

# TWR-ADCDAC-LTC

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## Lab Guide

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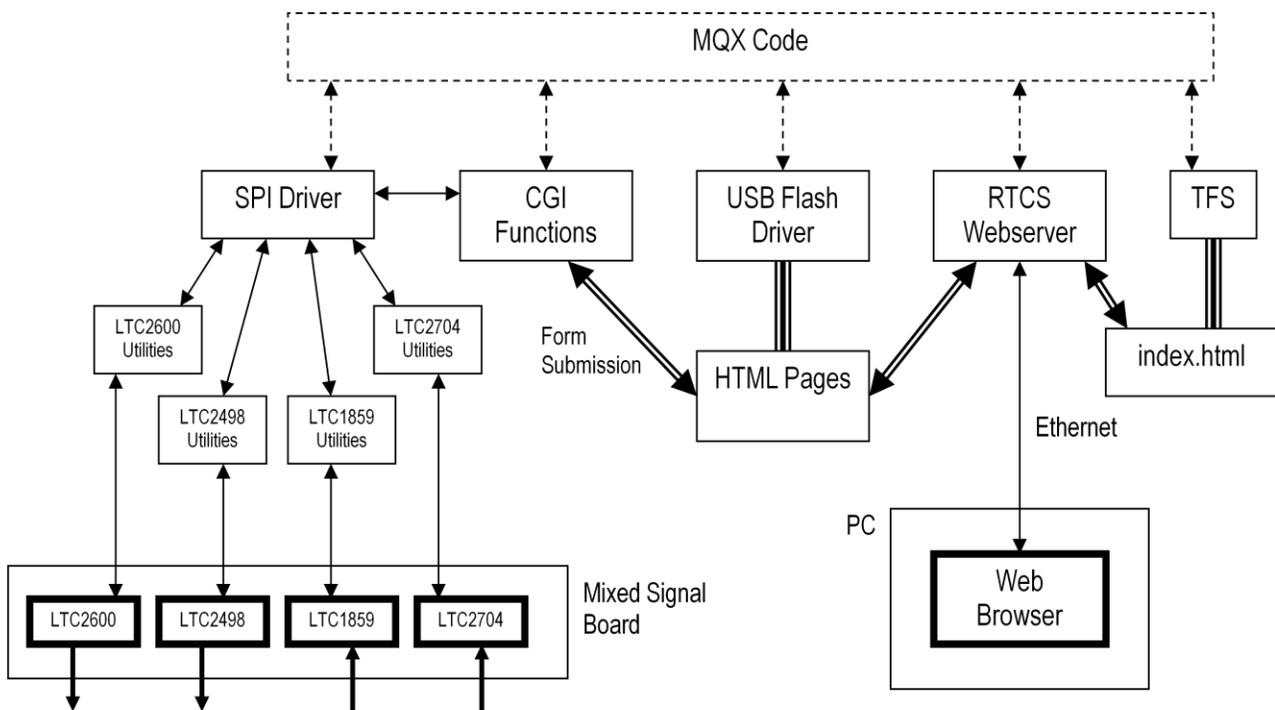
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# 1 Overview

**TWR-ADCDAC-LTC Lab Guide** describes the procedure for setting up a Freescale Tower peripheral **TWR-ADCDAC-LTC analog module** and demonstrates its usage. A readymade web enabled application using Freescale MQX™ RTOS is used for the demo purpose. Other than **TWR-ADCDAC-LTC** Tower Module, a Tower MCU module **TWR-K60D100M** (using IAR IDE) and a Tower peripheral module **TWR-SER** are also used. The first few sections of this manual describe the setting up of Freescale Tower hardware and remaining sections describe the usage of development tools.

This lab guide also describes the procedure for setup and execution of TWR-ADCDAC-LTC Demo Suite. This suite of software uses an embedded webserver to control the actions of both the MCU module and the TWR-ADCDAC-LTC analog module. An embedded USB host is utilized to store web pages and can also be used for data logging. Figure 1 shows the block diagram of the Demo Suite software and hardware system. Follow the steps in the relevant sections below to set up and go through the demo software.



**Figure 1.** TWR-ADCDAC-LTC Demo Suite System Overview

## 1.1 TWR-ADCDAC-LTC Hardware Overview

The TWR-ADCDAC-LTC is a Freescale Tower-compatible high-precision analog peripheral module with the following features:

- Controllable by any Freescale Tower controller module with an SPI interface

- Two Linear Technology digital-to-analog converters (DACs)
  - LTC2704-16: Quad 16-bit voltage output SoftSpan™ DAC with readback
  - LTC2600: Octal 16-bit rail-to-rail DACs
- Two Linear Technology analog-to-digital converters (ADCs)
  - LTC1859: 8-channel, 16-bit, 100 kps SoftSpan ADC with shutdown
  - LTC2498: 24-bit 8-/16-channel delta sigma ADC with Easy Drive™ input current cancellation
- Linear Technology voltage regulator
  - LTC3471: Dual 1.3A, 1.2 MHz boost/inverter
- Linear Technology voltage reference
  - LTC6655-5: 0.25 ppm noise, low drift precision buffered 5V reference
- Four 14-pin headers for connecting to any Linear Technology QuikEval™ demonstration board

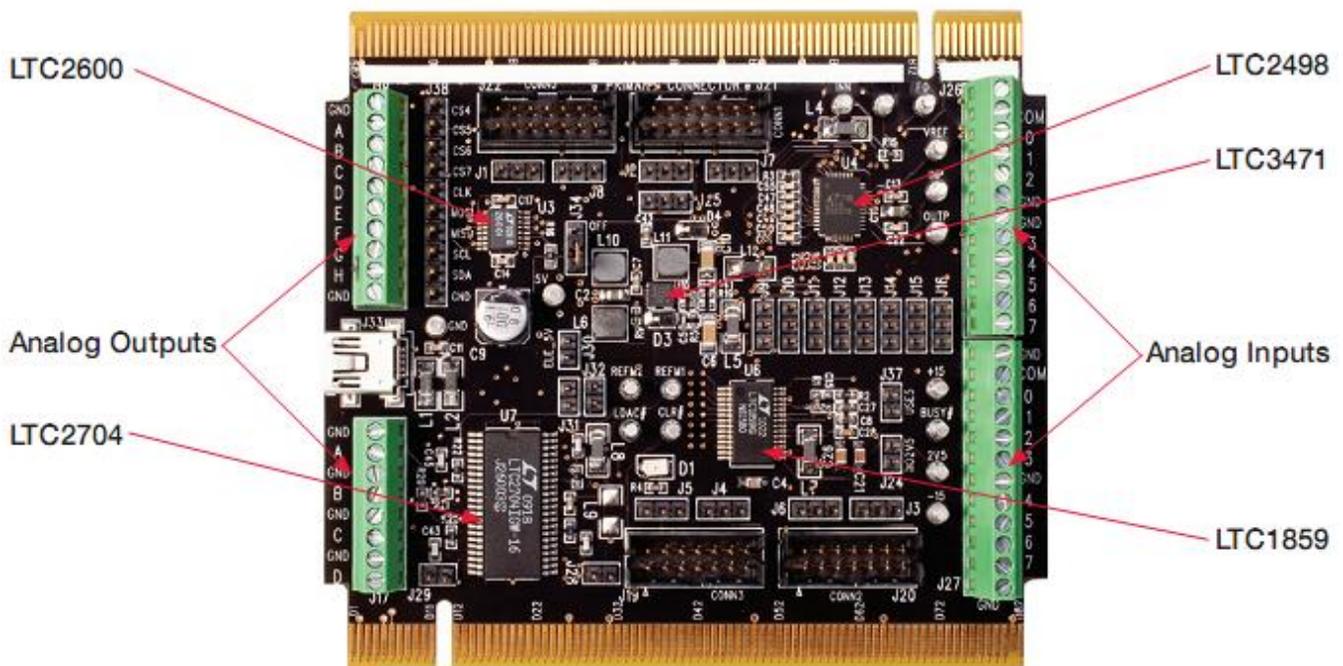


Figure 2. TWR-ADCDAC-LTC Feature Call-outs

## 2 References

For more information on the Freescale Tower System refer <http://www.freescale.com/tower>. The documents listed below should be referenced for more information on the Freescale TWR-ADCDAC-LTC.

- *TWRADCDACLTCQSG: TWR-ADCDAC-LTC Quick Start Guide*
- *TWRADCDACLTCUM: TWR-ADCDAC-LTC User's Manual*
- *TWRADCDACLTCSCH: TWR-ADCDAC-LTC Schematics*

These documents can be found in “Featured Documentation” section of TWR-ADCDAC-LTC Product Summary Page.

[http://www.freescale.com/webapp/sps/site/prod\\_summary.jsp?code=TWR-ADCDAC-LTC#](http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=TWR-ADCDAC-LTC#)

### 3 Hardware Configuration of TWR-ADCDAC-LTC

The hardware components required to run a demo using the TWR-ADCDAC-LTC Demo Suite are:

- Tower MCU Module: TWR-K60D100M(instructions for setup are provided in this document)
- Tower Analog module TWR-ADCDAC-LTC
- Tower Serial module TWR-SER
- Pair of Tower Elevators TWR-ELEV
- USB mini-B to A adapter (provided in TWR-ADCDAC-LTC box)
- USB Memory Stick (not provided)
- Various cables and wires (provided)
- Development Computer

The default jumper shunt positions for the TWR-ADCDAC-LTC are marked as RED in Figure 3, and shown in bold enclosed within asterisk (for SPI0) in Table 1.

The Tower MCU module and TWR-SER should be configured to settings as described in the relevant sections later in this document.

