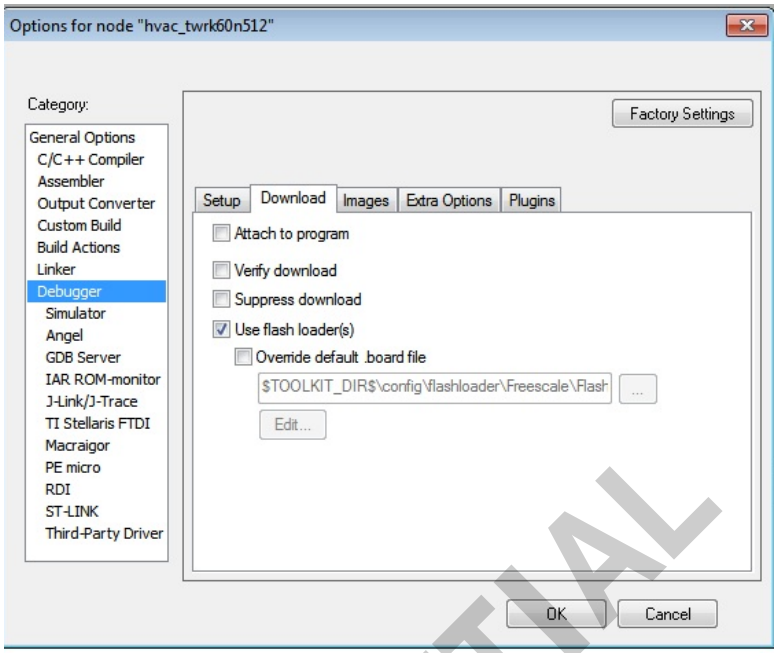
Once the project is built successfully, download the image:

5. Set up the debugger by right-clicking on a demo project in the workspace and choosing Options.
6. In Category, select **Debugger**. Ensure that:

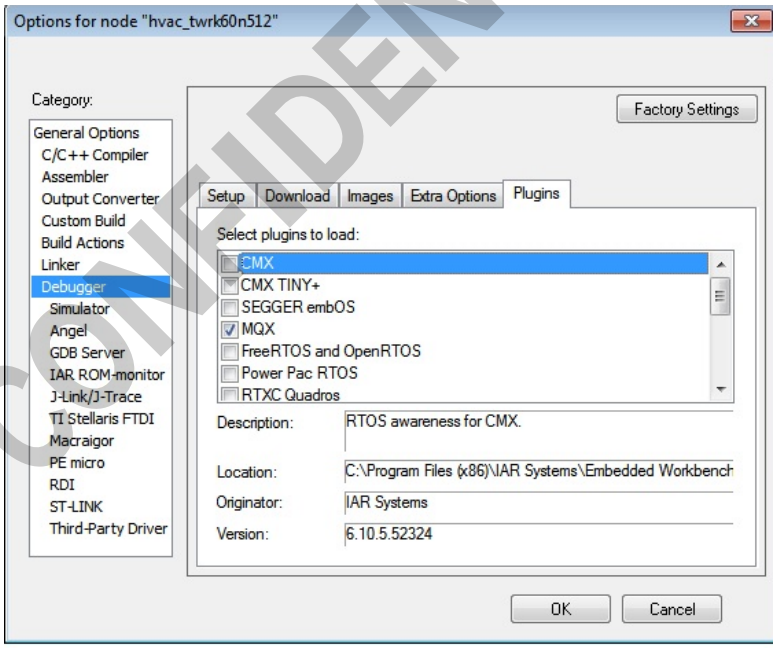
- In the Setup tab, PE Micro is selected as Driver.



- In the Download tab, the **Use Flash Loader** check box is checked.



- In the Plugins tab, MQX checkbox is checked.



7. In the Category tab, select PE micro. Ensure that the P&E Hardware Interface type is set to OSJtag.
8. Click Project > Download > Download Active Application to download the image.

   The board is now ready for use after a reset.

7 Reflashing the Development Kit

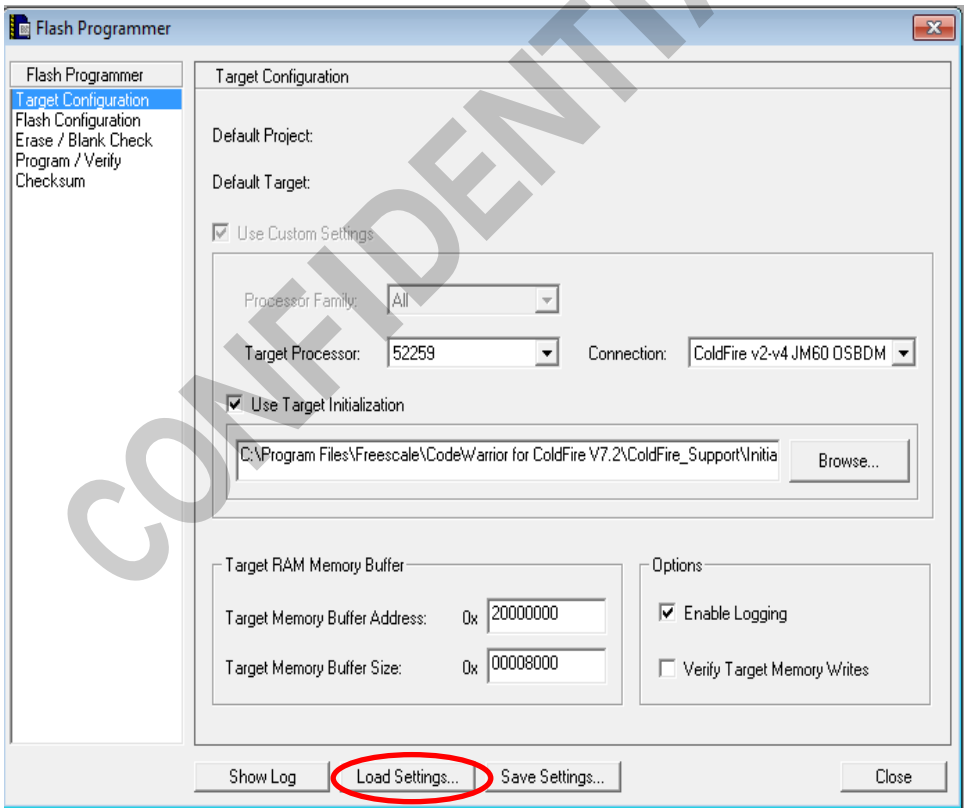
The AR4100 TWR-WIFI-AR4100 reference boards will be programmed with the firmware in the serial flash memory. These steps show how to re-flash the firmware with the latest one that is required for this release.