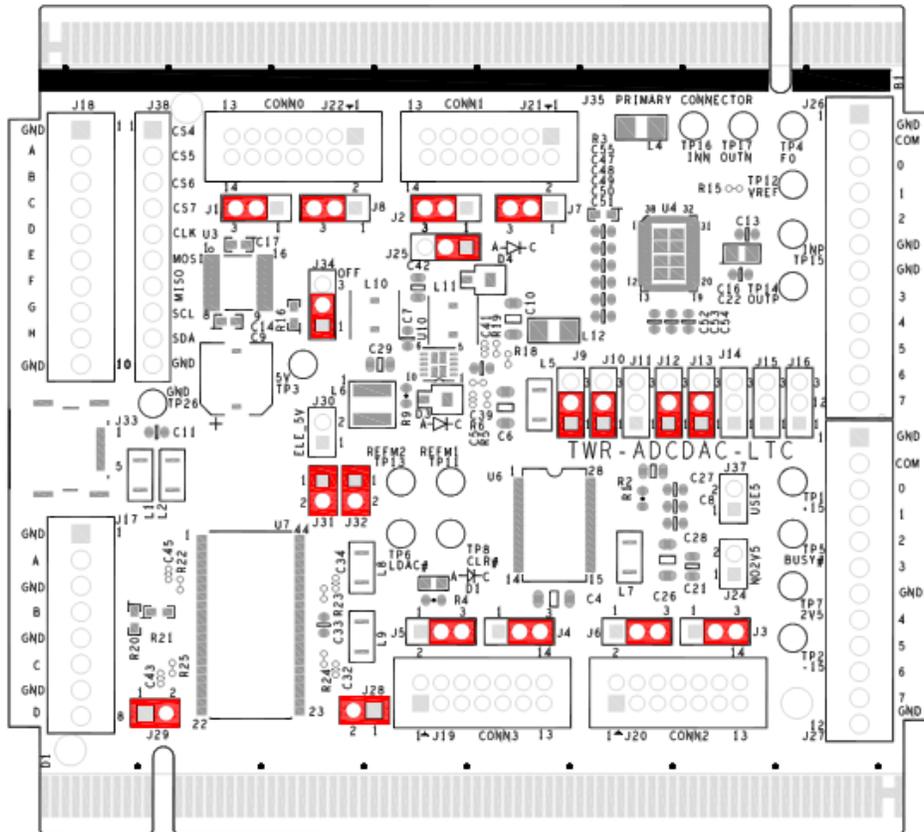


Figure 3. TWR-ADCDAC-LTC Default Jumper Settings

**Table 1.** TWR-ADCDAC-LTC Default Jumper and Switch Settings

Jumper	Option	Setting	Description
J1 - J8	QuickEval I <sup>2</sup> C/SPI Selection	1-2	Connect I <sup>2</sup> C signals to QuickEval header
		<b>*2-3*</b>	Connect SPI signals to QuickEval header
J9	SPI Port Selection -- SPI_CLK	<b>*1-2*</b>	Use SPI_CLK signal from SPI0
		2-3	Use SPI_CLK signal from SPI1
J10	SPI Port Selection -- SPI0_CSx	<b>*1-2*</b>	Select SPI0_CS0
		2-3	Select SPI0_CS1
J11	SPI Port Selection -- SPI1_CSx	1-2	Select SPI1_CS0
		2-3	Select SPI1_CS1
		<b>*OFF*</b>	SPI1 not used
J12	SPI Port Selection -- SPI_MOSI	<b>*1-2*</b>	Use SPI_MOSI signal from SPI0
		2-3	Use SPI_MOSI signal from SPI1
J13	SPI Port Selection -- SPI_MISO	<b>*1-2*</b>	Use SPI_MISO signal from SPI0
		2-3	Use SPI_MISO signal from SPI1
J25	SPI Port Selection -- SPI_CS	<b>*1-2*</b>	Use SPI0_CSx (see J10)
		2-3	Use SPI1_CSx (see J11)
J14	SPI Chip-Select Encoding Bit 0 Setting	1-2	Connected to 3.3V
		2-3	Connected to GND
		<b>*OFF*</b>	Driven by GPIO9
J15	SPI Chip-Select Encoding Bit 1 Setting	1-2	Connected to 3.3V
		2-3	Connected to GND
		<b>*OFF*</b>	Driven by GPIO8
J16	SPI Chip-Select Encoding Bit 2 Setting	1-2	Connected to 3.3V
		2-3	Connected to GND
		<b>*OFF*</b>	Driven by GPIO7
J28, J29, J31, J32	LTC2704 VOSx GND Connection	<b>*ON*</b>	Connect VOSA, VOSB, VOSC, VOSD to GND
		OFF	Disconnect VOSx from GND
J30	Tower Power Connection	ON	Connect on-board 5V rail to Tower System
		<b>*OFF*</b>	Isolate on-board 5V rail from Tower System
J34	LT3471 Shutdown	<b>*1-2*</b>	LT3471 voltage regulator enabled
		2-3	LT3471 voltage regulator disabled
J37	LTC1859 Reference Voltage Selection	ON	Use output of LTC6655-5 as reference
		<b>*OFF*</b>	Use GND as reference

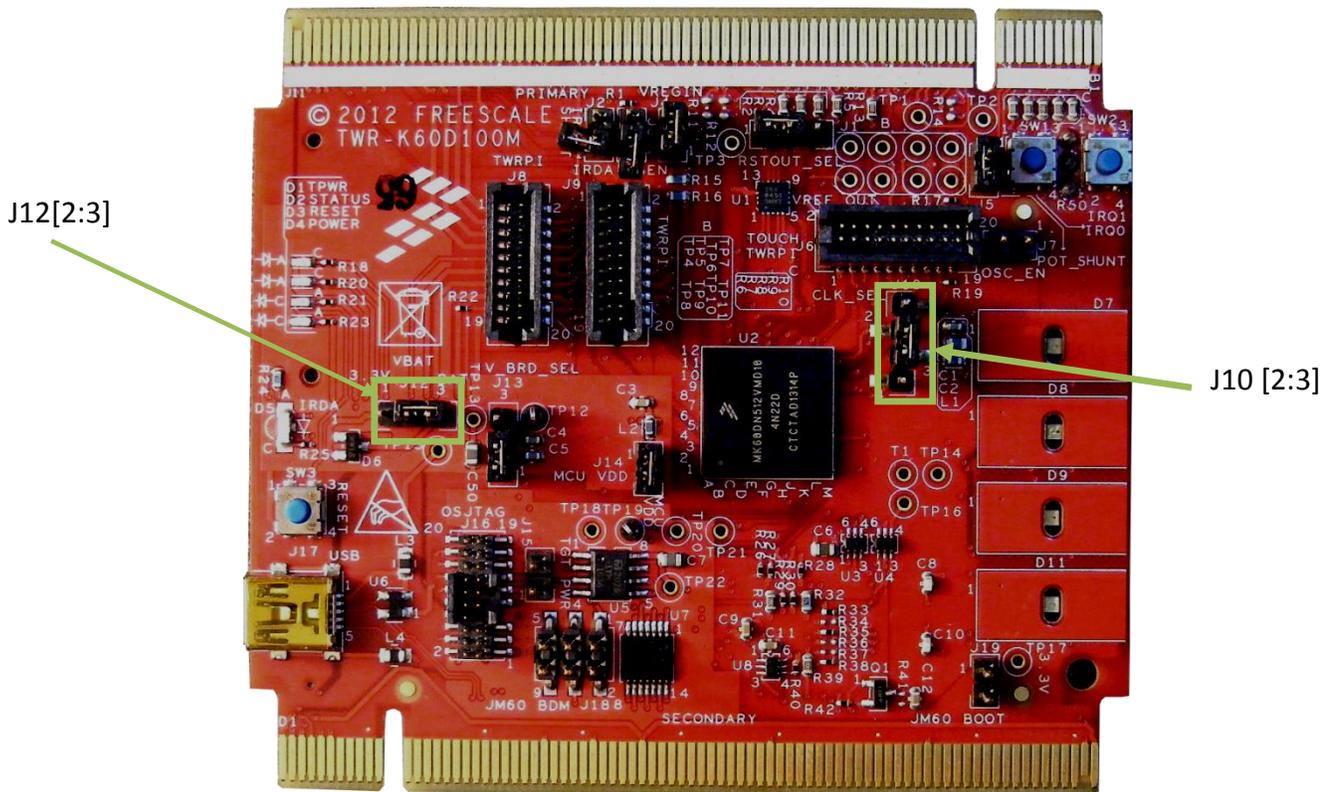
## 4 TWR-K60D100M Setup using IAR

This section describes how to setup the TWR-K60D100M as the Tower MCU module used to run the Demo Suite and interface to the TWR-ADCDAC-LTC.

## 4.1 Hardware Setup

Using the TWR-K60D100M board with the TWR-SER board requires the following jumper modifications to be made:

1. On the TWR-K60D100M board:
  - a. Change jumper **J10** to pins 2-3 to use the 50 MHz clock from the TWR-SER board.
  - b. Change jumper **J12** to pins 2-3 to connect VBAT to the higher voltage between on-board 3.3 V supply or coin-cell supply.



**Figure 4.** TWR-K60D100M module J10 & J12 jumper settings

The remaining jumpers should be placed in their default locations as described in its User's Manual. Below is a summary of the required TWR-K60D100M jumper settings for use with this project. Review the following table and ensure that the jumpers are populated appropriately.

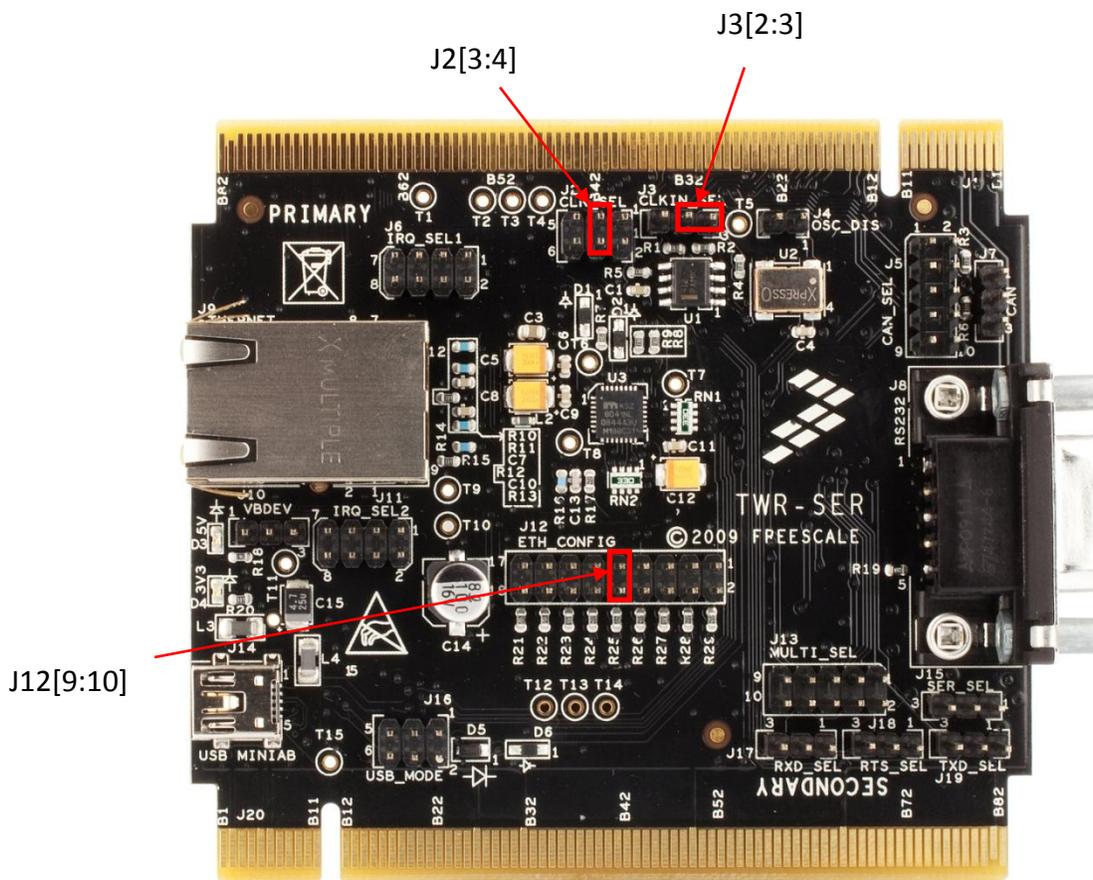
**Table 2.** TWR-K60D100M Jumper Settings

Jumper	Option	Setting	Description
J4	USB VREGIN Power Connection	ON	Connect USB0_VBUS from Primary Elevator (A57) to VREGIN
J2	Infrared Transmitter Connection	OFF (no jumper)	Disconnect PTD7/CMT_IRO/UART0_TX from IR Transmitter (D3)
J10	Clock Input Source Selection	2-3	Use 50 MHz external oscillator on TWR-SER board

J14	MCU Power Connection	ON	Connect on-board 3.3V supply to MCU
J12	VBAT Power Selection	2-3	Connect VBAT to the higher voltage to the coin-cell supply
J19	OSJTAG Mode Selection	OFF (no jumper)	Debugger Mode
J15	JTAG Power Connection	OFF (no jumper)	Disconnect on-board 5V supply from JTAG port

2. On the TWR-SER board:

- a. Change jumper **J2** to pins 3-4 to provide a 50 MHz clock to the Ethernet PHY module
- b. Add jumper to **J3** pins 2-3 to bring up the 50 MHz clock from the TWR-SER board
- c. Add jumper to **J12** pins 9-10 to configure the Ethernet PHY module for RMII mode



**Figure 5.** TWR-SER Jumper settings for J2, J3, J12

The remaining jumpers should be placed in their default locations as described in its User's Manual. Below is a summary of the required TWR-SER jumper settings for use with this project. Review the following table and ensure that the jumpers are populated appropriately.

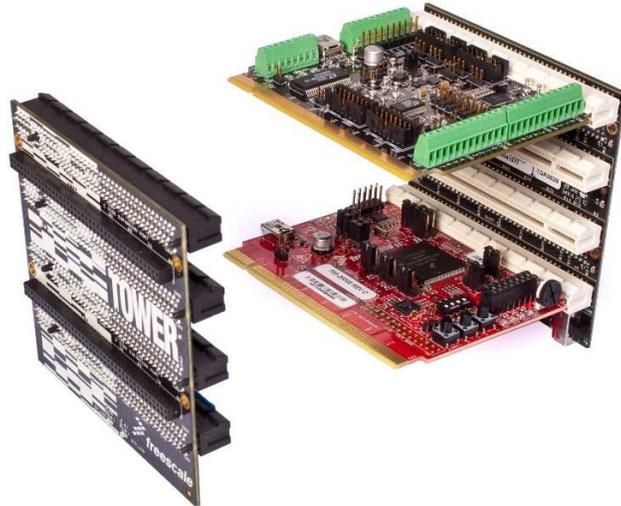
**Table 3.** TWR-SER Jumper Settings for use with TWR-K60D100M

Jumper	Option	Setting	Description
J2	Ethernet PHY Clock Select	3-4	50 MHz
J3	CLOCKIN0 Driver Select	2-3	Route 50 MHz clock to CLOCKIN0
J5	CAN Selection Options	1-2	Put CAN transceiver into sleep mode
		3-4	Connect Sleep pin to CAN pin (B43)
		5-6	Connect RXD pin to CANRX pin (B41)
		7-8	Connect TXD pin to CANTX pin (B42)
		9-10	Apply 120-ohm termination resistor
J6	Ethernet PHY Interrupt Select	Open (no jumpers)	No PHY interrupts selected
J7	CAN Transceiver Input	Open (no jumpers)	
J10	USB VBUS Select	1-2	Supply 5 V on USB Connector (Host Mode)
J11	USB OTG Interrupt Select	Open (no jumpers)	No USB OTG interrupts selected
J12	Ethernet PHY Configuration	9-10 All other pins open (no jumpers)	Pull-up CONFIG0; RMII Select
J13	Misc RS232/485 Config	Open (no jumpers)	
J15	RS232 / RS485 Select	1-2	RS232
J16	USB Mode Select	1-2	Host Mode – supply 5 V to VBUS
J17	RS232 / RS485 RX Select	1-2	RS232
J18	RS232 / RS285 RTS Select	Open (no jumpers)	
J19	RS232 / RS285 TX Select	1-2	RS232

Assemble the Tower system consisting of the TWR-K60D100M, TWR-SER and TWR-ADCDAC-LTC. Be careful to match the Primary edge of each module to the Primary (or Functional on older systems) TWR-ELEV module.

Make the following connections from the Tower System to the development computer:

- 1) USB cable between the computer and the TWR-K60D100M module power/debug USB connector.
- 2) USB cable between the computer (or, optionally, a wall-adaptor power supply) and the USB connector on the TWR-ADCDAC-LTC.
- 3) Serial cable from the computer to the DB9 on the TWR-SER (optional, serial cable not included).
- 4) Ethernet cable between the TWR-SER and Ethernet port on computer.

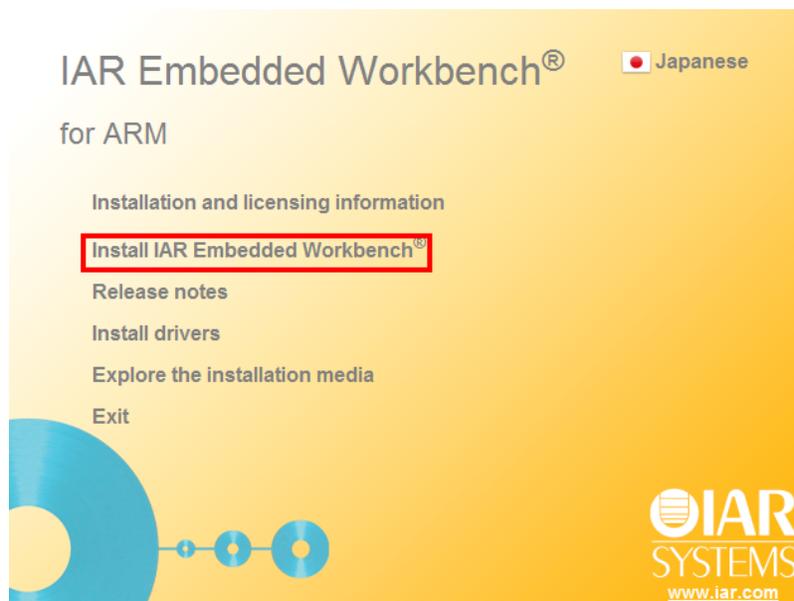


**Figure 6.** TWR-ADCDAC-LTC + Tower MCU Assembly (TWR-SER not pictured)

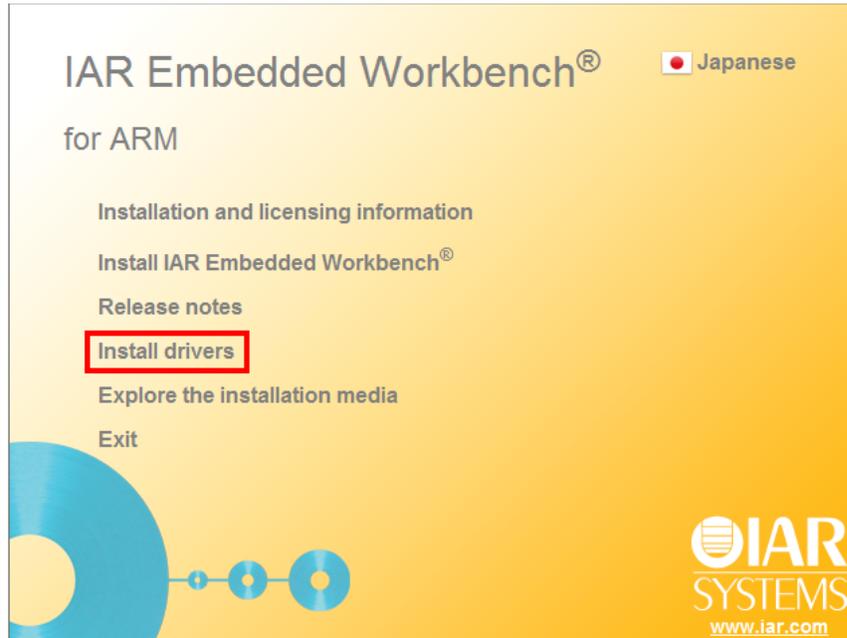
## 4.2 IAR Embedded Workbench IDE for ARM v6.60

This section provides a walkthrough for setting up the TWR-ADCDAC-LTC Demo Suite using IAR Embedded Workbench IDE for ARM v6.60

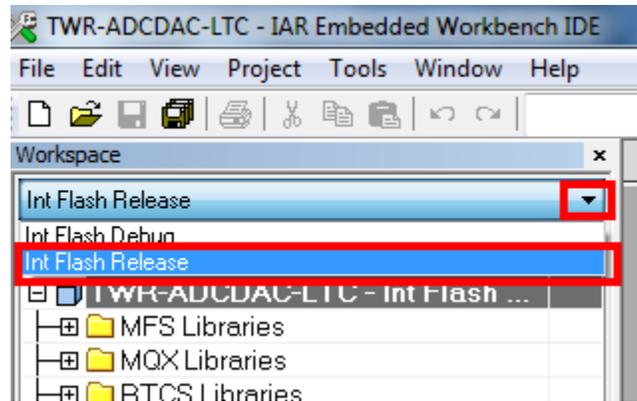
- 5 Install IAR Embedded Workbench IDE (latest version is 6.60 at the time of this writing):
  - a. Install IAR Embedded Workbench IDE for ARM (need v.6.10.2.x or higher) – <http://www.iar.com/> (see figure below)



- b. Install drivers for PEmicro (see figure below)

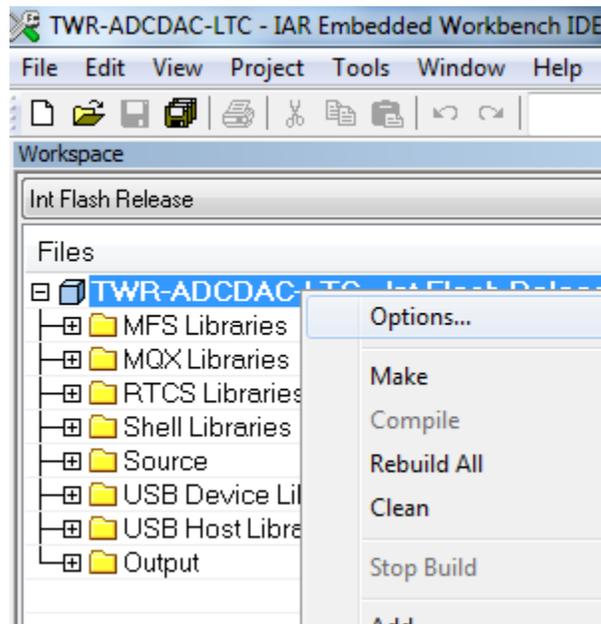


2. Install MQX RTOS version 4.0.2 –  
[http://www.freescale.com/webapp/sps/site/homepage.jsp?code=MQX\\_HOME](http://www.freescale.com/webapp/sps/site/homepage.jsp?code=MQX_HOME)  
**NOTE:** If you are running Windows Vista or Windows 7, it is recommended that you install MQX outside of the default C:\Program Files\ directory. Windows UAC prevents writes to that directory if you are not running as administrator. Regardless of where MQX is installed, ensure that you have read and write access to the parent MQX folder and all of its subdirectories.  
Restart the system after installation.
3. Unzip the attached TWR-ADCDAC-LTC Demo Suite.zip and copy twradcdactlc\_demosuite\_v2.0 folder into the **<MQX Installation Directory>\demo** folder (<MQX installation directory> is C:\Program Files\Freescale\Freescale MQX x.x by default).
4. Open IAR Embedded Workbench IDE for ARM.
5. Open **TWR-ADCDAC-LTC.eww**: Select the menu File-> Open Workspace... and navigate to the twradcdactlc\_demosuite\_v2.0 folder which was copied earlier in step 3. Now select **iar**. Select **TWR-ADCDAC-LTC.eww**.
  - a. In the Workspace navigation pane at the left, ensure **Int Flash Release** is selected in the Workspace drop-down menu (see figure below).