WARNING: Firmware does not typically require re-flashing. Care should be taken when following these steps.

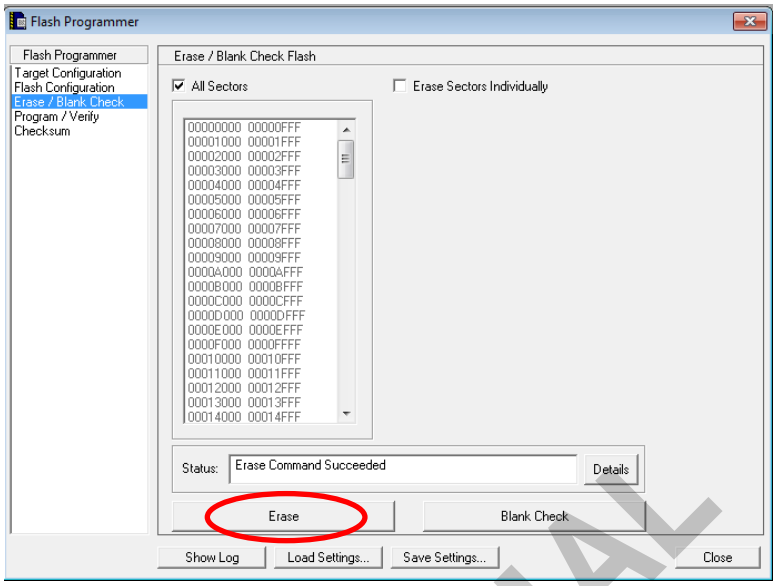
NOTE: These steps illustrate how to do this using the CW IDE. Equivalent steps will have to be taken when using other IDE/tool chain.

To upgrade the firmware image, program the re-flash elf image (**atheros_reflash_intflash_d.elf**) on the microcontroller board using CodeWarrior IDE tool.

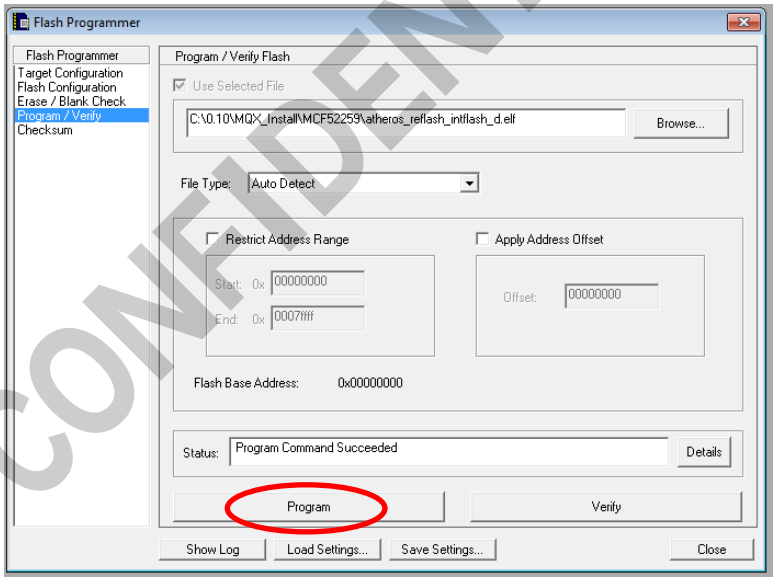
1. Open CodeWarrior IDE and choose **Tools > Flash Programmer**.
2. In the Flash Programmer window, ensure that Connection is set to **ColdFire v2-v4 JM60 OSBDM**.
3. Click **Load Settings** and select **MCF52259_INTDLASH.xml.**



4. On the **Erase/Blank Check** tab, click **Erase**.



5. On the **Program/Verify** tab, click **Browse** and select the **atheros_reflash_intflash_d.elf** file.
6. Click Program.



The board is now programmed.

Reset the board by pressing the **Reset** button. Once the programming is complete (it takes 5-10 seconds), two green LEDs will be lit indicating successful operation.

8 Lab Demos Included in this Release

- Web HVAC WiFi Lab - Sample application for web base command and control
- HVAC WIFI Lab– Command line version of the Web HVAC WiFi
- Throughput Lab – Sample application used to transfer packets for throughput measurements