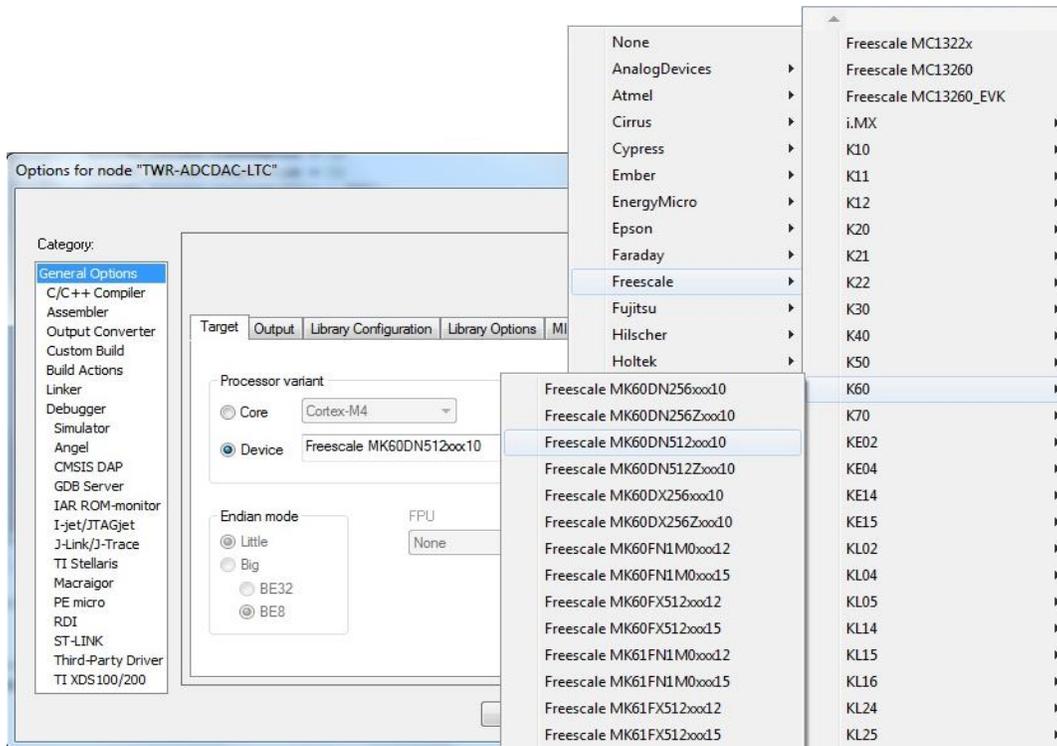


b. To ensure proper project settings:

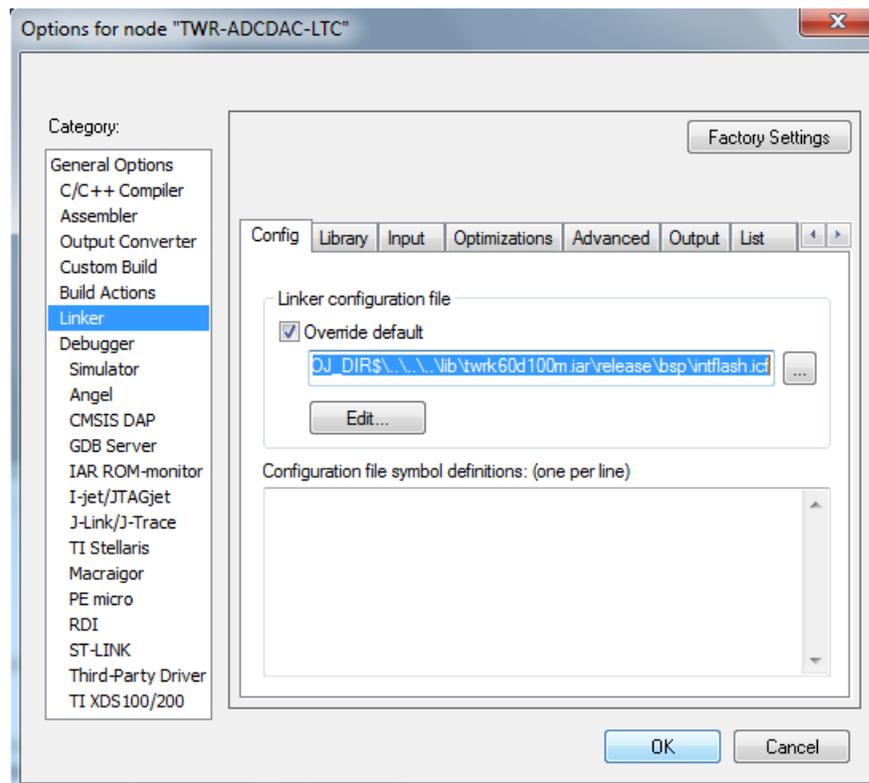
- Right click on workspace TWR-ADCDAC-LTC in the left project navigation area and then click on Options (see figure below):



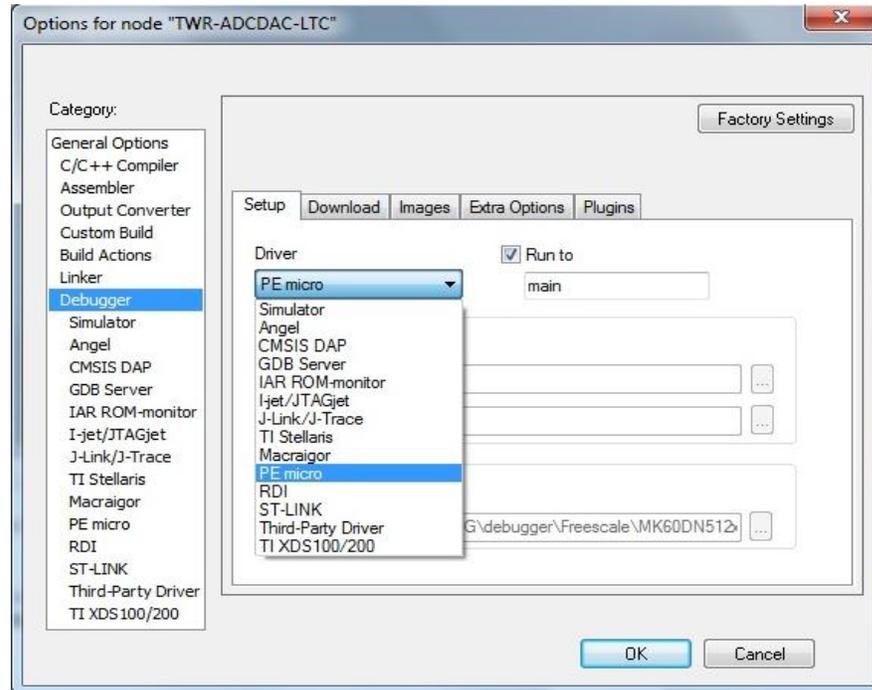
- To select the proper device, click on General Options category in the left column--> click on Target tab --> select Device(radio button) --> browse to select the device "Freescale MK60DN512xxx10" (see figure below)



- Again, in the left column, Category, click on Linker; under the Config tab, make sure the Override default option is checked and ensure that the value for Override default file is \$PROJ\_DIR\$\\..\\..\\lib\\twrk60d100m.iar\\release\\bsp\\intflash.icf (see figure below)

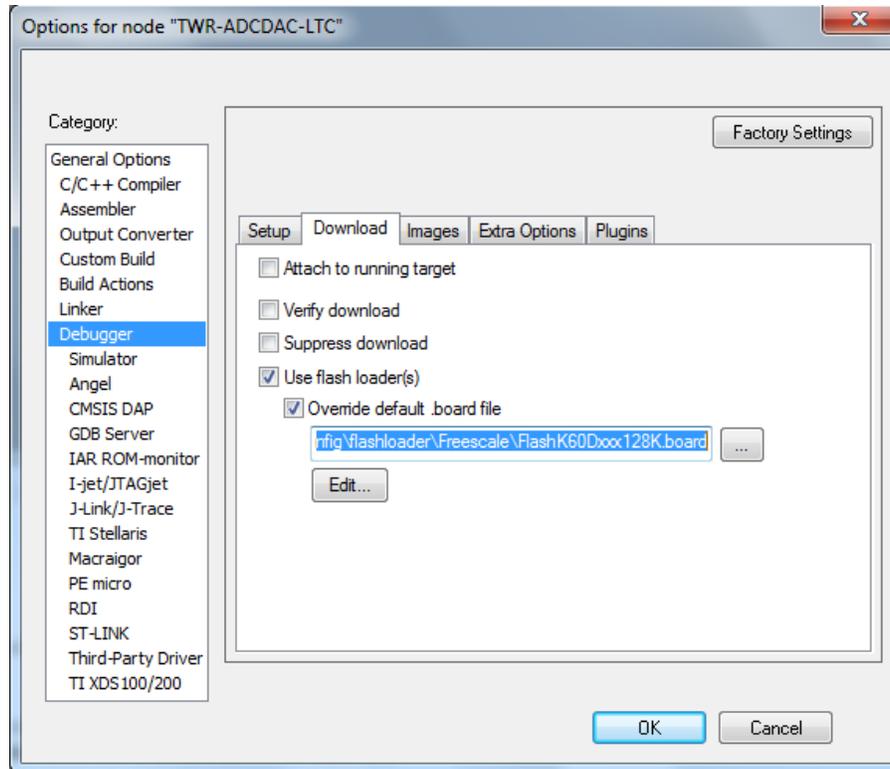


- Click on **Debugger** category and under the **Setup** tab, make sure **Driver** is **PE\_micro**: (see figure below)

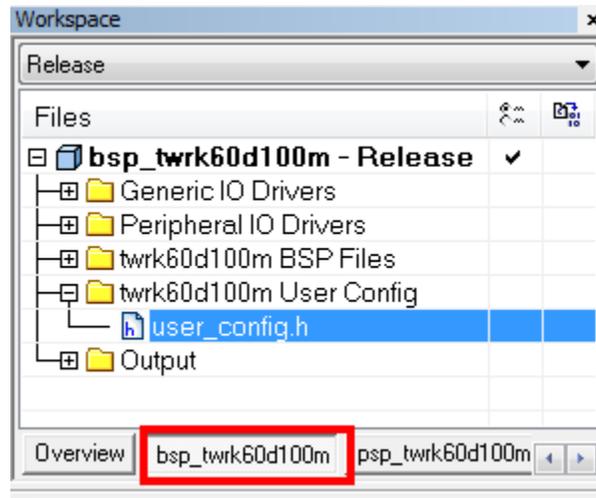


Still in the **Debugger** category, select the **Download** tab, and make sure the **Use Flash Loader(s)** and **Override default .board file** options are checked. Ensure that the value for **Override default .board file** is

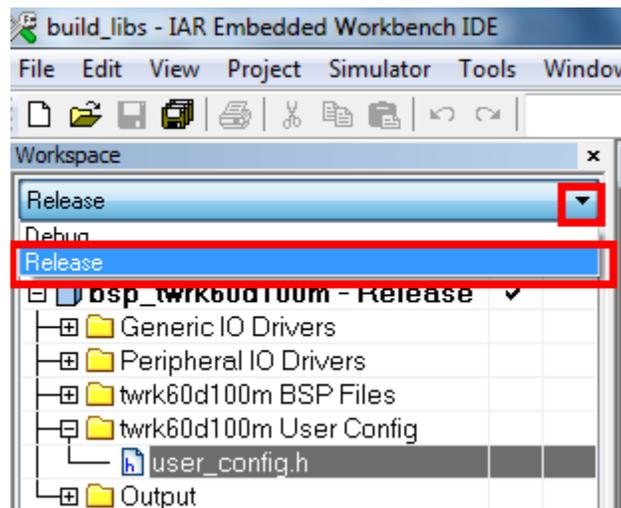
\$TOOLKIT\_DIR\$\config\flashloader\Freescale\FlashK60Dxxx128K.board (see figure below)



- Click **OK** to exit the Project Options dialog box.
- c. Save workspace from “File Menu -> Save Workspace”.
6. The source code is provided with pre-built binary. However, if you are flashing the TWR-K60D100M board for the first time after MQX installation, a modification needs to be made to the prebuilt TWR-K60D100M MQX BSP—a timer used by the TWR-ADCDAC-LTC Demo Suite which is OFF by default. Also, the SPI2 module needs to be enabled. We need to make changes in the configuration file and rebuild the MQX libraries:
- a. Select File->Open Workspace
  - b. Navigate to the **<MQX Installation Directory>\config\ twrk60d100m \iar** directory.
  - c. Open **build\_libs.eww**. This step will close the TWR-ADCDAC-LTC .eww workspace.
  - d. At the bottom of the Workspace navigation pane, see below, click the button **bsp\_twrk60d100m**:



- e. In the Workspace navigation pane at the left, select **Release** from the Workspace drop-down menu:



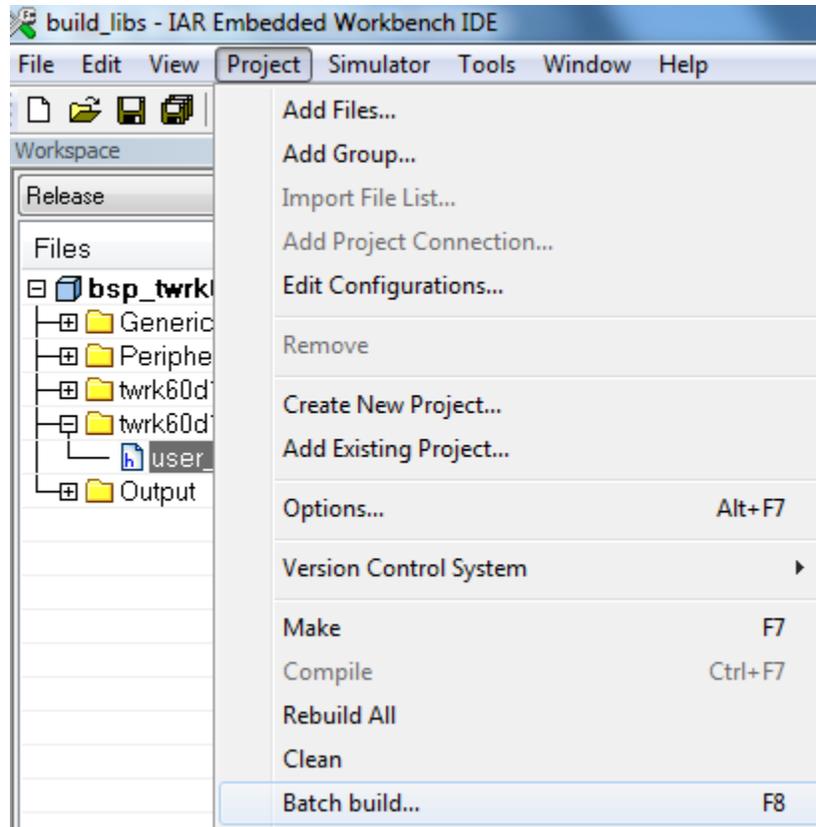
- f. In the Workspace navigation pane at the left, find the folder labeled **twrk60d100m User Config** then double-click the file **user\_config.h** to open it.
- g. In **user\_config.h**, ensure that **MQX\_USE\_TIMER** is defined as follows (change the define from a "0" to a "1" or add this line if needed):

```
#define MQX_USE_TIMER          1
```

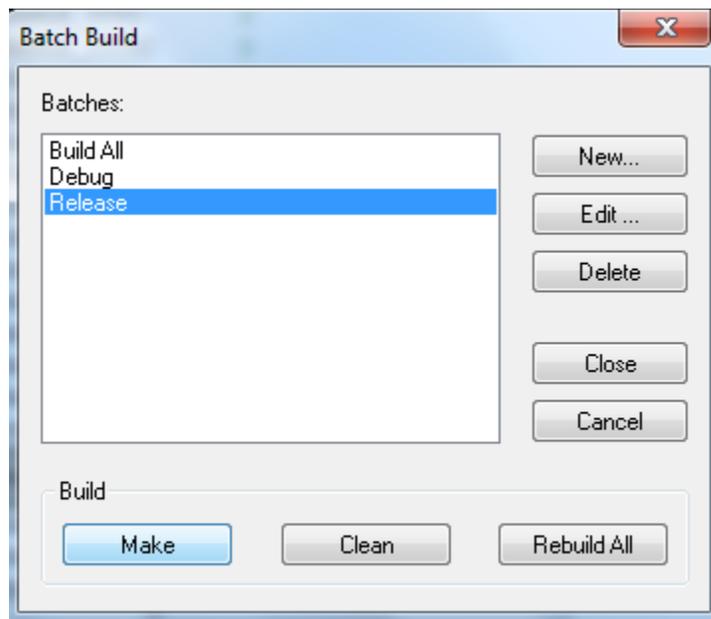
- h. Ensure that the SPI2 modules are enabled by modifying the following defines in the **user\_config.h** file so that they are set to 1. If these defines are not present in **user\_config.h**, then add them:

```
#define BSPCFG_ENABLE_SPI2    1
#define BSPCFG_ENABLE_ISPI2  1
```

- i. Batch build mqx libraries:
  - o Under Project menu click Batch build.

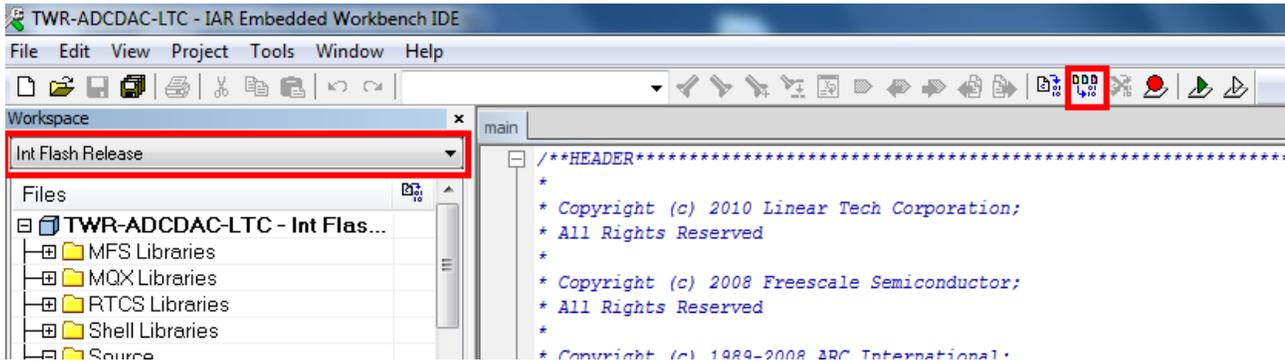


- In Batch Build dialog box, select Release and click Make button.



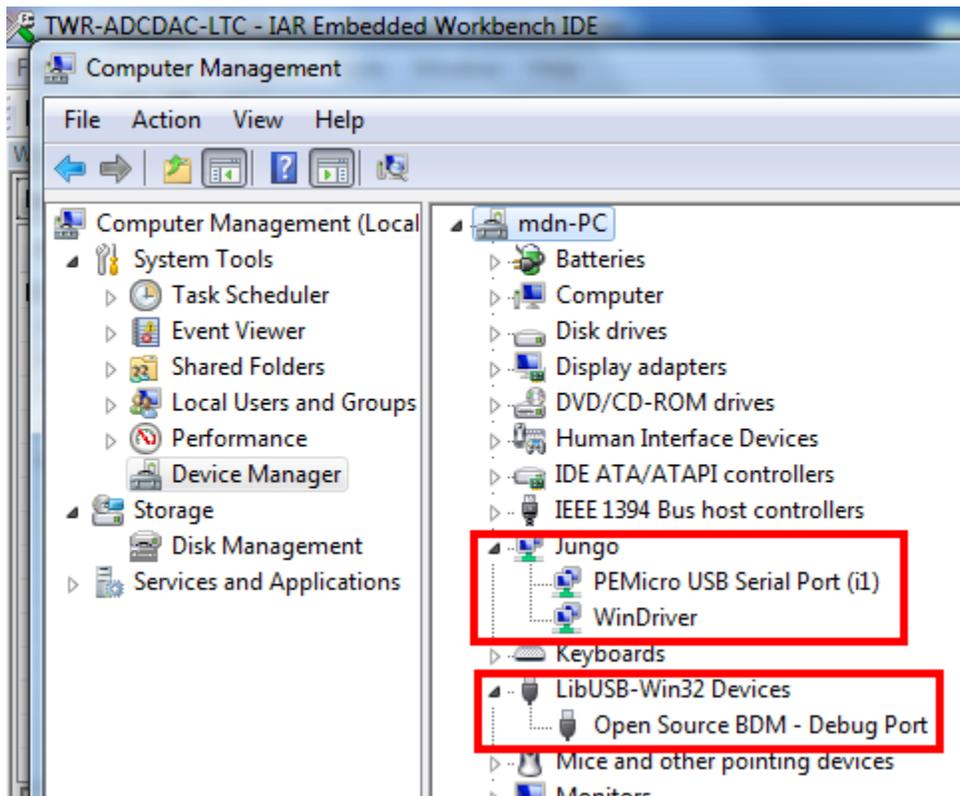
This step will take several minutes to build bsp\_twr60d100m, psp\_twr60d100m, rtc\_s\_twr60d100m, usbd\_twr60d100m, usbh\_twr100m libraries successively one after another. No errors should appear after the Make operation. You may ignore any warnings.

- o Close the `build_libs.eww` workspace.
- j. Re-open the `TWR-ADCDAC-LTC.eww` workspace. Make sure **Int Flash Release** is selected from the Workspace drop-down menu and click the **Make** icon , as shown below:



No errors should appear after the Make operation. You may ignore any warnings.

7. Connect a USB cable between your development computer and the TWR-K60D100M PWR/OSBDM USB connector.  
Wait till windows finish installing drivers for Open source BDM- Debug Port and PE Micro USB Serial Port. Now you should be able to see drivers name listed in windows device manager as shown below.



8. Program the flash by clicking the Download and Debug button . Alternatively, you may select Project->Download and Debug from the menu. The internal flash of the K60DN512 MCU on the TWR-K60D100M is now programmed with the Demo Suite software. IAR Embedded Workbench IDE can now be closed unless you wish to step through the software.

## 5 Running the Demos

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The TWR-ADCDAC-LTC uses an embedded web server to provide a graphical user interface with controls for the ADCs and DACs. This section describes how to connect to the embedded web server and demonstrate the analog interfaces.

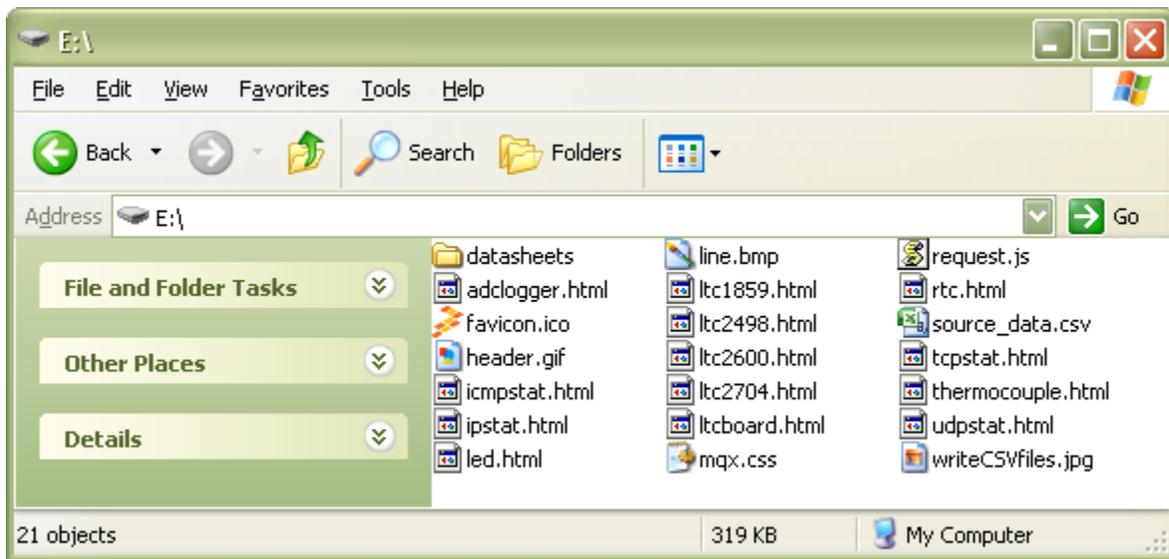
### 5.1 Connecting to the Web Server

Follow these steps to run the embedded web server and connect to it using a web browser:

1. Assemble and connect the computer to the Tower System as explained below:
  - a. Connect a USB cable between the computer and the TWR-K60D100M power/debug USB connector.
  - b. Connect a USB cable between the computer (or optionally, a wall-adaptor power supply) and the USB connector on the TWR-ADCDAC-LTC.
  - c. Ethernet cable between the TWR-SER and Ethernet port on the computer.
  - d. Ensure that the power indicator LEDs are lit on all the modules including the GREEN LED on the TWR-ADCDAC-LTC.
- 5 The default IP address of the Tower System is 192.168.0.3 (set in config.h in the twradcdac\_ltc\_demosuite\_v2.0). Typically, when you connect your computer directly to the Tower, the computer will default to an auto IP address on the same subnet as the Tower (192.168.x.x), therefore requiring no setup to the internet connection settings on the computer. Note, the computer may take a few minutes to default to the auto IP address and may report “Limited or No Connectivity”. Alternatively, you may configure the IP address of the computer manually to be 192.168.0.4 with a subnet mask of 255.255.255.0. See the Troubleshooting section below if there is an issue connecting to the embedded web server.
3. Program the Tower MCU module as described in the earlier section.
4. Press the RESET button on the Tower MCU module or power cycle the board by removing and re-applying the USB cable to the Tower MCU Module.
5. Start your internet browser. Disable any proxy settings and navigate to the target device address: 192.168.0.3.
6. You should see “**Freescale MQX Web Server**” home page in the browser window.

Websaver Home	 <h2 style="margin: 0;">Freescale MQX™ Web Server</h2> <p style="font-size: small; color: #4F81BD;">The MQX Real-time Operating System provides real-time performance within a small, configurable footprint. The MQX RTOS is designed to allow you to configure and balance code size with performance requirements. The easy-to-use MQX API and out-of-box experience ensures first-time RTOS users can start developing their application on the day you install the software but is powerful enough for experienced OS developers easily migrate legacy application code to an MQX-based platform.</p>
Network Status...	
System Run Time (RTC)	
LED Control	
LTC Mixed Signal Board...	
ADC Datalogger Config	
Thermocouple Reader	

7. Copy all the files of the “usb\_pages” directory of the twradcdactc\_demosuite\_v2.0 to a USB stick. The files should be in the root directory of the removable disk as shown in the figure below.



8. Insert the USB stick into the TWR-SER module using the provided mini-B adapter.
9. Reload the Web server home page by pressing F5 in the browser window. You should see the “LTC Mixed Signal Board” option in the menu on the left of the screen.

Websaver Home	 <h2 style="margin: 0;">Freescale MQX™ Web Server</h2> <p style="font-size: small; color: #4F81BD;">The MQX Real-time Operating System provides real-time performance within a small, configurable footprint. The MQX RTOS is designed to allow you to configure and balance code size with performance requirements. The easy-to-use MQX API and out-of-box experience ensures first-time RTOS users can start developing their application on the day you install the software but is powerful enough for experienced OS developers easily migrate legacy application code to an MQX-based platform.</p>
Network Status...	
System Run Time (RTC)	
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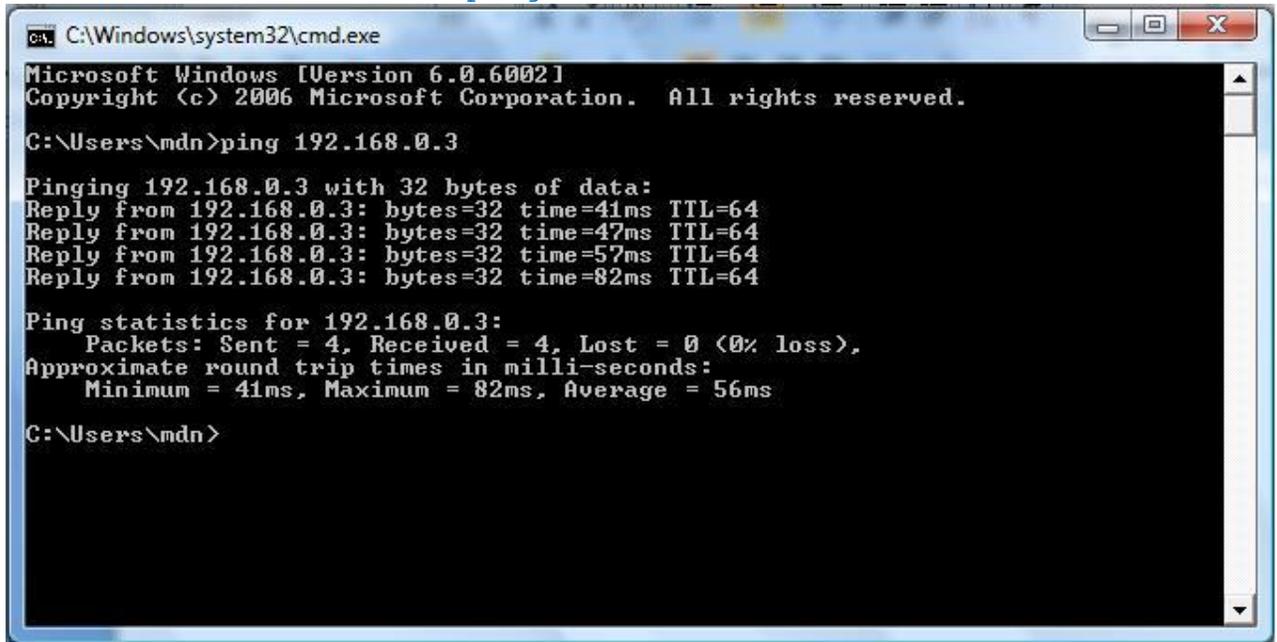
### 5.1.1 Troubleshooting the Web Server

If you are unable to communicate from a computer to the embedded web server of the Tower System, try the following:

1. Ensure the Tower system is assembled correctly. Each tower module has a primary and secondary card edge connector. The primary side must be connected to the Primary (or Functional in older systems) Elevator.
2. Ensure that the computer's internet connection is properly configured and able to connect to the web server. In a command window, try the ipconfig and ping commands to test the communication with the Tower System.

Example: Launch "Command" terminal by clicking Start Menu -> Start Search. In Start Search Box enter text "cmd"

In "Command" terminal enter text "ping 192.168.0.3" as shown below



```
C:\Windows\system32\cmd.exe
Microsoft Windows [Version 6.0.6002]
Copyright (c) 2006 Microsoft Corporation. All rights reserved.

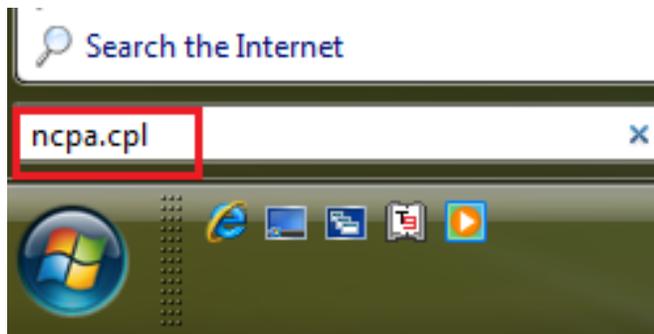
C:\Users\mdn>ping 192.168.0.3

Pinging 192.168.0.3 with 32 bytes of data:
Reply from 192.168.0.3: bytes=32 time=41ms TTL=64
Reply from 192.168.0.3: bytes=32 time=47ms TTL=64
Reply from 192.168.0.3: bytes=32 time=57ms TTL=64
Reply from 192.168.0.3: bytes=32 time=82ms TTL=64

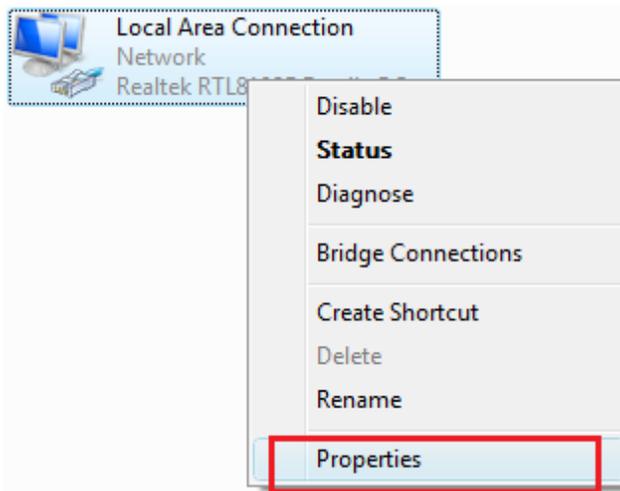
Ping statistics for 192.168.0.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 41ms, Maximum = 82ms, Average = 56ms

C:\Users\mdn>
```

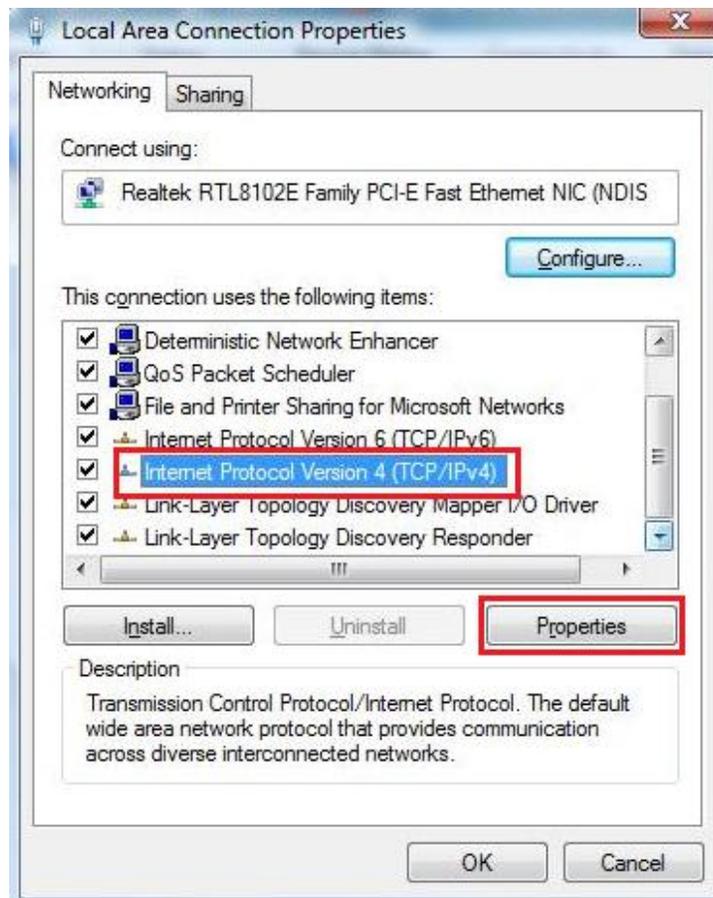
3. Ensure any proxy settings in your browser are turned off.
4. Turn off any other network connections (real and virtual).
5. Configure the laptop network adaptor:
  - a. Type ncpa.cpl in the Windows search field. Press Enter.



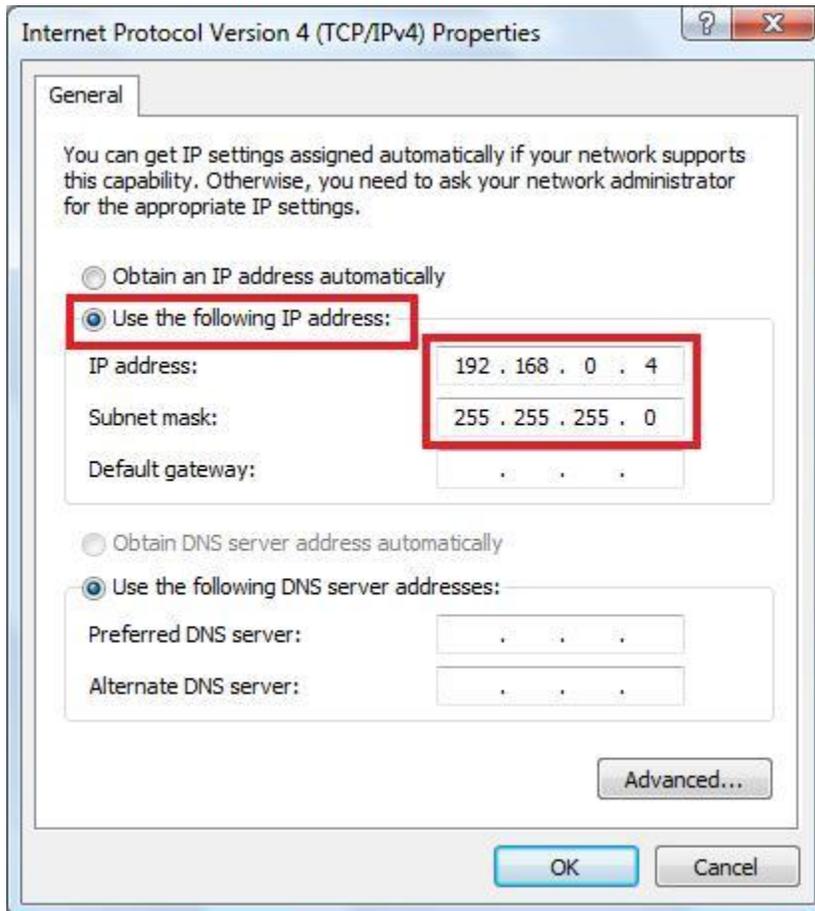
- b. Select the appropriate Ethernet adaptor. Right click and select Properties.



c. Select Internet Protocol Version 4. Press Properties.



- d. Setup the IP address as shown below. Press OK.



- e. The PC IP should be 192.168.0.4

**NOTE:** It is recommended to use Internet Explorer browser. If using any other browser, the cache should be cleared.

## 5.2 LTC Configuration Pages

At the left side of the web server home page, click "**LTC Mixed Signal Board**" link. A configuration page for each of the four Linear Technologies analog converter chips can be found on the left pane of the web page under the "Configuration Pages" link. These pages provide a convenient way to change the operational settings of the converter chips and the ability to perform simple input/output operations to set values on the DACs or read values from the ADCs. Links to the datasheet for the device are provided on each of their respective configuration pages.

Webserver Home	 	
Network Status...		
System Run Time (RTC)		
LED Control		
<u>Configuration Pages</u>	LTC2600 DAC	elopment Board integrates seamlessly into Freescale's Tower Platform, giving immediate access to four of LTC's top-selling ADCs and DACs. With the on-board embedded developers can interface with any number of LTC's Demo Boards for experiment purposes.
ADC Datalogger Config	LTC2704 DAC	
Thermocouple Reader	LTC2498 ADC	
	LTC1859 ADC	

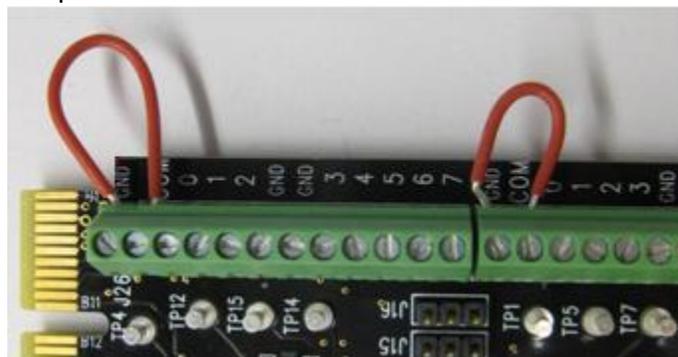
**NOTE:** When using the TWR-K60D100M board, you may notice that when clicking the “Set / Read” or “Set / Write” buttons on the LTC2704 DAC and LTC2498 ADC Configuration Pages, the network connection will drop momentarily and then be restored after a few seconds. This will happen because of a hardware issue of the TWR-K60D100M boards that affects web server functionality while communicating with the LTC2704 DAC and LTC2498 ADC analog converter chips. The software accommodates for this issue by waiting until after the command to the LTC2704 DAC and/or LTC2498 ADC chip has completed, resetting the Ethernet transceiver and then sending updated data to the web page.

### 5.3 DAC to ADC Loopback

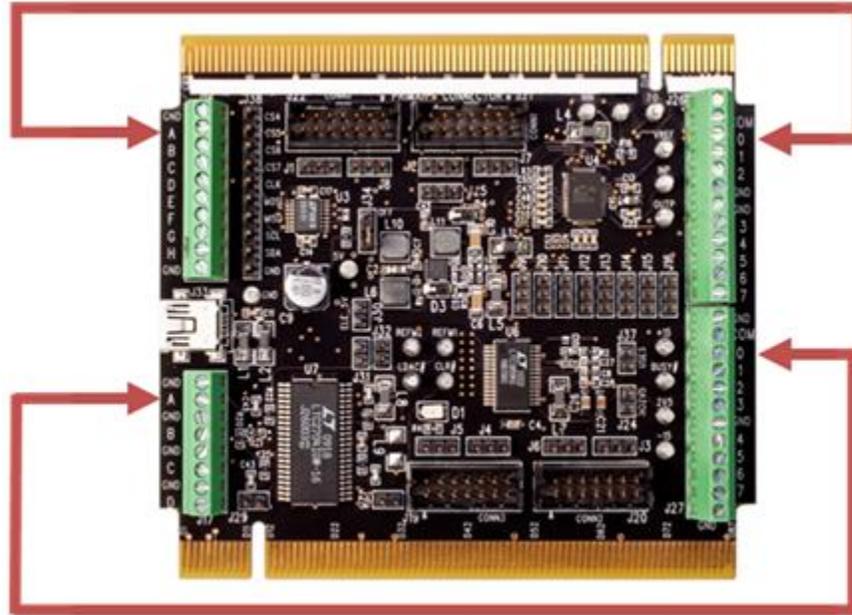
The steps below describe how to setup the TWR-ADCDAC-LTC for a simple loopback from a DAC output to an ADC input.

**NOTE:** Take care to connect only from the LTC2600 to the LTC2498 and from the LTC2704 to the LTC1859.

1. Short the common (COM) pin input to the GND terminal for both the LTC2498 and the LTC185 as shown in the picture below.



2. Connect a wire from channel A of the LTC2600 to channel 0 of the LTC2498
3. Connect a wire from channel A of the LTC2704 to channel 0 of the LTC1859



- In the web browser, go to the LTC2600 configuration page and enter a voltage value (e.g. “1.8”) in the “Value to Write” field. Leave the other settings at their default value as shown below. Click the “Set / Write” button.

Webserver Home	 
Network Status...	
System Run Time (RTC)	
LED Control	
Configuration Pages	
ADC Datalogger Config	
Thermocouple Reader	

### LTC 2600 Configuration Page

This is the page to configure the LTC 2600 8-channel 16-bit Rail-to-Rail Digital to Analog Converter  
 Datasheet: [LTC2600 - 8ch 16bit Rail2Rail DAC](#)

Value to Write:       Vref:       Channel Setting:

Command Setting:

- Write Channel N
- Update Channel N
- Write and Update All
- Write and Update N
- Power Down N
- No Operation

Value to Send:

- Switch to the LTC2498 configuration page. Select “Single-Ended 0” in the “Channel Setting:” drop down box and click the “Set / Read” button. The updated voltage reading will be displayed on the page. Verify that it is approximately the same value set as the output on the DAC.

Webserver Home

Network Status...

System Run Time (RTC)

LED Control

Configuration Pages

ADC Datalogger Config

Thermocouple Reader



## LTC 2498 Configuration Page

This is the page to configure the LTC 2498 8-channel 24-bit Sigma-Delta Analog to Digital Converter

Datasheet: [LTC2498 - 8ch 24bit DeltaSigma ADC](#)

**Channel Setting:**

**Keep Previous Speed and Rejection Setting:**  
 Keep Previous

**External Input - Speed and Rejection Setting:**

- Reject 50/60 Hz, x1 speed
- Reject 50 Hz, x1 speed
- Reject 60 Hz, x1 speed
- Reject 50/60 Hz, x2 speed
- Reject 50 Hz, x2 speed

**Temperature Sensor - Speed and Rejection Setting:**

- Reject 50/60 Hz, x1 speed
- Reject 50 Hz, x1 speed
- Reject 60 Hz, x1 speed

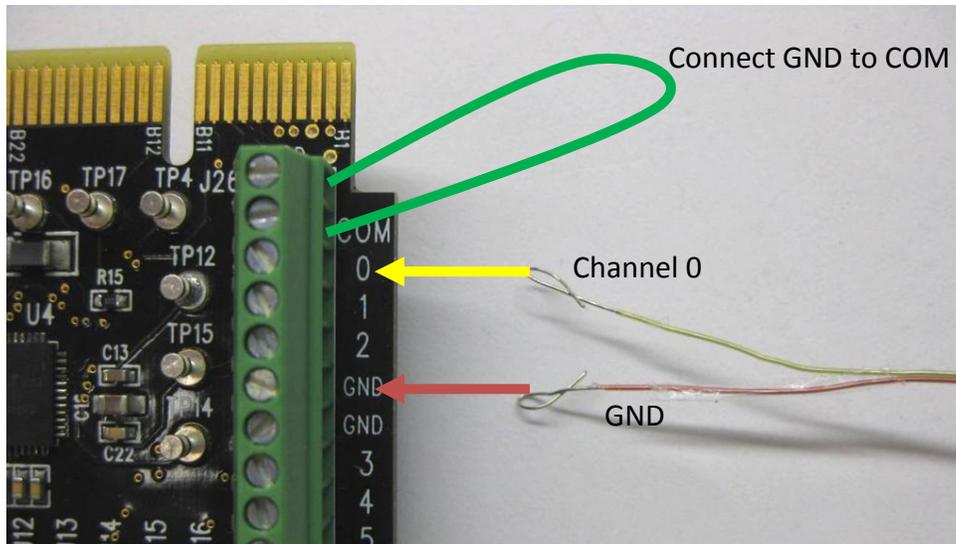
**Reference Voltage (V)**

**LTC 2498 Voltage Reading:**  
 1.79108 Volts

6. Repeat steps 4 and 5 above for the LTC2704 DAC and LTC1859 ADC

## 5.4 Thermocouple

The “Thermocouple Reader” link in the menu on the left pane of the web page provides a utility to use the LTC2498 as a thermocouple reading device. Connect the provided thermocouple wire to the LTC2498 inputs as shown below (yellow wire to Channel 0 and brown wire to GND). A wire should also be connected between COM and GND as shown below. Then, follow the instructions on the “Thermocouple Reader” web page.



**NOTE:** When using the TWR-K60D100M board, you may notice that, when clicking the “Set / Read” button on the Thermocouple Reader page, the network connection will drop momentarily and then be restored after a few seconds. This will happen because of a hardware issue of the TWR-K60D100M boards that affects web server functionality while communicating with the LTC2498 DAC analog converter chip. The software accommodates for this issue by waiting until the command to the LTC2498 DAC chip has been completed, resetting the Ethernet transceiver and then sending the updated data to the web page.

## 5.5 Data Logger and Generator

The “ADC Datalogger Config” link in the menu on the left pane of the web page provides a utility to setup a datalogger using either of the ADCs. Instructions for using the datalogger are provided at the top of the web page.

The samples are stored on the USB stick. Select the required channel of ADC using check box. After the “Set / Read” button is clicked, the screen may go blank for sometime and reloads the page while sampling with the “Datalogger State” on the web page being displayed as “Sampling...”. After the sampling completes, the “Datalogger State” then displays the number of samples taken for sampling.

**Sampling Interval (ms):**

**Number of Samples (per channel):**

**Read from Datafile to DACs:**

 Enabled

**1859 Channel Setting:**

- Differential 0:1
- Differential 2:3
- Differential 4:5
- Differential 6:7
- Differential 1:0
- Differential 3:2
- Differential 5:4
- Differential 7:6
- Single-Ended 0
- Single-Ended 1
- Single-Ended 2
- Single-Ended 3
- Single-Ended 4
- Single-Ended 5
- Single-Ended 6
- Single-Ended 7

**Span Setting:**

- Bipolar [-5V to 5V]
- Bipolar [-10V to 10V]
- Unipolar [0 to 5V]
- Unipolar [0 to 10V]

Set / Read

**Datalogger State:**

20 Samples Taken

**Logfile Name (without .csv suffix):**

**Datafile Name (without .csv suffix):**

**2498 Channel Setting:**

- Differential 0:1
- Differential 2:3
- Differential 4:5
- Differential 6:7
- Differential 1:0
- Differential 3:2
- Differential 5:4
- Differential 7:6
- Single-Ended 0
- Single-Ended 1
- Single-Ended 2
- Single-Ended 3
- Single-Ended 4
- Single-Ended 5
- Single-Ended 6
- Single-Ended 7

**External Input - Speed and Rejection Setting:**

- Reject 50/60 Hz, x1 speed
- Reject 50 Hz, x1 speed
- Reject 60 Hz, x1 speed
- Reject 50/60 Hz, x2 speed
- Reject 50 Hz, x2 speed

**Temperature Sensor - Speed and Rejection S**

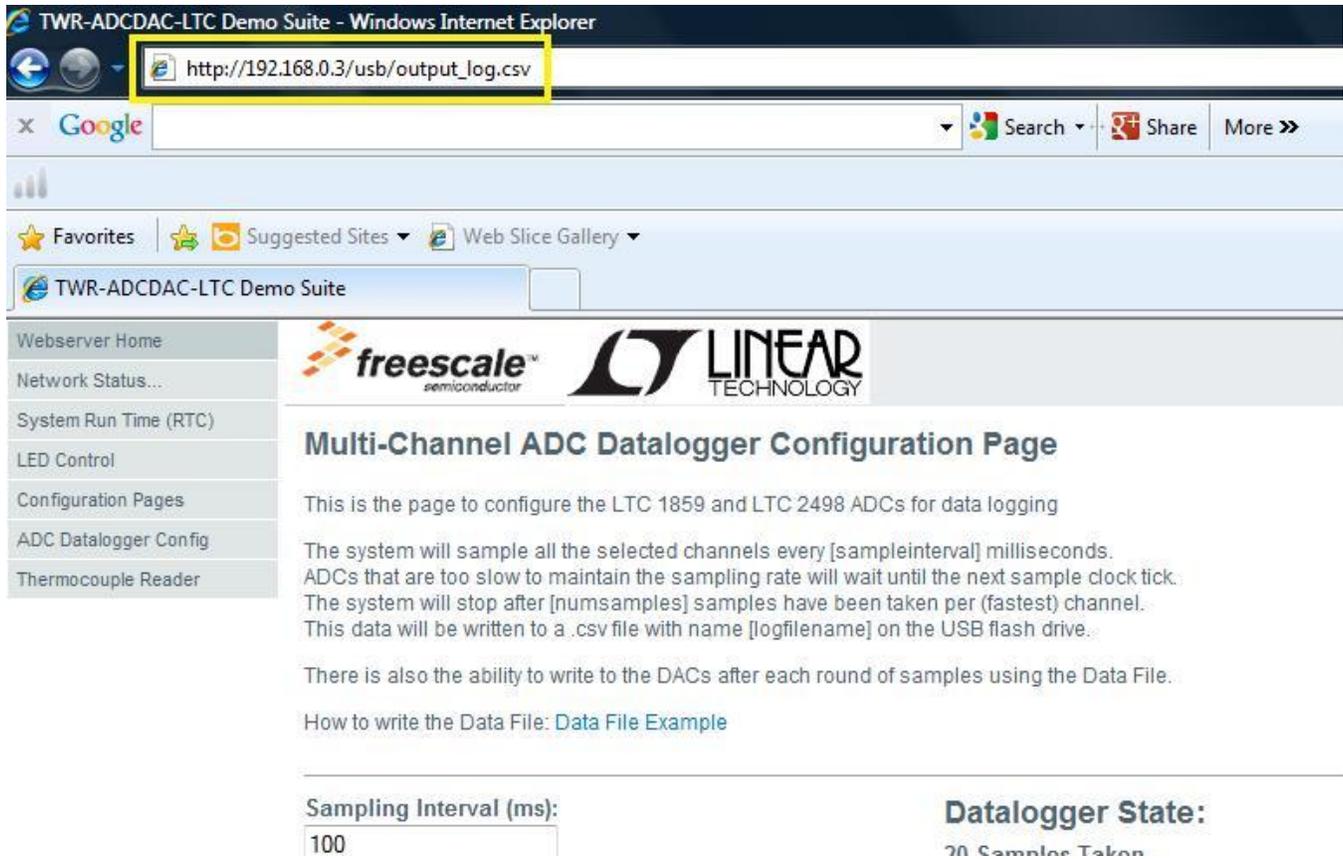
- Reject 50/60 Hz, x1 speed
- Reject 50 Hz, x1 speed

You can access the log file (.csv format) over the internet connection by typing the name of the output log file in the address bar of your browser. For example, if you left the logfile name as the default of "output\_log" in Datalogger configuration page, then you can access the log file by browsing to " [http://192.168.0.3/usb/output\\_log.csv](http://192.168.0.3/usb/output_log.csv) "

Note: Please use Internet Explorer version 9 /Chrome version 31/Firefox version 26 or later. Older versions may not work well.

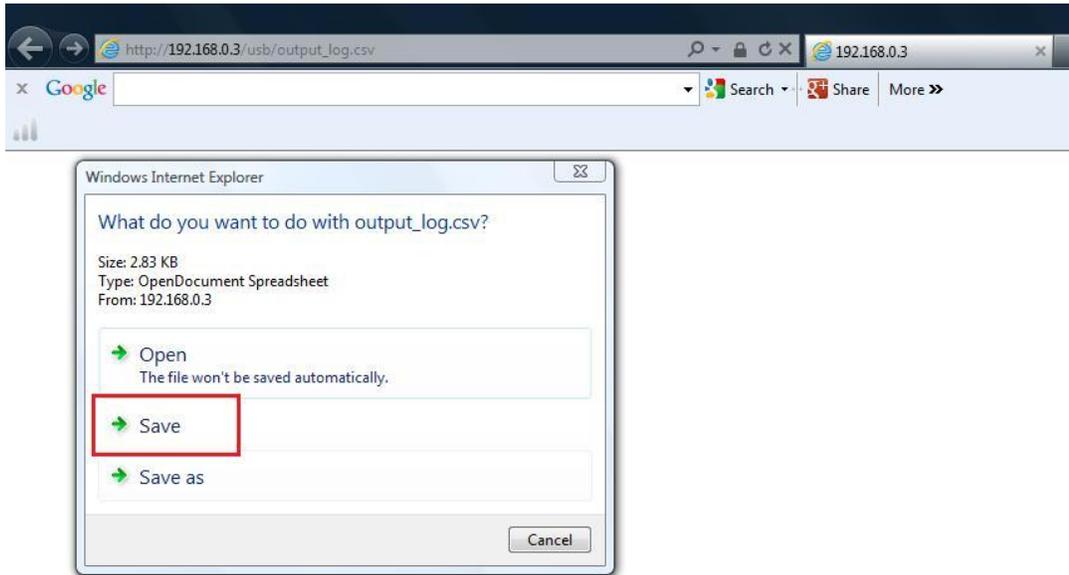
a) To open generated Datalogger file, Open Internet Explorer and enter URL of “.csv” file in Address bar.

Example: “ [http://192.168.0.3/usb/output\\_log.csv](http://192.168.0.3/usb/output_log.csv) ”

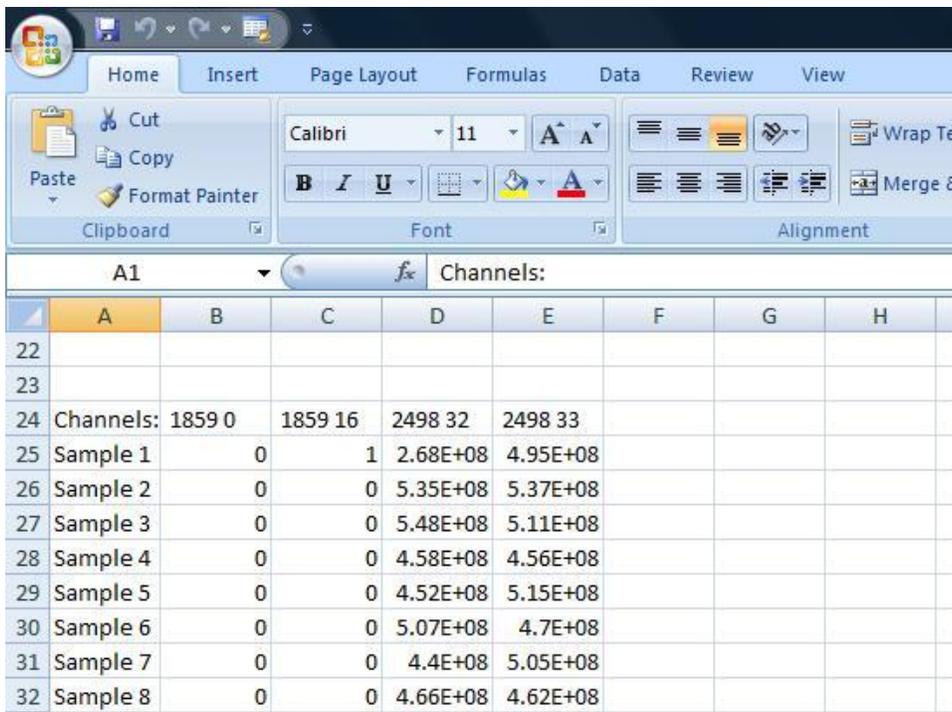


The screenshot shows a Windows Internet Explorer browser window titled "TWR-ADC DAC-LTC Demo Suite - Windows Internet Explorer". The address bar contains the URL [http://192.168.0.3/usb/output\\_log.csv](http://192.168.0.3/usb/output_log.csv). The browser interface includes a search bar with "Google" and "Search" buttons, and a "Share" button. Below the browser window, the page content is visible. On the left is a sidebar with navigation links: "Webserver Home", "Network Status...", "System Run Time (RTC)", "LED Control", "Configuration Pages", "ADC Datalogger Config", and "Thermocouple Reader". The main content area features the Freescale Semiconductor and Linear Technology logos, followed by the heading "Multi-Channel ADC Datalogger Configuration Page". The text below the heading explains the configuration options for the LTC-1859 and LTC-2498 ADCs. At the bottom of the page, there are two configuration fields: "Sampling Interval (ms)" with a value of "100" and "Datalogger State:" with a value of "20 Samples Taken".

b) Click on “Save” button when browser prompts to save the file.



c) Now open downloaded csv file using Microsoft Excel.



**NOTE:** When using the TWR-K60D100M boards in this lab, you may notice that, when clicking the “Set / Read” button on the ADC Datalogger Config page, the network connection will drop momentarily and then be restored after a few seconds. This will happen because of a hardware issue of the TWR-K60D100M boards that affects web server functionality while communicating with the LTC2704 DAC and LTC2498 ADC analog converter chips. This issue prevents the web page from dynamically updating the “Datalogger State” on the web page after the “Set / Read” button is clicked. The software accommodates for this issue by waiting for the datalogging to complete, resetting the Ethernet transceiver and then sending the updated data to the web page. If the value that you specify in the “Number of samples” field is high enough, the web page refresh may time out before the datalogging of samples has completed. If this occurs, you will need to manually refresh the web page.

## 5.6 Real Time Clock

The “System Run Time (RTC)” link in the menu on the left pane of the web page provides a utility to display the real time clock. Ensure the coin cell battery is installed on the bottom side of the TWR-K60D100M module to enable to RTC to retain the set time.



Webserver Home		<b>Real Time Clock (RTC Demo)</b>	
Network Status...		8	PM
System Run Time (RTC)		35	Minutes
LED Control		26	Seconds
Configuration Pages			
ADC Datalogger Config			
Thermocouple Reader			

To synchronize RTC time with the system time, click on “RTC sync” button and reboot the tower. After rebooting the tower, the current system time will be displayed on the web page.